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Tracing interactions in the indigenous Caribbean through a biographical approach: Microwear and material culture across the historical divide (AD 1200-1600)

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Citation
Breukel, T. W. (2019, April 18). *Tracing interactions in the indigenous Caribbean through a biographical approach: Microwear and material culture across the historical divide (AD 1200-1600)*. Retrieved from https://hdl.handle.net/1887/71555

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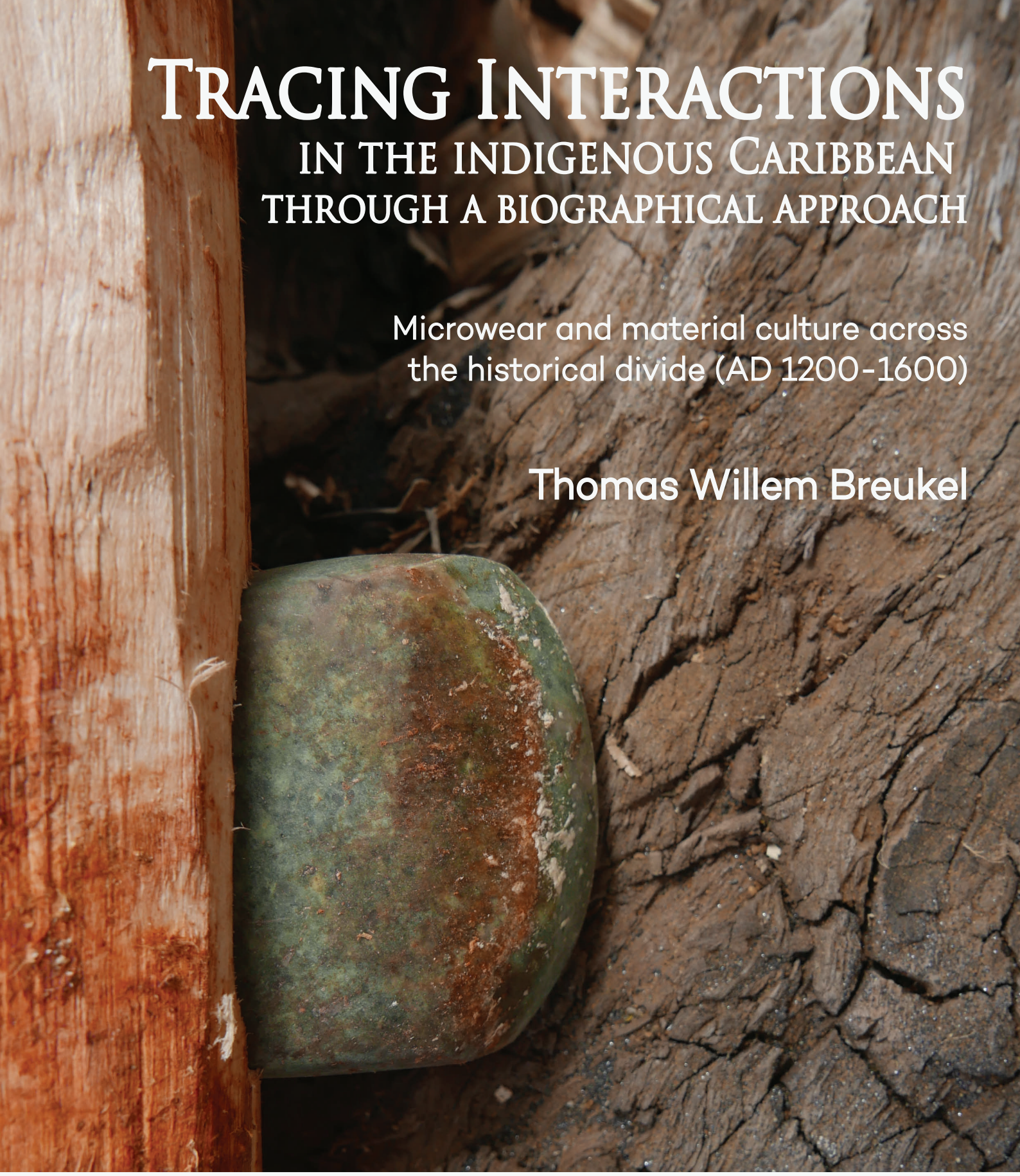
Author: Breukel, T.W.
Title: Tracing interactions in the indigenous Caribbean through a biographical approach: Microwear and material culture across the historical divide (AD 1200-1600)
Issue Date: 2019-04-18

Tracing Interactions
in the Indigenous Caribbean through a biographical approach

Microwear and material culture across the historical divide (AD 1200-1600)

Thomas Willem Breukel



TRACING INTERACTIONS IN THE INDIGENOUS CARIBBEAN THROUGH A BIOGRAPHICAL APPROACH

Microwear and material culture across
the historical divide (AD 1200-1600)

Proefschrift

ter verkrijging van
de graad van Doctor aan de Universiteit Leiden,
op gezag van de Rector Magnificus prof. mr. C.J.J.M. Stolker,
volgens besluit van het College voor Promoties
te verdedigen op donderdag 18 April 2019
klokke 13:45 uur

Door

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geboren te Noordoostpolder, Nederland
in 1989

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De totstandkoming van dit proefschrift werd financieel mogelijk gemaakt
door de Nederlandse Organisatie voor Wetenschappelijk Onderzoek (NWO)
Open Competition grant 360−62−060.

Dit proefschrift volgt de Ethische Code van Universiteit Leiden.

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Acknowledgements

The biography of a dissertation such as this is inseparable from the context in which it was written, being the Caribbean Research Group and the Laboratory for Artefact Studies of Leiden University. I want to thank my supervisors foremost, for the encouragement, guidance, and intellectual inspiration they have given me over the years. Prof. dr. Corinne Hofman and Prof. dr. Annelou van Gijn have always supported the directions in which I took my ideas, and provided firm but fair advice when needed most.

This research would not have been possible without funding provided by the NWO (Netherlands Organisation for Scientific Research) to the Island Networks research project. I owe much to all my colleagues from it and the CARIB (HERA) and NEXUS1492 (ERC-Synergy) projects that have been working on the archaeology, ethnography, and history of the circum-Caribbean region. For their insights, arguments, and camaraderie over the years I want to thank especially Jana Pesoutova, Floris Keehnen, Marlieke Ernst, Eduardo Herrera Malatesta, Katarina Jacobson, Andy Ciofalo, Sony Jean, and Natalia Donner. I am equally beholden to the members of the Laboratory for all the chats and discussions on artefacts, wear, biographies, and technology over the years. Annemieke Verbaas, Joost Wijnen, Virginia García-Díaz, Eric Mulder, and Andrew Sorensen are warmly thanked for looking with me through the microscope (and fixing them when needed).

I have had many stimulating discussions on a variety of topics with Arie Boomert, Stephen Rostain, Sebastiaan Knippenberg, Andrzej Antczak, Marlena Antczak, Christina Tsoraki, Ben Chan, Angus Mol, Jimmy Mans, Ryan Espersen, Hayley Mickleburgh, Ann Brysbaert, Loe Jacobs, Jason Laffoon, Till Sonnemann, Jaime Pagán Jiménez, Geeske Langejans, Aimée Little, Angus Martin, Peter Siegel, Roberto Valcárcel Rojas, Jorge Ulloa Hung, Ben Hull, Julijan Vermeer, and many others who participated in the events and meetings at Leiden and abroad over the years. Their mentoring and friendship was no less important to the formation of my Ph.D., and I would often turn to them with specific questions and expertise.

A special mention is warranted for Prof. dr. Gareth Davies and Alice Knaf, whose geological contribution to my work was instrumental. They examined and identified the rock types from various assemblages for me, and both provided me with a ton of information regarding rocks of which there is much I still do not fully understand. If there are any incorrect attributions in my work, the responsibility is solely my own. Alice and Gareth also collected many of the raw materials for my experimentations during their surveys of the Dominican Republic. Andrzej Anctzack, Menno Hoogland, and Jason Laffoon also shared their expertise regarding raw material identifications, for which I am grateful. Furthermore, I learned much from Diederik Pomstra and Leo Wolterbeek during experimental house construction projects first in Horsterwold, The Netherlands, and later at Argyle, St. Vincent. Their insights and experiences with woodworking using stone axes form the basis of my own.

Thanks are due to all the colleagues, students, and collaborators at the various field campaigns that I attended. Erasto Robinson and Augustine Southerland at the St. Vincent *tabouï* project kindly shared their knowledge about the local trees, and Menno Hoogland instructed me on photography in the field. Permission to study the artefacts in this work was kindly granted by the Ministerio de Cultura de la Republica Dominicana, the Museo del Hombre Dominicano, Adolfo Lopéz Belando, the Saint Vincent and The Grenadines National Trust (SVGNT), the Ministry of Tourism, Civil Aviation & Culture (Grenada), the Willcox family, and Dolton Charles. I am indebted for all the warm hospitality we received in Grenada and the Dominican Republic. Finally, Finn van der Leden made the great drawings of Figure 26, and Simone Casale helped tremendously with rendering the maps.

I am immensely grateful to my parents and brothers, my friends and family for extending their support and understanding even as I would disappear from the social radar for months to complete this work. Most of all, I owe Catarina deeply for the support and companionship she provided through every step of the completion of this journey.

1

Introduction

This work investigates how the biographical study of material culture contributes to understanding in what way patterns of interaction and mobility characterised societies of the past. Prior to the European encounter, local Caribbean communities were connected through intensive social networks stretching from regional to pan-Caribbean scales (e.g. Berman 2011; Boomert 1987; 2000; Cody 1990a; 1991; Cooper 2010; Curet and Hauser 2011; Hauser and Curet 2011; Hofman and Hoogland 2011; Hofman *et al.* 2007; 2008a; 2010; 2011; 2014a; 2014b; Mol 2013; 2014; Mol *et al.* 2015; Rodríguez Lopez 1991; Rodríguez Ramos 2010a; 2010b; 2011a; 2011b; Serrand and Cummings 2014). Afterwards, this interconnectedness shaped how colonial materials, politics, and economies permeated local societies and simultaneously how indigenous peoples organised their resistance against colonising powers (Cody Holdren 1998; Hofman *et al.* 2008a; 2014a; 2018b; Valcárcel Rojas *et al.* 2013). As everywhere else in human history, these networks were cemented by the movement and exchange of objects, ideas, and people.

Material culture thus forms a cornerstone of the archaeological study of human interactions. In the Caribbean, much archaeometric work of the last two decades has been directed towards the inter-island circulation patterns of unevenly occurring lithic materials (García-Casco *et al.* 2013; Harlow *et al.* 2006; Knippenberg 2004; 2006; Knippenberg and Zijlstra 2008; Schertl *et al.* 2018). Isotopic studies of osseous elements, primarily tooth pendants (Laffoon *et al.* 2013; 2016; 2017a) and compositional analyses on objects made in precious metals (Cooper *et al.* 2008; Martinón-Torres *et al.* 2007; 2012) trace long-distance ties that connected societies across the Caribbean Sea. Research on ceramic recipes and technologies evidences the mobility of clays and craftsmen between and within single islands (e.g. Hofman *et al.* 2008c; Scott *et al.* 2018; Venter *et al.* 2017). Furthermore, the importance that exchanging paraphernalia held in maintaining the socio-political landscape has received scrutiny from various angles (e.g. Fitzpatrick *et al.* 2009; Helms 1987; Hofman *et al.* 2008a; 2011; Hoogland and Hofman 1999; Mol 2007; 2011; 2014; Oliver 2009; Walker, 1993), and there is increasing attention towards transformations of indigenous material culture as a result of colonial encounters (Hofman 2013; Hofman and Hoogland 2012; Hofman *et al.* 2014a; 2018b; Keehnen 2011; 2012; Ostapkowicz, 2018; Ostapkowicz *et al.* 2017; Valcárcel Rojas *et al.* 2013; Ting *et al.* 2018). Each given angle has provided new insights into the nature of social relations within and between (circum)-Caribbean communities first before, and second after the New and Old Worlds connected. Nevertheless, such analytical perspectives often repeat top down theoretical models, or clarify only the fact of their transportation across the archipelago through isotopic or geochemical provenance. There remain gaps in our understanding of the Caribbean past concerning the manners in which materials were moved between social contexts and reinterpreted along the way.

It is the holistic integration of these analytical angles that promises nuance into the types of interactions and intensities with which Caribbean communities stood in contact. Studies in which researchers chartered (parts of) the biographies of Caribbean artefacts have demonstrated exactly this potential (e.g. Hofman and Jacobs 2000/2001; Hofman *et al.* 2008c; Knippenberg 2006; Martinón-Torres *et al.* 2012). Using a biographical approach to do so enables the investigation of how material culture changed social relations and itself metamorphosed through entering into new cultural contexts. Ultimately, such aims may show how societies transformed, reinvented themselves, or dispersed as a result of inter-cultural encounters sustained to globalising pressures. These are broadly speaking the goals of the NWO-funded Island Networks research project,[1] which forms the academic context of the present dissertation. This work aims to address the topic of human interaction by investigating the biographical trajectories of the material culture enabling it: if provenance studies shed light into matters of origins and material selection, functional studies provide insight into economic activities and the practical associations of objects. Technological approaches provide a window into issues of skill and craftsmanship, as well as the social dimensions in which these were organised. Combining such vectors generates an inquiry into the position and significance things held in the context of Caribbean interactions. Two main categories of objects serve as the lines of inquiry, namely ground stone celts and paraphernalia from shell and bone. The microscopic analysis of traces of manufacture and wear is combined with experimental archaeology, contextual analysis, and incorporates data on provenance as well. In doing so, this work thus traces raw material procurement, technology, the use of objects, deposition processes, and in cases where this matters the itinerary that followed afterwards.

This approach is the reconstruction of artefact biographies (*sensu* Van Gijn 2010; 2012), which itself provides a methodological framework for investigating the cultural biography of objects (Chapter 3). This concept holds that objects accumulate a biographical profile by entering and passing through new social contexts, which is elucidative of the cultural conceptions and processes at the basis of these movements (Kopytoff 1986). Accordingly, cultural biographies gravitate towards the mean of cultural appropriateness – what people consider to be the 'ideal' life trajectory for an object within their given cultural context – but can also violate them (Gosden and Marshall 1999). Fontijn (2002) discusses the example of the wedding ring as an object with evident biographical expectations and personal connections in our society, and one whose values take on new meanings when the marriage is ended. Such ideals also change when objects move towards another cultural context (or social setting, political system, ontology, …) which involves reinterpretation of it, the outcome of which may be recursively interrogated. Equal reinterpretations take place when objects enter different biographical phases. Technological processes can transform raw materials into powerful regalia, and social aphorisms may turn curated implements into the furniture for a grave.

Explaining such movements in the biographies of objects requires their conceptualisation from indigenous perspectives, which is approximated through anthropological perspectives inspired by the tropical lowland societies of South America (e.g. Descola 2013; Santos-Granero 2009c; Viveiros de Castro 1998). Departing from scholarship on indigenous ontologies in this area frames the interactions between indigenous groups, Caribbean communities, colonial structures, and archaeological objects as relations between subjects possessing various, often conflicting, but crucially negotiable natures (inter-

1 Full title "Island Networks: modelling inter-community social relationships in the Lesser Antilles across the historical divide (AD 1000-1800)". Project no. 360-62-060 granted by the Netherlands Organisation for Scientific Research to prof. dr. C.L. Hofman in 2013.

subjectivity). Here, material culture can be inextricably linked with the base concept of persons (and comparable entities), with mythological versions of animals or body parts, with political interactions and cementing social relations, and with the technologies of making and using simultaneously constituting the self, community, and social order (Section 3.2). This provides a fruitful framework for examining the participation of local Caribbean communities in wider networks, including their negotiation of access, control, supply, and independence, their resilience, and the social impacts of arriving exotica.

1.1 Research objectives

My immediate objective is to gain a deeper understanding of the material culture that played part in human interactions and connectivity within the Caribbean. Why did specific materials and artefact types play such a large role in these processes and others not? Along which aspects of their material culture did communities leverage outside pressures, and how did this alter the biographies of objects? Two of the object groups which feature in such questions are stone celts and paraphernalia, which form the focus of this thesis. From amongst all things constituting Caribbean material culture, objects from these groups have consistently displayed the highest degrees of inter-island circulation (Chapter 2) together with ornaments (studied by Falci in prep.) and flint (studied by Knippenberg 2006).

Celts are more properly defined as edge-ground macro-lithic percussion implements (Adams 2013; Adams *et al.* 2009) and in the Caribbean comprise axes, adzes, and several other tool types. A diverse variety of rocks were exploited for this purpose, including materials such as jadeitite with highly restricted occurrences and circulation patterns that cross large distances. Since celts maintain an extensive archaeological presence within the pre-colonial Caribbean, and the introduction of metal axes proved critical to *any* colonial setting (e.g. Cobb 2003; Metraux 1959; Salisbury 1962), edge-ground tool complexes form a primary target for biographical analysis. In practice, celt-shaped specimens with blunt 'edges' and ground stone fragments of unclear original typology are also included whereas celts of non-lithic materials are not.

Paraphernalia, as termed in the present work, comprises miscellaneous artefact categories that are considered to be associated with the spheres of political office and shamanic ritual activity. Such objects are also classifiable as figurative portable art and are all exotica (as redefined by Brysbaert and Vetters 2013, *contra* Vianello 2011), in the sense that they are rare in their (wider) archaeological context and imply non-local origins and/or high craftsmanship. The present selection consists of osseous pendants and windpipe instruments, carved shell inlays, plaques, and face-depicting objects (*guaízas)* from collections with recorded archaeological contexts. All are traditionally presumed to be (part of) highly singularised objects with the capacity of having a personal biography forming around them (e.g. Breukel 2013; Mol 2014; Oliver 1998; 2009; Roe 1997; Walker 1993). These occur mainly as infrequent finds within excavated contexts, and include examples of rare categories of which no more than a few dozen specimens are known. A biographical approach to such paraphernalia will not only elucidate how 'exotic' they really were within their cultural context, but also provide a venue to address resulting value ascriptions, prestige of ownership, and social identity. This ties directly into the dynamics of power and inter-cultural contact surrounding the most important indigenous socio-political institutions, in particular during the chronicled interactions of the early colonial period.

The primary research question that these materials address is:

> *What do the biographies of potentially exotic artefacts reveal about the dynamics of the social interaction networks binding communities from the late pre-colonial and early colonial Caribbean?*

The research is structured according to four subquestions:

1. What were ideal configurations of the biographical trajectories for the paraphernalia and stone celts of the indigenous insular Caribbean?
2. How can the biographical trajectories of artefacts be conceptually adapted to relational ontologies as expressed by Amerindian communities?
3. At which biographical phases do individual artefacts diverge from their culturally ideal trajectories and what do such transitions indicate about interactions and local contexts?
4. Are any influences from external culture spheres visible in the biographies of local artefacts and if so, how are they characterised?

1.2 Approaching artefact biographies

These questions are addressed departing from two core areas (Figures 1 and 2): the (northern) Dominican Republic and the southern Windward Islands (with a focus on northeastern Grenada). Both are of pan-regional importance to the study of interaction networks from before to around the time of the European encounter and colonial periods afterwards. The Dominican Republic is a region where several high-quality celt materials naturally occur that were exploited and extensively circulated throughout (late) pre-colonial times. Grenada formed a crucial node between the archipelago and South American mainland throughout its occupational history. The Windward Islands were also the place of long-lasting indigenous resistance in the colonial periods, in spite of regular transit from European vessels (Allaire 2013; Beckles 2008; Boucher 1992; Cody Holdren 1998; Hofman and Hoogland 2012; Shafie *et al.* 2017). In its turn the Hispaniolan north forms the site of the first colonial route across the Americas and was the first island to be colonised in full (Deagan and Cruxent 2002; Hofman *et al.* 2018b; Wilson 1990). Both areas have also been the subject of various recent archaeological investigations, including extensive work carried out for the NWO-Island Networks, ERC-Synergy NEXUS1492, and HERA-CARIB research projects.

Naturally, there are several further criteria which need to be met by the selected assemblages and samples from within these core areas. An ideal selection would encompass a series of (1) recently excavated archaeological sites (2) containing both relevant artefact classes (3) in sufficient quantities (4) with adequate chronological and spatial context. Inferred participation of the site in inter-communal interaction networks is of course an essential prerequisite, with complete biographical characterisations attainable through collaborative work on geoprovenancing (see Section 1.2.2). However, the preference for assemblages containing both celts and paraphernalia could not always be met. Obviously, issues of access and ability to conduct analyses using laboratory equipment play a constraining role as well. These standards limit the assemblages and materials that qualify for inclusion, but are necessary to be fully able to contextualise the dense information derived from reconstructed artefact biographies. They are met for the assemblages of celt materials and to a large degree also for the paraphernalia, although the more restrictive occurrence of those materials necessitated some

leeway with respect to contextual certainty.

In accordance, the following materials are studied (Figure 1). For celts, these comprise assemblages from the sites of Playa Grande (ca. 160 specimens) and El Flaco (ca. 110 specimens) from the northern Dominican Republic, and from the site of Pearls (20 specimens) from east Grenada. For paraphernalia, these comprise specimens from El Flaco (4 specimens), La Luperona (1 specimen), and El Cabo de San Rafael (henceforth El Cabo, 16 specimens) for the Dominican Republic, from Brighton Beach (2 specimens) for St. Vincent, and from La Poterie (2 specimens), Telescope Point (3 specimens), and two specimens with region-wide context for eastern Grenada. Certain additional assemblages have been examined with some detail and will be referred to in the discussion, but were not included in the main work due to time constraints or inconclusive data. These include celt materials from the sites of Amina, El Carril, and El Cabo, as well as Argyle (St. Vincent), St. Eustatius (Golden Rock 1), and east Grenada, and additional paraphernalia from El Flaco and Kelbey's Ridge 2 (Saba). Broadly speaking, the sites from the Dominican Republic date from the 12th to the 15th century AD and include quasi- to confirmed colonial period date ranges.[2] Pearls precedes this time span (AD 200-600 and later), but the other materials from the Windward Islands date to the late pre-colonial (ca. AD 1200-1500) and especially the early colonial period (15th-17th Century AD, see Chapter 6).

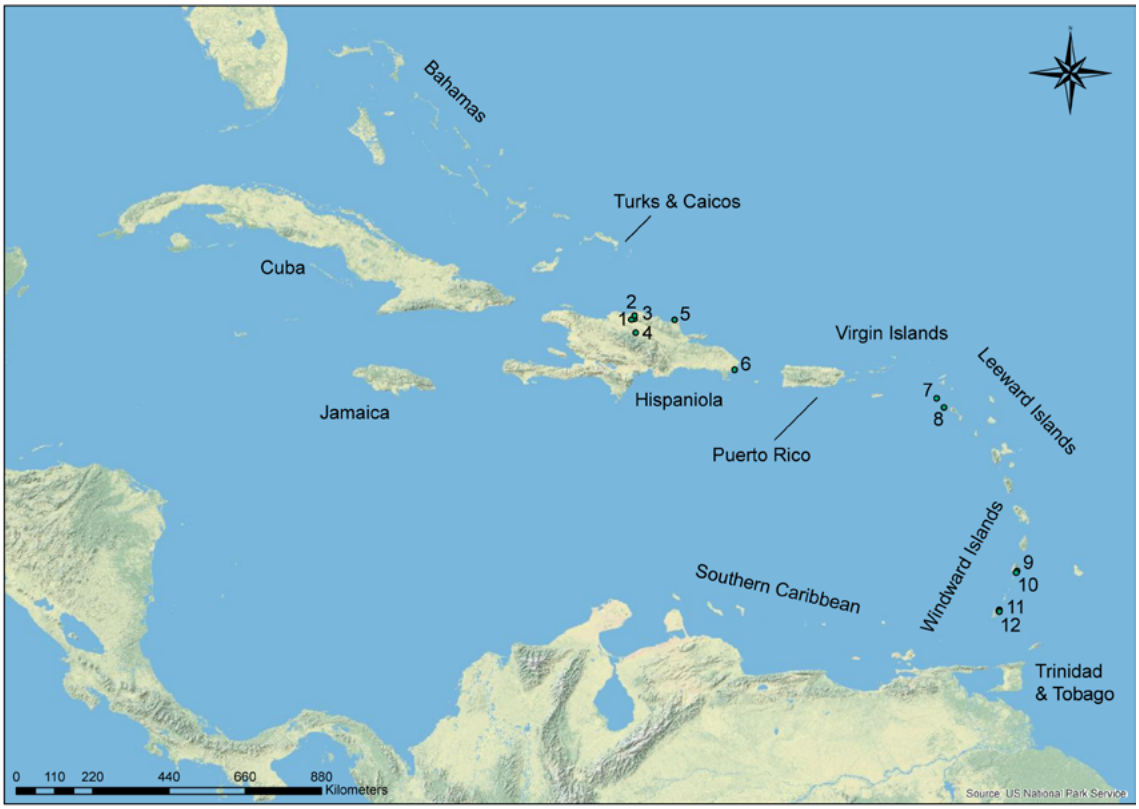


Figure 1: Map of the Caribbean. 1) El Carril. 2) La Luperona. 3) El Flaco. 4) Amina. 5) Playa Grande. 6) El Cabo. 7) Kelbey's Ridge 2. 8) Golden Rock 1. 9) Argyle. 10) Brighton Beach. 11) Pearls. 12) Telescope Point.

2 Most also have earlier components, exhibiting date ranges from ca. AD 800 onwards, but these occupations are not significant (El Flaco) or were largely excluded during sampling (Playa Grande, El Cabo).

1.2.1 Traces of wear and experimental references

All study materials were subjected to a full biographical analysis. This approach comprises an array of analytical methodologies and contextual evaluations. Wear trace analysis forms the baseline of this work. Also known as functional analysis or the study of use-wear or microwear, this method examines microscopic traces of wear from activities related to the functional use of archaeological tools (Semenov 1964). However, its application is much broader than that. Wear traces accumulate during any activity in the biography of an object and may also inform on matters of procurement or of deposition. For edge-ground macro-lithics, traces that relate to use alone provide insufficient resolution to the present questions. Rather, it is the combination with wear from distinct hafting arrangements, and especially the microscopic analysis of manufacturing traces from grinding and polishing, that will prove most informative.

Figure 2: Map of the Lesser Antilles.

Regardless of whichever biographical aspect is in focus, the method of wear trace analysis rests upon the same basic tribological principles. Whenever two material bodies come into contact with each other they interact, which results in alterations to the (micro-)topographies of the surfaces of both. Any technological or functional activity creates such an interaction, and the resulting alterations will in certain ways model after the initial parameters. Accordingly, it is theoretically achievable to distinguish between activities of different kinds; fifty years of research on especially the edges of flaked lithic implements has demonstrated it feasible to distinguish and interpret a great many economic and technological activities (Keeley 1980; Semenov 1964; Van Gijn 1990; 2010; Vaughan 1985). The nature of these activities is thus interpreted from the specific features of the traces of wear, as originally imprinted upon the microtopographies of the surfaces of artefacts. Such features include edge scarring or micro-flaking, rounding of flake edges and surface asperities, the presence of striations, topographical scarring, and the development of micro-polish structures, each of which can be described according to attributes both internal to the feature (e.g. texture, vertical invasiveness) and external (location on the tool, spatial distribution, density). In ideal situations, wear is interpretable for the hardness and type of the contact material, gestures involved in the activity, presence of grit or lubricants, duration of contact, and so forth.

The analysis of these traces of wear is carried out using optical microscopy (OM). Since the permission to access many of the assemblages under study is party to the NEXUS1492 code of ethics or granted as part of comparable Memoranda of Understanding (MoU's) with the Faculty of Archaeology, this analysis was two-pronged. Specific samples were brought to Leiden and studied at the Laboratory for Artefact Studies, but the bulk of the materials were analysed in the respective home countries using portable equipment.[3] Starting in each instance with an examination by naked eye and assessment of the material, artefacts were subsequently subjected to low magnification analysis using stereoscopic microscopes (7.5-65×) in the laboratory and digital travelling microscopes (0-50×/200-230×) when in the field. Thereafter, high magnification analysis was conducted using metallographic microscopes (100-500× at the laboratory, 50-200× in the field). The interpretation of their traces is based upon a dual framework: comparison with reference materials obtained through experimental archaeology, supported by models on the formation of wear derived from insights in tribology (Chapters 4 and 5). Experimental reference collections such as those housed at the Leiden Laboratory for Artefact Studies provide much data on the factual results of specific wear interactions, and therefore a reliable source for the interpretation of resulting traces. The Leiden reference collection is extensive, with almost 4000 recorded experiments in the manufacture and use of replicated archaeological artefacts designed to aid in the interpretation of specific traces and interactions of wear.

However, such reference collections are oriented towards specific cultural, regional, and environmental circumstances. In this and many other cases, those are craft and subsistence activities using flint, macro-lithic, and bone tools in the biogeographical regions of Atlantic and Continental Europe. Naturally, the subject materials of the present work necessitate a departure from these. Hafting systems for edge-ground macro-lithics differ from those for flaked stone artefacts and the interpretative models recently developed for flint (e.g. Rots 2010) are only partially applicable. Their use wear traces require work with contact materials from the Neotropics, particularly on improving the ability to distinguishing varieties in wear micro-polish resulting from contact with tropical hardwoods.

Most significantly, the raw materials in question include a variety of metamorphic and igneous rocks with heterogeneous mineralogical composition, for none of which the interaction with processes of wear and subsequent development of traces are well studied. It is known that differences exist in the rate of development of wear already between micro- to cryptocrystalline silicates (flints, cherts, obsidian, quartz). These become more pronounced with coarser grained materials (quartzites, basaltic rocks), potentially affecting interpretative accuracy (e.g. Beyries 1982; Bradley and Clayton 1987; Clemente Conte and Gibaja Bao 2009; Lerner 2014; Pedergnana *et al.* 2016; Stemp *et al.* 2013). The comparative data is better for the materials used to manufacture paraphernalia in, but limited by our current understanding of technological systems in the indigenous Caribbean.

The experimental programme of the present work explores all of these issues. It includes both controlled experiments (oriented to testing parameters) and actualistic activities (oriented to completing a task). The former includes a focus on wear patterns resulting from different grinding and polishing techniques as well as haft friction types on some of the main lithic and mollusc shell materials of the work, and assesses of how the specific mechanical and structural characteristics thereof exert influence. The latter includes woodworking experiments as part of a heritage outreach project

3 This includes some artefacts brought over specifically for conducting wear trace analysis within laboratory setting, but also materials designated for whole-rock destructive geochemical analysis (at the VU) or other scientific methods requiring specialised facilities (e.g. clean micro-residue sampling).

in St. Vincent that aimed to experimentally reconstruct house structures on the basis of excavated floorplans (Hofman *et al.* 2015), and collaborative experiments in shaping and carving ornamental materials (Breukel and Falci 2015; Falci 2015c; Falci *et al.* 2017b).

1.2.2 Provenance, context, and the biographical framework

A comprehensive artefact analysis needs to regard the entire biography of the object, being the complete succession of events and contexts it experienced. This means incorporating information regarding raw material provenance, manufacture, typology, exchange, deposition, and so forth. Determining whether traces were caused by production activities, consumption, or other processes, and systematically arranging them in a profile is thus the second step in the analytical process. As noted, biographical approaches to artefacts draw inspiration from the conceptual metaphor introduced by Kopytoff (1986) in combining microwear data with archaeological and geological lines of evidence to arrive at a holistic reconstruction of the operational system and life trajectory (e.g. Breukel 2013; Little *et al.* 2016; Van Gijn 2010; 2012; Van Gijn and Wentink 2013; Wentink 2006). Such reconstructions connect and interpret the events that transpire in different biographical phases, namely procurement, manufacture, use life, and deposition, and that govern the (multi-directional) movements between them. Biographical reconstructions thus provide a myriad of cultural information on the choices and (re)contextualisations that drove artefacts through and between these phases (e.g. Fontijn 2002; Gosden and Marshall 1999; Hoskins 1998; 2006; Joy 2009; 2010). A particular interest therein is tracking the spatial movements of objects across the landscape, which is emphasised by discussions on the metaphor of object itineraries (Fontijn 2013; Hahn and Weiss 2013; and Joyce 2017; Joyce and Gillespie 2015). It is therefore necessary to consider matters of provenance, how they line up with technological sequences, and both the functional and social context behind the entry of objects in the archaeological record.

The classifications of raw materials within the present work are based upon collaborations with experts, and in the case of materials analysed in the field by my own comparisons therewith (see Section 4.1.3). Notably, the lithic materials were examined by prof. dr. Gareth Davies and Alice Knaf (Vrije Universiteit Amsterdam). They study the provenance and archipelagic-wide distribution of rare rock materials in the Caribbean, in particular jadeitite, including the development of high-precision portable geochemistry sampling instruments (Knaf *et al.* 2017). Identifications of the bone and shell materials were reached primarily in discussion with prof. dr. Menno Hoogland and dr. Andrzej Antczak. My subsequent inferences concerning nearest and potential alternative provenance areas draw upon literature on the geology and biogeography of the circum-Caribbean. The main trends are outlined in section 2.1.

My technological analyses address the stigma from manufacture as specific traces of wear, and incorporate these in the biographical reconstruction as such. For both celts and paraphernalia the information on the manufacturing technologies and operational sequences is derived from examining the stratigraphic overlay of traces on finished artefacts. Production debitage is barely present in these assemblages (possibly an issue of the respective excavation strategies at Playa Grande and Pearls) and the primary reduction sequences are thus poorly preserved. Data on the deposition of artefacts is approached through this technological perspective as well, by evaluating the status of the artefact as a conclusion of its biographical potential. This concerns an assessment of markers of mechanical failure, destruction, continued viability, and so on. Contextual data is incorporated from unpublished and

published excavation reports, but since most materials are from on-going projects such details are not always available as of the conclusion of this work.

1.2.3 Conceptualising indigenous objects

These different lines of evidence combine in reconstructions of the biographical profiles of celt assemblages (Chapter 7) and individual paraphernalia (Chapter 9). To bring them into a discussion on the indigenous values of certain materials, their desirability across different cultural contexts, and the impacts of resulting interactions on local communities, one needs an understanding of what shifts and movements in the biographical trajectory might signify in such a context. Models for a shared indigenous ontological substrate offer the best frame. The ontological turn within anthropology acknowledges indigenous worldviews as valid classifications of realities that exist independently of the historical contingency of Western naturalism, reduced to one reality amongst many (e.g. Holbraad *et al.* 2014; Venkatesan *et al.* 2010). It originates in part with work done in the tropical lowlands of South America on perspectivism and new animism (e.g. Descola 2005; Viveiros de Castro 1998). Expressions from these ontologies on the 'socio-relational' nature of the cosmos and the transmutability of physical bodies are widely shared amongst indigenous Amerindian societies. The ontological statuses of things take a wide range of forms therein (Santos-Granero 2009b). Amerindians regularly acknowledge the potential for certain artefacts to possess souls capable of articulating a relational existence, or more commonly, share in the derivate energies of human souls through co-relational engagement. Such engagements are called inter-subjectivities and may take the form of technological behaviour (making), modes of use (which defines a relation with Others, e.g. hunting, domesticating), exchanges, and other practical outcomes that can be addressed through the biographical framework. Section 3.2 traces this argument in detail.

Importantly, the employment of ontological frameworks should not be seen through to a cultural homogenisation of the indigenous Caribbean, then interpreted following transcultural rules. Analogies from individual ethnographic examples form an important element to wear trace analysis as a way of expanding tool possibilities following the observation of specific trace patterns (González Urquijo *et al.* 2015; Van Gijn and Raemaekers 1999; Beyries and Rots 2008). However, when analogies are applied as a model for explaining human behaviour they risk imposing contextually contingent cases onto unrelated and inappropriate situations, amongst other issues (see Section 3.2.3). It is difficult to avoid such issues even when investigating how situations compare at the broadest level. Nevertheless, there are strong grounds for assuming that a certain degree of similarity with tropical lowland societies must have been present. The deep history of the Caribbean is one in which the mobility and interaction of its inhabitants stand central, both between themselves and with the surrounding mainlands. By the time of the European encounter, the indigenous insular landscape was constituted by a tessellation of autonomously developed societies comprising communities speaking different languages/dialects, self-identifying as different ethnic groups, with different material cultural complexes, and so forth (Hofman *et al.* 2010; Wilson 1993; 2007). The origin of this mosaic lies in a series of migrations and continued interactions with various mainland areas, primarily in lowland South America, though intersected by significant measures of local development in the Antillean islandscape.

Based upon recorded words from the 'Taíno' *lingua franca* of the contact period it is presumed that the Ceramic Age inhabitants of the archipelago spoke languages belonging to the Maipuran or core Arawakan family (Granberry 2013; Granberry and Vescelius 2004; Hofman *et al.* 2010). The

well-documented vocabularies of the Kalinago – late pre-contact arrivals from the Guyanas to the Lesser Antilles (Section 2.2) – are also Arawakan in basis, though influences from Cariban languages are acknowledged (e.g. Boomert 1986; Whitehead 2002, 54). Various biological lines of evidence indicate that ancestral Caribbean populations shared more commonalities with specific contemporary populations in northern South America than with others (e.g. Benn Torres 2016; Coppa *et al.* 2008; Lalueza-Fox *et al.* 2003; Schroeder *et al.* 2018). Though speculations differ on which contemporary groups or ethnicities are most closely related, the broader pattern is clear.

Indigenous mythologies recorded during early colonial interactions carry many themes, structures, and elements also recurrent amongst South American communities (e.g. Boomert 2000; Petitjean Roget 1997; 2015b; Roe 1982; 1997; Stevens-Arroyo 2006). The origins of Caribbean ceramic series are traced to stylistic and chronologic antecedents in the archaeology of northern South America as well (Boomert 2000; Rouse 1986; 1992; Rouse and Cruxent 1963), though the equivocality of the modelled displacement of earlier communities is now in question. Some of these 'Archaic-age' populations may have originated in Central America (Wilson *et al.* 1998), the Isthmo-Columbian area (Rodríguez Ramos 2010a; 2013; Roksandic 2016), or the north coast of Colombia and Venezuela (Callaghan 2002; 2013), while others came from the south through Trinidad (Boomert 2000; Pagán-Jiménez *et al.* 2015); there are multiple concurrent hypotheses. The potential continuity and cultural contribution made by these long-settled communities to the development of Late Ceramic Age societies are now being reconsidered (e.g. Hofman 2013; Keegan and Rodríguez Ramos 2005; Reid 2018 and papers therein; Rodríguez Ramos *et al.* 2008; Ulloa Hung 2013a). Furthermore, there is some sparse evidence in the Greater Antilles that could suggest influences derived from non-Arawakan language families (Granberry and Vescelius 2004; Roksandic 2016; Hofman and Carlin 2010). All of this will have had repercussions on indigenous Caribbean ontologies, which goes to illustrate that there can be no guarantees for any predisposition towards selective cultural groups or linguistic families over others. All the more so, given the vast geological and biogeographical differences between the islands and the mainlands (Chapter 2).

1.3 Outline of the dissertation

The dissertation consists of eleven chapters. This introduction has outlined the wider context of the study and the specific research questions it aims to address, followed by a brief overview of the datasets and approach that will be used. Chapter two devotes itself to the natural and cultural background of the Caribbean archipelago with particular attention to the archaeology of celts and paraphernalia.

Chapter three sets up the theoretical framework. The artefact biography is defined here as a concept that encompasses both a clear theoretical focus and a practical avenue for connecting methodologically discordant datasets. Recent critique on the metaphorical baggage of object biographies is considered, and the social processes which the original biographical concept was concerned with are oriented towards viewpoints proper to the studied context. Intersubjective relations define indigenous social life, and how adopting such ontologies changes the perspective of a biographical approach is explored in the final sections.

Chapter four describes the methodology. The protocols and practical conduct of the analyses is summarised first, and includes a reflection on laboratory versus field protocols. The chapter continues by defining the major concepts of wear traces, wear processes, methodological approaches, and the limitations of inference. The latter part is devoted to wear trace analysis situated in a Caribbean

context, and pays particular attention to the working properties of relevant rock and shell materials.

These methodological principles are put to practice in the experimental programme. Chapter five details the background and experimental approach to each focus, being hard stone grinding, wood working, and carving softer materials. The resulting traces are described in Appendices 1 and 2, and the chapter subsequently analyses the experimental outcomes to construct a direct frame of reference for interpreting the archaeological materials.

Thereafter, the results of this work are presented. Chapter six describes the archaeological context and level of preservation for each selected and studied assemblage. Chapter seven interprets the observed wear trace patterns and other biographical possibilities for celt assemblages, of which the outcomes are analysed on an inter-site level in Chapter eight. Chapter nine contains the reconstructed artefact biographies for all paraphernalia. The data on each consecutive artefact are provided in Appendices 3 and 4 for the respective chapters.

Chapter ten synchronises these results with the theoretical and ontological perspectives attached to the biographical framework. I will discuss how particular biographical phases relate back to the totality of their trajectories, reflect on the wider problematic of exchange and object mobility, and explore the relational dimensions implied by specific data patterns. The eleventh and final chapter concludes the dissertation by highlighting the findings that answer the original questions, followed by methodological evaluations and further recommendations for topical research.

2

Natural and cultural background

The first purpose of this chapter is to introduce the biogreography and geology of the Caribbean insofar as is necessary to situate the use, non-use, and total absence of various types of materials in the islands. Second, it provides a brief overview of the cultural history of the archipelago up until the Early Colonial Period, in order to contextualise the material histories of the artefact groups studied in this work. This includes a review and evaluated of various observed and hypothesised stages in the biographical trajectories of celts and paraphernalia alike (Sections 2.3 and 2.4).

2.1 The natural setting

The geography of the Caribbean Islands is the result of a complex geological history beginning with westward movements of the Caribbean plate in the early Cretaceous. The Greater Antilles arose early on through processes of active volcanism and tectonic deformation, modified by later seabed uplift, whereas the Lesser Antilles are composed of uplifted coral reefs and younger volcanic events dating from the late Tertiary to the present day. Overviews of these processes can be found in Burke (1988), Draper *et al.* (1994), and Jackson and Donovan (1994). The result is an archipelago rich in lithic resources, but with a highly variable spatial distribution of specific desired materials (Knippenberg 2006, 151-156).

Topographic variation is large and ranges from steep mountainous terrain, coastal ranges, rolling foothills, flat river plains, and limestone cliffs to shallow banks, extensive neritic zones, and oceanic trenches. This provides a wide range of habitats, micro-climates, and ecosystems with proportionally high rates of species diversity and endemism in light of the total surface area of the region (Myers *et al.* 2000; Woods and Sergile 2001). The last large-bodied terrestrial mammals inhabiting the oceanic islands went extinct in the mid-Holocene (Steadman *et al.* 2005). As a result, raw materials such as antler and leather are not naturally present in useable quantities. However, there is an abundance of smaller terrestrial mammals and reptiles, bat species, invertebrates, avian fauna, and so on. The West Indies as a whole count circa 10.500 native seed plant species (Acevedo Rodríguez and Strong 2012), with at least 300 native trees in islands such as Puerto Rico (Little and Wadsworth 1964, 11). Over a hundred plants are archaeobotanically attested in past craft, subsistence, and ritual economies (Newsom 2008; Newsom and Wing 2004). As studies in indigenous historical ecologies show, however (Balée 1994), that can only pertain to a very partial selection of its original richness. Maritime biodiversity is also incredibly rich, counting ecosystems such as mangroves, coral reefs, and a densely inhabited pelagic zone. It includes economically significant molluscs such as *Lobatus gigas* (for meat and their shell), large aquatic mammals such as Trichechus manatus, and stony corals whose skeletal structures provide unique tool materials (Kelly and Van Gijn 2008).

Hispaniola, the main island of study, has a complex tectonic history. It is composed of twelve geological provinces roughly oriented as long west-northwest terranes that include fragments of oceanic plateaus, remnants of volcanic arcs, and metamorphic terranes, some overlain by sedimentary basins (Mann *et al.* 1991). The northern Dominican Republic is therefore topographically characterised by the northwest-southeast oriented Cibao valley, bounded on the south by the high peaks of the Cordillera Central and on the north by the coastal belt of the Cordillera Septentrional. The valley itself is mostly flat and forms the drainage basin of the El Yaque del Norte river, which is fed by tributaries from the mountain ranges. These contain a variety of igneous and low-grade metamorphic formations (up to greenschist facies, with some local amphibolite facies). Three separate inliers from a forearc terrane are exposed on the northern flank of the Cordillera Septentrional, which contain various rock types resulting from high-pressure subduction metamorphism at low to high temperatures (e.g. Draper *et al.* 1991; Escuder-Viruete *et al.* 2011; 2013). The Puerto Plata Complex to the west contains a serpentinite-gabbro complex with dioritic intrusions and volcanic rocks, with low-grade metamorphic rocks occurring and high-pressure rocks from the eclogite facies and the blueschist facies present. The La Samaná Complex to the east contains retrograded eclogite and blueschist rocks, besides a variety of other metamorphic schists (Escuder-Viruete and Pérez-Estaún 2006). The Río San Juan Complex (RSJC) lies on the northeastern flanks in between, forming the watershed of the eponymous river. This complex contains a host of various rock types, including two distinct serpentinite mélanges embedding tectonic blocks of the aforementioned low to high-pressure metamorphic materials. Significantly, jadeite-bearing rocks of varying purity were recently found in these mélanges, occurring as blocks up to several meters in size (Draper *et al.* 1991; Hertwig 2014; Krebs 2008; Schertl *et al.* 2012). These raw materials were exploited and probably exchanged by the community of Playa Grande (López Belando 2013; Knippenberg 2012; Schertl *et al.* 2018).

The second Caribbean occurrence of jadeitite consists of deposits associated with the serpentinite mélange of the Sierra del Convento in southeastern Cuba (Cárdenas-Párraga *et al.* 2010; 2012; García-Casco *et al.* 2009b; 2013). This complex contains a suite of high-pressure subduction rocks similar to the Río San Juan Complex, and forms part of the same general rift zone that extends all the way towards the Motagua Fault Zone (MFZ) in Guatemala (Figure 3). The Blue Mountains in Jamaica form part of this tectonic feature as well, containing rocks from the greenschist, amphibolite, and blueschist facies (Draper 1986; Roobol and Lee 1975). The MFZ extends over 200km with two main source mélanges of jadeitites (North MFZ and South MFZ) and a host of other high-pressure rock types. The high chemical and mineralogical diversity of these sources has been extensively studied in connection to its exploitation by various Mesoamerican cultures (e.g. Harlow 1994; Harlow *et al.* 2011). These rare occurrences form the background of the current discussion on the exploitation, circulation, and acquirement of celt raw materials by indigenous Caribbean communities.

The southern Windward Islands, as the other core area, form part of the Lesser Antilles. This island chain is geologically divided into two arcs: an outer arc composed of uplifted coral reefs, and an inner arc formed by recent volcanic activity (Wadge 1994). The older limestone formations are overlain by igneous materials deposited from the formation of volcanic peaks in the Windward Islands (Draper *et al.* 1994), and the island arcs separate in the Guadeloupian archipelago. The majority of igneous rocks are intermediate to mafic in composition (andesitic to basaltic), and certain basalts found in Grenada and Carriacou are chemically distinctive (Section 4.4.2). Trinidad and Tobago are not oceanic islands but are instead located on the continental shelf of South America, leading to

significant geological differences. The latter island contains accessible formations of low- to medium-grade metamorphic rocks, diorite, and sandstone (Jackson and Donovan 1994). Their biogeography also reflects that of the adjacent continental areas, with which these islands were connected until the Holocene sea level rise. Altogether, the Caribbean Islands offer a strikingly diverse landscape which has been exploited since the very beginning of human migration into the island chain.

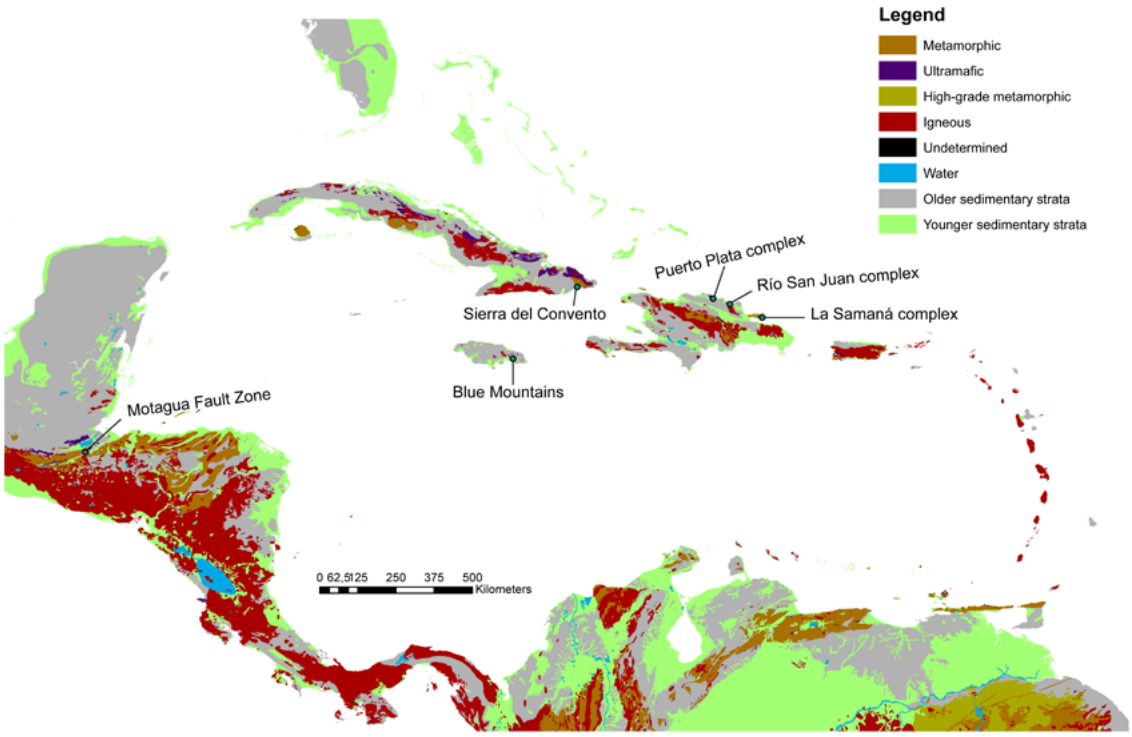


Figure 3: Simplified overview of circum-Caribbean geology based upon French and Schenk (2004) with relevant high-pressure rock source locations indicated.

2.2 Indigenous Caribbean cultures: a short overview

The oldest archaeological complex within the Caribbean Islands is found at sites such as Banwari Trace and St. John in Trinidad, dated to around 5000 BC. It is typified by an a-ceramic material cultural complex containing various types of macro-lithic materials such as mortars, anvils, and grinding stones for processing cultivars, and sizeable edge-ground celts with substantial grooves for attaching hafts. Relatively simple siliceous lithic flakes and pointed tools made of modified bones and teeth are common (Boomert 2000, 54-68; O'B. Harris 1971; Pagán-Jiménez *et al.* 2015). Though the islands north of Trinidad lack such early sites, paleoenvironmental research does indicate anthropogenic landscape modification after 3000 BC (Siegel *et al.* 2015). The eared/winged axe types (see below) typical of the Windward Islands are often considered as associated with the Archaic Age (O'B. Harris 1981). The earliest Lithic Age and Archaic Age assemblages in Cuba and Hispaniola both date to around 4000 BC (Rouse 1992; Wilson 2007). The former are typified by a set of material culture that is classified by Keegan and Hofman (2017, 22-23) as flaked stone complexes, since they are principally known from lithic workshop sites and not from domestic contexts with broader economic focuses. Macro-lithic and shell tools are clearly present in essentially contemporaneous 'Archaic Age' complexes, however, including various types of celts (Kozlowski 1974, in Keegan and Hofman 2017, 33, 38-43; Veloz Maggiolo 1976). The archaeological nature and social organisation

these early societies are still poorly understood, in spite of the gradual recognition of significant variability in their material cultural expressions and subsistence economies. However, a sustained, inter-generational interaction network based around the exchange of lithic materials (and associated knowledge) has been demonstrated to exist in the northeastern Caribbean leading to the Archaic-Saladoid interface (Hofman *et al.* 2014b).

These interactions tie into culture historical developments that begin to take place starting between 800-200 BC (*sensu* Keegan and Hofman 2017, 67), outlining what is classified as the Early Ceramic Age (ECA) period. The traditional position is that Arawak-speaking populations from the Orinoco Basin migrated into the Antilles around 500 BC, introducing egalitarian sedentism, a horticultural economy based on manioc, White-on-Red painted pottery, and an animist ontology from the tropical lowlands (Boomert 1999; 2000; Rouse 1986; 1992; Siegel 1989; 2010; Wilson 2007). The earliest sites are located in the northeastern Caribbean and are characterised by a new material cultural complex. This includes abundant pottery of the Saladoid and/or Huecoid series, a rich variety of bodily adornments, and polished petaloid celts. The timing, origin, and character of these 'migration(s)', the monolithic 'veneer' of Saladoid material culture, and the degree to which those aspects of the 'Ceramic Age kit' originated with Archaic populations all remain under debate. The most up-to-date overview is provided by Keegan and Hofman (2017). Early Ceramic Age sites were initially sparse but connected over long distances. This gradually gives way to more archaeologically expressed heterogeneity, with the emergence of additional sites leading to a more densely inhabited landscape and contractions in the geographic distance of their social networks (e.g. Boomert 2000; Crock 2000; Crock and Petersen 2004; Hofman 2013; Hofman and Hoogland 2004; 2011; Hofman *et al.* 2007; 2011; Keegan 2000; 2004; Keegan and Hofman 2017). Between 200 BC and AD 400 sites such as Pearls (Grenada), Trants (Montserrat), Elliott's and Royall's (Antigua), Hope Estate (St. Martin), Prosperity (St. Croix), La Hueca and Sorcé (Vieques), and Punta Candelero (Puerto Rico) were tied through the large-scale production and exchange of lapidary materials. These include a number of green-coloured rocks (nephrite, serpentinite, aventurine, malachite, peridotite, turquoise, purported jadeitite), translucent crystals (rock crystal, amethyst, carnelian, chalcedony), as well as diorite, *Lobatus gigas*, *Spondylus americanus*, and a few other materials (e.g. Boomert 2007; Cody 1991; Falci *et al.* in prep.; Murphy *et al.* 2000; Narganes Storde 1993; 1995; Rodríguez Lopez 1991; Rodríguez Ramos 2010a; 2011b; 2013; Watters 1997; Watters and Scaglion 1994; see also Knippenberg 2006, 169 and references above). Contemporary communities further west remain characterised as Archaic Age, despite indigenous pottery production occurring in the Greater Antilles long before Saladoid ceramics entered the archipelago (e.g. Keegan and Hofman 2017, 43-47; Rodríguez Ramos *et al.* 2008; Ulloa Hung 2005).

This picture changes with the appearance of new material cultural expressions that are typified as belonging to the Late Ceramic Age (LCA). These first occur in the Greater Antilles at around AD 600 to 700, and are based in demographic, economic, and socio-political developments. The outcomes of these processes included centralised political structures (*cacicazgos*) ruling over dense populations (collectively homogenised as the so-called Taíno) with elaborate and well-developed ceremonial complexes (e.g. Curet 2005; Curet and Oliver 1998; Curet *et al.* 2004; Deagan and Cruxent 2002; Oliver 2009; Rodríguez Ramos 2010a; Rouse 1992; Siegel 2004; 2010; Wilson 1990; 2007). This view is acknowledged to entail significant documentary bias and historical simplification, since the archaeological record indicates a much more heterogeneous past. This is a past comprised of long,

local, and interactive historical contingencies culminating in a mosaic of island societies with different settlement strategies, economic orientations, material cultural repertoires, and social identities (Curet 2003; 2014; Keegan 2007; 2013; Keegan and Hofman 2017; Ulloa Hung 2013a; Veloz Maggiolo *et al.* 1981; Whitehead 2011, 29-32; Wilson 1993). Nevertheless, it remains apparent that political developments centred in Hispaniola were outpacing those on other islands and exerting influence as far as the Lesser Antilles (e.g. Crock 2000; Crock and Petersen 2004; Hofman *et al.* 2008a; Hoogland and Hofman 1999). Factors such as human mobility and stylistic influences (the Ostionoid, Meillacoid, and Chicoid ceramic series) connected local communities across (pan-)regional scales, which includes the exchange of socio-political valuables such as cotton, wooden artefacts, precious metals, ritual belts, lithic, shell, and bone paraphernalia, complex bodily adornments, and polished celts (Alegría 1993; Helms 1987; Hofman *et al.* 2008a; 2011; Keegan 2015; Keehnen 2011; 2012; Mol 2011; 2014; Oliver 2009). Such local and regional socio-political structures persisted during the early years of the European encounter, but were rapidly pressured by European greed for gold and riches. The large-scale imposition of feudalist *encomienda* structures collapsed most indigenous socio-political structures in the early 1500s, and the indigenous people of the Caribbean were subsequently written out of the history books. This notion of cultural extinction is now under severe criticism from numerous directions, including archaeology, history, genetic studies, and popular discourse (e.g. Anderson Córdova 2017; Benn Torres 2014; Castanha 2011; Forte 2006; Hofman *et al.* 2018b; Valcárcel Rojas 2016).

Late Ceramic Age changes in the Lesser Antilles are perhaps equally diverse. They are similarly composed of a series of local contingencies and independent transitions that are interconnected in relation to developments on larger scales. The ceramic evidence indicates the co-existence of various series in the archipelago, particularly at AD 600-850 (Saladoid – Troumassoid – Ostionoid) and 1000-1450 (Troumassoid – Suazoid – Ostionoid – Meillacoid – Chicoid – Cayo complex). Locally, micro-style areas reflect the culmination of the (material) cultural diversification observed to begin in the later Early Ceramic Age (Hofman 2013; Keegan and Hofman 2017, 215-216). Socio-political organisation oscillates with certain sites or islands attaining regional importance at certain times, by manipulating social capital through lithic resource and ceremonial material-based interaction networks. The centralised polity developing in Anguilla between AD 850 and 1200 is interpreted as based around regional control over the distribution of St. Martin mudstone celts and calci-rudite threepointers (Crock 2000; Crock and Petersen 2004; Haviser 1991; Knippenberg 2004; 2006). Greater Antillean influences are increasingly felt in those islands, while the Windward Islands show connections with mainland South America, in particular Orinocia and the Guyanas (e.g. Boomert 2000; 2009; 2013; Crock and Petersen 2004; Hofman and Hoogland 2004; 2011; Hofman *et al.* 2008a; 2014a; Hoogland and Hofman 1999; Keegan and Hofman 2017; Mol *et al.* 2015). The northern islands depopulate in the late pre-colonial phase (Keegan and Hofman 2017, 229, 238) while the Cayo ceramic complex appears in the Windward Islands. Its origin is the subject of debate but now appears to represent a social constellation of people from various island and mainland societies coming to inhabit these islands. The Cayo complex correlates to the historical phenomenon of 'Island Carib' and eventually the ethnic Kalinago people. It represents an amalgam of coastal South American motifs (the Koriabo complex of the Guyanas), connections with other mainland areas, local continuities and adaptations, influences from the Greater Antilles, and incorporation of European material culture (e.g. Allaire 1980; 1997; 2013; Boomert 1986; 1995; 2004; 2011; Cody Holdren

1998; Davis and Goodwin 1990; Hofman and Carlin 2010; Hofman and Hoogland 2012; 2015; Hofman *et al.* 2008a; Honychurch 1997; Hulme and Whitehead 1992; Keegan and Hofman 2017, 15, 231-236; Lenink 2012). It became portrayed as a single coherent social unit the early colonial period for a variety of reasons, though it probably entailed more of a diffracted collective. 'Island Carib' communities maintained their presence in the Windward Islands throughout the following centuries, offering cultural and military resistance against European geopolitical aspirations, or supporting them for mercantilist and political gain (Beckles 2008; Fraser 2014).

2.3 Edge-ground tool complexes

Though the emergence of ground stone celts is generally associated with Neolithisation processes, their antiquity often exceeds that. The oldest examples of such tools date back to over 65kya in Australia (Clarkson *et al.* 2017; Geneste *et al.* 2012; Hiscock *et al.* 2016), and axes from Mesolithic Ireland are characterised differently than Neolithic specimens (Cooney 2008; 2015; Little *et al.* 2016). Similarly, Caribbean edge-ground macro-lithic tool complexes precede any kind of 'Ceramic Age package', with both stone and shell celts being common occurrences in Archaic Age sites (Boomert 2000; Keegan 1994; Hofman *et al.* 2018a; Rodríguez Ramos 2010a; Rouse 1992; Veloz Maggiolo 1991). These tools formed an integral component of early Caribbean lifeways. Though biographical contrasts emerge over time, these are for the most part poorly chartered. The frequencies of typological designs change, including an increase in petaloid forms and the disuse of double-bitted 'butterfly' shapes (*hachas mariposoides)* (Veloz Maggiolo 1972). The use of 'bright' polishing techniques for celts (see below) essentially commences with Cedrosan Saladoid contexts, in partial association with the 'plano-convex adze' type (Rodríguez Ramos 2001; 2010a). It is absent in contemporaneous (and nearby) Huecoid deposits. Much publicity has also been given to inter-island exchange ties from the distribution of (newly) identified exotic green-coloured celt materials, primarily jadeitite and St. Martin mudstone (Crock 2000; Mendoza Cuevas *et al.* 2009; García-Casco *et al.* 2011; 2013; Harlow *et al.* 2006; Hardy 2008; Hofman and Hoogland 2011; Hofman *et al.* 2007; 2011; Haviser 1991; Knippenberg 2004; 2006; Rodríguez Ramos 2010a; 2010b; 2011a; 2011b; Roobol and Lee 1975; Schertl *et al.* 2012; 2018). These patterns transform during the LCA, and include the continued utilisation of a mixture of locally available rocks and imports from elsewhere as well as the further materialisation of 'ceremonial' types (Herrera Fritot 1964; Lovén 1935). However, there is not much evidence for the biographical trajectories of individual Caribbean celts. Manufacturing technology, hafting, use, and values remain largely theoretical, and uninformed beyond spatial distribution patterns, chance finds, and ethnohistoric information post-dating the introduction of metal to the islands. This section recounts what we do know, and what expectations have been formulated.

I will first define the main anatomical terms and functional forms of celts, as edge-ground macro-lithic haft heads, since these are continuously referenced throughout this thesis. For the general orientation, imagine a petaloid celt resting on its flatter side with the bladed end facing down. This end holds the cutting edge, which is the sharpened angle that bears the impacts during use. In other contexts it is common for the area directly behind the edge to be slanted, demarcated from the rest of the surface with an abrupt angle; this is called the bevel. In Caribbean celts the transition is always gradual, and I therefore refer with this term to the maximal extent of the use wear in the area behind the edge (generally 10 to 15 mm). The gross exposed surface aspect is referred to as the face, divisible into proximal, medial, and distal zones in relation to the edge. Both face aspects meet side

aspects at the lateral margins, but the transitions between them are nearly always smooth curvatures in Caribbean celts. Finally, the distal 'tip' is called the butt or poll and can be variably shaped; the bilateral sides taper towards a point in petaloids, but butts may be sculpted or flare outwards in eared axes and related types. I also refer to the transverse plane, which divides the proximal edge and distal butt (a straight cross-section from side to side), and oblique planes which incline at least 30° thereto.

Axes and adzes comprise two major types in the indigenous edge-ground tool complex(es). These further contain a variety of other functional forms, as well as purported ritual tool forms and capable non-lithic materials. Defined on the basis of their attachment to the haft, axes occupy a lateral position with the edge parallel to the long axis of the handle. Adzes instead occupy a latero-distal position and with the edge perpendicular to the long axis of the handle, which is often also bent to allow for a downwards striking motion (Figure 4). These functional realities need to be extricated from typological classifications, which tend to designate asymmetric planviews as adzes or assume attachment bindings from morphological features such as notches. Such associations are not in reliable agreement with traces of wear or limitations of design, however (Sections 8.3 and 10.2.5), and thus require demonstration. It is mainly for these reasons that I use the term celt as the undefined analogue for physical artefacts, to forego the implication that the relation to haft and function is known.

There are additional reasons why typology is problematic for the interpretation of celt biographies. Any morphometric variation is ill-defined and currently of no interpretative value (Rodríguez Ramos 2010a), while given shapes are continuously altered through the use life (Section 3.1.3.3). Nevertheless, it remains important to describe several common forms as these recur frequently. The majority of materials are petaloids in the broadest sense. In planview these celts have convex or round blades and variable tapering of the bilateral sides towards the butt, ranging from tear-drop shapes ('true' petaloids) to more almond shaped (almonoids) outlines. Median cross-sections are elliptical

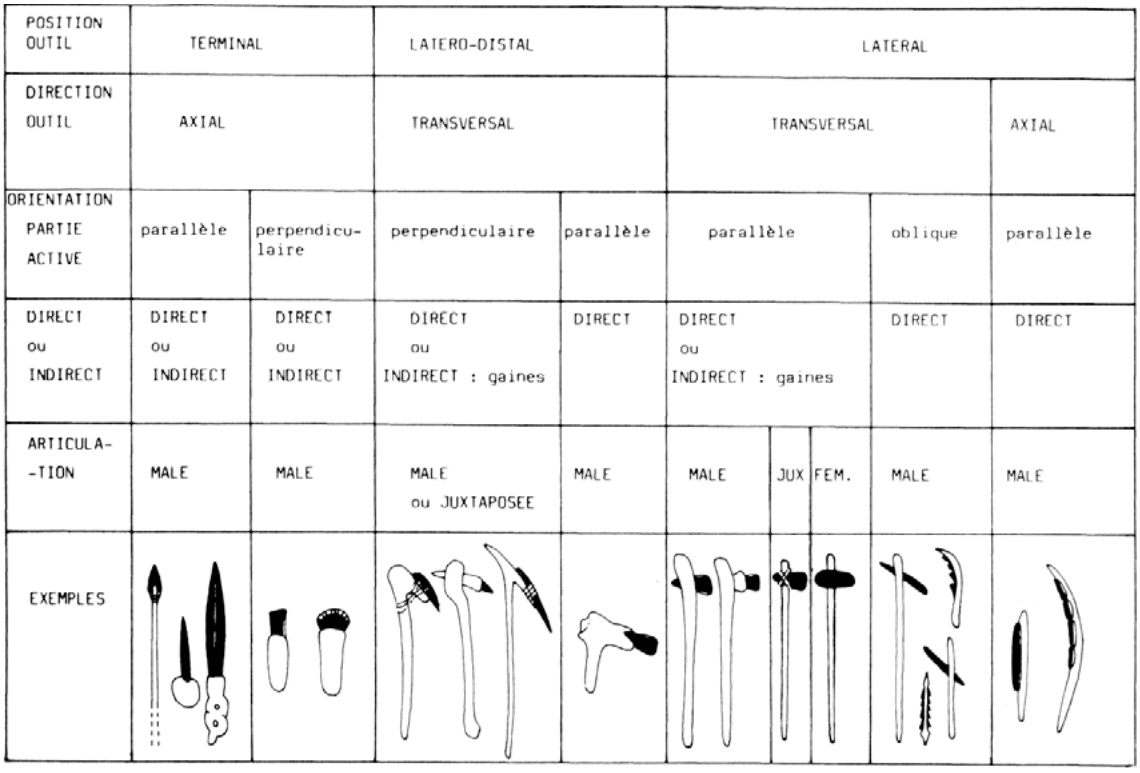


Figure 4: Schematic combinations for different attributes of a haft (Stordeur 1987).

or biconvex (which can be asymmetrical, but opposes more defined plano-convex morphologies), and the transition between edge and side can be gradual or demarcated. Celts with straighter edges, wide butts, or lacking tapering are more generally termed biconvex celts, and will for instance include wedges. Both occur in all sizes, which for the present purposes I define as very small (below 5 cm), small, (5-7 cm), medium (7-10 cm, to 10-12 cm), large (10-12 cm), and very large (above 15 cm). Morphological chisels are usually smaller, elongated tools with straight edges and sides, and rectangular to circular transverse cross-sections. Most typological 'micro-axes' from the literature are either chisels or very small petaloids, some of which were analysed during the present study.

By far the best explored biographical characteristic of Caribbean celts is the variety of raw materials employed to manufacture them. The typifying presence of certain materials in regional contexts has long been recognised and includes early descriptions of the presence of such rocks as 'jadeitite' (Mason 1876, 373) as well as cultural contrasts drawn between Greater Antillean 'greenstones' and Lesser Antillean 'volcanic materials' (e.g. Lovén 1935; Mason 1884, 734-737). More recently, much attention has been given to the ties between source regions and the exotic contexts in which some materials are found. The current focus is on jadeitite, as several recent studies have convincingly reaffirmed both the archaeological exploitation and long-distance exchange of celts from this rare rock material (Cárdenas-Párraga *et al.* 2010; García-Casco *et al.* 2011; 2013; Hardy 2008; Harlow 2007, in Rodríguez Ramos 2010a, 140-141; Harlow *et al.* 2006; Hertwig 2014; Knippenberg 2012; Schertl *et al.* 2012; 2018). However, it is far from the only rock that was transported across the archipelago and thus cannot provide a good picture of the actual complexity of celt exchange. Many of those are commonly described as 'greenstone', the application of which - like that of 'jade' – is inconsistent and problematic. In essence, these groups are ideational units (*sensu* O'Brien and Lyman 2002), constructed upon extensionally derived descriptions (the state of being or having been green for greenstones and added social value for jades). They do not actually correspond to petrological definitions or to empirical units which constrict internally characteristic source locations or geochemical fingerprints. Properly speaking, most Caribbean celt materials described as 'greenstone' are jadeite-bearing rocks or materials associated with greenschist facies metamorphism, which contain the pyroxene mineral jadeite, and green chlorite-group, epidote, and/or actinolite minerals respectively (Section 4.4.3).[4] The ideational unit further includes the grey-green mudstone from St. Martin, the previously mentioned green-coloured lapidary rocks of which serpentinite was used for ECA celt-making in Puerto Rico (Hofman *et al.* 2010), and probably still other green rocks (e.g. green peridotite in Herrera Fritot 1964). Certain green minerals are linked to desirable working properties for celts (Risch and Martínez Fernández 2008; Rostain and Wack 1987), but the colour has long been recognised as having significant cosmological depth: its use is shared with important iconographic-symbolic artefacts (Boomert 1987; Roe 1982).

'Greenstone' is in this sense basically synonymous with the term of 'social jade'. This term is used in Mesoamerican research to describe rocks with greenish hues considered as potentially symbolically interchangeable with the true material (Lange 1993). It has recently been imported into the Caribbean with the equivalent intent of associating 'other greenstones' with the circulation of pure jadeitite (e.g.

4 The rock petrologically defined as greenstone is dominated by chlorite, actinolite, epidote, and albite (the greenschist assemblage, but absent the eponymic schistosity). These rocks are in the present work referred to as (non-schistose) greenschists to avoid confusion with ideational groupings. My use of terms such as 'greenstones' henceforth refers to literature descriptions that lack identifications of the actual rocks.

Rodríguez Ramos 2010a; 2010b; 2011b). Mesoamerican 'social jades' actually comprise, amongst others, "jadeite, omphacite, serpentinite, metagabbro, albitite, basalt, gabbro, and porphyry" (Powis *et al.* 2016, 61; see also e.g. Jaime-Riverón 2010; Tremain 2014), a heterogeneous suite in formation and mechanical properties. These authors caution against the liberal application of such ideational categories, as well as against perpetuating the analytical bias towards singling out jadeitites, especially the presumption that this rock type is a homogeneous 'emerald-green'. This has proven detrimental to an understanding of other valued rock materials in Mesoamerica, both in their own respect and with respect to their valuation against each other, as those materials are currently only assumed to be interchangeable as a form of 'non-pure jade'. Distinguishing the actual rocks involved has clear bearings upon arguments involving source and origin, access to materials, technological procedures, and aspects of materiality, all of which differ immensely between the various lithic resources captured under otherwise generic terms. The pertinence of this discussion to the archaeology of the Caribbean is evident.

Thus far these various greenstones comprise the main metamorphic categories, as blueschists and other metamorphic rocks have only rarely been identified in celts previously (Casagrande in Romon *et al.* 2017, 52-56; Hull 2014; Roobol and Lee 1975). Igneous and sedimentary rocks are both common, however, though as with any material the use and frequency varies between contexts. Basalts and andesites are common volcanic rocks in the region and form the most basic material for celt-making. Nearly all buttressed types are said to be of such materials (Keegan and Hofman 2017, 41; cf. Section 6.1.1). Properly speaking, these are mafic and respectively intermediate volcanic lavas, since the mineralogical and/or geochemical compositions are usually not detailed. Other commonly identified igneous rocks include (siliceous) tuff, black peridotite, plutonic rocks of relatively small grain (often with a salt-pepper texture), and so on. Siliceous shale is also encountered in numerous assemblages. Some of these are region-specific (e.g. black peridotite in Puerto Rico, R. Rodríguez Ramos, pers. comm. 2018) and others associated with particular time-periods (Section 10.2.2), but this variation has only been mapped for the Leeward Islands (Knippenberg 2006). Shell formed an important raw material, since both the lip and the columella of an adult *Lobatus gigas* provide sufficient body and sturdiness for the production of medium to large-sized celts. Such celts are very common in the Lesser Antilles, the Bahamas, and are also frequently seen in the Greater Antilles from the Archaic Age onwards. Other large *Lobatus* molluscs and a few taxa in other genera also grow shells thick enough to be made into hafted edge-ground percussion tools. Additional exceptional materials include tortoise shell and a knapped chert celt in LCA St. Lucia (Negrete Martínez 2015). Chert is otherwise not used at all for such tools in the region.

The technological sequences for Caribbean hard stone celt-making are not well known, as these have been studied in only a few cases. St. Martin mudstone is the proverbial exception, since extensive attention has been paid to the inter-island reduction trajectories of this material (Crock 1995; 2000; Haviser 1999; Knippenberg 2004; 2006). Grey-green material from specific mudstone beds with the best flaking and corrosion properties was acquired on St. Martin in blocks from the primary outcrops by communities from the surrounding islands. Brought to the settlements, the blanks were shaped by a few bifacial thinning blows and subsequently ground, before being used and rejuvenated or exchanged with communities farther away (Knippenberg 2006, 243-253). Similarly, the experimental sequence for shell celt separation involves the separation of the lip through percussion and successive grinding to attain the shape, which is the main feasible route given the architectural particularities

of the material (Section 4.4.4). In Aruba, diabase pebbles were reduced at the Coashiati quarry where they occur using either direct conchoidal or bipolar percussion, depending on the size, to be subsequently taken to the settlement for further pecking and grinding (Rostain *et al.* 2005). Other than that, the generically observed trajectory for hard rock materials is procurement of a suitable sized pebble from primary or secondary context, followed by the potential use of percussion (pecking more often than lateral flaking) and then grinding of the edge area. Further abrasion is again optional at all levels, but high levels of lustres ultimately be attained (e.g. Casagrande 2011; Knippenberg 2012; Rodríguez Ramos 2010a).

The manufacture of an edge-ground macro-lithic is therefore a complex and multi-step process, even if choices are often made to avoid certain operations. The aforementioned techniques can be applied in dynamic order, but in sequence they follow progressively finer scales of material removal. The shaping of the blank into a bifacial roughout involves direct percussion divided into fashioning the bifacial (elliptical) contour and finishing the bilateral plane (sides and edges) (Inizan *et al.* 1999, 43-55). In freehand mode this produces flakes and scars approximating conchoidal morphologies on isotropic materials (force radiating evenly, includes feather terminations), but when the blank rests on an anvil counterblow occurs and step fractures and hinge terminations become more common. Hard hammerstones are known in many materials and sizes, which would translate to different attrition rates (Dickson 1982, in Olausson 1982/1983; Pétrequin *et al.* 2012a), whereas there are no reliable indicators for softer hammers in the Caribbean (cf. Rostain *et al.* 2005). Indirect flaking and pressure techniques are also not known from stigma, whereas grades of pecking are exceedingly common.[5] It is through these techniques that basically unmodified blanks are roughed out and thereafter preformed, terms which equate to initial and advanced shaping stages and which are presently employed to distinguish flaked from (subsequently) pecked half-fabricates. It must be observed that there are plentiful ethnographic and argued archaeological settings in which celts were exchanged in this stage of their biography, rather than as finished products (e.g. Boomert and Kroonenberg 1977; Burton 1984; 1989; Frieman *et al.* 2017; Rostain *et al.* 2005; Rosenberg *et al.* 2008; Pétrequin and Jeunesse 1995; Pétrequin and Pétrequin 1993).

Abrasion, which is defined as a mode of wear (Section 4.2.1.1), forms the primary process of the grinding and polishing techniques commonly used to complete the manufacturing process. There is substantial variation in smoothened and lustred surfaces of circum-Caribbean artefacts indicating diverse abrasive technologies. Distinguishing between these sets of techniques remains rather qualitative, however, as there are no established methodologies for separating or ranking the results. For present purposes I define *grinding* as a technique with the primary intent to reduce surface asperity and remove material in the process, and *polishing* (verb) as a technique with the primary intent to form a macroscopically visible lustre. Both are laborious, repetitive processes requiring prolonged contact between media. *Polish* (noun) refers to reflective microwear structures further defined in section 4.2.1.3, and the macroscopic outcome of reflectance from a smooth glossy surface is referred to as *lustre*. Analogous to its use in mineralogy, dull (or earthy) lustres actually denote the absence of any particular reflection, most brighter reflectances being greasy or metallic. Lustres in between are diffuse, scattering light rather than reflecting a smooth adjoined sheen. Practically, grinding and polishing can operate independently, or a single combination of abrasive platform (grinding station),

5 Alternative extraction and blank shaping techniques, such as (string-)sawing and thermal shock treatment, have not been identified from amongst insular Caribbean celt production chains as of yet.

lubrication and additives, and kinematics may yield both primary intents as outcome. The actual variables and successive sequences form the major topic of analysis.

In spite of a large geological variety in rocks and sands of probable suitability, and for several a recurrent archaeological presence as querns/metates or unspecified grinders, what indigenous grinding and polishing technology consisted of remains uncertain. Elkhorn coral (*Acropora palmata*) had been employed for polishing shell (Lammers-Keijsers 2007; Van Gijn *et al.* 2008; cf. also Kelly 2003; 2004; Kelly and Van Gijn 2008; and Breukel and Falci 2015), but it is not suitable for hard rock materials and not distinctive when serving as the surface for a quartz sand abrasive (Chapter 5). The main contending hypothesis is the *polissoir* model, which entails the use of large boulders in riverine or coastal settings as stationary grinding surfaces. Such activities are well documented in the ethnohistory and archaeology of nearby South America (e.g. Amaral 1995; Boomert and Kroonenberg 1977; Bueno 2010; Loncan 1985; Rostain 1994; Rostain and Wack 1987; Tenório 2003; Versteeg 2003, 27; Vieira de Oliveira 2013), and a few promising 'basaltic' boulders are known from the Windward Islands (Barbotin 1974; Hanna 2017; Kirby 1969; cf. Casagrande 2011; Van den Bel 2018). However, in spite of frequent contemplation no convincing identifications of stationary cupuled boulders have yet been provided north of these islands. Lacking any corroboration of materials, then, the primary experimental option will be sandstone as this is the all-purpose class of abrading materials, which is both common in Amerindian ethnohistory (Section 5.1) and as an identified material in various Caribbean archaeological sites (e.g. Boomert and Kameneff 2003; Bullen and Bullen 1973; O'B. Harris 1971; 1979; Knippenberg 2006; López Belando 2013; Rodríguez Ramos 2001).

Celts from the region are typically assumed to be hafted as axes, unless morphological aspects suggest tying or resting in which case they are designated as adzes. This approach is directly correlated to the major dichotomy in use types, between the felling of trees (for land clearing or timber purposes) and the hollowing out of dugout canoes. Caribbean axes are generally assumed to consist of the celt head transfixed in the perforated and embossed distal end of a wooden handle. Direct evidence for this rests in a few surviving wooden hafts known since the 19th century (Herrera Fritot 1964, 135; Mason 1876, 372-373; Ostapkowicz *et al.* 2012), recently augmented by finds from the waterlogged deposits of the Manantial de La Aleta, Dominican Republic (Beeker *et al.* 2002; Conrad *et al.* 2001; Ortega and Atiles 2003) and the LCA habitation site of Los Buchillones, Cuba (Jardines Macías *et al.* 2013; 2015). Furthermore, the skeuomorphic design of the rare category of monolithic axes from the Greater Antilles imitates this particular hafting system in stone (Lovén 1935; Herrera Fritot 1964; Saville 1916). Slightly modifying the classification system of tool attachment modes from Stordeur (1987) stated above, this is a *direct* articulation (protruding the *split*) *male* slot positioned *laterally* from the long axis of the handle, with the cutting edge *parallel* to it and moving in *transverse* orientation from it. The system does not discriminate ligatures and adhesives, which are optional for any type of attachment. Traces of wear form where the head actually connects with the handle and thus distinguish only the type of articulation and slotting, but morphological factors and symmetric distribution of traces of use can contribute to a reconstruction of the position and orientation (e.g. Rots 2010).

Direct evidence for adzes has emerged only in recent years from Los Buchillones, with the discovery of four carved bent handles together with 36 axe hafts of varying lengths. These appear to be within the size range for one-handed use and present triangular depressions for the fastening of a petaloid using a binding system (Jardines Macías *et al.* 2013; 2015). A fifth handle consists of a

small (7cm) straight shaft with an oval depression, implying a terminal-axial-juxtaposed fitting. The existence of sea-going dugout canoes and asymmetric celt shapes already indicated the presence of hafted tool designs capable of downward (perpendicular-transverse) motions, though they do not prove juxtaposed attachments. The issues with symmetries have been noted, and to my knowledge, stone adzes are also virtually absent from lowland South America in spite of canoes forming the principle watercraft in that context. Two additional attachment systems are known from ethnohistoric sources, both variants of male articulations for axes. Oviedo describes a hafting system from the Greater Antilles in which the handle is split and the celt inserted in the cleft, secured with twine (Joyce 1916, 236; cf. Carneiro 1979b), and various authors describe hafting by inserting the celt into a hole cut in the living tree and waiting for several months until the wood has grown around it. It was primarily practiced in the Guyanas (Crevaux 1993, 49; Stedman 1806, 412), with purported discoveries of winged axes embedded high in old, hollow trees in Surinam (Penard and Penard 1917). Mason (1884, 737) also associates it with Guadeloupian 'Caribs'. Experimental research has demonstrated the procedure to result in a viable haft (Neves de Souza and Pessoa Lima 2014; Petitjean Roget 1985). Additional attachment types are known from amongst several Amerindian groups in lowland South America (though see sections 3.2.3 and 10.2.4). Those are often based around large buttressed types, such as grooved axes, T-shaped axes, notched axes, semi-lunar axes and so on, though biconvex celts are used by others. The first is termed wrap-around hafting (*sensu* Adams 2013, 171-174) and is not well definable in the system of Stordeur (1987), but consists of a branch that is either bent over or fully wrapped around the medial area of the head (examples in Carneiro 1974; Fernández González 2016). The second consists of axes with juxtaposed abutting, in which the wide butt is positioned to rest against the long axis of the shaft and affixed with adhesive resins and ligatures (examples in Carneiro 1974; Cristiani *et al.* 2008; Rostain and Wack 1987; Versteeg 2003; Versteeg and Rostain 1999).

As was mentioned, woodworking is traditionally considered to be the functional domain for regular-sized Caribbean celts, with tree-felling and canoe making as the main activities. Indeed, there is abundant ethnographic and ethnohistoric information pertaining to them. The dugout canoe was the primary class of indigenous watercraft both in the Caribbean and in lowland South America, eliciting frequent commentary– and when necessary use – by European chroniclers and seafarers (see Callaghan 2007; Fitzpatrick 2013; Glazier 1989; Lovén 1935; McCusick 1960; Slayton 2018). Several rich descriptions survive on the social and technological procedures in making canoes by the inhabitants of the 17th century Windward Islands, who had by then fully transitioned to a steel tool economy (Anonymous flibustier, in Moreau 1990; Breton, in Barbotin 1971; Petitjean Roget 1961; Du Tertre, in McCusick 1960; cf. Glazier 1989; Nicholson 1975). A tree would be felled by axe or girdled with fire, after which the log would be gradually hollowed out by burning small fires and hewing out the char, and perhaps steam-bent. Such watercraft continue to be made until today by the Kalinago of Dominica, as well as Amerindian communities in northern South America: the Warao from the lower Orinoco are historically famous for their canoes.

Tree-felling, as the other main activity, is connected primarily to the clearance of land for horticultural practices. Until recently manioc (*Manihot esculenta*) was considered to be the staple crop of indigenous subsistence strategies (Boomert 2000; Newsom and Wing 2004; Rouse 1992). This tuber is historically cultivated via swidden agroforestry, or slash-and-burn, which involves the periodic clearing and burning of new forested plots following depletion every few years. Nowadays, the pre-

colonial extent of manioc cultivation needs to be reassessed in light of the increasing evidence on the importance of staples such as maize (*Zea mays*) (Berman and Pearsall 2008; Mickleburgh and Pagán-Jiménez 2012; Pagán-Jiménez *et al.* 2015) and of concerns raised on stone axe efficacy in Amazonian swidden practices (Section 3.2.3). Nevertheless, indigenous land clearing practices are not limited to swidden alone, but address habitational concerns as well.

Impact marks on house posts and surviving utilitarian and ceremonial wooden objects are strongly suggestive of the use of edge-ground tools in their fashioning (Ostapkowicz *et al.* 2013; Valcárcel Rojas *et al.* 2006), although wood as a contact material on celts has only been demonstrated in a study on shell from LCA Anse à la Gourde, Guadeloupe (Lammers-Keijsers 2007). Here, wear traces evidenced fresh, dry, and burnt woodworking next to a mixture of traces more properly indicative of multipurpose activities. Though woodworking is often presumed from the presence of macroscopic edge scarring, such traces may also develop from other hard contact materials. Alternative use domains are sometimes proposed as well, but have not garnered much inquiry in the Caribbean. Conversely, the ethnographic and archaeological literature from other continents demonstrates uses ranging from underbrush clearing to barkworking and soilworking, the butchery of large carcasses, preparation of leather, and honey gathering. More commonly accepted is re-use of damaged celts, with the sides repurposed as edge-grinders or the faces as anvils, ground surface fragments used as polishing stones, butts used for percussion, or the blade blunted into pounding implements. Examples of such biographical trajectories are known from various places since at least the Early Ceramic Age onwards (e.g. Breukel 2015; Chancerel 2003; Kaplan and Patch 2014; Knippenberg 2006; Rodríguez Ramos 2005a, 61-63). Finally, with respect to deposition, most celts in the Caribbean originate in midden areas or habitation palimpsests, and otherwise as context-less finds in the fields. The only exceptions that I am aware of concern two instances of celts as burial gifts in the sites of Erin and Atagual, Trinidad (Boomert 2000, 317) and the occasional association with burials in ECA Puerto Rico (e.g. Rodríguez Ramos 2010a, 106; Siegel 1992; 2010).

2.4 Perspectives on paraphernalia

The categories of ethnic art produced by the indigenous societies of the Caribbean are incredibly diverse (see e.g. Arrom 1975; Bercht *et al.* 1997; Dacal Moure and Rivero de la Calle 1996; Kerchache 1994; McGinnis 1997; Oliver *et al.* 2008; Vega 1987). The majority of these can be defined as paraphernalia in accordance with the criteria specified previously. However, this only emphasises that the label primarily serves to categorise 'other [special] objects' separable from quotidian artefact groups such as tools or refuse. The variety in this group needs to be unpacked in order to grant the label explanatory meaning. For instance, the object classes traditionally regarded as *zemi* (also spelled *cemí* or *cimi*) in deference to the tangible spirit-physicalities of Ramón Pané (1999) all qualify as paraphernalia, yet an identifier such as *zemi* is specific to its particular context. It is debatable if face-depicting carved shells should be considered as a type of *zemi* (Mol 2014), while inlays are mere components at best, ornamental plaques seem incomparable, and the term is inappropriate to objects indigenous to the 'Island Carib'. There are myriad ways in which such things can relate, constitute, or interfere with social, ceremonial, or quotidian processes, which is why again each biography must be considered on their individual trajectories.

The carved shell object types in the present work comprise inlays, plaques, and various face-depicting shells. The osseous materials include tooth pendants and carved bone instruments, primarily

aerophones. What each of these classes consist of and how they are understood in relation to the Caribbean archaeological record is discussed here in the necessary detail. Unlike for the celts there is little point in defining a terminology, since these terms usually describe outcomes of the analysis. For the more complicated artefacts, standard anatomical terminology is used where applicable to bony features or iconographic designs.

Carved shell objects are a common occurrence in the circum-Caribbean, owing to the great diversity and abundance of suitable shells in the region. Besides a plethora of expedient and simple formal tools, the prolific diversity of regalia carved from them ranges from small personal adornments and figurative pendants to engraved trumpets, and includes many types of objects of whom the function is not well understood (see e.g. Clerc 1973; Keegan 2018; Lammers-Keijsers 2007; O'Day and Keegan 2001; Ortega 2001; Serrand 1997; Sutty 1977; Van der Steen 1992). The inclusion of some of these as potential paraphernalia in the present sample also reflects my intent to examine their biographies to affirm how they should be regarded as such (Chapter 9). The technological possibilities offered by shell are relatively well understood, since significant work has been done on the experimental replication of the various tools and ornaments made in this material (e.g. Breukel and Falci 2015; Dacal Moure 1997; Falci *et al.* 2017b; Golding-Frankson 2009; Keegan 1984; Lammers-Keijsers 2007; Lundberg 1983; Vargas Arenas *et al.* 1997).

A frequently encountered class of such artefacts are inlays, objects of whom the presumed function is to be embedded within a host material of wood, stone, or pottery (Alegría 1981; Boomert 2000, 477-478). The majority of Caribbean anthropozoomorphic sculptures retain negative features with rough production stigma, particularly on the facial area, that may have carried encrustations in the past to complete or enhance their imagery. Some stone and wooden sculptures still retain their linkage with inlays of shell and nacre, precious metals, and other materials as their eyes and mouths (see e.g. Alegría 1981; Oliver *et al.* 2008; Rodríguez Ramos *et al.* 2013). Furthermore, the few extant cotton idols display a complex joining of inlays, including European materials such as mirrors, also in ear and palm depressions (Alegría 1993; Martina *et al.* 2010; Ostapkowicz 2018; Ostapkowicz *et al.* 2012; 2013; Taylor *et al.* 1997). As separate artefacts the most commonly identified inlay forms are incised bared-teeth motifs, easily associable with the mouthpieces of aforementioned carvings and adornos. Oval to circular pieces with concentric motifs are sometimes interpreted as the inlays for eyes, particularly rare nacreous ones. Once encrusted, the biography becomes that of a composite artefact – a merge of materialities –, which is archaeologically identified with the bare host sculpture rather than the isolated material of the inlay. However, at least one alternative biographical joining is suggested by the placement of a bared-teeth inlay in the mouth of a human burial at the site of Paso del Indio, Puerto Rico (Walker 2005, 76). Potential types of inlays that lack such diagnostic motifs are not commonly identified, though they undoubtedly existed. It is imaginable that many smaller geometric shapes that otherwise appear to serve no particular function were once encrusted into a wider variety of larger artefacts than presently suspected. Such inferences are sometimes made likely by the presence of wear and residues, but these indicators usually lack; the present dissertation is limited to typological eye and mouth inlays.

Shell plaques form a second category of which examples are widely distributed; they can be blank or engraved and appear in two-dimensional (flat) and three-dimensional (sculpted) forms (e.g. Clerc 1973; Lammers-Keijsers 2007; Turney 2001; Sickler Robinson 1979). These objects are commonly regarded as decorative, emphasised by the recovery of such plaques from a burial context at the site of

Golden Rock 1, St. Eustatius (Van der Steen 1992). However, the literature is undecided with respect to their precise functioning. Some could be strung as pendants, others link unconnected strings (whether part of an ornamental configuration or not), be sewn onto clothing or composite artefacts, or have had yet unconsidered uses. A specific three-dimensional sub-variant thereof contains a central ridge on the long axis that ends in dual oblong projections, isolated examples of which are known from numerous sites.[6] The primary hypothesis infers these plaques as bead spacers. This is suggested by the specimen acting as a bead and string separator in the beaded belt displayed at the Fundacíon García Arévalo in Santo Domingo, supposed from an archaeological context (Alegría 1993). Conversely, both Cartwright *et al.* (1991) and Lammers-Keijsers (2007, 90) interpret these plaques as potential fishing lures. Considering the inferred relation of plaques with composite ornamentation, in particular chiefly regalia, the purpose behind their inclusion is also to figure out how diverse such applications are.

The various face-depicting shells include several shells that are (completely) transformed into depictions of the heads or faces of beings, a particular type known from ethnohistoric descriptions as *guaízas*, as well as a few artefacts to which the addition of a zoomorphic face is secondary to the primary function. Specifically, these include a ring-like object, a zoomorphic pendant, and a geometrically engraved tinkler (since these are otherwise always face-depicting when engraved). *Guaízas* are social valuables that were frequently exchanged in the strengthening of indigenous political relationships between local and regional elites (Arrom 1975; Mol 2007; 2010; 2011; 2014; Oliver 2009). Furthermore, these artefacts are understood to physically exemplify, signal, and embody (to index, in the terminology of Gell 1998) the *perspectives* of living beings (Section 3.2). They therefore have certain (latent or agentive) spirit-like properties of their own. *Guaízas* are a Late Ceramic Age phenomenon which have a clear connection to the societies of the Greater Antilles. Their occasional provenience deep in the Lesser Antilles therefore signals the geographic breadth to which those political institutions exerted some degree of cultural presence (e.g. Crock 2000; Crock and Petersen 2004; de Waal 2006; Hofman 1995; Hofman and Hoogland 2011; Hofman *et al.* 2008a; Mol 2007; Sutty 1977). The precise functional application of these objects remains enigmatic, though it has been suggested that they were worn on the body in various guises or in belts and headdresses, and could support inlays from precious metals and small adornments themselves.

As for the other objects, they form more classic examples of iconographically embellished paraphernalia. Ring-like artefacts are not well known from the Caribbean, though rings and larger bracelets made of bivalves such as *Spondylus* spp. were prized exchange valuables in other premodern contexts, e.g. the Neolithic Balkans (Chapman and Gaydarska 2007; 2012; Dimitrijević and Tripković 2006; Gaydarska *et al.* 2004) the Lapita complex of Melanesia (Szabó 2010), and Mesoamerica (Price 2012). Rare examples from the eastern Caribbean are mostly broken (e.g. Van der Steen 1992, 114), though lavishly sculpted intact specimens survive (Dacal Moure and Rivero de la Calle 1996, 116-122; Petitjean Roget 2015b, 305). Their functions are unknown. The ornamental implication found these other studies is merely hypothetical, since such objects may also have anchored strings in any

6 Amongst others, the Le Moule museum and Anse à la Gourde, Guadeloupe (Lammers-Keijsers 2007, 90), Carriacou (Sutty in Lammers-Keijsers 2007, 90), 'Pearls' (personal observation), St. Kitts (Fewkes 1922, 163), Spring Bay 1a, Saba (Hoogland 1996, 87), Puerto Rico (Rainey 1940, 203), the Dominican Republic (Alegría 1993), and Elliot's, Antigua (Turney 2001, 77-79). Small plaques without ridges from Tanki Flip bear the same perforation structure (Serrand 1997), and related objects with different perforation configurations occur in Silver Sands and Hillcrest, Barbados (Cartwright *et al.* 1991).

sort of other configuration. Finally, tinklers are struck idiophones that produce sound when they impact each other when dangling from a string. They are common in the archaeological records of the islands and are typically made of shells from the *Oliva* genus, which are modified for resonance and suspension (see e.g. Falci 2015c; Lammers-Keijsers 2007; Sickler Robinson 1977). Examples are known from the Greater Antilles in which morphological tinklers are technologically merged with the expressive three-dimensional facial design styles normally reserved for *guaízas* (Dacal Moure and Rivero de la Calle 1984, 144-145; 1996, 120-121), but little attention has been paid to these artefacts specifically.

Carved bone materials form the final aspect of indigenous material culture of high interest to the present study. Bone as a raw material was not in regular use by Ceramic Age communities in the insular Caribbean. When modified osseous elements are found, they were virtually always made into ornaments, snuff paraphernalia, portable figurative art, or related object categories. The present assemblage divides into two distinct technological categories.

Tooth pendants consist of dental elements from a variety of animals that are pried loose from jaw structures (presumably skeletonised) and perforated, but usually not further modified. The vast majority of archaeological tooth pendants are canines and molars of dogs (*Canis lupus familiaris*), thousands of which are known some of which are engraved with geometric or facial designs (Boomert 2000; Ortega 1978a; 1978b; Narganes Storde 2003; Roe 1989; Walker 1983). The dog is argued to have occupied an elevated social status within the societies of the islands (e.g. Boomert 2000; Giovas 2018; Grouard *et al.* 2013; Newsom and Wing 2004; Plomp 2013; Rodríguez López 2007; Roe 1982; 1989; 1993; Shev 2018), and isotopic studies have revealed how both osseous elements as well as the animals themselves were widely exchanged in pre-colonial times (Laffoon *et al.* 2013; 2016; 2017a). Dental elements from mainland mammals, such as tapirs, peccaries, and jaguars are occasionally found in insular context as well (Giovas *et al.* 2012; Laffoon *et al.* 2014), the latter thus far only in the Early Ceramic Age. Such pendants are principally thought to have been strung in necklaces by the hundreds, as this is their most common mode of use in ethnographic contexts (Ribeiro 1988; cf. Breton, in Petitjean Roget 1961, 58). Nevertheless, teeth pendants can also be incorporated in clothing such as aprons or belts, or used to decorate artefacts (e.g. the Quebradillas vessel, in Ostapkowicz *et al.* 2012). A great variety of animal species contributed to the adornments of various communities in the Guyanas, as Roth (1924, 432) illustrates.

Often ignored in this discussion of (arguably pan-)Caribbean material culture and human-animal-thing relations is the propensity to adopt the osseous elements of large marine animals for the same adorning purpose. The ethnographic use by Amerindians of dental elements from fish and sea mammals as objects of personal ornamentation is nowadays rarely observed, but not entirely unheard of (Roth 1924, 433). The conceptual contrast rests between the inland riverine lowlands, and the marine setting of the Caribbean archipelago: perforated seal and shark teeth, fish vertebrae and dental plates, and so on were evidently widespread, sometimes in significant numbers.[7] With the exception

7 From a cursory review of the literature, such artefacts were found in Cuba (Dacal Moure and Rivero de la Calle 1984, 92-98; 1996), Playa Grande, Dominican Republic (López Belando 2012, 203), Sanate, Dominican Republic (Hall 1978, 38); Cagüitas, Puerto Rico (Rodríguez Lopez 1985), San Salvador Island, Bahamas (Winter and Wing 1993), Barnes Bay, Anguilla (Crock 2000), Anse à la Gourde, Guadeloupe (Grouard 2003 in Lammers-Keijsers 2007, 50), Grand Bay, Carriacou (Sutty 1977; 1989), Pearls, Grenada (Cody 1989), Golden Grove, Trinidad (O'B. Harris 1975), Tanki Flip, Aruba (Grouard 1995) and the Archaic Age Spaanse Water site in Curaçao (personal observation). Furthermore, De Wolf (1953, in Allsworth-Jones 2008,157), reports a perforated tooth of a crocodile in the Jamaican site of Retreat (A13).

of sea turtles, whom feature prominently in the few recorded mythologies (Pané 1999; see Section 3.2.1) and manatee, whose bones were frequently used for making paraphernalia, little is known about the significance attributed to these particular animals by indigenous communities.

With respect to carved bones, the present research involves wind instruments and a long bone decorated with anthropomorphic curvilinear design. Other types include snuff pipes and bowls, vomiting spatulas, engraved pectorals, small carved figures, geometrically incised bones, and so forth, known from various time periods and cultural contexts. Such objects are presumed to have fulfilled important functions in the ritual, political, and perhaps social landscape, the exact domain of use depending on the type of artefact (Oliver 2009; Rouse 1992; Stevens-Arroyo 2006; Vega 1987). These are made predominantly of manatee bone, but occasionally from other large species such as deer, dog, or human. Modification of the latter is nowadays viewed mainly in the light of ancestor veneration practices, though trophy taking remains a distinct possibility (Petersen and Crock 2007; Roe 1989). Bone tubes may have functioned specifically as containers for narcotic products, in light of ceramic pipe finds containing rolled tobacco leaves (Boomert 2000, 480). Both occur in mainland and insular Saladoid contexts, and many parallels exist in ethnohistoric Antillean ethnohistory and Guyanan ethnography (Boomert 2000, 452-453). For many Amerindians hollow tubes such as blowpipes channel and transmogrify the force of breath into other ambiguous energies, relating to variably expressed shamanic inquisitions during hunting, ritual, sickness, and warfare (Chaumeil 2001; Erikson 2001; and see e.g. Lévi-Strauss 1966; Rivière 1969).

Aerophones are part of this continuum of hollow tubular instruments (Hill and Chaumeil 2011b). There is a tremendous variety in aerophone design, material, and taboo amongst Amerindian groups, ranging from small panpipes to the sacred Yurupari instruments of northwestern Amazonia, and from manipulated animal skulls to enormous rolled bark trumpets (e.g. Aretz 1991, 451; Biocca 1965, 337-338; Chaumeil 1997; 2007; Izikowitz 1935; Koch-Grünberg 1921, 191; Ribeiro 1988, 195-212; Roth 1924, 451; Yde 1965, 190-194). wind instruments[8] made of long bones find widespread expression, if somewhat less common today, and are designed both as end-blown or side-blown flutes, with our without duct. The placement of mouthpieces, ducts, and tone holes varies, though three holes seems the most common. Such instruments date back to at least ca. 8000 BP in northern Amazonia (an end-blown flute made of a human radius, Groot de Mahecha 1992, 56-58), and ethnographic examples are commonly made of deer (*Odocoileus virginianus* and *Mazama* spp.), jaguar (*Panthera onca*), tapir (*Tapirus* spp.), or monkey (*Platyrrhini*) long bones.[9] Few bone wind instruments are archaeologically known from the Antilles, predominantly in association with burial contexts in the ECA Puerto Rican archipelago (Alegría 1947, in Roe *et al.* 1985; Hardy 2008, 125; Lovén 1935,

8 Following the Hornbostel-Sachs system, aerophone instruments (that produce sound from vibrating air) are defined as flutes if they are edge-blown wind instruments, which are defined as producing sound by blowing a narrow stream of air against the edge (of the mouthpiece) while containing the vibration within the instrument (the pipe, which acts as the resonator) (von Hornbostel and Sachs 1961). Closely related designs include trumpets, in which the player's lips vibrate the air, and reed pipes, which vibrate a reed insert in the mouthpiece.

9 The modification of human bones into flutes is reported occasionally, these bones originating either as trophies from warfare or with the recently deceased, whom conceptually transform into 'enemies' of the community also (Chaumeil 2007). The Tupinamba in mid-16th century coastal Brazil were described as using the long bones of their enemies (De Léry 1993 [1580], 127), the Kalinago of the 17th century were accused of it (de Rochefort 1666, 307; Moreau 1990, 166-167, 221-223), and the same practice is described for various communities of the Guyanas (Roth 1924, 458, 592-594), as well as the Cashibo (Estrella and Shell 1977, cited in Roe 1989, 856) and formerly the Yagua (Chaumeil 2001, 89) of the Peruvian Amazon. Despite these popular notions archaeological examples of identified human bones made into musical instruments are rare, and one may wonder to what degree animal bones were misidentified by historiographically minded observers.

498-499), LCA Cuba (Hernández Ramírez and Izquierdo Díaz 2011), and as caches in the southern Caribbean (Antczak 1995; 1998, Figure 49; Antczak and Antczak 2006, Figure 408). In contrast, the existence of various aerophone instruments and their socio-mythological associations had been well documented ethnohistorically. Pané (1999, 20) describes an instrument called *mayohabao*, which appears to be a wind instrument and probably a flute or trumpet (contra Arrom's footnote). As for the Kalinago, most late 17th century sources describe their "immusical" use of various wind instruments during the morning hours before bathing or at the celebration of *cayounage* (inter-communal festive gatherings) (Anonymous flibustier, in Moreau 1990, 171, 187-191; Breton, in Petitjean Roget 1961; de Rochefort 1666, 307; Labat 1722, in Hulme and Whitehead 1992, 163). These instruments are variously described as flutes, fifes, flageolets, panpipes, and so on, but invariably produced "boring" and "immusical" sounds. However, experiments with Paleolithic designs has shown reconstructing the sound ranges on the basis of bone pipes to be extremely difficult (d'Errico *et al.* 2003; Safa *et al.* 2016). Not only are the artefacts factually resonance chambers that may have been tuned through perished components such as reed fiddles, waxes to narrow their openings, and so on, but the volumetric configurations are unique to the internal morphology of the specimens. These acoustic matters cannot be explored for the artefacts of the present research, but are important to be aware of.

3

Of biographies and ontologies

The main task of this chapter is to integrate object biographies with Amerindian ontologies. It first needs to navigate the divided contemporary theorisation in the biographies of archaeological materials. Only then can a working framework be formulated that is capable of providing insight into ways object biographies are integrated with social life (Section 3.1). When discussing the metaphorical and theoretical connotations to different concepts I shall employ 'life trajectory' as the neutral basis of successive events. The second effort is the ontological construction of a model for subject/subject and subject/object relationships insofar as may apply to the indigenous peoples of the Caribbean to a reasonable degree (Section 3.2). Even if specific orientations of Amerindian materialities adhered to in the Caribbean are unknown, this is still necessary to properly ground the choices and paths that individual itineraries may follow. This ultimately leads to the issues of ethnographic analogies and stone axe users from the tropical lowlands of South America discussed in section 3.2.3.

3.1 Biographical theories and frameworks

Ever since Kopytoff (1986) introduced the idea of a cultural biography of objects, scholars in the social sciences have used this concept to consider successive stages within the life trajectories of things. Such notions have been applied in various schools of thought in archaeology and anthropology, including behavioural and function-oriented life history approaches, the economy of commodities in transaction, the more sociological concept of cultural biographies, and the relational materiality of object itineraries (e.g. Appadurai 1986a; Boschung *et al.* 2015; Burström 2014; Dubreuil *et al.* 2015; Fogelin and Schiffer 2015; Fontijn 2002; 2013; Gosden and Marshall 1999; Graeber 2001; Hahn and Weiss 2013; Holtorf 2002; Hoskins 1998; 2006; Jones 2002; Joy 2009; 2010; Joyce 2017; Joyce and Gillespie 2015; LaMotta 2012; Meskell 2004; Schiffer 2011; Schiffer and LaMotta 2007). The notion that diverse stages connect the life trajectories of single objects, and anchor any and all relations they create through them with other entities, has surpassed the boundaries of traditionally overarching theories and become a core occupation of archaeological inquiry (e.g. Caple 2006; Chapman and Gaydarska 2007; Dobres 2000; Gosden and Malafouris 2015; Hodder 2012; Knappett 2005; 2011; Schiffer 2011; Shanks 1998; Thomas 1991;).[10] The present work finds the closest theoretical affinity with materiality approaches, out of concern for the social construction of technological processes (flowing forth from functional analysis), and for the desire to integrate human

10 The concept of cultural biographies has undergone a parallel development in the field of museology. Here the main focus lies upon the 'modern' itinerary of the artefact (i.e. since its removal from the original cultural context), both in conceptual terms and in analytical approaches. Similarly, the term is often applied in landscape archaeology to frame and connect the successive socio-environmental histories of places and areas.

relations and actions with the structural and sensual properties of materials. Both are crucial influences on how biographical phases succeed one another. Section 3.2 will explore what this signifies coming from relational ontological terms, and subsequently, from actors (as humans and things) operating in the indigenous socio-political environment. For now, it suffices to state that recent archaeological debate on material sciences and theories of materiality is advancing towards the interdisciplinary integration of both (e.g. Kristiansen 2014; Martinón-Torres and Killick 2015; Pollard and Bray 2007; see also Jones 2004 and associated comments in *Archaeometry* 47, 1). That is to say, scientific analysis is increasingly and inescapably merging with archaeological theory from the formulation of large questions to the synthesis of datasets and investigation of smaller records. Biographical studies are gradually moving into this direction as well, no doubt following the position that *chaîne opératoire* research has already achieved in this respect. However, the field of artefact biographies is at present in a state of inconsistency regarding its manners of application.

One might observe that the underlying thoughts and premises characterising this field are often less than perfectly clear in published research, and sometimes absent altogether. If this is the case, the application of the concept of biography is often accused to be mere metaphor (see below). In actuality, it is then usually used as a way to conceptually mix and consider observations that pertain to various stages in a life trajectory. In a formalised sequence, *artefact biographies* form a suitable framework in which to organise biographical phases from front to back, and in this way connect elements that originate in independent data sets. This is akin to what the *chaîne opératoire* sets out to do at its core, and forms the basis of the present research (Section 3.1.3). Neither of these applications necessarily proceed towards theoretical inference, though they can form a strong basis for it. Those inferences typically take the form of cultural or social phenomena that are being decoded from movements along the biographical framework or the configuration thereof. Though, what these moves signify or which phenomena are targeted differs greatly, as does the degree to which data observations are formally organised. Besides artefact biographies, several key terms are used in the following sections to designate the main conceptual currents and to contrast their theoretical stipulations and backgrounds. *Life history* approaches trace the interconnected segments of behavioural chains and aim to reconstruct social organisation and technology through entanglements of human activities (Schiffer 2011, 30-34). *Cultural biographies of objects* concentrate on the social agency and structure that shapes objects and their particular qualities, and is illuminated when things are brought from one cultural context to another. These are also referred to as *object biographies*, particularly with the focus on singular things, but this short-hand is confusing with the artefact biography more central to this work. In archaeological work these shifts tend towards being equated with the different stages in a life trajectory, notably the linear succession of production to consumption (use). *Itineraries of things* are largely preoccupied with objects of individual qualities as well. The introduction of this term objects to the linearity and anthropomorphising qualities of the biography metaphor, favouring instead the spatial perspective of movements across the social and physical landscape.

There is both significant overlap and disagreement over the subtle nuances championed by these individual approaches. Indeed, practitioners have dedicated considerable thought to the discussion thereof (Gosden and Marshall 1999), particularly since the advent of two different strands of itinerary thought (Hahn and Weiss 2013; Joyce and Gillespie 2015). These react primarily to the issue of inconsistent theorisation with much biography research, decrying the inclination towards simple metaphor found in many works. The subsequent issue is the implicit anthropomorphisation

of material objects that occurs with the imposition of a vocabulary founded upon human qualities ('life' and 'death' as the most notable "offenders"). It is an issue of rigour, of course, and the charge of anthropomorphisation also has positive connotations especially in contexts such as that of Amerindian materiality (where certain things are quite literally defined by such qualities). The various cultural biography and object itinerary approaches of sections 3.1.1 and 3.1.2 will come to address theoretical perspectives that are in fact complementary to one another, when departing from the artefact biography as a common grounding framework.

This springboard-type of approach is one of the virtues that permits biographical theory a methodological place of its own, in comparison to *chaîne opératoire* research. Certainly, many of the objectives I set out to do here are also accomplished by the latter and there developed to a much wider degree. A *chaîne opératoire* approach examines the individual gestures and techniques used in the processing of materials, usually lithic or ceramic. This allows a reconstruction of the chain of operation, enabling inquiries into the organisation of technology in society and all that is entailed by it, from cognition to (motor) skill to apprenticeship (e.g. Balfet 1991; Cresswell 1983; 2003; Desrosiers 1991; Leroi-Gourhan 1964; Pelegrin *et al.* 1988; Sellet 1993; Inizan *et al.* 1999; Tixier 1980; for a synopsis of the intellectual history see Audouze *et al.* 2017). The state of an assemblage, and whether it contains manufacturing debris and rejects from exotic materials, potentially evidences patterns of exchange (Perlès 2007). Besides its methodological value for research into manufacturing sequences, it is theoretically well connected for inquiries into technological styles or choices and for research into issues of craft (e.g. Brysbaert 2011a; Dobres 2000; 2009; Lemonnier 1986; 1993; Sillar and Tite 2000). Both of these, as aspects of technology in the broadest sense, are pertinent to the present work. Biographical frameworks and theories are not as experienced in dealing with these topics, and in particular the details of production will basically adopt *chaîne opératoire* perspectives (I will use the term 'operational sequence' there). Ultimately, both approaches have similar concerns and questions to be asked of materials.

However, none of these points detract in any way from the contributions that biographical theory makes in areas where *chaîne opératoire* approaches do not typically venture. For one, it is better positioned to combine separate datasets and focus a theoretical discussion into the movements of objects across inter-cultural spaces. This includes, of course, the depositional and post-depositional contexts, and significantly the museological itinerary that many objects accrue. Both of which are topics not generally considered part of a *chaîne opératoire* study, and in this context the biographical approach draws firmly on the insights of the behavioural life history. Furthermore, the vocabulary associated with the metaphoric use of the biography concept introduces a discussion on the (conception), birth, life, and death of objects (e.g. Breukel 2013; 2015; Falci 2015c; Fontijn 2002; Holtorf 1998; Maeir *et al.* 2015; Raemaekers *et al.* 2011; Van Gijn 2007; 2010; 2012; Van Gijn and Wentink 2013; Verbaas and Van Gijn 2008; Woodward *et al.* 2005; 2015). These phases engender a sequential organisation of analytical data regarding provenance, manufacture, use and re-use, as well as deposition. These usually comprise technological choices in some way, even if only in the broad sense such as a procedure of intentional breakage to create a depositional context. However, generic exchange cannot be *a priori* pinned into any of these phases (Pollard *et al.* 2014), there are non-technological and often non-linear dimensions to the relationships that object biographies seek to address (Joy 2009), and room must also be sought in this framework to accommodate the 'afterlife' (see a.o. Holtorf 2002). This includes the events of excavation, potential (illicit) transaction, and a myriad of curation practices (Breukel

et al. 2015). Such socially engendered extensions as relocation, transportation accidents, or onlooker appraise of displays are much more difficult to grasp from a technological perspective, which separates them from the inquiry of a *chaîne opératoire*. The key concept that defines biographical theory in all these respects is recontextualisation, as this concept encompasses the mechanisms that lay behind all shifts in the biographical profile.

3.1.1 The cultural biography of objects

The main insight of Kopytoff (1986) is that things 'lead lives' just as humans do, metaphorically speaking, both of which are constructed through the overarching structure of society alongside similar pathways. The manners in which things move around society thus reveal something about this structure, its patterns, and what general expectations society predicates of material culture. Drawing upon the perspectives of both Durkheim and Mauss, the primary occupation of Kopytoff formed the question of how value is created, lost, and re-created, observing that regular objects were never wholly commodified, nor perfectly singularised, but negotiated value somewhere between. The ebb and flow of these opposing processes within commoditisation thus formed a driving force that would see things entering new contexts and 'experiencing' events done unto them. As a result, any associated values would shift with the things, and meanings created in new settings are different from that of previous contexts. Indeed, the further an artefact is distanced from its original cultural context, the higher the theoretical significance of its biography becomes. Cultural biographies of things form the sum of these movements, which Kopytoff (1986) defined as recontextualisation processes, and which allow questions to be asked about the values that drive them. The interplay to which this refers originally is between the total reduction of the object to monetary value and the total singularisation of the object away from its potential for exchange (a form of inalienability). In turn, this plays out between the sphere of public interests and the response of individuals to understand objects on their private terms. It is difficult to view these ideas in separation from the simultaneous contribution of Appadurai (1986a), as this is where the metaphor of a social life finds further footing. Appadurai's notion of a 'tournament of values' follows objects placed into social arenas, of which the auction of a painting forms a prime example. Here the proverbial re-valuations are clear and directly connected to the power plays of the individuals caught up in the performance of these transactions. A new value for the thing is then negotiated in this political regime, relatively detached from the public economic worth of its commodified form.

Both authors thus see outside mechanisms that stem from economy, politics, culture, or society as responsible for driving objects from context to context, and between 'regimes of value'. It is intertwined with their enmeshment with 'large-scale, commercialized, and monetized' economies nearing optimal commoditisation, something to which all societies are seen as inherently driven to within the bounds of their exchange technologies (Kopytoff 1986, 87-88). As a result, there is a strong overtone of the ultimate status of things as common goods which implies the depreciation of any agency held by the object itself – and indeed its biography (Graeber 2001, 33; Hoskins 2006, 75).[11] Adopting this position would necessarily sterilise the materiality in the objects, and in the case

11 It is not at all counterintuitive to for value regimes to draw upon the biographical profile of things and any of the relations caught up therein. As an example, think of the impact on the value of a painting re-emerging from an obscure collection if it turns out to be a lost work from a famous painter, or towards the opposite direction, a masterful forgery.

of Amerindian materials, their potential for autonomous behaviour (Breukel 2013, 63-64). This is why the present work will proceed to substitute Kopytoff's commoditisation and Appadurai's political tournament with elements of indigenous thought on how society is structured and functions (Section 3.2). This also accomplishes the necessary deprivileging of (commoditised) exchange as the primary context in which biographies are written, allowing the consideration of processes such as ceremony and performance, rites de passage, curation, colonial dynamics, musealisation, and other types of enmeshment with human social relations (Fogelin and Schiffer 2015; Gosden and Marshall 1999; Hoskins 1998; Meskell 2004, 56-58; Skeates 1995; cf. Gosden and Malafouris 2015). As it turns out, these provide at least equally powerful settings in which things gain or write value and history.

The topic of value shifts in recontextualisation never gained a wider traction in archaeological thought, despite it having proven fruitful in ethnography and museum studies alike. Instead, one of the main handles has been to search within assemblages for broadly shared biographical trajectories. These emerge out of communal sociocultural expectations about befitting practices and conventions which people hold of things, and render them salient. Similarly, discrepant biographies become highlighted as outlying occurrences enacted following alternative customs, whether as more ambiguous possibilities, a different set of cultural standards, or as deviant behaviour indicating other concerns (Fontijn 2002; 2013, 184-187; Kopytoff 1986). The interplay of biographical information will reveal whether such discrepancies may simply entail technological adaptations to previous flaws in the execution, or adaptations to e.g. the entry of new socio-cultural value sets within the local setting. Thus, whichever individual particularities an object may possess is mainly of importance for the contrast it provides against the shared cultural notion of its proper biographical profile. To illustrate this with an example from archaeological materials, the axes studied in this work form an assemblage of biographies which conventionally envisages them as tools to be used. As a deviation to this pattern, imagine the unexpected lack of indicators for use activities on a perfectly shaped and intact celt. Such an observation would subsequently lend credence to the notion that the regime of values circumscribing these objects is primarily related to ceremonial settings and relation-building through gift exchange. Comparable ideas are frequently postulated for the indigenous Caribbean (e.g. Antczak *et al.* 2018; Dacal Moure and Rivero de la Calle 1996; Hardy 2008; Morsink 2013; Siegel 1992) in reference to a better grounded argument from Mesoamerican archaeology (Aoyama *et al.* 2017; Hirth and Hirth 1993; Taube 2000), often for intact or very large/small-sized celts thought inappropriate for traditional functions. It would simultaneously reinforce the idea that customary biographical trajectories regard axes as functional tools, however, that being the most generally desirable use-life for them.

Most current applications of the object biography concept prioritise the unique particularities of individual things, and do so through a heightened emphasis on the relational aspects. Objects such as ornamental and ritual paraphernalia bear a relatively large biographical potential, by virtue of the technological complexity and socially important functions many (are presumed to have) had. Each of these biographical possibilities mirrors human relations entangled with the biography. For instance, the endowment of a bone pipe with carvings reflects specific artisanal intent, its material form relates the previous existence of another being, and its performance connects the wielder, participants, and onlookers with shared cultural ideas yet may force into contest the ritual knowledge of each. The actual nature of these relations will vary wildly, of course (e.g. what animal or human did it belong to, was this an entity known by the maker or its community, and so forth). However, the point is that

biographies are formed through relations with humans, further shaped by the accumulation of new and reconfiguration of existing relations, and transform again when these relations become severed. They also entangle each other, for instance in the biographical profiles of hoards and collections (Blanco-González 2014; Joy 2016). Another example are composites, such as an axe-head, its haft, and any added decorations, which in turn perhaps ensnare the house it built. Such 'thing-thing entanglements' also criss-cross with human actions all the time, the general stuff of technology a case in point (Hodder 2011), which means that the objectives of our inquiries are formed at their junctures. Following Strathern's (1988) work on the constitution of personhood in Melanesia as the sum of the social relationships held by an individual, Joy (2009; 2010) has argued that object biographies are relational in precisely the same way as those of humans. This emphasis on the relational aspects also somewhat diminishes the gaps left by the empty spaces that inevitably occur in the practice of reconstructing archaeological biographies: the preferred perspective is that of a series of 'connected jumps' of events and relations (Joy 2009). Seen from this concern, derived of today's overarching theoretical projects (primarily the new materialism), the object biography term has largely come to share its focus with the one advocated by the itinerary approach. Kopytoff (1986) had already provided the basis of this thought in his original views, robust since and compatible still with contemporary perspectives upon materials and culture.

3.1.2 Itineraries of life and death

This brings us to the term of itinerary. Recent discussions on this topic assert that the metaphor of biography imposes undesirable conceptualisations on materials, their meaning, and the life trajectories they are permitted to take (Hahn and Weiss 2013; Joyce and Gillespie 2015). The "offending" qualities are the anthropomorphisation of the object, the linearity of its trajectory, and the impermeability of the biographical phases, notably the talk of birth and death. Their propositions of the itinerary metaphor aim to rethink the essences of materials and the qualities of things that their life trajectories reflect upon. Furthermore, itineraries of things are also claimed to enable a wider range of biographical possibilities, chiefly by subjugating the finality inherent in the metaphor of death as taken to occur by the moment of deposition. However, such critiques strongly insist that the metaphoric associations of the biography serve as the immutable method of analysis (e.g. Hahn and Weiss 2013, 4, 7; Joyce and Gillespie 2015, 11), which as seen by now is simply not the case. Indeed, thinking in terms of defined phases is by no means shared across the breadth of biographical approaches. Besides, itineraries also confer metaphoric conceptualisations into the promises of its renewed perspectives. It thus remains to be seen if such issues are strictly inherent to biographical theorisation, truly debilitating to it, and whether itineraries indeed provide a superior alternative or simply add to the theoretical body.

An additional contribution is offered by Joyce and Gillespie (2015) when they move from object itineraries to things in motion. They qualify these as the mediating construct and its outcome respectively, contending that the factual nature of *objects* holds them within the constraints of discourse. A burgeoning understanding of these objects quickly shifts them into *things* now capable of relational engagements, contextual, and embedded in a spatial and temporal flow. This view aligns closely with my own (Breukel 2013, 19) and derives from the new materialist dissatisfaction with the term 'object' as being a construct of a naturalist ontology (e.g. Henare *et al.* 2007; Holbraad 2009; Olsen 2010). In it objects are material and form the topic of attention, closely perused by agentive entities, but are themselves inert and incapable of engendering actions or responses from those around them. This is

useful in the laboratory, but less so in understanding how their material qualities and relations are integrated with those of human beings. By comparison, things are murky. They have the capacity to be contextual and ambiguous in their nature, or to fade into backgrounds (Heidegger 1962), and can come to exist through any creative or transformative act independent of the need for human craftsmanship. Crucially, things are potential subjects, certainly so when following perspectives held in the Amerindian world, and thus capable of producing and maintaining relationality with other subjects (Santos-Granero 2009c; Viveiros de Castro 2004a).

It is in this contingency that the issue of anthropomorphisation, that of the attribution of human qualities to objectified matter without potentiality, resolves itself. Since the ontological turn in anthropology (Alberti *et al.* 2011; Venkatesan *et al.* 2010), itself greatly persuaded by theories on Amerindian perspectivism (Viveiros de Castro 1998), what these human qualities entail has itself become a matter of debate. Briefly put, what being human actually consists of in the terms of new animism is not the equivalent of what it consists of in post-Enlightenment naturalism (Descola 2005), namely of being *Homo sapiens*. Thus, the imposition of connotations for Western human beings on things, such as an immutable bodily integrity, or proportional capacities for agency, is avoided. This position merely permits things to possess subjectifiable qualities, which open it for engagements with other entities through a shared potential for relational interconnectivity. This happens to be the innate form of existence for many types of artefacts in Amerindian societies (Santos-Granero 2009c).

The second charge against biographies is that they are restrictively linear, and are oriented towards progressing and aging. Hahn and Weiss (2013) introduced the concept of itinerary partially to restore the capacity of things for jointly entangling with other itineraries and following convoluted pathways (cf. Hoskins 1998). Things may make strides or encounter obstacles during their circulation, indeed may suffer periods of relative inertness, or stillness. Thus, an itinerary of 'things in motion' (phrased after Appadurai 1986a, 5) explores how objects come to be things as discussed above, by asking questions about all the aspects of their circulation. This includes both the journey itself, and any relations, connections, and transformations revealed between "persons, places, and things across space and time" (Joyce and Gillespie 2015, 12). Equally important are episodes of stillness, bounded by rapid and energetic shifts, as well as the fixicity exhibited by certain things. Indeed, the metaphoric quality of the itinerary concept situates a life trajectory within its space, geographic or otherwise, and questions how such spatiality (as for instance the archaeological site) is constituted by the actions and relations of all things jointly (cf. Jones 2002, 86-89 for similar concerns).[12]

The focus on circulation is common in thoughts on the itineraries of things, presumably on account of the metaphoric tension in this term. As Hahn and Weiss (2013, 8) put it, itinerant objects do not sit still. This is not something things do out of their own volition, however; their mobility is a consequence of differences in social, economic, or cultural aspects between groups of humans that drive to push or block objects moving from one place to another. This argument harkens directly to Kopytoff's emphasis on tracking the recontextualisations that occur when objects move from one context to another as the main method of retracing value. Unfortunately, this perspective cannot apply to other ontologies since it separates the potential for agency not from the tempting or restricting,

12 This emphasis converges with moulding a biographical profile through social network analysis, although this has yet to be accomplished commencing from a biographical framework itself. Nevertheless, this field is now increasingly utilising analytically obtained biographical qualities of things to reconstruct social and itinerant landscapes on a number of scales (e.g. Buchanan *et al.* 2016; Hofman *et al.* 2014a; Knappett 2013; Mol 2014; Mol and Mans 2013; Thompson *et al.* 2017).

but from the very real autonomous qualities things may exhibit. Otherwise, doing the itineraries of things would, for all its emphasis on materiality, inter-subjectivity, biographies entangling with other biographies, and flux and flow in all resulting aspects, ultimately remain just another arena for people to negotiate culturally constituted meaning in amongst themselves (Olsen 2010, 3-4; Schiffer and with Miller 1999, 6). Another element of biographical thought resurfacing in these ideas on itineraries and spaces is that exchange once again forms the principle mechanism behind its drive. Though by now clearly beyond the early fixation with commoditised exchange, rightly criticised from the outset (Bloch and Parry 1989, 14-16), there is still a risk that other kinds of biographical possibilities will fall behind. Stasis and inertia are framed as mere preludes, building up to the zenith of renewed mobility. Biographical possibilities such as extraordinary lifespans can clearly endow values derived from the physical characteristics they slowly develop, however (Breukel 2013; Gosden and Marshall 1999; Skeates 1995), without the need for major contextual shifts induced by processes like exchange and spatial dislocation.

In biographical terms, the shifts and events discussed under this preoccupation with mobility generally fall under its phase of life (including 'second lives'). Previously noted to bear connotations of primarily the use-life and functionality, this preoccupation greatly expands the contents that can be discussed under it. It does so firstly by anchoring exchange and circulation and secondly by providing a sense of space, in which the contextual and material transformations of things can play out. The transformative potential of matter is, of course, the key property in technology and the key dynamic in its relation to the social and sensorial experiences of others (e.g. Dobres 2000; Lemonnier 1993; Sillar and Tite 2000; also Ingold 2007; Jones 2004 and associated comments in *Archaeometry* 47(1); and cf. Gosden and Malafouris 2015). This topic, then, forms the basis of the critique leveraged against primarily the metaphors of both birth and death (object lives seem to be less of an issue). Such concepts are charged as inappropriate to discuss examples like origin-less, mythical things which were simply always in existence (Gell 1998, 23; Pétrequin and Pétrequin 2011), and made objects intended to have everlasting permanence (Fontijn 2013, 192-193). The idea of object death is found jarring since it proposes a due date to the life trajectory, thus slated to end at a finite point, and it produces an insurmountable break that separates the archaeological past from movements within the contemporary world. Hahn and Weiss (2013, 4, emphasis mine) capture this point by stating that "the idea of a definite disappearance or final step, similar to the death of a person, … hardly captures *all* of the changes that can be observed in the context of an object". It is much more likely that its transformation to waste or rubbish simply engenders more troubles and new meanings, attributed to them by the same or different people (played out in Holtorf 2002). Nowhere does the physical integrity of things experience anything like a 'death' when they are placed in tombs as gifts, sink, or are forgotten in an attic, or does the social integrity 'die' when it is broken up for distribution (Blanco-González 2014). Things always turn up later outside of their original context, and in this sense death is just another transformation to go through.

The issue is therefore not that the metaphor of a death is limiting, but that a naturalist ontology is impermutible with respect to things and life cycles. Notions such as immutable finalities and the strict state of aftermath need to be left behind (Joyce and Gillespie 2015). Amerindian worldviews generally identify sickness and dying as transformative processes, which continue long beyond the grave.[13] I

13 Following ideas from perspectivism (Viveiros de Castro 1998, 482), death destroys the constituted identity of a being through the catastrophic metamorphosis inflicted upon its physical cultural form (the body). Its interior

thus favour viewing 'death' as the hallmark transformation in the thing or its context that signifies a rupture with the context of a life itinerary. This can be the usual breakage and discard, whereupon it enters the archaeological record, but even this transformation is not at all instantaneous. For instance, broken things easily remain on the surface as a silent witness, a reminding presence from the corner of one's eye, before they are swept out of view. From this point onwards the phase of a death no longer closes off possibilities, but instead opens them to revival, providing extensions and new connections for social destinations. It again enables analysis on Hispaniolan idols supposedly hidden away in caves in face of encroaching conquistadors (e.g. Saunders and Gray 1996; but cf. Du Tertre 1973[1667-1671], 349), which preserved material integrity but 'died' socially when the original context of their existence disintegrated around them. Similarly, instruments interred as part of the funerary furniture undergo an irrevocable transformation in how they connect to the living and the dead.[14]

For these reasons, I do not consider it expedient to rebrand the conceptual phase of 'death' into something else at present. Rather, as will be argued below, it is a useful concept and phase to retain in the framework of artefact biographies since it is naturally associated with specific forms of data. The caveat is that 'death' should not fulfil a concluding role therein, since anything that is brought under analysis again has obviously progressed past that point.

There are no agreed upon metaphors for what happens from the excavation onwards, that point when biographical inertia is reactivated, its 'long life history' (*sensu* Holtorf 2002). Afterlife is the most frequently suggested, but is rather clunky and imposes undesirable associations, chiefly amongst which are the qualities of everlasting, unchanging, and rewarding. I prefer the notion of revival, which implies that an artefact is brought back to the intricacies of birth and life trajectories. This may be a restoration to the original social context, or an activation into a new one. A revival does not necessarily presume a true physical 'death' of the object, as the social equivalent of unused stillness suffices well. Revival emphasises the recontextualisation which brings an object out of its 'death', and facilitates a way of seeing life trajectories through periods of abandonment, perceived finality, or decay, only to pick up motion once again whenever this becomes desired. Things can then cycle back into a new life trajectory or continue on towards some final destination which draws into movements on the contemporary scale.

In all, despite the claims that using the lens of itineraries opens and broadens theoretical perspectives, there are distinct advantages to retaining the biography as a concept. For one, thoughts on itineraries proclaim to avoid any stifling metaphors within the vocabulary of biographical thinking. However, such arguments frame the metaphoric associations of the biography as its principal virtue, and proceed to deconstruct the universality of its usefulness from that point. This position is misguided, since it side-lines the actual theoretical contributions and arguments derived from the concept to which the life cycle metaphors are merely heuristic shortcuts. Besides, the degree of emphasis upon birth,

nature (the soul) will then become a different kind of entity (such as a stranger, an animal, an artefact, or a roaming spirit), shift in the hierarchy of predator or preyed-upon, or traverse the boundaries that exist to separate worldly layers or realms. The outcomes are usually relational in terms to the other and constructivist in terms of the self and own society, whether positively or negatively so. However, an incredible variation of practices exists. Human bones may be kept and venerated, consumed and their energies recycled, the body interred, mummified, or urn-buried, and more usually a combined sequence of any such or other options is seen (Chaumeil 2007). The notions of finality and the cessation of an existence are clear absurdities within this context.

14 Given the prevalence of secondary burial customs and grave manipulation in the Caribbean, it should be considered that material objects can be manipulated and retrieved in the same way that the bones of the interred are. I would expect this transformation to be even more socially significant than simple deposition, however, even if we have at present no framework for detecting such biographical possibilities.

life, and death is extremely varied within its field and overly metaphoric dependencies in specific cases should not reflect upon merits of the theory as a whole. The development of biographical theory for objects can certainly strive to be more explicit in the ways in which it derives theoretical significance from the framework it purports to use. As a matter of contemplating data, defined segments such as the birth phase are exceedingly useful to frame the technological aspects of material culture and the position of transformations that objects undergo as raw matter (conception) and when they become useful (life). Fruitful is the way itinerant thinking emphasises the time dimension of a life trajectory, including stillnesses and periodic activities. Such temporalities are in fact regularly addressed in cultural biographies of monuments and landscapes (e.g. Gillings and Pollard 1999; 2016; Holtorf 1998), but are indeed less often highlighted for objects. Notions of time flow and moments are particularly beneficial in decompressing any spatial and social distances that remain embedded within associations of provenance, viewed too often as simply 'direct' (Pollard *et al.* 2014). The same goes for unravelling long lasting, heavily entangled object lives (enchained lives, *sensu* Chapman and Gaydarska 2007).

That being said, the prevailing sense is one of conceptual continuation between the cultural biographies of objects and the itineraries of things. There have been tremendous shifts in archaeological theories in the thirty years since *The Social Life of Things* (Appadurai 1986b) was published. The concerns of biographical approaches have shifted along with them, from how societies create value and moving to how people create cultural behaviour, then how people attribute meaning to things, and nowadays towards how things connect and attribute meaning to people. The main tension bridged by the concept of itineraries, in my view, is the relatively unlimited and undefined space left open in the life phase of objects, and most significantly, revived lives. Conception, birth, and death are more constricted in the way that archaeological data addresses them, even if they sometimes intrude on one another. How they do this forms the topic matter of the following section.

3.1.3 Artefact biographies as an analytical framework

The artefact biography operates foremost as an intrinsic framework. As such, it lays the groundwork for sequentially organising methodologically disparate data into a holistic profile. This is basically the manner in which the biography concept is applied amongst archaeologists dealing with heterogeneous datasets, amongst which wear trace analysts associated with the Leiden Laboratory for Artefact Studies. Thus, data on the raw material provenance is associated with the conception of an artefact, and primary aspects of the technology and typology with its birth. The use and duration define the life, and the death of an artefact covers the deposition and its repose in the archaeological record (Blanco-González 2014; Fontijn 2002; Jones 2002; Van Gijn 2007; 2010; 2012; cf. Holtorf 1998). Events that occur in further along the itinerary of an object are discussed here under the notion of revival, to provide an equal degree of organisation. Any perceived metaphoric connotations are rejected in favour of the open-ended structure these terms provide. The theoretical nuances and implications may remain debatable, but this cannot be seen as a methodological issue considering the technological universality of sourcing and production and respectively the reality of deposition in the archaeological record. In terms of the overall argument in this dissertation, consider the following paragraphs to sketch the focus without yet committing to analogical or data oriented predictions for the materials.

3.1.3.1 Conception

A biography commences with its conception. This term is a relatively novel introduction into the biographical vocabulary, distinguishing the need for separating matters of procurement from matters of production (Van Gijn 2007; 2010; 2012). The identification and procurement strategy of the raw material are primary components, but not the only qualities addressed in this phase. The choice of material actually entails a choice for specific attributes and working properties which that material has. This may pertain to different mechanical capacities, spiritual characteristics, aesthetic qualities, or symbolic associations. The context of this choice entails also a set of external considerations, such as the availability of material, valuation of specific sources, the reliability of exchange partners, and so forth. A key aspect is the origin of the material, which in many cases can be determined by geological or ecological provenance analyses. The level of detail will range from broad (e.g. undefined coastal areas for the common *L. gigas* mollusc) to highly specific (discrete geolocations highlighted by multi-isoscape probability calculations; Laffoon *et al.* 2017b).

Each level of detail, however, still provides a sense of space and of spatial relations between the origin and the find context that need to be explored, and not just in the sense of transportation. Non-local signatures alone do not simply imply evidence for direct human exchange, nor can they indicate whether this took place during procurement, production, or throughout the use life (cf. Pollard *et al.* 2014). Brysbaert and Vetters (2013) distinguish at least five categories of an object's 'localness' at Bronze Age Tiryns, Greece based upon the context of their production: made by whom, with material from where, in what style, and with local or foreign skills and knowledge. Many artefacts fell into multiple categories simultaneously. Furthermore, it is not uncommon that places of procurement are associated with liminal or spiritual qualities, in turn considered necessary for its substances to be procured. This is the case for several communities from the Guyanas, the members of whom obtain potting clays from specific and fairly distant places for ancestral, traditional, and spiritual reasons (Duin 2000/2001; Hofman *et al.* 2008c; Vredenbregt 2004). There are protocols to be followed, that serve to transform the substance from its raw and natural occurrence into a material with biographical potential. This further begs the question of by what method procurement took place, in terms of primary versus secondary context. Were the materials extracted from outcrops or from live animals, or were pebbles in secondary context or abandoned osseous elements more sought after? In the case of extraction the requisite technology needs to exist, for instance mining or fire-setting, which leave initial traces on the materials. Different biographical values are attested in flint axe-heads retaining a spot of cortex from the subterranean mine (Rüdebeck 1998), or Alpine and Iberian axes in which the depressions of fire scars were sometimes polished into (Lozano *et al.* 2017; Pétrequin *et al.* 2012a). The visually distinctive Neolithic axe-head materials circulating across Britain and Ireland originate with quarries specifically targeting outcrops located on islets and small islands, and this is thought to signify an association with these insular spaces (Cooney 2015; Cooney *et al.* 2013; Edmonds 1995; 2004). Any of these possibilities necessitate knowledge of the source areas, i.e. where to find and obtain the material, or social contacts with access to them.

Another matter relates to the social organisation of the procuring community, and how this influences the actual practices. These stretch from the individual decision to head out and obtain needed materials, to heterarchically decided multi-day expeditions, to centrally organised resource procuration industries which feed into circulation networks. The possibilities on this scale imply different kinds of knowledge systems concerning how the actual selection of pieces transgresses, i.e.

the evaluation of their characteristics. Such attention may be directed towards the working properties, for instance if a material is homogeneous enough to be knapped, has a nice ring to it, or is of a good grain size for easier grinding (Pétrequin and Pétrequin 1993; Stout *et al.* 2005). There are pragmatic requirements involved in size and shape that ultimately govern what is technologically feasible, and may reduce the workload or technical difficulty towards attaining the intended shape. Or, indigenous priorities could be with ideas only loosely related to technological concerns. Examples include distinctive colour patterns (e.g. Cooney 2002; Van Gijn and Raemaekers 2014), lustre and brilliance (Saunders 2001; 2003), and sensorial properties or associations that stretch beyond the physical characteristics of a material (Oliver 2000). As Saunders (2004) argues, Amerindians consider the 'natural landscape' as culturally and mythologically constructed signifying that its (geological) components are also constituted foremost out of such qualities. It is thus entirely probable that certain materials possess innately subjectifying properties that manifested already as a precondition to becoming entangled with agents from human society. In other words, these were conceived not by human hands but by natural processes and understood as things of their own right. I previously made an argument along these lines based upon the writings of Ramón Pané (1999) for Caribbean threepointers (Breukel 2013, 73-75). Likewise, thunderstones in pre-Enlightenment Europe may have behaved under similar ontologies (Goodrum 2008). The specific relation wherein the matter is the known corporal form of an existing entity (more familiarly but improperly described as an animistic spirit residing in matter), would also fall under this type of subjectified knowledge. Ultimately, the way in which such issues are negotiated governs to a large extent whether things are conceived 'the right way' or not. This is what creates further expectations of the impending trajectory, and decides whichever biographical possibilities remain viable to them.

3.1.3.2 Birth

Following the phase of procurement comes the birth, which primarily circumscribes technological processes of production. A common outlook is to view manufacture as consisting of one or more interconnected operational sequences (*chaîne opératoires*), towards an intended goal or end-product. Births may ensue within a given context, transforming the object as part of a single continuous process, but interruptions commonly occur across the spatial or temporal spread. Key to this is the social organisation of technological behaviour, of which the place or setting forms an important aspect. Production may be carried out within domestic contexts, craftsmanship performed in groups within communal space, workshop areas provided and managed by society, and so forth. Equally important are issues of skill (time investment, craft mastery), and how relevant yet socially restricted knowledge (and know-how) is transferred between members of the community (e.g. Bamforth and Finlay 2008; Ferguson 2008; Kuijpers 2017). For instance, in medieval Europe crafts were organised around sanctioned guilds, which would provide recognised places and oversee apprenticeships as they controlled the practice of their expertise (Epstein 1998). The knowledge itself may in fact be easily transmissible within such contexts, but strict social controls may be in place to prevent 'leaks' to the uninitiated and retain the mystifying impression of supernatural craftsmanship that masterworks emit (Van Gijn 2010, 163-165).

The idea that collective learning emerges from mutual engagement with a domain, a craft, skill, or commitment (such as pottery making) shared with other practitioners is captured by the concept of communities of practice. The social scaffolding of this shared commitment provides a bounded

context in which learning, training, resource sharing, and skill transmission takes place through the interactions between its members (a.o. Minar 2001; Lave and Wenger 1991; Sassaman and Rudolphi 2001; Wenger *et al.* 2002). Communities of practice may be culturally instituted (i.e. workshops), but are more appropriately seen as the generational context within which people repeatedly come together to discuss and explore; indeed, its members remain in direct and sustained contact with one another. As such, technological approaches are continuously communicated, shared, and reinforced, as novices develop their know-how following older experts. Notably, this operates without creating presumptions on the existence of self-identifying traditions or the political organisation of community at large. When such presumptions are theorised the discussion moves into the territory of technological styles (e.g. Gosselain 1992; 2000; Lemonnier 1993; Roux *et al.* 2017; Stark 1998). Here, technological systems become spread across geographic spaces and archaeological time depths that are beyond the living confines of a community of practice, as a result of the inter-generational transmission of ideas and mobility of its practitioners. As such, technological styles are viewed as a window into the reconstruction of social boundaries and identities harboured within (cross-)cultural and (multi-)ethnic records.

The relational transformations that are caught up within this phase become multifarious. Unworked materials may be seen as blank slates, only given their first potential for attaining meaning when made into elaborated things. Or, conceptualised objective matter may be severed from its entanglement with the natural world to make way for investments of a social nature, relational to the involved human beings. Technological actions may seek to acculturate such matter to the fabric of society, or to construct it as part of a dividual. In exceptional cases, the latter transformation may forego technological alteration altogether (Breukel 2013; and in initial stages, Hofman and Jacobs 2000/2001). During this phase it is already possible for things to enter circulation. This may be related to the separation of stages in the craft between different specialists, as is the case for the melting of raw glass (primary production) and the blowing of glass objects (secondary production). Another example is where objects circulate as preforms with the finishing polishes or decorations to be added by the recipient. This is how the Palikur of French Guyana distribute their ceramics, before adding the highly communicative decorations that transform them into feasting pots (Rostain, pers. comm. 2017), and also how adzes from Mount Hagen in New Guinea were ideally exchanged with other communities (Burton 1984; 1989; McBryde 1984; Strathern 1969). In such cases they only progress into life after it transforms into a functional object, though objects can also be technologically altered as part of their life trajectories (see below). The transformation from unfinished into functional may be taken as the dividing line, but this is contentious and will ultimately depend upon the actual trajectory of a given object.

The study of technology forms the basic source of information on movements within this phase. For this, the present work pays attention to the sequence of reduction and succession of technical interactions. The interpretation of whole surface modification techniques forms a main avenue, which in principle refers to grinding and polishing, and to which wear trace analysis is pivotal. Like the choice of technique in ceramic vessel shaping, or what core reduction strategy best suits a purpose, the stages of abrasion form a nexus of technical possibilities and differentially desirable outcomes in ground stone analysis. A complete operational sequence also entails attention towards other material forms coming together for the final product, for instance the union between axe-head and hafting system, base paint and colourant, or statuette and accoutrements. For the latter combination there is now

persuasive evidence of maintenance and potential renewal of the various inlays that large Caribbean wooden carvings were endowed with (Ostapkowicz *et al.* 2012). A final consideration of the birth phase is that of the resulting shape, the transformation towards which the entire technological process is geared. This is not to be mistaken with the morphometric properties of artefacts upon the moment of analysis, since they are subject to wear and repair processes that alter their working dimensions, as well as repurposing and recycling in advanced phases. Even so, there are valid concerns caught up in the shape and design of things insofar this is the intended outcome of craftsmanship, or limitations imposed by material properties, and how these are governed by cultural consonance and societal concerns at large. In all, there is a multitude of transformations caught up within the phase of birth, from unworked material, in process of fashioning, to an object fully prepared to function, or a thing given new potential for meaning.

An important consequence is the emergence of a kind of meshwork within which individual operational sequences or crafts interconnect with others. The creating of a single object regularly involves other types of objects, each conceived of from their own technological frame (materials, production values, adequacies). This evokes the concept of toolkits, where collections of distinct tools of various materials may 'belong together' in their application towards the manufacture of other objects and subsistence activities (Van Gijn 2008b; 2010; Van Gijn and Lammers-Keijsers 2010; Van Gijn *et al.* 2008). The conceptual relation between a collection of variously sized, worn, and spherical to elongate tools of different lithic and organic materials becomes clear when they are discussed in terms of harder and softer hammerstones. By-products from craft and subsistence processes may in turn flow back into the creation of yet other materials, and stored or directly used towards new activities. Artefacts altogether different from one another, such as axes and ornaments, may nevertheless share a significant proportion of their operational approaches, and with them the knowledge requirements and social settings of their crafts (Tsoraki 2011). Technologies that are developed around one type of material may lead to the innovation of another, as is argued for glassworking as emerging from connections with faience glazing and metallurgic crafts (Fenn 2015). Crafts employed in such contexts increasingly intertwine in technical, spatial, and logistical aspects, as well as in shared learning and proficiency, creating progressively complex chains. Termed cross-craft interaction (Brysbaert 2007; 2011b), such dynamics refer not only to the drawing together of complex, multi-material industries within circumscribed social spaces, such as the processing of multiple pigments, mould-making, and plastering in Aegean palatial contexts (Brysbaert 2008a; 2008b). They also encompass the cyclical dynamics where potters create weights for looming, which provides cordage to haft adze heads whose woodcutting ultimately feeds back into the sustained firing of pottery. From the point of view of individual artefact biographies, these objects become involved first through the technological domain of their birth, but clearly do so in relation to other objects that are firmly passing through phases of life.

3.1.3.3 Life

The life of things is the most open ended phase in this framework. Records that indicate a confined length of circulation will generally not exist for archaeological materials. Indeed, their temporality is conceivably unlimited between curation, inheritance, maintenance practices, shifting exchange potential, and the vestigial existence that characterises a 'thing between motions'. Even functional capacities (use, disuse, re-use, and so forth) are to be conceived of as having a cyclic trajectory in which

exhausted tools loop back into another way of use (Brysbaert 2011a). This is where the life phase of an object resembles the metaphor of an itinerary most of all, swerving across spatial and social contexts, and having possible uncertainty *en route* as to where its destination lies. Of course, none of this voids the questions of which of these transformations and recontextualisations correspond to culturally valued trajectories, and which are considered as deviant to what is proper and right for things to do.

The subject matter of a life draws together various analytical means. The physical use of objects forms a major factor in their biographical profile and from a functional perspective comprises the entire life history. The wear trace method of this work forms the primary means of appraising object lives, and indeed is often referred to as use-wear analysis. For the most part, however, wear traces signify use activities that occur towards the end of a life trajectory, with wear from previous instances having been erased before that. Isolated functional data says little about shifts that may take place after the primary function concludes, nor about all sorts of unintended uses. This is regardless of whether it concerns a common domestic tool, or a thing slated to appear only in highly specific contexts.

The wear that objects obtain influences how values and ideas are take shape around them. This pertains not only to down-valuing as in the case of generic second-hand goods, but also the aura of age and proficiency (*sensu* Shanks 1998), not to mention personal investment and valuation, that speaks out of well-worn tools, suitcases, and so forth. Skeates (1995; 2002) argues how this is the case for middle Neolithic to Bronze Age stone axes of the central Mediterranean. Many specimens of harder and greener rocks gradually obtained visual distinction and personal relations as they wore down in size through resharpening, losing power and efficacy, which culminated in sacralisation and the removal from regular circulation. At that point they were re-made and technologically elaborated as axe-pendants, shifting the direction of their trajectory in life towards ritual curation and political competition.

Combining these with other biographical evidence lines stands a better chance at unravelling multiple use phases and shifts in functionality. As argued, these then provide insight in cultural values and mechanisms of appreciation. A good example is provided by the biographical study of large, exotic flint tools found in contexts of the Middle Neolithic (4220-3940 cal. BC) site of Brandwijk in the Dutch wetlands (Van Gijn 2008a; 2009; Van Gijn and Wentink 2013). These foreign objects are typologically associated with the contemporaneous Michelsberg culture to the south, and show wear trace patterns associated with specific hide-working activities. Those activities are characteristic of that cultural context, but unknown in the wetlands, suggesting that implements with prior life histories moved between cultures. They thus came to be valued not as tools, but specifically for their affiliation with distant Michelsberg communities. Later Swifterbant contexts continue their import, but as unworn tools subsequently used in socially important activities such as bead-making for burials and fire-starting. In these times they also appear to be ritually killed (Van Gijn 2010; 2014a). Exchange forms the pivotal recontextualising process in this example, and the artefact biography approach enables a more precise appreciation of what transpired during local transformations from hunter-gatherer to agrarian societies.

The topic of exchange is not always clearly separable from that of procurement (and birth), given that materials can circulate across the landscape regardless of the state of working (Perlès, 2007). The issue is in disentangling the various ways in which things move around. They might pass between the hands of different people and communities (reflecting commercial or reciprocal exchange), originate with long distance procuring expeditions (in their conception), or circulate through foreign

landscapes with a familiar person (as part of the travel kit), to name some biographical possibilities. These may even be combined in the biographies of specific objects, such as lithics from Long Island in the northeastern Caribbean. Procured from the source by communities in surrounding islands and first modified there, material was exchanged down-the-line in the form of cores and core-flakes for further local reduction (Hofman *et al.* 2007; Knippenberg 2005; 2006; cf. Hofman *et al.* 2014b; Mol 2014). Outside of its (fluctuating) supply and destination zones Long Island flint is found only incidentally in the archaeological landscape. This adds the possibility that other, less institutionalised types of interactions circulated the material outside of this organised network. Material abundance, cortex ratios, and flake sizes were instrumental in the reconstruction of these patterns, showing the continuing importance of technological studies of debitage products. Objects found close to their source area are typically inferred to have remained local and within the community, in particular if a large quantity of debitage is present. Otherwise, if for instance a particular material is widespread throughout a region, the degree of circulation present within an assemblage cannot be established.

Technology returns as a viewpoint from which to approach the topics of maintenance and re-use. These are analogous to the behavioural definitions of maintenance, and lateral cycling and recycling (Schiffer 1995, 27-28). Maintenance includes all those acts that serve to stabilise the properties of an object in order to prolong the operability of its primary set of functions. Retouching a dulled lithic edge is the archetypical example of maintenance in archaeological materials, and the resharpening of ground stone axes is a similarly common practice. This is often discussed of as curation in the lithic studies literature, a concept there defined in relationship to utility (Andrefsky 2008; Shott 1996). Such practices will result in altered and slanted edge profiles, as well as potential holdover traces from chipping or abrading. For edge-ground materials this has mistakenly resulted in typological classifications distinguishing different categories within assemblages, which are actually all axe-heads of the same morphometric type in differentially progressed states of reparation (e.g. Boer-Mah 2008; Kufel-Diakowska and Skuła 2015; Lekberg 2000). Maintenance also includes the repair of attachments associated with such objects, notably hafting systems in the case of axe-heads, which may require the replacement of the handle, additional bindings, or fresh adhesives, and so forth. Every such possibility introduces new knots to the biography of the axe-head, which may itself have been used for the conception of any of those substances. Other types of maintenance are focused on longevity, examples of which are greasing joints to slow down the accumulation of wear or the impregnation of wood to inhibit decay.

This leaves only re-use activities to be addressed. These can occur as part of the life phase, in which case we talk of repurposing. *Repurposing* brings a thing away from its intended primary function, though this does not mean that it is biographically undesirable (e.g. Skeates 1995; 2002; Swift 2012). The reworking of damaged petaloid axes into pestles/pounders in the Caribbean Ceramic Age is widespread enough to assume it is a legitimate transformation of these things, even if they are individually uncommon (e.g. Roe *et al.* 1985). Technological modification is not necessarily required, however. Simple shifts within the patterns of circulation that see improvisations within the range of functional abilities (such as de-hafting an axe head to use it as a wedge), or a complete reinterpretation of use potential, are similar examples of the ways in which objects can find new purposes. *Recycling* occurs specifically after the object undergoes discarding processes and thus enters into an entirely new biographical trajectory (its older life may, but need not always, be recognised). This is a slight departure from the behavioural definition where technological re-working separates

lateral cycling from re-cycling (Schiffer 1995, 27-28), so that it better encapsulates the nature of the reinterpretations and transformations invariably caught up in its rebirth (cf. Adams 2013, 27). Still, recycling is an act that retains a connection with the primary cultural context, and should not be conflated with the revival trajectory of sourcing archaeological artefacts for cultural purposes (Section 3.1.3.5). An excellent example of this definition of recycling is the pounding of ceramic sherds from broken pots to create grog temper for the fabric of new ceramic vessels. Another is the knapping of discarded bottle glass from European origins by indigenous actors within a colonial context (or by enslaved or maroon communities, for that matter). Cases are recorded for both the Americas, including potentially the Caribbean, but they are best known from aboriginal groups in Australia (Akerman *et al.* 2002). This example entails a major recontextualisation, since it is virtually always accompanied by the re-interpretation of the substance into new ways of understanding its properties out of an association with familiar lithic materials.

3.1.3.4 Death

In accordance with the prior discussion, the death phase captures any set of transformations that objects undergo as part of their removal from the active use life and in response thereto. The finality of this phase must be firmly rejected, if only for the reality that any object archaeologically studied will in one way or another have passed through phases of deposition. What the metaphor does invite is to consider any threats to the material existence of the object, seen saliently in the discard of failed preforms and use-cracked axes. Such are deposited as consequence of the unexpected loss of proper functionality. Changes in the material integrity are no prerequisite, however. Things deposited as funerary architecture seldom reached the functional end of their use-life on their own; instead, such events may draw together artefacts with widely varying trajectories (Van Gijn 2017). For other types of objects the transformation comes when it is the right biographical moment for it to do so (see Fontijn 2002), or in defiance thereof. Such biographical possibilities are strictly emic, reasoned to internal cultural considerations and not relating to changes in material integrity. For instance, the Malangan funerary idols from New Ireland die after the completion of the charged ceremonial rites, at that moment conceptually decaying like human corpses do (Gell 1998, 223-226). In previous times they were simply abandoned in the forest to rot, but nowadays are sold for money; the extracultural transfer is of no consequence to New Irelanders, since its social existence remains terminated. However, there are usually multiple death trajectories that can be recognised as culturally cognisant. For the Nukak of southeastern Colombia, each blowpipe "has a unique trajectory and is subject to all sorts of contingencies. Some endure until they are over-used; others survive until a wise Nukak "blows on the *chicha*" of the user [which harms his potency as a hunter]. Still others remain in use for a short time, until destroyed during a conjugal argument" (Politis 2007, 232). Even so, once 'regular' defects occur or its social debilitation is clear, this is followed by ritual disposal in the form of careful and complete destruction in accordance with Nukak cultural expectations (Politis 2007, 227).

As a premeditated process, the death of an object can thus be accompanied by deliberate destruction if social propriety so requires. Intentional destruction is itself a complex notion, that potentially draws together technological behaviour, social context, ritual connotations, and ceremonial performances (Adams 2008; Chapman 2000; Chapman and Gaydarska 2007; Fontijn 2002; Hoffman 1999). It may entail the severance of a relationship (as a way of protecting against harmful influences), the continuation of one (accompanying other broken things), or a dividual transformation (connecting

humans through the distribution of fragments). Regardless of which case applies, the matter arises of the place where the transformation occurs, the place where actual deposition is situated, as well as the setting that surrounds either. More often than not, the resting place in which objects are archaeologically recovered reflects complex site formation processes and not the location of initial deposition. In turn, that location may merely reflect the space of a designated midden or land-fill on the periphery of domestic space, rather than the space where a tool fractured and was left *in situ*. This leads to questions such as whether social or symbolic paraphernalia that failed during expeditions were brought back to the village to be disposed of appropriately. Or, did they lose any and all of their importance upon that critical moment of failure? Even intact artefacts are sometimes lost while being left around in 'open-air storage' awaiting new use, as was the case for stone and metal axes amongst the Shipibo *(*Siegel and Roe 1986). Contextual information is key in elucidating such movements and with them any (re-)valuations and performances that are bound to have taken place around them.

Archaeologically informative surface modifications occur within this phase of death and either superimpose or erase preceding modifications. Breakage patterns are a primary line of evidence. These will obviously evidence the likely origin of the death as a major transformation in the object, and potentially give insight as to how this came to be. Notably, it will show whether they are consistent with functional behaviour and thus presumably use-related, or if some other form of explanation is required. Intentional destruction leaves traces that are biographically distinguishable from manufacture or function, depending on the method used (Van Gijn 2014a). However, not all fragments will bear the complete set of traces and the association of, for instance, points of impact with destruction over the alternative of manufacture is hardly straightforward. This renders the identification of deliberate practices of breaking notoriously difficult. Though objects may end up in a state of discard, this does not remove them from human context either. The way in which they remain in the periphery of view is difficult to approximate, but one strand of evidence thereto consists of trampling damage. Following sedimentation, taphonomic processes and alterations form yet another intrinsic part of the biographical death. Mechanical, chemical, and/or biological weathering may act upon an object to speed up decomposition or fossilisation processes. This is highly dependent upon the environment an object is buried within; relevant (wear-inducing) processes to the material within this study are discussed in section 4.2.1.4. They are not solely of analytical detriment, however. In certain cases specific diagenesis markers reveal prior interactions with particular taphonomic environments (Burroni *et al.* 2002; Donahue and Burroni 2004) and may expose past circulations in such manner. Taphonomic processes transform things (slowly), they may lose some properties, and gain others. There are thus clearly continuing relations with their context. Any ensuing characteristics are in turn an outcome of a long history of human-thing interactions in the wider landscape, as a depositional environment shaped by site formation processes. Transformations induced in it are irreversible and will shape what biographical possibilities are afforded to things once they re-enter active social contexts.

3.1.3.5 Revival and modern lives

There is a vast number of trajectories that can occur after (the first) death. Most objects that underwent deposition in the archaeological record will have been exhumed at some point, by professionals knowledgeable in archaeological practices or otherwise. Others will have eroded out in the open and collected by the observant, a trajectory that is comparable to objects lost or hidden and found at later points in time. The renewed entry into circulation and contexts constructed by humans

forms another process of recontextualisation. Here this process is carried out by excavators, collectors, curators, academics, and the general public, who organise finds and attribute them a material identity and desired storyline (Holtorf 2002). Few objects of archaeological interest exist that would not have undergone a transformation of such sort. Even things which verifiably circulated from authentic contexts to itinerant destinations would usually experience periods of stasis and inertness in which all connection to the prior sequence of social contexts is for that time lost. Consider the example of the gifts given by Hispaniolan *caciques* to the party of Columbus and transported to Spain, whose whereabouts are at present unknown. If the actual artefacts still exist, their interlacement with these historic moments is currently all but removed from the physical objects. The potential rediscovery may see this meaning restored in the contemporary world, a study of resulting re-appreciation forming a good example of the focus of cultural biography research in museum studies.

Though most archaeological objects are no longer functional in this part of the biography, nor their material integrity significantly threatened, they do not fall into stasis either. Matter continues to interact with the world on a physical and a chemical level; modifications such as corrosion and patination derive from this interplay. Think of the aura of decay, a cluster of evocations and feelings deriving from the impact of perceived wear, ruin, and dysfunction (Shanks 1998). This already constrains actions and communicates information on the biography of a thing without necessarily requiring an ontology of animacy. Similar changes may result from the efforts of conservators that substitute such relations with some of their own. These include alterations to the chemistry of surfaces, as well as changes to the appearance of objects by labelling and restoration. On the physical side of things, excavation practices can leave myriad microscopic traces. Contact with trowels and other digging tools, sampling, sieve meshes, and notably from motion against other objects in sieving, bagging, transportation, and storage are all examples (Breukel *et al.* 2015). The use of materials in teaching practices will wear them down and leave residues (d'Errico 1993; Graziano 2013) and so will the curatorial aspects of musealisation (Nugent 2015; Woodward *et al.* 2015, 15). These modifications do not stand in direct relation to any potential alterations of a contextual nature, but they do provide a means of recording them within the biography of a thing (Falci *et al. 2018).* Holtorf (2002) tracks the way in which archaeologists create knowledge during fieldwork and build contextual interpretations around the nature and properties of finds. Journeys through museum contexts sees new interpreters coming and going, appraising questions regarding origins, aesthetics, ideas of ancient cultures, their significance to contemporary society, and authenticities (Geurds and Broekhoven 2013; Guerra 2008; Joyce 2013). The museological dimension to object biographies is particularly prevalent in collection histories, where the successive shifts in the contextual association of pieces and their collections both indicate and impact the social and cultural aspects of public values (e.g. Françozo 2012;2016; Hill 2012). Reinterpretations and shifting contexts may even threaten to (again) end object lives. Here, telling examples include the Iconoclasm of the Protestant Reformation in 16th century Europe and the politicised episodes of heritage destruction organised by ISIS in the Near East in 2015-2016 (Harmanşah 2015).

Thus far the discussion has focused on the terms of the contemporary world (of the past few centuries), the relevance of which is indeed evident. However, it is not the only context that can lay claim to providing a new destination for things. The revitalisation of things from deposition and contexts of abandonment is a theme that has deep roots in history and human society. For instance, many Egyptian tombs and pyramids were broken into and looted within the span of a few generations,

bringing the objects interred back into economic circulation and possibly bestowing them additional meaning (Meskell 2004, 160-163). Consider also the example of communities sourcing some of the knappable raw materials they use from older cultural deposits, thereby breathing new life into old flints (Egypt, McDonald 1991) and, in colonial contexts, glasses (Australia, Akerman *et al.* 2002). The archaic dimension of such objects is not necessarily lost within the newer context. In fact, there are plenty of records of ancient historic societies engaging with objects taken from their pasts out of ceremonial, ancestral, and indeed archaeological interests (see Trigger 2008, 42-47). Numerous examples of such concerns are known from Amazonian ethnography, which usually (though not necessarily) consider such objects as created and gifted by non-human entities such as demiurges and spirit masters.

3.2 Ontologies and the ethnological record

Artefact biographies form an explicit groundwork with which to organise the data in a way that is reflective upon the life trajectory of the object. It is also clear that there are various ways to draw interpretations from it. Whichever perspective is prioritised must ultimately depend upon the shape the data takes. However, it has not yet been explained why relations between things, their biographical phases, contexts, and outside entities are configured the way they are. A number of themes repeated in the past sections necessitate closer scrutiny on this front. These include ontologies, (inter-) subjectivities, what it really entails for things to be relational, and so forth. All of these themes are derived from Amerindian ways of viewing the world and constructing the universe, though they now find application in anthropological fields far beyond it. How they may be integrated into theorised workings of biographical trajectories within pre-colonial Caribbean societies forms the topic explored in the current section.

Within anthropology, the term ontology is inexorably connected to the ontological turn. In it, the alterity of thought displayed by non-Western Others is a recursive anthropological description of the alterity of the Western subject (e.g. Alberti *et al.* 2011; Henare *et al.* 2007; Holbraad 2012; Holbraad *et al.* 2014). It rehabilitates non-Western worldviews as being internally consistent, and externally structured around the fundamentally different realities or worlds they inhabit. As ontologies they are classifications of independent realities, not mere relativisms of how Westerners have classified the world such as representationalisms or 'socially constructed' viewpoints (Paleček and Risjord 2013; Pedersen 2012). In other words, this removes the practice of ethnographic analysis from the confines of Western epistemology, deconstructing the idea that all human societies inhabit the background of one single, shared world. Rather, the ontological turn places the Western worldview as a historical contingency existing besides other ontologies in equally as many worlds, and accepts its epistemic achievements as descriptive of only Western reality. Our overarching ontology is described as naturalism by Descola (1996; 2013, vis-à-vis three other core ontologies), and 'multiculturalism' by Viveiros de Castro (1998; 2004a; 2004b, opposing Amerindian 'multinaturalism', or more recently anti-epistemology).

3.2.1 Indigenous ontologies from the New World

It follows that the study of any society, ethnographic, archaeological, or that of our own, should seek to describe them departing from their own reality. That is, from their indigenous classifications of

the world and thought on the essence of being. An ontology is indeed not simply another term for culture (Venkatesan *et al.* 2010), and operates beyond social boundaries of that scale. Amerindian perspectivism is expressed throughout the South American lowlands (Viveiros de Castro 1998; 2004a), for instance, or at least major elements of it are (e.g. Århem 1990; 1996; Overing 1990; Santos-Granero 2009b; Stolze Lima 1996; 2000; Vilaça 1992). It is especially well articulated amongst groups from the Tupian language stock, from whom it derives its heavy emphasis on a predator-prey type of hierarchy in the relationality between subjects (Viveiros de Castro 1992; a point of critique in Hill 2013). According to perspectivist descriptions, the essence of Amerindian cosmoses is one of intersubjective relationality, in which each being is potentially intertwined as a subject with other entities on the basis of their permanent ontological sameness. This sameness is reflected in the soul, as an interiority that is defined separately from the physicality of the body (adopting the terminology of Descola 2013). This duality is possessed by every subjective entity, regardless of whether they are what Western naturalists classify as humans, animals, plants, spirits, or things. The soul is alternatively understood as a shared template for cultural behaviour: it derives this from the world of mythical times in which all beings were human-like, many of whom regressively transformed into the variety of corporeal forms that populate the world of today. The body, as the corporeal form that cloths the cultural template, encompasses the tools of practice of this cultural behaviour. As such, raw meat is the culinary art of Jaguar, mud pools are ceremonial houses for Tapir, a rock outcrop may be the body of a mythical hero, and, purely conjecturing, the relation between decorated hafts and axe-heads may be conjugal. These are not permanent relations, however. They are the outcome of how these clothed souls perceive the subjects around them, and understand the nature of this relationship in specific, but in contingent manners. Hence, the stability of such intersubjectivities depends upon the comprehension of a relationship, which may dawn only as new natures reveal themselves. At that point, masks fall away and the hidden layers of Others may be unveiled, as spirits donning the bark of trees emerge and by their predatory glances have the constructed self of an unsuspecting human become undone. The spirit becomes the cultural human, and the Amerindian becomes its prey, losing all initiative and its own humanity in the process (Viveiros de Castro 1998). As such, things which naturalists consider the revolving order of nature, such as the sun rising in the east or for plants to grow in seasonal cycles, are from an intersubjective point of view the result of (manipulable) social agency. Similarly, the 'supernatural' becomes a dimension of nature, and is thus subsequently integrated as an outcome of relational engagement. Amerindians perpetually negotiate these engagements and this requires degrees of shamanic knowledge, as the reflexivity to recognise other bodies for what they are and not become incontrovertibly subjugated by the subjectivities of Others. Naturally, the ability to relate to powerful subjectivities such as spiritual entities, and to master techniques as ritual trances and the manipulation of vision, is what distinguishes experienced ritual specialists from the uninitiated.

There are two core tenets relevant for the present discussion. The first is that Amerindian realities operate on a relational filament, instead of a natural hierarchy. Actions and consequences emerge in it when the natural essence of Others is established through social connections between subjects. The second is that all of these subjects are people with an immutable cultural soul that opposes the transformative and sometimes uncertain nature of bodies. Whether they look like jaguars, palm trees, or *Homo sapienses* is only a momentarily outcome of active subjectification processes. While these tenets are incredibly widespread among Amerindian groups, they are not universally shared. A major critique of perspectivism holds that it generalises far too many individual expressions and exceptions

to the points just raised into one ontology (Halbmayer 2012b; Ramos 2012; Turner 2009a). It is overly essentialist, insisting on the symmetric inversion that nonhumans perceive Amerindians not as humans but as other nonhumans, and are not reflexively aware of their own nonhuman nature. These features by no means reflect on all animistic or Amazonian societies (Descola 2013, 138-140). As it stands, the degree to which lowland South America is characterisable under a single overarching ontology is hotly debated (e.g. Costa and Fausto 2010; Halbmayer 2012b; Latour 2009).

The formal structure of Amerindian ontologies is also captured by the modern concept of Animism (Descola 1996; 2013), which delineates predation and reciprocity as the specific modes of relational engagement practiced from the tropical lowlands towards Siberia. Seen in this way, Amerindian thought contrasts three other core ontologies: the four form a paired symmetry based upon whether the essences of physicalities (bodies) and interiorities (souls) are each continuous or discontinuous between beings. The other regimes are naturalism (the Western separation of culture from nature altogether), totemism (primarily Australian with protection as a main mode of relational engagement), and analogism (a multiplicity of essences with gradual discontinuity and overlapping influences, such as the Great Chain of Being of 'pre-Western Europe', or Mesoamerican and Andean cultures) (Descola 2013). Elements of these may also suffuse the worldviews of individual Amerindian communities. Halbmayer (2012a) argues that many Carib-speaking groups express assumptions that more closely resemble an analogical ontology. They perceive of people as fractally constituted, as opposed to the dividuality of body/soul. Different body parts are thus analogous to different energies, locations, and so forth, and associated with various aspects of their multiverse.

What may be said of indigenous ontologies within the pre- and early colonial Caribbean? Most evidence suggests linguistic and cultural connections with Arawak-speaking groups in northern South America (Section 1.2.3). Though that offers no guarantees that indigenous Caribbean thought closely resembled that of mainland Arawakan cultures, ethnohistoric documentation from the Antilles does contain strong links with ideas from the mainland. The *Account of the Antiquities of the Indies* contains an enumeration of myths, ceremonies, and ritual behaviour from the Cibao Valley (Pané 1974[1571]). The information contained therein can be sensibly explained using a perspectivist ontology (Breukel 2013; Mol 2014), when mindful of the problematics surrounding the document.[15] The problem is its transposition outside of the historical context from which it originates, which is a village of ambiguous ethnicity experiencing colonial upheaval, onto other regions and time-periods. Pané himself states that his inconsistencies are true to the narrations of his informants and that his account relates only to the inhabitants of *Aiti* (Hispaniola). These would be the high-ranking and politically and spiritually engaged individuals with whom he conversed, less to the commoners with scant knowledge on these matters and not to those of other islands (Whitehead 2011, 22-34). The transformative elements spread throughout iconological material culture more broadly do indicate

15 The original manuscript dates between 1496 and 1498, but this version is lost and contemporary reconstructions are based upon early translations in other languages (sometimes rich in imagination). The Catalan friar Ramón Pané did not speak any of local languages and interpreted the information relayed to him through Jesuitic Catholic themes, the perspective of his own 'ontology'. His work is also presented as if deriving from a timeless snapshot, whereas in reality the socio-political landscape was undergoing major upheaval as a result of the colonial encounter (Arrom 1974; Breukel 2013, 28-30; Hofman *et al.* 2008a; Keegan 2007; Keegan and Hofman 2017, 245; Oliver 2008; Ragolta 2008; Whitehead 2011). This has not prevented its use for the interpretation of the pre-colonial archaeological record in connection with broader themes from Amazonian ethnography, however. Notable efforts in this vein include the works of, amongst others, Peter Roe (1982); (1997), Arie Boomert (2000); (1999), José Oliver (2009), Antonio Stevens-Arroyo (2006), and Henri Petitjean Roget (1997; 2015b).

predominantly animistic/perspectival thought structures, but there is also significant heterogeneity and oscillation in these patterns. For that reason, Mol (2014, 70-75) argues against the existence of a shared ontological substrate for the Ceramic Age Caribbean in its entirety. However, such discussion about deeper nuances on specific human-spirit-animal interactions takes place at a level of resolution that is beyond the nature of the material culture studied at present. The third member of that triad is anyway problematic, considering the tremendous geographic and ecological differences between the archipelagic Antilles with its lack of large-bodied terrestrial fauna and the biodiverse riverine geographies of the tropical lowlands. Otherwise, I see no compelling evidence that subjective being and interaction in the Caribbean is affected more by elements from analogism or other ontologies than hitherto proposed.

3.2.2 Relational things

The qualities that Amerindian ontologies attribute to humans, animals, and plants, to a certain extent also apply to things. Examples of relational, autonomous, and constructivist things in *The Occult Life of Things* (Santos-Granero 2009c) show how object regimes differ from community to community. Any society is likely to harbour distinct modes of 'being a thing', depending upon the qualities ontologically inherent to them. These qualities define how things possess relational agency, communicate with beings, and exist in practical interdependence. The most important traits are the manner in which things comes into existence, and the strength of their souls during life. At least five different such modes are observed among Amazonian societies, ranging from inanimate objects and the socially incapable to highly autonomous and subjectifying things that brought themselves into being (Santos-Granero 2009a, 106-111; Santos-Granero 2009b, 8-11). Most of these are to various degrees infused with soul stuff derived from their (social) closeness with other beings, or are in full possession of souls of their own. As such, things are relational, sometimes in the same way that humans are, and are communicative, intersubjective, but may sometimes be objectified and thus depraved of their social qualities. Many possess life cycles in which they are constructed and eventually die, mirroring that of people and often intertwined with them (e.g. Lagrou 2009; Walker 2009). Things may also come to constitute the bodily aspects of other beings, through analogism, or transformations which occurred in mythological times. They – and not just bodily ornaments – are critical to the construction of ones humanity and personhood (e.g. González-Ruibal *et al.* 2011; Miller 2009; Santos-Granero 2009b; 2012; Walker 2009). That said, this is not a survey of modes predicted to coexist in a given society. Rather, they are merely possible ways of being.

The most powerful types of things are as defined by their interiority-physicality as organic beings are. Such things originate in the transformation of human-like beings in mythical times, that become (artefactual) elements of the contemporary world in the same way that other human-like beings became the animals of today (e.g. Lagrou 2009; Miller 2009; Santos-Granero 2009b). A powerful class of being consists of demiurges and hero figures which at the time of creation descended upon the world of today and transformed themselves into material things like mountains, cataracts, celestial patterns, and certain types of artefacts. Such self-transforming beings act in the same manner as spirits, with the potential for wringing harmful changes upon humans if encountered in their natural state (Barcelos Neto 2008; 2009; Santos-Granero 2009b; Viveiros de Castro 1998). These classes of beings are nearly always endowed with the potential for autonomous capacity, to enter a subjective relation in equal terms and come to dominate it. It seems more common for such transformations to have

been forced onto the soul in question, which today relates to capturing such a soul by the process of making. In perspectival terms, this amounts to reshaping its physicality in order to transform how the relational and cultural worlds are seen by the thing, which requires technological and shamanic know-how (e.g. Barcelos Neto 2009; Van Velthem 2001). The ontological class of artefactual beings native to the Caribbean, described in the documents as *zemies* (and derivatives), likely included entities of these natures (Breukel 2013, and see Mol 2014; Oliver 2009).

Typologically, such artefacts are invariably things with a high degree of shamanic cohesion. Ceremonial musical instruments and shaped stone objects are common examples (e.g. Barcelos Neto 2008; 2009; Hugh-Jones 2009; Santos-Granero 2009a; Van Velthem 2001; Walker 2009). Their artefactual forms are their bodies, composing its "bundles of affects and capacities" that calibrate the capacity for a point of view (Viveiros de Castro 1998, 478). This means that, for instance, the mineral patterning and colouring of a pebble can expresses ritual clothing and/or bodily ornamentation (Bilhaut 2006). Similarly, weapons for hunting and warfare often possess interior qualities, mobilised for the synecdochal transformations of enemies to prey (Erikson 2001). The skill in the technological execution of the artefactual body can form a defining characteristic of the strength with which the subjective relationship is enforced (Erikson 2001; 2009). The destruction of such bodies then instantly terminates whatever subjectivity shackled the interiority of the being in question, allowing its natural perspective to resurface. However, technological efficacy is a contingent characteristic, as it is unassuming or biographically absent for things like refractory minerals and shamanic stone pebbles (e.g. Bilhaut 2006; Santos-Granero 2009a). Of course, a culturally right way of seeing through the process of making such a being into a part of the social fabric of the human world will end up with the artefact in hands of human caretakers (cf. the *zemi* tree of Pané 1999). In reality, such things are always in a state of process, and if the proper taboos and protocols are not followed they may revert to their original and dangerous perspective, necessitating maintenance on social and ritual grounds (inseparable aspects, really).

The most common mode of existence is when artefacts become ensouled through human subjectivity (Santos-Granero 2009b). Such things relate to humans in various ways, as creations, subordinates, or as constitutive of one's body, personhood, or sociality. They become subjectivised under these circumstances, and remain vibrant and interactive, but are generally not themselves subjective and thus lack the autonomous exercition of agency. Some of these artefacts act as vessels that acquire a fill of other soul energies, others may be things with a latent soul that becomes activated in the presence of subjective relations, or are constructed in an act that reproduces one's cultural humanity. Such modes are contingent on the society in question, and multiple may coexist (e.g. Erikson 2001; 2009; González-Ruibal *et al.* 2011; Turner 2009b; Walker 2009). The vitality or 'sensorial soulstuff' of Yanesha persons lacks corporality and physical boundaries, and may thus diffuse into objects of daily use and close personal contact (Santos-Granero 2009a, 109). Cashinahua stools, which are made from the wood of a powerful, predatory tree, are actively sung to and seated upon so that they become capable of constructing new beings (Lagrou 2009). Tools and ornaments are thus common examples of ensouled artefacts, the former enabling cultural behaviour such as the procurement of honey and the latter constituting integral elements of the cloth of one's physicality. Things so closely connected with the soul energies of human beings are readily destroyed or interred alongside when their owners or caretakers pass. Artefacts that originate in mimesis are generally of much higher subjective potential, but derive their interiority from elsewhere. Such things index

their agency from prototype objects, to use the terminology of Gell (1998), so that for instance the potency of feather bibles is subjectively appropriated from that of Christian tomes. It is a form of being primarily associated with artefacts that emulate the foreign objects of Others, most visibly missionaries and colonisers (Santos-Granero 2009a, 109) – as such, it forms a particularly important mode for early colonial artefacts and skeuomorphs.

Finally, there also exist types of things that lack subjective qualities within most Amerindian ontologies. Such objects are generally not beautiful, and lack social prominence. Among the Yanesha they are very often simple substances, like dirt, air, water, and pebbles, plain for all intents and purposes. They have little to no potential for becoming relational, though there are exceptions. Generic alien objects like kitchen pans and plastic bowls are also lifeless, if they do not form indices for mimetic things. However, things like landmarks or gales may again rise to prominence (Santos-Granero 2009a, 109-110) – they are defined aspects of the 'weather world', in which social agency may be found responsible. Of course, the subjective potential for things is separable from the actual content of a thing in context. There is significant biographical tension in the process of desubjectification, as objectification, that acts to remove and deprive existing subjective energies from things – to disconnect them from the social context. For instance, this is a necessity in dealing with things like hammocks and toys that a person outgrows, but which have such degrees of personal investment that they cannot simply be left to rot – that would open the person up to supernatural attack. There is a certain repulsion associated with the decay of powerful things (Van Velthem 2001). Furthermore, objectification is widely used as a means of turning stuff into goods and thereby facilitate their exchange, cutting off the danger that subjectivity turns sour and adversely affects those who lose relations or obtain bad ones.

Currently, there exist unresolved conflicts between the relational nature of certain things and the drive to circulation forced by commercial regimes of values, resulting from the enmeshment of indigenous regimes of things with nation state economies (Turner 2009b). However, this is not to be misunderstood for an argument that only lifeless things can be exchanged, as a way of protecting one's own social soul. This would amount to placing the protective label of 'inalienable' on every object infused with sociality, which is at odds with the ethnography and dangerously obstructs inquiries into biographical circulation as driven through social relationality. It seems to me that this is a conflict with colonial commerce, meaning that in pre-colonial times there were long-standing indigenous solutions to this conflict that must have made the exchange of things salient again. Artefacts presumed to be charged with soul energies – or even defined by their interiorities – could also change hands as the subject of raids. Ceremonial ornaments from the upper Rio Negro changed hands through theft and intertribal warfare, incorporated into new contexts through ritual speech and performance (Costa Oliveira 2017), and European chroniclers recorded the raiding of *zemi* objects between indigenous Caribbean polities (see Oliver 2009). Unfortunately, there is little ethnographic information that details in what specific manner subjective relations are altered by such actions, leaving their effect upon both victim and retriever up for what is basically ontological speculation. The inheritance of artefacts with autonomous souls and subjective potential appears rare, but is not altogether unheard of (Barcelos Neto 2009; also Costa Oliveira 2017). Commercially valuable objects may even be claimed by descendants in defiance of cultural norms – as reported for shotguns amongst the Kayapo (Turner 2009b) and Awá (González-Ruibal *et al.* 2011). Outside of Amazonia, the custom of Kula exchange forms an archetypical example of how, despite ever accumulating personal connections

and dividual histories, it may become biographically salient for things to 'move on' and obtain ever growing biographical value in doing so (Munn 1986; Weiner 1992).

3.2.3 'Ancient' axes in modern Amazonia

This brings us to the issue in which respect any details of these modalities may be applicable to the Caribbean. The use of analogies between ethnographic and archaeological case studies is a time-tested approach, but one which over the course of this time turned out to be rather problematic (e.g. David and Kramer 2001; Gosselain 2016; Wobst 1978). There are various reasons for this. One of the objections raised early on was that analogical reasoning only permitted the conceptually accessible range of human alterity to be as wide as what was recorded in contemporary ethnography (Gould 1980; Gould and Watson 1982). This robbed the archaeological record of any genuine innovativeness in the way in which humans would express themselves in culturally and socially unique terms. Furthermore, analogies proved incapable of confirming causal relationships between the appearance of traits, and could not deal with variability on a diachronic level. However, any proposed solutions at the time were ultimately judged to be simply formalised hypotheses to be tested following analogical standards (Gould and Watson 1982; Watson 1980; 1982; Wylie 1982; 1985; 1988). As inductive arguments, analogies rank possible solutions according to their probability, which amongst other factors include searching out and accounting for the dissimilarities that remain. These counterarguments further held that analogical reasoning ultimately formed the conceptual basis of all archaeological research, a position supported by research from the cognitive sciences which argue that analogies form core cognitive processes (Gentner and Holyoak 2001; Hofstadter 2001). This, however, did little to abate the issues originally raised by Gould (Dunnel 1989, 8-9). Schmidt (2010) recently argued that as analogical reasoning introduces a form of metonymic tension within archaeological inquiries. Through the act of classifying and naming things of the past, qualities from the present domain are imposed on them that may unduly suggest metaphoric closeness (and therefore analogical suitability). This is equally problematic both for when information from the unrelated present domain or from the direct historical domain is mixed in with a contingent past, as argued for the ethnohistoric chronicles on early colonial Hispaniola (Breukel 2013).

In light of this, one reason to commence from the previously outlined ontological generalisations is that their window into the structure of Amerindian thought on the use and role of things in society is less enriched by the particular details and modalities developed by specific ethnographic records (communities). Certainly, such records sometimes appear to be exceptionally strong analogues, for instance through purported or established historical links. Direct historical analogies using, say, stone axe users from tropical forested South America may seem to contribute better to the conceptualisation of Caribbean lithic materials than that Papua New Guinean materials might. The move is flawed, however. The domains of source (present ethnography) and subject (past archaeology) remain separate from each other by myriad factors and processes, and are recursively defined by them. This section thus explores the domain of contemporary stone axe use for several reasons: 1) it forms a way of deconstructing both direct historical analogies between the Amazonian societies of today and those of the pre-colonial past, 2) this also obviates such direct analogies between the Caribbean and lowland South America, 3) its topic matter is of extreme interest to the present work, and 4) it forms an under-evaluated kernel of current debates on Amerindian agroforestry.

The manufacture and functional use of stone axes is described in numerous ethnographies from

between the mid-20th to early 21st centuries, which range from southern Brazil to northwestern Amazonia/southeastern Colombia. Perhaps the best known are the Héta from the high plateau of the southern Brazilian state of Paraná (e.g. Kozák 1972; Kozák *et al.* 1979; Laming-Emperaire 1964; 1978; Miller 1979). This group was first contacted in the 1950s, at which time they practiced a far-ranging nomadic hunting and gathering economy and had no access to metal tools. Amerindians with similar ornamentation and toolkits had been encountered in that area in the 1870s, but then disappeared again for generations. The Héta were once more numerous and practiced sedentary horticulture, possibly as neighbours to the Šetá, Kaingáng, and Guaraní, but were forced to abandon their lifeways due to epidemics and encroaching exploitation of their forest (Kozák *et al.* 1979, 355-366). Kozák and colleagues recorded aspects of Héta technology from the few survivors, before the group all but disappeared by the 1970s. This case is emblematic for the primary issue with analogies that could be made between contemporary axe users and pre-colonial Amerindian societies: 'uncontacted groups' are not somehow representatives of pre-colonial traditions with pristine material culture and preserved know-how (the 'ethnographic present' problem, e.g. Sanjek 1991; cf. Wobst 1978; Denevan, 1992). Rather, in Amazonia this means they were not recorded and visited by anthropologists during the late 19th and 20th centuries. There exist no guaranteed 'protection' from previously experienced encroachment by rubber barons, loggers, and ranchers, nor earlier contacts by Europeans that were not recorded in history. Certainly, such groups would have been (or still are) connected with other, 'contacted' Amerindian groups. The Héta are generational refugees whom 'recently' abandoned potentially centuries of early colonial lifeways under encroachment pressures. This must have resulted in a severance of connections with middlemen Amerindian groups that circulated metal tools back then, leading to a reinvention of stone axe making.

Such a scenario is historically recorded for the Aikuro of southeastern Surinam. Though contact with several nomadic groups was only established in the 1960s, their existence was indirectly known since the early 17th century (Boomert and Kroonenberg 1977, 39-41). The Aikuro were constantly on the move in the 1960s to gather food and procure raw materials for different crafts. However, that particular pattern arose only in the late 19th century when antagonism with neighbouring groups disrupted their supply of metal axes, and the Aikuro had to abandon horticulture and sedentism. Boomert and Kroonenberg (1977) consider their stone axe-heads as inferiorly made to pre-colonial examples and infer that this technological tradition had long been forgotten before the historic situation necessitated its re-invention. The situation of the semi-sedentary Zoé of northern Pará (Kästner 2007) may well be similar, since this group lives further inland on broadly the same geography and their stone axes are technologically quite comparable. In the same vein, the Münkü were in established contact with Brazilian society, before the Myky were separated from them in 1900. They turned to making stone axes until contact was re-established in 1971, and today still casually manufacture them for tourists (Fernández González 2016). It is common also for Amerindian groups to have abandoned their stone axes one or two generations before visitation by ethnographers, still remembering their use. Examples here are the western Nukak from eastern Colombia (abandoned in the 1980s, Politis 2007, 194, 214-215) and the Amahuaca from Eastern Peru (abandoned in the 1920s, Carneiro 1974). Though some elder Amahuaca were still in possession of stone axe heads by the time of Carneiro's visit, they remembered only generalised knowledge on manufacture and use.[16]

16 More ephemeral mentions include the Amarakaeri, the Kreen-a-krore, and possibly the Cinta Largas and remnant Yuri, mentioned as still using stone axes in the 1970s by Carneiro (1974). An earlier Nambikwara stone axe

In light of these historical trajectories, any notion that uninterrupted traditions of axe-making knowledge and skilled use survived from pre-colonial times to the situations of near today is highly debatable (cf. Denevan, 1992). It is far less controversial to assume that metal tools rapidly spread over the continent from the early colonial encounters onwards, even if such paradigms require sensitivity to local contexts (Bamforth 1993; Cobb 2003). The indigenous demand for access to metal is proverbial (Metraux 1959), its attraction resting in both the superior functional properties of the material and the trade wealth represented by owning them. It is widely presumed that Amerindian communities relinquished their use of lithic tools the moment metal tools became obtainable within sufficient quantities (in the study area, Lovén 1935, 138-139). In spite of relatively limited European points of entry, introduced wares circulated rapidly in the indigenous world foremost as the result of extant exchange networks between Amerindian communities. This was observed by Columbus in the first week of the European encounter (Dunn and Kelley 1989, 83-85), and is a well documented phenomenon in frontier contexts such as the Orinoco basin (e.g. Gassón 2000; Scaramelli and Scaramelli 2005). Stone axes circulated along such networks quite frequently, as historically recorded for the upper Xingu, monopolised and led by the Trumai and Kuyabi (von den Steinen 1897, 196) and archaeologically inferred for Surinam (Boomert and Kroonenberg 1977) and the Tairona of coastal Colombia (González and Hinthorne 2017).

Since gifting metal tools is a familiar way of establishing peaceful contact and breaking recluse (e.g. Fernández González 2016; Kozák *et al.* 1979), 'uncontacted' groups from contemporary history are clearly aware of what the material represents. This means that their recent isolation from metal tools must be seen foremost as a historical contingency and not the untouched base culture. It is possible that stone axe making traditions survived (or were remembered) due to eminence in social dynamics, unrelated to their functional capacities, as seen in Papua New Guinea (Pétrequin and Pétrequin 1993). However, the poor technical execution of most recent examples of stone axe-head manufacture suggests that these traditions were re-invented from scratch, probably relying upon cultural memories of stone knapping and examples seen in archaeological deposits. Some of these evoke European steel axe designs for heavy woodworking, and most can in general be regarded as post-metal stone tools. Of course, that does not mean such tools are of the same efficiency as metal axes, but it is difficult to offer reliable comparisons (Mathieu and Meyer 1997). Ethnographic opinions on cutting rates are quite insistent on the superiority of steel (e.g. Goeldi 1906; Ferguson 1998), and experimental work has suggested it lays somewhere in the order of ten to thirty times, increasing exponentially for trees with larger circumferences and higher hardness properties (Carneiro 1979a).

These notions are of central importance to the historical ecology paradigm of a domesticated

is also shown, and Carneiro laments the lack of attention given to such tools by early explorers and (ethno)historic accounts from Amazonia. Roth (1924, 72-76) notes the widespread replacement of stone hatchets, and obtained one through (but not from) the Warao. The Rikbatsa and the Panará are also described in passing as recent users of stone axes (Fernández González 2016). Ferguson (1998) argues that the Yanomamï were drawn towards their current territory by the lure of steel axes, despite the region's poorer ecology, and adopted a sedentary lifestyle in order to control access to the Western sources. Rostain (1986/1990) describes numerous groups out of second hand with respect to their hafting practices. The Kalina, Kashinawã, Boróro, Xéta, Akuliyo (Aikuro), Araweté, Arára, Tapayúna, Trumaï, Guarani, and Guayaki all use male hafting systems, and the Huachipairi, Guarayo, Baníwa, Katawasí (Katukina), several groups along the Ucayali and Napo rivers, and also the Yanomamï use juxtaposed axe hafting systems. Certain Jê groups obtain edge-ground artefacts for ceremonial purposes from sacred places (archaeological sites, Cristiani *et al.* 2008), and the Andoke of southern Colombia self-identify as the people of the (stone) axe and were reputed producers (Piñeda Camacho 1975). Listed also are catalogue descriptions of stone axes attributed to the Nambikwara, Apinaye, Ramakokamekra, Krao, Gavios, Asurini, Huarí, and Wayãpi, next to aforementioned groups (Rostain 1994, 697-698).

Amazonia. Recent debates on the emergence of horticultural practices in Amazonia have posited this as a relatively late phenomenon, only starting at ca. 1000 BC when climatic conditions became wetter and a veritable explosion of archaeological signatures is found. That complex social polities developed in these periods was enabled by the bountiful tropical forest environment, exploited through limited horticulture and opportunistic agroforestry (e.g. Clement *et al.* 2015; Neves 2013). The ability of indigenous peoples to fell trees at larger scales and modify the tropical forested landscape is appraised as ephemeral, due to the inadequacies of their lithic technologies (Denevan 1992; 2001). In turn, the level of indigenous demographic organisation seen in historic times is now considered as resulting from the introduction of metal technologies, and regarded as largely a colonial period situation (Neves 2013; Ferguson 1998).[17] Experiments like Carneiro's (1974; 1979a; 1979b) highlight these inadequacies, but there are serious issues with them. Foremost is that his informants (Yanomamï and Kuikuro) had switched to steel for generations by this time, and thus attempted to cut using inappropriate swinging and felling techniques. Besides the obvious inexperience of the users, the working properties and suitabilities of the used stone axe type and hafting arrangement are unclear, and may be doubted. Seen from the viewpoint of experimental archaeology, they associate an unjustifiable difficulty with the felling of trees from the tropical forests. This will not be the case with stone axe users from recently 'contacted' groups, but they would not have remained uncontacted if practicing landscape modifications at such scales. The discussion will revisit this argument from a Caribbean point of view.

3.3 Synopsis

In its barest essence, the biography of an artefact consists of the sequence of events resulting from its involvements with other actors. This can be framed as a series of data points pertaining to one or more episodes therein, that methodologically collate the (surviving) evidence for that sequence. Such involvements are always social, but depend upon which actors are ontologically considered as agentive. Technological manipulation of the nature of an object engenders a biographical transformation quite literally, whereas its transportation or exchange over distance does so more conceptually. The end result is the same: relationships between subjects close off old stages and enter new ones (or simply metamorphose), sometimes in archaeologically evident ways. These are called biographical movements, and they can be driven by concerns for cultural logics, economic needs, social customs, or by taphonomic processes, and so forth. As a concept, the biography is quite open ended; the trick is in finding the appropriate perspective on these drives to reach a reconstruction of the social and archaeological contexts constituting the playing field of the biographical trajectory.

17 A parallel argument is made by Van den Bel (2015) for the introduction of metal graters in the Guyanas vis-à-vis the cassava subsistence economy.

4

Methodology

The framework for a comprehensive interpretation of artefact biographies stands, and this chapter focuses on the method to attain such interpretations. First, I will detail in section 4.1 the practical conduct followed in the laboratory and the various field settings. This section also acknowledges the appropriate contributions made by others to Chapters 7 and 9. The tribological nature of traces of wear and the inferential process used to interpret them are reviewed in section 4.2, in which I explain in greater detail the terminology of the wear trace method. Section 4.3 addresses wear trace contributions to the study of Caribbean materials and the physical properties of rocks and shells. Wear trace analysis is primarily a method for the functional study of cryptocrystalline silicates such as flint. This is true both by historical emphasis and by volume of examined materials, though recent decades have seen great efforts directed towards bone tools, grinding stones, and ornaments. For this reason I define present terminology for the description of microwear traces associated with stone grinding and woodworking in Chapter 5, drawing upon the experiments therein.

4.1 Practical conditions of analysis

The research has been conducted partially in the Leiden Laboratory for Artefact Analysis, and partially in various locations set up in the field. The analyses conducted in the Laboratory adhere to modern standards in Optical Microscopy (OM), utilising multiple microscopes, free-arm configurations, integrated micro-photographic software and so on. The involved artefacts were freely available to peers for discussion and comparison of the traces of wear, for hand examination of the raw material, and for multi-disciplinary analysis when applicable. However, permissions for transporting archaeological collections to The Netherlands were granted only for specific samples. The majority of materials were studied by using portable instruments at the NEXUS1492 Archaeological Centre in Cruce de Guayacanes, Dominican Republic (June-July, 2015, January, 2018), and at the La Poterie guesthouse and the Willcox residence, both in Grenada (January-February, 2016). Here the level of resolution is comparatively lower, given constraints of time, collaborative isolation, and local contingencies. This section explains the research protocols and resulting resolutions in detail for both settings, followed by the strategies and collaborations employed to obtain full biographical data for both object groups insofar possible given the fragmentation of artefacts.

4.1.1 Laboratory protocol

The first step consisted of drawing the artefact from all sides on Laboratory forms to a 1:1 scale. Size measurements were taken down to the nearest 1 mm using digital callipers and edge angles recorded using a goniometer on the edge and 5 mm behind it. Described at this stage were macroscopic

observations (with the naked eye) on the raw material, artefact morphology, technological features and stigma, potential use wear, residue deposits, and breakage patterns. The artefacts were photographed from various angles using a Nikon D5100 digital camera, with the possibility to produce z-stacked images using the Helicon Focus software.

The second step consisted of a full examination of all surfaces under low magnification. The equipment comprised a Leica M80 series stereomicroscope equipped with segmented LED ringlight (7.5-64×) and a SMZ800 Nikon stereomicroscope using adjustable oblique light (10-63×). Both models possess a camera mount, of which the Leica MC120HD model of the M80 is integrated with the Leica Application Suite (LAS) 4.8 software. I principally examined the artefacts in handheld motion but for photographs mounted them on Blu-Tack™ putty covered by Parafilm™, allowing precise manipulation of the angle without leaving residue. These observations were registered on the form containing the drawing. Certain types of technological wear, such as impact damage and perforation morphologies, are interpretable at the lower range of this level of magnification, referred to as the stereoscopic range. The spatial distribution and inter-relation of most other alterations are usually observable as well, permitting some basic and preliminary inferences regarding use, manufacture, and operation (hafting and suspension).

The third and final step gave closer scrutiny to these worn areas, through examination under levels of magnification of 100× and higher using incident light OM. The primary instrument was a Leica DM6000 M metallographic microscope (100-1200×) with inbuilt digital (replicable) settings and z-stackable micro-photography using a Leica DFC 450 camera through the LAS 4.8 software. Also used were microscopes of the Nikon Optiphot-2 X/Y series equipped with different lenses (ranging 100-500×, Nikon DXM 1200 camera) including a custom built free-arm variant, and a Leica DM2700 with extended vertical stage (Leica MC120HD camera). The latter two allowed examination of larger artefacts under steeper angles. All are outfitted with measuring graticules as well as polarizer and green filters used to enhance the contrast and visual examination of potential residues. The artefacts were mounted on an adjustable stage using the aforementioned putty and scanned by moving them under the static incident light beam. Since most studied surfaces have intrinsic curvatures, the artefacts required constant rearrangement to maintain a 90° light beam angle while moving to new areas. Given these practical matters, and the high resolution (the level of detail is measured in micrometers), this step formed the most laborious part of the process. Microwear traces were described at 200× and 500× magnifications, recorded on the form, photographed, and entered into the Laboratory Database after interpretation.

Prior to cleaning, surfaces were subjected to an initial stereoscopic scan for general residues and polarised microscopic examination of celt blades and anvil pits for potential starch fossils. The decision to clean was made only if necessary and when no residue was present. The cleaning protocol consisted of a warm rinse and ultrasonic bath for 60 minutes to remove excessive dirt. Longer durations and soap were used if the artefacts were insufficiently clean and the dirt saved if residues were suspected to be lodged underneath. Grease deposits were removed using cotton pads with 96% alcohol. Chemical cleaning has not been used on archaeological artefacts. Such practices have become a source of contention in the field because it is uncertain how much evidence is removed from flint using increasingly aggressive chemicals (cf. MacDonald and Evans 2014) . This issue relates to the lack of certainty on the mechanisms that cause polish formation (Evans and Donahue 2005), since the models disagree on whether the removed matter constitutes evidence (Section 4.2.1.3). As the

present dataset consists of hard organic materials and rocks of different chemical composition than flint, the uncertainty regarding its effects on the traces was felt to outweigh the minor improvements in visibility.

4.1.2 Field protocols

The protocols followed in the field are based upon the same steps as the Laboratory protocol. The primary differences rest in the tools and instruments used, since all equipment had to be transported to location and operated in the local environment. The decision was made to use USB-based travelling microscopes to substitute for the low magnification analysis and transport an early model Nikon Optiphot as the stationary instrument, since these are robust, simple, and easily (dis)assembled.

The macroscopic step remains largely unchanged. I used a millimetre scale for size measurements in the Dominican Republic since all available callipers were made of metal, and as camera models a Nikon D610 and in Grenada a Nikon Coolpix P510. Cleaning protocols remain as explained, except that 70% isopropyl alcohol was used to clean off grease in Grenada with diminished effect.

The low magnification analysis used a Dino-Lite Pro AM-413T model with 1280x1024 (1.3 Megapixel) resolution in the Dominican Republic and a Dino-Lite AD7013MZT Premier model with 2584x1936 (5 Megapixel) resolution and polariser in Grenada. These are USB-based digital microscopes that feed an image stream into the DinoCapture 2.0 software producing a live feed with photograph capacities, but do not allow direct observation. The instruments are sensitive to vibrations and the digital frequency is not sufficient to capture movement, therefore the artefacts had to remain stationary during the analysis. Effective magnification ranges are located at 1-ca. 50× and ca. 200-230×, with the latter range useful primarily for close-up photography of residues. The models have in-built LED ringlights and exposure adjustment, but capture topographical detail poorly. It proved preferable to turn off these functions altogether and rely on natural sunlight (falling under an oblique angle at morning and afternoon hours) or an oblique-held flashlight for illumination. These models did not approach the ease of detection and photographic resolution offered by conventional stereomicroscopy, but provided adequate aid at assessing the spatial distribution and inter-relation of most traces.

The use of the Nikon Optiphot model in the field is not any different than its use in a laboratory, yet there are two issues that contribute to a diminished resolution of analysis. The ability to observe surfaces was impeded by the available lenses on the model (allowing a 50-200× magnification range) and restrictions in artefact sizes. The stage allowed full analysis of artefacts with dimensions up to 90 mm, but aspects in excess of that were not examinable. In practice, the bevels, edges, and bilateral sides of large celts and elongated artefacts could often not be reached or stably mounted. Furthermore, the model lacks a camera mount which led to issues with the reproducibility of observations by description alone. Documentation the Dominican Republic in 2015 therefore relied upon the micro-photographic comparison with previously documented instances of archaeological traces, experimental references aside. These wear trace signatures were conclusively interpreted only after additional experiments had been conducted and older interpretations revisited, though certain traces had not been encountered previously or since. In subsequent fieldwork in Grenada I used a compact camera (Olympus VR-340) of which the lens fitted against the oculars of the Optiphot to photograph the microscopic view. Provil Novo™ silicone casting material was used to replicate specific wear trace signatures for artefacts with non-porous matrices (on which it leaves no stains). Finally, an Optiphot-2 body tube with camera

mount was available for the 2018 field study which fitted a digital single-lens reflex camera (Nikon D5100) equipped with a trinocular lens for micro-photography.

4.1.3 Analysis of biographical phases

Data on procurement can be divided into raw material identification and the interpretation of signs relating to (extraction from) the natural context. These data were obtained through collaboration with members of the NEXUS1492 group, principally prof. dr. Gareth Davies and his students from the Cluster of Geology and Geochemistry, Faculty of Earth and Life Sciences, Vrije Universiteit, Amsterdam. They contributed a basic classification from hand samples of the different lithic materials from the sites under study, and provided matching raw materials for experiments. Specifically, Alice Knaf classified the lithic materials in Leiden whereas materials from Pearls and jadeitite-bearing rocks from Playa Grande were classified by her and prof dr. Gareth Davies for geochemical sampling while in the field. These identifications form the basis of the raw material discussion for celts. The materials studied in the Dominican Republic in 2015 were organised into macro-groups by myself, based upon their gross petrologic characteristics in reference to the aforementioned classifications. Tijmen Opschoten, a MA student of prof. dr. Gareth Davies visiting the field centre in 2016, classified some remaining celt materials from El Flaco thereby improving the accuracy of my own groups. Taxonomic identifications for the paraphernalia were reached in discussion with dr. Andrzej Antczak for marine animal materials and provided by prof dr. Menno Hoogland and dr. Jason Laffoon for terrestrial animal materials.

With respect to signs from the natural context, the primary concern was to distinguish lithic cortex from anthropogenic modification at Playa Grande since this had proven problematic macroscopically (Knippenberg 2012). Such surfaces tend to be highly variable as a result of fluctuating energetic conditions and sediment load within the fluvial environment, and under certain circumstances resemble technologically modified topographies. For instance, rough and pitted surfaces may mimic pecking, and smooth and flat surfaces approximate grinding. The examination of stereoscopic undulation of surface relief, irregular spacing, dimensions, gradient, and penetration of microscopic interstices, and erosion of asperities and mineral cleavage aided in separating out traces, further discussed in section 7.3.1. For paraphernalia this was done through reference materials and images in relation to wear and patination patterns.

The primary phases observed in celt production are flaking, pecking, and abrading. The stratigraphic overlay of the various traces from technological wear indicates in what order observed production gestures were applied. For instance, it is not uncommon for completely manufactured celts to retain terminations or deep running scars from initial flake removals, incompletely pecked and ground over. The gradation of pecking impacts is assessed from coarse to fine, depending upon whether a preform is shaped via hammering (resulting in impact craters) or the resulting topographical relief of a surface is minimised. Pecking marks sometimes overlays abrasive manufacture when new features are being shaped (common on the bilateral sides for later hafting) or underlay them in the form of small pitting, relief all but erased. Traces from abrasive techniques were assessed through topographical characteristics, including the measure of levelling and patterning of striations stereoscopically, and signs of fatigue and polish structures microscopically. These traces are usually best developed in the proximal area of the face, which is the most visible area during use and the one least likely to be overlain by traces from hafting or use.

The technological analysis of paraphernalia obviously depends on the individual shape of the object in question. However, these object types involve a different set of technological activities as means to obtain the end-form. I presently use carving and sculpting as catch-all terms for artefacts evidencing detailed modelling and engraving operations. Engraving refers to the specific patterns of decoration placed into a surface by technical motions, of which iconography is the depicted outcome. Technical motions inferred in this work include incising (a longitudinal motion consisting of a single cutting stroke), sawing (back-and-forth longitudinal strokes), scraping (which pulls a perpendicular edge at a high angle), whittling (which pushes a point or perpendicular edge at a low angle), and chiselling (which pressures a point into the surface at a low angle or uses indirect percussion to do so). Excising refers to the use of a series of such gestures to create a central protruding area by removing the surrounding material. Grinding and polishing were defined in section 2.3 as surface reduction and lustre production respectively, and drilling entails the rotary motion of a tool across its long axis. These categories are simplified from a wider set of characterisable technical motions for tool edges (e.g. Odell 1981), in which the terms of carving and graving in fact express distinct kinematics and motions such as slicing and shaving are separated from cutting and scraping. My reason for simplifying these terms is that the principle concern is with articulating the given outcomes of these shaping techniques.

Analysis of attachment systems, which can be seen as part of either the birth or life phase, is the most challenging aspect of celt biographies. For hafting systems, the traces of wear themselves will merely reflect common contact materials that are shared across many possible systems for a particular zone of an artefact (Rots 2010). These traces and associated residues tend to be concentrated on the distal areas of the faces and sides, sometimes extending to the medial areas and the butt, and overlay wear from manufacture in these areas. It is their detailed spatial distribution and how this contrasts with unworn areas that approximates the original hafting arrangement. For instance, a male embedded system should display traces from wood friction on all aspects from the circumference to the butt, whereas a male split (or perforated) slot should leave the butt and sometimes the faces free from impacts. A basic juxtaposed haft should display traces of a wooden rest on one face with traces of bindings on the other aspects. Particular morphological aspects (notches, tangs) may be suggestive of specific hafting arrangements, though they are not *a priori evidence*. The symmetry of the spread of use wear traces and residues can aid in evidencing a particular orientation as well. These variables are often determinable for intact celts, for which a relation with the symmetry of the use wear and the extent of the haft can also be drawn, but problematic to impossible for fragments. For originally suspended paraphernalia, the associated traces of wear tend to be concentrated around perforations if drilled, and the borders of contact if whole.

The location of use wear depends on the morphology of the artefact as well, and is naturally located on the edges of celts, the mouthpieces of flutes, while conceptually overlapping with ornament suspension. Celt edges become rounded and chipped, but the most reliable development of microwear polish occurs on the bevel directly behind it. Most probably, this is because the bevel remodels less quickly during regular contact and generates additional friction by sliding against the contact material. Such data was sometimes obtainable from the proximal part of the blade, even if the bevel and edge themselves were no longer present. It represents the later moments of use up to the last concerted effort, since older traces of wear are erased by newer traces of wear whether from use or resharpening. Other areas of celts may bear impact damage, whether as by-product from the primary

chopping motion or from various re-use trajectories. For paraphernalia, the use trace modalities are independently provided within Appendix 4. Residues, irrespective of the biographical phase they are ascribed to, are only described morphologically. Tentative interpretations are provided based upon their association with traces of wear and the overall biographical profile, but remarks concerning their nature and function are best seen as predictions to require substantiation from the analysis of additional materials.

Analytically speaking, assessing the biographical 'death' generally attempts to establish a deviant point in the object integrity that interrupted biographical progression. Irreparable production mistakes, breakage patterns in used artefacts, and signs that imply possible intentional destruction are common examples. Typical celt breakage patterns are major impact damage on the edge, and bending-initiated fractures in the medial zone from when the line of force is arrested by the haft. Second and finally, evidence for the deposition was obtained through a contextual analysis of the find location relying upon fieldwork reports. In practice this data merely reflects general depositional and site formation processes in which the artefacts were carried. Certain individual paraphernalia from El Cabo form the exception, as they relate to specific house trajectories at that site.

4.2 Analysis of wear

Wear is formed on the surface of a body when it is in relative motion against another body and one or more other substances. Mechanical and chemical processes reduce and alter the original surfaces, producing wear patterns that correlate to the conditions of the interaction. These conditions include the natures of both contacting surfaces, the force, motions, and gestures exercised (kinematics), and the effect of intermediate substances. By examining the wear patterns conclusions can be drawn about these original interactions which may be situated in the past human context. This section explores those processes, the resulting traces, and the analysis and interpretation thereof in greater detail.

4.2.1 Surface wear: definitions and formation

Tribology is a subfield of engineering and material sciences that is concerned with friction, lubricants, and wear on surface interactions in relative motion. The field investigates the frame in which such interactions take place in order to understand the processes of wear on surfaces, primarily to improve the stress resistance and bearings of industrial metals, ceramics, and polymers (Bhushan 2013). A surface consists of multiple layers with properties different from the solid body. The three outer layers contain environmental molecules adhering to the surface by molecular bonding and atomic exchanges of different strength. These consist of the physisorbed layer (weaker physical adsorption), the chemisorbed layer (stronger chemical adsorption), and the chemically reacted layer (oxidation deposits and similar processes) (Figure 5). Beyond that lies the original molecular mass, forming the beilby layer and further a severely and lightly deformed layer both which have undergone plastic alteration (Menezes *et al.* 2013a, 4-5; Takadoum 2008, 3-4; Wen and Huang 2012, 226-227). The beilby layer (also called work-harded or bainite layer) is a thin amorphous or microcrystalline structure formed when melting and machining processes induce the migration and rearrangement of surface molecules. It is not present on all materials, but experiments first evidenced its existence with polishing the surface of metals and minerals such as quartz (Finch 1936; Jones and Uehara 1973). This layer is sometimes associated with microwear in the form of polish (Mansur 1997).

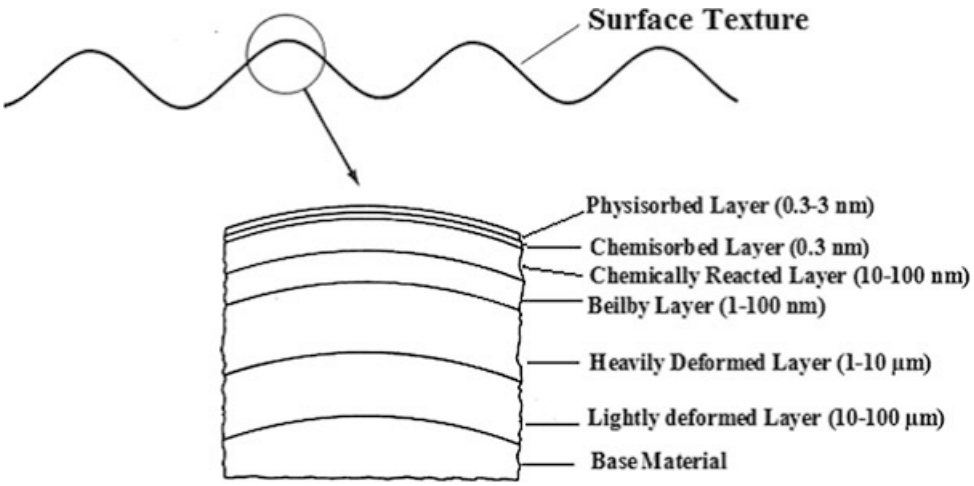


Figure 5: Schematic diagram of various surface layers (Menezes *et al.* 2013a, Fig. 1.1).

All surfaces possess topographical structures and elevations. The (usually) irregularly spaced peaks and valleys constitute (micro-)topographical relief, including for surfaces that appear flat with the naked eye and finger. Its heterogeneous and discontinuous spacing creates differential conditions for the stress that occurs when surfaces contact each other, resulting in wear. *Wear* is defined as the progressive displacement and loss of substance from the surface of either or both solid bodies brought about by the relative motion between them (Bhushan 2013, 315; Czichos 1978, 98; Kato 2002; Menezes *et al.* 2013b, 64). This alteration can be mechanical or chemical, the former imposing pressure, stress, and dislocation on the surface and the latter creating and breaking atomic bonds between the surfaces and lubricants (Kato 2002; 2005). A third mechanism is thermal wear, but this is not significant in archaeological application. These mechanisms cover multiple processes that describe the actual interactions causing modifications to the surface and development of specific alteration patterns.

4.2.1.1 Tribological surface interactions

In the prehistoric environment, the main wear processes that influence stone microtopographies are surface fatigue, adhesive wear, abrasive wear, and tribochemical interactions (Adams 2002; 2013; 2014; Adams *et al.* 2009; Donahue and Burroni 2004; Dubreuil and Savage 2014; Evans and Donahue 2005; Wiederhold and Pevny 2014).[18] Fatigue wear concerns the crushing and collapse of the elevations on a surface that bear stress load caused by mechanical contact. A repeated stress cycle will cause subsurface and superficial cracks to form, which propagate when energy escapes in the form of frictional heat (Czichos 1978, 105-112; Kato 2005; Takadoum 2008, 34-35). Adams (2014, 133) describes such wear at low magnifications as "cracks, step fractures, and pits" creating a frosted appearance, and notes that it destroys previous wear patterns while opening up new surface for successive microwear to form. Particles are loosened and dislodged from the surface by fatigue stress, and are subsequently positioned to cause abrasive wear. Intermittent grains and asperities located on the tougher surface dig into and displace the matrix of the softer contact surface, causing shallow

18 Tribochemical interactions are considered a subset of corrosive wear in tribology, but are treated as a distinct wear mode in the microwear literature. Other major wear phenomena are erosion wear and electrical arc induced wear, and a large number of submodes such as fretting and melting is recognised in the tribology of industrial materials (see e.g. Bhushan 2013; Kato 2002; 2005).

striations and deeper gouges aligned with the motion. The concurrent removal of material flattens a softer surface and contributes to the rounding of harder grains (Adams 2014; Adams *et al.* 2009). Adhesive wear is generated when surface point adhesion occurs, meaning that molecular forces are bonding between the contact surfaces. Small amounts of matter are then sheared away when the mechanical motion continues, and these ions and particles are deposited on the other surface (Wen and Huang 2012, 264). This type of wear also includes the adherence of residues such as hand oils and metal streaks.

Tribochemical wear encompasses chemical interactions depositing reaction products (oxides and films) on the surface, which are visible as sheen (Czichos 1978, 123). These chemical reactions are made possible in the sliding environment by the frictional energy and mechanical activation of the motion and take place constantly (Bhushan 2013, 360-361). Some scholars consider this accumulated film the tribological correlate to microwear polish (Adams 2002; 2013; 2014; Adams *et al.* 2009; Dubreuil and Savage 2014). If so, its additive accumulation is restricted by the mechanical wear patterns which concomitantly remove material from the higher surface especially in the initial stage (cf. Ollé and Verges 2008; 2014). Such film build-up is prone mostly to already levelled surfaces and the interstices, depending on the pliability of the material.

The characteristics of the surface topography are vital in determining how and where wear formation takes place (Adams 2002; 2013; 2014; Adams *et al.* 2009; Dubreuil and Savage 2014). Asperity and durability are the main characteristics emphasised for macro-lithic surfaces. The asperity of a surface is a measure of the protrusion of projections, so that a higher asperity indicates a larger distance between the peaks (asperities) and the low laying areas in between (interstices). Asperity defines the roughness of a surface, and in rocks results primarily from granularity and surface texture. As the higher elevations of a surface, its asperities are the first to interact with the contact surface, and are the sites where initial microwear develops. In contact between hard and resistant materials, peaks on the tougher surface will bear fatigue stress while penetrating and gouging the matrix of the softer surface. More pliable contact materials enter the topographical relief contributing to rounding of the asperities, and soft materials like fresh hide reach deep into the topographical valleys (Adams 2014, 134-135). The interstices constitute prime sites for residue attachment. Durability indicates the resistance of a surface against matter being dislodged from the layer under motion, and arises from the hardness, isotropy, and cementing of the grains. Weakly cemented grains are easily removed from a rock matrix through adhesion or fatigue. If so, the fast exposure of new unworn surface also acts to prevent the build-up of microwear in that area. Both soft and brittle minerals are fractured more easily, reducing the asperity and dislodging particles as debris. Tougher grains will endure the motion stress better and may become rounded or levelled through other wear processes.

Besides the properties of both contact bodies, the wear interaction also contains as parameters the presence of intermediate substances (water acting as lubricant, dislodged particles, processed materials, etc.) and the kinematics (nature, force, angle, and duration of the relative motion exercised). Whichever wear processes – or modes of wear – operate in an interaction depends on the conditions shaped by these parameters. The formation of wear is a dynamic process, that begins with more severe 'initial wear' followed by a lower rate of 'steady wear' after the surface topography stabilises under the stress (Kato 2005). As sequential experiments demonstrate, wear trace patterns observed on archaeological materials constitute an arrested moment from anywhere in this process, and as outcomes vary depending upon the configuration of those initial conditions.

4.2.1.2 Traces – loss of material

Most wear on archaeological implements forms mechanically, inducing the loss of material. The formation of (micro-)retouch and dulling of edges constitutes primary lines of evidence for wear from use on flaked lithic artefacts, and is associated with the Low Power approach (Odell 1981; Odell and Odell-Vereecken 1980; Tringham *et al.* 1974). Such scarring develops from pressure that operates against the edge during use under relative motion, resulting in (Hertzian) point-cone initiation at intersections with sufficient load. The morphology and termination of (micro-)retouch is associated with the force, motion and hardness of a contact material, as well as edge shape and curvature, and could therefore be related to activity patterns. However, manufacture, trampling, and post-excavation treatment are all known to inflict scars on flint edges, and these scars may resemble (micro-)retouch from use (Moss 1983). Used independently of other wear patterns this feature is fairly unreliable (Keeley 1980; Vaughan 1985), with at best mid-low correlation of fracture shapes and patterns to pursued activities (Van den Dries and Van Gijn 1997; Van Gijn 1990, 4).

Edge dulling develops from gradual rounding through removal of material, and results in the loss of sharpness and ability to bite into the body of contact. Different modes of wear contribute to this process. Fatigue wear may be involved to dislodge the highest asperite particles (Wiederhold and Pevny 2014), but the reduction of the edge topography is clearly facilitated by abrasive factors (Mills 1993). The rounding of asperities anywhere on a surface is also thought to be associated with plastic deformation, occurring when grains become enveloped by a softer contact surface that eliminates individual protrusions (Adams *et al.* 2009). It is likely that some of this matter is sheared off through adhesive wear, perhaps after weakening of the outer layer and angularities takes place through fatigue. The interaction is complex and may resolve differently depending on the circumstances.

Levelling is definable as the wearing down of asperities to the level of the matrix, decreasing the roughness of a topography. Such wear results primarily from abrasive wear from a tougher body, whose asperities enter the relief of the surface and in the motion shear away swats of grains (Delgado-Raack *et al.* 2009). The degree of levelling is dependent on the durability of a surface since elevation is evened only if the affected particles are not dislocated from the bedded matrix. Otherwise, the exposure of fresh interstices results in an increase of the relief. The extraction of grains leads to surface pitting and is primarily encountered on poorly cemented materials with coarse granularity. These are not very resistant to mechanical wear stresses, and shed material at faster rates (Adams *et al.* 2009). Fatigue wear acts to loosen and dislodge particle clusters, while adhesive wear bonds 'draw out' the grains from the groundmass. These processes may operate in conjunction, but need not. The result is that valleys open on a level below the topographic mean and the overall roughness of the surface is maintained, and also that intermittent grains will become involved in the process. Weakly cemented surfaces are prone to shed the sites of initial wear before characteristic trace patterns can develop.

Finally, linear features (scratches, gouges, striations) commonly form under mechanical stress. Linear scratches occur at various microscopic scales; more extensive and deeper gouges that affect topographical relief (naked eye to stereomicroscopy) are presently separated from finer and thinner striations occurring as or within polish structures (at higher magnifications). Such features are principally caused by abrasive wear, specifically by asperities digging into the other contact surface and being dragged in the direction of the motion. Intermediate debris from the host mass or the environment draw scratches in the same manner, which is why striations reflect foremost the direction and intensity of a motion. The resulting interactions can differ: both the dislodgment of a line of

crystals or particles from the surface, and the pushing aside of matter in the matrix through plastic deformation are observed (cf. LeMoine 1994; Mansur-Franchomme 1983). They may also form or become erased as a result of post-depositional alteration (Levi-Sala 1986), and striations resulting from initial wear may disappear later on in the process (Ollé and Vergès 2014).

4.2.1.3 Traces – polish

The term polish refers to structures of relative smoothness and reflectiveness compared to the surrounding micro-topography, forming primarily on the higher elevations thereof. This category of traces was first emphasised by the High Power initiative (e.g. Anderson-Gerfaud 1981; Keeley 1977; 1980; Keeley and Newcomer 1977; Vaughan 1981; 1985), and subsequently became the most debated type of wear. Criteria for comparing polish traces on flint tools were further developed by Plisson (1985), Van Gijn (1990), and Yamada and Sawada (1993), amongst others, adding additional depth to the High Power starting point. While some issues surrounding the formation of polish remain unresolved, it is generally considered to be the most informative feature on the type of contact material. Even so, early optimism that polish potentially represented a diagnostic attribute, capable of providing hard identifications of the material worked, proved overconfident (e.g. Levi-Sala 1986; Odell 2001; Plisson and Van Gijn 1989; Unger-Hamilton 1984; Van den Dries and Van Gijn 1997; Van Gijn 1990). This information remains at the level of inference, and requires assessing the complete series of micro-topographical alterations from wear in order to obtain an acceptable level of confidence (Van Gijn 2010; 2014b). Analytical accuracy is further discussed in section 4.2.3.

The nature and formation of polish has been under consistent debate ever since, and these topics are still not adequately resolved. A number of different models have been proposed, rejected, and revived over the years, not all of which are mutually exclusive. The most favoured explanation is that polish on flint results purely from mechanical wear, chiefly abrasion, inducing loss of material from the original topography (e.g. Diamond 1979; Fullagar 1991; Grace 1993; Levi-Sala 1993; 1996; Masson *et al.* 1981; Meeks *et al.* 1982; Wiederhold and Pevny 2014; Yamada 1993). Accordingly, micro-topographical asperities would be abraded down to a smoother and increasingly homogeneous level, potentially aided by the hydrolisation and subsequent weakening of the tool surface. Discussing broader microtopographical changes, Ollé and Vergès (2014) emphasise a combination of clastic responses (fracturing and abrasive smoothening) and plastic responses (compression and translocation of matter). A contrary position holds that polish is partially residual formed not only out of matter from the body, but incorporates extraneous material from the wear interaction or environment (e.g. Anderson-Gerfaud 1981; Keeley 1980; Levi-Sala 1986; Plisson 1983; Plisson and Mauger 1988). The operation of adhesive wear processes in the formation of polish has been argued by some (Anderson *et al.* 2006; Kamminga 1979; Kay and Mainfort 2014). Another possibility is the presence of tribochemical interactions in the environment shaped by mechanical wear (Del Bene 1979; Evans and Donahue 2005; Hurcombe 1997; Knutsson 1988; Mansur 1997). This could result in the addition of chemical elements from worked materials into polish (Christensen *et al.* 1992; 1993; 1998; Šmit *et al.* 1998; 1999), though strongly bonded residue is not always distinguished from actual wear polish. Others argued for the dissolving and precipitation of silica from the upper molecular layer, or through molecules from this layer entering a semi-liquid 'gel' state and flowing into topographical valleys, both potentially trapping particles (Andersen and Whitlow 1983; Anderson 1980; Anderson-Gerfaud 1982; 1986; Masson *et al.* 1981 and cf. Mansur-Franchomme 1983; Mansur 1997; Unger-Hamilton

1984; Witthoft 1967).

While the results of some cited studies have been invalidated by subsequent work, the evidence suggests overall that multiple formation models may lead to the outcome of polish from wear on the original microtopography of the body. Dominant abrasive wear will smoothen asperities to the point where they become reflective, but there is no reason to exclude in all cases the potential contribution from other wear processes. The range of initial conditions that follow from human activities is immeasurable, and it may well be that cutting siliceous or acidic plant materials with flint induces different wear modes than polishing jadeitite with clay would. Lubricating water and intermediate silicate particles such as phytoliths and amorphous opal are significant to the formation of polish (Fullagar 1991; LeMoine 1994; Mansur-Franchomme 1983), yet polish can also develop in interactions when neither is present, such as the dry abrading of shell on coral (Section 5.3.4).

Optical examination of such polish provides information regarding a number of attributes, including topographical characteristics, texture, location, and distribution, as well as on the intensity and apparent stage of development. Which of these attributes are accredited significance varies somewhat depending on the scopes and aims of particular studies, however. Since the entire micro-topography potentially indicates wear, I use the term 'polish structures' for bounded units of amorphous reflective spots draped over topographical features (creating volume) to emphasise the contrast with wear from adjacent areas bearing non-polish traces. Large interstices, for instance, may be wear from pecking impacts and some wear trace signatures from grinding lithic surfaces are characterised by other variables (Section 5.1.2). Morphological attributes for polish in the present work are the brightness, texture (measure of roughness), presence of directionality, and its relation to the topography (e.g. flat, domed, undulating), which includes the invasiveness and the degree of linkage and/or pitting. Spatial attributes comprise the location, extent, distribution, and density. Importantly, invasiveness refers to the vertical penetration of a polish from a peak into the surrounding slopes and interstices in this work, as the horizontal spread emanating from a feature of tool morphology (e.g. the edge) is defined by the extent. The brightness of polish is not very indicative for separating different contact materials (Van den Dries and Van Gijn 1997, 508), but is potentially important for inducing macroscopic lustre. The distribution and density of polish within its extent is described following the classification of wear zones on macro-lithic artefacts as proposed by Adams *et al.* (2009), here applied for polish and striations (Figure 6). The variables of important attributes are further defined in Chapter 5 following the analysis of experimental wear traces.

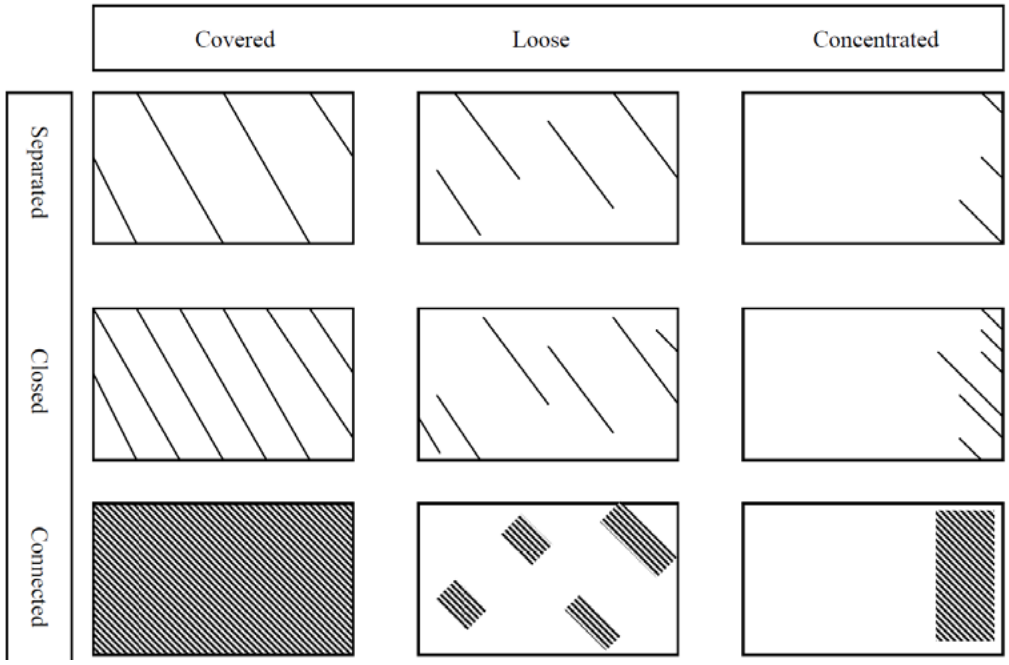


Figure 6: "Graphic representation of the correlation between distribution and density of traces (defined for linear traces but applicable to other use-wear types)" from Adams *et al.* (2009, Fig. 6.5).

4.2.1.4 Post-depositional surface modification (PDSM)

A surface microtopography is affected by a variety of post-depositional processes, which can alter or remove patterns of wear and create new traces in sometimes indistinguishable ways (Keeley 1980). These processes include trampling, sediment rolling, fluvial processes, weathering and patination from chemical effects such as molecular breakdown and dissolution, and thermal stress cycles. For non-brittle lithic materials, the primary effect of the first three processes mentioned is the movement of soil particles over the surface. Trampling exerts pressure on the surface of substrate lithics resulting in friction with between sediment grains and the micro-topography, potentially causing localised abrasive wear, polish, and bright spots or streaks (Asryan *et al.* 2014; Levi-Sala 1986; Shea and Klenck 1993). Motion within sediment strata (e.g. soil creep, solifluction) creates similar low intension interactions between the surface and moving grains. Tumbling and rolling experiments induce comparable wear as trampling, and moreover smoothing, rounding and micro-cracking on especially coarser grained surfaces (Burroni *et al.* 2002; Levi-Sala 1986; 1996; Venditti *et al.* 2016). Natural rolling and glacial actions produce larger abrasion planes (Mansur 1997). Overall abrasion of a micro-topography is also recorded for experiments with slow moving fine sand mixtures, reproducing the effects of a low energy fluvial environment (Chu *et al.* 2013; and cf. Harding *et al.* 1987). Rain torrents causing surface run-off and sea level fluctuation are two examples of such environments that may affect Caribbean sites.

Chemical weathering results from a host of different atomic and molecular interactions between the surface and the burial environment, in severe cases leading to molecular degradation and breakdown of the topography by reactive compounds. Both leaching (exchange of ions and dissolution of elements) and the intrusion of atoms can induce patination, influenced by soil pH, soil composition, temperature, moisture, and duration (Andersen and Whitlow 1983; Burroni *et al.* 2002; Schiffer 2011, 152-155). The concurrent humidity, salinity, and heat of the subtropical insular environment aggressively impairs the preservation of Caribbean organic materials; lithic materials

can be susceptible within the archaeological timeframe as well, notable examples being St. Martin mudstone (Knippenberg 2006) and chert (Berman *et al.* 1999). Presently, olivine minerals form a complication for certain basalts and greenschists often develop small white streaks as patination, but high-pressure rock types do not appear to suffer from severe diagenetic alteration.

Shell may suffer from a series of PDSM types, including perforation, fragmentation, encrustation, abrasion, acid dissolution, chemical conversion, and heating (Claassen 1998, 55-66; Szabó 2004, 118-126; Zuschin *et al.* 2003). Living molluscs suffer attacks from predators who break or perforate the shell in order to access the animal within (e.g. Antczak and Antczak 2006; Cadée and Wesselingh 2005; Claassen 1998; d'Errico *et al.* 1993; Taborin 1993; Zuschin *et al.* 2003), and fluvial action or trampling can further fracture a shell. Such damage may resemble anthropogenic modification, but can be distinguished through wear trace patterns and reference collections. In addition to previously described processes of abrasion in sediment, shell surfaces wear from particles in the tides, on the ocean bed, beach-rolling, as well as hermit crab occupation; the morphological architecture of mollusc shells is in part an evolutionary response thereto (Section 4.4.4). Topographical degradation further occurs by the decay of the organic content in the microstructure, through absorption by bacteria, fungi, and other animals, while chemical dissolution and conversion processes affect the inorganic calcium carbonate (Claassen 1998, 59-61). Notably, calcite-aragonite conversion, recrystallization, and mineral replacement may actually create technologically advantageous working properties in certain shells (Moir 1990). Concentrated shell middens may form a protected environment for shell due to aridness and alkaline pH levels preventing the penetration of chemical agents to deeper shells (Lammers-Keijsers 2007, 19-21), but may adversely affect polish traces on high silica rocks (Mansur 1997).

4.2.2 Microscopy

The analysis of traces of wear necessitates instruments capable of exposing sufficient detail on a microtopography. Optical Microscopy (OM) has been the traditional method for doing so and remains the main technique for the analysis of archaeological assemblages. Such instruments guide visible light through the objective and additional optional lenses into the oculars where the image can be observed. Semenov (1964, 22-23) used both stereomicroscopes and metallographic microscopes in combination with metallising additives to enhance surface reflectivity and thereby the visibility of traces. Since the translation of his work, microscopic examination initially diverged along two different paths. These are referred to as the 'Low Power' and 'High Power' approaches, distinguished by the magnification ranges and types of wear traces studied. Around 1990, the position prevailed that the examination of surface wear at different microscopic levels is congruent, if not essential. A combined analysis of microwear variables at multiple scales of magnification provides a better understanding of the wear, reduces the margin of error, and accommodates the sampling of assemblages (e.g. Bamforth *et al.* 1990; Grace 1990; 1993; Odell 2001; Seitzer Olausson 1980; Van Gijn 1990). The distinction between low magnification stereoscopy and high magnification microscopy does remains useful to distinguish the ranges obtained using these different instruments, however (Section 4.1).

A Low Power approach uses stereomicroscopy to investigate retouch and scarring on edges, in magnifications not exceeding 160× and generally much lower (e.g. Odell 1980; 1981; Odell and Odell-Vereecken 1980; Tringham *et al.* 1974). Stereomicroscopes are reflected light optical microscopes that offer magnifications commonly ranging from 10× to 60×-100×, depending on the

model. Light from an external source is transmitted on the object and reflected by its surface, captured in the objective and then observed through the ocular. This approach is comparatively fast to carry out and efficient in determining whether tools were used, and which surface areas display wear and residues.

A High Power approach utilises the magnifications offered by metallographic microscopes, usually ranging from 50× to 600×, and Scanning Electron Microscopy (SEM) up to 5000× and above. Keeley (1980; Keeley and Newcomer 1977) originally drew attention to the diagnostic potential of polish spots at this magnification, and this position garnered the support of most analysts (e.g. Anderson-Gerfaud 1981; Juel Jensen 1988; Mansur-Franchomme 1983; Moss and Newcomer 1982; Vaughan 1981; 1985). With metallographic microscopes the microtopography is observed under incident light, which casts light from an internal source and directed through multiple lenses before it reflects on the artefact surface and is observed. This range of magnifications is well suited to examine polish on the microtopography and the presence of micro-striations, interpretable in terms of contact materials and motions exerted. However, it is more laborious because of increased detail on surface coverage and the lower field of depth. Light transmitted through the objective is optimal only when it falls at a precise 90° angle and deviation severely degrades microwear visibility, necessitating the continuous repositioning of the artefact (Van Gijn 2010, 31).

An SEM fires a stream of electrons on the surface of the object (ideally coated and placed in a vacuum chamber) and measures the backscatter and emission of secondary electrons by excited atoms. In microwear studies it offers much better imaging resolution, a greater field of depth, and the ability to conduct *in situ* chemical characterisation of residues (Borel *et al.* 2014). However, it is even more time intensive and less proficient at visualising topographic elevation, brightness intensity (which is negatively rendered, i.e. darker), and does not capture colour. Overall the systems should be seen as complementary, optical microscopes performing better with the identification of striations, gouges, and with the differentiation of use, whereas the SEM excels in displaying topographic structure (Borel *et al.* 2014).

The last decade has again seen much effort directed into the quantification of the measurement, analysis, and interpretation of wear. The interpretation of traces using OM remains a qualitative science, with good but imperfect inferential accuracy (Section 4.2.3). Attempting to address what is sometimes seen as the 'subjectiveness' of qualitative assessments, quantitative efforts aimed to prove that such assessments could be replicated in quantifiable terms, improve the standardisation, and increase the confidence of wear trace assertions in specific settings. Common methods to do so are the digital quantification of polish micrographs by measuring various attributes of individual and groups of pixels (González Urquijo and Ibáñez Estévez 2003; Grace 1989; Grace *et al.* 1985; 1987; Lerner 2007; 2014; Knutsson *et al.* 1988; Maigrot 2008; Mansur and Srehnisky 1996; Vila and Gallart 1993; Yamada and Sawada 1993), and the indirect to direct scanning and calculation of the microtopographical profile using tribometric techniques such as interferometry and laser scanning confocal microscopy (Anderson *et al.* 1998; 2006; Astruc *et al.* 2011; Dumont 1982; Evans and Donahue 2005; 2008; Evans and Macdonald 2011; Evans *et al.* 2014; Faulks *et al.* 2011; Ibáñez *et al.* 2014; Key *et al.* 2015; Kimball *et al.* 1995; 2017; Procopiou *et al.* 2011; Stemp 2014; Stemp and Chung 2011; Stemp and Stemp 2001; Stemp *et al.* 2009; 2013; Stevens *et al.* 2010; Vargiolu *et al.* 2007). Very few of these have been applied to macro-lithic implements or hard animal materials, however. Most studies failed to match qualitative polish interpretations early on, probably for failing

to incorporate as much variables with the ease that qualitative analyses did (Bamforth 1988; Plisson and Van Gijn 1989). Nowadays these techniques return results of comparable reliability, but the intricacies of set-up have seen them applied primarily to method development and understanding rates of wear trace formation, not so much to the more wide application of analysis of bulk materials.

4.2.3 Interpretation and inferential limits

Discussion regarding inaccuracies and subjectivity within the inferential process of analysis first arose during the late 1980s and early 1990s, when a series of blind tests on flaked lithics returned less than satisfactory – even contradictory – results. The percentages of correctly identified uses in these blind tests varied wildly, and it was made clear that typological and intuitive predispositions about artefacts could induce errors. As a result, interpretations made by different analysts sometimes contained a significant range of error (e.g. Bamforth 1988; Bamforth *et al.* 1990; Fredericksen and Sewell 1991; Keeley 1980; Keeley and Newcomer 1977; Newcomer *et al.* 1986; Odell and Odell-Vereecken 1980; Shea and Klenck 1993; Unrath *et al.* 1986). These results were based on risky interpretations, however, aiming for comparatively high resolutions in order to pinpoint areas for methodological improvement (Bamforth 1988; Evans 2014; Hurcombe 1988; Ibáñez and González 2003; Moss 1987; Newcomer *et al.* 1988). Accordingly, the relatively low total accuracy does not reflect analytical capability under generally applied circumstances when permitting lower levels of interpretation ('material hardness', 'used/not-used', 'contact indeterminate', 'unsure'). Blind tests conducted in more recent years – including on macro-lithic grinding tools and residues – generally scored much higher when correlating for analytical confidence (e.g. Hamon and Plisson 2008; Hayes *et al.* 2017; Lemorini *et al.* 2014; Rots and Williamson 2004; Rots *et al.* 2006). On the whole, these blind tests underline that experienced analysts are capable of correct inferences, but reinforce that a complete answer cannot always be reached. A good inference should settle for lower resolutions in result when that is the appropriate level of confidence. Intra-observer error – a single analyst concluding differently at different moments – has not been blind tested for, but forms part of the process as well. I re-evaluated and sometimes re-analysed earlier data when personal preconceived expectations changed (cf. Van Gijn 2014b) and when later results from experimental and archaeological studies were made available.

A significant problem exposed in part by blind testing, and reinforced by surface metrology, is that wear trace patterns once considered diagnostic of certain contact materials frequently overlap in attributes. Given the finite amount of parameters of wear and the near limitless variation in human activities, it is to be expected that different initial conditions can produce seemingly equivalent outcomes in wear. This is known as equifinality and becomes more prominent between more closely related activities: common problem areas are bone and antler processing (Van den Dries and Van Gijn 1997), polish from siliceous plants and woods (Fullagar 1991), traces of projectile impact (Rots and Plisson 2014), and there is also significant overlap between metric readings from hide in different states (Evans and Donahue 2008). The interpretation of traces of wear is further exacerbated by interference from other processes that can produce wear, such as PDSM (Section 4.2.1.4), excavation and restoration activities, and so forth. Not all initial conditions (wear-forming activities) are known to us, which causes issues in the interpretation of either unknown or unrecognised activities (Van Gijn 2014b). The best known example is the clearly defined so-called polish '23 from early Neolithic obtuse-angled implements, possibly related to flax processing but never satisfactorily replicated (Sliva and Keeley 1994; Van Gijn and Mazzucco 2013). It cannot be known how many 'unknown activities'

of the past produced microwear traces currently undistinguished from known activities, either. Precise identifications of particular activities on the basis of patterns of wear are thus unrealistic, but inferring the original conditions of the formation of observed wear remains soundly possible and ultimately empowers interpretations about the human context.

Experimentation has been instrumental in discovering interactions in which trace overlap and equifinality occurs, and the resulting reference collections form the empirical basis for the interpretation of wear itself. Additionally, the field heavily utilises ethnography and ethnoarchaeology in order to reach hypotheses on artefact manufacture and use in pre-industrial societies, subsequently reapplied in experiments (e.g. Bamforth 2010; Beyries and Rots 2008; Cuenca Solana *et al.* 2011; González Urquijo *et al.* 2015; Rots and Williamson 2004; Terradas *et al.* 1999; Van Gijn 1990; 2010; 2014b; Van Gijn and Raemaekers 1999). This has vastly expanded the referential framework of conceptually accessible information to further exploring wear patterns of unknown origin. Analogy is the principle cognitive instrument used. Wear trace patterns on archaeological artefacts are compared to empirically obtained wear trace patterns on experimental (or ethnographic) implements from new experiments or existing reference collections, and if considered mostly equivalent, support an analogy drawn between the experiment carried out and the prehistoric activity (cf. Section 3.2.3). As Bradfield (2016) emphasises, inferring wear is a form of abductive reasoning. The interpretation of an artefact biography, not known *a priori*, is made by an appeal to specific and known knowledge of some predictive ability (i.e. experimentally obtained traces of wear and tribological principles). The inference that results therefrom cannot be of deductive certainty, but ranks in validity according to the plausibility of competing hypotheses and falsification of others (obtained through experiments, reference collections, and the combined experience of the field).

Since the formation of wear characteristics is subject to kinematic variables such as load and angle, it is thus also subject to human variables such as ability, skill, and effort. Abductive confidence thus relies upon experiments which appropriately recreate also these initial conditions of prehistoric activities. Archaeologists commonly distinguish between controlled laboratory experiments, designed to test one or a limited range of variables, and actualistic experiments. Controlled set-ups go as far as using robotic systems to draw a sequence of arbitrary strokes with lithic flake edges on a plank under constant load, angle, and motion (Key *et al.* 2015; Pfleging *et al.* 2015). Such experiments are well suited for examining the outcomes of tribological processes and progressing effects of wear on the micro-topography, but are far removed from the goal-oriented activities of the prehistoric environment (Outram 2008; Van Gijn 2014b). Actualistic experiments aim to recreate such conditions by carrying out tasks in ways considered as potentially authentic to a prehistoric environment, accumulating wear as they go about. This translates to the tangible result of having chopped down a series of tree trunks comprising different species, including impacts from different angles, with varying force and at different chopping rates depending on fatigue. Such experiments are closer to past realities since the aim is the completion of a task necessary in a given subsistence or craft environment, and the resulting wear is 'secondary' to that aim and thus a better reflection thereof. Nevertheless, it is not fully comparable: novice experimenters racked up much more wear using axes in 'Neolithic' construction activities than experienced woodsmen did (Pomstra and Van Gijn 2013; Van Gijn and Pomstra 2016; Wijnen *et al.* 2018). The middle road may consist of experiments that tend to control more parameters but carry out the interaction organically, or forego unnecessary elements in an actualistic environment.

These points lead to the closing aspect of the argument. Archaeological wear patterns must be understood through empirical reference comparison, and the field has demonstrated the feasibility of distinguishing wear patterns originating from distinct initial circumstances of formation. Inferring what these circumstances consisted of, and in what sequence and interrelation the causing activities occurred, produces the biographical elements for interpreting human activities from the archaeological past. The local environment and relevant ethnographies not only expand the frame of reference, but importantly bring a sense of human scale thereto. As a rule, wear traces reflect only the latest (set of) activities as the wear from prior events becomes overlain, but what is measured during analysis may nevertheless be stretched out over long periods of time. For instance, heavy wear from woodcutting comparable to five hours of contact may be stretched out over weeks of actual use, with the tool lying dormant in storage in the meantime. An intense lustre from polishing may be argued to reflect significant 'investments' of 'labour' and 'time', whereas practically speaking axe grinding could simply reflect intermittent side activities carried out during social congregations in the evening hours (cf. Burton 1984, 120). The importance of a biographical framework cannot be over-emphasised at this stage (Van Gijn 2012; 2014b). It draws out the life trajectory of an artefact over exactly such periods of stillness and activity, emphasising the social, technological, and relational transformations captured by wear in it (Chapter 3).

4.3 Microwear analysis in the Caribbean

The analysis of traces of wear has a long history in the Caribbean, though it has not been regularly practiced, nor been acknowledged for its early contributions to the methodological field. As anywhere else, the first general descriptions and speculations of wear on artefacts coincide with the onset of culture-historical investigations (e.g. Fewkes 1904, 178-179; Mason 1876, 380). Shell tools were first studied microscopically in the Caribbean, by Sears and Sullivan (1978) and later Lundberg (1983) to assess whether tool-like fragments of *Lobatus gigas* shell displayed traces of wear under low magnifications. Grace analysed *L. gigas* celts under high magnifications but refrained from distinguishing manufacture from use (Cartwright *et al.* 1991). Walker (1981; Walker and Wilk 1988) conducted one of the first microwear studies of flaked lithics from ethnographic contexts in 1980-1981, on grater teeth obtained from a Garifuna community in Belize. These data and experimental recreations served for the interpretation of the flaked lithic assemblage of the Saladoid period Sugar Factory Pier 1 site, St. Kitts (Walker 1979; 1980; 1981). Others also discussed and applied traceological methods to the analysis of Caribbean lithic materials in this period (Bartone and Crock 1991; Febles 1988).

Since then, methodological inroads have been made into a series of other materials and artefact types, making more regular use of high magnification methods. Kelly (2003; 2004; Kelly and Van Gijn 2008) carried out a first explorative study of abrader stones and platforms made of stony corals (*Acropora palmata*, *A. cervicornis*, and *Porites sp.*) on a variety of contact materials from the Caribbean environment, finding them to be exceedingly effective at this task. These experiments were subsequently applied to archaeological materials from Anse à la Gourde, Guadeloupe. The flint, shell, and pottery sherd artefacts from this site and nearby Morel have been extensively studied (Lammers-Keijsers 1999; 2007; 2008; Van Gijn and Hofman 2008; Van Gijn and Lammers-Keijsers 2010; Van Gijn *et al.* 2008). These authors reconstructed a series of multi-material toolkits on the sites involved in a series of subsistence and craft activities, including the production and

use of pottery, ornaments, shell celts, and grater boards. The utilisation of bivalves as scrapers was identified here, and have since been found at other sites in the archipelago (Ruiter 2009; cf. Ciofalo *et al.* 2018).

Other microwear research in the Caribbean has focused on the production and use of lapidary materials (de Mille and Varney 2001; de Mille *et al.* 2008; Falci 2015a; 2015c; Falci *et al.* 2017a; 2017b), use traces on flaked lithics (Berman *et al.* 1999; Briels 2004) often combined with residue studies (Berman and Pearsall 2000; 2008; Nieuwenhuis 2008), manufacturing traces on metallic ornaments (Martinón-Torres *et al.* 2012), macro-lithics (Kaplan and Patch 2014), additional work on traces on shell (Dacal Moure *et al.* 2004; Peters 2001), experimental research into particular trace patterns (Breukel and Falci 2015; Rodríguez Ramos 2005b), and the biographies of artefacts with non-functional connotations across several raw materials (Breukel 2013). This listing is not exhaustive, but demonstrates well how diverse and largely non-conventional the study of traces of wear has been within the archipelago. This is in no small degree attributable to Caribbean geo-biodiversity (Section 2.1), in which region-specific tool and contact materials comprise significant portions of archaeological assemblages. Worked and expedient shell artefacts are abundant in coastal sites, and stony corals were commonly made into a variety of abrading implements. Conversely, Ceramic Age assemblages mostly lack bone tools and their lithic industries are broadly characterised by expedient to informal flake reduction, including bipolar knapping of small pointed microliths interpreted as microdrills or teeth of grater boards (e.g. Bérard 2008; Knippenberg 2006; Rodríguez Ramos 2010a; Walker 1981). Macro-lithic tool materials are extremely varied. Most tool types were in fact made from varying raw materials and all of those supplied multiple forms of artefacts. Properly assessing the technological flexibility exhibited by the indigenous peoples of the Caribbean, however, poses significant challenges.

4.4 Materials

The principle issue of methodological concern is that different types of materials do not develop wear in equivalent ways. Rather, the rate in which traces of wear form, even the properties they take upon, are dependent upon the gross morphology, surface topography, structural properties, and chemistry of the tool material. Even amongst isotropic brittle siliceous lithic edges, minor measurable differences in their physical properties are known to affect the rate of wear formation (Beyries 1982; Bradley and Clayton 1987; Lerner 2007; 2014; Lerner *et al.* 2007; Stemp *et al.* 2013). In flint-focused research, the issue is compounded for edges in other tool materials, such as quartzite and flaked igneous rocks (Clemente Conte and Gibaja Bao 2009; Pedergnana *et al.* 2016; Pedergnana and Ollé 2017). Comparatively, other tool materials differ tremendously in the types of wear they develop. A glossy polish is a natural surface feature of bone, for instance, and this material is much more susceptible to abrasive wear. Conversely, the specific working properties of different bone or stone materials may be precisely why they are chosen over others (e.g. Delgado-Raack *et al.* 2009; Margaris 2014). The present issues are primarily with interpreting wear traces that appear similar on rocks that are lithologically distinct and compositionally heterogeneous, and understanding the working properties of various shell structures.

In this section, I will focus on the archaeologically relevant properties of basaltic igneous rocks, and three groups of metamorphic rocks: greenschist, blueschist, and jadeitite. Other rock types have low representations or limitations with hand examination. Described mineral assemblages highlight

minerals which affect the working properties (such as quartz or garnets) or are currently seen as important to characterisation studies. Thereafter, I will detail the microstructural characteristic and wear resistant properties of shell as a raw material.

4.4.1 Rock properties

Archaeological heuristics traditionally divide lithic raw materials in cryptocrystalline silicates and holocrystalline rocks: the former are generally employed to produce flake and blade artefacts through knapping, and the latter generally employed to create macro-lithic artefacts through pecking and grinding. The divide may be artificial from a social or technological perspective, but the working properties of macro-lithic materials are decidedly different from those of flints.

The wear of such rocks follows the characteristics of their given surface topographies. These are derived from the composition, texture, and fabric of the rock, which are governed by the nature of the individual grains and their relation to the aggregate mass. The literature emphasises these aspects as the primary properties that influence the formation of traces of wear, and are thus of relevance to archaeological classification (e.g. Adams *et al.* 2009; Adams 2013; 2014; Delgado-Raack *et al.* 2009; Dubreuil and Savage 2014; Schneider 2002; 2008). Whichever specific lithology a rock corresponds to is of secondary importance to a wear trace perspective, since internal petrographic variations may exceed those derived from external variation when it comes to the actual working characteristics of individual rocks (Horsfall 1987; Schneider 2002).

The *mineralogical composition* remains of principle concern. This refers to the different types of minerals present, of which the percentages and relative proportions affect the overall hardness, cleavage, and tenacity of the rock. The different minerals retain their individual properties, of course, and will usually respond to wear conditions differently. For instance, comparatively harder grains may be dislodged from a cohesive mass more swiftly than that they themselves break down under stress (Adams *et al.* 2009). Softer grain particles will wear away at higher speeds, while more resistant constituents retain a certain level of roughness of the surface microtopography. For that reason quartz- and garnet bearing rocks predominated as grinding stone materials in the Iberian peninsula (Delgado-Raack *et al.* 2009). These are not necessarily selected for the most tenacious or stress-resistant matrices (called rock competence, in geological parlance), since the wear around harder asperities advantageously renews the surface.

The *texture* of the rock is a factor of the granularity (size, shape, and angularity of grains), cohesion, and porosity (Adams *et al.* 2009). The *absolute size* of the particles as well as the *size range* spectrum in the mass will have a strong influence on the impact of wear processes, including ease of dislodging (and corresponding retention of relief), transmission of force (determining workability with conchoidal fracturing of certain mineral constituents), and the microtopographical peak-valley distribution. The degree of *angularity* of the particles broadly influences the level of asperity of the surface, and thereby its abrasive capacities. The variable also contributes to the development of grain rounding. *Cohesion* entails the type and degree of attachment of grains to neighbouring grains (recrystallization or binding matrix), and the associated resistance to friction and loss of material by displacement from the surface. *Porosity* is a measure of the number and volume of the holes (or voids) in porous or vesicular rocks, which are referred to as vesicles. Vesicles increase the longevity of the abrasive properties of a surface by acting as a sink for residual material that would otherwise clog a shallow relief. In general, textural properties determine the workability of a given rock and its

suitability as a grinding implement (Delgado-Raack *et al.* 2009; Schneider 2002; 2008).

The *fabric* is the geometric arrangement of the particles, of which the orientation may be isotropic (random or no preference) or anisotropic (overlapping, foliated, lineated, banded, etc.). This orientation influences the organisation of the microtopography and the way force travels through the rock, including fracturing and crack propagation. This is further affected by the rock *density,* the measure of how closely knitted together the particles. Tests showed that higher densities confer better friction resistances and negatively affect the retention of surface roughness (Delgado-Raack *et al.* 2009). In compact rocks it is more likely that asperities are sheared away during levelling rather than the grains dislodged, which would open new relief. This factor is further affected by the mineralogical composition, as denser rocks often sport particles too small and interknitted to measure a high rugosity. Optimal celt materials are dense, massive, quartz-free, non-porous, and highly cohesive with hard, fine-grained, and equigranular mineral constituents. Such materials are tough, durable, and capable of withstanding the stress from directed percussive force impacts well.

4.4.2 (Meta-)igneous rock varieties

The majority of igneous celt materials are extrusive rocks formed out of lavas with intermediate to mafic composition, and therefore comprise primarily andesitic to basaltic rocks. Basaltic rocks are poor in silica, and minerals characteristic of its range are plagioclase feldspar, pyroxene, amphibole, olivine, and biotite. Their colours range from grey to almost black. True basalt is petrochemically defined as between 45-52 wt.% SiO_2 and <5 wt.% $Na_2O + K_2O$ (Le Maitre 2002), though archaeologists have applied the term loosely to any fine-grained dark greyish volcanic lava in the field. Basalts from the Lesser Antilles largely correspond to the calc-alkaline series, but flows on Grenada and Carriacou comprise distinctive MgO, olivine-rich and silica-undersaturated series (Devine 1995; Arculus 1976; Arculus 1978). The igneous rocks of the central Dominican Republic are also characterised by significant petrogenic differences (e.g. Kesler *et al.* 1991; Torró *et al.* 2017). These rocks are normally fine-grained as a result of the rapid cooling they undergo, and can be described as aphanitic (<1mm sizes). Many of the Caribbean basalts lack the vesicular texture for which the rock type was commonly exploited as prized grinding platform material (Delgado-Raack *et al.* 2009). They are exceptionally suited for the production of edge-ground macro-lithics, for which varieties with massive fabrics were chosen, and respond reasonably well to percussion techniques relying upon isotropic behaviour.

A significant portion of metamorphosed celts consists of low-grade alteration products. These are primarily the rock types geologically defined as greenschist/greenstones, forming under greenschist facies conditions (low-temperature/low-pressure). These commonly metamorphose from mafic igneous protoliths, in which case the mineral assemblages are replaced primarily by (green) actinolite, epidote, and chlorite-group minerals, as well as albite and periodically quartz. Garnets can occur when P/T conditions are higher and approximate amphibolite facies conditions (Bucher and Grapes 2011, 365). Discounting quartz, the hardness of such rocks averages around 5 to 6 on the scale of Mohs'. Greenschists are typically foliated, but may retain a massive texture if the metamorphism is weak or platy minerals do not align well. In these cases they comprise greenstone in its geologically definition, though the term is also applied to field specimens of chlorite bearing metavolcanic rocks (see footnote 4). Lower metamorphic grades (zeolite/prenite-pumpellyite facies) are also referred to as sub-greenschist facies when the altered mineral assemblages are too poorly developed to properly designate the metamorphic facies (Bucher and Grapes 2011; Winter 2001). The archaeological assemblages

contain many mafic lavas and fine-grained volcanic tuffs that display incomplete alteration in the greenschist facies, and partially retain the original structure and mineral assemblage. These are – as hand samples – described here as the protolith rock with metamorphic overprint; rocks with strong overprinting are grouped as functionally metamorphic.

The majority of metamorphic formations in the Caribbean are in greenschist facies, and mafic protoliths form the most commonly altered members. Their mineralogical and structural variety is in general quite large, and some terranes provide rocks with better working properties than others (Roobol and Lee 1975). Two important groups in Hispaniola are the Maimón formation, which include the Amina schists, and the Duarte Complex, both belts on the northern flank of the Cordillera Central. Maimón greenschists are foliated and defined by epidote, chlorite, and albite; quartz and mafic phenocrysts occur commonly, and actinolite is responsible for the strong foliation of the northwesternmost outcrops (Kesler *et al.* 1991). Metafelsic and metasedimentary rocks are also found there. The formation approximates a transition to blueschist facies, but no glaucophane is present in it (Torró *et al.* 2016). The Duarte Complex ranges from sub-greenschist to amphibolite facies. Its greenschists do not contain as much albite, and are often weakly schistose. However, massive fabrics are common for basaltic protoliths outcrops that underwent sub-greenschist metamorphism (Draper and Lewis 1991). This pattern is also seen in greenschist outcrops from the Blue Mountains, Jamaica, where very fine-grained, massive greenschists are interspaced with outcrops containing schistose rocks (Roobol and Lee 1975).

4.4.3 High-grade metamorphic rock varieties

The second group of metamorphic rocks consist of high-grade alteration products from the blueschist facies (low-temperature/high-pressure). Glaucophane is the characteristic mineral metamorphosing from a mafic protolith, and blueschist or glaucophanite is the associated rock. Blueschists from the Río San Juan Complex (RSJC) occur with jadeite or jadeite-lawsonite, or garnet and/or omphacite; small quantities of quartz may be found in all (Krebs *et al.* 2011). Samaná blueschists are predominantly retrograded eclogites, mechanically deformed and often bearing garnets (Escuder-Viruete and Pérez-Estaún 2006). Schertl *et al.* (2018) characterise an artefact from Playa Grande as blueschist bearing garnet, omphacite, and lawsonite, a combination for which no matching rocks have yet been sampled; however, it is predicted to occur in both terranes. Glaucophane is dark blue in colour, averages at around 6 on Mohs' scale of hardness, and has acicular to columnar crystal habits. As a result, blueschist microtopographies are incomparable to those from granoblastic matrices, and fabrics composed of bar- and needle-shaped constituents fracture in schistose or blocky patterns.

The rare pyroxene-group mineral jadeite also belongs to the blueschist facies suite, and forms within subducted serpentinite mélanges with ultramafic or greywacke protoliths. Different types of jadeite can form through metasomatic replacement of other rocks via contact with hydrous fluids, or by direct precipitation of these fluids in veins (Harlow and Sorensen 2005; Harlow *et al.* 2015; Tsujimori and Harlow 2012). It is one of the gemological jades, a category which further includes the tremolite-actinolite (amphibole) rock called nephrite, which forms under different metamorphic circumstances (Harlow and Sorensen 2005), and occasionally omphacitite (Coccato *et al.* 2014). Omphacite is a pyroxene that is closely related to jadeite but occurs more commonly in high-pressure facies. The rock jadeitite has *sensu stricto* a jadeite content exceeding 90% and *sensu lato* falls between 75% and 90%. Caribbean jadeitites usually contain several accessory minerals, such as omphacite,

glaucophane, quartz, lawsonite, epidote, albite, and mica, amongst others.

As explained in section 2.1, there are three identified sources of jadeitite in the circum-Caribbean: the Río San Juan Complex (RSJC) on the northeast flanks of the Cordillera Septentrional, the Sierra del Convento serpentinite mélange in eastern Cuba, and the extensive and well researched Motagua Fault Zone (MFZ) in Guatemala. All are compositionally heterogeneous and originate from the same series of tectonic events, which renders it difficult to define a mineralogical or geochemical 'fingerprint' for any one source area (García-Casco *et al.* 2013; Harlow *et al.* 2006; Schertl *et al.* 2018). The jadeite-bearing rocks found in the RSJC occur as tectonic blocks within weathered serpentinite mélanges, and can be divided into a northern suite which also contains quartz and lawsonite in the matrix, and a southern suite where albite is common and quartz absent. The albite group also contains rocks rich in omphacite and rarely pumpellyite. Mineralogically analysed artefacts derive only from this group: they generally lack fabric orientation though some display foliation, vary in the fineness of grain size, formation of crystal faces, intergrowth of accessory fibrous minerals, and so on (Schertl *et al.* 2012; Hertwig 2014; Hertwig *et al.* 2016; Schertl *et al.* 2018). The surface occurrence of jadeitite and other rocks in the RSJC is described in section 6.1.3. The jadeite-bearing rocks from the Sierra del Convento have broadly comparable chemistry and mineralogy. They are rich in omphacite and also contain albite, phlogopite, epidote, and a variety of accessories including quartz, but no glaucophane (Cárdenas-Párraga *et al.* 2010; 2012; García-Casco *et al.* 2009b; 2013). A potential third source area may exist in central Cuba, but jadeite minerals in that location have thus far not been seen to form large aggregates (Maresch *et al.* 2012).

Jadeitite is ranked amongst the hardest, densest, and toughest naturally occurring rocks. Jadeite crystals are granular or fibrous and form highly cohesive aggregates, which measure their hardness at 6.5 to 7.0 on Mohs' scale. Its colouration is based upon mineralogical and chemical properties, with most of the greens exhibited by jadeitite deriving from the ratio between Fe^{2+} and Fe^{3+}. Other important elements are chromium and manganese, which may result in emerald green or mauve respectively, and the pure endmember of jadeite is white (Harlow and Sorensen 2005). Pure jadeitite can be knapped, though with difficulty (Andrieu *et al.* 2014; Pétrequin *et al.* 2012a). Compositional differences will greatly influence this technique, as the presence of non-granular crystals or impurities such as albite veins will interfere with the process. Due to its hardness, it is often assumed that only organic techniques operating abrasives (such as sawing) were employed in the manufacture of objects of jadeitite (Charlton and Pastrana 2017).Rocks such as basalts and limestones are suggested as viable platforms when combined with loose abrasives, as based upon finds at Nativitas, Tlaxcalca (Hirth *et al.* 2009) and Cancuen, Guatemala respectively (Andrieu *et al.* 2014). Indeed, rich jade working toolkits using multiple organic and inorganic tools in combination with abrasives in different grades (powdered forms of a.o. quartz, flint, emery, corundum, and carborundum) were documented in both pre-industrial China and Mesoamerica (Foshag 1957; Hansford 1950; Melgar Tísoc and Solís Ciriaco 2013; Su-Jung *et al.* 2014). On their own other rock types are considered too soft to effectively work jadeite, as are pre-industrial metals. Present experimental work and examples published in the literature indicate this is not necessarily the case, however. In another study, Melgar Tísoc and Andrieu (2016) infer the polishing of jadeitite by using more jadeite, as well as eventual burnishing with skins.

4.4.4 Shells

Mollusc shell is one of the most diverse raw materials of the Caribbean, and through its widespread utilisation forms a distinguishing characteristic of indigenous material culture. Shells were used for the production of all sorts of tools, paraphernalia, ornaments, as well as rainwater traps, lime, and so on. A mollusc shell is the exoskeleton of a conchiferous (shell-bearing) animal belonging to the phylum Mollusca. The bivalvia and gastropoda classes are the most common and diverse. The animal builds it around itself by excreting calcium carbonate from its mantle into an organic framework, in which the crystallisation takes place. It then forms a compact calcareous mass that is well suited to endure the stresses of marine life (Lowenstam and Weiner 1989, 103-110). It typically consists of multiple structural layers, beginning with the thin iridescent inner layer towards the outer layers that provides the shell its mass, thickness, and colourful appearance. These layers consist of crystalline aragonite or calcite laid down in various structures, encased within an organic matrix of which the composition and weight percentage differs per species (Marin and Luquet 2004). Aragonite is predominant in tropical seashells, while calcite and aragonite crystals co-occur outside of the tropical-temperate water boundary (Lowenstam and Weiner 1989, 214; Vermeij 1993, 18-19). The outermost layer is again a protein-based organic called the periostracum, which covers the calcareous layers of the shell. This layer decomposes quickly after death or disappears already during the later life of the mollusc as a result of wear.

Since shell is a biomineral, the aragonite and calcite crystals are laid down in regularised structures specific to the given species. Most shells exhibit several coexisting microstructural types, and have distinct crystallographic texture patterns, ensuring that it responds differently to loads and forces than carbonates of natural formation do. As a result, the category of 'shell' is technologically heterogeneous. These microstructural differences produce significant differences between mollusc species in how their shell interacts with manufacturing processes (Szabó 2004, 103-126; 2008). For instance, it can lead to different types of edges – in turn having specific wear patterns – coexisting at random within the same shell (Choi and Driwantoro 2007). The six main microstructural types are cross-lamellar, prismatic, foliated, nacreous, spherulitic, and homogeneous, which include many different subsets (e.g. Carter and Clark II 1985; Carter *et al.* 1990). Their architecture strongly influences how the shell resists friction, tension (e.g. Lin *et al.* 2006; Taylor and Layman 1972), and how it fractures in the natural environment (Zuschin *et al.* 2003), thus affecting the development of wear both as active and as passive body.

C*ross-lamellar* microstructures are laid down as bundles of lamellar crystals packed together along one orientation, which cross neighbour packs oriented into a different direction. The exact orientation may differ between species, some having multiple subtypes across layers (Chateigner *et al.* 2000), whereas others vary in the nature of their overall organic content (Dauphin and Denis 2000). This structure provides extreme fracture toughness, since when one lamellar layer is subjected to stress the resulting crack propagation is bridged and dissipated by the bifurcated interfaces of adjacent layers (e.g. Currey and Kohn 1976; Kamat *et al.* 2000; Menig *et al.* 2001). *Prismatic* shell consists of elongated rods laid down side by side. Accordingly, a bundled prismatic microstructure will guide the force of knapping straight and directly through the material with fairly little lateral dissipation (Szabó 2008). Both structures produce bending-initiated fractures on the edge. *Nacre* crystals are tabular and develop as columnar stacks in gastropods while they interlock in a brick wall sheet structure in bivalves (Nakahara 1991), applied in archaeological taxon identification (Debruyne 2014). The

organisation of these stacks dissipates and spreads out energy travelling in perpendicular orientation, resulting in the highest structural fracture resistance (e.g. Currey 1988, in Szabó 2004, 109; Jackson *et al.* 1988). *Foliated* shell consists of flat oriented lathes which overlap each other, and appears to be a comparatively weak microstructure (Taylor and Layman 1972). *Spherulitic* microstructures have elongate crystallites radiating from a central axis, and finally, *homogeneous* shells consist of aggregated fine granular crystals lacking identifiable orientations. Moreover, multiple crystallographic axes (textures) can occur for and within each microstructural type (Chateigner *et al.* 2000). Altogether these structural properties impose different technical limitations and allowances, with significant impact upon what is technologically feasible.

These structural and crystallographic properties have their origin in how mollusc shells have evolved to withstand the wear of the natural environment. The main agents that induce improvement are predation (cracking and boring), corrosion, and abrasion from seabed sediments. Shells typically also develop sculptural features to increase their ability to resist tension from abrasion and fatigue (Zuschin *et al.* 2003). For instance, bivalve shells are often corrugated with longitudinal ribs, shown to be an evolutionary adaptation to burrowing behaviour (Tian *et al.* 2014). It was found that these corrugations could redirect environmental particles thereby reducing the intensity of the abrasive wear process, with mechanical differences between species influencing the effectiveness (Tong *et al.* 2005). Shell surfaces in general possess well-developed anti-wear properties, lending them a natural resistance to environmental abrasive wear and cracking. Their hardness averages at only 3 on the scale of Mohs (Coomans 1987), however, while small weaknesses can occur due to structural responses to soaking and wear deflection (Leung and Sinha 2009). Nevertheless, shell microstructures approach high to optimal strength configurations (Fleischli *et al.* 2008; Zuschin *et al.* 2003), which combine with the friction and wear resistance of the surface layer to arrest fatigue cracks that result from abrasive friction (e.g. Hirvonen *et al.* 1993; Tian *et al.* 2010). Cross-lamellar microstructures best inhibit the dissipation of energy to prevent crack propagation, whereas prismatic structures better resist predatory drilling (Currey and Kohn 1976; Gabriel 1981). Bivalve nacre is extremely resistant to directed pressure due to a high bending strength, especially when wet, as a result of its tightly packed brick wall structure (Jackson *et al.* 1988; Taylor and Layman 1972). Its sheet plates are easily split apart, however. Contrarily, homogeneous layers have little architectural resistance to fracture, and may behave comparatively isotropic. However, they are very durable under abrasive wear and energetically inexpensive to build (Avery and Etter 2006).

Structural and topographic behaviour aside, still other properties matter in shell wear formation. The cited studies consistently report a scattering of the results due to variation between individuals from the same species, which relates to the life history of the individual. For instance, environmental factors (food supply, predator density) will induce growth responses in the structure of the shell, while shell repair may remodel the microstructure of a localised area (Avery and Etter 2006; Lowenstam and Weiner 1989, 110; Szabó 2004, 115-117). The degree of degradable organic content affects the path of the force and subsequently the ability to flake the shell (Szabó 2004, 112-113; 2008). Drying and organic decay after the death of the mollusc significantly impacts the strength, stiffness, and wear resistance of the shell, however, even for low-organic crossed-lamellar layers (Hou *et al.* 2004; Liang *et al.* 2008; Neves and Mano 2005; Hirvonen *et al.* 1993). Curiously, Moir (1990) demonstrates an adaptive technology in the New Guinean Takuu Atoll that entails the curing of fresh *Tridacna gigas* shells. This bivalve shell has a low organisation needle-like aragonitic cross-lamellar microstructure,

which recrystallizes over time when left in seawater. The needles and voids from organic decay are gradually replaced by aragonitic plates to form a denser and less soluble structure that has a higher resistance to wear and degradation. Summarising, the cured shells make for better tool materials. The state of material selection strongly impacts the workability of the shell, and will likely rely upon a technologically advantageous moment for the intended use. The specific fracture mechanics greatly affect knapping strategies, and may require learned technical gestures and approaches to operate (Romagnoli *et al.* 2016). Similarly, topographic protrusions may necessitate specific technological responses when mechanical abrasion is intended. In all, different shells maintain different resistances against impact, force, and general contact as an evolutionary outcome of environmental stresses, which must be understood to better comprehend shell wear formation.

Caribbean taxa themselves are virtually unstudied from the biomaterial perspective, with the obvious exception of *Lobatus gigas* (e.g. Barthelat *et al.* 2009; Dauphin and Denis 2000; Hou *et al.* 2004; Kamat *et al.* 2000; 2004; Kuhn-Spearing *et al.* 1996; Lin *et al.* 2006; Menig *et al.* 2001; Nakahara *et al.* 1981; Su *et al.* 2004). *L. gigas* shells are fully aragonitic, built in three highly organised simple cross-lamellar layers (more in the lip) structured as 'ceramic plywood' with little (0.1 wt.%) proteinaceous organic content. This structure provides several anti-fracture control mechanisms which lead to a high dynamic compressive strength, even in comparison to other cross-lamellar shells. In my experiments, knapping of fresh shell performed at a different moment revealed the extent to which the structure inhibits crack propagation, and enforces a pecking mechanism. The use of pointed hammerstones to pound the shell resulted only in localised crushing, whereas cracking was not observed at any moment. It proved relatively easy to hammer out the intended products, which displayed no propagated fractures on the internal layer at all, or to remove the apex in this way without structurally damaging the rest of the shell (see also Dacal Moure 1997). Some first order lamellae came off during knapping experiments with an older shell of this species, and these proved to be functional for sawing (Section 5.3.2). Presumably, these properties will differ little for other taxa within the genus. While inter-genera differences in microstructures are sometimes observed, no better analogues are available for the other mollusc species relevant here than other members from their genus. The *Spondylus* sp., *Oliva* sp., and *Conus* sp. objects are all taken to be aragonitic and share cross-lamellar layering, given that such microstructures are reported for related taxa (*Spondylus princeps*, *Oliva miniacea*, and *Conus leopardus)* (Chateigner *et al.* 2000). Nevertheless, some differences in the orientation of the plates within the internal and intermediate layers are present, while the *Oliva* species may potentially deposit homogeneous shell and *Spondylus* sp. sports an additional cross-lamellar layer. Two specimens are nacreous, and likely to respond poorly to directed force. The use of 'compressive force', by which a sawing or incising technique is implied, is better suited to deal with the microstructural properties of such a material (Szabó 2004, 109-110; 2008). Since most of the unidentified bivalve shells analysed in Chapter 9 also display cross-lamellar layering, this remains by far the most important shell microstructure.

5

Experiments

Thus far, the argument is that axes and paraphernalia have an exceptional potential for biographical variation (Chapter 3), and that possible outcomes can be analytically distinguished if the referential framework permits such distinctions (Chapter 4). This chapter reports on the experiments with specific combinations of human activities and material properties, and assesses real outcomes for several relevant possibilities. The topics are hard stone grinding (Section 5.1), wood chopping and static friction (Section 5.2), incising (Sections 5.3.1 and 5.3.2), drilling (Section 5.3.3), and soft material grinding (Section 5.3.4).

The experimental programme was conducted subsequent to the first analyses of archaeological materials, in order to pursue specific technological scenarios and material interactions that were indicated therein. Thus, use wear experiments focus on working with different wood types and do not explore other forms of use contact, and incisionwork is conducted with an eye to the outcomes of using distinct raw materials. The six topics represent a variety of interactions that is far too great the address to exacting comprehensiveness otherwise. The reference collection of the Leiden Laboratory for Artefact Studies supplied the necessary background for obtaining basic interpretations regarding types of wear with relatively low incidence in the data (e.g. polishing a celt against soft materials, which could entail plants or animal materials). This collection contains almost 4000 experiments, including many ground stone tools and carved objects. In any case, such interpretations remain inferentially limited in light of the great regional diversity in both lithic and organic raw materials that was conceivably or demonstrably utilised in the past (Section 2.1).

Accordingly, the goals of the experimental programme are summarised as follows: 1) investigating and recognising technological feasibility in the archaeological biographies; 2) analysing inter-material variability when subjected to the same technique and extrapolating these results to the interpretation of traces; 3) constructing a frame of reference aimed at distinguishing distinct categories of tools and contact materials. The present study distinguishes six different categories, three focused on edge-ground macro-lithics and three focused on paraphernalia of stone, bone, and shell. The resulting sections on edge-ground macro-lithics are structured in line with the stated goals, first by defining the context, the set-up, and its various parameters. This is followed by overviews of the experimental outcomes and definitions of relevant traces of wear, concluded by an analysis of the inferential potential for specific wear patterns. Technical descriptions of the resulting wear trace signatures are confined to Appendices 1 and 2. The resulting sections on paraphernalia describe and analyse the series of resulting trace patterns in subsequent turns.

5.1 Grinding axe materials

The first aim of the experimental programme is to investigate the variation in indigenous grinding and polishing techniques. The understanding of manufacturing wear created by different rock types and slurries remains an underexplored field, due to the historical emphasis on use. Indeed, the bulk of knowledge from stone-on-stone contact wear is built on use traces encountered on lithic abraders and grinding platforms, rather than the manufacturing traces on the surfaces rubbed against these tools (e.g. Breglia *et al.* 2016; Cristiani *et al.* 2012; Dubreuil 2002; Hamon 2008; Hayes *et al.* 2018; Liu *et al.* 2010; Van Gijn and Houkes 2006; Verbaas and Van Gijn 2008). Non-traceologists conventionally characterise an evened levelling of the surface of the artefact as indicating abrasive manufacture: bands of striations indicate the abrasive character and directionality of the motion, and lustre indicates the use of polishing agents. Hard lithic platforms are assumed tools and intermediate abrasives are often postulated if the surfaces appear particularly striated, but it is not clear how this can be analytically distinguished from generic asperite rocks, or what effect different types of the proverbial 'sand' would have. Research into the microscopic details of manufactured lithic surfaces has increased only recently, intending to gain better insights into various abrasive technologies on lithics (Alvarez Soncini and Mansur 2017; Boleti *et al.* 2015; Breukel and Falci 2015; d'Errico *et al.* 2000; Groman-Yaroslavski and Bar-Yosef Mayer 2015; Gwinnett and Gorelick 1989; Lewis *et al.* 2009; 2011; Mansur 1997; Melgar Tísoc *et al.* 2014; Procopiou *et al.* 2011; 2013; Solís Ciriaco *et al.* 2016; Thirault 2004; Velázquez Castro and Melgar Tísoc 2014).[19] These studies have focused primarily on celts and semi-precious ornaments, as such artefacts are both common and the types most frequently abraded in the past.

Sandstones are frequently considered as prime grinding stones, due to their abrasive character, abundance, experimental viability, and universal ethnographic documentation of their use. Within Amazonia, the abrasion of axe surfaces was indeed carried out primarily on grinding platforms of sandstone, under wet conditions. This is reported for at least the Galibi (Barrère 1743, in Petitjean Roget 1985, 76) and other groups in the Guyanas (Roth 1924, 72), the Héta (Kozák 1972; Kozák *et al.* 1979, 400), Myky (Fernández González 2016), Trumai (von den Steinen 1897, 197), Amahuaca (Carneiro 1974), and the quartz cylinder ornaments of Tukanoan groups (Koch-Grünberg 1921, 205). None of these observations divulge much information regarding any care in selecting lithologies, however, nor is it clear what rock types they specifically represent. Added abrasives are uncommon in the area, being reported only for the Héta (Kozák *et al.* 1979, 400), which may reflect issues of availability to them. The Héta mix this with fine kaolin clay as a polishing agent; the Tukano instead use fine sand and pumice on their quartz cylinders (Koch-Grünberg 1921, 205), while Carneiro (1974) speculates on the use of slate. Nevertheless, sandstone or sand-based slurries are often suggested as the responsible techniques in the archaeology of the circum-Caribbean (e.g. Boomert and Kroonenberg 1977; Rostain and Wack 1987; cf. Rostain 1994, 344). Practically, Boomert and Rogers (2005) associate the presence in Troumassoid Tobago of coarse-grained quartz-bearing sedimentary rocks with lithic grinding stones, and Berman (2011, 117) does the same in the Bahamas (cf. also López

19 Much experimental research has been conducted into the production of axes and other ground stone materials, this has always been directed primarily towards grinding technology and viability experiments, not into the characterisation of traces of wear. The situation is analogous to the growing study of polishing and burnishing of ceramic surfaces in the production of pottery (e.g. Ionescu *et al.* 2018; Lepère 2014; López Varela *et al.* 2002). Research into the technology of softer materials, bone objects in particular and shell to a lesser extent, is much ahead in this regard (Section 4.4.4).

Belando 2013). However, these associations remain untested. Experimental wear trace research has elevated the notion of using stony coral grinding platforms for various tasks, especially the processing of shell materials (Kelly 2003; 2004; Kelly and Van Gijn 2008; Lammers-Keijsers 2007; 2008; Van Gijn *et al.* 2008). Still, as carbonaceous biominerals these are functionally limestones with high fabric organisation, and not very suitable for abrading harder rock materials. Most portable stone slab artefacts are actually associated with food processing, used as *metates* (querns) or griddles, and not thought to be stone grinding platforms. Nor is there compelling evidence that the *polissoir* model extended deeper into the Antilles, in spite of infrequent finds in the Windward Islands (Section 2.3).

There is thus a lack of good evidence for stone grinding and polishing techniques in the Caribbean. Furthermore, a selection of 'sandstones' can have wildly different abrasive capacities depending on their specific lithological properties (Hamon 2008; Hayes *et al.* 2018). The variety of equally capable rock types in the possession of highly abrasive properties and other desirable traits of mechanical behaviour is itself much larger (Delgado-Raack *et al.* 2009). Each has in fact the potential to produce distinct surface trace patterns on celt preforms, since their structural properties are parameters that govern the initial conditions of wear (Chapter 4). The present work distinguishes several distinct wear trace patterns within the archaeological assemblages that apparently signal variety in the manufacture of celt surfaces through stone grinding. Such differences in possible grinding strategies might shed light on cultural choices or (the negotiation of) regional technological availabilities, yet issues remain regarding wear trace comparability among different rock types and need to be investigated. Caribbean alternatives need to be examined for commonly made associations, such as that lustrous reflective surfaces result from polishing activity with leather and fine abrasives. Thus, the experimental programme aimed at comparing the wear traces that resulted from using different grinding stones (the platforms) against a series of different relevant rock types (the blanks).

5.1.1 Experimental conditions

A series of thirteen experiments has been carried out, using eight different blank materials and six grinding platforms. The goal was to obtain sequences of traces developing on a large number of different rocks under comparable circumstances. These were subsequently analysed to distinguish the effects of various rock properties on the formation of wear, and to distinguish distinct wear trace signatures that aid the interpretation of archaeological materials. The primary parameters include the active material and platform material, with the presence or absence of water for lubrication and quartz sand as abrasive additives.

The active blanks are fine-grained basaltic rocks and altered mafic lavas in a near complete state of greenschist facies overprinting, which correspond to the main range of archaeological materials. They were procured as pebbles from the tributary system of the El Yaque del Norte by Gareth Davies and Alice Knaf during a geological survey towards the source areas for archaeological assemblages. The altered fragments were subjected to a later lava flow and retain non-metamorphosed relict feldspars, but produced fairly even breaks. The basaltic surfaces have slightly larger grain sizes, which amounts to increased relief with a higher roughness value. Both are massive, non-porous, and they contain the mineral suites previously described for such rocks (Section 4.4.2). A jadeitite blank was obtained commercially in the form of small polished lenticular discs with flat faces carrying a cylindrical perforation (so-called *Bi* discs, undecorated and 2cm in size). It is assumed to be of B or C jade quality, meaning that the colour and translucency has been chemically altered, but this is not thought

to affect the mechanical behaviour of the minerals. The jadeitite is fine-grained and homogeneous but for a few brittle inclusions (possibly quartz). Also used was a fine-grained volcanic sediment obtained from the Río Turabo in eastern Puerto Rico to examine the contrast with the metavolcanic blanks. Macro-lithics made of such materials are rare in the Caribbean, but not unheard of.

The selection of abrasive platforms consists of various types of sandstone and the stony coral *Acropora palmata*. The first is a fine-grained quartz arenite (a sandstone consisting almost entirely of quartz grains) obtained from the Laboratory. It has high cohesion, angular granularity, and mild porosity as a result of low matrix content. The individual crystals were well cemented and upon abrasive use constituted a surface with relatively low roughness and micro-relief. Furthermore, I used two types of sandstones with various granularities obtained from the Río Unijica, Puerto Plata (north of the Cordillera Septentrional). These are a fine-grained sandstone with good cohesion and a sub-angular fraction, and a medium to coarse-grained sandstone of unknown origin with higher matrix content. The fourth sandstone, originating in Schleswig-Holstein, Germany, is a fine-grained rock with hard but rounded grains and poor cohesion due to a lack of matrix and cementation. Finally, I selected two *A. palmata* slabs from the Lesser Antilles. Stony corals (Selacterinia order) form a hard carbonaceous exoskeleton in life in the form of excreted calcium carbonate aragonite crystals. This material is laid down as an interlocking mesh of rods and bars on the microscale (Gladfelter 2007). The 'matrix' is characterised by highly regularly patterned corallite tubers that act as vesicles, originally housing individual living organisms. As a result, stony coral has high resilience, cohesion, and excellent abrasive properties, though its hardness remains low and the material is subject to a rapid turnover rate. The carbonaceous powder produced in this way acts as intermediate particles from a tribological perspective, and form a natural slurry with added moisture (Breukel 2013; Breukel and Falci 2015). Water formed the sole lubricant in the stone grinding experiments, and quartz sand with a coarse and sub-angular fraction was used as abrasive. The micro-topographies of these platforms before and after experimentation are shown in Figure 7. Some comments are provided concerning the progression of wear on these platforms, but their traces of use are otherwise not described in the present work.

The production process followed a specific protocol. Flakes of 3-5 cm sizes were struck from the procured pebbles in order to expose non-weathered surfaces and conserve the limited raw material (Figure 8). Both sides of the breakage were briefly pecked with a hammerstone to break up large asperities, and subsequently ground in paired experiments. This ensures that each two surfaces are equal in textural and fabric properties and have corresponding areas under contact. Since these rock types are not homogeneous some intra-raw material variability will exist for blanks struck from different parts of the pebble, though their properties remain comparable at large. The reproduction of morphological celt shapes would entail much additional preparation that is not only very time intensive, but also experimentally unnecessary. Grinding a single surface as opposed to a whole axe should not modify the topographic alterations and polish formation to a significant extent, but affect only the distribution of macroscopic striations in morphological features. All blanks were ground as active elements against the respective platform, usually in intervals of 30 minutes, up to a total duration of 90 minutes depending upon progress. In experiments using water and/or loose abrasives, these were present at the start and added when needed to replenish evaporating moisture and loss of grains. My gestures were consistently back-and-forth with a slight elliptic deviation to allow a wider surface contact. The surfaces were analysed, photographed, and recorded using Provil Novo™ negative impression material at the start, interval points, and end of each experiment, leading to observation

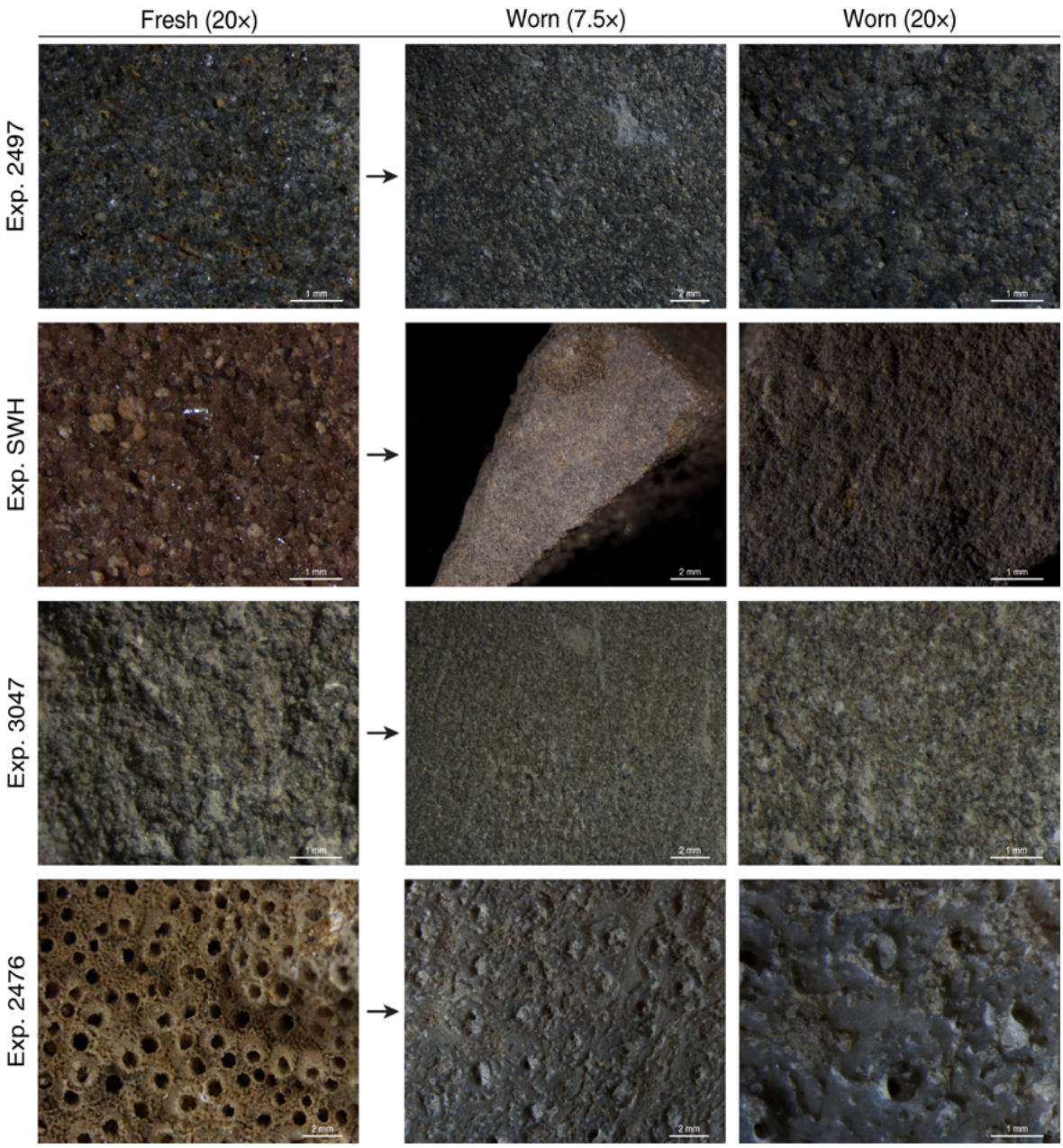


Figure 7: Stereographs of the grinding platforms. Top row: quartz arenite (2497). Second row: low cohesion sandstone (exp. SWH). Third row: fine-grained sandstone (3047). Bottom row: *Acropora palmata* stony coral (2476).

moments at 0, 30, 60, and 90 minutes. Three exceptions exist (Table 1). The volcanoclastic sediment was a pebble of ca. 10 cm that was pecked into a preform and ground into a celt, one greenstone was manufactured by professional experimenter D. Pomstra in an actualistic set-up, and the jadeitite blank was briefly pre-ground in order to remove extraneous waxes and similar adherents from the surface.

5.1.2 Analysis of results

It is evident from the experiments reported in Appendix Z that wear from abrasive contact produces broad similarities that may vary greatly when examined in more detail. All efficacious grinding platforms levelled the experimental blanks down to a smooth surface, which in most cases developed

rough polish if water was added to a cohesive platform. However, there are significant differences between the efficiency of various platforms and between the ensuing microtopographies, including the patterning of polish and the formation of striations across various microscopic ranges. Table 1 contains a concise overview of the primary characteristics of blanks and platforms, the experimental parameters, and the observable outcomes on several microscopic levels. Table 2 provides a nomenclature of the most commonly seen wear trace characteristics for stone-on-stone manufacture in the present work.

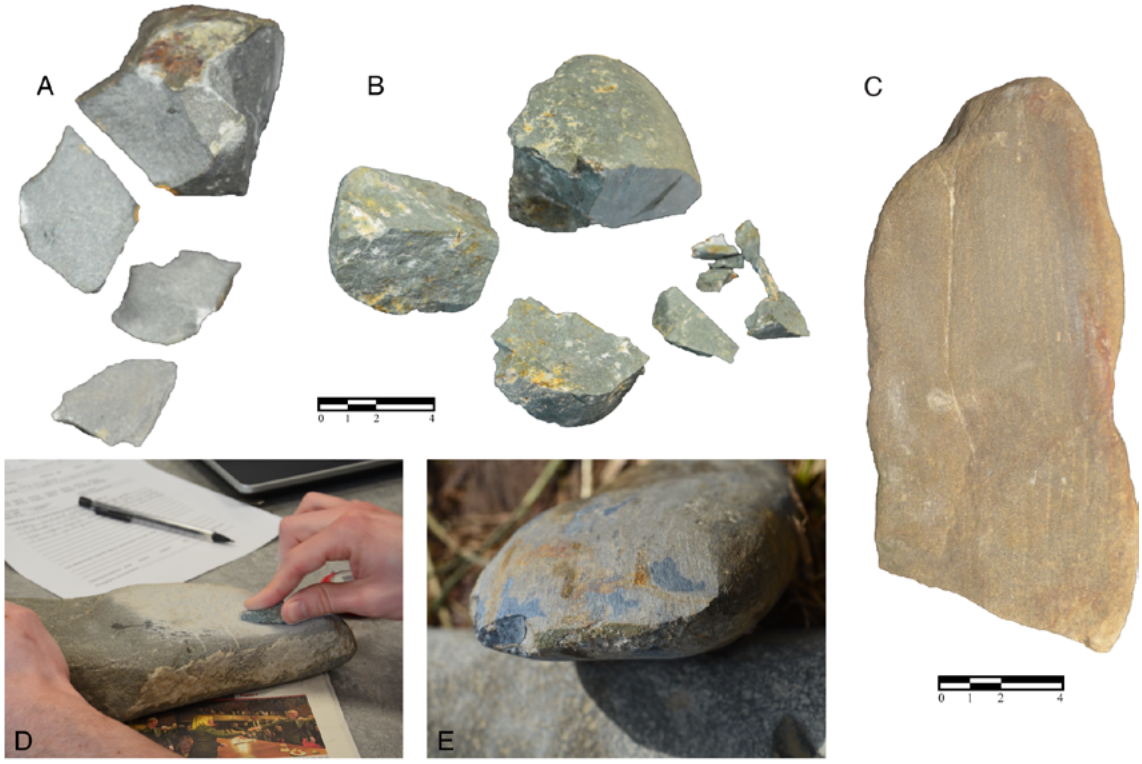


Figure 8: Hard stone grinding experiments. A) Basaltic pebble with removed flakes. B) Greenschist pebble with removed flakes. C) Grinding platform 3047. D) Abrading basalt on quartz arenite (exp. 2512). E) Outcome of grinding volcanoclastic celt 2494.

5.1.2.1 Defining modes of stone-on-stone wear

There are certain general patterns that stand out from the data that characterise broadly the interaction that takes place when a macro-lithic surface is in relative motion to another. The main modes of wear in stone grinding are abrasive wear and fatigue, which have as primary effect the levelling of the original microtopography by the gradual reduction of material from the higher areas. The resulting smoothness depends upon the finesse of this removal and the configuration of interstitial space, as well as the degree to which new interstices are opened. Abrasive wear will flatten out existing roughness, but the associated energy dissipation from friction fatigue will continuously weaken the surface underneath through crack formation and crushing of micro-asperities. The former mode eventually produces flattened out plateaus if the ploughing asperities are small and regular enough, which can grow to large sizes if grain ejection from other modes of wear is minimised (the 'bright mineral mirror polish' found on certain archaeological specimens; Section 10.2.3). Micro-topographies dominated by fatigue assume a crushed appearance, probably resulting from the weakening structural integrity

Table 1: Experimental variables, parameters, and resulting observations of all stone-on-stone abrasion experiments. See Appendix 1 for detailed descriptions and microphotography.

Active blank			Inactive platform			Experimental conditions			Low magnification observations			High magnification observations		
Blank (exp. no)	**Grain types**	**Texture properties**	**Platform (exp. no)**	**Grain types**	**Texture properties**	**Additives**	**Time and intervals**	**Observations**	**Topographic relief**	**Macroscopic lustre**	**Gouges**	**Crushing**	**Polish**	**Striations**
Volcanic sediment Exp. 2494	Unknown	Fine-grained, poor cohesion	Quartz arenite Exp. 2497	Cemented silica crystals, angular	Fine-grained, regular, porous, high cohesion	Water	90	Very efficient, but blank is unsuitably soft for use	Striated	Lacking	Closed/ connected distribution	Not clear	Absent	Absent
Greenschist facies overprinted volcanic Exp. 2510	Greenschist-facies mineral suite, euhedral feldspar	Fine-grained, massive, anhedral matrix	Quartz arenite Exp. 2497	Cemented silica crystals, angular	Fine-grained, regular, porous, high cohesion	None	30*30*30	Very efficient, produced stone powder	Well levelled, roughness minimised	Lacking	Fine scratching	Widespread scintillation, details observable starting at 500× mag.	Absent. Scintillation is flat and dull	Stone scratches only in plagioclase minerals
Greenschist facies overprinted volcanic Exp. 2511	Greenschist-facies mineral suite, euhedral feldspar	Fine-grained, massive, anhedral matrix	Quartz arenite Exp. 2497	Cemented silica crystals, angular	Fine-grained, regular, porous, high cohesion	Water	30*30*30	Efficient, feeling is smoother	Well levelled, roughness minimised	Sub-metallic	Fine scratching	Scintillation in between polish spots, but topographic details not well visible	Typical stony polish, bright, flat, dense, closed/covered distribution	Absent
Basaltic Exp. 2512	Mafic mineral suite	Fine-grained, massive, non-porous, granoblastic	Quartz arenite Exp. 2497	Cemented silica crystals, angular	Fine-grained, regular, porous, high cohesion	None	30*30*30	Very efficient, produced stone powder	Well levelled, roughness minimised	Dull or lacking	Fine scratching	Widespread scintillation, details observable starting at 500× mag.	Absent. Scintillation is flat and dull	Directionality present, occasional stone scratches
Basaltic Exp. 2513	Mafic mineral suite	Fine-grained, massive, non-porous, granoblastic	Quartz arenite Exp. 2497	Cemented silica crystals, angular	Fine-grained, regular, porous, high cohesion	Water	30*30*30	Fairly efficient, feeling is smoother	Well levelled, roughness minimised	Diffuse with matt and sub-metallic streaks	Scratching	Scintillation in between polish spots, but topographic details not well visible	Typical stony polish, duller, less connected, closed/covered distribution	Striations in polish
Jadeitite Exp. 3797	Jadeite, rare brittle inclusions	Fine-grained, granoblastic	Quartz arenite Exp. 2497	Cemented silica crystals, angular	Fine-grained, regular, porous, high cohesion	None	30*30	Not very efficient	Well levelled, minimal roughness except mineral bounds	Diffuse with silky-like texture	Absent	Widespread medium scintillation, few grains fracture conchoidally	Smoother and in bands, associated with stone scratches	Directional organisation of polish bands and troughs (stone scratches)

Greenschist Exp. 2514	Greenschist-facies mineral suite	Fine-grained, massive	*A. palmata* Exp. 2476	Aragonite (carbonaceous)	Highly regular, 'vesicular', cohesive	Water	30	Ineffective	Little reduction	Dull	Directional shimmer	Fairly bright scintillation, rounding, between stony scratches	Little polish, associated with stone scratches, low roughness	Large stony scratches, ploughed polish
Greenschist Exp. 2515-surface B	Greenschist-facies mineral suite	Fine-grained, massive	*A. palmata* Exp. 2574	Aragonite (carbonaceous)	Highly regular, 'vesicular', cohesive	Quartz sand (sub-angular, ca. 800-1200μ), water	30	Not very efficient	Reduction remains poor	Lacking	Absent	Widespread medium scintillation, little rounding	Dull structures occur around the stone scratches	Few stone scratches
Greenschist facies overprinted volcanic Exp. 2782	Greenschist-facies mineral suite, euhedral feldspar	Fine-grained, massive, anhedral matrix	Sandstone Exp. 3047	Sub-angular silica grains, some matrix content	Fine-grained, cohesive	Water	30*30*30	Fairly efficient	Well levelled	Dull to sub-metallic	Fine scratches	Scintillation in between polish spots, but topographic details not well visible	Typical stony polish, scattered to linked, with rougher texture	Polish distribution is directional, and occasionally striated
Greenschist Exp. 2515-surface A	Greenschist-facies mineral suite	Fine-grained, massive	Sandstone Exp. 3038	Sub-angular to rounded silica grains, high matrix content	Coarse-grained, cohesive	Water	30*30	Highly inefficient	Little reduction, frosted appearance	Diffuse, brighter	Fine scratches, dense	Topographic details not well visible	Strongly developed, typical stony polish with high roughness	Polish structures are ploughed
Greenschist Exp. 2550	Greenschist facies mafic mineral suite, possibly epidote and quartz	Medium-grained, sub-hedral, weak layering	Sandstone Exp. SWH	Loose silica grains, rounded, no matrix	Fine-grained, poor cohesion	Water	Unknown, several hours	Performed by D. Pomstra	Fairly well levelled	Dull to a greasy diffuse	Striations near sides	Medium to bright scintillation on rounded plateaus	Scintillation is rough textured and mildly invasive. Rare small polish structures	Absent, except for few stone scratches
Diorite Exp. 3037	Plagioclase, hornblende, pyroxene, biotite	Coarse-grained, heterogenous properties, massive	*A. palmata* Exp. 2476	Aragonite (carbonaceous)	Highly regular, cohesive, contains interstitial spaces	Quartz sand (sub-angular, ca. 800-1200μ), water	60	Fairly efficient	Moderate levelling, dark minerals are lower	Dull to absent, biotite pearly	Absent	Medium to bright scintillation on rounded high relief plateaus	Absent. Scintillation is rough textured and mildly invasive	Absent
Diorite Exp. 3036	Plagioclase, hornblende, pyroxene, biotite	Coarse-grained, heterogenous properties, massive	Sandstone Exp. 3038	Sub-angular to rounded silica grains, high matrix content	Coarse-grained, cohesive	Quartz sand (sub-angular, ca. 800-1200μ), water	60	Efficient	Fairly well levelled, dark minerals are lower	Dull to absent, biotite pearly	Absent	Medium to bright scintillation on rounded high relief plateaus	Absent. Scintillation is mildly invasive	Absent

of the uppermost surface micro-layer of which the material is abrasively displaced by sliding or rolling asperities. The microscopic appearance is scintillating and grainy with some degree of internal elevation, sometimes with smoothly reflective polish-like 'fill-in' bridging individual points (Table 2).

Polish is not guaranteed to form or remain stable under the circumstances of stone grinding. If it does, it is usually categorised as bright, rough, and not invasive, owing to the stiffness of the rock asperities. These displace material from the blank surface after direct contact, but do not bend around topographical irregularities without shearing away the higher points; asperities on the blank will break due to mineral brittleness, rather than deform. Polish developed from stone grinding is usually spread over the entire abraded surface in spatially regular patterning. Starting off as small and isolated patches, these will increase in brightness and density and structures forming close to one another may eventually link up.

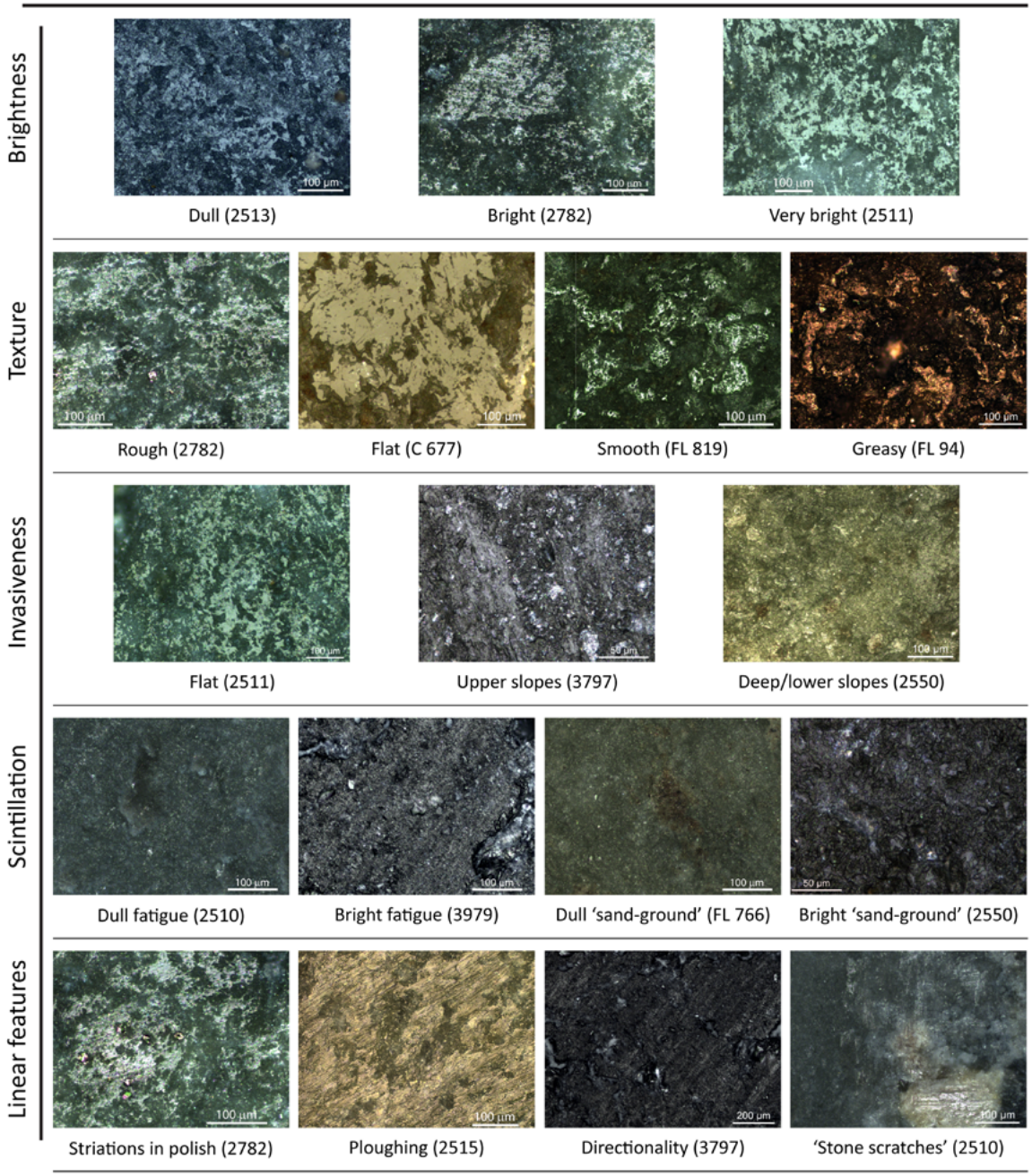
Linear striations can again occur at different scales; the width and depth profile is dependent upon the dimensions and penetration depth of ploughing asperities. Gouges may be macroscopically visible and can be well characterised under low magnification views. Metallographic microscopes better visualise 'stone scratches' (bright ploughing marks with internal striations embedded in the surface, sometimes interrupted) and fine micro-striations set within directional polish structures (Table 2). The relationship between striations and abrasive wear processes is obvious, but their presence on ground surfaces is not guaranteed at all. Their lack in many experimental observation moments can probably be linked to interfering non-abrasive wear processes: these must either render the blank surface too brittle or weak to retain striations, or blunt the ploughing asperities without outright renewal taking place so that these points cannot penetrate the blank surface well. The fact that macroscopic striations on archaeological materials cluster on peripheral surface zones simply suggests that they originate from the initial conditions of wear, which are erased on the faces when these are brought to an equilibrium with fatigue. The most important property of the platform appears to be its asperiteness in conjunction with the hardness and cohesion of those grains, but it is not a matter of simply having higher 'values' thereof. The technical skill of craftsmen in India lies instead in the ability to recognise when to alternate in motion or abrasive material, and know to what material (Procopiou *et al.* 2013). Evidently, this pertains to the negotiation of wear modes through selecting the needed material properties, and how their resulting interaction affects a surface topography of a particular make-up.

5.1.2.2 Variation in the blanks

This characterisation of stone grinding wear is based upon blanks of (meta)mafic and granoblastic or anhedral matrix composition. Field observations suggest particular crystal habits may respond differently if well formed, acicular glaucophanes in particular, though wear on these is more comparable if the crystal faces are instead intergrown. Rocks containing well-formed brittle minerals have the added wear type of specific crystals fracturing along Hertzian patterns. Still, the wear trace patterns and topographical characteristics that each experiment developed are to a certain degree distinctive (Table 2). The wear trajectories of the jadeitite, basaltic, and greenschist facies-altered blanks ground dry on quartz arenite were all slightly different from one another, differences which became more pronounced under wet conditions. The heterogeneity of these macro-lithic materials plays a large role therein. Mineral boundaries affect the eventual relief, as differences in hardness and wear resistance usually translate to some crystals wearing down deeper than others. This was clear for diorite blanks,

and archaeological materials sometimes show garnet inclusions resisting the loads wearing down the surrounding softer matrix. The well-formed feldspar minerals in the incompletely metamorphosed experimental greenschist blanks clearly differed in their response to the wear from the surrounding

Table 2: Atlas and nomenclature for experimental wear trace characteristics on rocks relating to manufacturing conditions for abrasive contact against other rocks.



Brightness, texture, and invasiveness are primary variables for polish. Scintillation and linear traces depict frequently described traces for the surface topography more generally. Experimental numbers are provided, micrograph numbers prefixed with C or FL are from archaeological specimens from the sites of El Cabo and El Flaco respectively. The micrographs for texture-rough and invasiveness-flat are good examples of typical 'stony polish', a short-hand used for polish indicative of contact with lithic materials in Appendix 3. Smooth and greasy textures are not commonly seen from contact with stone; the micrographs shown for contrast depict archaeological traces interpreted as woodworking (use) and soft plant contact from ligatures (hafting) respectively.

matrix as well. Polish developed at comparatively later stages at lower densities, whereas stone scratches became well pronounced on these minerals since commencing these experiments.

It is conceivable that such differential responses may aid in separating equifinal outcomes or poorly developed results in certain cases. However, the matrices of the relevant rock types are at present comparable enough in wear trace formation to group analogous archaeological wear trace signatures under the same technical category. Blanks of different raw materials that were ground under the same conditions consistently resemble each other more so than they resemble other results. This is especially the case for basaltic and greenschist rocks. Nevertheless, they are not equivalent, and the exact level of inference also differs per technique (applied grinding platform and additives). Blanks with greenschist matrices (whether partially overprinted or fully metamorphosed) were ground using seven different techniques, resulting in distinctive sets of outcomes. These outcomes (which I will reference as wear trace signatures on archaeological surfaces) permit inferences into some of the parameters of the original interaction and can therefore (partially) reconstruct the used technique. Microtopographical characteristics, developed polish, and striation patterns all stand out as delineating certain interaction groups.

5.1.2.3 Resulting technological categories

The experimental results which proved inferentially useful group roughly in four different technological categories (Figure 9). The 'dry ground' and 'sand-ground' topographies developed little to no polish whereas most experiments with water/without abrasives did, and whose development differs internally. This distinction translates exceptionally well to different categories of macroscopic lustre of the experimental surfaces. The reflections they display are undoubtedly derived of microtopographical characteristics, increasing with smoother and denser polish and decreasing from topographical relief and scratching. They therefore comprise technological indices as much as their brilliance can also reflect sociocosmic values (Sections 3.1.3.1 and 10.2.3.1).

The experiments with quartz arenite showed that lustre can be manipulated by the simple addition of water, but at the expense of a more striated topography and overall less abrasive effectiveness compared to when the blanks were ground in dry conditions. Other types of sandstone failed to match the intensity of polish development and these results are macroscopically distinguishable, emphasising the crucial importance of choosing the platform. Most sequential observations indicated little increase in polish between 60 and 90 minutes, indicating a balance between polish formation and loss of surface (under my own grinding kinematics). Further increasing the lustre would require the expertise to recognise this equilibrium and subsequent switch to a different technique. However, differentiating macroscopic lustres does not correlate to a technological succession from coarse abrading to finer polishing. The quartz arenite was equally the most efficient abrader, and the use of abrasives resulted in comparable surfaces in spite of whichever platform facilitated the grinding. Even the addition of water is not a true correlation to the formation of more intense lustres, given that rough polish structures barely formed in exp. 2550 (wet) and yet were present in exp. 3797 (dry, both are described in Appendix 1; cf. also the use of dry emery paper in Procopiou *et al.* 2013). These results thus indicate that technological choices in abrading rock surfaces do not simply rest in matters of successive decreases in grain sizes, but in having knowledge of and access to both best practices and local alternatives.

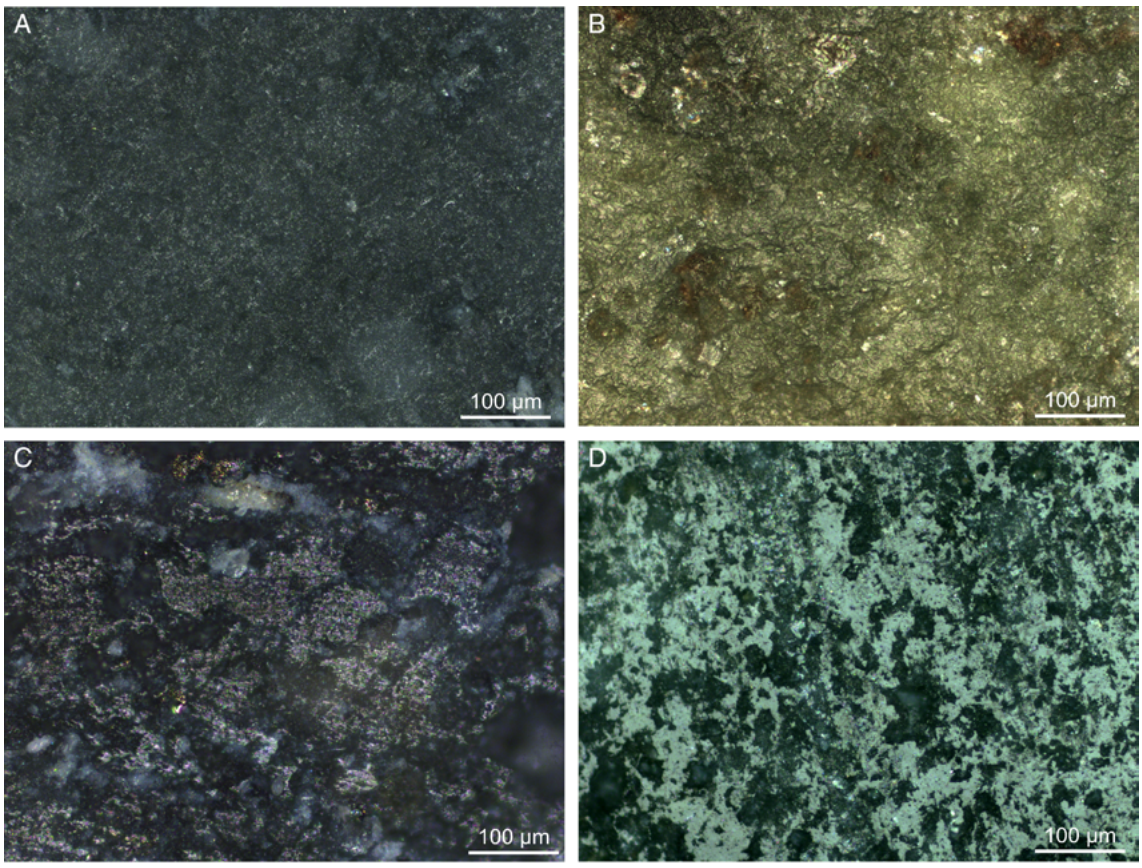


Figure 9: Experimental wear trace signatures reflecting different technological categories. A) 'Dry grinding' from exp 2510. B) 'Sand-ground' topography from exp 2550. C) Microtopography with dull striated rough polish and diffuse lustre from exp 2513. D) Microtopography with bright rough polish and high lustre from exp 2511.

Abrasion without micro-polish development

Dull 'dry grinding' experiments (without moisture) all attained very high degrees of microtopographic levelling (Figure 9, a). There is a near complete lack of traces up until the 200× magnification, at which point the surface texture is shown as dull, flat scintillation resulting from steady fatigue crushing. Directionality could be observed, yet polish and true striations remain virtually absent, even for the jadeitite in which the crushed appearance brightens and localised ploughing occurred. The macroscopic lustre of these experiments is dull, or even altogether lacking. These characteristics set them apart from the other experiments, and must result from specific properties of the quartz arenite platform. Lacking a cooling lubricant in the interaction, its resistant matrix induced high levels of fatigue friction and prevented polish build-up. While the angular quartz grains enable the consistent abrasion seen in the directional indicators, they are too cohesive to shed much silica to the intermediate zone and too level to enable asperities to gouge the blank. A minimum tenacity of the blank matrices is probably needed to prevent outright failure of the surface, however (cf. exp. 2494). That said, this specific result is largely 'traceless', which means that the risk of equifinal outcomes from other types of interactions is much higher here than it is for the other experiments. For instance, the micrographs published by Alvarez Soncini and Mansur (2017) from grinding unidentified stones appear quite comparable. Until a broader set of experimental conditions in grinding becomes known, or new contextual data becomes available, observations of such surfaces (Sections 7.1.3, 7.2.3, 7.3.3) cannot actually infer dry ground quartz arenite platforms. Rather, such dull 'dry grinding'

surfaces methodologically signify unspecific rock types that are capable of producing the type of wear interaction described above. The absence of moisture is probably required, but as stated above the correlation is not universal.

A second, important grouping consists of microtopographies dominated by brighter and well-spread crushed grain scintillation, which retain rounded down topographical volume and relief which the scintillation invades (Figure 9, b). Such surfaces formed on the sandstone platform with poor cohesion (exp. SWH) and in the experiments in which quartz sand abrasives were added. This suggests a connection with intermediate particles rolling within the moistened flow of motion to induce fatigue crushing, their compressive load spread towards the lower surface areas on the blank. On occasion, small, bright, rough, and isolated polish structures occur. Macroscopic lustres are mostly dull to diffuse. The main difference between the respective outcomes for the sandstone and the added abrasive is that the former produced stereoscopic striations, associated either with static asperities or with the actualistic motion, and a higher sheen on the upper topography than the latter. The archaeological materials actually show greater variation in this wear trace signature than this description accounts for. There, the degree of rounding and relief, presence of striations, intensity of the sheen, granularity of the crushing, and presence of polish formation all fluctuate. This most likely relates to other minor differences in abrasives and platforms that are not reproduced by the current experiment, such as different fractions or percentages of silicate.[20] Therefore, this wear trace signature consists of a range of closely related interactions that approximate each other greatly, which I will refer to as 'sand-ground' throughout this work to facilitate comparisons. Freely moving sand particles (presently of ca. 800-1200µ) form the connecting factor in conjunction with water. Consequently, both well-adapted lithologies and quartz sand abrasives are equifinal for current intents and purposes. A better grasp on the archaeological occurrence of either is needed to further establish how the degree of technological adaptation, choices, and abilities in tool material selection interrelate in the process of grinding.

Abrasion with micro-polish development

This leaves the discussion of surfaces on which polish topographies developed. The experiments with greenschists ground without abrasives on coarse-grained sandstone or coral are techniques of very low grinding efficiency. These interactions resulted in poor levelling with a relative abundances of stone scratches and ploughed polish structures. Both resulted in diffuse macroscopic appearances that were brighter than experimental surfaces described as dull. However, they are recognisable from the erratic and interrupted gloss as inefficiently reduced compared to the other experimental surfaces. For that matter, such wear signatures have not been observed on analysed archaeological surfaces. Experiments 2782 (greenschist matrix on fine-grained sandstone) and 2513 (basaltic groundmass on quartz arenite,

20 For instance, micrographs provided by Masclans Latorre *et al.* (2017, Fig. 4c) show similar wear traces on hornfels ground on non-described sandstone, aside from minor directional polishes. Procopiou *et al.* (2011; 2013) have demonstrated strong differences to occur when polishing diasporite surfaces (a form of metabauxite) using alternate abrasives (emery, corundum) and lubricants (olive oil). Little *et al.* (2016), citing Gilhooly (2012), state that adding abrasive while grinding with sandstone is more likely to cause small chips and nicks to occur, but this may be an occurrence specific to their shale or to an incorrect handling of the edge, as no detriments of the sort have been presently observed. Granite sand and possibly diatomite were used as abrasives by the artisans of so-called Teotihuacan stone faces in central Mexico (Rose and Walsh 2016). Pétrequin *et al.* (2012a) also conducted tests using different sandstone varieties, and report that the variant most efficient in abrading produced smooth yet dull surfaces similar to some archaeological specimens. These may well correlate to the present grouping, too.

which regressed in lustre after 90 minutes of work) were brighter in lustre. They developed spatially well spread polish, but these structures remained microscopically dull and striated (Figure 9, c).

The lustres that developed on the non-regressed experiments with the basaltic and greenschist surfaces on quartz arenite with water can be described as sub-metallic, easily exceeding the light reflectance of the previously mentioned. Microscopically, the polish on these two experiments has higher density and brightness, a somewhat less rough texture, and lacks striations therein (greenschist more so than basaltic; Figure 9, d). Since these properties are all well developed they will permit more certainty in the archaeological interpretation thereof, if not in an association with (common) source rocks, then at least as them being technologically distinctive.

Inferential resolutions

Some final comments are in order on the level of inference that these experiments establish. It is clear that every unique combination of factors has the potential to result in traces of wear that are distinctive as a set, and that slight shifts in variables (reapplying water, kinematics, or adding new abrasives) can shift the outcome. However, there are also many similarities and nuances shared between more or less comparable conditions of wear. The problem of interpretation is compounded by the relatively limited set of wear trace variables that develop from stone-on-stone contact. The wear trace signature alone does currently not provide the level of precision needed to infer the exact nature of the archaeological grinding platform and additives. Interpretative uncertainty is further added by the observed regression in polish characteristics (exp. 2513), the near equifinality seen to occur between various distinct interactions (exps 2513 and 2782, and the 'sand-ground' range), and un-replicated types of wear on archaeological specimens. Many archaeological rock types were not experimented with, and for those that were fabric/texture differences will still remain; though wear develops along broadly similar lines on similarly structured matrices, at some point different mineralogical groups will differ in the result. I am well aware that some of the currently described differences in wear trace formation are basically minutiae that would not support extreme analytical precision.

However, it is certainly viable to distinguish between gross categories of traces resulting from grinding. Selective interactions can sometimes be carried further, depending on how distinctive the wear trace signature is. For instance, very close matches with the group ground wet on quartz arenite are sometimes seen from amongst the archaeological materials. These stand out from several other distinctive bright lustred hard stone contact configurations defined in sections 7.2.3 and 7.3.3 that by their mismatch indicate the potential for other rock types to be experimented with. Platforms of igneous rocks probably have the highest priority for this, due to local availability. In general, this type of approach is most promising when there are good archaeological hypotheses as to what type of abrasive technique could have been used in the past, since then selective experimentation towards archaeologically found grinding platforms can be applied. It was noted before that this type of inventory is at present not well known in the Caribbean. As such, the archaeological analyses will commonly refrain from pursuing the interpretations much beyond the level of the gross categories defined above.

5.2 Wood chopping and experiments with friction

The second aim of the experimental programme is to investigate wear from woodworking. Wood chopping forms the main theme, since the literature is not well established regarding hardwoods

exceeding a specific density of ca. 0.6 g/cm^3, and divulges little on how trace characteristics differ on percussion tools of (meta)volcanic rocks. The second focus is on friction (implied by a haft), which was primarily conducted to provide reference for certain material contacts involved in hafting arrangements.

Active contact

Wood forms a primary category of contact materials in use wear studies, grading as pliable to hard and somewhat yielding. While harder than soft organic matter (meat or hide varieties) or non-woody plants (such as cereals), it is not as stiff and unyielding as hard animal materials (bone, antler) or inorganic minerals. It is frequently experimented with and the resulting wear trace patterns in principle well known, primarily for use activities involving brittle lithic tools such as scrapers, blades, and borers. Woodworking polish on flint is considered distinctive from other primary categories when well developed, though in practice some confusion will occur due to variability in its formation *(*e.g. Anderson-Gerfaud 1981; Fullagar 1991; Unrath *et al.* 1986; Van Gijn 1990, 32). It was recognised early on that the category of woodworking traces could itself represent a spectrum between softer and harder woods (Binneman and Deacon 1986; Kamminga 1977), though the formation of distinctive trace patterns between them was questioned (Keeley 1977; Vaughan 1981; 1985).

The most consistent characteristic of microwear resulting from contact with wood is a domed topography. This term refers to the propensity of the smoothened reflective structure to form a slope or inclination over the high points of a rounded or flattened asperity. Wood polish begins as a rough development of bright peaks, often surrounded by scintillating upper slopes. It is not uncommon to find such structures distributed as interlinked nettings draped over a surface of low relief, described as reticulation (Table 4). Early stage polish subsequently progresses towards semi-smooth domes, and obtain glistening smooth textures in well developed formations. Finally, they may begin to display undulation and will ultimately cover most of the surface, as a rule highly linked (Vaughan 1985); or a concentrated and closed-connected distribution (Figure 6).[21] Pitting is typical; this essentially refers to the polish developing around various levels of interstices between peaks, specifically the intra-asperity micro-roughness relief itself. Thus a consequence of the texture of the base material during wear formation, the so-called smooth-pitted polishes are rather ancillary as they (are indeed known to) occur from multiple contact materials. Depending on how linked the polish surrounding the pits, itself a factor of the spacing of the microtopographic relief, such patterns are alternatively construed as reticulated polish areas.

These specifications are principally based upon brittle lithic tools employed in sawing and

21 Other dome-forming wear contacts exist, but the spatial distribution (extent) and texture are defining characteristics for traces resulting from wood. Antler-contact polish is often undulated, but will develop towards what is called a 'melting snowbank' texture and remain localised to the very edge. Bone working traces are flat, undulating, and have 'comet-tail' like craters, or troughs. Contact with reeds also frequently develops domed topographies but the polish is not as smooth as well developed traces from wood are, instead developing so-called 'terraced bumpy' texture distributed behind the main contact surface. The case is similar for other types of high siliceous content plants, such as bamboo (cf. Fullagar 1991). Hayes *et al.* (2018) recently published experimental data on grinding Acacia seeds on sandstone, producing polish which characteristics very similar to that resulting from contact with wood. Traces on the pounding implements used on this material are much flatter, however. It would appear that tough-shelled seeds thus produce comparable wear as wood, and as a class of contact material their stiffness is probably on the same order since they are often also composed of lignin. Still, one may wonder in which specific mode celt edges would be used on such seeds. Extensively spread bright and flat polish that approximates strongly developed wood polish is reported by Masclans Latorre *et al.* (2017) from scraping hide with ash using a hornfels celt, but the topography is strongly undulating.

scraping motions. Woodworking wear development has been documented along similar lines for percussive motions using edge-ground bifacial tools (e.g. Gaertner 1994; Olausson 1982/1983), though characteristics such as distribution and linkage develop differently under chopping motions than they do for others (Vaughan 1981, 148). Striations in polish perpendicular to the edge are commonly reported, thought to be associated with environmental particles during felling (e.g. Yerkes and Barkai 2004; Yerkes and Koldehoff 2018; Yerkes *et al.* 2014). Most experimental materials remain flint and similar brittle lithics, but an increasing number of studies now engage celt use wear on volcanic and metamorphic rocks (e.g. Aoyama *et al.* 2017; Barkai and Yerkes 2008; Binneman and Deacon 1986; Breukel 2015; Clarkson *et al.* 2017; Cristiani *et al.* 2008; Little *et al.* 2016; Lunardi 2008; 2009; Masclans Latorre *et al.* 2017; Mills 1993; Wijnen *et al.* 2018; Yerkes *et al.* 2003; 2012; 2013; and cf. Semenov 1964). The data published in these studies indicate that woodworking traces are broadly comparable on macro-lithic celts, but details often remain sketchy. The rate of edge scarring and required renewal differs from flint, with tough and comparatively coarse-grained rocks clearly being superior in this regard (Olausson 1982/1983; Pomstra and Van Gijn 2013; Van Gijn and Pomstra 2016). It appears that interpretable wear develops more slowly on them (e.g. Little *et al.* 2016), however. The experiments with hard stone grinding in section 5.1 also demonstrate how development rates and characteristics may differ between mineral groups, necessitating more work with rock types comparable to the relevant archaeological records.

The vast majority of archaeological traces do indicate contact with wood-like substances, as opposed to soilworking, butchery, and other types of contact conventional elsewhere. Since thousands of tree species occur within the circum-Caribbean, the generic inference towards 'woodworking' is not a satisfactory analytical goal. In order to create methodological resolution to go beyond the generic category, Appendix 2.3 compiles published identifications from Caribbean archaeology, ethnohistory and archaeobotany that indicate at least five major activity groups involving the felling and working of wood. Of these, the systematic clearance of plots of land, felling of construction timbers, building of canoes, and fashioning of portable objects are well-known (Section 2.3). Silvicultural practices (or arboriculture) form another major group that comprises the management of fuelwood and other woody resources (Cartwright 2018; Newsom and Wing 2004). From the review of the data, each of these groups comprises a potentially different strategy for targeting selective woods by specific technological means, or acting partially indiscriminate. In turn, these tree groups may be botanically distinguished from one another by the variable of specific density (explained in Appendix 2), which influences the formation of wear. By way of example, trees preferred for building large canoes in the ethnohistoric records are light and buoyant, with specific densities between 0.25-0.45 g/cm^3. Conversely, most construction timbers identified from fragments in post holes range between 0.7-0.9 g/cm^3 and 0.8-1.0 g/cm^3, and are known as tough and durable woods. Departing from the biography of a used tool, these activities ought to be distinguishable.

Static contact

The possibility that the act of hafting left specifically patterned traces of wear on flint had been recognised since the 1980's (e.g. Keeley 1982; Unrath *et al.* 1986), but these were never well studied. Traces from hafting became the target of systematic experimental research around the turn of the century (Rots 2003; 2005; 2008; 2010; Rots and Vermeersch 2004), and have since then been investigated for many different raw materials and tool types (e.g. Chen *et al.* 2017; Clemente Conte

et al. 2017; Gaertner 1994; Little *et al.* 2016; Lombard 2005; Pawlik and Thissen 2011; Tomasso and Rots 2017; Wijnen *et al.* 2018; Yerkes and Koldehoff 2018). Rots demonstrated that hafting traces on flint were both recognisable and interpretable, with as main characteristic the formation of pronounced bright spots caused by friction with ejected micro-chips that remain lodged within the haft. These spots are associated with scars and develop quickly, potentially distributed over large areas, and in such cases evidence the reach of the haft over the lithic surface. She investigated various hafting variables, finding that the dominant factors in the formation process are worked materials, use motions, hafting materials, and hafting arrangements. As may be expected, the wear will exhibit characteristics typical of the material from the hafting arrangement and commonly be distributed over the higher surface areas in contact. Their intensity may increase towards the medial limit, where freedom of movement is greater. Furthermore, traces from the haft are patterned variably from specific attachment systems, permitting the reconstruction thereof (Rots 2010; Rots and Vermeersch 2004).

The spatial distribution and characteristics of the various traces of wear is thus the main type of evidence needed to distinguish various systems. The primary Caribbean hafting system for celts is a lateral transversal male axe, as indicated by surviving handles and lithic skeuomorphs (Section 2.3), but variations on this theme are possible. The archaeological and ethnographic records from the tropical lowlands provide examples of wrap-around axes and abutted juxtaposed axes (e.g. Carneiro 1974; Cristiani *et al.* 2008; Fernández González 2016; Rostain and Wack 1987; Versteeg 2003; Versteeg and Rostain 1999), and notably, the addition of ligatures to male arrangements (Boomert and Kroonenberg 1977; Carneiro 1979b; Rostain 1986/1990; Rostain and Wack 1987; Versteeg 2003; Versteeg and Rostain 1999). Typological ruminations on juxtaposed adzes existing in the Caribbean were recently supported by evidence emerging from Los Buchillones, which also indicate the use of bindings, wrappings, or ligatures (Section 2.3). Cotton is considered to be the most conventional stringing material in the Greater Antilles, but both agave fibres (Agavoidea) and grasses have been recorded as cordage by late 15th century observers. Indeed, analyses of fibrecraft indicate complex spinning traditions utilising a wide variety of raw materials (Ostapkowicz and Newsom 2012). Many palm trees are a source of strong fibres, and certain liana can probably be used as well. Bark strips from maho/mahaut are known from 17th century descriptions in the Lesser Antilles (see Lammers-Keijsers 2007, 34), and such bindings were used to good effect during the *tabouï* reconstruction project. Clearly, ligatures are a distinct biographical possibility even when not functionally critical, and different types of contact materials could have been used to fasten a celt. Expectations for how the main types of hafting arrangements would produce specific patterns of wear were formulated in section 4.1.3, and will be illustrated from archaeological finds in section 7.1.4. The present experiments serve primarily to assess wear from different potential hafting materials in order to distinguish types of contact on a rock type relevant to the present study, in order to verify asymmetrical wear distributions on archaeological specimens.

5.2.1 Experimental conditions

The wood chopping and friction experiments number ten in total. Six of these were carried out under the same experiment number (2550) in succeeding stages and four more were set-up and conducted in the field in the summer of 2016. Two main types of wear contact were replicated: 1) use (repeated percussion) and 2) hafting (localised sliding friction). The goal was to obtain a sequence of wear traces resulting from the use on tropical hardwoods of higher hardness and specific densities than reference

collections built around temperate materials could account for. A house reconstruction project in St. Vincent, February 2016, provided an actualistic environment for experimentation with the stone axe head manufactured for this purpose.[22] The later field experiments pertain to controlled interactions simulating friction from several types of hafts, primarily aiming to improve the interpretative resolution during that campaign (see Section 5.2.1.2).

5.2.1.1 Wood chopping experiments

The principle aim of the heritage outreach project at Argyle, St. Vincent was to rebuild a historical Kalinago *tabouï* (men's house) following the floor plans recovered during the excavations five years earlier (Hofman and Hoogland 2012; Hofman *et al.* 2015; Hoogland *et al.* 2011). The project used a variety of different timbers (and other resources) in seeking to strike a balance between woods named in ethnohistoric sources and recommendations from experienced local constructors. In general, these were forked trunks of young trees which had developed little heartwood. The construction materials were supplied to the project by the St. Vincent Department of Forestry. Due to delays between the time of felling and delivery, the trunks had on average lain in the sun for one to two days, with a few up to five. Both posts and beams needed to be cut to the correct size and the forks shaped, which amounted to one medium-sized and two small-sized circumferences to be cut from each trunk (ca. 8-12 cm and 3-7 cm respectively). Most of this work was carried out using steel axes and machetes due to time pressure. Thin mahaut/mahot poles were used for creating the rafters, battens, and the ridgepole, but were not extensively experimented with as they required little shaping time. Mahaut bark strips and catclaw were used for fastening the construction elements, but were easily split using both lithic and modern knives and required no other tools (both names could indicate a variety of unrelated species). Roseau reed was used as roofing material, which was collected and processed using shell adzes and steel machetes.

I used a single stone celt head during the construction programme, manufactured specifically for this project (exp. 2550). It is made from a medium-grained greenschist facies rock with a heterogeneous matrix, including partially formed quartz crystals, and weak layering that was obtained in the Dominican Republic by G.R. Davies and A.C.S. Knaf. The availability of suitable raw materials precluded the manufacture of additional experimental tools; the multiple experiments mentioned throughout this section refer to distinct phases in the experimental biography of exp. 2550 as recorded by casts. It was hafted as an axe and this arrangement was maintained throughout the experiments (Figure 10).

The chopping experiments can be divided into two setting. The first setting comprised full participation in the construction process, in which trunks of mahogany (*Swietenia mahagoni*) were cut to the requisite sizes. Following the recommendations of local collaborators on the longevity of the structure, the project switched to galba (*Calophyllum brasiliense* var. *antillanum*) and waterwood (*Chimarrhis cymosa*) for the final load-bearing posts. These were worked the same way. Upon completion of the building requirements, left-over trunks were further chopped into pieces to record

22 The opportunity also arose to obtain a set of impressions from an ethnographic implement, used by a member of the resident Kalinago community during a canoe construction project in 2007. This was a large notched basalt axe, set in the cleft of a short shaft partially split into halves and bound with coarse ligatures. Originally an archaeological object found lying in the fields, this axe was resharpened using a metal grinder and subsequently used to initiate the felling of a Gommier tree (*Dacryodes excelsa*). Unfortunately, the analysis of these casts failed to produce wear traces that corresponded to the cutting of the wood.

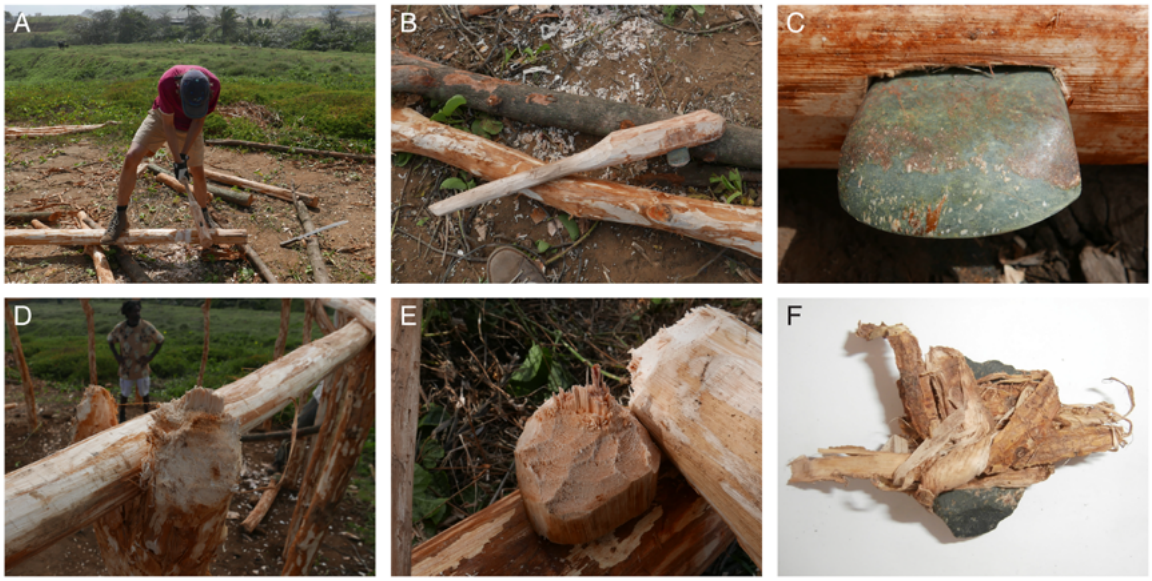


Figure 10: Photos of various experiments. A) Wood chopping, bringing a log of mahogany to size. B) Axe head 2550 hafted in a mahogany handle. C) close-up. D) Resulting chopping marks on a fork of mahogany in the first days. E) Resulting chopping marks on a pole end of galba. F) Bark bindings applied to exp. 2554.

additional time on the experimental tool for these woods. The chopping motions comprised vertical swings, with the post lying down on a rest suspended above the floor. Both Spanish ash (poss. *Inga laurina*) and angelique (*Dicorynia guianensis*) were worked for a few minutes at the beginning of the phase with galba and not counted separately due to insufficient time of contact. Construction work had finished during the second setting and the experimental activities were reoriented towards the harvesting of trees growing around the experimental site. Trunks of fresh and dry seagrape (*Coccoloba uvifera*) and fresh bleary cedar (*Prosopis juliflora*) were felled, which due to the gnarled woods of the selected specimens also comprised vertical chopping motions.

An activity log detailing the experimental programme is available in Appendix 2.1. Thirty-one tasks were completed with exp. 2550, amounting for a total of ca. 10 continuous uninterrupted hours of woodworking contact. The first chopping experiments with *S. mahagoni* were conducted by Finn van der Leden, an inexperienced student attending the project, previous to my on-site arrival. These account for a significant time of working on mahogany, but resulted in very little wear (Appendix 2.2). Thereafter all experimental tasks were performed by myself, having reasonable experience in handling stone axes though no particular expertise therein (cf. Figure 10, d, e). In order to retain comparability, I made effort to select diameters predicted to end each phase of contact with a specific wood type at around 90 minutes. Upon conclusion, the axe was washed to remove woody tissues, resins, and soil particles and casts were taken from the bevels on opposing sides (*S. mahagoni* forms the exception for the aforementioned reasons, resulting in use intervals of 30, 125, and 195 minutes). Casts were also taken after breakage of the hafts and when switching from fresh to desiccated wood. Upon laboratory analysis several of the casts proved to contain large deposits of grease, which on some persisted after multiple alcohol-based cleaning episodes. This often hindered the observation of wear, and prevented a detailed characterisation of the wear traces for fresh *C. uvifera*. Other casts were not affected, in particular the desiccated *C. uvifera* and difficult to penetrate *C. cymosa*, suggesting that adhesion wear of saps naturally present in greener wood may have been responsible for the formation.

The properties and suitability of the five main woods are further described in Appendix 2.2 and 2.3. All rank as tropical hardwoods with specific gravity ranging from 0.6 to 0.8 g/cm^3, varying in toughness and moisture content. They do not approach the hardness of extremely dense woods such as lignum vitae (*Guaiacum officinale*) and ironwood (a.o. *Krugiodendron ferreum*), but they are clearly denser than temperate woods. By comparison, the specific gravities of temperate willows (*Salix* spp.) range from 0.28 to 0.42 g/cm^3 and English oak (*Quercus robur*) reaches only 0.5 to 0.6 g/cm^3. Extremely hard wood such as ironwood was available only in seasoned state, much too hard and resistant to work with stone, shell, or even metal tools. The majority of experimental contact time was with sapwood, as a result of the size and maturity of delivered trunks, though always ending against the heartwood core. This likely impacts wear traces since heartwood is generally denser (Woodcock and Shier 2002) and contain different quantities of resins, oils, and tannin. Similarly, the *P. juliflora* experiment cut into reaction wood, which means that the percentage of lignin and cellulose will be somewhat different from ordinary sap/heartwood. A desiccated off-shoot of *C. uvifera* was cut to register its wood in a different state, but otherwise no seasoned (and soaked) or charred woods were worked either. These factors constrain the present inferential resolution and need to be addressed in future experimental research.

5.2.1.2 Hafting and friction experiments

Experiment 2550 was continuously hafted during the actualistic experimental series described above, in a perforated male slot of an embossed *S. mahagoni* shaft. This hafting system can be defined as lateral-transversal direct parallel-male (Figure 4), appearing embedded but with the butt not in contact with wood. As described in section 2.3, this is the basic type of handle known from the Caribbean. Three hafts were used in total due to breakage along the grain of the wood, all made from fresh mahogany segments not used in the construction with a suitable thickness for the embossing. The handle was first cut to size and a perforation was then chiselled which would hold the axe head by its side aspects, leaving the face aspects mostly free from contact (Figure 10, b-c). This design prevents the thinner wood from breaking in this area. Mahogany proved an effective wood for this purpose for various reasons. Not only is it easy to shape while in a fresh state, it does not split after drying due to its dimensional stability, and continued to absorb the shocks of the percussive activities well. Coeval with use, the experiment recorded ca. 10 hours of uninterrupted use-related friction. However, the axe remained lodged within its haft for nearly two full weeks and was continuously handled and transported over this period.

Beyond this experiment, four expedient experiments were conducted during research in June 2018 to address concerns on the interpretability of certain wear traces that rose in the field. Limitations in time and opportunity confined the ability to experiment with various lithic materials vis-à-vis hafting systems, which is why these options were investigated by simulating friction from specific contact materials through controlled interactions. As such, surfaces were subjected to arbitrary friction in a similar set-up as the grinding of material blanks previously. First, several flakes were struck from a fine-grained volcanic lava cobble with greenschist facies overprint. Five flakes were ground dry for 30 minutes against a dissimilar fine-grained volcanic rock in order to level down the asperite ridges, one set aside as referent for the manufacturing traces. These surfaces consisted of smooth, slightly striated plateaus with rough interstices lacking evident polish and displaying slight scintillation from grain crushing.

Four different contact types were then reproduced on these blanks: prehensile wear (exp. 2551), seasoned wood (exp. 2552), soaked wood (exp. 2553), and bark bindings (exp. 2554). Prehension is a suggested hafting style for certain stone axe typologies in the region (Rostain and Wack 1987; O'B. Harris 1981; Roth 1924, 73-74), while non-haft handling is a distinct biographical possibility in other itineraries. Ethnographic research has observed both the polishing of stone axes by hand contact (Boleti *et al.* 2015) and the long-term accumulation of prehensile contact in valued gift exchange (Pétrequin and Pétrequin 2011). As the latter is also hypothesised for the present archaeological context, handling wear needed to be taken into consideration. Exp. 2551 was submitted to constant prehensile interaction, clocking two episodes of 60 and thereafter 75 minutes. Prior experiments on fine-grained hard rocks have suggested this timeframe to suffice for incipient development of a greasy and invasive polish that rounds the asperities and covers the topography completely (Breukel 2013). Experiments 2552 and 2553 simulated the short heavy blows and wrenching that a surface is modelled to undergo in a haft through fairly intense pressure contact for 30 minutes each, occasionally twisting the flake. A sun-dried sliver of local *P. juliflora* was used in exp. 2552, given the expectation that the wood of a handle will season over time, contrasted by a soaked sliver of the same material in exp. 2553. Finally, exp. 2554 was a pointed flake around which wet strips of bark from *P. juliflora* were bound and left to dry, periderm to the inside (Figure 10, f), It was subsequently used for 60 minutes of direct percussion impact against a wooden surface while held only by the bark.

5.2.2 Analysis of results

The chopping experiment proved successful. The working of the main timbers was relatively feasible, with *C. cymosa* and *P. juliflora* being somewhat tougher to cut into than the other woods. Little wear is visible by stereomicroscope, including almost imperceptible dulling and only a single instance of barely visible micro-retouch registered after chopping desiccated *C. uvifera.* Manufacturing striations were gradually erased, but not replaced by use striations except occasionally under high magnification. This pattern coincides with Mills' (1993) observations on experimental woodworking, and separates it from his underbrush clearing and soilworking which led to significant surface striations and heavy degradation of edge sharpness. Similarly, experiments conducted in the Netherlands in recent years (Pomstra and Van Gijn 2013; Van Gijn and Pomstra 2016; Wijnen *et al.* 2018) showed little to no macro-wear on quartzite and basalt axes, even after periods of prolonged use. Probably, the rounding and strong micro-chipping reported on macro-lithic percussion tools used on green wood by other authors (Lunardi 2008; Masclans Latorre *et al.* 2013) relates to unforeseen flaws in the material of the celt head, or an incorrect handling of the tool.

Microscopically, however, a clear sequence of traces of wear has developed from use, gradually erasing previous traces from manufacture on the bevel (Appendix 2.2). These remained spatially consistent throughout and are concentrated on the centre of the edge and bevel, extending up to ca. 5 mm inwards and fading out towards the lateral sides. This limited distribution probably corresponds to the restrictive set of chopping motions as a constant parameter (as opposed to e.g. felling, carving, hollowing, or harvesting). The other areas on the bevel had barely come into contact with the wood as it was being chopped out of the trunk, and showed only scant traces of wear from occasional overstrikes. The microwear differs from phase to phase in a way that is not merely a successive increase, but entails the fluctuating emphasis of specific micro-characteristics (Tables 3 and 4). The weaker development of traces from use contact with *S. mahagoni* may perhaps be ascribed to being first in this

sequence, though the slow pace from the wood is echoed in the underdeveloped wear from the haft. Finally, the sharp corners bounding the sides developed interpretable wear, but since this morphology is unusual for Caribbean materials it is not further considered as potentially indicative for specific chopping activities. Bands of wear traces also formed on the location where the bevels graded into the faces, since these areas accumulated macroscopic deposits of woody pulp during the experiments.

The effective resolution obtained from the hafting experiments varied. The actualistic experiment (2550) barely developed traces of a haft. This stands in stark contrast to the aforementioned experiments conducted in The Netherlands, where polish indicating friction with wood developed quickly and very strongly on its hafted axes and adzes (Wijnen *et al.* 2018). Conversely, the controlled simulations all resulted in traces of wear on the areas of the surface under load, including macroscopically observable changes for prehension and contact with bark. All four are distinct, emphasising that different parts of a wood, and the different states in which they enter contact, thus also lead to different microscopic characteristics.

5.2.2.1 Wear from tropical woodworking

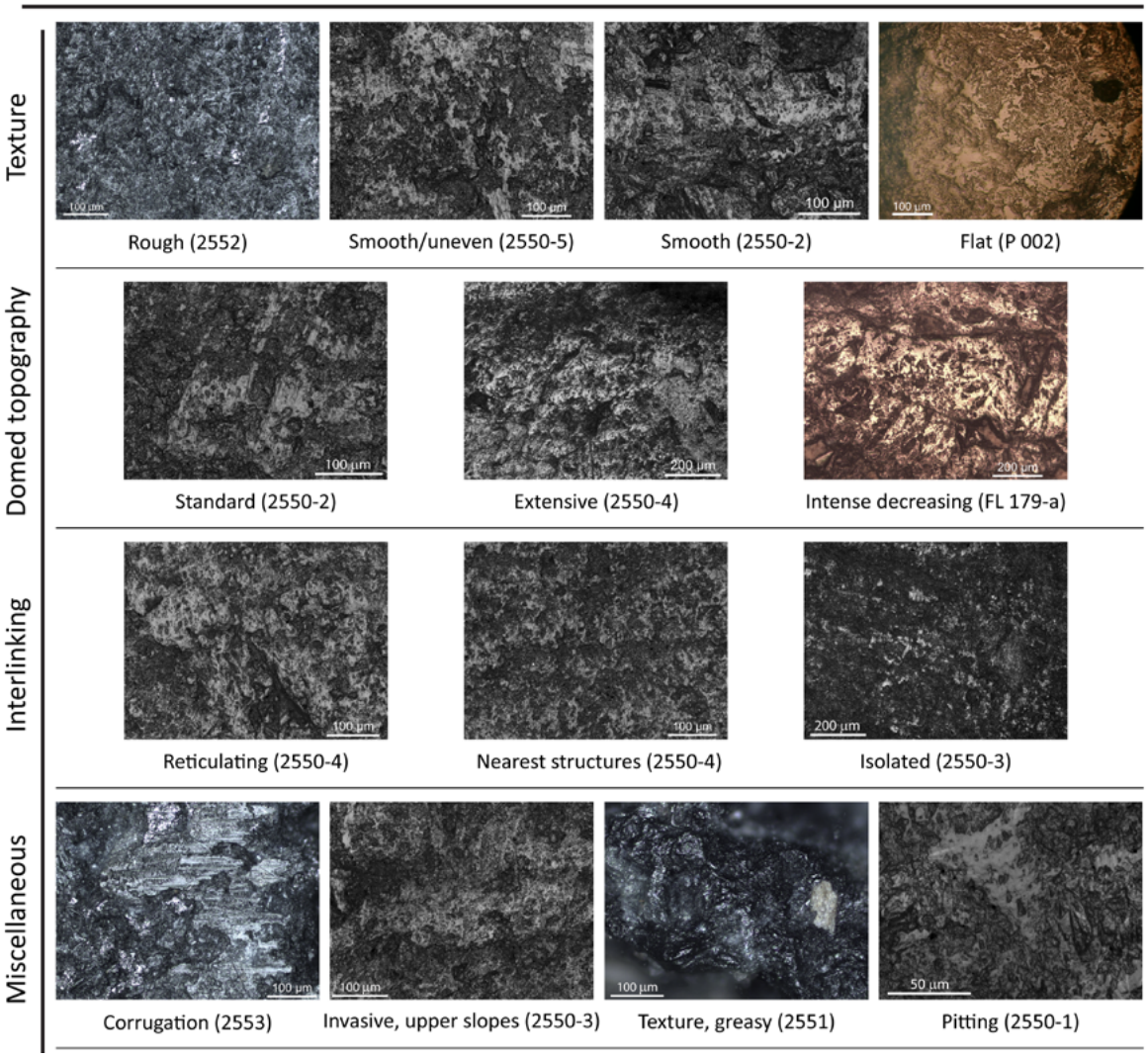
The experimental sequence of 2550 indicates contact with different woods results in differences in the development of wear. The initial trend is towards a higher density and linkage between polish, and to a lesser extent towards more extensive pitting and invasiveness of the upper slopes (Figure 11). The hardness of these woods induced little invasiveness overall, though clearly lowering topographical relief so as to permit linkage and reticulation, and the average texture is uneven nearing smooth. However, most characteristics of the polish fluctuate with each moment of observation. The size, texture, and brightness of polish structures all vary and topographical characteristics such as doming and density can clearly regress. The hardness of the wood species does not show an obvious correlation with particular tendencies in the trace variables, as they are fairly comparable. Moisture content appears to be the main factor instead, as long as the motion remains constant (chopping).

The first two wood species, galba and mahogany, were cut relatively fresh yet diverge somewhat in working properties. Galba produced wear traces more rapidly and extensively than the other wood species, resulting in mostly smooth textured domes in which occasional corrugation is present (Figure 11, b). This latter characteristic did not form in any other experiment besides 2553 (friction on soaked cambrón), but the distribution of polish is in most cases directional. Mahogany produced few traces of wear and fewer polish still with sufficient development of characteristics typical for contact with wood, being a semi-smooth and somewhat domed texture with some pitting. Conversely, waterwood was sundried for up to a week and one seagrape stem was desiccated. The former topography had lost doming and regressed in polish distribution and interlinkage, while the texture had become brighter, smoother, and occasionally undulating. The traces from chopping the desiccated seagrape were brighter still while remaining comparable in texture and invasiveness, though its polish is much denser with a reticulating and extensively domed topography (Figure 11, c, e). These latter characteristics may have partially carried over from the felling of green seagrape that separates the phases, however. Pitting is less prevalent for either than it was or again becomes for the other wood species. Both experiment phases were followed by green tree-felling, fresh seagrape in the case of waterwood and bleary cedar in the case of desiccated seagrape (Figure 11, d, f). The main correlation between those woods consists of a domed topography with a high density of well linked and relatively invasive polish, but with diminished directionality/striations and an uneven to rougher texture. The size of individual polish

Table 3: Main variables of experimental woods and resulting characteristics of experimental wear polish.

Experimental parameters					Observed wear trace characteristics							
Wood species	**Specific densities**	**Hardness**	**Texture**	**Time (minutes)**	**Polish texture and topography**	**Pitting**	**Invasiveness**	**Direction**	**Structure sizes**	**Linkage**	**Density**	**Brightness**
Swietenia mahagoni	0.75	Moderate-hard	Medium, grain varies	125	Occasionally domed, smooth but uneven	Dismissable	Not observable	Striations	Small	Nearest structures	Isolated, dispersed	Dull (albeit greasy from residue)
Swietenia mahagoni	0.75	Moderate-hard	Medium, grain varies	195	Domed, smooth but uneven	In the larger patches	Upper slopes, occasionally (grease)	Striations, directionality	Small-medium	Nearest structures	Isolated, but more frequent	Medium
Calophyllum brasiliense var. *antillanum*	0.5-0.7	Hard	Medium, interlocked	90	Domed, smooth	Present from interlinking	Slopes	Corrugated, striations (occasional)	medium	Inter-connecting	Fairly even, fairly dense	Dull-medium
Chimarrhis cymosa	0.71	Medium-hard	Coarse	90	Barely domed, smooth	Present from interlinking	Upper slopes	Striations, undulation (occasional)	Small	Little	Fairly even, spread out	Medium-bright
Coccoloba uvifera (green)	0.7	(Very)-hard	Coarse, close-grained	45	Semi-smooth to rough, strong dome	Present	Appears to slopes fairly well (grease)	Absent, slight direction	Small	Well developed	Appears spread, fairly dense (grease)	Medium-bright
Coccoloba uvifera (dry)	> 0.7	Very hard	Coarse, close-grained	45	(near-)smooth, strongly domed	Minor	Upper slopes	Variable	Medium-large	Well-developed reticulation	Dense, clustered	Bright
Prosopis juliflora	0.75-0.8	Moderately hard	Medium-coarse, wavy-straight	90	Barely domed, smooth but uneven	Present	Upper slopes, occasionally (grease)	Directionality occasionally	Small-medium	Well-developed reticulation	Dense, covering	Dull-medium
Prosopis juliflora (soaked, exp. 2553)	< 0.75-0.8	< Moderately hard	Medium-coarse, wavy-straight	30	Large, smooth	Extensive in reticulations	Invasive	Clear, corrugated	Up to very large	Strong	Dense	Medium or dull
Prosopis juliflora (sundried, exp. 2552)	> 0.75-0.8	> Moderately hard	Medium-coarse, wavy-straight	30	Rough, rare isolated bright domes	Little	Upper to lower slopes	Slight	Very small	Complete, but domes are isolated	Very dense	Dull

Table 4: Atlas and nomenclature for experimental wear trace characteristics relating to use conditions for percussion contact against fresh felled woods.



Texture variables refer to the polish, and doming refers to the topography. Both of these variables grade into one another. Interlinking is a feature of the topography, whereas the remaining characteristics are separate variables that may co-occur independently of other characteristics. Invasiveness from wood contact refers to the propensity for a rough, duller polish to cover the elevations below bright polish, of which an example covering the upper slopes is given. For examples of variation therein and characteristics such as striations in polish that also commonly affect wear from contact with wood, see Table 2.

structures also diminished for bleary cedar, in spite of the overall density thereof.

Juxtaposing these wear microtopographies against what is known from the literature results in three conflicting models for distinguishing woods on the basis of their 'hardness'.[23] The first model is that the pace of wear formation may differ, but the resulting traces are not discriminant towards particular hardness categories (Keeley 1977; Vaughan 1985). This position is not supported by the results of this study, since the formation of woodworking wear is not a linear progress towards

23 On edges of flint, the scale of micro-retouch would provide a basis for a general ranking of hardness (Odell and Odell-Vereecken 1980), but this variable is of less interest for macro-lithic celts. It was described previously how the experimental literature is variable in the resulting damage on celt edges, which may have more to do with skill levels and material flaws than with hardness of the wood.

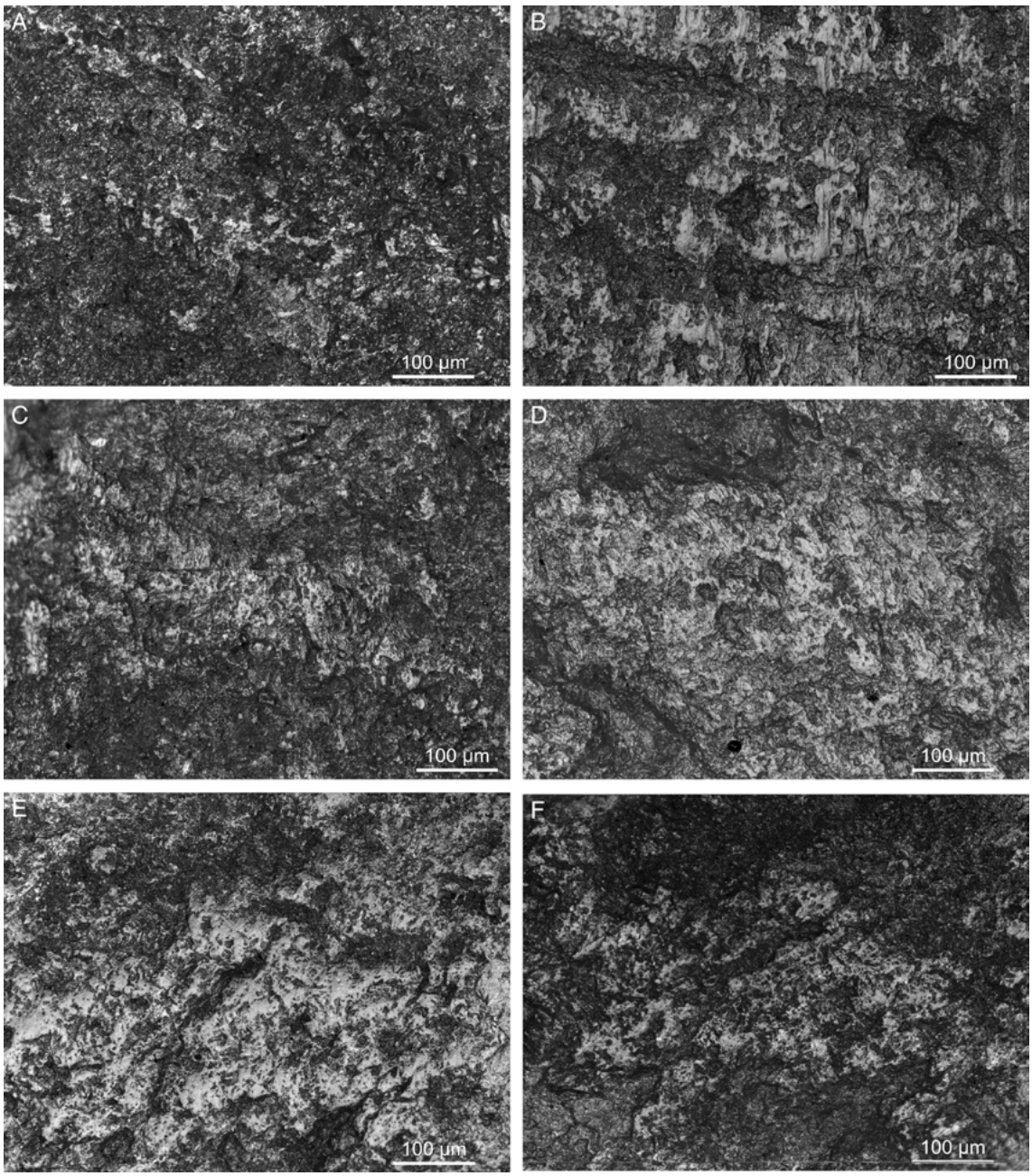


Figure 11: Sequence of polish areas with strongest development from wood chopping on experiment 2550 at each interval. A) *S. mahagoni* (195 minutes). B) *C. b.* var. *antillanum* (90 minutes). C) *C. cymosa* (90 minutes). D) *C. uvifera*, green (45 minutes). E) *C. uvifera*, desiccated (45 minutes). F) *P. juliflora* (90 minutes).

smoother, denser, and flatter polish but subject to the properties of the wood being chopped. Factors such as moisture (and theoretically, heartwood extracts) also clearly play a role therein, but cannot understate the combined set of mechanical properties governed by the specific density variable (itself a factor of moisture content in real time – Appendix 2).

The second model holds that chopping harder woods result in polish that is glossier (very smooth and bright) and less invasive, with the upper topography mostly flat and few domes, and the lower topography unaffected. This is consistent with the results published by Masclans Latorre *et al.* (2017) conducted with an eclogite axe on *Quercus ilex* (0.82 g/cm^3, n=1), since their depth of penetration into the wood renders the suggested interpretation of contact with bark implausible. The idea is that

the higher hardness of the contact has reduced impact on topographical valleys, while affecting the asperite points quite strongly. I favour this model for the brief but intense frictious contact that the micro-topography undergoes when penetrating hard woody tissues in chopping motions with edge-ground tools. The third model is that polish resulting from hard woods is much rougher than that of soft woods, and less clearly developed overall due to increased stress upon the micro-topography. The smoother brighter spots with topographical invasiveness are assigned to soft wood contact (e.g. Kamminga 1977), closer to siliceous plant polish in terms of hardness category. At present, the medium-hard wood species generally produced uneven to smooth polish, contradicting this model. If the results published by Fullagar (1991) are converted to the specific densities of those woods in Zanne *et al.* (2009), the published micrographs and few results on sawing green woods appear to support the third model. His dataset is larger on the scraping of both green and dried woods, and resulting polish rankings of intensity and extent are higher for wood species with higher specific densities, thus more congruent with the second model (on his principle variable of silica content, see Appendix 2).

Both models are near diametric oppositions in which end of the spectrum of wear traces from contact with wood they assign towards harder and softer contact materials. Moreover, these categories could still be construed as over-development and under-development of 'standard' wood contact traces, which vary considerably anyhow (Van Gijn 1990; Vaughan 1985). It is probable that differences in the experimental impact of motions, skills, and activities have influenced the formation of traces unto different trajectories as well. In line with section 5.1.2.2, these trajectories are further liable to experience some differentiation based upon the material of the tool, with interpretative nuances derived from flint not necessarily transposable on volcanic and metamorphic rocks.

The best information thereon is available for the state in which the wood was worked. Binneman and Deacon (1986) link fresh wood chopping with greasier, brighter, and more densely linked polish structures, whereas dull and rough textured polish resulted from working dry wood. The data in Fullagar (1991) contain similar discrepancies in the intensity and extent of polish between scraping green and dry woods. Binneman and Deacon (1986) also experimented with charcoaled wood, of which the resulting polish was much rougher, more pitted, yet less striated, and developed over larger areas spreading to the lower topography. In contrast, Gaertner (1994) describes contact with charred wood as closely resembling contact with regular wood, except with pronounced undulation and black micro-inclusions assumed to be incorporated charcoal residue. The adzing of charcoaled wood also left charcoal residue in experiments conducted by Yerkes and colleagues (in Yerkes and Koldehoff 2018), and both deep and pronounced striations in the polish. Striations and directionality in wood chopping traces seems a contentious point more generally, since if not associated with underbrush clearing (e.g. Mills 1993; Yerkes *et al.* 2012) they frequently originate with artificially introduced grit to simulate 'environmental particles'. These striations are not nearly as ubiquitous during regular actualistic work, including the present study. Most polish orientation in my results consists of topographical directionality and probably originates with the friction contact itself, though it was admittedly extremely variable.

Ultimately, the evidence has been seen to support conflicting interpretations at times. It appears clear that wear from softer contacts and harder woody contacts does differ, as does wear from wood in alternate stages, but except for charcoal residue no variable is overwhelmingly diagnostic. Still, the archaeological materials are characterised by a series of traces inferred to result from working tropical

woods that is best characterised as a spectrum of wear. Some parts thereof match the present experimental results well, some exceed them in many characteristics, while others fail to reach them or comprise different combinations altogether (Chapter 7). I will base my interpretations of the archaeological wear on differentiating these broad groups of woodworking wear based upon their correlation with the variables obtained experimentally, i.e. working tropical woods with average specific densities of 0.6 to 0.8 g/cm^3. Wear trace signatures that are exceedingly flat, glossy, and dense are provisionally interpreted as resulting from contact with wood above that specific density range. Signatures that remain invasive or follow topographic relief more generally are provisionally interpreted as resulting from contact with wood below that range. Above all, these groups are hypotheses made in order to deal with the range of variety vis-à-vis other contact materials, and need to be tested, confirmed, and expanded in future undertakings. It is not implausible that these assertions will require adjustment in the future. Even so, the archaeological artefacts contain large differences in their traces of wear even when retaining an overall 'woody' character, and as the primary source of data this spectrum needs to be dealt with. Later on, I will propose to designate artefacts with specific use wear signatures towards some of the major activity groups, in conjunction also with data on hafting and morphology (Section 10.2.4). The aim is to demonstrate the interpretative value in establishing links between specific tools and particular tasks, but these designations are acknowledged to remain contingent upon further work with various tropical woods.

5.2.2.2 Inferring static friction

Concerning hafting, the spatial association of traces continues to be the main line of evidence. For edge-ground macro-lithics, these primarily comprise friction traces from wooden rests and/or flexible bindings located in specific spatial configurations towards the distal portion, and adhesive residues concentrated in these locations. Scarring is much reduced on celts, in spite of emphasis on its importance (Section 5.2), though frequently described 'impact use wear' on butts could originate with repeated impacts against the stopping ridge of an adze handle instead (cf. Rots and Vermeersch 2004). Grain ejections will be restricted or absent altogether. Striations caused by these may remain, but simple bright spots (highly bright, flat, and non-invasive localised polish spots) are much rarer on Caribbean macro-lithics than in comparison to flint-based models.

The wear traces will commonly indicate the type of contact material of the haft, usually seasoned wood friction in Caribbean contexts. However, these traces are not always clearly developed and need to be distinguished against the background of manufacturing traces. Following the experimental results of this study this may in fact be problematic. Exp. 2552 produced friction traces which would be difficult to distinguish from manufacturing modifications leaving a brighter scintillating surface, such as 'sand-ground' wear (Section 5.1.2.3). Exp. 2550 developed hafting wear at a very slow pace, possibly attributable to its uncharacteristic morphology or a particularity with mahogany wood. Asperite polish was not generally distinctive in these, exempting the experiment with soaked cambrón for which no archaeological correlates were found. At least for the friction experiments it may be assumed that the duration fell short, since hafting traces are known to develop extensively in actualistic experimental contexts.

As such, these experimental traces provide a relatively poor resolution for inferring specific contact materials, but this is of little interpretative hindrance. Eventually, typical mature polish structures such as they are known from use will develop (Little *et al.* 2016; Rots 2010; Wijnen *et al.* 2018), and

early stages thereof were observed on exp. 2550. Different materials are sometimes distinguishable in this way and will give a better idea of the type of articulation and indirect fitting. Altogether, these characteristics provide a sufficient resolution on hafting systems for celts with their posterior portion left intact, and can permit distinction of hafting traces versus manufacture for fragments.

5.3 Experimental shellworking and boneworking

The paraphernalia comprise a large variety of materials and morphologies. For the purpose of manufacturing them they can all be considered as carved objects. However, this general term conceals a wide range of different techniques involved in the production of the engraved, perforated, and smoothened surfaces observed on them. Traditionally, such techniques are considered to utilise flaked lithic tools and abrasive macro-lithic platforms. Nevertheless, there much opportunity for choice within these typical categories, and ample ethnographic documentation of alternatives to these tool materials, including widespread utilisation of organic tool materials. Previous experience, cursory examination of the present materials, and the lithic-poor impression of the Hispaniolan sites all express the need to take a wider range of possibilities into account.

A number of experiments have been conducted to address this need. The conduct and wider context of these experiments has been described in several publications before, since they form a reference library for circum-Caribbean ornaments and decorative stoneworking (Breukel and Falci 2015; Falci 2015a; 2015c; Falci *et al.* 2017b). Briefly, they were all oriented towards accomplishing a specific task, such as placing a decorative perforation on an abraded surface. Rather than attempting to recreate artefact forms, we instead aimed to reproduce a variety of suggested technologies to obtain corresponding traces. The materials which were worked and are pertinent to this study include *Lobatus gigas*, *Spondylus* sp., *Oliva* sp., and *Bos taurus*. Nine incision experiments were conducted using fine-grained flint flakes on the selected raw materials, and fifteen used wood, bone, mollusc shells, and animal teeth as organic tool materials. Seven drilling experiments are included using similar tool materials, and the outcomes of four experiments grinding shell on *Acropora palmata* and sandstone are briefly described. Details are provided in Appendix 1.2, Table A1. It is of course impossible to satisfactorily address all combinations that are possible. Incision experiments using bamboo and shark teeth, or drilling with hollow reeds and fish spines are conspicuously absent in this regard, as are abrasive files. Published trace characteristics of such techniques are reviewed for comparative purposes.

5.3.1 Engraving with lithic tools

Angular lithic blades operate through a sharp edge obtained by conchoidal flaking. When employed in back-to-forth cutting the cut-marks incline to grooves with a V-shaped profile and internal striations, stepped if retouch is present (Fisher 1995). Experiments were enacted to confirm this basic model for Caribbean local materials, and thereby obtain on-hand reference materials for analytical comparison. The selected tools were unretouched flakes knapped from mostly medium to fine-grained flints available to the Laboratory, primarily the Rijckholt variety from the southern Netherlands.

The experimental results produced smooth, near V-shaped grooves which are relatively uniform across the incised materials. Obviously, this is because the hardness of flint (ca. 7 on Mohs' scale) far outweighs that of the other materials, so that the groove models after the shape and angle of the lithic edge. The morphologies are sharply defined for cutting motions and develop towards steep-

walled grooves with a narrow bottom for back-and-forth sawing (Figure 12). The internal surfaces consistently displayed fine striations.

These results are well within the range of flint-derived incisions reported in the literature. The most extensive body of data derives from studies experimenting extensively on bony tissues in order to distinguish lithic cut-marks from grooves made with metal (e.g. Boschin and Crezzini 2012; Greenfield 1999; 2002; 2006; Krasinski 2018; Olsen 1988). These studies are not entirely comparable since they are butchery studies which ideally reproduce single motion cut-marks by raking a bone while slicing fresh soft animal tissue. Nevertheless, they are pertinent for the bone-cutting experiment (Figure 12, b) and for awareness during the analyses of the carved bone objects later in this chapter. Compared to flint, metal-made cut-marks are narrower, have steeper and regular walls with flatter bottoms, and usually lack ancillary grooves (striations on the walls). However, metric studies indicate a range of overlap in the outlines which completely encompasses metal-made grooves, assessing differentiation of the two to be contingent on multivariate morphometrics on the assemblage level. Different bony structures (density, lamellar versus spongy) proved to make a difference at this level, but are subordinate to the variables of the cutting implement (Boschin and Crezzini 2012; Krasinski 2018; see also Val *et al.* 2017).

A related line of research is to distinguish different lithic materials and retouched from unretouched tools (e.g. Greenfield 2006; Val *et al.* 2017; Velázquez Castro 2012; Wright *et al.* 2014). Retouched edges differ from unretouched materials in groove symmetry and stepping, but are not common in Antillean assemblages (Knippenberg 2006; Rodríguez Ramos 2007). The pattern and dimensions of microstriations (sub-µm) within the groove have the potential to distinguish cherts from sharper obsidians, which relates to differences in granularity. While more promising in light of potential coarser lithic tools such as the flaked volcanic rocks at El Flaco, there appear some methodological difficulties. The reported metrics do not take into account the relationship between the groove and differing tool morphologies/edge remodelling during use. As will be elaborated below, the outline of incision is largely dependent upon the angularity of the particular edge, and less useful for defining material characteristics. Furthermore, field limitations and erosion on the hard animal objects both prevented the observation of microstriations more generally. Conversely, the material properties of the different blank materials do not seem to significantly affect the groove they receive. Velázquez Castro and Melgar Tísoc (2014) see little difference between experimentally sawn blanks, nor were indicative characteristics recognised in the present study.

Angular edges are the primary, but not the only possible lithic cutting tool. Other potential techniques include using quartz and agate crystals (British Columbian

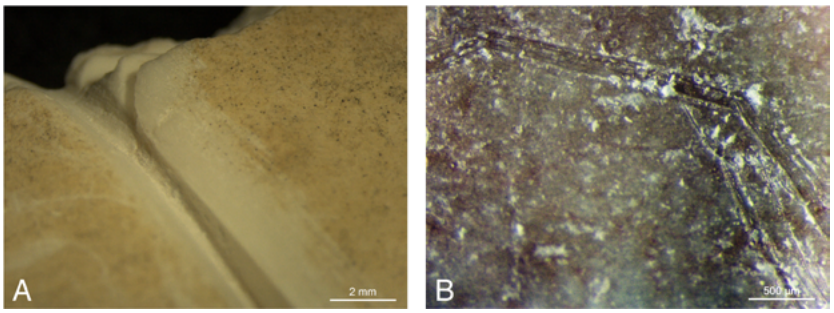


Figure 12: Incisions with flint. A) sawing a *L. gigas* lip. B) single cutting motion on *Bos Taurus* longbone.

ethnohistory, see Darwent 1998, 32-34), or the mounting of circular abrasive saws or blanks on rotary lathes (Mesopotamia and China, e.g. Sax and Meeks 1994; 1995; Sax *et al.* 1998; 2004). However, the main alternative is sawing or filing with thin sheets of laminated sandstone or similarly performing rock types, such as slate and quartzite (Attenbrow *et al.* 1998; Beck and Mason 2002; Kelterborn 1991; Sax and Ji 2013; Sax *et al.* 2004; Smith *et al.* 2015; Velázquez Castro *et al.* 2006). A wide variety of hard materials could be sawn using such implements, from shell and bone to serpentenite, fibrolite, and jadeitite. Though infrequent, there are occasional identifications in the Caribbean both of such tools (Drewett and Cartwright 1991; Drewett and Harris 1987; Rostain 1997, 241-242; Section 6.2.5) and of materials sporting elongated – sawn – grooves (Antczak *et al.* 2018, Fig. 2; Rodríguez Ramos 2010). Depending upon the intent, ceramic fragments may also be considered as having certain technological capabilities (Van Gijn and Hofman 2008). The trace pattern of a granular sawing plate is expected to consist of a broad but variable groove with clusters of striations sharing orientations, though the details are dependent upon the granularity and texture of the implement itself.

5.3.2 Engraving through organic materials

In comparison with the framework for lithic and metal incision marks, both perceived as efficient edge materials, the use of tools of an organic nature is far less understood. This is in spite of the wide spectrum of organic crafting tools that has been observed in ethnographic fieldwork. Shell scrapers have been identified at several Caribbean sites (Lammers-Keijsers 2007, 82, 94; Ruiter 2009), and are documented both ethnohistorically (Dacal Moure and Rivero de la Calle 1984; de Las Casas in Serrand 1997; and see Boomert 2000) and ethnographically (Roth 1924, 77; and see Cuenca Solana *et al.* 2011). Teeth lacerators were used by the Kalinago (Breton and La Borde, in Petitjean Roget 1961; Moreau 1990, 146, 185) and the dentitions of various animals contributed to a wide variety of tasks in Amazonia (Koch-Grünberg 2000[1916], 147; Kozák *et al.* 1979, 403, 406, 423; Roth 1924, 77-78; Yde 1965, 264). Indeed, von den Steinen (1897, 197) described the Amerindians of the Xingu as living in a Teeth and Shell Age. Experimental work has frequently demonstrated the discernibility of its traces and the corresponding presence of organic technologies in archaeological artefacts, and not just for drilling technologies alone. Accordingly, incisions and grooves were experimentally produced using four organic tool materials, namely shell, tooth, wood, and string (Appendix 1).

The experiments with shell were conducted with four different implements, one *L. gigas* first order lamellae applied in sawing calcite and three North Sea bivalves in single-motion incisions on a fresh, boiled, and abraded bone. The sheet-like structure of the *L. gigas* flake proved very efficient in sawing the softer calcite blanks, producing narrow grooves with near vertical walls and a flat bottom (Figure 13, a). These correspond to the laminated morphology of the tool. It proved ineffective on harder stone materials and on the dense wood of *G. officinale*. The first bivalve was a *Spisula* sp. fragment with a thin and jagged edge. It produced incisions moving from a rather narrow and deep U-shaped incision to a shape with vertical walls and a flat bottom, the end becoming shallower and wider due to edge wear. On the boiled bone the outlines were near V-shaped due to the sharpness of the fragment, but inconsistent due to rapid edge remodelling. The second bivalve was a thick mantled cockle from the genus *Anadara*, notched to create a point. The resulting incisions were thin, deep, and linear with an irregularly grooved bottom, sometimes widening a bit, and had striated borders with the bone surface. The third used a notched rim of *Aquipecten opercularis*, which is a broad, flat shell

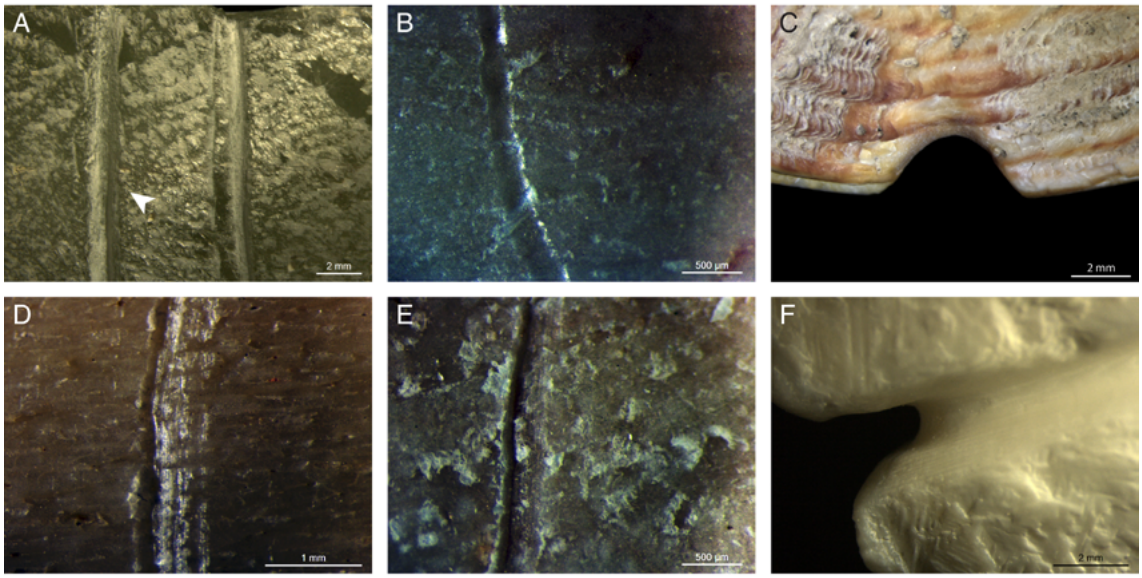


Figure 13: Engraving with organic materials. A) *L. gigas* lamina groove (left incision, arrow). B) tooth cusp groove on abraded bone. C) wood-widened groove (after Falci 2015a). D) *Anadara* sp. groove on boiled bone. E) *Spisula* sp. groove on abraded bone. F) string-sawn groove on *L. gigas*.

with a thin border. While the incisions were thin they were wider and shallower than the previous experiments, and possess a sharper border to the bone surface. In all cases the shell asperities were remodelled and refreshed under the wear, which finds expression in the slightly variable widths and depths across the resulting incisions (Figure 13, d-e). The internal bottoms consistently displayed long grooves intermitted with ridges that follow the direction of the motion (Buc *et al.* 2010 also observed this), indicating plastic deformation.

The experiments in engraving with teeth were conducted using a single asperite cusp of a deer premolar. Multiple incisions were set on each bone with a single motion, and effort was made to include curves next to straight lines which resulted in the appearance of multiple angular interruptions. Regardless of the state of the bone, they produce a bowl-shaped profile: smooth, shallow U-shaped bottom, semi-spherical walls, lacking internal striations (Figure 13, b). The border with the bone surface obtained an indented appearance. The first incision (on boiled bone) was straighter and had regular internal striations, which disappeared afterwards. It is possible that either this gesture blunted the cusp, or that displaced bone formed intermediate particles in the interaction.

Wood experiments were conducted using angular edged *Guaiacum officinale* flakes as sawing tools. Whereas such tools were completely ineffective without lubricant and an abrasive, adding these resulted in a viable filing ability. In this manner shallow flint-made onsets on *Spondylus* sp. shell were enlarged and widened. The resulting grooves have wide U-shaped outlines and round bottoms with fine parallel striations (Figure 13, c). The wide U-shape is a result of the morphology of the wooden flake as it abraded down the narrow edge into the thicker mass of its body. The wooden flakes acted as mediums carrying the abrasives back and forth over the surface, though the tools abraded at faster speed than the shell did. The groove morphology is thus a factor of abrasive variables and continuing edge degradation. Other soft tool edges are expected to deteriorate following a similar gradual pattern, however, making the result useful in a broader sense.

String sawing was conducted with a cotton cord and quartz sand abrasive on *L. gigas*. This resulted in U-shaped bottom cross-sections with undulating walls, which lacked internal striations

in either material. The groove profile itself is convex in the centre with the ends abrading deeper into the material (Figure 13, f), consistent with published models (Sax and Ji 2013; Sax *et al.* 2004). This profile is significantly distinct from the other types of incisionwork discussed here, which used solid implements whose thickened bodies widen the incision as they progress into the blank. A flexible string does not have this characteristic, and instead can change the abrasive direction in order to produce designs. However, its progress proved slower than other methods, and required renewal of the string on a regular basis.

At first glance, the morphologies of these grooves and cut-marks are sufficiently distinct. Most lean towards U-shaped bottoms more shallow and with wider cross-section profiles than obtained using angular lithic edges. Internal striations are not always present, while those that were are coarser. However, the actual extent to which these results represent their tool materials or extrapolate across tool morphologies remains to be seen. Shell and tooth are materials which naturally provide asperite points with adequate shearing capacities, and were thus more similar to each other. Conversely, the wood flakes and string devices are intermediaries using a pliable matrix to carry active abrasives across the contact surface. These also required an initial cut from an asperite edge, or alternatively, guiders such as wooden spalls to keep the tools in place during the initiation of a cut.

The main variable that transferred to the groove profile in these experiments is the edge morphology of the incising implement, irrespective of the material and wear mode. This is consistent with the literature, but methodologically problematic for identifying the more rapidly remodelling edges of organic cutting materials. The configuration of grooves, ridges, and microstriations in bottom and walls relates primarily to the measure of asperity within the tool and/or abrasive intermediate particles. It is thus useful mainly for discriminating the wear mode and graininess of the edge. Using both sets of variables will allow for some discrimination between the tested tool types. Essentially, the cut of solid, resistant edges is distinct from the shear created by the faster remodelling asperities of shell and bone upon the softer blanks. For organic carriers only the morphology of the groove remains suggestive, striation patterns instead referencing the used abrasive. Under the right circumstances, additional inferential resolution is attainable.

The variation in the penetration depth and internal appearance (furrows and ridges) of the present shell-created grooves may be attributable to the different microstructural make-up of the taxons. The experimental literature diverges on the description of shell cut-marks, ranging from wide V-shaped to open and shallow U's and bowls (Buc 2011; Buc *et al.* 2010; Choi and Driwantoro 2007; Toth and Woods 1989), but none of these contrast the present results. In each case these traces are correlated to the morphology of the edges used, following individual trajectories of fracture and remodelling behaviour. Shell as a raw material clearly produces a significant variety of traces, though judging by the published micrographs the divergence is not necessarily as large as the different terminologies would seem to suggest. These specific asperite configurations (tool edges) formed in bivalves do produce interpretable cut-mark morphologies, that group together in characteristics compared to the other materials tested. The cut-marks made by a Caribbean taxon such as *Codakia* sp. should not be appreciably different so as to overlap with grooves made with flint.

Dental enamel is a dense, wear-resistant biomineral with a Mohs' hardness of 5, above iron and untreated steel and on par with obsidian. Furthermore, canines and (pre)molar cusps have a morphological propensity towards puncturing and shearing. As a result, the tooth-made grooves are distinctive through continuous indentation on the rim and a more consistently bowl shaped profile

lacking pronounced striations. The plastic displacement of bony matter and indenting of the ridge set these grooves apart from the other experiments, but approximate other furrow types found on bone, in particular predator gnawing traces (e.g. Blumenschine *et al.* 2007; d'Errico *et al.* 1998; Haynes 1983; Potts and Shipman 1981), and superficially certain taphonomical grooves (d'Errico and Villa 1997). Predator-made cut-marks are well known vis-à-vis lithic incisions in relation to questions on ancient animal butchery and bone aggregation, but are evidently also relevant for anthropogenic tooth-drawn patterns. This does pose problems for the detection of tooth-based tools in other regional and cultural contexts, for which wear trace analysis may be the surest indication (Van Gijn 2005). The regularity of the engraving will provide the clearest indication of human tool use.

The wooden filing flake and string-sawing device essentially represent semi-malleable and respectively flexible organic mediums that slide active abrasives over the surface. They therefore create potentially distinguishable profiles and depths of in grooves, but the trace patterns on the microtopography thereof is a function of the abrasive particles used. Flexible strings may swerve in cross-section and the grooves are deepest at the extremities, whereas semi-malleable to rigid files create generally straight profiles. Ethnographic data is scant (e.g. Burton 1984), but both techniques are frequently inferred on archaeological materials based upon experimentally characterised trace patterns (e.g. Andrieu *et al.* 2014; Falci *et al.* 2017b; Nougier and Robert 1953; Pailler 2005; 2009; Pétrequin *et al.* 2009; 2012a; Proskouriakoff 1974; Sax and Ji 2013; Sax *et al.* 2004; Wagner and Schubert 1972), and sometimes through historical information (Hansford 1950; Lothrop 1955). Morphological differences in the pattern and dimension are attributable to different setups, involving resistant fibres for the string and adhesive coating to facilitate the abrasive contact.

Two important, additional categories of organic incision tools are shark teeth and bamboo strips. Unlike mammalian teeth, shark teeth possess a plano-convex cross-section and serrated edges; associated grooves sport an asymmetrical cross-section and clearer internal striations (Joordens *et al.* 2015). A single shark tooth with possible use wear is reported from Curaçao (Haviser 1993), while two more purported tools come from Puerto Rico (Rivera Fontán and Oliver 2003). Bamboo (and reed) knives were often used by tropical forest communities for a variety of practices, though apparently restricted to contexts in which metal tools were not available (de Goeje 1910; Kozák *et al.* 1979, 375, 391, 394, 411; Roth 1924, 77). Bamboo stalks offer silica rich outer halms which produce elongated sharp edges when split, producing distinctly asymmetrical grooves between halm and inner fibrous pulp (West and Louys 2007). Despite being not as efficient as lithic edges, the material is both expediently useable and environmentally abundant. In sum, considering these additional possibilities expands the inferential framework by highlighting the limitations in the present set of experiments, when considering the potential range of cut-marks.

5.3.3 Drilling

Various perforations are present in the studied material types, seemingly applied for purposes of stringing, aesthetics and appearance, or acoustic function. The morphology of the perforation and patterning of striations can be indicative of the type of perforating technique used, including both drill bit and rotary equipment (Bains 2012; Gwinnett and Gorelick 1979; Kenoyer 1997; Vidale 1995). Drills made from flaked lithic materials will produce perforations with a conical shape, due to the increasing width of the flake. These are usually drilled from both surfaces ending up with a biconical or hourglass outline. Somewhat irregularly stepped concentric striations are typical,

originating with protruding asperities of the ribs characteristic to flaked lithics, though these may be erased by subsequent wear from use. Cylindrical perforations are instead obtained using tubular drills, which can be either solid or hollow. They are shaped from organic raw materials, or metals in later periods, and used to rotate abrasives through the blank material. Such bits have no upper limits for depth and perform efficiently even on very hard materials, allowing a great variety of technical performances (Sax and Ji 2013). The solid bits can in effect be shaped in any desired size and produce conical perforations matching those dimensions. Hollow bits abrade only the circumference of the perforation, leaving an inner rod of stone which is subsequently broken out. Both wood and bone were tested as potential drilling materials. An experimental perforation of dentine using a *Canis familiaris* canine from the Leiden Laboratory reference collection is also included here.

Experiments with hand, palm, and bow drilling of shell and soft stones have been detailed in previous work (Breukel and Falci 2015; Falci 2015c; Falci *et al.* 2017b). Briefly, in hand drilling we used a hand-held lithic drill in twisting motion, which is a combination of gouging and drilling. The other methods use hafted drill bits which are rotated around their axis. Both techniques had already been inferred during previous investigations on Caribbean materials (Carlson 1993; de Mille and Varney 2001; de Mille *et al.* 2008; Falci 2015a; 2015b; Lammers-Keijsers 2007; Van Gijn *et al.* 2008) and are widespread throughout lowland South American communities; palm drilling is also mentioned in ethnohistoric fire making (Moreau 1990, 209-210). These involved both lithic drill tips and tubular organic bits with abrasive, finding the results to be both distinct and applicable to the archaeology of the region. The perforations set with flint are all conical with a pointed leading edge, and display thin striations on the wall profile. This outline is consistent regardless of the blank material in which they were placed, all of which are softer materials (Figure 14, a-b, d-e). Conversely, the perforations produced using the organic materials have near-flat leading edges and a potentially cylindrical cross-section. Since their shapes also modelled after the drill bit morphology, the bone bit perforation assumed a tubular profile and the V-shaped wooden bit perforation a stepped cone profile.

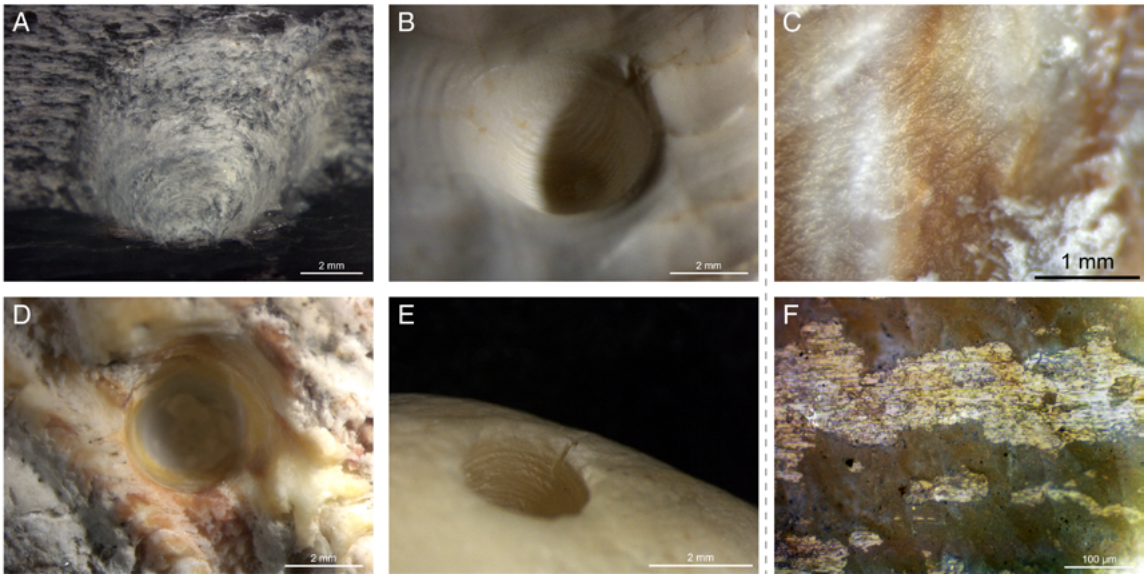


Figure 14: Perforation profiles and grinding traces. A) Palm drilling calcite with flint (from Breukel and Falci 2015). B Bow drilling *L. gigas* with wood and abrasives. C) *Spondylus* sp. ground on coral with abrasives. D) Bow drilling *Spondylus* sp. with bone and abrasives. E) Bow drilling dentine with a dog tooth. F) Polish on *L. gigas* ground on coral with abrasives.

Both possess thin concentric striations and regular concentric gouges, the former resulting from the abrasive powder and the latter likely from debris particles of the fast wearing bits (Falci 2015c, 108; Falci *et al.* 2017b). The entrance into the material required an irregularity in the surface to stabilise the drill, which for *L. gigas* was created using a lithic point and for *Spondylus* sp. was naturally present. The perforation set with a dog canine is bicylindrical, has a slightly inflected entrance into the bone, and is characterised by larger furrows and gouges in an irregular pattern.

These experiments are largely consistent with the literature, and the use of the organics is pertinent to the present case study. Flint, [animal] bone, and fish spine are recorded in Caribbean ethnohistory (Las Casas 1967, cited in Ostapkowicz 2013), while bone tips, wood splinters, and hollow reeds are known from mainland ethnography (Roth 1924, 78-79). Animal teeth especially are known to be the preferred drilling tools in certain ethnographic contexts, the elements ranging from dog canines to rodent teeth and tiny rat incisors (e.g. Kozák *et al.* 1979, 411; Roth 1924, 78; von den Steinen 1897, 1999). Of these, bone drills are occasionally recognised in other archaeological records (LeMoine 1994; Buc and Loponte 2007; Holmes 1897, 307-309). Bird bones in particular may act as efficient hollow drills. The use of other materials can be inferred solely through experiment-based analysis. Most options are highly degradable, and not easily recognised as tools. Archaeological teeth from the Caribbean have yet to be systematically examined for traces of active drilling. Other local materials that may be of interest include the pointy apices of *A. cervicornis* coral and *L. gigas* picks, although Sickler Robinson (1977) failed to achieve results with these in shell perforation experiments.

5.3.4 Grinding soft materials

The tool materials best suited for abrading organic materials are not necessarily the same as those for abrading hard lithic materials. Nevertheless, the wear environment remains comparable (Section 5.1).

Shell abrasion experiments were conducted using *Spondylus* sp., *Oliva* sp. poss. *reticularis*, and aged *L. gigas*. The grinding of *L. gigas* on *A. palmata* without a lubricant resulted in a burned appearance due to frictional heat, associated with a bright, rough, flat, and striated polish appearing in large connected swaths on the surface plateaus. The polish is the same as when water is added, but the neutralisation of the frictional heat results in an entirely different macroscopic appearance, smooth and unstriated white (Figure 14, c, f). The frictional energy clearly enters the microstructure in dry state, but the cross-lamellar structure mostly inhibited crack propagation. The *Oliva* sp. performed similarly on moistened coral, but accumulated dense bands of striations. Grinding fresh conch lips on oceanfront volcanic lava boulders with black sand (composed of minerals from weathered volcanic rocks) also produced macroscopically striated results. However, these experiments were carried out informally in St. Vincent and the specimens were not exported for microscopic analysis. *Spondylus* sp. was ground on *A. palmata* with quartz sand abrasive, which sped up the process and produced a fairly level surface with a gouged topography of low roughness. The accompanying polish was bright and striated, but less flat and not well linked due to the higher surface roughness. The second *Spondylus* sp. was wet ground on fine-grained sandstone and produced an intensely bright and striated stereoscopic surface with otherwise similar micropolish.

Bone was not subjected to grinding experiments given the lack of distinguishable traces on the archaeological artefacts, but a brief consideration of the literature remains pertinent to the analysis. Bone abrasion technologies, use related wear overlay, mechanical weathering processes, and taphonomic surface degradation have all been extensively researched elsewhere (e.g. Blumenschine *et al.* 2007;

Bromage 1984; d'Errico 1993; d'Errico and Villa 1997; Griffith *et al.* 2016; Madgwick 2014). Even if precise identifications can be troublesome general material groups are clearly distinguishable from one another, foremost by assessing the spatial distribution (d'Errico 1993; LeMoine 1994). As with cut-marks, the specific anatomy and density of the bone is expected to impact the wear development rate and spread (Krasinski 2018). Handling is perhaps the most important activity the archaeological materials were subjected to. This will gradually erode the bony surface, including incisions and other morpho-technological traces, and is sometimes associated with the development of a golden-brown coloured patination visible with the naked eye (Bradfield 2015; Choyke and Daróczi-Szabó 2010; Van Gijn 2005). The data in these publications provide a sufficient framework to understand the weathering and erosion on the materials below and put the production and wear of their engraved patterns into perspective.

6

Sites and Materials

This chapter provides the context of the materials selected for analysis. The analytical approach and methodological requirements have all been met in the previous chapters, and these now need to be applied towards the archaeological materials under study. The present chapter discusses the direct archaeological, cultural, technological, and taphonomical contexts. Specifically, the sites from which celt assemblages are studied are described to the extent that each of the above contexts is made salient (Section 6.1). This encompasses the relevant history of investigations, cultural associations and dating of the sites, geological and environmental characteristics where these pertain to the materials, types of material culture recovered from the site, relevant spatial and stratigraphical information for the studied materials, and their state of preservation. The sites and proveniences from which paraphernalia were selected for analysis (Section 6.2) are given lighter descriptions due to the individual character of the materials for this case study. There is both less opportunity and also less need to provide an in-depth examination of all aforementioned factors on the site scale. In most cases these artefacts are not well contextualised within the general space of the archaeological record, and so will not enable much discussion on the scale of their site contexts anyhow. The aim is then to create further coherence between the selections, by highlighting material cultural, diachronic, and contextual connections.

6.1 Case study 1: Ground stone celts

6.1.1 Pearls, Grenada

Pearls is a large Early Ceramic Age site located north of the Simons river on the Atlantic side of Grenada. The site was first brought to attention by archaeological investigations conducted by Bullen (1964), who conducted several test pits in the bulldozed overburden. He recovered ceramics with characteristic early Saladoid fabric and decoration, consequently designated as the representative early ceramic tradition for Grenada, as well as some later materials. By this time the deposits had already been heavily disturbed by landscaping activities, in particular the construction of an airstrip overlaying the site. The looting of its material deposits has continued up until present times, through illicit digging and from collecting artefacts exposed by agricultural activities. Keegan (1991; Keegan and Cody 1989) and Cody (1989; 1990a; 1990b; Cody and Banks 1988; cf. Cody 1991) carried out further excavations in the late 1980s and early 1990s, excavating several test pits and a trench in one of the accessible areas of the site. Their research affirmed that the site contained an extensive Saladoid habitation locus, involving large-scale lapidary production. The abundance of raw and finished semi-precious lithics originating in other islands and mainlands have since established Pearls as a central node in long distance interactions. Three shells associated with pottery vessels from the test pits were radiocarbon dated to 40 BC - AD 530 at 2σ, two of which not predating AD 140 (see also

Fitzpatrick 2006; Haviser 1997). Hanna (2017, 67-68) recently calibrated these dates to AD 385-890 instead, and like Petitjean Roget *et al.* (2000), estimates the occupations as a whole to persist until the 2nd millennium AD (up to AD 1200 specifically). At present the extent to which occupations at Pearls supersede the Saladoid series remains unresolved, due to disturbance of the record and limited testing. Material studies have focused on excavated faunal remains (Fandrich 1989a; Lippold 1989), and both ceramic adornos (Keegan and Byrne 1999) and additional lapidary materials (Boomert 2007; Cody 1989; 1990b; Falci *et al.* in prep.; Knaf *et al.* in prep.) from private collections. Even though precise contextual information lacks due to looting, those assemblages can be correlated on typological grounds with first millennium AD activities at Pearls. Given the partial destruction of the site stratigraphy it is questionable how secure contextual association is even for artefacts still remaining within the deposits.

As the southernmost island of the volcanic island arc, Grenada consists of mountainous centres and more gently rolling coastal peripheries. Eocene sedimentary deposits and pyroclastic tuffs occur in the northwest of the Island, but the majority of the geology is composed of volcanic formations dating from the early Miocene to the present. These formations include older andesite domes in the north of the island, followed by eruptions of andesitic, basaltic, and some dacitic lava flows throughout the interior (Devine 1995; Arculus 1976; 1978). The coastal areas consist of reworked volcanics that were redeposited from the centres through fluvial action or mudstreams. Thus, the geographic location of Pearls provided the community with fair access to various igneous rock resources. Unfortunately, little can be glanced with regards to the tool kits from Pearls from the inventories made available thus far, though as a ceramic and lapidary workshop significant technological know-how and resources must have been available. Indeed, ornament production at the site indicates different gradations of lustre on widely varying raw materials (Falci *et al.* in prep.). Volcanic boulders as potential polissoirs are readily available in the area, and such an abrasion platform was recorded in private context. This is a boulder of local basalt with oval grinding depressions on three sides that could be alternated by turning over the piece. The depressions grade between coarse and granular, intermediate, and shimmering levelled which indicates alternating abrasive techniques of increasing fineness. Microwear traces on a cast from the levelled depression confirmed stone polishing activities (Figure 15).

Questions remain concerning the availability of other types of abrasive lithic platforms and materials. A microcrystalline whetstone has been reported, and interestingly, micaceous schist and pyrite have been recovered from the site (Cody 1989; 1990a). Powder from

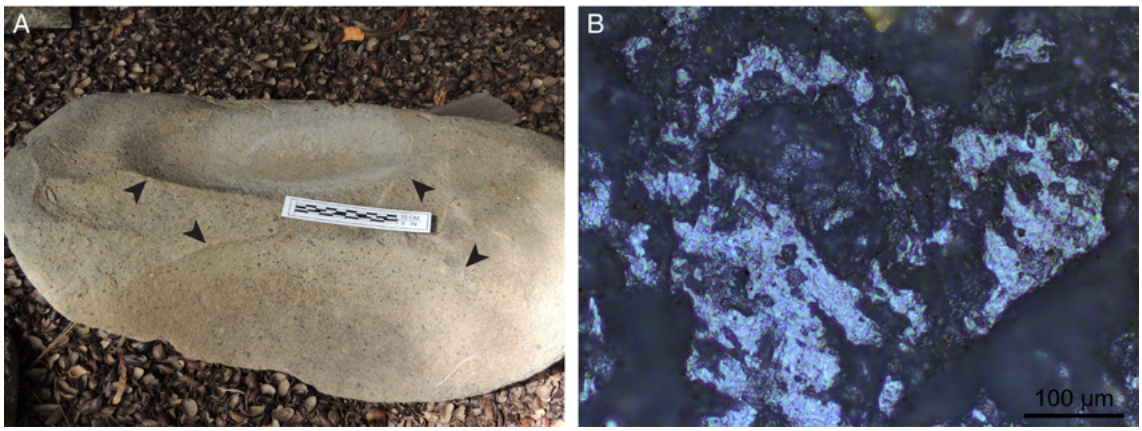


Figure 15: Large but mobile *polissoir of local basalt with three cupules* (two indicated in A). B) traces of wear from stone grinding on levelled cupule (not visible in A).

these rocks could be utilised towards finer abrasive (polishing) techniques. Chert microliths appear to be fairly common in the site, and the material is suggested to originate from the Grenadines or further afoot (Cody 1990b). Bullen (1961; 1964) had already recovered grinding and 'sharpening' stones from the upper layers, as well as hammerstones and an unfinished celt, but does not describe the materials. Keegan and Cody (1989) similarly report a number of unspecified grinding stones from the surface, assumed though not demonstrated to be associated with food production. As for sandstones, lithified eolianites occur on Grenada (Hanna 2017, 25-26, 136) and volcanogenic sandstones are known from the Tufton Hall formation (Saunders *et al.* 1995) and the Grenadines (Speed *et al.* 1993), but these contain little detrital quartz and the working properties are therefore not comparable. Varieties of suitable sandstones do occur on nearby Barbados (Kasper and Larue 1986) and Trinidad and Tobago, and quartzite outcrops on the latter island (Boomert 2000; Boomert and Rogers 2005). Otherwise, with non-carbonaceous sandstones absent from the remainder of the arc (Knippenberg 2006, 151-156), the nearest sources to the north are the Virgin Islands and Greater Antilles.

Materials

The analysed materials are part of the private collection of the Willcox family. The intermediates through whom the collection was built up are known, which provides a rough contextual estimation for the majority of the objects (C.L. Hofman, pers. comm. 2016). The 'jade rush' of the 1990s centred on Pearls (Keegan and Cody 1989) provides additional social context for the provenance of the various greenstones. The complete collection totals nearly four hundred edge-ground macro-lithics and several hundred shell celts, most of which are intact. Biconvex, petaloid, and wedge shapes are well represented in the whole assemblage, occurring in a variety of shapes irrespective of their material. Conversely, fragments and early-stage manufacturing products are virtually absent. This state of the assemblage is obviously a bias of the looting process.

The selection for study was made amongst materials associated with Pearls only. It includes twelve celts and one blank of potential jadeitite, subjected to both wear trace analysis and provenance study by portable sampling of the geochemistry (see Knaf *et al.* 2017). Eight others comprise mixed non-local greenschist, (meta-)sediment, and igneous materials (Figure 16). One of the latter is a roughout and four more are fragments of which one was reworked into a pounder. The typology of the sample group is predominated by (largely) intact petaloid and biconvex celts, but includes two wedges, a micro-chisel, and a semi-lunar axe. This selection is representative of the macro-lithics made from material not naturally occurring on Grenada. Comparatively few specimens from the upper size range were sampled, however, as these were overwhelmingly made of local volcanic rocks. While not less relevant to the research, many of these, particularly the olivine-rich basalts, are severely weathered and unsuitable for microwear analysis. Most thin elongated chisels and other typically early forms fall in this category, as do all forms of eared, notched, and winged celts.[24]

Being part of a private collection, the analysed materials lack chronological and contextual information. Despite previous efforts at establishing morphological typologies (Section 2.3), these

24 Almost all of the latter forms are basaltic, as opposed to andesitic or dasitic, and very few are made of non-igneous rocks or materials not native to Grenada. Nevertheless, these do occur (see also Fandrich 1989b). Amongst the petaloids, the presence of significant numbers of specimens made of darker and lighter green metamorphic rock types exotic to the Windward Islands was noted already in the early 20th century (Lovén 1935, 145).

Figure 16: Celts from the analysed assemblage of Pearls.

are insufficient for assigning the selected celts to specific cultural series. Most are typical petaloid shapes found throughout the Ceramic Age. Only the plano-plano rectangular wedges may potentially be regarded as morphologically restricted to earlier periods (Rodríguez Ramos 2010a), but the stratigraphic relation lacks. As such, the broadest periodisation of Pearls as Saladoid to early post-Saladoid is used. This placement suffices for characterising the sample as pre-dating the other studied assemblages, though it overlaps with earlier occupations of the Dominican sites. Given the recovery of an intact small winged axe while fieldwalking overturned deposits, the intact status of the sample is not considered supportive of any further speculation with respect to depositionary contexts.

The chemical weathering of igneous materials in the complete collection formed a significant concern in the feasibility of further selection. Many of the shell celts are similarly degraded. Recent impact damage is prevalent on especially large-sized specimens, including the winged axes measuring up to ca. 50cm. These often bore recent scars on and around the edges, which resulted at least partially

from them being balanced on the edge for display. The materials selected for microscopic analysis were generally in good condition, for the metamorphic rocks probably due to their different chemistry. The main inhibition proved to be thick layers of grease present on several artefacts. These substances had filled in the interstices and were firmly wedged between textural features inside the polish themselves, obscuring analysis. Cleaning procedures consisted of repeated soap washes and wipes with 70% alcohol, the most concentrated that was obtainable in the field. This proved effective for some artefacts, but failed to completely clean others. Specimens containing residues were not washed, but were also less affected by the grease. This proved a significant complication, but on average analysis was conducted successfully on each artefact. In cases where visibility remained partially obstructed the confidence level was lowered accordingly.

6.1.2 El Flaco, Valverde, Dominican Republic

The site of El Flaco is a late precolonial habitation site located in the northern Dominican Republic. It is situated on the southern flanks of the Cordillera Septentrional, facing the Paso de los Hidalgos and overseeing the Cibao valley. El Flaco is the subject of ongoing archaeological investigations by the NEXUS1492 project and the Museo del Hombre Dominicano (Hofman and Hoogland 2015a; 2015b; Hofman *et al.* 2016; 2018b). Veloz Maggiolo (1972) and colleagues first reported the site in the 1980s (see Hofman and Hoogland 2015b), and its archaeological potential has been reemphasised in recent survey work (Ulloa Hung 2013a; 2013b). Large scale excavations have started at El Flaco in 2013 (Hofman and Hoogland 2015b). These studies found landscaping activities common to the region, with mounds and both typical Chicoid and Meillacoid ceramic series sherds as well as stylistic hybrids (Ulloa Hung 2013a). Landscaping activities entailed the formation of levelled habitation platforms and a large number of multi-purpose mounds (1-2m high) with a complex stratigraphy. Significant deposits of ash layers are found in the mound stratigraphy, and a large number of off-mound hearth places and cooking areas have been recovered. This has led Hofman and Hoogland (2015a) to interpret the site as having intensified activities in the domain of food processing. The surplus production thereof could have formed its main connection with other sites in the region (see Ulloa Hung 2013a). These connections are similarly seen in the presence of marine materials and inferred in both ornamental materials (Falci 2015a; 2015c), ceramic paste recipes (Ting *et al.* 2016), and human mobility (Laffoon *et al.* 2017a). El Flaco dates as early as the 9th century or the earlier part of the Late Ceramic Age (C.L. Hofman, pers. comm. 2017). However, the main occupation is characterised by primarily Chicoid ceramics and radiocarbon dated to fall in between the 13th and 15th century, with a terminal date from a burial at AD 1490 (Hofman and Hoogland 2015b; Hofman *et al.* 2018b).

El Flaco is located roughly 15km away from the El Yaque del Norte, with a few streams in the immediate vicinity. Some lithic materials available from this river derive from the Cordillera Septentrional. Most of the southern flank is overlain by a variety of sedimentary rock formations containing carbonates and sandstones, as is the Cibao valley (de Zoeten and Mann 1991). The main contribution of lithic materials to the El Yaque is by tributaries descending from the Cordillera Central, including the large Duarte complex and the Amina-Maimón belt (Sections 2.1 and 4.4.2). The Duarte complex contains a range of basic to ultrabasic volcanic rocks (basalts, diabases, gabbros, and intrusive tonalite) with regional metamorphosis of sub-greenschist, greenschist, and amphibolite facies. Metasediments, metatuffs, cherts, and ultramafic rocks also occur. Separated from the Duarte

belt by serpentinites and mafic basalts are heterogeneous chlorite-grade metamorphic schists from the Amina-Maimon belt. Slight overprinting to low greenschist-facies occurs frequently, and schists with greywacke and shale protoliths occur to the western end of the formation (Draper and Lewis 1991; Lapierre *et al.* 1997; 1999; Lewis and Jiménez G. 1991; Kesler *et al.* 1991). The tributaries to the El Yaque that descend from these mountain ranges cut, such as the Río Amina, through the aforementioned lithologies. As such, a majority of the materials they transport across the basin comprise igneous source rocks and (partial) greenschist facies.

El Flaco itself occupies a transitional geomorphic zone between the high altitude Cordillera Septentrional and the El Yaque del Norte basin, where sediments from the El Mamey belt form the bedrock. The formations from this group and from the Tavera Belt (at the northern foothills of the Cordillera Central) are predominantly carbonaceous, but also contain a variety of sandstones (De Zoeten and Mann 1999; Dolan *et al.* 1991; Draper *et al.* 1994). Of this a reddish coarse-grained variant was obtained close by El Flaco for experiments. Nowadays, the vegetation around the site is mainly xeric, dry-adapted woodland, with the excavation shaded by cambrón (*Prosopis juliflora*), and a small stream flows from the mountains on its borders. In the past, the geomorphological location must have afforded the inhabitants of the region materials from a range of biogeographical zones. A range of lithic materials have been recovered, including a large number of macro-lithic objects. At least one translucent red cherty flake with usable edges is present, but the origin of this specific variety is unknown. Most flake reduction on the site occurred using volcanic and low-grade metamorphic rocks (below). Other suitable tool materials include metamorphic hammerstones, an *A. palmata* grinding slab, and smaller *Acropora* spp. fragments some of which are worked.

Materials

A substantial amount of macro-lithic fragments has been recovered from El Flaco during the 2013-2015 field seasons. Since no cleaned occurred in the field given potential residue analysis, lithic objects were not immediately classifiable. Edge-ground celts comprise a significant portion of the macro-lithic assemblage. A selection of 69 fragments was first analysed at Leiden University (2013-2014 collections), and 55 later finds (2014-2015 collections) were analysed in the field. The total number of edge-ground macro-lithic fragments is 77, including debitage flakes with percussion but not counting three other ground objects, and all but six were analysed. Those six were finds from unknown surface contexts and heavily affected by sediment encrustation, and excluded in the interest of time. The remaining fragments in this selection included sharp edged flakes (flake production industry), and dissimilarly smooth (water-worn) surfaces. Their raw materials have a strong overlap with the edge-ground macro-lithics and occur in comparable relative quantities, but appear to diverge into a core-flake industry based upon direct freehand percussion (Figure 17). Some checks for the

Figure 17: Large reduction flakes from El Flaco.

presence of use wear were made, but produced inconclusive results due to probable PDSM (on basalt flakes, cf. Asryan *et al.* 2014; Key *et al.* 2015). Further study is required to better assess the scope and extent of these materials, also in light of indigenous carving technologies (cf. Chapter 9).

Large and medium-sized petaloid and biconvex celts with asymmetric cross-sections dominate the assemblage (Figure 18). They can be roughly divided into low-grade metamorphosed greenschists with volcanic or volcanoclastic protoliths, fine-grained volcanics with intermittent alteration, and a number of uncommon materials. There is considerable variety with concern to the manufactured surface, with most showing various intermixtures between pecked and polished surface. Fragmentation is high, however, and several of the celts were (re-)designed for rubbing/pounding activities. Half-fabricates and associated debitage occur in low numbers. Pending examination of materials from later field seasons to obtain the full macro-lithic assemblage, the assemblage appears representative for the site.

The site is being excavated using a zone-sector-square grid system to geo-reference the arrangement of features while the stratigraphy of the mounds and in between areas is followed in 10 centimetre layers, providing a strong contextual control on the material. Much of the material culture recovered originates from the sweeping areas located 'off-mound', that is, away from the platformed house areas which were kept clean, and yielded few finds (Hofman and Hoogland 2015a). These materials subsequently end up in newer mounds as these are formed out of multiple sweeping accumulation, burning events, and other forming activities (Hofman *et al.* 2018b). This is also the case for the macro-lithic materials, which were primarily recovered adjacent to house platforms (2013-2014 specimens) or from within mound layers (2015 specimens). The former derive from unconsolidated sediments located to the south and west of the platforms, downhill towards the valley. Celt fragments

Figure 18: Celts from the analysed assemblage of El Flaco.

are rarely associated with the large house areas themselves, whereas this is decidedly more common for flaked materials (particularly at house platform unit 2) and other items of material culture in general. Other parts of the celt assemblage consist of surface finds encountered throughout the topography of the site, and fragments found in cultural horizons, mostly as mound fill. They are uncommon in the underlying burn layers, and have not presented clear evidence of heat modification indeed suggesting they were rather mixed in with the soil during fill-in. Stratigraphically, the materials are distributed evenly throughout the layers, the only notable clusters being Layers 2 and 3 of Unit 49 (six specimens) and Layers 5 and 6 of Unit 59 (seven specimens, including a preform, reworked and polished blunt celt, and a possible blueschist), both of which are smaller mounds. That said, the 2016 excavations revealed different (micro-)contextual processes at other parts of the site with several intact specimens of high-pressure rock types, indicating that the complete picture for celt biographies at El Flaco cannot yet be obtained.

The preservation of the macro-lithic assemblage is excellent in some respects, but problematic in others. Surface topographies are on the whole well preserved, as neither mechanical nor chemical weathering seem to have disrupted traces of wear on a site level. However, the taphonomic environment of the site has adversely affected a proportion of the assemblage. Many of the artefacts from throughout the site have significant carbonaceous deposits encrusted to the surface (in particular from the moundfill C-horizon between the soil and burn layers), resisting attempts to clean them for analysis. Though wear traces can still be found on most, concentrations on edges have in several cases prevented an assessment of use wear. Reconstructions of the hafting arrangements are severely inhibited due to the high rate of fragmentation, obscuring the spatial distribution of wear. Similarly, the higher roughness of pecked sides traps encrustations within, and these then become completely unobservable. Second, the propensity towards expedience within the assemblages forms a complication. Specifically, a portion of the surfaces has not been ground, but simply kept as water-smoothened. However, since these surfaces basically lack much polish, and are indeed fairly smooth, it has not always been clear whether artefacts retain natural surfaces or whether they had been ground for short duration. In most cases, an inference is made towards natural surface as explanation on the basis of observed elevated micro-roughness and eroded mineral fractures. Finally, there is significant presence of residual matter in a variety of colours and morphologies among the assemblage. Often, they consist of microscopic grainy masses located in one or few interstices, only rarely as more densely spread and spatial associated residues. Though modern pollution is excluded, it is probable that most derive from the sediment. As residue analysis is not part of the present study, these deposits are taken into account only when their spatial distribution and density corresponds with the biography as indicated by traces of wear.

6.1.3 Playa Grande, María Trinidad Sanchéz, Dominican Republic

The coastal site of Playa Grande is located in the northeastern Dominican Republic, on an elevated shore behind the beach. It is one of the numerous sites found along the coastline of the María Trinidad Sanchéz and Espaillat provinces (see Hofman *et al.* 2004; Ortega 2005; Veloz Maggiolo and Ortega 1980). From the Rio San Juan area in particular various forms of lithic paraphernalia are known, including bowls, pestles, and axes with decorative carvings (Veloz Maggiolo and Ortega 1980). Playa Grande was investigated first in the 1980's when landscaping activities for resort construction had exposed part of the stratigraphy. Veloz Maggiolo and Ortega (1980) identified three occupation layers

therein, the middle one being the thickest, all containing red earth house floor lenses with compact archaeological deposits situated in the sandy substrate. The abundance of griddle fragments and agricultural mounds led them to suggest that manioc cultivation and processing played an important role at the site, which they estimate to occupy thirty hectares. A series of shovel tests were later placed by Olsen Bogaert and Atiles Bidó (2004), in order gain a better understanding of the stratigraphy and extent of the site. The recent investigations of 2011 and 2012 excavated several larger units, finding remnants of house floors, structures, and dense archaeological deposits (López Belando 2012; 2013). A significant number of cooking and pot firing hearths were also recovered, giving further insight into some of the main activities at Playa Grande. Eleven radiocarbon dates range from the ninth to the seventeenth century AD, with an earlier occupation around ca. AD 800-1100 that appear to be overlain by midden layers dating AD 1400-1700 (López Belando 2012, 167, 182-183, A2). The ceramic assemblage agrees with the Late Ceramic locus, having a fairly constant Ostionoid component throughout the layers of the site, and increasing percentages of Meillacoid closer to the surface over Chicoid style pottery. The site has further yielded a large quantity of macro-lithic fragments, various ornaments, threepointers, and other paraphernalia, as well as European materials, faunal materials, and human remains. The early colonial materials include glass beads, a coin minted in 1505 Sevilla, moderate quantities of pig remains, and Spanish ceramic fragments indicating survival of the settlement into the early colonial years. A defining aspect of indigenous Playa Grande, however, is the presence of much jadeitite material in various stages of production (Knippenberg 2012; Schertl *et al.* 2018).

The natural environment of the site is dominated by the littoral setting, consisting of sandy beaches and mangroves. The site margins are located on the coastal plain behind a series of wind-swept, mostly carbonaceous coastal dunes that reach up to a few meters in height. Dark marine clays, rich in organic matter are found in the area as deposits remaining from late Pleistocene to early Holocene intertidal regression (Burkhalter 2012). Today, numerous fruit-bearing trees grow on the plain, and an abundant variety of useable woods can be found nearby the site (Olsen Bogaert and Atiles Bidó 2004). The nearest large river is the Río San Juan, which springs from the northern flank of the eastern Cordillera Septentrional and discharges into the ocean about ten kilometres to the west. This river lies in the main watershed of the Río San Juan Complex (RSJC). As explained (Sections 2.1, 4.4.3), the RSJC is a high-pressure terrane containing a diversity of metamorphic and igneous rock units. Eclogites, blueschists, jadeites (monomineralic or as jadeite-bearing composition), amphibolites, metasediments, and other metamorphic rocks all crop out in the region, mostly associated with eroding serpentenite matrix mélanges (Draper *et al.* 1991; Krebs 2008; Schertl *et al.* 2012). Dolerites and (micro)gabbros occur as intrusions in other serpentinised peridotites. Various greenschists and metalavas occur as independent sets, and amphibolite facies rocks can be found towards the south. The most significant primary outcrops of jadeitite and blueschist are to the far west, and occur as tectonic blocks up to several meters in size. Such larger blocks would pose significant challenges in mining, but the bodies are also cut through by several bodies of water. These streams all transport the rocks towards the Atlantic Ocean as pebbles of directly usable sizes, tens of centimetres at the later ranges. However, the coastal descents form unlikely source locations, as the sandy mouth sediments and mangrove areas bear little material (Knippenberg 2012; Schertl *et al.* 2012).

Materials

The 2011-2012 excavations yielded over 300 edge-ground macro-lithics, over a third of which are jadeitites, and this assemblage was immediately recognised as representing a jadeitite manufacturing context. Indeed, this this rock appears in such quantities that Playa Grande has since been considered the workshop centre of at least a significant portion of the jadeitite materials in circulation through the Antilles. Furthermore, the macro-lithic inventory includes a large number of sandstone 'sharpeners', i.e. hand-sized stone fragments with grooves of 1-2 cm in width and/or clearly abraded facets. Being suitably fine-grained and cohesive, the excavators have linked these artefacts to the production of (jadeitite) celts (López Belando 2012, 185; 2013; cf. Knippenberg 2012). A microscopic examination of a small sample failed to produce convincing traces of stone grinding wear (encountering starch grains instead), however, and a more comprehensive study is necessary to better evaluate their range of use. Grinding platforms of softer rocks were also present, and the few examined specimens appeared to have been used for processing softer, starch-bearing materials. Pumice was imported to the site, and further relevant observations include a number of undetermined ecofacts, large rock crystal nodules (transparent macro-crystalline quartz) with heavily impacted ridges that probably served as hammerstones, limestone hammerstones, a few chert blades and reportedly scrapers, and a variety of coral, shell, and bone tools suitable for various tasks and activities.

Approximately 36% of the edge-ground macro-lithic assemblage consists of jadeitites, a percentage that far exceeds the type of lithic diversity distributions seen in other sites in the Caribbean (Knippenberg 2012). Schertl *et al.* (2018) studied nine jadeite-bearing artefacts from the site and found that the majority are jadeitite *sensu stricto* (>90% jadeite content), with both quartz and omphacite absent in the matrices. These derive from one of the two jadeitite suites from the RSJC (Section 4.4.3), and are suggestive that jadeite rocks enriched in especially quartz were of a quality selected against. Similarly, glaucophane was not present in the jadeite-rich rocks analysed, and appears absent or secondary in geological samples as well (cf. Hertwig 2014). The remainder comprises blueschists, greenschists, and a variety of different rocks of mostly metamorphic and volcanic origin. Medium to small-sized petaloid and biconvex shapes dominate the assemblage, while (micro-)chisels, roughouts of large-sized celts, and several other types occur in lesser numbers (Figure 19).

The majority of celts derive from the centrally excavated area (Corte 7, 7A, …, 7H), including nearly all presently analysed fragments. The layers of this area consist of waste and sediment fill-ins superimposed on largely pre-colonial house floor lenses, excavated in arbitrary 25cm layers (UE's) from which the radio-carbon dates derive. The excavators identified multiple house and hearth structures from the arrangement of postholes here, between which lithic finds are concentrated in small groups (López Belando 2012, 13-27; 2013). Thereabove the different lithic categories are more dispersed and occur in stable numbers throughout, with only a slight increase in axe fragment abundance in Corte 7 (A-H)'s uppermost layer (López Belando 2012, 173). However, there are various factors indicating a degree of admixture in the topsoil, resulting from root action and perhaps the landscaping observed in the 1980s. Human skeletal materials, thought to be from burials, are mixed in with artefact-bearing sediments, colonial period sherds intrude as deep as 50 cm, and the upper date ranges are unrealistically late and in all likelihood date late colonial activities (the area was used by smugglers and buccaneers; López Belando 2013). Since information regarding the individual placement of artefacts within these deposits is lacking, the best generic association for materials from Corte 7 UE's 0 to 3 are occupation phases 6 to 8 (continuous land filling between AD 1200-1600), with the extension of UE's 4 into late

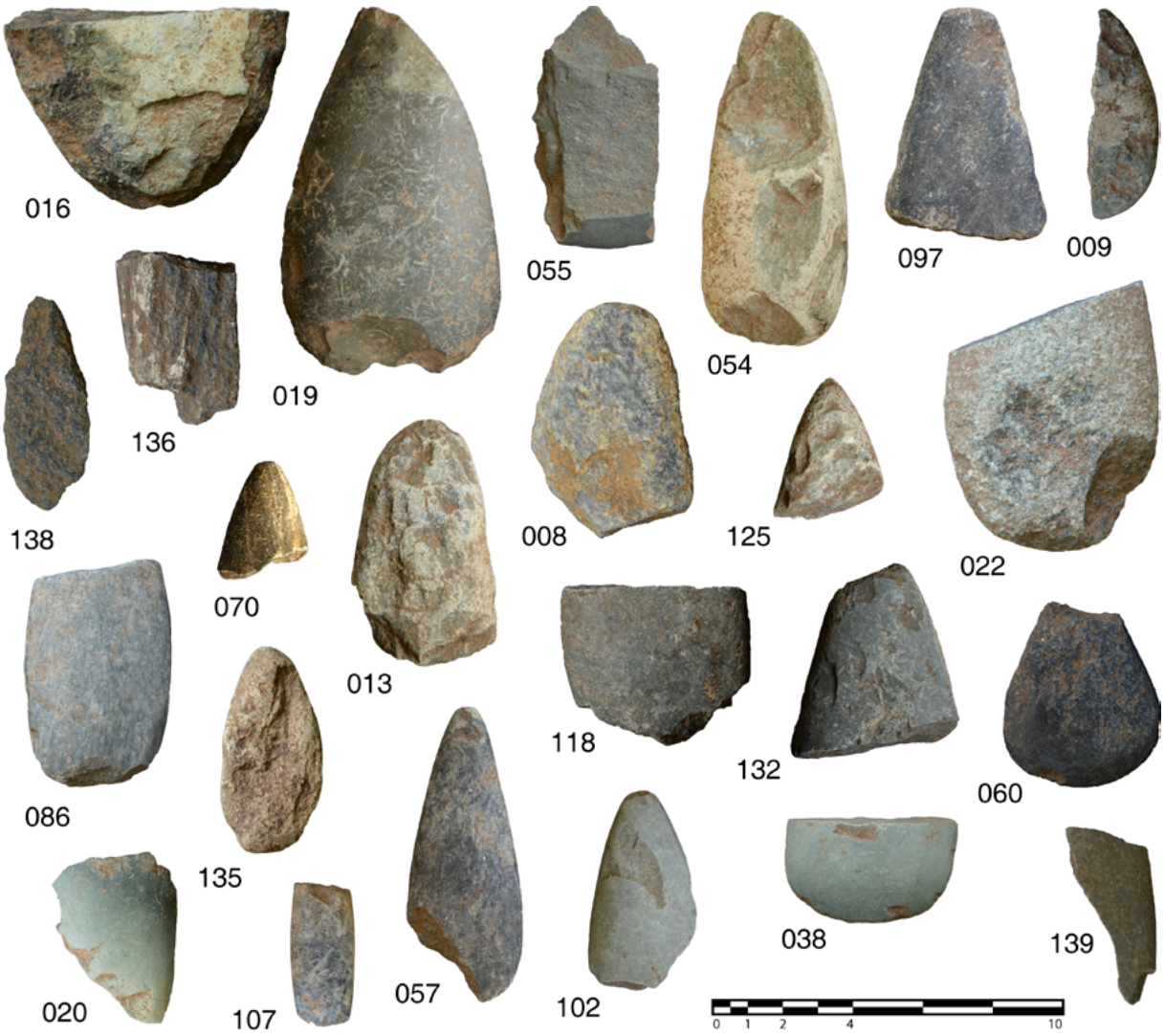


Figure 19: Celts from the analysed assemblage of Playa Grande.

occupation phase 5 (AD 1000-1200). The surrounding units (Cortes 1 to 6) are smaller, and only materials from Corte 5 UE 1 were included. This area consists of a dense stratigraphic layer of waste fill-in rich in celt materials and Chicoid series pottery, and is contextually broadly comparable to Corte 7 (A-H) (López Belando 2012, 71-82). The other units lacked significant celt materials or had them concentrated in deeper layers.

The materials were analysed in relatively clean state, and sediment encrustations were negligible. This can be partially attributed to mild soil compaction in several areas of the site, though the materials are expected to have been cleaned beforehand. Residues were low in number, and there are issues with the spatial distribution of the common heat-treated resins (Section 7.3.4). Grease concentrations were easily removable with alcohol. The main issue of preservation proved to be their unprotected bagging, allowing the materials continuous motion against one another which resulted in impact marks and stone scratches distributed at random over the surfaces. These traces were not detrimental to the study, but proved to be a hindrance regarding several issues. Chief amongst these were interpreting the techniques behind surfaces ground without polish development and assessing the nature of certain points of impact, both of which are treated with caution. Finally, notable leads were provided by the preliminary analysis which Knippenberg (2012) conducted to classify the various phases of the

reduction process. These indicate procurement from streambeds given the abundance of jadeitites with water-worn cortex, while flaking stages were thought to be absent considering the lack of on-site debris. The mineralogical and textural variation of the worked jadeitites somewhat exceeds that known from the Río San Juan Complex, but this likely reflects as of yet unsampled source variation (Schertl *et al.* 2018). Use in woodworking activities and hafting of the materials were reasoned to be evident. It also appeared that the indigenous craftsmen ceased grinding of the celt once a rudimentary edge was established, presumably due to the tenacity of the rock, and reworked certain edges into pounding implements. Knippenberg's study encountered difficulties with distinguishing water-worn from finely hammered and poorly abraded surfaces, particularly since these stages often occur intermixed and 'out of order' in the assemblage (Knippenberg 2012). These issues are largely resolved by the present study due to the use of multiscalar microscopy and the ability to conduct more extensive examinations.

6.2 Case study 2: Paraphernalia

6.2.1 El Cabo de San Rafael, La Altagracía, Dominican Republic

El Cabo de San Rafael is a habitation site located on a karstic promontory rising above the eastern shoreline of the Dominican Republic, facing the Mona Passage. This area is part of the so-called Chicoid heartland (Keegan and Hofman 2017, 141), densely inhabited in the past and the last region of Hispaniola to fall to Spanish colonial repression, during the Higueÿ wars of 1504. This also represents the terminal date of the site, which was variously inhabited from AD 600 onwards into the very early colonial period. Known since the early 1970's, the main series of excavations were carried out by Leiden University between 2005 and 2008 (Hofman *et al.* 2006; 2008b; Samson and Hoogland 2007). This project uncovered a large number of structures in the bedrock that represent a complex history in which individual houses were rebuilt to overlap with the preceding structure, resulting in long-term house trajectories (Samson 2010; 2011). Not all of these are contemporaneous, as – for instance – only one of the excavated house trajectories dates to the early colonial period. The habitation of the site appears continuous, however, with the later phase of construction dating between roughly AD 1100-1400 (Samson 2010, 120-124). The stratigraphy in this part of the site is a veritable palimpsest, with numerous centuries compressed in ca. 10 to 20 cm soil. The paucity of material remains from within the identified most recent structures, as opposed to their relative abundance on the outskirts of these, suggests that house floors were frequently swept clean. The material assemblage at El Cabo is dominantly Chicoid, though the earlier centuries are characterised by the Ostionoid series. Its midden deposits are located directly outside of the excavated habitation space, with progressively higher quantities of Ostionoid materials towards the north.

The site is located in the Seibo coastal plain which is composed primarily of limestone with coarse-grained sandstones interbedded close to El Cabo (for an overview see Samson 2010). Calcite occurs within this facies and nodules of other rock types are occasional found nearby, but the nearest primary deposits for igneous and metamorphic rocks are farther away: these are the Sierra Oriental and La Samaná in the Dominican Republic, and such rocks also outcrop in western Puerto Rico across the Mona Passage. Nevertheless, a large assemblage of edge-ground macro-lithic implements has been recovered from El Cabo, which contains many small and medium sized fragments of igneous and greenschist-facies rock types. A few rocks from higher metamorphic grade occur also occur within the assemblage (Hull 2014). Pilot analysis of this assemblage indicate a multitude of manufacturing techniques and modes of use (Breukel 2015), then considered similar to those seen at El Flaco, but

the assemblage awaits a more complete investigation. Other types of macro-lithic artefacts are rare at the site, and flaked siliceous materials are virtually absent. Conversely, coral objects are relatively frequent and implements were also made out of shell and bone. The site inventory also comprises a significant number of lapidary materials and paraphernalia, of which seventeen specimens of shell are included in the present work. This includes stone, bone, and shell ornaments of various types,[25] shell tinklers, engraved plaques, and other carved shell materials including some pieces that appeared to be incompletely made. Furthermore, the excavations uncovered twelve threepointers of various local and non-local materials (Breukel 2013) as well as pieces of a stone collar, small face-depicting objects (notably *guaízas*), and several other artefacts that are less typologically defined (Samson 2010). A cache with several thousand perforated dog and seal teeth was recovered from nearby (Ortega 1978a; 1978b) and a few of such objects were recovered from the site as well.

Contextually, most of these materials derive from the habitation area, though associations with a house trajectory are not always present. The most important house trajectory is trajectory 2, the one that reaches from the 11th century AD into the early colonial age. This trajectory is associated with early colonial pottery (olive jars and majolica) and beads of the Nueva Cadíz type (Ernst and Hofman 2015; Valcárcel Rojas *et al.* 2013), and also with some of the most elaborate paraphernalia excavated from the site (Breukel 2013; Samson 2010). Several other materials derive from house trajectory 3, which is associated with the pre-colonial Chicoid and the relevant houses in particular to the 9th to 12th century. Other materials derive from house trajectories 1 and 4 and are contemporaneous with the aforementioned ranges. Finally, a few artefacts derive from the excavation pits in the middens and surveying of the wider area, and include association with earlier Ostionoid layers. The taphonomic preservation of the shell materials is generally poor. Though the morphologies are macroscopically intact, the microtopography has generally not survived well. Striations presumably once formed during engraving and abrading contacts are no longer present, sharp angles have deteriorated, polish distributions appear to have been affected, and PDSM grease is frequently observed. These factors often impeded the high magnification analysis, and most emphasis was laid on the stereoscopic examination. Yet, also variables necessary to specify different grinding and incision tools (striations, wall morphology) have frequently deteriorated (cf. Figure A14, h).

6.2.2 El Flaco (paraphernalia)

The site of El Flaco was detailed previously (Section 6.1.2), but no attention was yet given to the context of its paraphernalia. Such finds include carved stone pestles, a lustrous twinned pendant, small spherical stones, marine animal dental elements perforated for suspension, as well as other carved and engraved ornaments (for these see Falci 2015a; 2015c). It are the dental elements that are of primary interest here, given the penchant for circulation exhibited by members of this artefact class. Three specimens of different design were available from the excavation seasons of 2013-2015, at least two of which derive from artefact-bearing horizons in the slopes of a platform mound. Several more have been excavated since, and skeletal refuse from marine animals is a regular occurrence (G. Shev, pers. comm. 2018). Though fractured and worn, these materials are in fair condition for microscopic analysis.

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25 These beads (single centre perforation) and pendants (off-centre perforations) are under analysis by C.G. Falci in the context of her doctoral research. Notable objects include nacreous pendants, asymmetric beads with frog-legged engravings, centrally perforated rectangles, and small carved appliques with unknown function.

6.2.3 La Luperona, Unijica, Dominican Republic

The site of La Luperona is located on the northern flanks of the Cordillera Septentrional, close by the northern entrance to the Paso de los Hidalgos with a view on the ocean eighteen kilometres away. Recent investigations were conducted on the site between 2011-2013 by the NEXUS1492 project and the Museo del Hombre Dominicano (Hofman and Hoogland 2015a; 2015b; 2016). These comprised trench and 2x2 test pit excavations and yielded numerous features belonging to house and kitchen structures in the site, also bearing evidence of fire-cracked rocks and burned trash deposits. Two radiocarbon dates place the occupation of the excavated area in the thirteenth century AD (Hofman and Hoogland 2015b). The material culture shares many similarities with El Flaco, as seen in the ceramic styles and fabric compositions (Ting *et al.* 2016), the ornaments (Falci 2015c), and certain paraphernalia. This includes a figurative pendant of calcite made in the same style as the lustrous pendant from El Flaco.[26] Studied at present is a bone adornment from Unit 4. Otherwise, the geological and natural environments of La Luperona are also essentially comparable to El Flaco for the present purposes. Mounds potentially existed on the site, but contemporary topographic variation now consists of only slight undulations in the landscape (Hofman and Hoogland 2015a).

6.2.4 Brighton Beach, St. Vincent

The site of Brighton Beach is located on the southeastern tip of St. Vincent, at the so-called Brighton Bay south of the mouth of the Diamond river. This is a large, multi-component site that is nowadays partially destroyed and remains under heavy threat from coastal erosion and illegal sand mining from its deposits (Boomert *et al.* 2015; Mol and Boomert 2011). Investigations by Leiden University between 2010 and 2015, in particular in 2011, revealed dense midden deposits that stretch from the earlier ECA (AD 100 onwards) to the early colonial period. These middens grade into yellowish sandy dunes formed during recent eolian activity that act as a barrier between the volcanic (black) sand beach and waterfront, and what is in contemporary use as topographically even pasture land in the valley behind them (Boomert *et al.* 2015). This area of the site contains few features, including postholes and potential hearths. The primary sequence from these investigations contains both earlier and later Saladoid strata, as well as Troumassoid and Suezoid materials. Besides pottery characteristic of these ceramic series, the site yielded several cherty materials including flint from Long Island, ochre, greenstone, a few fragments of eared axes and grinding stones, and abundant faunal remains.

The early colonial component is primarily known through surface finds of early colonial European beads mixed with European and Amerindian pottery, including much materials in the Cayo style. Previously, late pre-colonial and early colonial archaeological layers existed in the now destroyed northern part of the site. Of note is that Brighton Beach is located ca. 6 km south of the site of Argyle. This is a 16th century Kalinago settlement with a single Cayo component and a plethora of early colonial materials mixed with Amerindian remains (Allaire and Duval 1993; Hofman and Hoogland 2012). If they were separate social entities in historical times, the two communities still likely maintained close social and political contact. Relevant to the present work are two perforated dental elements from non-local mammals (Laffoon *et al.* forthc.) that are associated with the early colonial component of Brighton Beach. Both derive from the area of Unit A, of which the surface was

26 The specimen was recovered from layer 0 and analysed during the course of this work, but is not included in Chapter 9.

rich in Cayo style materials and European artefacts such as gunflints (Mol and Boomert 2011, 21, 25). The smaller *Sus scrofa* incisor derived from the surface, the pantherine canine from the uppermost archaeological level. Their preservation is poor in some respects but moderate in others; the canine shows differential weathering with one side retaining a greasy but mostly preserved micro-topography and the other a degraded and bleached surface, likely due to extended exposure to the elements before finally being covered. In contrast, the surface-found pig incisor was weathered over its entire surface. Some of the biographical complexity of these objects was realised only in hindsight (they were studied early on) and re-examination is advisable when they become available for analysis again.

6.2.5 La Poterie, Grenada

The site of La Poterie is situated on a sedimentary bluff in St. Andrew's parish, northeastern Grenada, facing the Atlantic Ocean and overlooking Conference Bay to the south. It is primarily an early colonial period site yielding Cayo style pottery and various European artefacts, but also contains significant Afro-Caribbean and late pre-colonial Troumassoid components (Hofman 2016; 2017). Archaeological investigations on the plateau have uncovered a series of domestic structures, whereas much of the material cultural repertoire has been retrieved as floor-swept secondary deposits from the base of the eroding cliffs at sea level (Hofman 2016, 35). This type of site is characteristic of habitations affiliated with Cayo pottery in the region, including the site of Argyle, St. Vincent (Hofman and Hoogland 2012; cf. Petitjean Roget 2015a, 159). Radiocarbon dates place the occupation of the site between the 8th and 18th century AD, with the early colonial Cayo locus dating between AD 1500 and 1600 (Hofman 2017, 17, 26).

The site was first brought to light by D. Charles, a local inhabitant of La Poterie, who collected archaeological materials eroding out of the cliff following a landslippage in 2010 and brought them to the attention of the archaeological community (Hofman and Hoogland 2016; Petitjean Roget 2015a, 98-99; Petitjean Roget and Charles 2015). As with Argyle, this cliff side acted as trash disposal location during the indigenous occupation of La Poterie and accumulated cultural materials with no further stratigraphic context to them. Amongst these finds are large fragments of locally made Cayo pottery (Scott *et al.* 2018), use-modified macro-lithics, various osseous artefacts, Spanish coins, early European pottery, and gunflints (Petitjean Roget and Charles 2015). No metal objects, flaked lithics, or formal macro-lithics were recovered during the investigations, raising questions about local subsistence and exchange economies. The osseous artefacts include three perforated dental elements of tapir and peccary that originated in different locations from mainland South America (Laffoon *et al.* 2014), and two wind instruments made of deer bone analysed in the present work. These materials are very poorly preserved, perhaps as a result of their interment in the acid clay sediments of the site. This is the case more generally for bone and shell materials from the plateau also (Hofman 2016, 19). The specific taphonomic and curatorial modifications of the two windpipes are discussed in detail in section 9.3.

Of note is the recovery of several rectangular to oval sheets of fine-grained sandstone, with rounded borders and flattened faces. These objects have the overall morphological appearance of tools capable of operating as abraders for sawing grooves and sanding surfaces (Figure 20). If confirmed as used, such artefacts would be defined as saws or perhaps files or knives, being active abrading tools that permit flexibility in the production of smoothnesses, curvatures, and three-dimensional aspects in objects. I specifically highlight their presence in La Poterie with respect to the discussion

of the experiments (Section 5.3.1) and the interpretation of technological traces on p006 from Grenada (Section 9.3), since such implements are not generally reported from the Antilles.[27]

Figure 20: Thin sandstone slabs from La Poterie, up to 5 mm in width (Charles collection).

6.2.6 East Grenada

Several of the paraphernalia studied in this work have the broader provenance of eastern Grenada. These are all materials made available from the collection of the Willcox family that derive from the general area of La Poterie-Pearls, inhabited uninterruptedly for at least the past two millennia, but where the site context is less precise. This is the case for the large *guaíza* engraved with curvilinear designs, that stylistically exudes its being a Greater Antillean exotica in the geographic context of the southern Windward Islands. Its microtopographic features are fairly well preserved, and the analysis of it links with the selection of similar artefacts from El Cabo previously. The wooden artefact of section 9.4 is included in the present work on the same grounds, in spite of it originating from a submerged archaeological site in southern Grenada. This object also provided the unparalleled opportunity to conduct a methodological analysis of such paraphernalia in wood. Finally, three carved bone pipes are ascribed to the site of Telescope Point, a Cayo affiliated early colonial period site that is probably located on the promontory south of Pearls that is intervisible with La Poterie. The exact coordinates of its deposits have not been established in spite of repeated visits to likely locations, probably due to extensive landscape modifications in the area (de Ruiter in Hofman 2016). The association of its deposits with the early colonial period is based on shared provenience with a series of intact Cayo affiliated vessels (Petitjean Roget 2015a), made locally in Grenada but exhibiting a variety of stylistic influences (Scott *et al.* 2018). The bone instruments themselves are in poor to very poor condition of preservation, and as before and due to the unique circumstances of these artefacts this is discussed in detail in section 9.3.

27 It is my suspicion that sawing and filing sheets are not easily recognised as important potential assets to craft production, and that within site assemblages they have rather remained within the larger mass of lithics classified as unmodified stones. Finegrained sandstone knives are reported from Barbados (Drewett and Cartwright 1991), and argillite slate knives have been found in the Coashiati site, Aruba (Rostain 1997).

7

Assemblage biographies of edge-ground celts

This chapter contains the results, presented as the analysis of all biographical possibilities that occur within the assemblages, highlighting the general patterns and commenting on significant deviations wherever these occur. The data obtained from each individual artefact is organised in Appendix 3, ordered according to the biographical phase to which it pertains. Comments on the analysis of specific objects are also made available there.

The numbers provided in each subsection are reduced from the totality of the assemblage to the number of specimens relevant to that subsection. By way of example, butt fragments are not accounted in percentages on edge use-wear (they are inherently empty records) and are also discussed separately from medial fragments with respect to the traces of hafting (it is often not clear whether fragments would have been in the position to contact a potential haft to begin with). Accordingly, the numbers cited therein are not initially relatable to each other.

7.1 Pearls

The analysed selection from Pearls includes 21 specimens. Most of these are intact artefacts and thus provide data on the complete biography. Hence the Pearls assemblage offers a comparatively deep understanding of the different biographical possibilities, even if the sampling strategy precludes assemblage representativity to the results. The picture on procurement and early reduction strategies is less illustrative, however, as few materials in the assemblage could provide good information on these stages. Similarly, analysis of the depositional processes is comparatively hampered by the lack of contextual data. All materials were studied in the field.

7.1.1 Materials and procurement strategies

An overview of the raw materials in the selection is presented in (Figure 21). The group is diverse and exotic rock types are overrepresented in comparison to the total assemblage.

High-pressure rocks predominate, and harbour a degree of variation within their group. The majority are jadeitites (>95% jadeite mineral content) but this group is varied: some are slightly foliated or banded, one stood out for the observation of mica and another for its omphacite content (Davies, pers. comm. 2015). Two more are jadeite-bearing high-pressure rocks but their mineral content is potentially more heterogeneous. P 001 appears to be rich in omphacite. All are heavy and dense, and barring one all have a fine-grained, sugary texture exposed in fresh fractures. The RSJC is the nearest known source of jadeitite at >1200km direct distance. However, only the MFZ is known to have been

exploited at times contemporaneous to the ECA, and is at >3000km direct distance. The provenance of these materials is under geochemical investigation (Knaf *et al.* in prep.). Until then, it remains possible that they originated from multiple sources or from as of yet undiscovered localities as well. It is also unknown whether the potential routes were archipelagic, coastal, or inland. However, there is some evidence indicating that at least part of the materials entered Grenada as unmodified blanks collected from secondary contexts. A petal-shaped water-rolled pale jadeitite pebble measuring ca. 75 mm forms a medium-sized blank. The pebble was never worked and this is possibly due to a vein crosscutting the material. Furthermore, Falci *et al.* (in prep.) found two unmodified jadeitite blanks and a core associated with lapidary production. The colouring of the jadeitites is diverse. Most are pale translucent, ranging from very pale green towards light green and mottled variants. Two are of a deeper olive green and few contain darker minerals.

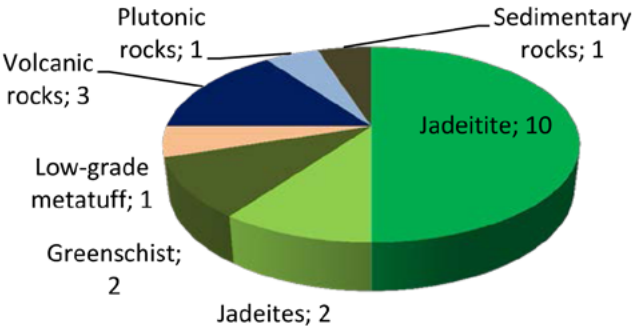

Figure 21: Overview of raw materials from the Pearls sample.

At least five finished specimens (42%) exhibit internal defects that were exposed during reduction and could not be erased by further shaping (Figure 22). They consist of crack lines and vugs, some of which quite severe, that do not follow initiation/termination outlines characteristic of (technological)

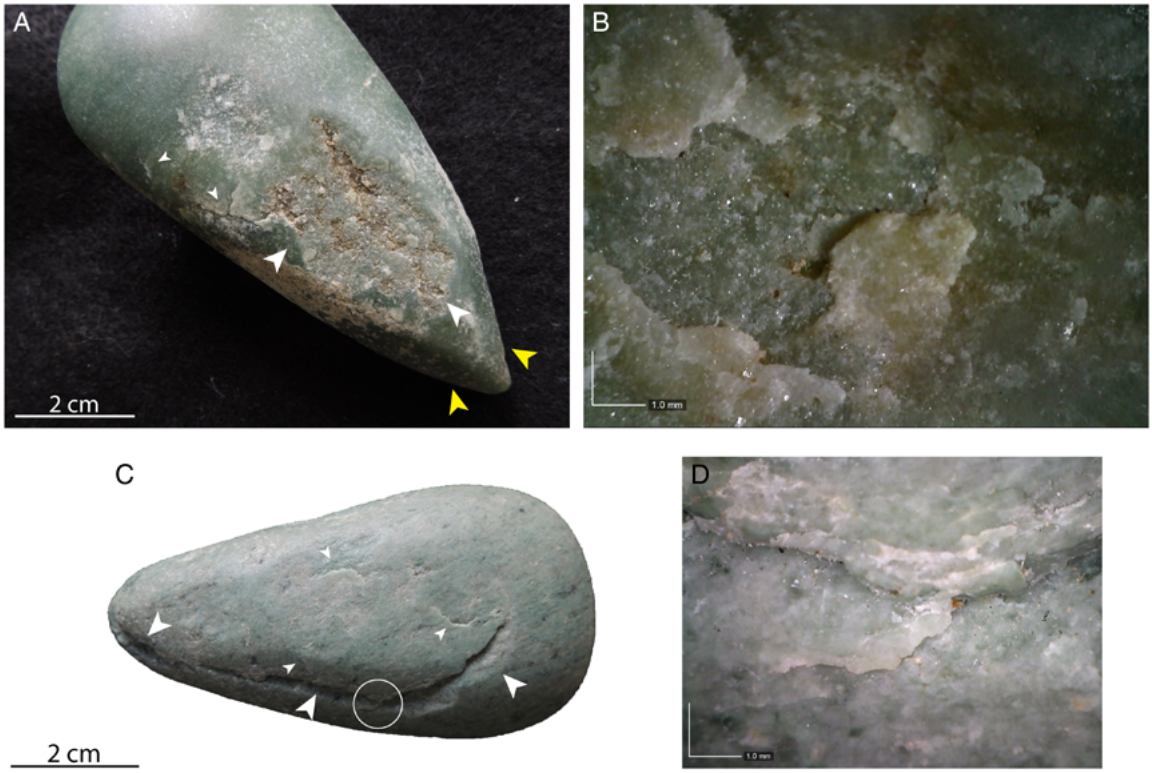

Figure 22: Stigma in jadeitite celts from Pearls. A) Vug in P 009 exposed during manufacture (large arrows) and smaller crack lines (small arrows). Note also bilateral 'burin facets' (yellow arrows). B) Well-formed, fresh crystals exposed on P 018. C) Deep crack on P 003 running lengthwise (large arrows), paralleled by minor sub-surface crack lines (small arrows). D) Close-up of white circled area.

impact scarring. The boundaries of these features are abrasively smoothened over and were thus formed prior to manufacture. It is possible that they are natural features of poor quality raw material, in which case the question rises why they were retained. Perhaps the flaws were not initially noticeable if the rocks arrived at Pearls in unworked form. Alternatively, they may be technological stigma from heat contact, proposing the possibility of mining from primary context through fire-setting. The same features are observed in experimental, ethnographic, and archaeological contexts of high-pressure rock celt procurement (Lozano *et al.* 2017; Pétrequin *et al.* 2008; 2012a), but other associated stigma such as rubefaction and curved flake profiles were not. The issue is further discussed in Chapter 8.

The other metamorphic rocks in the sample include a very fine-grained low-grade metatuff and two fragments of fine-grained greenschist. All have massive fabrics, with the metatuff having mottled grey-brown colours and the greenschists being typically green. Neither rock is local to Grenada. Both lithologies could derive from mainland South America, for instance from the Guiana shield through the stone axe production networks in that area (Boomert and Kroonenberg 1977). Low-grade metamorphic rocks including metatuff and greenschist are also known from the geology and archaeology of Tobago (Boomert and Rogers 2005). They similarly occur both in the geological and archaeological assemblages of the Dominican Republic (Section 7.2 and 7.3), making the Greater Antilles a third possible point of origin. There are no indications of possible procurement strategies. The final greenstone is not metamorphic but a volcanoclastic sediment, which has thin bands in lighter and darker greens radiating over the surface. It is fine-grained and relatively heavy, and the only specimen within the collection to display this pattern. Its provenance or procurement are unknown.

The three volcanic rocks include an olivine-bearing ultramafic semi-lunar axe, an ultramafic volcanic lava, and a large trachyte/phonolite roughout. The fourth igneous rock is a fine to medium-grained plutonic with a dark, near-black appearance mottled by light coloured minerals. The ultramafics are dark, almost black in colour whereas the trachyte/phonolite is blue-greyish in appearance. The olivine content points towards the South American mainland as the most likely source for the semi-lunar ultramafic (Davies, pers. comm. 2015), which is in accordance with the typology of the specimen. For the other ultramafic and the plutonic rock no specific origin can be given. Trachyte and phonolite potentially occur throughout the volcanic arch. This specimen was collected from a secondary context and transported to Pearls as a raw material blank, given that it still exhibits some water-worn cortex.

7.1.2 Early reduction

The reduction trajectory is clear only for the trachyte/phonolite roughout. The original boulder approximated the current dimensions, given that the butt was left unmodified and patches of cortical surface also remain on the edge. Two well-placed blows thinned the bifacial outline, with one slight bulb of percussion on the blade evidencing direct percussion. This was followed by impacts on the bilateral sides, which are variably defined by heavy step/hinge terminations and major crushing overlapping earlier scars. Both stigma indicate that the dominant technique of bilateral shaping was bipolar percussion. Still, the continued use of direct percussion is implied by several less invasive conchoidal scars on the edge. Some crushing is also attributable to a roughing up of scar ridges. Manufacture of this specimen appears to have been discontinued due to a series of large, heavy hinge terminated scars located proximolaterally to the edge, which severely weakened the mass of the blade (Figure 23, a).

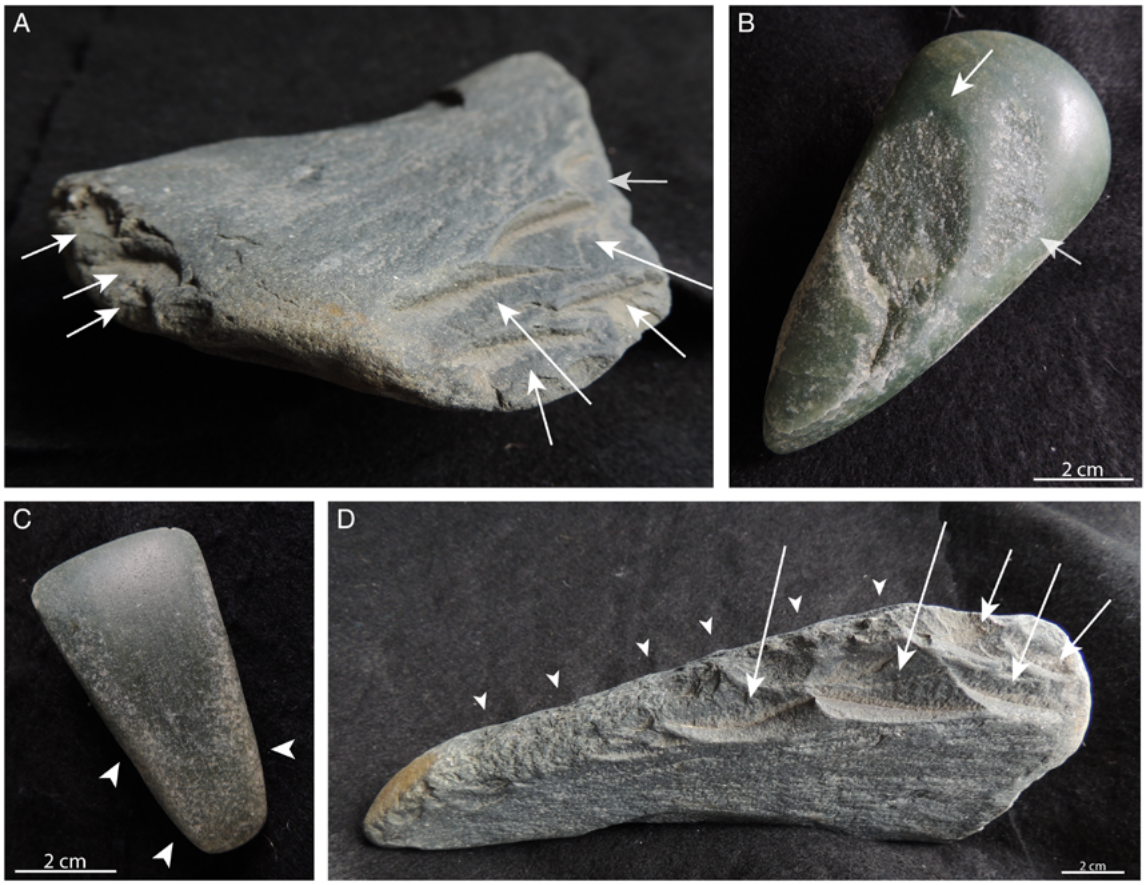

Figure 23: Manufacturing traces in Pearls. A) Invasive flake reduction on trachyte/phonolite P 014. B) Bifacial thinning scars on jadeitite P 009. C) Pecking traces on jadeitite P 010. D) Scars from impacts and counterblow (small arrows) on P 014.

The jadeite bearing rocks display enough evidence to presuppose that a flaking phase was widely applied, but not enough to reconstruct to what degree that operational sequence was shared. Some retain evidence related to the shaping of the sides and the blade, seen in vestigial scars and the asymmetry of the resulting edge. Flake negatives on the butt remain present on two other jadeitites and on the sedimentary rock. Bifacial thinning is observed in three jadeitites where shallow flaking concavities are retained in spite of subsequent abrasive manufacture. In a fourth the technique has left deep scars terminated only by flaws in the rock (Figure 23, b). The bilateral plane of this specimen is characterised by two large scars along the parallel axis, which approximate burin facets (Figure 22, a). These scars appear to be stigma from the burin blow technique (Inizan *et al.* 1999, 84-85), rather than a preparation perpendicular to the faces as is common to bilateral aspects. They run from the butt upwards for about one quarter of the total length, and visibly interrupt the intended petal-shaped outline. In this particular specimen (P 009), the reduction programme is poorly executed in comparison to other materials. The invasiveness of the flake scars indicates a lack of technical know-how in shaping jadeitite, perhaps in the form of misapplied force or inappropriate hammerstone materials. The damage is too extensive to fully erase by later smoothening, though in most other cases attempts were made. In comparison with the other materials, such flaws appear comparatively more often on jadeitite and to larger degrees.

Little can be said for the early reduction sequence of the other raw materials. Small vestigial flake scars were found on the edge and tang of the ultramafic semi-lunar axe, which were not completely

erased by later treatment. These remain from the knapping of the outline, indicating a previous phase where the morphology was shaped through numerous small and well-placed facets. The metatuff, plutonic, and greenschists bear no compelling evidence of a potential flaking stage.

A similar conclusion is reached for the pecking of preforms. Seven celts display some form of pecking, six being jadeitite and one greenschist. Pecking traces take the shape of regularly spaced surface pitting in most specimens, the pits being interstitial remnants of the pecked topography that were not completely erased. Such traces will disappear upon better levelling, or can be mistaken from intrinsic porosity: this is why the ultramafic celt lacks confidence for this technique. Two jadeitite specimens are incompletely ground, and here the pecked topography is retained in full towards the sides and back of the object (Figure 23, c). In both the roughness remains low and craters small, indicating careful finishing of the impacts with fine precision favoured over rough crushing of the topography (Section 4.1.3). Coarse pecking is seen only in the repurposed jadeitite in which these pecked areas are superimposed on the polished surface.

7.1.3 Abrasive manufacturing

All celts were subjected to an abrasive treatment, with the exception of the roughout (Table 5). Many exhibit multiple applications of both grinding and polishing. Twelve specimens display well-developed bright lustres, ranging from a deep greasy gloss to a vitreous shimmer. Prior abrasive reduction techniques could not be recognised in six of those, but are inferred to still have taken place for those polished with soft materials. As most were incompletely polished evidence of reductive grinding was often retained. One sign pertains to the retention of coarse grinding grooves on the sides in cases where they are clearly not associated with the later abrasive technique. Multiple abrasive techniques were observed on nine jadeitites (75%), and further on a greenschist, ultramafic, and sedimentary rock. Though these percentages again reflect the sampling strategy, there is a higher tendency for green-coloured rocks within the assemblage to bear stronger lustres. In 73% the abrasive action occurred all over the surface, though not reaching deeper production scars and often superimposed by pecking marks on the sides. The remaining five specimens were abraded mainly on the bevels and faces.

Table 5: Trace signatures of abrasive manufacture categories in Pearls.

***n*=19**	**Dull**			**Bright**				**Multiple**	**Other**
	Dry ground	Intermediate	Sand-ground	Wet ground	Mirror	Wood	Soft		
Igneous rocks	1	1		2				2	2
Low-grade rocks		1	1		1			1	1
High-grade rocks	1		3	2	2	2	3	9	1
Sedimentary rocks			1		1			1	
Total	2	2	5	4	4	2	3	13	4

*Dull lustres (*n=*11)*

A jadeitite and plutonic rock both display a well levelled microtopography characterised only by a dull, flat scintillation that strongly resembles the 'dry grinding' signature obtained experimentally (Section 5.1.2). The plutonic rock also displayed the coarse grinding grooves discussed above, indicating the use of a less fine-grained rock than the experimental platform; the jadeitite did not and most closely

resembles the result of exp. 2510 (greenschist blank on quartz arenite). Stereoscopic striations are otherwise rare amongst the sample, and the technique(s) associated with the coarse grinding grooves on the sides could not be interpreted due to complete overlay by other wear patterns.

Nine additional specimens display microtopographies that remain characterised by a dull and rough scintillation of the higher areas, but show varying invasiveness into the upper and lower slopes (Figure 24, a-c). The signatures corresponds to asperities crushed and further rounded by abrasion and fatigue stress, and match well with the experimental 'sand-ground' results. These traces are found across a range of rocks, including four jadeitites, one greenschist, the sediment, olivine-bearing ultramafic, and metatuff. Variation in the wear trace signature persists within this group, however. The contrast between the modified highs and unmodified lows is lower in some specimens, on which 'stone scratches' (see Table 2) are also present. These two fall in between the 'dry ground' and 'sand-ground' signatures (Table 5). Others developed a stronger, brighter topographical contrast and small isolated rough polish structures. The microtopographies of a greenschist (P 015) and jadeitite (P 011) show a distinct wear characteristic. They display the general rough, invasive scintillation and rounding of a 'sand-ground' signature, but the space between the rough textured points (which are not erased through abrasion) has been smeared out into extensively distributed dull polish (Figure 24, d). There are hints of this occurrence in the manufacture of experiment 2550 (Appendix 1), but not to the extensive distribution seen here.

It is difficult to estimate to what degree this range reflects one or more technological variations, since there will be some interference from the rocks themselves differentially responding to the

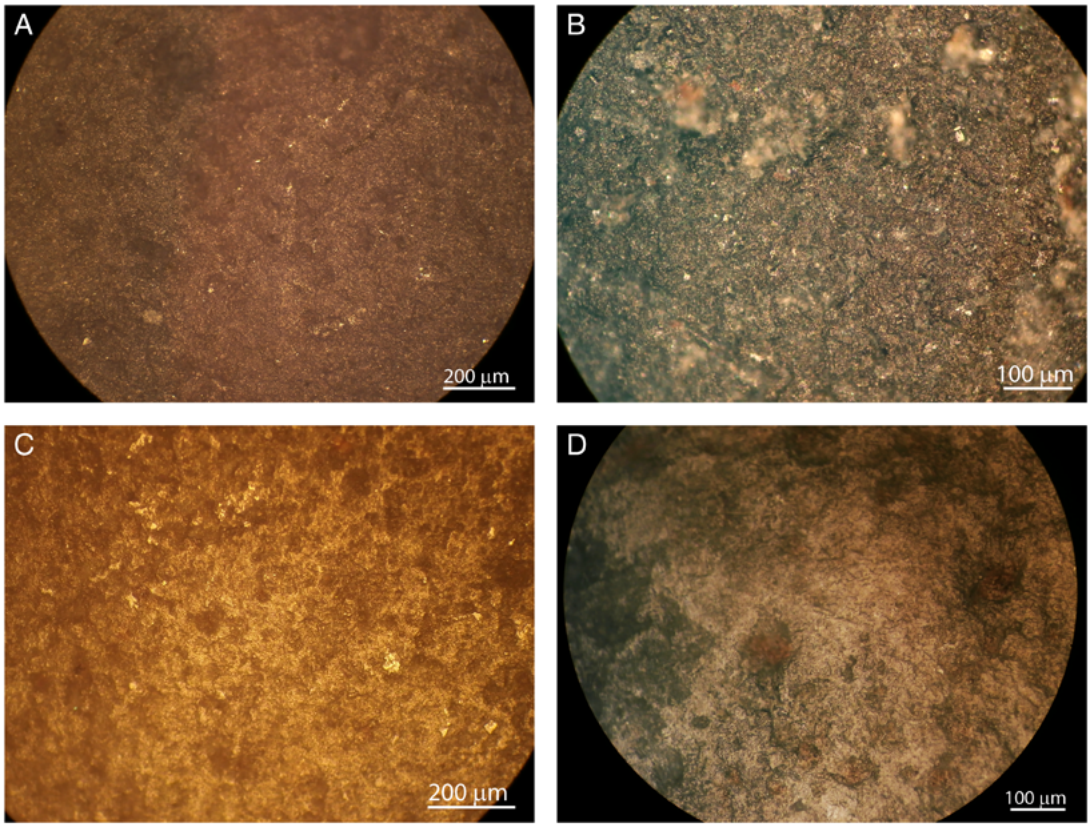

Figure 24: Wear traces from abrasive grinding in the Pearls assemblage. A & B) Dull and rough scintillation from 'dry grinding' on olivine-ultramafic P 006. C) Brighter and rough scintillation from 'sand-ground' techniques on volcanoclastic sediment P 005. D) Rough micro-asperities amongst smeared dull polish on greenschist P 015.

interaction. Further overlay by later wear trace patterns may also play a role in the brighter and more rounded appearance of certain micro-topographies. Still, the use of either loose sand abrasives or sandstones of similar granularity and cohesion as experimental platform exp. SWH seems evident. Perhaps both were in use for different artefacts, depending on the context in which they were abraded (at Pearls, or before) and where the community obtained its grinding platforms from.

Finally, a successive finer grinding technique was applied to two igneous specimens, which show thin striations located parallel to the edge. These indicate contacting rocks of finer granularity than the grinding slabs or abrasives, likely applied to sharpen the edge after grinding. Since igneous rock blanks were more susceptible to retain striations during the experiments, the absence of such whetting on the metamorphic rocks in the sample is not regarded as indicating differential treatment.

*Bright lustres (*n=*13)*

Six other manufacturing wear signatures are heuristically distinguished as polishing techniques, since they resulted in the visible surface lustres. They pertain to stone grinding polish, mineral derived polish, wood derived polish, and indications of the use of soft materials. The distribution of these lustres is usually at the most intense on the proximal and medial face. Fluid transitions with the bevels suggest that in many cases these areas were originally polished towards a similar intensity, which is now covered by wear from subsequent use. Towards the backside most lustres fade out independently of the distribution of hafting friction, suggesting that this cut-off reflects the extent of the focus on polishing.

Three specimens display traces interpreted as the result of polishing with different variants of soft materials. The surfaces of two are characterised by a greasy lustre with the naked eye, mirrored by a microtopography covered in a dense blanket of polish. Its texture is rough and dull and it is evenly spread throughout the microtopography in a highly invasive, connected/covering distribution. Any angularity in the asperities is rounded and most areas evidence a lack of relief reduction (Figure 25, a), which distinguishes this modification from the scintillative categories of hard stone grinding traces that evidence abrasion and/or fatigue wear (Section 5.1). Adhesion shear is probably the dominant mode of wear, and a soft contact material is strongly implicated. The microtopography of the third celt shows a higher contrast between small, rough, and bright polish structures on the higher points, a widely distributed dull and rough blanket over the intermediate relief of the slopes, and the unmodified deep interstices (Figure 25, b). The asperities appear more strongly smoothened, but the relief is otherwise largely unmodified from what is inferred as a preceding abrasive technique. The two wear trace patterns potentially indicate different types of soft contact materials, such as hide, prehension, or non-siliceous plants versus more abrasive silica-rich vegetal materials (e.g. palm leaves, bamboo stems). Experimental work is needed to understand the interaction of various potential candidates with a jadeitite matrix.

Two celts displayed traces of wood friction, homogeneously distributed over a well levelled surface. The consistent association with abraded surface areas evidences that these traces relate to a polishing technique, rather than to use wear or hafting friction. P 003 has use traces distinct from the polishing and displays more plant-like hafting wear, whereas P 009 appears unused lacking both use traces and haft friction. Their macroscopic lustre is also greasy, but much brighter than that of the surfaces just described. Microscopically, the polish is domed, pitted, and bright on the asperities, and rough and dull on the upper slopes (Figure 25, c-d). The characteristics are divergent otherwise:

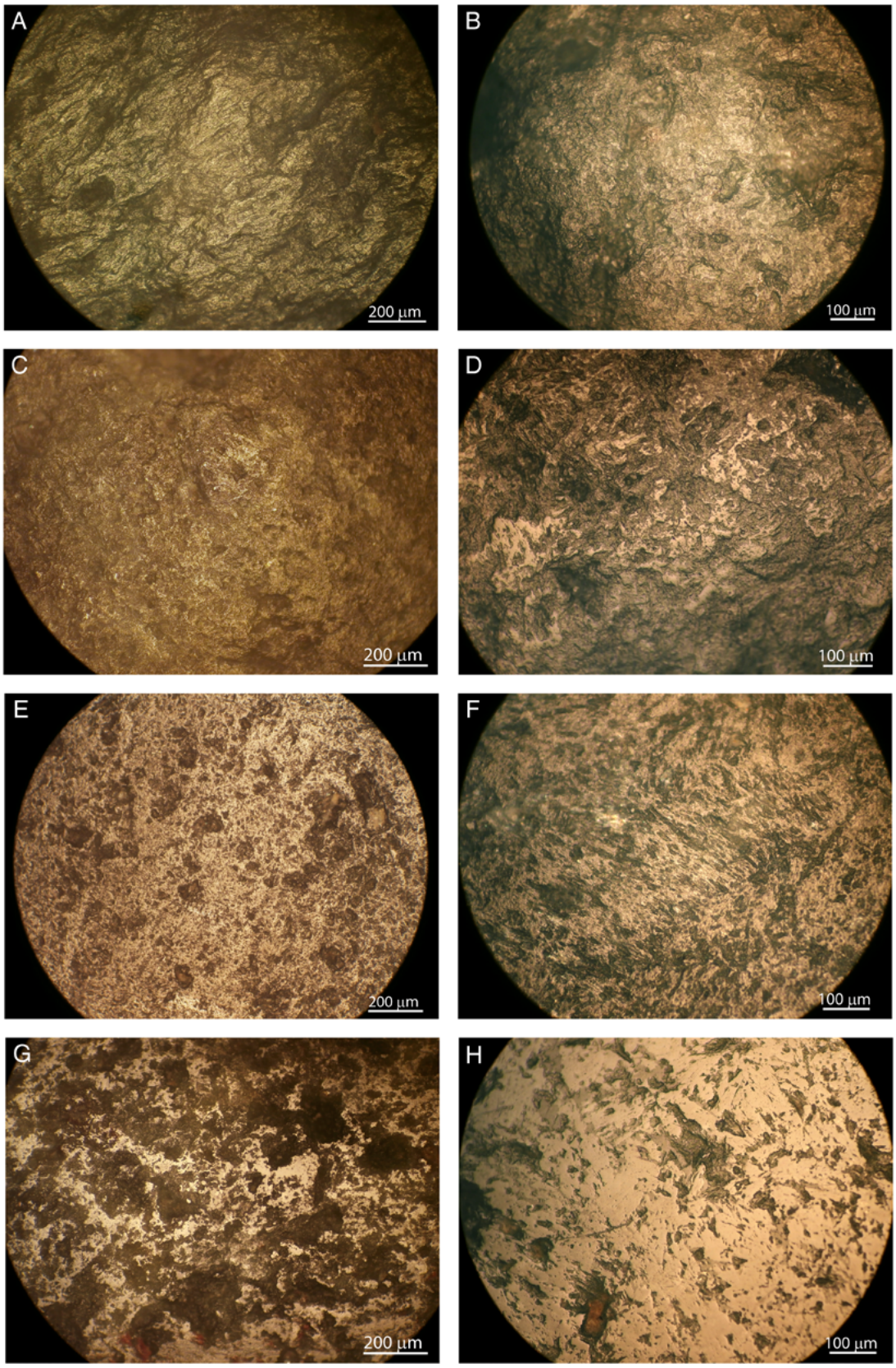

Figure 25: Wear traces from various polishing techniques in Pearls. A) topography from polishing with soft material A on jadeitite P 001. B) topography from polishing with soft material B on jadeite-bearing P 013. C) traces from friction with wood on jadeitite P 003. D) traces from friction with wood on jadeitite P 009. E) wet grinding traces on a quartz arenite type of platform on jadeitite P 021. F) wet grinding traces on a hard lithic platform on ultramafic P 019. G) 'bright mineral mirror polish' on greenschist P 016. H) 'bright mineral mirror polish' on jadeitite P 011.

on P 003 the domes have a rough and slightly greasy texture and remain mostly isolated, whereas on P 009 the polish developed more extensively. It is smooth to almost flat and topographical doming abates, with a connected/loose distribution and striations in multiple directions. The rough polish is bright immediately afterwards and dissipates at lower elevations, indicating mild pliability in the contact materials. The former wear trace pattern of P 003 closely resembles the outcome of the friction experiment against seasoned dense hardwood (Appendix 2, exp. 2552), and was likely subjected to polishing with such a material for no longer than intermediate duration. The latter signature seen on P 003 indicates hard wood in which more moisture was present, either from fresh preparation or (more likely) added as lubricant.

Four celts displayed traces resulting from extended abrasive contact with a hard and cohesive lithic platform under wet conditions. Two of these exhibit the same characteristic as the abrading experiments using quartz arenite under wet conditions (Figure 25, e). The microtopographies display very bright, flat, and rough polish in covered/connecting distribution, that exceed the experiments in developed intensity. The surfaces are also slightly striated under low magnification, and the abrading platform is therefore inferred to have been a rock of similar properties as exp. 2497 (Section 5.1.1). Evidence indicating a previous abrasive technique was observed on both. The other two celts exhibit similar traces of abrasion, but the overall topography is more directional and retains more evidence of crushed and abraded peaks in its relief (Figure 25, f). The polish is also less bright and in covered/closed distribution, failing to connect over the higher ratio of interstitial space. The overall appearance is very similar, but the granularity or mineralogy of the abrading platform probably differed somewhat, i.e. less angularity, more matrix content, or mineralogical heterogeneity. The macroscopic lustres were of (sub)metallic intensity.

The final polishing technique observed in this assemblage, which results in a bright metallic to vitreous lustre, was applied to four specimens. The topography is extremely levelled, and microscopically corresponds to a very bright and extremely flat polish restricted to the asperities that reach the upper topographical level (Figure 25, g-h). The polish occasionally displays small pits (probably from particle ejection under fatigue stress) or extremely fine multidirectional striations, and is sharply bounded from the interstitial space. The interstitial space may be very shallow and is usually not modified, but sometimes carries modification from previous abrasive episodes such as a 'sand-ground' pattern. The wear signature is quite typical, and is henceforth referenced to as 'bright mineral mirror polish'. It has not been experimentally reproduced thus far; the interpretation is further discussed in section 10.2.3.

7.1.4 Composition of the hafts

The indications for hafting is well preserved within this assemblage, and various ways of dealing with the handling system could be distinguished. The exclusion of the blank, roughout, and edge fragment leaves 18 artefacts potentially bearing traces of wear, resulting in a complete reconstruction of the hafting arrangement for twelve specimens (including un-hafted wedges). The main hafting arrangements that result from the analysis are represented in Figure 26.

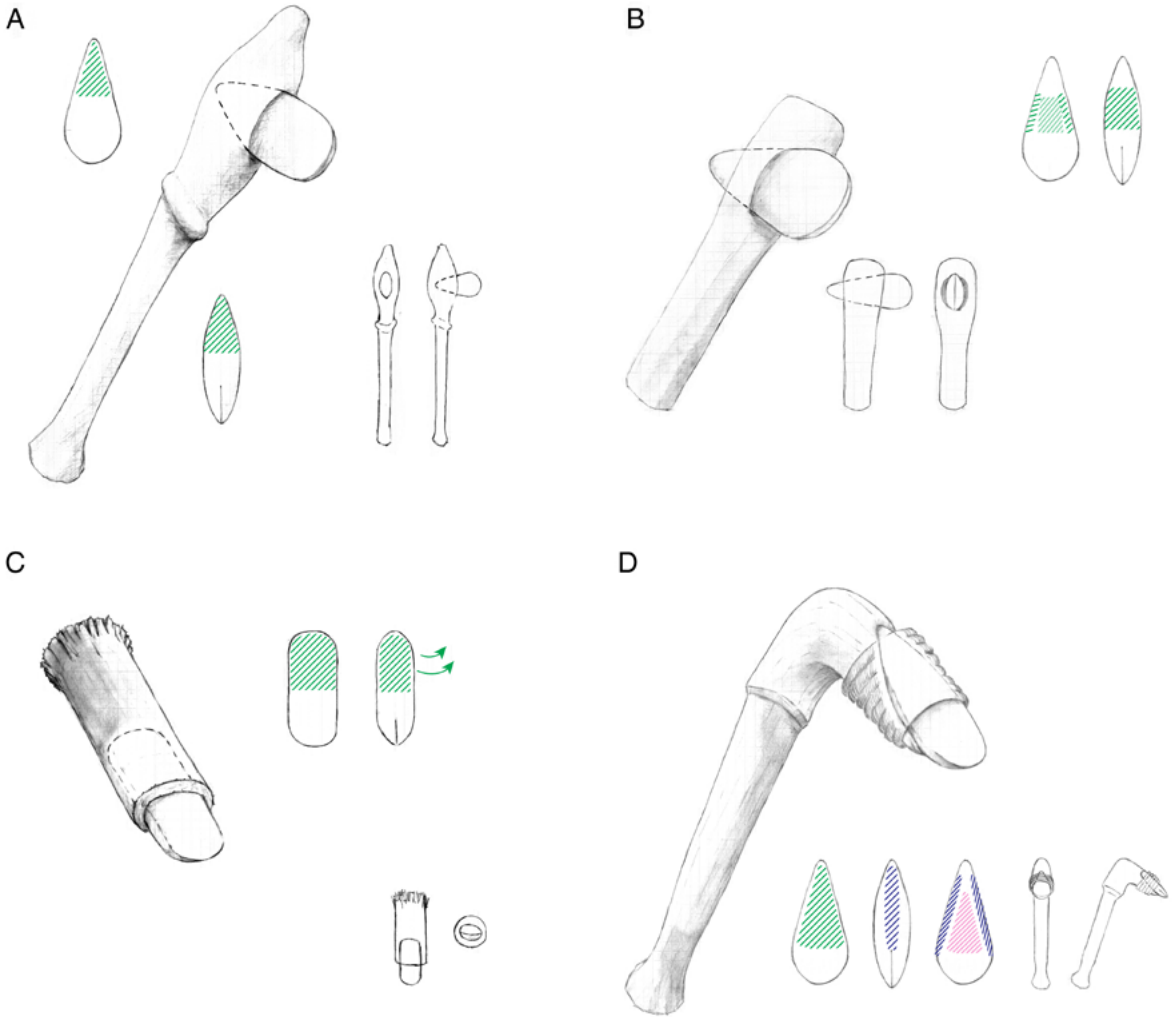

Figure 26: Identified spatial zones correlated to basic hafting types for edge-ground macro-lithic tools. A) male embedded axe, P 002. B) male split axe, P 021. C) male embedded chisel, P 001. D) juxtaposed adze, P 013. Green hatching indicates friction against the material of the handle, blue hatching indicates friction from binding materials, transparent hatching indicates areas of non-obligatory contact. The designs of A, B, and D are inspired by published photographs of recent finds from Los Buschillones (Jardines Macías *et al.* 2013; 2015), and the thickened distal pads follow a handle from north Caicos (Mason 1876, 373).[28] Drawings by Finn van der Leden.

Axe-style hafts (n=5)

Three specimens display traces consistent with lateral-transversal direct parallel-male fitting (see Figure 4), corresponding to basic axe handles (Figure 26, a). The traces consist of a slightly domed topography with smooth but uneven polish, restricted to the asperities and little interlinkage. The topography approximates that of the experimental chopping of desiccated seagrape (exp. 2550 phase 4, Appendix 2.2), and is in general characteristic of well developed wood contact wear. These traces evenly cover a clearly defined zone on the butt, evidencing a single contact material on all sides, beyond which they disappear abruptly to give way to the manufacturing wear present underneath (Figure 26, a, green

28 Note that most known long handles actually have male split attachment slots, and that P 021 from image B is a very large-sized celt that in reality was hafted in a large handle. An embedded design would be more suitable for medium or short handles, but no such handles are archaeologically known to me.

hatching). Two of these contained residue deposits in association with the hafted zones, which based on morphological grounds could be a type of processed, non-pristine resin (following Langejans and Lombard 2015, 206). It corresponds to a category of residues that is documented under laboratory conditions for the assemblage of El Flaco, and will be detailed exhaustively in section 7.2.4. The smaller celts were embedded for ca. 1.5-2.5 cm and the larger one up to 5 cm in its haft. All had symmetrical distributions of use wear traces, suggesting the orientation was parallel and not perpendicular (i.e., they were not male-hafted adzes).

A similar attachment system but one in which the slot fully perforates the handle (male split) is indicated for two fragmented, (very) large-sized specimens. One displays a polish similar to exp. 2552 (seasoned wood friction): this is developed very densely on the curvatures that lead towards the lateral sides, but fully absent in the centre of the face. It is consistent with the faces left floating in the socket to prevent pressure on the thin walls from potentially breaking the handle. The other displays well developed polish indicating contact with wood on all distal aspects, terminating evenly after 5.5 cm counted distal to medial, and with a slightly brighter and smoother texture on one lateral side. The fact that its butt is missing and estimated to have added between five and ten centimetres of length strongly suggests the axe protruded from a split slot (Figure 26, b). Neither carried micro-residue deposits.

*Chisel-style haft (*n=*1)*

A terminal-axial positioning is inferred for P 001, otherwise hafted as perpendicular-male and embedded (Figure 26, c). Polish from friction with wood is well developed on the distal areas and extends into fracture negatives, suggesting de- and re-hafting episodes next to an extensive use life. The texture somewhat resembles the non-corrugated areas on exp. 2553 (soaked wood friction), which may simply indicate a different wood. Crucially, the polish spread is directional, perpendicular to the long axis of the chisel, and contains striations of the same orientation (Figure 27, a). This seems to correspond to a twisting gesture along the long axis of the celt, which therefore must be hafted axially. Considering also the small-sized rectangular morphology, the specimen is interpreted as a chisel suited for intricate design-work.

*Adze-style hafts (*n=*4)*

Two specimens display a wear trace pattern fully consistent with latero-distal transversal direct perpendicular-juxtaposed fittings (see Figure 4), corresponding to adze handles hafted with bindings (Figure 26, d). Both celts display wear trace patterns indicating dissimilar contacts on the dorsal and ventral faces, supported by associated residues on three sides. The ventral faces contain mostly domed microtopographies with polish characteristic of contact with wood (Figure 27, c). The dorsal faces show contrasting wear, which variably extends to the lateral sides. On the smaller P 007 the levelled microtopography contains densely packed, invasive polish with a rough and greasy texture. It has the appearance of modified material filling up the space between the roughness of micro-asperite points, though the deeper interstices remain unaffected (Figure 27, b). It indicates a softer contact material with adhesive redistribution of material as the main mode of wear, and is therefore most probably attributable to flexible ligatures (Section 5.2 describes some potential materials). These traces spatially extend for ca. 3 cm covering the distal half of the three non-ventral aspects, and are interlaced with residue deposits.

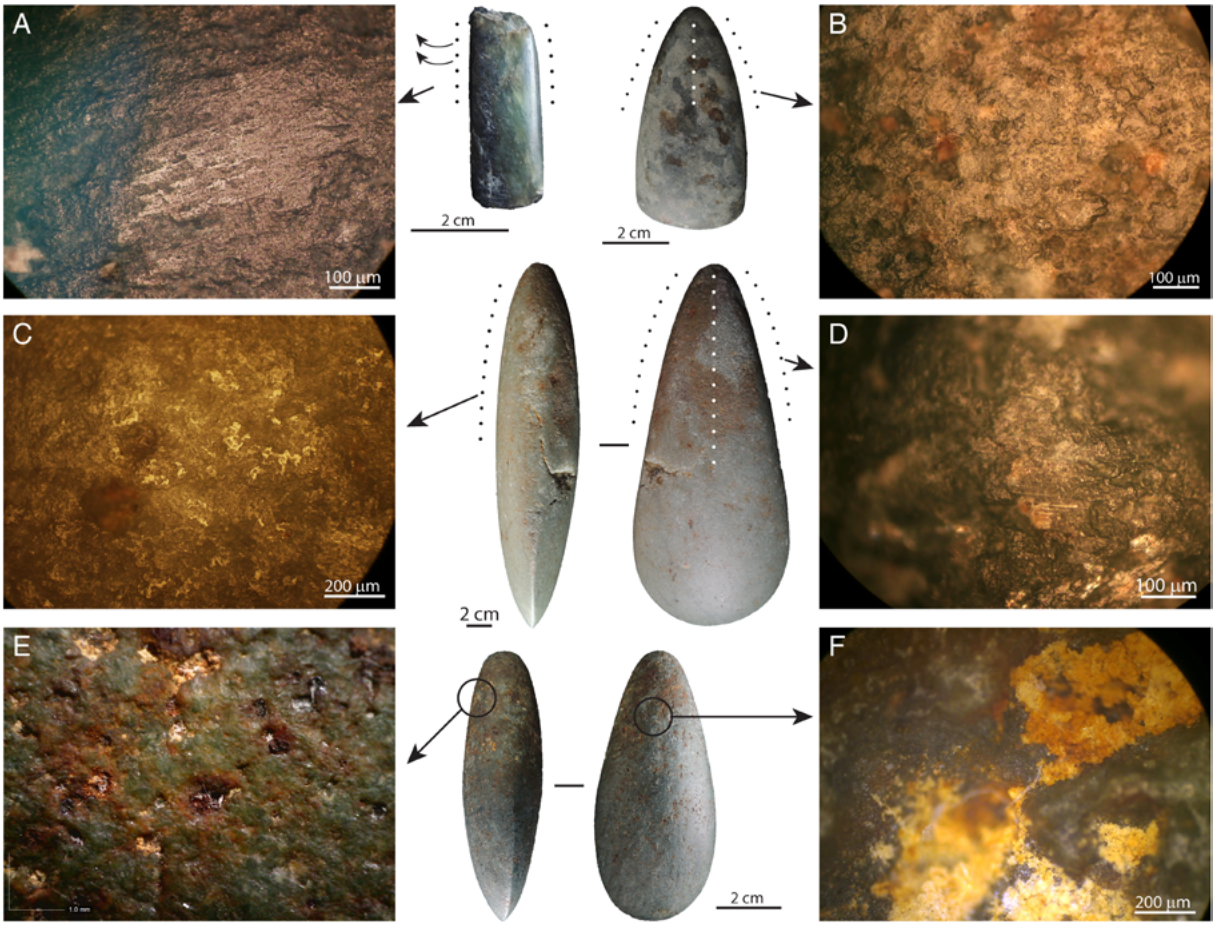

Figure 27: Wear traces associated with hafting in Pearls. A) Directionality on jadeite-bearing P 001 overlaying wear from polishing. B) Topography associated with soft material binding on metatuff P 007. C) Polish characteristic of contact with wood on jadeitite P 022. D) Rough peaks with developed striations and some interaction with the upper topography on jadeitite P 022. E & F) deposits of residue on jadeitite P 013.

On the larger P 022 the pecked microtopography contains matt polish with mild abrasive and invasive characteristics (Figure 27, d), that somewhat resembles the more developed experimental traces of contact with bark bindings (exp. 2554, Appendix 2.2). It similarly suggests contact with a flexible material tightened around a wooden rest, though of a different type than was used for P 007. The polish occurs in association with sharply defined residue deposits, that may have served as adhesives to keep the bindings in place. For both adzes these deposits strongly resemble or match the resinuous residue deposits also observed for axe-style hafts before, that are described in detail in section 7.2.4. Two additional celts were probably hafted in this fashion as they display the same asymmetric distribution of wood friction traces and residues, but traces of binding were not observed to have developed. The residues on these specimens appears to contain anorganic components of granular red-to-yellow morphology (Figure 27, e-f).

P 022 displays well developed bright and smooth polish located ca. 4-5 cm to 0.5 cm from the distal end of the lateral sides, indicating extensive contact with wood. These traces are not congruent with the mildly developed friction polish of the ventral face, and can suggest two things. Either, fresh wooden inserts were in place underneath loose bindings to better secure the haft, or, the biography contains multiple hafting episodes including a male split attachment in which the faces were left floating (Figure 26, b). At this point neither option is favoured, nor are they mutually exclusive.

Other indicators

An oft-seen adaptation to potential hafting is roughening of the medial-distal zone of the lateral sides, which improves the grip of the system of attachment. In four specimens these areas were simply not thoroughly abraded during manufacture, while in four others they were purposefully enlarged after polishing. This was done by fine pecking, resulting in a surface lower in elevation than the levelled faces, with which they share a sharp boundary. No correlations appear with the type of fitting, haft material, or use of residue.

The remainder of the assemblage showed poorly developed, unclear, or an absence of traces regarding potential hafting systems. One specimen displayed asymmetrically distributed friction on the distal aspect and use wear, but the traces were not interpretable. Three others also displayed uninterpretable types of wear on the posterior surface microtopography, including the semi-lunar axe, due to unknown contact materials or probable re-polishing. P 010 contained a spot of residue corresponding to the aforementioned morphologically resinous category, but lacked traces. Traces of wear from a haft were also absent from P 009 and P 019, which is consistent with other aspects of their biographies.

7.1.5 Use-wear

Wear traces associated with the working of various woods were observed on 12 out of 16 celt edges (75%), sometimes as multiple signatures. Three others displayed unidentified pliable and hard material contact, and one edge contained no traces of use (Table 6).

Table 6: Trace signatures of use categories in Pearls.

***n*=17**	**Woodworking traces**			**Other use traces**		**Miscellaneous**			
	Typical/ unspecified	Experimental range	Exceeding	Hard material	Pliable-soft material	Reworked pounder	Heavy edge wear	Resharpening	No wear
Igneous rocks	1	1		1			2		
Low-grade rocks					1* (see text)			1* (see text)	
High-grade rocks	3	3	5	1		1	4		1
Sedimentary rocks		1							
Total	4	5	5	2	1	1	6	-	1

Woodworking

The traces from woodworking at Pearls include various distinguishable subcategories of wear. Commensurable with the inferential division of section 5.2.2, there are five specimens displaying wear matching the experimental results in its characteristics. Two (P 003, 019) appear as a mixture between the uneven, semi-rough texture and domed topography of mahagony and the somewhat reticulated spread and spatial distribution of the galba experiment (Figure 28, a; compare Figure 11), though the archaeological wear is much more densely developed. P 005 and one side of P 020 also display an abundantly domed topography with semi-rough polish, pitted and with scintillation from contact extending to the upper slopes, but with little inter-linkage. The signature is quite similar to

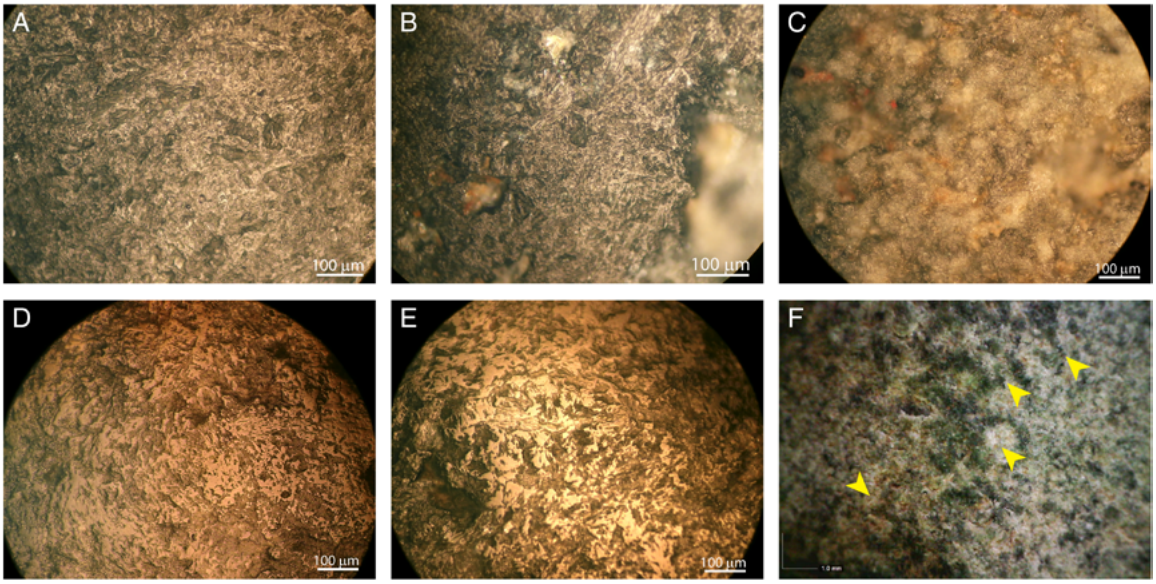

Figure 28: Woodworking wear traces in Pearls.

Typical wear trace signatures on A) ultramafic P 019 and B) jadeitite P 021. C) Wear from use contact with a pliable-soft material on metatuff P 007. Hard material wood-associated wear traces on D) jadeitite P 002 and E) jadeitite P 004. F) Rounding of grains on the central (vertical) ridge of jadeite (arrows) P 011.

the experimental results from chopping waterwood, dry seagrape, and bleary cedar, though it does not resemble all variables for each individual result. More clustering of polish is seen on P 010, otherwise comparable in characteristics.

Four celts (P 017, 018, 021, 022) display rougher, sometimes pitted polish with moderate invasiveness on the microtopography, though individual structures are not very domed and remain quite small in size. In some the polish is abundantly distributed and well reticulating, indicating an extensive stage of development (Figure 28, b). Such traces are more comparable to general expectations for wood chopping wear (Section 5.2), and may thus represent contacts against woods of lower specific density than the experimental range (cf. Section 5.2.2). The state of wear is not as developed in others, which are best regarded as contact against wood with unspecified detail. In any case, these trace patterns illustrate on-going shifts in wood categories at the site, perhaps also involving different states of working.

The two morphological wedges, previously seen to lack indications of hafting, are set apart by unusual trace distributions. P 010 exhibited extensive longitudinal striations, and P 019 invasive use wear up until deep into the medial zone of the faces, where it is thickest. Both are heavily rounded and have partially worn over microretouch, whereas the other celts were rounded variably but, mostly within the range of usability (cf. Mills 1993), with little to no retouch. These patterns are highly suggestive of the celts being wedged into a resisting woody mass, gradually splitting it apart through pressure from the thickest areas.

Five celts displayed traces from woodworking that are provisionally interpreted as representing contacts against woods of higher specific density than the experimental range (cf. Section 5.2.2). The micro-topography on these specimens retains only slight doming, best visible when partially out of focus (Figure 28, d-e). The polish distribution is closed on the asperities and fully connected through a rough and dull scintillation more generally (see Figure 6), concentrated over the entire bevel. However, the size of individual structures and degree of reticulation follows primarily the (minimised)

microtopographical relief. Polish texture is smooth to flat (Table 4), bright, and sometimes glistening, whereas pitting is minor and corrugations are occasionally seen. Such patterns developed to a very high intensity on P 002 and P 004, but less so on the others. Rounding, chipping, and morphological distribution varies. Both polish characteristics and the level of modification of the topographical slopes indicate a hard contact material, but more pliable than unyielding bone/antler or minerals. Nevertheless, the polish is smoother and less invasive, domed, and pitted than wear trace patterns resulting from contact wood commonly are. There is a textural resemblance with some experiments, particularly galba and desiccated seagrape (Figure 11, b, e), but on the whole denser and/or differently worked materials remain implied.

Other use activities

Three celts displayed dissimilar traces of wear from use. The small rectilinear chisel (P 001) and semi-lunar axe (P 006) displayed polish from contact with a hard material, being rough and confined to the microtopographical peaks with little modification of the slopes. Because of poor development and interference of traces from manufacture, no further interpretation can be given. Traces on P 006 were clustered on the central part of the bevel, however, indicating that semi-lunar axes operate in functionally similar ways to biconvex celts. Force traverses only the central edge and tang, and though the wings add weight they do not impart significant percussive contact on their own.

One celt (P 007) displayed a wear trace signature characterised by dull, moderately invasive polish with a rough and greasy texture (Figure 28, c). Smoother, glistening polish was observed only occasionally on isolated domed structures. While thus retaining some variables characteristic of wood, the traces appear more indicative of a softer pliable material than at least the experimental woods. However, it is unclear if the overall signature is not partially related to potential 'sand-ground' resharpening activities. The micro-topography is comparable to those traces, while the edge is currently sharp and free of damage, contrasting extensively developed traces of hafting. The distinction remains ultimately unclear.

The last remaining celt (009) displayed no traces from use whatsoever. Otherwise, a butt fragment (011) was reworked into a pounder, whose broken aspect showed shaping and repecking scars with the intermittent ridges displaying rounding and polish indicative of a softer contact material (Figure 28, f).

7.1.6 Depositional context

The depositional context of these materials is unknown. Still, some assessments can be drawn from the apparent integrity of the celts. The roughout and the fragments all appear to have been discarded following catastrophic failure. Re-use, which could be either repurposing or recycling (Section 3.1.3.3), took place only for fragment originally large enough to maintain enough grip for handheld use afterwards. The other fragments would not have permitted this, nor were any sharp edges utilised.

For the complete celts no single explanation is easily favoured. Though intact specimens are not common, explanations that invoke ceremonial depositions are not possible given the contextual issues with the site. Such inferences tend to regard unblemished specimens as unused and therefore specially produced (Section 3.1.1), an assumption disproven by the extensive development of wear from use. Nevertheless, the selection contains little exhaustion. Apart from fragmentation the best indication therefore would be widespread and heavy dulling (Mills 1993), but extensive rounding is

only seen in a few celts. Even then, the duller edges are not scarred or otherwise rendered incapable of simple renewal through quick resharpening. One celt indeed showed corresponding traces, and the practice could have affected several others given that the edge morphologies are often slanted, dent, or otherwise deviate from an ideal straight profile.[29] Without context, it may well be the case that specimens were habitually left lying around when not needed (*sensu* Siegel and Roe 1986), and that the intact celts were never retrieved but lost over time. The deposition of these celts thus remains unresolved, and warrants further research into depositional practices at Pearls.

7.2 El Flaco

The analysed assemblage from El Flaco numbers 106 in total, of which 80 are macro-lithic artefacts. Some of these are mostly intact and provided information on wear traces for the full biography, but most are fractured artefacts and flakes from manufacture or catastrophic breakage. The remaining 26 are flakes that may relate to the (meta)volcanic flaking industry rather than celt production debitage, but this could not always be distinguished (Section 6.1.2). These artefacts are considered in the section on procurement strategies due to their overlap in raw materials. However, they do not constitute (hypothetical) bifacial thinning waste, since most flakes easily reach or exceed the maximum dimensions of the largest celts found on the site.

The assemblage was studied partially in the laboratory (fnrs 20-1258, 2317, and 9999, except 718) and partially in the field (all others). Several artefacts originating from a surface context were not submitted to high magnification analysis in the interest of time.

7.2.1 Materials and procurement strategies

The raw material identifications and their distribution through the assemblage are depicted in Figure 29. Fine-grained volcanic rocks, low-grade metamorphic greenschists with basaltic protoliths, and incompletely altered volcanics (with metamorphic overprint) comprise the vast majority of both celts and lithic flakes, in broadly similar proportions. These can derive from either mountain range (Sections 2.1 and 6.1.2) and indicate a strong reliance upon materials which are accessible from alluvial contexts both within the Cibao valley and north of the Paso de los Hidalgos.

With few exceptions, the volcanic rocks can all be characterised as massive and fine-grained with dark grey/blackish colouring. A bluish tinge is brought out on some specimens with comparatively higher degrees of polishing. Some could be identified as basalts using the plagioclase feldspar/quartz/k-feldspar triangle, but most were too fine-grained to make a distinction (Knaf, pers. comm. 2015). Brecciation is present in a few specimens. Concerning the phaneritic igneous and plutonic rocks, two are distinguished as rich in plagioclase and orthoclase (towards gabbro or diorite) whose minerals form a white/dark mottled pattern. These rocks do not co-occur as flaked materials.

Rocks which are incompletely altered (overprinted) by low-grade metamorphism comprise the second group. Basaltic protoliths dominate, though a few other volcanic rocks were also included, and are mostly characterised by low to medium degrees of overprinting.[30] They are somewhat tougher

29 Lacking further evidence, these indications are principally associated with edge scarring as a result of flaking during the early reduction phase. Resharpening has not been discussed for Caribbean materials in the context of eventually altering celt morphologies before, though abraders are occasionally called sharpening stones. However, in early colonial times the Kalinago were described to frequently sharpen their metal axes (Moreau 1990).

30 The exact percentages may be subject to revision, since the boundary with more completely

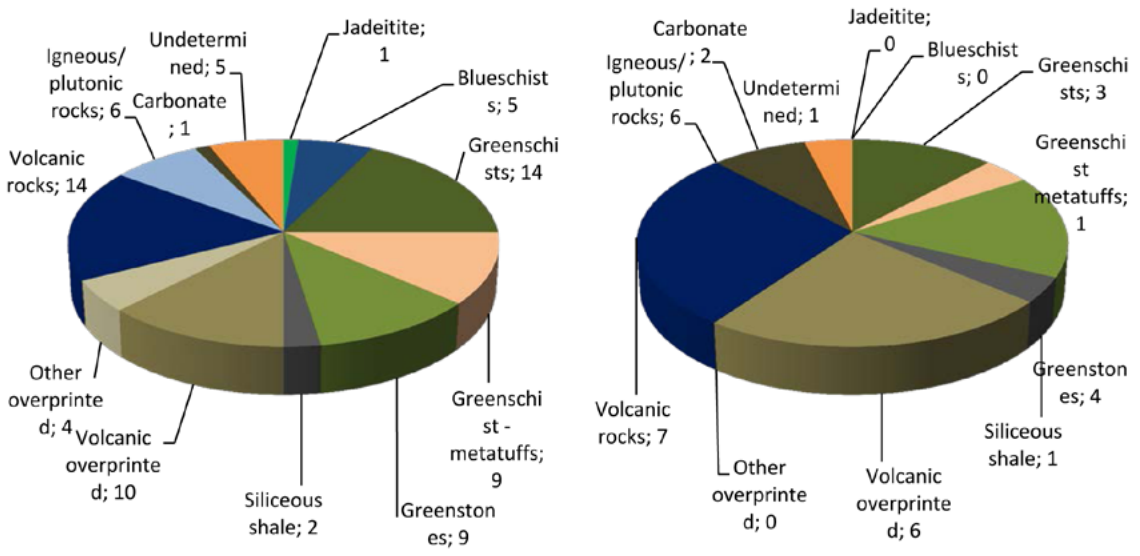

Figure 29: Overview of raw materials amongst the macro-lithic (left) and flaked stone assemblage (right) of El Flaco.

and denser than the unaltered equivalents and incline towards grey-greenish to dark-bluish colours. Most flaked materials and the expedient celts displayed water-worn surfaces, indicating they were procured from alluvial beds. Several other flaked materials have weathered natural surfaces and are of undisclosed origin.

Greenschists comprise the group of low-grade metamorphic rocks. Many have (basaltic) volcanic protoliths, remain fine-grained and with generally massive fabrics, exhibiting a variety of paler and darker green hues. A notable subgroup comprises nine specimens with tuff (or potentially siltstone) protoliths, most of which have even paler green colours and very fine granularity. Foliated layering and garnets are occasionally present, indicating further variation in the lithological origin. Such layering will weaken the rock by enabling fracture planes under the stress of percussive activities, and is likely to have been actively selected against. Most unspecified greenstones are expected to have been altered under greenschist facies conditions as well, but the variety in colouration, texture, and fabric is somewhat larger. Two of the low-grade metamorphic rocks are siliceous shales, which occur in the same lithological beds and were obtained from alluvial contexts. Certain varieties are potentially traceable to more distinct origins, such as metatuff outcrops in the El Yujo subcomplex near Jarabacoa, La Vega province (Lewis and Jiménez G. 1991). On the whole, however, they were likely transported by the El Yaque del Norte and detailed mineralogical study is needed to establish such provenances.

Other types of rocks are rare. High-pressure metamorphics include at least one blue-pale green mottled jadeitite fragment which resembles the materials worked at Playa Grande. Five others are probable blueschists, two having a striking white-interrupted foliation that results from subsequent alteration and one with partial omphacite recrystallization.[31] Few others additionally exhibit characteristics of these rock types, but were not true members (following specialist examination) or ultimately considered as undetermined in the field. Potential high-pressure rock types do not form

metamorphosed rocks is fuzzy. Rocks described to me as metabasalts could fall in either group, depending on whether the specialist identified alteration in a basalt, or the protolith of a largely metamorphosed rock.

31 The assemblage from 2016 includes few additional omphacitic and jadeitic celts, but these are not considered here.

part of the flaked stone assemblage. The closest nearby high-pressure zone is the Puerto Plata area north of the central Cordillera Septentrional, followed by the RSJC to the east.

7.2.2 Early reduction

Traces from the initial and intermediate steps of reduction are somewhat frequent in this assemblage (Table 7), but data on the sequences is lacking. Most specimens recovered from El Flaco are ground surface fragments, resulting in lower rates of observation on previous manufacturing steps. Nevertheless, both flaking and pecking were probably common. Roughly a third of specimens displayed traces of pecking in the forms of unground surfaces or minor pitting within ground areas, celts primarily on the finer scale. Evidence of initial flaking activities was identified in various forms as well. In the cases that technological characteristics are evident, they indicate direct percussion. Bipolar percussion is not evidenced within the assemblage. Four discarded roughout fragments and two mostly expedient, informally made celts provide additional resolution into reduction strategies at the site.

Table 7: Observed reduction techniques and manufacturing steps at El Flaco. See section 7.3.2 and Table 10 for explanations of collating and the sub-categories.

Technique	Times observed	Prevalence and comments
Flaking total	22	Probably medium to high
Cortex removal	*0*	-
Bifacial thinning	*6*	*Unclear*
Lateral intrusive flaking	*7*	*Unclear*
Direct percussion	*6*	*High (observations counted on celts only)*
Bipolar percussion	*0*	*Absent*
Hammering – heavy, transverse	2	Low
Pecking total	28	Probably very high
Coarse pecking	*5*	*Low. Most observations pertain to non-celt artefacts or reworking*
Fine pecking	*7*	*Medium to high*
Unclear/no evidence	40	-
Roughout/preform fragments	4	Very low to low
Expedient use	2	Very low

The intact roughout displays evidence of bifacial thinning in the form of large, well-placed conchoidal scars (Figure 30, a). Shallow flake negatives and ripples, more invasive than could be corrected with subsequent methods, were seen to indicate this technique in several other fragments (Figure 30, c). Subsequent 'lateral intrusive flaking' (*sensu* Rodríguez Ramos 2010a) on the bilateral aspects enacted more precision in shaping the final morphology of sides and edge. The outcome is a series of small scars usually with flat to gradual profiles and step terminations. The latest flaking impacts sometimes grade into pecking marks, indicating a transition in gesture, tool, or force of impact to reduce fracture propagation into the localised crushing of mineral grains. The primary intent of pecking was to prepare the preform for grinding, by removing flake ridges and other asperities. It is evident mostly from incomplete abrading due to elevation or remnant pitting and discolouration underneath ground surfaces, only rarely were the lateral sides left rougher for attachment of a haft. The fact that this procedure is not without risk is evidenced by a mishap flake which displays a mostly pecked dorsal surface, equalising a flake negative surface, that fractured the roughout by misdirected force or a

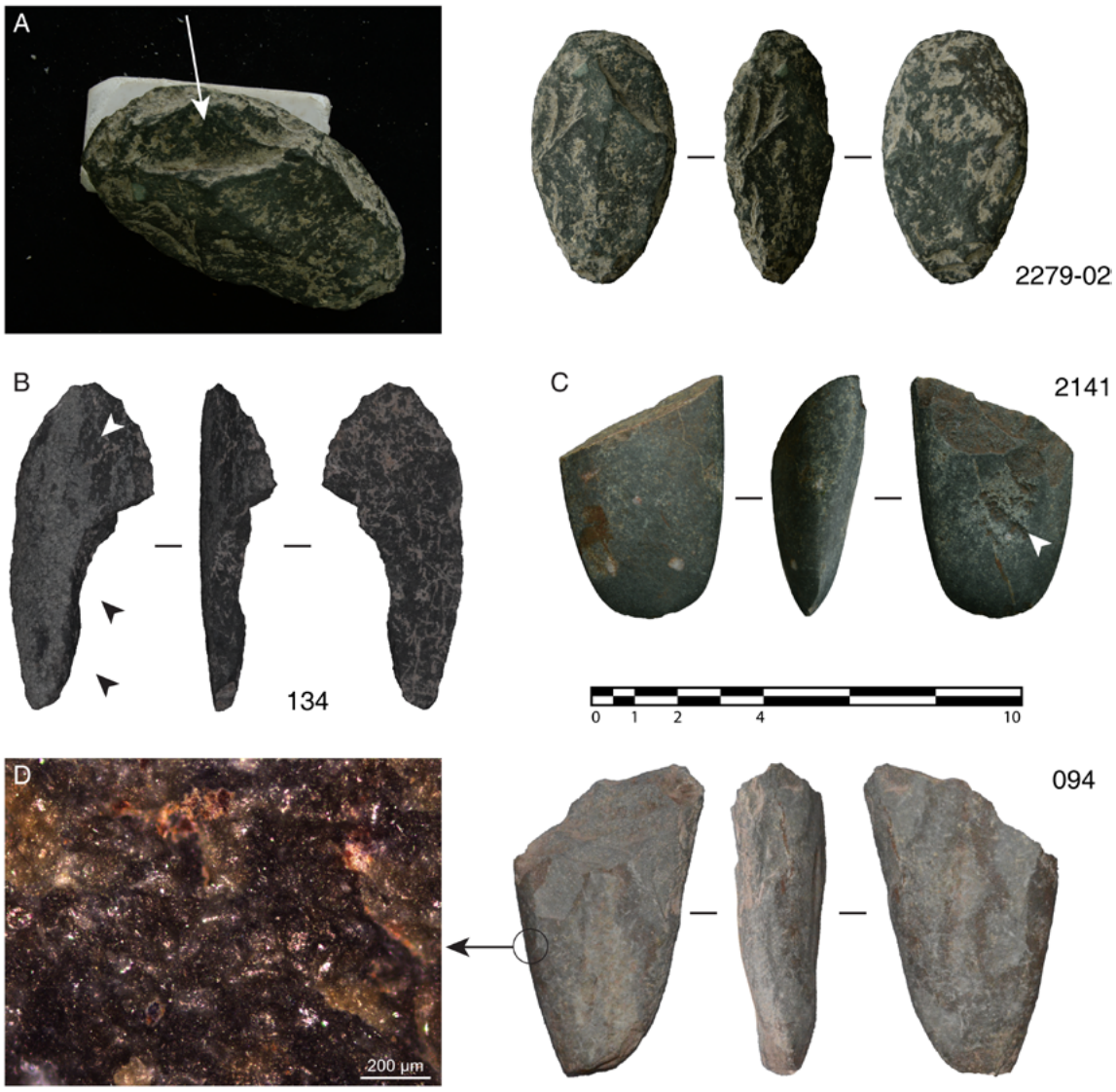

Figure 30: Early reduction of macro-lithics at El Flaco. A) Flaking roughout with critical removal on over-printed volcanic FL 2279-02. B) Pecking traces (arrow) overlaying mishap removal on low-grade metamorphic FL 134. C) Scar from bifacial thinning, partially covered in pecking marks (arrow), persisting on ground facial surface of volcanic FL 2141.D) Micrograph of natural (unmodified) surface on expedient metamorphic FL 094.

weakness in the rock (Figure 30, b, c).

This operational sequence appears fairly uniform, insofar that nearly all materials represent fragments of finished artefacts. Two expediently made pieces clearly deviate from it, by retaining most natural surfaces and form in combination with evidence from hafting and use. Medial-distal fragment 094 was originally a water-rolled pebble of which the natural shape approximates the morphology of a petaloid. Both faces are water-worn: these surfaces are relatively smooth but show an indistinct bright scintillation, irregular elevations, and rounding (Figure 30, d; and Section 7.2.4 for analysis of the overlying wear). The regularity and evening characteristic of abraded topographies is absent. Only some unwanted rugosities on a lateral side were corrected by incipient pecking and grinding. Similarly, edge-medial fragment 2318 is a wedge-shaped water-rolled pebble on which an edge was created by a few hard lateral percussion impacts on one face, followed up by a tranchet blow on the other. The surface is otherwise unmodified, while limited but interpretable wear traces confirm it was used in

this state. The remaining preforms display water-worn or weathered surfaces as well, indicating that dimensions fitting the intended result formed a criteria in some raw material selections.

7.2.3 Abrasive manufacturing

Abrasive reduction techniques were identified on 61 fragments, with 5 abraded artefacts not interpretable by microscopic analysis and the remaining 14 comprising roughouts and expedient celts. Most celts were fully abraded, but when discontinuous or with fluctuating intensity it are the faces and bevels that were consistently favoured. Manufacturing striations were erased from these areas, but sometimes retained on the curvatures of the lateral sides. Their directionality nearly always follows the long axis (maximum divergence of 45°), indicating back-and-forth gestures. The majority of surfaces display dull lustres and corresponding abrasive techniques, often joined by striations in the periphery. Indeed, the assemblage is distinguished by the significant variation observed for such techniques, which is assumed to indicate a larger variety of platforms than can be interpreted on the basis of the experiments. A minority of specimens display brighter lustres and abrasive techniques corresponding to wet contact with hard stone surfaces, though field limitations often inhibited more precise characterisations. Secondary polishing techniques are present, but rare.

Table 8: Trace signatures of abrasive manufacture categories in El Flaco.

***n*=61**	**Dull**					**Bright**					**Multiple**
	Dry ground	Intermediate	Sand-ground	Specified different	Unspecified	Wet ground specified	Wet ground unspecified	Wood	Mirror	Other/ Unclear	
Igneous rocks	1		4	1	2	3	2			1	2
Overprinted rocks	2		3	1	1	1	1	2			2
Low-grade rocks	5	10	9	1	2	4	2				4
High-grade rocks			2	1	1		1		1	1	1
Other rocks	2				2						
Total	10	10	18	4	8	8	6	2	1	2	9

*Dull lustres (*n=*50)*

The majority of surface microtopographies with dull macroscopic lustres range from 'dry grinding' to 'sand-ground' trace signatures, though some display other types of contact or could not be further interpreted. A type of 'dry grinding' is inferred for ten specimens. Seven of these display well levelled microtopographies that lack polish development, of which the non-greenschists display elongated fine striations under stereoscopic view (Figure 31, a). Three additional green metamorphics possess a higher micro-relief and are densely striated. Such patterns could have been obtained through grinding on cohesive quartz-rich sandstones, which probably occur in the Yaque del Norte river basin. However, further experimentation with other types of potential grinding platforms is needed to test whether this result is significant to the platform composition, absence of water, or the specific combination (Section 5.1.2.3).

Four celts were considered in the field as probably corresponding to 'dry grinding', but could also resemble a flatter and duller type of 'sand-ground' topography. This is the pattern wherein grain

crushing has led to slight or medium scintillation (Figure 31, b), and similar to the assemblage of Pearls, most dull surfaces exhibit some kind of correspondence. Six more are positively assessed to fall in between 'dry grinding' to a slight 'sand-ground' signature. Subsumed under the 'sand-ground' column in Table 8 are three additional specimens corresponding to a duller, lower roughness 'sand-ground' modification. Three display strongly correlating wear trace signatures, and five more topographies wherein the peaks are brighter, surface relief is higher, and minor polish typical from contact with lithic materials occur. The final seven were recorded under field limitations and here considered as having unspecified 'sand-ground' correspondences due to lack of details. These do vary in the presence and density of stereoscopic striations.

Altogether, 61.6% of the assemblage display traces of abrasive wear that strongly resemble specific experimental results (Section 5.1.2.3) or form a clear but varied gradation between. Importantly, that variation is spread quite evenly and is not clearly correlated with specific lithological groups, otherwise a factor at this level of inference. Instead the possibility exists that an unrecognised repertoire of grinding platforms of slightly different characteristics was chosen, since alternative choices (such as immature sandstones) are yet to be experimentally investigated. The pattern is not intrinsically suggestive of different technological choices. For one, these grinding platforms are potentially interchangeable in reductive efficiency and speed, and second, differences in the resulting surface appearances are not distinctive to the untrained (but attentive) eye.

Finally, four celts displayed dull lustred topographies with wear contrary to the experimental results, indicating unknown techniques. Eight others are unclear and not further interpreted, together accounting for another 20% of surfaces. These results are at least partially attributable to mineralogical differences (Table 8) since not all rock types were experimentally covered. Confusion over water-worn topographies was generally ruled out via high magnification comparison with local water-rolled pebbles.

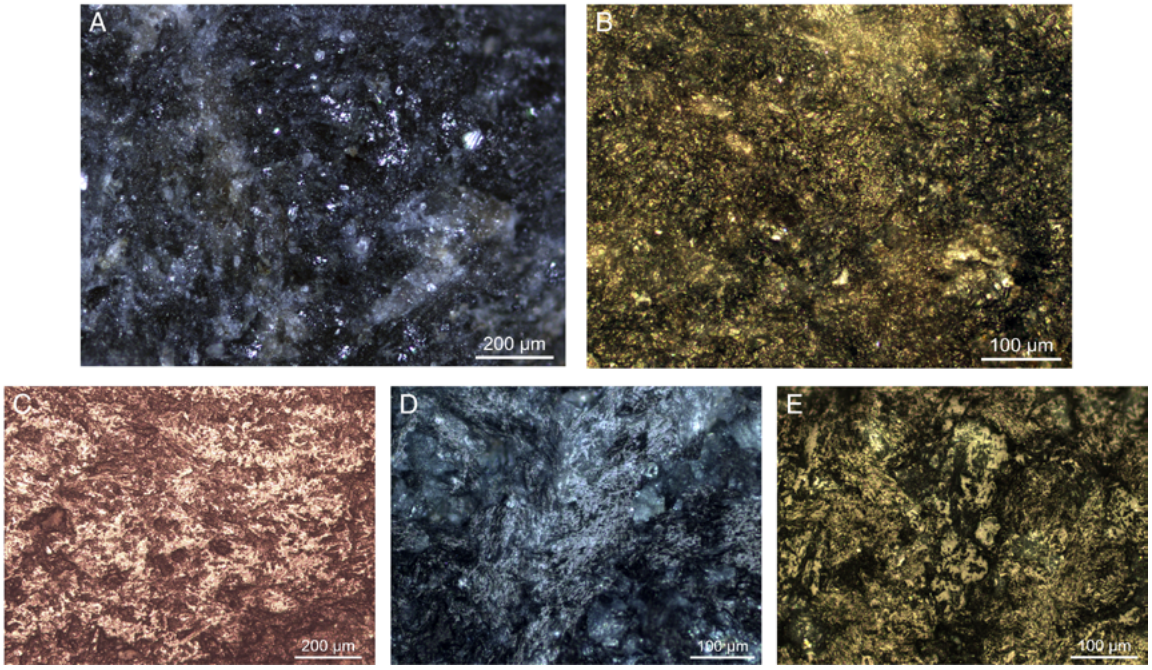

Figure 31: Wear from abrasive manufacturing in El Flaco. A) 'dry ground' surface on volcanic 1218. B) brighter 'sand-ground' trace signature on volcanic 1250. C) wet stone variant 1a on gabbro 179. D) wet stone variant 2 on volcanic 1002. E) partially wood contact-derived polish with very fine striations on overprinted volcanic 945.

*Bright lustres (*n=*19)*

A minority of surfaces was treated with a technique producing a bright lustred appearance, subdivided into mineral-based techniques (25%) and wood-based techniques (3.3-6.6%).[32] Surfaces in the former group display lustre up to sub-metallic intensity, and exhibit dense polish typical of wet contact with a stone on the microtopography. Specific correspondences to the experimental surfaces were not observed, but several archaeological specimens could be characterised as distinctive (field limitations inhibited this level of resolution for others). Levels of roughness, surface distributions, and striation patterns all varied.

Three share a rough and flat polish on the high microtopographical points, which is bright to very bright, non-invasive and of high contrast with the slopes, and interconnects in a covering distribution (Figure 31, c). The texture is rougher than the experimental polish from wet abrading on quartz arenite (exps 2511 and 2513) and the lacks the dense striations seen in wet abrading against cohesive sandstones (exps 2782, 2515-A). It is therefore considered a distinct modification, referenced as 'wet stone variant 1a' in Appendix 3. A fourth displays mostly equivalent wear except with the polish structures smaller in size and less densely distributed, and probably represents a shorter-term interaction with this technique (described as 'wet stone variant 1b'). It was observed on artefacts of different kinds of rocks.

By similar logic, 'wet stone variant 2' pertains to a wear trace signature exhibited on two igneous specimens. The surface is stereoscopically striated, and microtopography displays gouges and a well developed, non-invasive polish. It has a rough and highly pitted texture, and is distributed in loose/connected across a dull scintillating topography with the texture and micro-relief characteristic of fatigue crushing (Figure 31, d). The closest experimental correspondence for a platform is the fine-grained, cohesive sandstone (used in exp 2782), but the match is not strong and a different platform is more probable. 'Wet stone variant 3' is a provisional category for two celts on which the polish consisted of bright, rough plateaus with little to no invasiveness, that were heavily striated and interlinked in a reticulating type of pattern (partially as a result of microtopographical differences). Finally, a single blueschist of unspecified typo-morphology displayed spots of 'bright mineral mirror polish', but it is not certain if and how these traces relate to celt biographies.

The wood-based polishing techniques were evident on two celts, differentiated by a bright and greasy lustre as well as deeper colouration. The micro-topographies are well levelled and the asperities display characteristically interlinking domed polish, densely interlinked with a smooth, glistening texture and very fine micro-striations (Figure 31, e). Most of their surface areas are characterised by duller and rough polish reaching the upper slopes, however. This seems to indicate preceding abrasive contact against a lithic platform, but overlain by traces from contact with the more pliable wood. Given the presence of fine striations, the technique probably involved a fine-grained abrasive or particularly siliceous materials. Two additional specimens were probably also polished with (seasoned) wood, but the inference is not certain since the traces are not well developed, and one has a dissimilar mineralogical composition.

32 The total percentages add up to 113.2% as a result of multiple techniques being distinguished on several pieces.

7.2.4 Composition of the hafts

Indicators of hafting activities are observed on 31 specimens, almost all of which belong to the group of 62 abraded celt fragments (65 minus three unspecified macro-lithics). Wear from friction with wood is most common, followed by residues interpreted as adhesives and wear from contact with softer materials. For 17 artefacts a distinction between the parallel male (axe) and perpendicular juxtaposed (adze) hafting archetypes could be made (Figure 32, a), with some variation in the slotting and combination of bindings. Figure 26 (Section 7.1.4) remains a useful guide for the representation thereof. 16 others remain of unspecified fitting due to underdeveloped traces or the absence of spatial patterns. However, the wear trace patterns or residue accumulations on these remain associable to hafting activities and are wholly consistent with what is seen on fully interpreted specimens. An additional 16 fragmented pieces returned no traces associable to a hafting arrangement, four of which

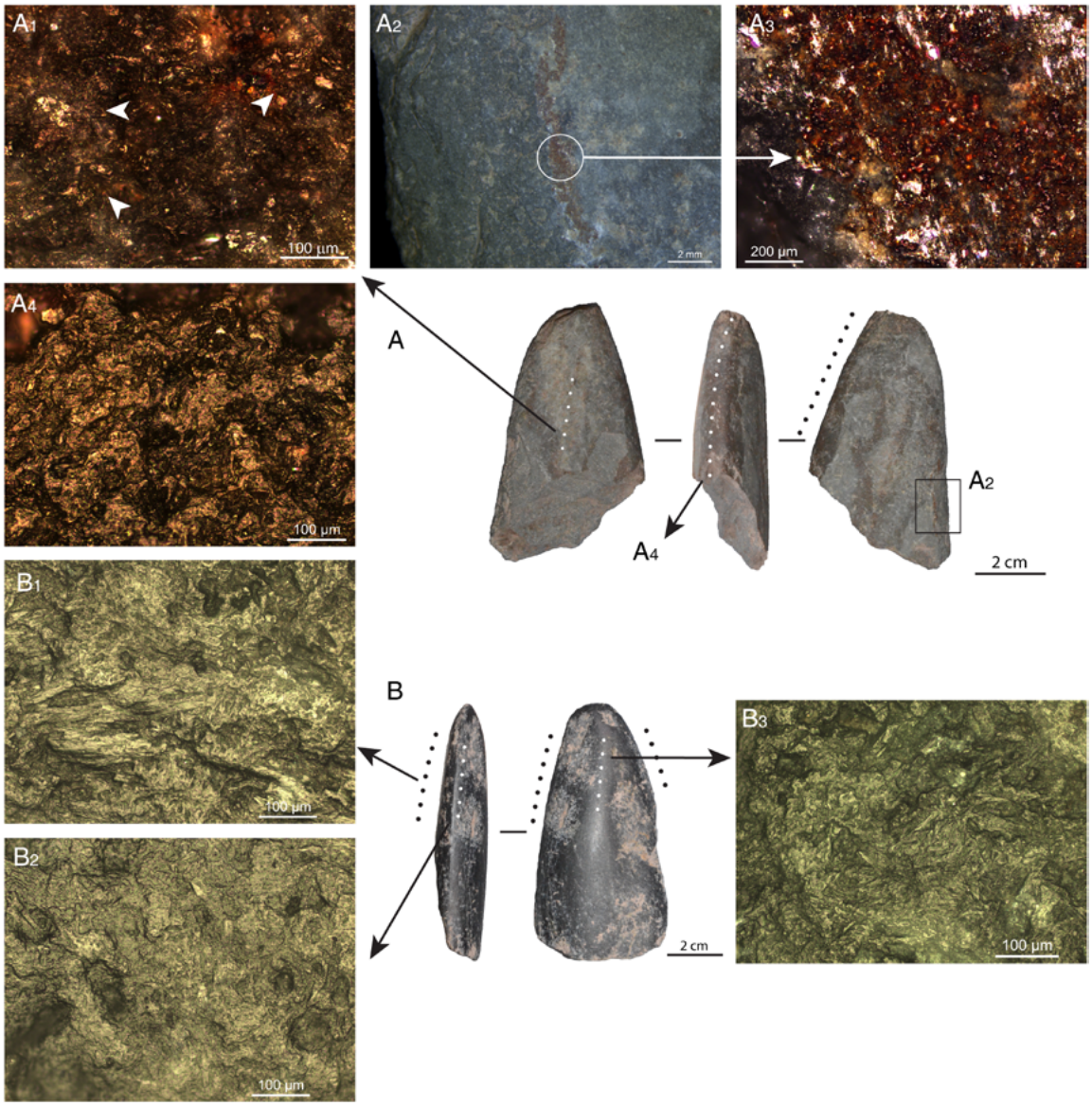

Figure 32: Reconstructed hafting compositions in El Flaco. A) juxtaposed hafted low-grade metamorphic 094. A_1) dispersed traces of contact with wood. A_2 and A_3) adhesive residues. A_4) very well developed band of traces from contact with a pliable-soft plant-like material on the lateral side. B) male probably-split hafted gabbro 179-01. B_1 and B_2) well developed traces of friction contact with wood on the distal zones of both faces. B_3) somewhat distinct development of friction contact on the lateral side.

were relatively intact and are discussed further below. Otherwise, these results are not distinguishable from preservation bias acting upon the spatial sensitivity of traces from a hafting arrangement (Section 4.1.3). Six small edge fragments are further excluded on these grounds, and 13 objects were considered indeterminate.

*Male hafts (*n=*10)*

Male embedded attachments (Figure 4) are inferred for eight specimens. The presence of hafting traces is always unmistakable in these, for both the consistent wear pattern (dry wood friction/residues) and the contrast with manufacturing traces. Four celts were hafted with an orientation parallel to the long axis, and thus functioned as typical axe-heads (cf. Figure 26, a). This follows from wear traces indicating friction with a pliable to hard material being consistently distributed from the butt to medial surface areas, notably developed on the faces. These specimens lack pronounced asymmetry in morphology or use wear patterns and must have been hafted with the blade parallel to the axis of the haft. For the remaining four this orientation was unclear since these had somewhat asymmetric outlines and/or were fragmented in the haft and use zones. For some of these the embedded slotting is extrapolated on the basis of observed penetration depth in wear versus a probable depth given the original dimensions. One specimen in particular (FL 179-01) displayed a stronger development of wood friction polish on its bilateral sides. Possible alternative reconstructions for this celt include a split slot, or an ill-fitting perpendicular embedded slot in a large handle (which would render it an adze).

Otherwise, only one other specimen was potentially hafted as an axe in a male split socket (cf. Figure 26, b). The bilateral sides displayed a stronger development of wear from friction than the faces, though (necessary) evidence for the distal interruption could not be observed due to fragmentation. A tenth celt (210) displayed friction wear on all mediodistal aspects (the butt is missing), as well as repecked bilateral sides carrying in the medial zone a smooth undulating friction polish on their boundary with the polished faces (Figure 33, a). The most congruent interpretation is a male axe fitting with additional supporting ligatures, similar to some ethnographic examples (Section 5.2). The type of attachment fitting is not certain, however, only that it was exceeded by the extent of the bindings. Of note is that male embedded fittings with an axial orientation to the shaft were not confidently inferred. Several 'chisel-like' small, elongated celts are present in the assemblage, but each of these ultimately proved to be indeterminate or not interpretable.

*Juxtaposed hafts (*n=*7)*

Juxtaposed attachment systems are inferred with high confidence for three specimens and with moderate confidence for four more. All display obvious asymmetries in the distribution of wear, the former more clearly from multiple trace signatures and residue deposits than the latter. Traces indicative of friction contact with wood are always present on the downwards (ventral) face, indicating the element that rested on a wooden surface. Contrasting wear is observed on the bilateral sides and upwards (dorsal) face. The three specimens of high confidence all exhibited a microtopography with strongly developed polish, most consistent with a resistant plantish material (Figure 32, a; Figure 33, b). The polish is usually well spread and invasive, having a rough and greasy texture on the peaks for some artefacts and a matt and duller texture for others. Further abrasive and/or adhesive wear of the peaks also differs per artefact, in the form of progressive rounding of asperities and filling in of

the interstitial topography (some comparable to observations for Pearls, Section 7.1.4). There were probably different preferences for binding materials, but all share the spatial emphasis on the most protruding locaitons of the morphology. The bindings resist the transmitted force of use blows better in these zones than in any other place, thus heightening friction and subsequent formation of wear. The poor attachment of FL 798 resulted in a higher intensity of wear on the distal zones and bright spot formation from counterblow flaking of the butt (Figure 33, c).

The four specimens of reasonable confidence lacked well developed wear from bindings, but share the characteristically asymmetric distribution of residues with potential adhesive properties on all surfaces but the ventral face.[33] These include the category of potential treated resins (Figure 32, a3), described below. Together, they range from smaller sized celts to fairly substantial specimens, providing a potentially broad range of applications towards various woodworking and fashioning tasks.

Other indications

One celt (FL 2294) displayed wear traces convincing of a perpendicular or adze-like orientation, but its direct attachment system (juxtaposed versus male) proved to not be fully interpretable. Furthermore, 16 specimens are classified as hafted in an unspecified manner. These celts were conceivably all hafted according to the archetypes described above, but issues of surface preservation and inconsistencies in the wear prevented a complete inference. The wear generally consisted of the same type of contact traces previously described and the residues addressed below. Four mostly intact specimens were defined by the absence of traces from a haft. One of these is interpreted as a wedge, further supported by morphological indicators and use wear (below). Another had been heavily polished against a wooden surface, which renders any recognition of hafting in wood strenuous. This specimen was reworked in a hammer/pestle and it must be considered that the heavy polishing took place as part of the reworking process thus obscuring the original biography. The other two are characterised by pecked surfaces which suffer from PDSM/encrustations and are difficult to interpret on those accounts. Similarly, one is blunt and the other may be a potential wedge on account of hammer-blows on its butt.

These are distinguished from the 16 on which no traces were observed, but have fragmented or damaged medial and distal areas. Nevertheless, some do contain technological modifications in the forms of leaving the bilateral sides unpolished, or more rarely repecking them. The active reworking is usually characterised by simple hammering crushing the surface (similar to the prior shaping technique) whereas regularised fine pecking is seen in only few specimens (Figure 33, d).

*Residues (*n=*15)*

Residues are relatively common on medial-distal areas in the assemblage. The residue group of potential heat-treated resins already referenced at Pearls (Section 7.1.4) is present on seven specimens. This residue consists of black deposits with an oily, granular to viscose texture and clear boundaries lacking cracking. Around these deposits it becomes smeared out as thin yellow-reddish droplets constituting a transparent film or stain with a fatty, viscose texture (Figure 33, e-f; cf. Figure 32, a3). It is not

33 It would appear that ligatures often do not develop clear patterns of wear. There may be several reasons for this, such as tight fixations (inhibiting friction), intermediate residue deposits (prevent modification of the underlying lithic surface), or poorer interpretability for particular contact materials (cf. Rots 2010, 135). Conversely, the wooden rest probably bears the brunt of the friction as wear is always well expressed on this aspect. Less clearly defined spatial distributions remained at the level of inference of being hafted through indeterminate means.

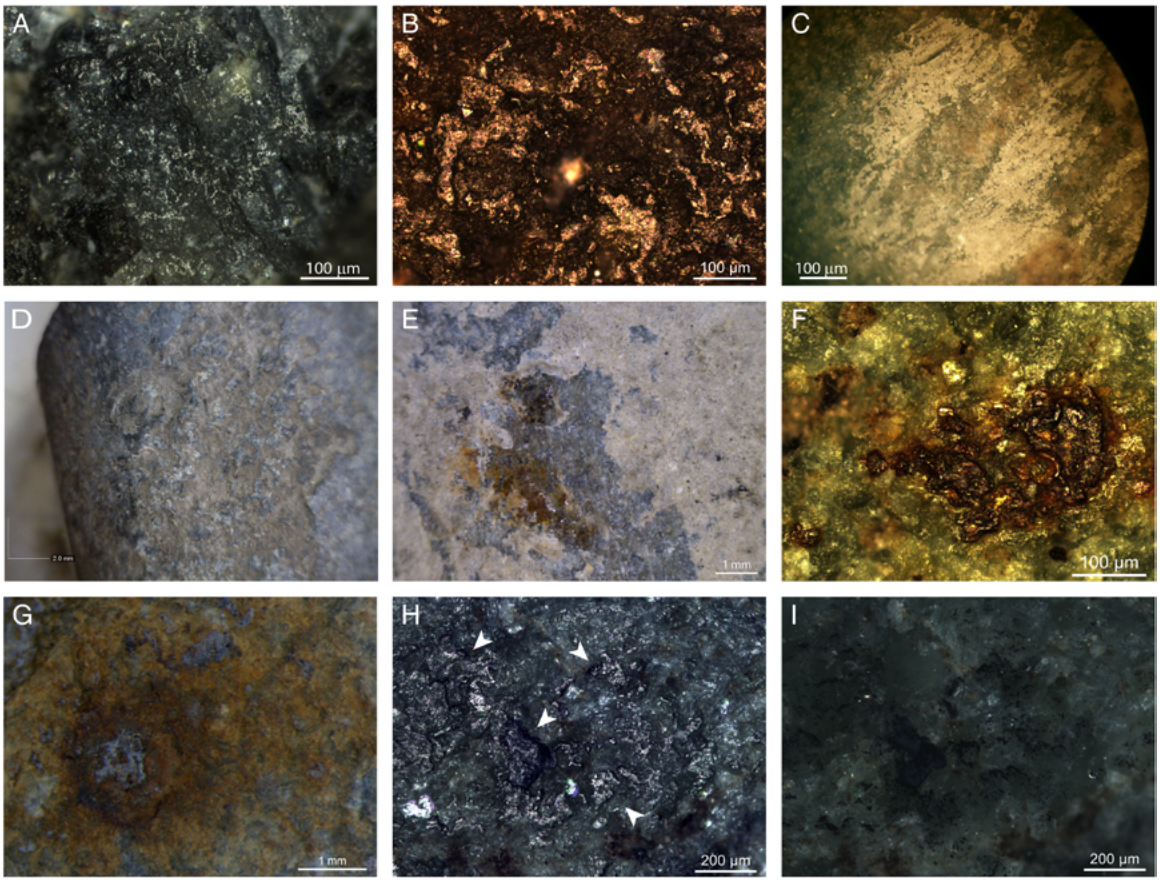

Figure 33: Traces of wear from hafting in El Flaco. A) Smooth reticulating friction polish on the boundary between ground and repecked surface on plutonic 210. B) rough and greasy polish from soft material friction on low-grade metamorphic 94. C) Troughed bright spots on metatuff 798. D) Roughening of a ground side through hammer blows on metatuff 798. E & F) Black viscose clumps with reddish film residue on greenschist 2171 (overlain by sediment encrustations) and metamorphic 544. G) Grainy red with black residue on greenschist 1244. H & I) Black tarry residue under normal and polarising light on blueschist 2317 (arrows indicate deposits under normal light).

clear whether this film corresponds to a thinner or diluted deposit of the same kind, or an exuded component thereof. This residue is morphologically interpreted as a (heat-)processed, non-pristine resin (following Langejans and Lombard 2015, 206). However, morphological variation occurs in colouring, viscosity, and density throughout the assemblages. This variation could be associated to taphonomic degradation, different preparation methods, or the presence of resins from different plants or compounds within the group. Elementary characterisation is required to further investigate what components there are and how it develops through time and space.

This group of residues is usually associated with the distal areas of artefacts, or medial and asymmetrically if a juxtaposed system is implied via wear, and is often correlated with the ligatures. This points towards an anthropogenic function, presumably as adhesive, over alternative possibilities such as natural extracts from the wood of the handle (*guayacan* excretes heartwood oils, for instance). The concentrated black deposits appear mainly on rougher topographies such as pecked sides, whereas most levelled surfaces contain only remnants of the film fading into a stain/discolouration.

Three other residues occurred in association with medial and distal areas. First, a granular red-and-black residue was found on two specimens, for one of which the archaeological attribution is

suspect.[34] It is a dense mixture of fine red grains and blackish clumps which is equally distributed over peaks and valleys (Figure 33, g; cf. P 007, Figure 27, e-f). The origin and relation to the treated resin class of residues is unclear, but one possibility is that it represents a mixture of such resin with anorganic material. Second is the appearance of a somewhat transparent and fluid, amber-coloured residue on two pieces, including the jadeite fragment. This is morphologically closer to a pristine resin (Langejans and Lombard 2015, 206). Third, five specimens carry residue consisting of viscose black strands or droplets with an oily texture and clear boundaries. Compared to the non-pristine resin, it lacks the yellow-reddish coloured film and concentration of larger clumps (Figure 33, h-i). Though its appearance is evocative of a tarry substance, the factual nature is not clear. Most of the fragments on which it is encountered actually lack mechanical wear that could link it unequivocally to hafting activities, though these deposits obscure most of the microtopography. Otherwise, when the wear trace evidence indicates a specific type of slotting for any type of residue, the deposits are associated primarily with ligatured attachments (7, versus 2 in embedded slottings).

7.2.5 Use-wear

A total of 26 edges are present in the analysed assemblage from El Flaco, all of which carry traces of wear. This count includes implements where the factual rim had been destroyed or reworked into a blunt surface, as long as remnant traces of use were detected along the proximal margins. Five of the largest celts could not be subjected to a full high magnification analysis due to working distance limitations in the field. Two preforms were confirmed to lack traces and four objects were unclear due to PDSM or the inability to link microscopic traces to macroscopic edge wear (Table 9). Two specimens also provided indicators of use wear on the butt, and are discussed at the end of the section. Residues in association with traces of use wear were not encountered.

Table 9: Trace signatures of use categories in El Flaco.

***n*=26**	**Woodworking traces**					**Other use traces**			**Miscellaneous**			
	Incipient	Unspecified	Experimental range	Exceeding	Distinct	Hard material	Soft material	Indistinct	Reworked pounder	Heavy edge wear	Resharpening	No wear
Igneous rocks	2		1	2			1	2		5		
Overprinted rocks				1	1			1	1	1	1	
Low-grade rocks	2	1	6	1	1			1	2	5	4	
High-grade rocks				1	1					1		
Other rocks												
Total	4	1	7	5	3	-	1	4	3	12	5	-

34 This specimen was sawn for petrography and residue was found on the sawmark as well as other distal areas. It is possible that residue deposits were translocated during the procedure by the water stream, but contamination is not ruled out.

Woodworking

Woodworking traces dominate the assemblage, various forms of which were encountered throughout. FL 2294 displayed two separate wear trace signatures, separated by a resharpening event. As before, some of these patterns can be further divided based upon their correspondence with the experimental results.

Seven celts display traces of wear of which textural, topographic, and spatial characteristics is in reasonable to strong correspondence to the experiments with galba, bleary cedar, waterwood, and fresh seagrape. These were likely used to work a similar suite of woods, being the fresh sapwoods of tropical hardwood species with specific densities between 0.6 and 0.9 g/cm^3. The archaeological microtopographies are domed, sometimes extensively, and the texture and degree of pitting in the polish fluctuates within the experimental variation (Figure 34, a). Interlinkage consists of reticulation between the nearest structures, and invasiveness is little (dull and rough) to absent (both variables become more pronounced with higher relief). The size and concentration of polish is larger, however, but is probably attributable to differences in working time and intensity. A few specimens display isolated clusters of reticulating domed polish, with a well developed near-smooth and pitted texture, sometimes surrounded by early stage rough and dull polish. These signatures match the experimental results from working mahogany very well, with a near perfect correspondence by FL 253 (Figure 34, b; compare Figure A8, d). Though specific wood species remain far beyond the current inferential limits, the archaeological traces are nevertheless noteworthy.

Five specimens display traces which far exceed in intensity and distribution the textural and topographical characteristics obtained from the experiments. They display bright, smooth, and non-invasive polish with intense doming, decreasing in volume (see Table 4), with variation (Figure 34, c-d). Polish structures on FL 179-01 are nearly flat and heavily pitted, with occasional directionality. Doming is visible only towards the boundaries of the polish structure, the lower topography being

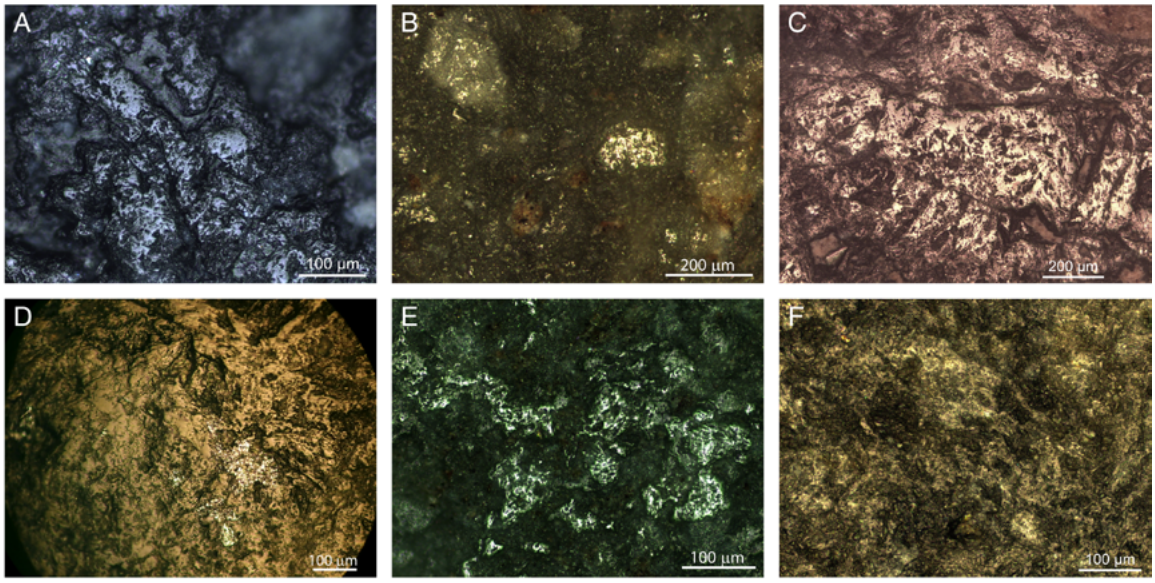

Figure 34: Use wear traces in El Flaco. A) Woodworking traces approximating experimental characteristics on volcanic 1002. B) Woodworking wear strongly resembling the experimental contacts with mahogany on greenschist 253. C) Exceeding woodworking on gabbro 179-01. D) Exceeding woodworking on possible blueschist 2279-06 at 100×. E) Distinct traces of woodworking on tuff greenschist 819. F) Use wear from a softer contact material on volcanic 1250.

directly modified through a dull and rough texture instead. The spatial distribution and interlinkage on this specimen resemble that of chopping desiccated seagrape (exp. 2550, phase 8; Figure 11, e), but harder and drier woods are thought to be implied in the formation of this wear. Conversely, FL 2279-06 displays polish with the corrugation and linkage characteristics of the experiment with galba, but is far smoother to flat in texture and almost devoid of pitting. This is consistent with expectations for a steady continuation of polish build-up and erasure of relief under stable conditions, the implication thus being a long use duration.

Four specimens display incipient traces of wear from woodworking, since the textural and topographic characteristics appear less well developed. These consist of extended patches of rough, dull, reticulating polish draped over flatter topographical areas, with the incidental presence of a dome. Though there is some resemblance with the experimental result from friction with dry cambrón (exp. 2552), they more likely represent early stages of development. Asymmetric distribution of the development as a result of visible resharpening favours this interpretation.

Finally, three specimens displayed well developed traces of contact with wood, but distinct from the experimental range of characteristics. Their microtopographies are extensively domed, containing smooth, bright, greasy textured polish restricted to the asperities in a somewhat irregular spatial distribution (Figure 34, e). There is little to no modification of the upper slopes. Possibly, the contact materials consisted of softer or greener wood varieties, or species with different extract or silica contents, than those cut during the experimental programme.

Other

FL 1250, a smaller celt, displayed wear indicative of a non-woody contact material on its bevel. The traces consist of a blanket of rough polish, non-abrasive and invasive up to the deeper valleys of the microtopography, but brighter on the peaks (Figure 34, f). This pattern is consistent with a soft material, and resembles contact with meaty tissue more so than plant materials. The edge carries fairly invasive impact retouch inconsistent with such a material, however. This indicates either a multi-use palimpsest with harder contact materials, or the working of materials with both soft and hard components, such as animal carcasses or hard-shelled meaty fruits.

Both resharpening and reworking activities are observed within the assemblage. Two different modes of resharpening are present at El Flaco: one operated by carefully flaking a new edge, and the other by honing a dull edge through abrasion (Figure 35). The former is evidenced in two specimens with a series of feather terminated flakes remodelling an exhausted edge, one of which ran into an unexpected direction and broke the edge of the depicted celt in half. Presumably, newly produced scar ridges would be ground anew to reproduce a smooth edge. Traces from abrasive resharpening were observed on three edges, but not necessarily in relation to hypothetical retouch flaking. In one specimen the wear resembles that of grinding using an ineffective coarse-grained sandstone (compare Figure 34, h with exp. 2515-A), resulting in ploughed polish interspaced with early stage weak wood traces. This invariably alters the morphology of the bevel by shaving of a few millimetres, and erases previous traces of wear.

Three analysed specimens were reworked. Edge damage had probably become too substantial to allow resharpening, which led to the repair of suitable fragments by removal of the original blade followed up by the pecking of blunt facets. This results in conical hammers/pounders/pestles characterised by a flat, generally multi-faceted frontal aspect (Figure 35). Subsequent use wear

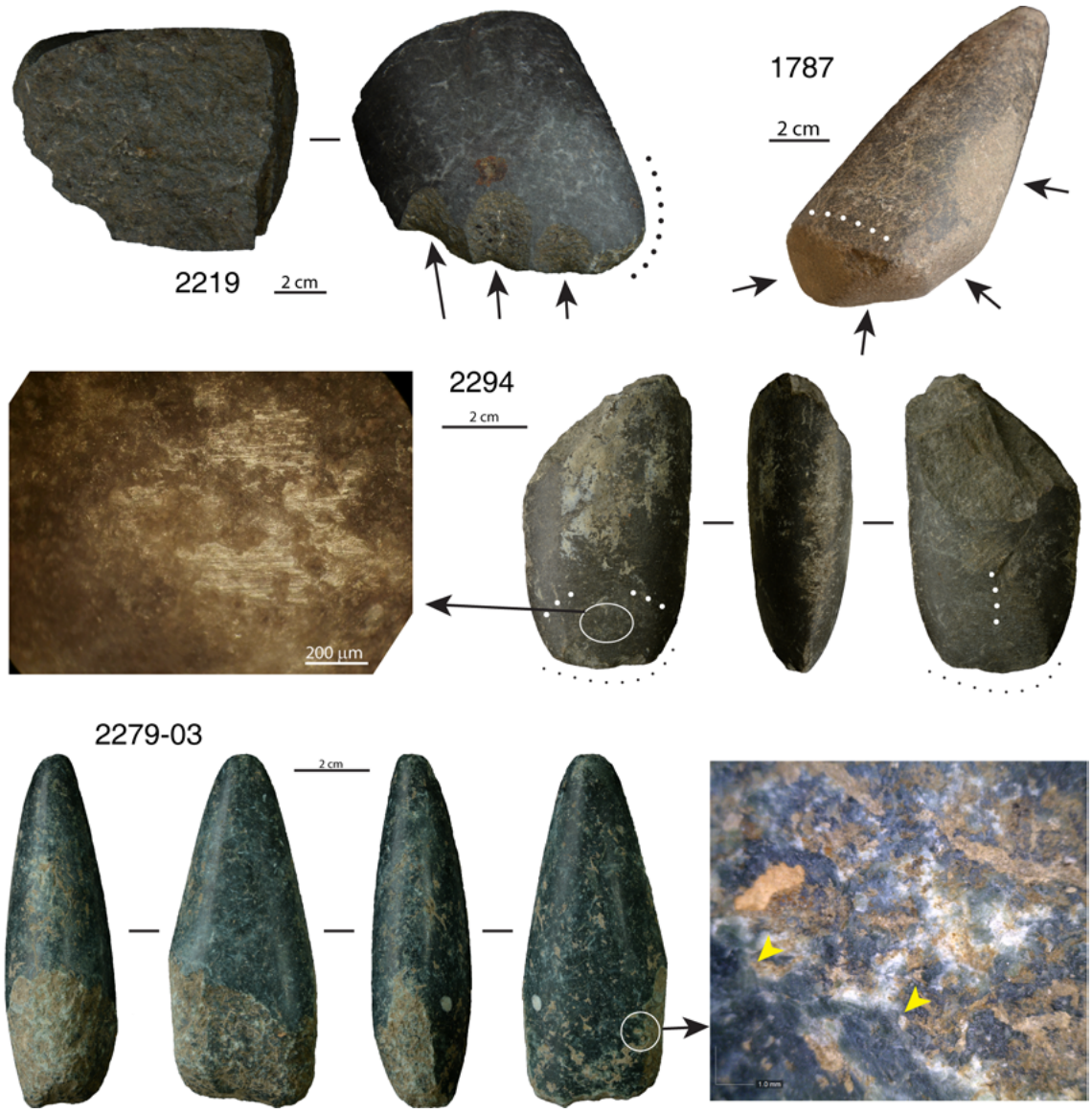

Figure 35: Resharpening activities in El Flaco through flaking on greenschist 2219 and abrasion on greenschist 2294, and reworking of metamorphic 1787 and overprinted 2279-03. Dots indicate relation to hold-over and newer use wear, and yellow arrows where the ground surface is interrupted by reworking scars.

from pounding consists of rounding of the asperities, but working distance limitations in the field unfortunately inhibited high magnification analysis. Two out of three, where the technique resulted in a fine pecked topography, also retained use wear on the proximal face and side aspects from prior use as celts. In 2279-03 this was not evident.

7.2.6 Depositional context

The spatial context of the materials from the 2013-2015 collections indicates that they entered the archaeological record as sweeping refuse. Upon abandonment in the domestic space, they were at a later point removed during the cleaning of the house and swept into the site formation context (Section 6.1.2). This pattern appears fairly widespread in Late Ceramic Age habitation in the Greater Antilles (Samson 2010; Siegel 1992), and occurs indiscriminately of the type of material culture (cf. Section 9.1). What has yet to be established is through what process these celts were abandoned prior

to having been swept out of the house.

The primary insight is not only that the assemblage is significantly fragmented, but moreover that the useful edges are almost completely exhausted. Of the 21 blades that could be examined for stereoscopic wear, five were completely destroyed (no bevel remained) and twelve more strongly dulled with heavy use retouch or the complete mangling of the edge (no edge remained). Only four edges were sharp, two of which were themselves flakes detached from the edge upon impact (unintentional or as rejuvenation) and the other whole-body breaks that equally rendered the fragments useless. Nearly all of the unusable edges also contain this type of breakage, where a sideway impact splits the medial area. The majority of fragments would appear to demand extensive repair, if not simply beyond salvaging, in addition to the common use-related breakage around the area of the haft (whether closer to the proximal or to the distal aspect).

There is good evidence for repair and reworking in the assemblage, indicating that simple breakage during use did not necessarily entail direct discarding. Small unifacial edge flakes with a percussion bulb on the edge may result from unintentional breakage during use, or may represent rejuvenation flakes. Either option is possible. Both sharp-edged and dull-edged flakes were present, but the former may have originated with an active edge deformed by retouch and so do not provide a means of distinguishing the two. The two specimens that were discarded during a resharpening episode had accidentally broken the bevel in it, which lends further credence to this idea.

Those two specimens also carry near-straight fractures across the transverse plane in the medial zone, as do many others in the assemblage. These breaks are most commonly bending-initiated or compressive fractures with straight or characteristic slightly curvaceous profiles. Fairly even microtopographies evidence fluid trajectories of the forces, sometimes with sideways rippling. In schistose specimens the fracture often results in more irregular patterns. Such transverse medial

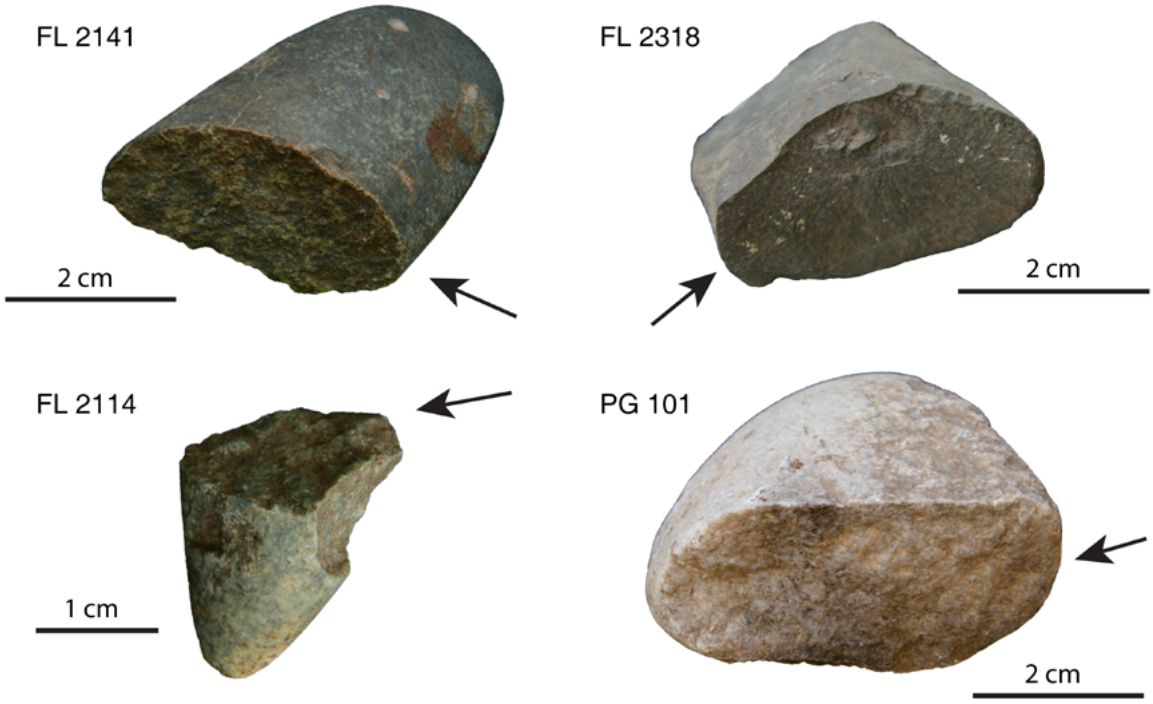

Figure 36: Fractures across the transverse plane between the proximal-medial and medial-distal zones on butt fragment FL 2114, edge-medial fragments FL 2241 and 2318, as well as blade fragment PG 101 from Playa Grande.

fractures are associated with the isotropic breakage of the artefact on or near the articulation with the hafting arrangement during active use (e.g. Olausson 1982/1983; Rostain 1994, 366). They are seen on the majority of specimens from El Flaco, including large medial fragments with both the butt and the edge missing (Figure 36). Furthermore, some specimens bear possible impact scars (crushed grains) located on the bilateral sides, and others indicate a transversal direction of force through smooth initiations and terminations (cf. Figure 36, d). These traces suggest another cause of transversal breakage, supported by the occurrence of such fractures on celts with completely exhausted edges or medial fragments with two breakage planes. Since these celts were already rendered inoperable the transverse fractures are unlikely to be related to natural use/haft fracturing. An alternative is the practice of intentional destruction, which will be more fully discussed in Chapter 8.

7.3 Playa Grande

The analysed assemblage from Playa Grande counts 160 specimens. It consists of a mixture of discarded production cores (primarily roughouts) and fragments exhausted after use, with few pieces of debitage, indeterminate objects, and intact celts present. For high-pressure rocks the entire biography is represented in the assemblage, whereas for other rock types this is generally not the case. As a result, and especially concerning the stage of early reduction, the data for high-pressure rock materials take centre-stage. This helps in addressing the dynamics of the production process, in which usually linear sequences are sometimes reversed (abrasion preceding shaping) and certain other processes flow into one another (various degrees of hammering and pecking).

The majority of materials (nrs 009-154) were analysed in the field and are subject to the relevant limitations (Section 4.1). As a result, the associated documentation for microwear from manufacturing and use activities restrains the average inferential resolution of these biographical phases.

7.3.1 Materials and procurement strategies

The general division of rock types between the analysed sample is provided in Figure 37. High-pressure metamorphic rocks comprise nearly two-thirds of the assemblage, including identified jadeitite and blueschist. A sizeable number of rocks with high-pressure characteristics were not definitely assigned to these groups. Furthermore, the assemblage contains lower numbers of typical greenschist rocks, metamorphic rocks with low-grade characteristics, as well as a few rocks of other types or uncertain lithology. Apart from most of the jadeitite celts, which had been petrologically sorted from the assemblage before, systematic examinations were lacking. The basic division in the present groups was therefore obtained in reference to petrologically examined rocks from other archaeological contexts.

High-pressure rocks

Jadeitite and jadeite-bearing rocks comprise 29% of the analysed assemblage (n=46), slightly below the number of 36% for the complete inventory (Knippenberg 2012). Speich and Hertwig (in Hertwig 2014, 143-147) describe six specimens as mainly granoblastic with coarse to fine graininess and usually subhedral to anhedral minerals, but sometimes displaying fibrous mineral forms or weak foliation. The present assemblage also contains this textural variation. Regarding their colours, about half have pale green to slightly yellowish variations. The remaining pieces incorporate some bluish colours therein, ranging from a tinge to a mottle. Macroscopically distinct accessories are

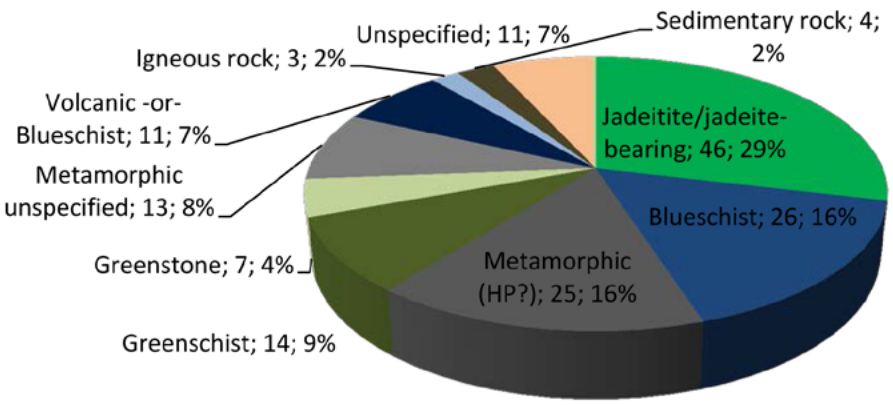

Figure 37: Overview of raw materials from Playa Grande.

sometimes present and include micaceous minerals, large blue minerals (glaucophane), and darker green minerals (omphacite). One jadeite-bearing specimen (PG 118) stood out as a visually distinct darker green and may perhaps be more omphacitic in nature. Published petrographic, mineralogical, and geochemical characterisations of specimens from Playa Grande indicate consistency with the Río San Juan Complex (RSJC) as a source area on all accounts, and a selection preference for the quartz-free suite (Hertwig 2014, 53; Schertl *et al.* 2018).

Identified blueschists comprise 16% of the assemblage (*n*=26), but the percentage of non-identifeid blueschists is probably larger than for other rock types given my initial unfamiliarity with the rock. Most have clearly foliated fabrics composed of glaucophane with partially to fully formed crystal habits, and varying grain sizes. The colours are correspondingly dark blue, with a green mottle in a few specimens (indicating accessory omphacite, jadeite, or epidote). A sub-group of 12 blueschists include white-coloured minerals in veins or mottles intersecting the dark blue glaucophane matrix. Some of these are barely affected, but other specimens contain up to 50% of such alteration. This sub-group is not as clearly involved in local manufacturing operations. Blueschist is readily available from the serpentinite mélanges in the RSJC, and further occurs in the various high-pressure terranes in the Greater Antilles (Section 2.1). There are currently no easy criteria for distinguishing the various outcrops, however (cf. Schertl *et al.* 2018).

The third group consists of metamorphic rocks with high-pressure characteristics that were not further specified (*n*=25). Most share characteristics in fabric, texture, and recognised minerals with the blueschist and jadeitite groups, but lacked confidence for a more precise classification. A few members were dominated by pale green minerals, and are potentially also jadeite-bearing rocks. Most contain a mixture of (often acicular) dark blue crystals, and (usually granular) green minerals in various shades. These rocks likely belong to the blueschist facies, but it was not clear how they should be classified further. The remainder consists of blue to nearly black metamorphic rocks with 'block-like' foliation structures, some of which contained micas and another pale grey mottling. These will probably classify as blueschists as well, but the accessories indicated by these colourations indicates uncertainty.

Macroscopically comparable rocks with little foliation were grouped separately as unspecified 'volcanic or blueschist' rocks (*n*=11). Most are similar to the rock groups now classified as blueschists, but were assumed to be a type of volcanic rock in the field given their dark colour and my unfamiliarity with blueschist variation. The biographical data often indicates more affinity with the blueschist and

high-pressure rocks than with the low numbers of volcanic rock celts, but the necessary mineralogical details were not recorded at the time.

Low-grade metamorphic, igneous, sedimentary, and unspecified rocks

The greenschists (*n*=14) consist of fine-grained green to dark green rocks with massive to slightly foliated fabrics. Some contain garnets, and closely resemble in their appearance some of the greenschists found both at El Flaco (Section 7.2.1) and El Cabo (Breukel 2015). Seven other greenstones exhibited stronger foliation and green-greyish colours, and are also low-pressure metamorphic rocks probably belonging to the greenschist facies. However, they were less typical of the rocks found at the other sites and thus separated; it is possible one or two are shales instead.

The unspecified metamorphic rocks are diverse in appearance (*n*=13). Colouration ranges from uniformly brown to nearly black in some, while others are lighter or possess blue or darker mottling. Most are massive, rather than foliated, but they differ from the aforementioned rock types in some ways. The group probably contains high-pressure rocks such as omphacitite (PG 070) and low-grade metamorphic rocks with tuff or sedimentary protoliths.

Three igneous rocks have been identified (*n*=3), all fine-grained grey-black mafic rocks. These numbers will probably grow upon better characterisation of the unspecified rocks, but remain percentually very low. The low number of sedimentary rocks present (*n*=4) is more in line with other sites. These are (pale) brown carbonate rocks with varying graininess. The group of unidentified rocks (*n*=11) contains primarily appearances in a mixture of lighter grey, brown, and greenish hues. These were incomparable to the main rock types or not clearly distinguishable from other possible identifications.

Procurement activities

Signs indicating procurement from secondary context are found on pale green jadeitite rocks (*n*=15), jadeite-bearing varieties (7), probable blueschists (*n*=4) and unspecified metamorphic rocks (*n*=3). For the most part these are water-worn surfaces, and alluvial micro-topographies thus characterise roughly half of the jadeite-bearing group. If indeed from the Río San Juan area, as seems likely, the materials could derive from the bed load of the river itself, some of its supplying tributaries, as well as the arroyo Sabana (Knippenberg 2012; Schertl *et al.* 2012). The pebbles in the assemblage are all in the range of 05 to 20 centimetres and have ovoid to elongated shapes insofar as is estimable, though irregularities are common. Based upon the survey findings supplied by Knippenberg (2012), this would indicate procurement from the lower beds where the river-rolled pebbles meet these dimensions.

Natural topographies were distinguished from technologically altered surfaces on the following grounds (Section 4.1.3): since reduction reduces relief, equivalent micro-topographies between the various inclinations of macroscopic undulations indicate a natural origin. High relief in a micro-topography can rule out abrasive manufacturing, while irregular behaviour of the gradient, size, and penetration of the interstices contends with the consistency expected from repeated percussion. Similarly, erosion of the peaks and of randomly exposed mineral cleavage indicates succeeding in situ weathering (Figure 38). Surfaces with recent percussion tend to have fresh and spatially abundant cleavage planes instead, though overlaying wear from later friction (e.g. hafting) complicates the inference.

A notable occurrence amongst these water-worn materials, and a few partially flaked specimens,

is that the areas near the (intended) edge were subjected to limited abrasion.[35] These traces show no relation to the grinding and (future) use of such specimens: the ground facets are diminutive, not always mirrored, and lack developed wear from manufacture (Figure 38), while seen as 'edges' they are unfinished and lack wear from use. Most of these artefacts were discarded for the appearance of terminal flaws during early reduction. This phenomenon is interpreted as resulting from short-term abrasive actions intending to manipulate the stone into showing its internal colouration. That way, the colours are consistently brought to attention and textural details obscured by the pale cortical exterior could be made visible. It indicates the appearance of the rock with further grinding and polishing, in order to affirm that the selection criteria inciting its collection were correctly anticipated.

7.3.2 Early reduction

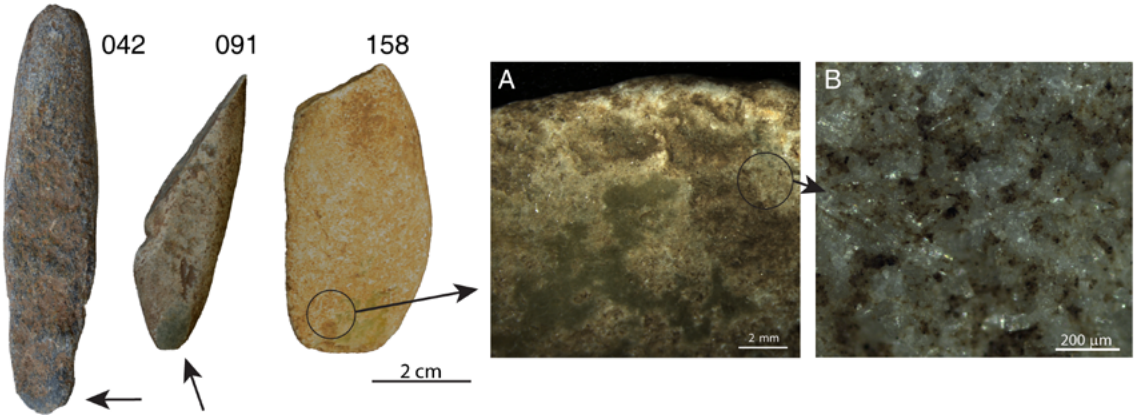

Figure 38: Procurement-related abrasion facets on the intended edges of high-pressure rock blanks. A) close-up of the edge on jadeitite 158. B) naturally worn micro-topography on the same specimen.

Many of the high-pressure rock materials are blanks, roughouts, or preforms, and return detailed information regarding the sequence of operations that led to their current form. A number of different techniques were used in their shaping, some of which are specific to particular raw materials. The situation is different for the other celt materials, in particular low-grade metamorphic rocks, all of which represent completed and exhausted fragments. Such specimens do contribute data, but at a different resolution due to the erasure of traces from previous steps. The results are collated in Table 10 per observation (not per artefact). What shape each technical operation takes and how they interrelate in the operational sequences is detailed below.

High-pressure rocks – flaking activities

The first thing to note is that the sequence of applications for the various flaking and hammering actions shows little standardisation. Different actions and techniques are applied interchangeably, synchronously, or are refrained from. Certain artefacts present a meshwork of motions: limited abrasive manipulation of the edge precedes all other actions, and is first followed by light pecking of

35 This concerns most, but not all, of the specimens considered as thereby finished by (Knippenberg 2012) in his preliminary study. He interpreted these materials as heavily used celts that were only minimally ground as a working compromise against the extreme hardness of the jadeitite, but this argument is not consistent with the microscopic data.

Table 10: Observed reduction techniques and manufacturing steps at Playa Grande. Individual observations only score certain points and therefore consistently underscore the actual prevalence in several categories. The prevalence therefore estimates the consistency with which such techniques would have been observed in an ideal situation (all celts finished and no traces erased, the whole biography laid bare). The totals do not count single artefacts multiple times (e.g., a preform with both coarse and fine pecking traces counts as 1 to the total).

Technique	High-pressure rock materials (97)		Other celt materials (63)	
	Times observed	Prevalence and comments	Times observed	Prevalence and comments
Flaking total	43	Very high	22	High
Cortex removal	*~11*	*Unclear, but probably high*	*3*	*Unassessable*
Bifacial thinning	*Up to 23*	*Medium*	*13*	*High*
Foliation plane splitting	*~11/15*	*Medium (without/with debitage)*	*1*	*Absent (pertains to an unspecified rock)*
Lateral intrusive flaking	-	*Not collated*	-	*Not collated*
Direct percussion	*8*	*Medium-high*	*2*	*Unassessable*
Bipolar percussion	*6*	*Medium-high*	*1*	*Unassessable*
Flaking skipped in the production sequence	*3*	*Very low*	-	*Unassessable*
Hammering – heavy, transverse	40	Very high	17	High
Pecking total	47	High	25	Very high
Coarse pecking	*18*	*Medium to possibly high*	*10*	*Medium*
Fine pecking	*21*	*Medium*	*9*	*Medium*
Unclear/no evidence	17	-	24	Especially for greenschists
Pre-reduction abrasion of the edge	12	Medium-high	1	Absent (pertains to an unspecified rock)
Pecking preceding flaking	10	Low	2	Low
Residue deposits	At least 7*	Unclear	-	-
Debitage	4		1	

*This includes two unspecified metamorphics (both green-coloured production fragments) and excludes residues spatially associated with possible hafting features. It is deemed possible that smaller deposits were originally dismissed during the analysis as 'probable contamination', before this became a consistent observation.

a surface, to shape the outline of primarily the edge area. These activities are only then overlain by flake scars from bifacial thinning and shaping of the sides through hammering. The order in which manufacturing processes appear for individual artefacts is preserved in Appendix 3. This section illustrates the innate dynamics constituted by individual decisions in and negotiations with working the materials.

Starting from the selection of pebbles approximating the intended length and elongation, the first procedure on average will be bifacial shaping through direct flaking. This procurement strategy largely precludes the need for significant initial flaking (*sensu* Inizan *et al.* 1999, 151), and reduction of the bifacial thickness is partially accomplished by simple cortex removal flaking. The evidence usually consists of shallow, non-overlapping flakes oriented along the long axis, often showing feather terminations and sometimes conchoidal outlines. Most edges are also worked in this way, and otherwise not subjected to percussion, though overlap with the next technique occurs.

The majority of flaking evidence pertains to bifacial thinning. Here, large step fracture scars in bilateral direction remove substantial volume, and in smaller specimens may cover the entire face with a single blow (Figure 39, 011, 124). Compared to the smaller cortex removals, the size and step termination of the scars indicate a switch to larger hammerstones and higher application of force. Both bipolar and direct percussion appear to have been used, in rare cases concurrently (Figure 39, 140). The necessary indicators for identification usually lack, however. Bipolar percussion is evidenced more often, through flake scars with step or irregular terminations opposed by another scar, frequently accompanied by localised impact crushing from the counterblow of the anvil. Alternation between percussion techniques was possibly more common, and dependent upon what was felt to be the best next step to work the material. Six specimens were rejected at this stage, after deep thinning flakes removed critical mass from (for instance) the edge.

The bifacial equilibrium plane of blueschist rocks was often aligned with the foliation plane of the rock, to take advantage of its fissile behaviour. Accordingly, when using direct or bipolar percussion (probably more so the latter) the rock splits along this plane producing an even, uninterrupted scar negative that extends over the full face of either surface (Figure 39, 004). At least twelve specimens show fairly good indications that this was how they were shaped, the scars being large, flat, uninterrupted, and aligned with the foliation in the rock. This technique has been described for blueschists in Alpine axe production context (Pétrequin *et al.* 2008; 2012a), though it has not been experimentally verified with RSJC blueschist yet. Several more glaucophane rocks displayed rectilinear sections parallel to the face with even, uninterrupted scars, but were not considered as split since these rocks lacked clear foliation.[36] The tools and technological environment for this strategy likely remain the same as for regular flake reduction. Nevertheless, it indicates a measure of skill and experience in working schistose rocks, knowing how to adapt the motions and gestures to rocks with different behaviours which lead to advantageous technical outcomes.

The assemblage contains barely any debitage from these activities. Knippenberg (2012) concluded therefore that the celts were initially manufactured without a flaking stage, also since conchoidal ripples and bulbs of percussion are infrequent in the scars discussed. I encountered only three large blueschist foliation split fragments, a smaller fourth of unclear lithology, and a large fragment possibly intended as cortex removal flake. It is unclear what this absence reflects. One small rectilinear adze (PG 084) was made from a thinning flake, but reworking cannot explain away the smaller debitage (all other celts were core tools). Some celts were immediately rejected upon manufacturing flaws, indicating that not all flaking occurred off-site. It is possible that concentrated activity areas were poorly sampled, but the issue, and with it the location of the initial reduction process, remains ultimately unresolved.

High-pressure rocks – hammering and pecking

The bifacial outline is shaped through repeated blows with a heavy and/or large hammerstone applied laterally to the bilateral sides, inducing fatigue crushing and the transversal transmission of force. The gesture results in a heavily impacted side morphology with crushed mineral clusters, frequent coarse cratering, and occasional minor cracking (Figure 39, 011, 072). Small to medium hinge terminationss grade into small flake scars on the faces, which are probably analogous to the 'lateral intrusive flaking'

36 This includes rocks in the 'blueschist or volcanic' category, which are otherwise discussed with the other rocks.

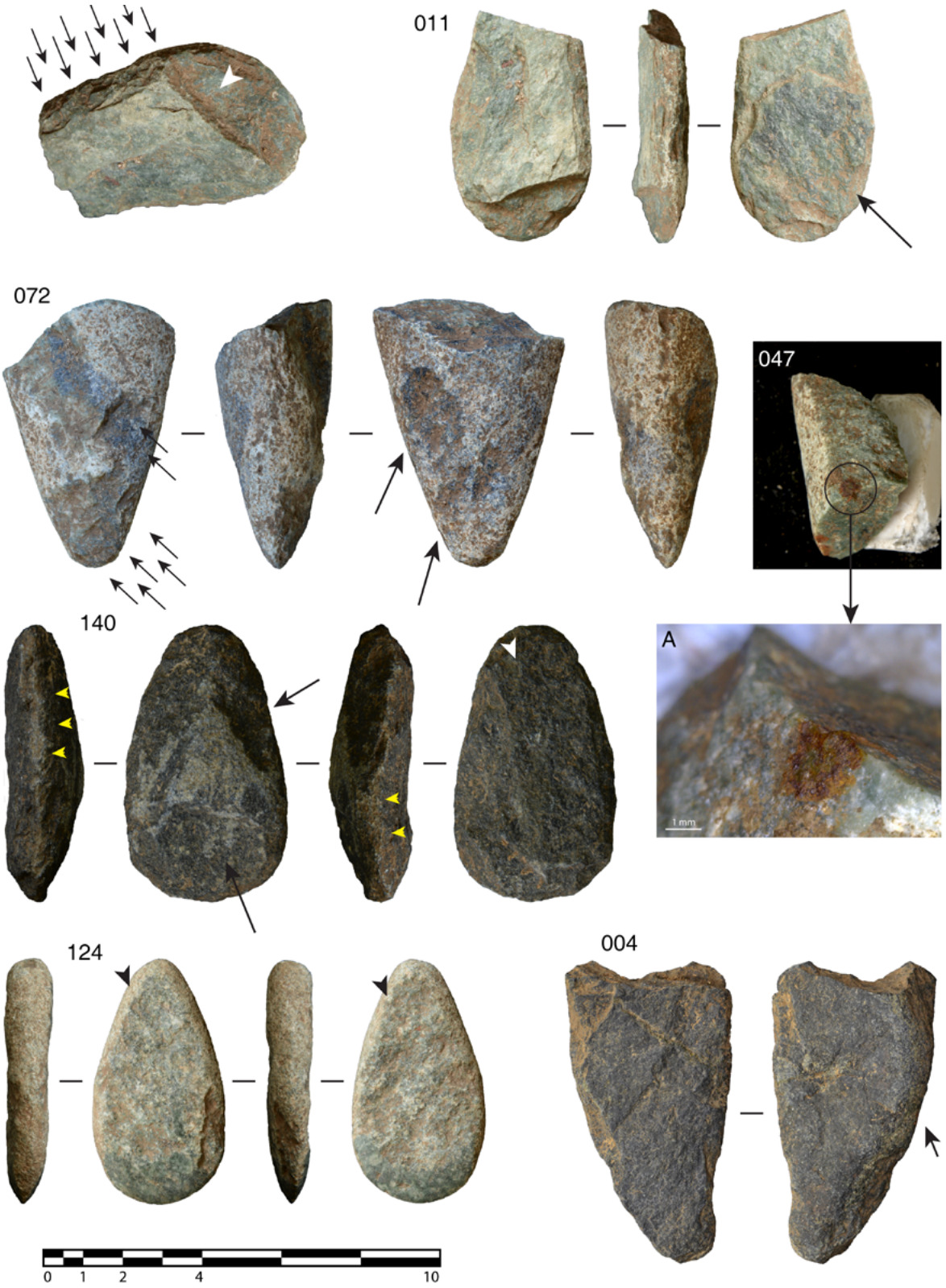

Figure 39: Manufacturing traces in Playa Grande. Jadeite-bearing PG 011 displays hammering hinges on the sides (arrow row) interrupted by an edge thinning mistake (white arrowhead). Single negative scar surfaces from bifacial thinning are visible on it (black arrow) and high-pressure PG 124 (arrowheads). Blueschist PG 140 shows evidence of shaping through feather terminated thinning scars (black arrows) removing a previously pecked surface and counterblow stigma (yellow arrowheads) opposing a debilitating bipolar initiation from the lateral angle. The dorsal face also consists of a single flat scar negative (white arrow) and may be split from a foliation plane. Glaucophane-veined jadeitite PG 072 displays a

coarse pecked topography amidst invasive hinges from hammering on the sides (arrow rows) and thinning scars from percussion (black arrows). Blueschist PG 004 is a flat foliation split plane with slight irregularities on blueschist, note also platform preparation through pecking (arrow). Jadeitite PG 047 carries treated resinuous residue, with a stereophotographic close-up in A.

of Rodríguez Ramos (2010a). This percussive activity is presently distinguished as 'hammering of the sides'. Its traces are most pronounced where the body is thickest, and taper off sharply near to the edge so as to avoid damaging its shape. Nevertheless, the majority of production flaws are associated with this phase, primarily as a result of force travelling across weaknesses in the rock resulting in more invasive hinges that damage the shape or edge. The resulting stigma are rarely erased by subsequent percussive and abrasive work, which contributes to the high observed prevalence of this hammering activity in the assemblage. This also indicates that the majority of celts flowing out of Playa Grande retain their smooth curved side morphology at that point, and are not related to the circulation of specimens with more angular shapes.

Though the flake negatives produced during the hammering of the sides do not form a real continuum with the scars from bifacial thinning, it is sometimes difficult to interpret which result was intended. The difference may rest primarily in alternating gestures and force directions. The techniques appear to have been interchangeable in practice for correcting earlier mistakes and preparing further stages of reduction.

Once hinges disappear and macro-topographical cratering lessens the impact traces are designated as (rougher) pecking, signifying a decrease in hammering intensity. The intent is clearly towards more precision in grain crushing to achieve a more homogeneous topography (Figure 39, 072), likely accompanied by a switch from large to medium-sized hammerstones to inhibit most of the chipping and cracking. Subsequent fine pecking is the principal final step, presumably using still lighter or softer hammers to smoothly even topographies by the crushing of individual grains to level. Out of 31 instances in Table 10, it is evidenced 22 times through holdover traces on mediodistal side aspects. However, traces of pecking form a continuous spectrum in the assemblage of Playa Grande. There is a fair degree of variation in the size and frequency of the cratering, indicating individual variance in the intensity of percussion and probably tool selection as well. Coarse pecking marks are often directly overlain by abrasive modification, and there are many instances in which (medium) pecking marks clearly averaged in between the ends of the spectrum. A regular observation is remnant pitting from pecking within ground surfaces, indicating they were well prepared in advance. These traces may even indicate a chain of repecking and regrinding to speed up the abrasive process on tougher rocks, drawing also abrasive processes within the dynamics of reduction seen here. It is unclear at this point how to distinguish the two alternatives, though.

Other

A recurrent observation in Playa Grande concerns the presence of treated resinuous compounds (see Section 7.2.4) on artefacts discarded during the early reduction process (Table 10). These are located at random, sometimes close to breaks, and are not in association with hafting zones or any further biographical progression (Figure 39, 047). Out of the several options that may account for this occurrence, the most likely candidates are interactions with resin processing at the site and/or fastening for stability during manufacture.[37] However, neither taphonomy nor contamination can be ruled out.

37 The options range from taphonomy to deviant biographical possibilities. It may turn out to be present

This underlines the urgency for identifying the exact nature of these residues, and if consistent with an anthropogenic origin, for further investigation of cultural activities at Playa Grande.

Low-grade metamorphic, igneous, sedimentary, and unspecified rocks

As stated, the evidence for reduction sequences in other types of rocks is meagre, and there are no roughouts or preforms present in identified materials. Though the sets of traces originate with the same types of production activities, there is no evidence that these rock types were manufactured into celts by the Playa Grande community. Over one-third failed to return clear indications of early reduction processes, most of which are greenschists and greenstones. These rock types otherwise carry few leftover thinning scars (*n*=3), scars from hammering of the sides (*n*=1), and holdover pecking marks (*n*=5). The situation is similar for the igneous, sedimentary, and unspecified groups, all of which are finished specimens. Some members from the unspecified metamorphic rock group and the 'blueschist or volcanic' group are roughouts, however, and therefore possibly mistaken high-pressure rock types. Discounting those, all of the finished celts display remnants of bifacial thinning, hammering of the sides, and pecking, with a bit more variation in the flaking procedures, spread of pecking intensity, and successive refinement than was the case previously.

7.3.3 Abrasive manufacturing

Abrasive manufacturing techniques are identified on 90 specimens, little over half the assemblage at 56%, and remained unclear on two additional surfaces. The variation is substantial, even within broader categories (Table 11), and is inferentially problematic due to the increased diversity of rock types. There are only few hafted or used specimens lacking abrasive modification (except for PG 089 presumably due to fragmentation). Counted separately are 13 specimens with brief abrasion on the intended edge to give an appraisal of the texture of the resulting surface. The spatial distribution is similar as before: the focus is towards abrading bevels and faces up to the medial zone, with the sides and distal areas periodically ignored. Though the frequency of previous pecking was scored as high (Table 10), the abrading of especially foliation splitting scars was often not preceded by such preparations. In such cases, the topographical lows remain unaffected as only the higher ridges are flattened.

*Dull lustres (*n=*41, 44.1%)*

Seven surfaces resemble the well levelled and weakly scintillating experimental topographies obtained by dry grinding on quartz arenite, or brighter scintillating in the case of jadeitite. Not all artefacts

from natural excretion, in which case it may be an occurrence local to Playa Grande's environment (1a) or one that is more widely spread (1b). In this case the range of its natural occurrence will determine whether or not the observations can be relied upon as cultural, rather than taphonomic, though it does not exclude the compound from having been utilised for adhesives regardless.

If it is a culturally produced compound, its association with the objects could still be unrelated to their biography as celts. Corresponding explanations may entail accidental spillage during the production of the compound (2a), facilitated by the spread of the celt materials across domestic floor layers at the site, or the expedient re-use of debitage fragments during resin processing (2b). Such possibilities are difficult to address further from the celt materials alone.

Thirdly, the residues may be objectively associated with the celt biographies, in which case it is moot whether the compound is pristine or has undergone processing. This leaves as prospects the fastening of blanks to an anvil for stability during manufacture (3a), or the adhesion of other materials to roughouts either before or after surface treatment for purposes not related to technofunctional considerations (3b).

Table 11: Trace signatures of abrasive manufacture categories in Playa Grande.

***n*=93**	**Dull**					**Intermediate**			**Bright**			**Unsp.**	**Absent**	**Multiple**
	Dry ground	Intermediate	Sand-ground	Specified different	Unspecified	Cf. 2782	Specified different	unspecified	Wet ground specified	Wet ground unspecified	Mirror	Unspecified	(edge optional)	
Igneous rocks							1					1		
Other/unspecified rocks	1	4			1	1			1	3		6		
Low-grade/unspecified metamorphic rocks	2	6	5	1	2		3		4	5		1		
Other high-grade rocks			2	2	3	3	2	1	4	7		5	3	1
Jadeite-bearing rocks	4	1	3	2	2	2			2	1	1		2	1
Total	7	11	10	5	8	6	6	1	11	16	1	13	5	2

match entirely the even relief or fine striation patterns from these experiments. However, on the whole they do fall within the 'traceless' signature of dry grinding against a lithic platform.

The range of trace patterns encompassed by the 'sand-ground' signature is found on ten, half of which are greenschists (Table 11). These all possess a moderately level topography with persisting micro-relief, which is rounded and characterised by a rough, medium-bright scintillation with little to no polish formation. Nevertheless, there is quite some variation in the brightness of the scintillation, the retention of said relief, and the configuration of the striations. For instance, the micro-topography of jadeitites is brighter (Figure 40, a), but best included here (below). This probably results from minor differences in fabric properties of the grinding platforms inasmuch as the characteristics of the celts in question. However, the general interaction of intermediate grains under load appears to define even acicular matrices equally.

There is a group of eleven surfaces with wear trace patterns deemed intermediate to dry grinding and 'sand-ground' characteristics. Essentially, these microtopographies display more relief and stronger scintillation than the dry grinding experimental results, but are duller and less rounded than the experiments with intermediate particles. Striations continue to vary, but are on average denser as well. The data are strongly biased towards low-grade metamorphic rocks, and lack verified high-pressure rock materials (Table 11). Presumably, this reflects inferential imitations in the characterisation of wear trace patterns on high-pressure rock surfaces by reference to experimental surfaces from other raw materials. Since the dry grinding experiment with jadeitite resulted in a much brighter scintillation (exp. 3797), it is conceivable that jadeite surface topographies are somewhat misrepresented at present, and that equifinal wear trace signatures do not necessarily represent equivalent initial techniques for different rock materials. Further experiments are needed to assess how this differentiation plays out and to what degree unforeseen technological possibilities take part in them.

Five artefacts display dull lustred surfaces adhering to the baseline of scintillation with micro-relief, which are distinguished due to incipient development of polish. Scattered and sparse, these structures are generally small, rough, bright, and weakly linked (Figure 40, b). Striations are mostly absent, except for stereoscopic gouges on sides and on the blueschists. Some specimens may reflect a particularly efficient grinding platform in dry conditions, similar to exp. 2512 (basalt on quartz

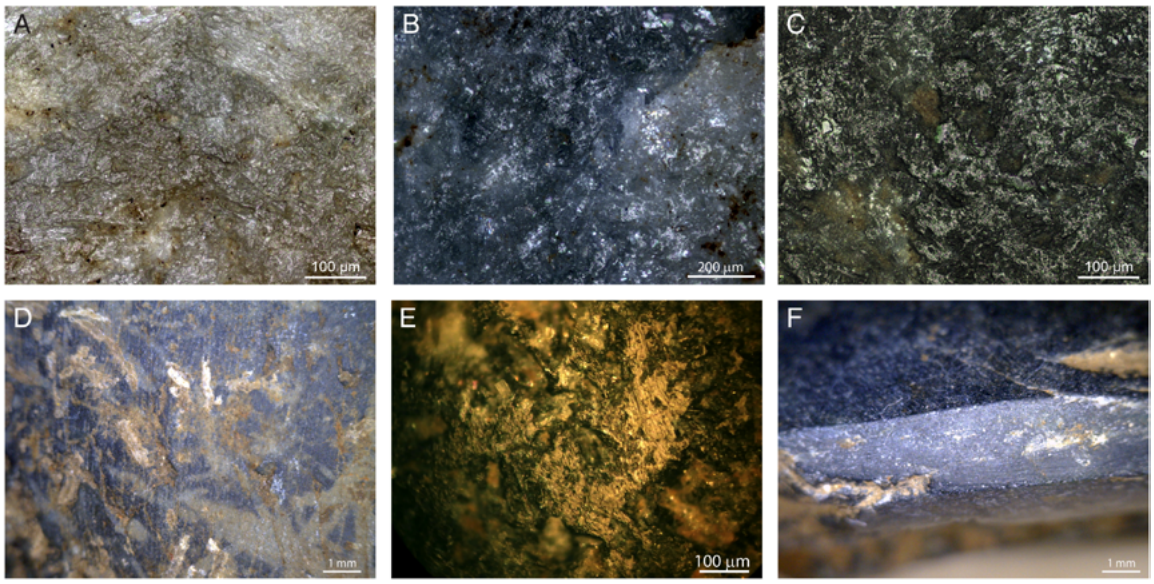

Figure 40: Wear from abrasive manufacturing in Playa Grande. A) 'sand-ground' polish on jadeitite PG 006. B) scintillating surface with best possible extent of scattered stone polish on jadeitite PG 001. C) dull, flat, rough, and striated polish on blueschist PG 161 with light overlay of wood friction traces. D) deeper gouges from intermediate grinding on greenschist PG 019. E) unspecified wet grinding trace polish on blueschist-like PG 105. F) blunting of the edge on 'volcanic or blueschist' PG 147.

arenite), though greenschist was already seen to interact differently under that set-up. The artefacts are overall well levelled, connoting efficient abrasive interactions, but in light of mineralogical differences inferences to the resolution of specific techniques are premature.

The remaining artefacts ground using a dull lustre-inducing technique remain unspecified. Additional variation in wear patterns is noted for some, such as deeply gouged topographies or bands of striations, but they were not well comparable to the aforementioned groups. Others lack such descriptions, partially lacking distinct traces and partially the result of field limitations. While differences in the utilised platforms are likely, the aforementioned inferential caution stands.

Intermediate lustres (n=*13, 14%)*

A number of specimens displayed matt or diffuse lustres, corresponding to the development of micro-polish. These are best categorised as intermediate to the heuristic categories of dull and bright lustres. The main group herein consists of fairly well levelled, scintillating topographies that developed concentrations of dull, flat, rough, and striated polish (Figure 40, c). The size and interlinkage of polish structures may fluctuate somewhat, as does the degree of scratching, but the results nevertheless match well with the experimental topographies of 2782 and 2513 (Section 5.2). The traces appear on six celts, all blade fragments made from high-pressure rock types. Following the experimental comparison, these were likely ground using hard, fine-grained, cohesive sandstones of comparable mechanical properties. Such tool materials are present at the site, and suggest the artefacts in question were fully made at Playa Grande. Additionally, the traces seen on a few blueschists with brighter lustres can also be characterised as such, but these are ultimately regarded as unspecified due to inferential limitations with acicular matrices.

Otherwise, there are several other specimens that, despite well developed polish on the micro-topography, nevertheless fail to reach a characteristic macroscopic brightness. Two greenschist celts displayed well developed, rough polish characteristic of contact with lithic materials superimposed

over a brightly scintillating topography. Striations are dense on the sides of the corresponding artefacts (Figure 40, d). Another signature corresponds to the heavily gouged topography of exp. 2515-A, with corresponding ploughing of the bright polish (see Appendix 1). These wear trace signatures are distinguishable as different from each other and appear to correspond to technical variations, whether in the properties of the lithic platform, additives, or other variables. They are seen to occur independently from the types of celt materials, though that is by itself no evidence that the initial conditions were otherwise equival. However, it must be noted that the high amount of striations and poor levelling implies that some of these wear trace signatures reflect rather inefficient platforms for the task at hand (cf. Section 5.2).

*Bright lustres (*n=*28, 30.1%)*

Section 7.2.3 defined several unreplicated abrasive techniques resulting in bright lustres on the basis of observed characteristics and patterns of wear. These descriptions remain useful here, in order to separate out distinct technical environments from ground and polished surfaces. Four specimens displayed dense developments of bright to very bright, well connected, rough and flat polish on a level microtopography, lacking striations altogether (wet stone variant 1a and 1b). Wet stone variants 2 and 3 characterise one high-pressure specimen each (cf. Section 7.2.3). Since the rock types are different, it is probable that also the techniques used are not equival to those of the specimens from El Flaco. Nevertheless, the separation of each 'variant' in Playa Grande reflects the application of distinct techniques in the assemblage, and implies further complexity into indigenous choices of grinding and polishing platforms.

An additional five specimens display metallic lustres that microscopically match the experimental topographies of wet grinding on quartz arenite. Some of these exceed the experimental intensity, and further variation rests in striations on the sides or in the polish structures. Additionally, three blueschists match the wear trace signature from in particular the experiment with basalt (2513), but are classified as 'unspecified' for inferential limitations at this level of resolution. Several of the other 'unspecified' materials can be reasonably well described (Figure 40, e), but the wear trace patterns do not stand out as distinct or comparable against the other archaeological and experimental data. There are differences between the intensity and nature of the lustres of each, and probably variation in the properties of both tool rocks and celt materials that account for the observed differences. All, however, are broadly consistent with wet grinding on a competent lithic platform lacking added intermediate abrasives for combined surface material removal and production of gloss.

One jadeite-bearing celt of rectilinear morphology displayed a metallic lustre, corresponding to 'bright mineral mirror polish' on the bevel. The polish was exceptionally well developed, being very bright, perfectly flat, and lacking pitting except where this pertains to interstitial space. Certain accessory minerals retained a rougher texture and some striations, however. The specimen lacked traces indicating other abrasive or use activities.

Other

The remaining specimens are classified as indeterminate, largely due to lithological disparities (carbonaceous rocks or acicular blueschists) or complete overlay by later wear. While abrasive contact was evident, it was not possible to establish the relation of these activities with the techniques described above.

Other abrasive contacts in the biography consist of the aforementioned manipulation of bevel areas during procurement. The observed wear trace patterns are highly variable, but understood as representing only a brief moment of contact and therefore not developed enough to be indicative of particular techniques. It is probable that these actions took place during procurement, and that nearby rocks in the river bed were simply utilised with little regard for reductive efficiency or end-lustres.

These observations clearly differ for the four specimens that were abraded only on their bevel and used in that state. The prevalence of this activity may be higher than indicated, since only artefacts with intact bevels and medial zones displaying both use wear and hafting traces were included in this count. It is not the dominant operational sequence for high-pressure celts, as Knippenberg (2012) argued, but nevertheless does characterise a handful of materials. Similarly, his observation that celts were reworked into grinder-pounder tools by abrading the edge to a blunt facet (Figure 40, f) is reassessed. Certain specimens (a.o. PG 127) do indicate previous episodes of use, but the majority of artefacts lack interpretable use wear, which suggests they are preforms and invites alternative explanations. One possibility is that it represents an adaptation during manufacture to preserve the integrity of the edge while the bevel is ground, as it minimises the occurrence and impact of 'edge' grains dislocating from the matrix under abrasion.

Finally, there are several instances of whetting of the bevel through a secondary abrasion episode, erasing previous use traces and contrasting the manufacturing signature. This is not very prevalent, but such treatments are no longer distinguishable once the bevel becomes overlain by new wear from use. Whetting activities form the only instances in which multiple abrasive techniques were detected on the analysed specimens. Otherwise, the celts from Playa Grande were abraded using a single technique only, whether dull or brightly lustred. Soft material polishing traces are absent from the assemblage.

7.3.4 Composition of the hafts

There are 72 artefacts with the potential for hafting traces, excluding unfinished materials and adjusted for non-abraded specimens with a biographical life. Of these, 38 returned traces of wear associable with hafting. The resolution of the inferences is rather low, considering the rate of fragmentation. Typical axe and adze arrangements could be distinguished on 14 celts, and three others displayed traces of a different nature. 22 bear traces associable to hafting which could not support a full reconstruction, and 15 more bear traces of uncertain association. The standard wear trace patterns permitting the different inferential levels encompassed here have all been discussed previously and will not be repeated. Additionally, seven celts carried residue in association with a potential hafting zone.

*Axe-style hafts (*n=*6)*

Direct embedded male hafting systems with probable lateral transverse parallel orientation were identified on three (probable) blueschists. As before, these are characterised by the symmetric presence of well developed wood friction on all circumferential aspects, often comparable to the seasoned wood friction experiment. When analysable, use wear traces are also distributed symmetrically between either bevel. One blueschist showed intense development of wood friction previously discussed as 'exceeding' the experimental range on the surviving lateral side, suggesting the insertion of a wooden prop to better fasten the piece.

A direct male split system is indicated on one greenschist by the clearly bounded spatial

distribution of the traces. Assuming a few centimetres of butt protrusion, the sheer size of this specimen nevertheless indicates the original hafting system was rather large. Two final specimens displayed increasing intensity of traces from wood friction on the sides compared to the faces, and fall in between the probability patterns for each type of slotting. Both displayed symmetric wear of the edge, indicating lateral transverse parallel orientation.

Adze-style hafts (n=*8)*

Latero-distal, transversal, perpendicular, juxtaposed hafting systems are inferred with certainty for two specimens. Consistent with previous observations, the traces are spatially asymmetric: one face displays clear polish from friction with wood, with the other three aspects showing traces indicative of bindings from softer materials. Such traces appear as well developed, matt to bright, invasive, rough polish that rounds the asperities but does not abrade them (best represented in Figure 41, a-b). One specimen (a non-ground blueschist) was clearly deeply bound into its haft and likely rested against a wooden ridge with its distal end. The second, green-blue metamorphic rock bore exceptionally well developed traces of hafting on the few ground zones, and was supported by adhesive residues on the

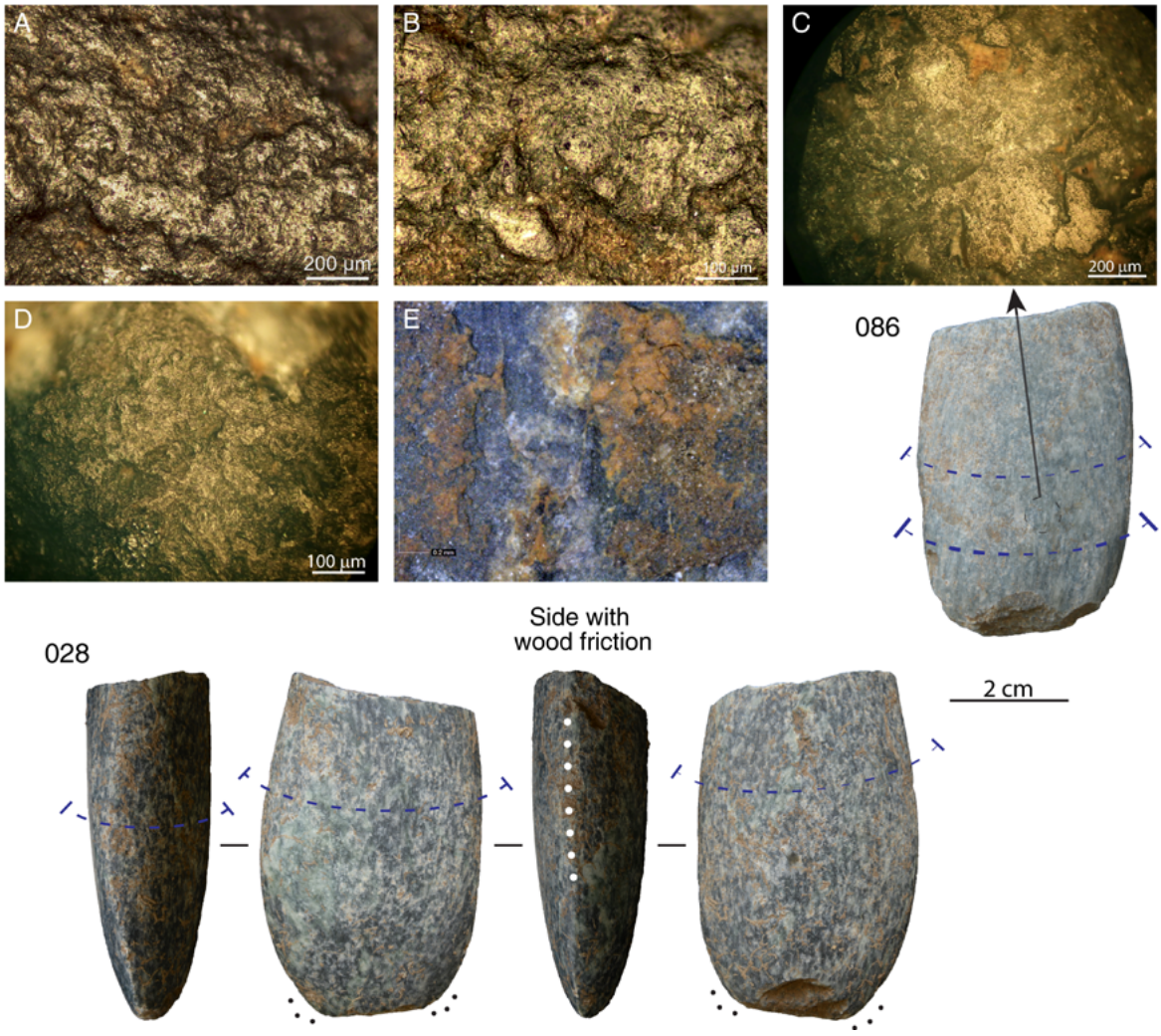

Figure 41: Hafting wear in Playa Grande. A-B) micrographs of wear from contact with plant bindings on greenschist C 1645 equivalent to a.o. PG 025. C) matt rough plantish traces on jadeite-bearing rock PG 086. D) strong developed rough and invasive traces on 'volcanic or blueschist' PG 097. E) Potential pristine resin on greenschist PG 019.

side in contact with the wooden slotting. A third specimen displayed traces of binding that are better described as a matt, greasy polish draped over the topographical relief and abrading it.

Five other specimens are characterised by asymmetrically distributed traces from friction with wood and residues. These were likely also hafted in perpendicular juxtaposed systems, but uncommon alternatives such as poorly fitting male hafts with bindings, or perpendicular indirect fastening, cannot be ruled out entirely. Traces from potential bindings were not seen or deemed interpretable on these, partially due to fragmentation. A high-pressure metamorphic rock displayed well developed traces of binding in combination with residue, but the surface presumed in contact with the wood was heavily damaged; another jadeite-bearing rock carried residue in association with friction traces on the ventral face, but lacked traces of bindings.

Other indications

Two high-pressure rock petaloids, of near identical morphology both originally and as fragments, may have been covered in wrappings while placed in the haft (Figure 41, 028, 086). Both displayed large, invasive polish structures with a matt and greasy to rough texture on both faces and one of the bilateral sides. The rougher variant compares somewhat favourably to the experimental traces obtained through friction with bark (Figure 41, c). The remaining lateral side aspect displays traces indicating wood friction, combined with residue on PG 086. Such patterns could form in a parallel male attachment if originally four-sided wrappings (or an embedded slot crammed with soft material) had worn through. Alternatively, wooden inserts could have been placed to increase the tension of the wrap. None of the ethnohistoric or ethnographic scenarios would produce such patterns (Section 2.3), but the butts are unfortunately missing, preventing a definitive assessment.

PG 097, a petaloid fragment with rectangular cross-section and shallow side notches in the 'volcanic or blueschist' group, was also hafted in a distinct manner. Both faces are characterised by traces from friction with wood and both sides by traces from an abrasive soft material (Figure 41, d), strongly suggesting bindings in combination with the side notches. The butt facet displays removal scars from impact or counterblow. Possibly, the celt was attached in a terminal axial male split arrangement, wedged between wooden spalls around which bindings would hold it in place. Another scenario is rehafting from an embedded male axe into a juxtaposed adze system, in which new wear from bindings would not overlay older wear from the wooden slot (less likely). Ultimately, the arrangement is so forth unique and not well interpretable.

Amongst the remainder of the assemblage, traces of wear indicative of hafting include polish from friction with wood, patination and rounding, and traces indicative of contact with soft-medium plantish materials. Traces leading to an unclear assessment (Appendix 3) include isolated bright spots, inferentially problematic topographies, adaptations such as side notches lacking traces, and distinct but uninterpreted wear in potential hafting zones. Repecking of the sides and other activities manipulating the zone of hafting are rare in the assemblage, but it is common that hafting zones were not abraded in high-pressure materials. Signs such as asymmetric distributions or isolated indications of ligatures are common, they are not accepted as evidence for perpendicular juxtaposition unless co-occurring on preserved morphologies (Section 4.1.3). Indeed, fragmentation is the main reason for the relatively low number of accepted reconstructions at Playa Grande. There are no cases in which the absence of wear from hafting could be convincingly argued to reflect the absence of a hafting arrangement.

*Residues (*n=*12)*

Residues with adhesive connotations in combination with patterns of hafting are rare at Playa Grande, and morphologically varied. They occur commonly on the sides, in which the topographical relief more easily traps and preserves the compounds. In a few cases they occur on face zones, in association with friction from wood.

The heat-treated resinuous compound defined in section 7.2.4 was encountered twice in good spatial association with wear from hafting. However, a correlation remains suspect considering that this residue group occurred frequently for other reasons (not counted here, Section 7.3.2). Instead, three specimens displayed a residue which appears morphologically consistent with a plantish origin and interpreted as a resin, potentially pristine (Langejans and Lombard 2015, 206). The deposits consist of medium to small-sized strands of a light yellow sharp bounded residue with a rust-brownish tinge, viscose texture, and sharp craqueler in one (Figure 41, e). Sediments overlay these resins. A clearer interpretation cannot be given in lieu of laboratory analyses. Three others carried black tarry droplets morphologically identical to the residue described for El Flaco (Figure 32, j-k), though their associations with a haft were never entirely clear due to fragmentation. Finally, one specimens displayed a black, micro-granular residue with sharp boundaries and three others uncharacterised residues.

7.3.5 Use-wear

There are 68 specimens retaining (parts of) the bevel, many of which display traces of use. These patterns could be inferred with some resolution on 41 specimens (Table 12). The division between high-pressure rocks and other rock types is roughly even, probably reflecting that use is the primary biographical phase at Playa Grande for the latter. The comparatively higher percentage of unspecified contact materials reflects interpretative caution with certain lithic materials and field conditions, as well as interference by traces from manufacture. Issues with the wear formation on high-pressure rock materials are considered as well. However, the generally good comparability on other wear trace patterns suggests that the apparent higher concentration of traces from contact with softer materials indicates real differences. There are no specimens at Playa Grande that signal a deliberate non-use as tool by means of otherwise highly developed biographical investments.

Woodworking

Two-thirds of the interpretable traces of wear from use pertain to various forms of woodworking contact, separable along similar lines as before. Five petaloid celts display wear that corresponds well to the experimental results (Section 5.2.2), and therefore indicate the working of fresh wood in the 0.6 to 0.8 g/cm^3 specific density range (probably slightly broader). The high-pressure rock types are all small to medium in size, the others large to very large. Polish structures are rough to near-smooth, bright to very bright, and occasionally greasy. They are abundant, mildly domed, and slightly to somewhat invasive, with the lower topography developing a dull scintillation where this occurs. Pitting and the degree of interconnection vary.

A few other specimens also resembled some variables from single experimental correspondences (most often mahogany), but were ultimately inferred as displaying incipient or unspecified woodworking wear. Incipient traces of woodworking are characterised by rough and dull textured modifications that interlink or reticulate, but have not yet formed connecting spots of polish.

Table 12: Trace signatures of use categories in Playa Grande.

***n*=41**	**Woodworking traces**					**Other use traces**			**Miscellaneous**			
	Incipient	Experimental range	Exceeding	Distinct	Unspecified	Hard/ hard-pliable material	Soft/soft-pliable material	Indistinct	Repurposing	Heavy edge wear	Resharpeing	No wear
Igneous rocks							1				1	
Other/unspecified rocks		1		1	1	1	1	1		5		
Low-grade/unspecified metamorphic rocks		1	1	2	3		3	3	5	3	1	
Other high-grade rocks	1	2	2	1	3	1	2	2	2	7	1	
Jadeite-bearing rocks	2	1			1		3	1	1	3	1	1
Total	3	5	3	4	8	2	10	7	8	18	4	1

Three fragments contain the highly developed traces of woodworking provisionally associated with the working of wood species with higher specific density values. Microtopographical doming is intense and decreases in volume, ranging from relatively small structures to extensive flat plateaus with smooth and very bright polish (Figure 42, a-b). Interconnection varies, invasiveness and pitting are low, and some directionality is present in the form of striations from environmental particles. Some areas display rougher and more invasive polish, which may represent a previous stage of development or palimpsest with somewhat softer wood types. Two of the specimens are blade fragments of medium-large petaloid celts.

Two medium to large-sized greenschist celts display a coherent and well developed wear trace signature which is distinct from the experimental variables, despite corresponding to the generic characteristics of wood friction wear. The polish remains isolated and forms near-smooth, highly pitted domes in spite of the generally low topographic relief (a characteristic example is Figure 42, c). Lower elevations may display a rough and bright scintillation, but it is not always present or distinguishable from wear from 'sand-ground' abrasive manufacture. A celt of undetermined lithology displays wear that falls between this distinct signature and the 'exceeding' morphology, displaying large, well developed spots of a smoother, greasy polish than described. The high-pressure entry in Table 12, woodworking (distinct) displays traces that may result from a more pliable contact, considering the large volume and invasiveness of the polish (Figure 42, d).

Traces from use on softer materials

A significant number of celts display wear traces that do not appear to result from woodworking, or grade from the lower range of wood hardness. Variation within this group ranges from inferred pliable-soft to very soft contact materials, described here though not interpreted further due to a lack of comparative experiments. Most are smaller petaloids and chisels, and there is quite some difference in the wear between them. Some artefacts display wear quite comparable to those seen from hafting ligatures, consisting of a matt, rough, and invasive polish (abrasively) affecting the underlying topographic relief (Figure 42, e). Brightness and invasiveness varies, for instance, such traces are restricted to the upper topography on PG 130, also displaying striations in the polish (Figure 42, f). Conversely, the polish is greasier and not as rough with a much higher degree of microtopographical

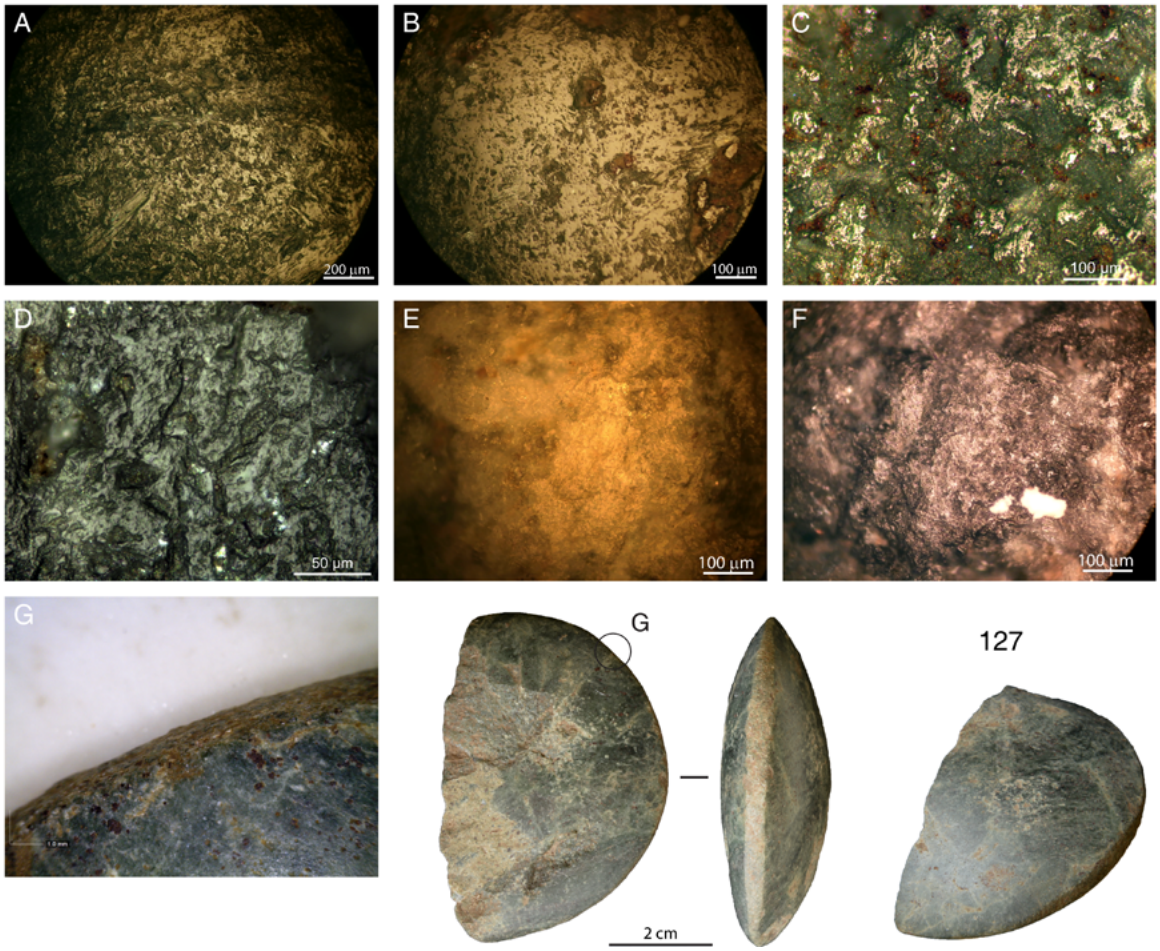

Figure 42: Use wear traces and repurposing in Playa Grande. A) woodworking of exceeding smoothness on high-pressure PG 060; B) woodworking of exceeding intensity on metamorphic PG 127; C) Woodworking, distinct equivalent to greenschist PG 018; this micrograph taken on greenschist C 1313. D) Pliable material (interpreted as woodworking) use wear polish on blueschist PG 161. E) Use wear polish (soft material, animal?) on possible sediment PG 099. F) 'soft material' polish with rough, matt, abrasive, and mildly invasive characteristics on blueschist PG 130. G) Close-up of edge of metamorphic 127 with clear evidence of percussive blunting.

rounding on PG 035. Others display the same invasive, bright, and non-invasive traces from use on soft materials as were previously described at El Flaco (Figure 34, f), combined with severe use retouch. Some of these contacts appear to involve plantish materials, particularly where the polish is more matt, smooth, and affecting the topographical volume. Still, it is impossible to satisfactorily verify such inferences, considering the wide variety of tool materials and lack of a referential basis addressing the corresponding activities.

Other activities

Resharpening is observed through both the application of abrasive techniques and by careful retouching of the edge. Abrasive resharpening is evidenced in two specimens. These display small facets right behind the edge that are characterised by wear from brief grinding, while retaining use wear traces on the bevel further back. Retouching of the edge is evidenced on three celts, all of which apparently discarded due to the procedure opening further fracture planes or inducing fissuring of the lithic mass. This is particularly clear for the greenschist and blueschist objects, which cracked across

internal foliation planes. Additionally, there are four edge flakes which are potentially rejuvenation products, though the grounds for making this distinction remain uncertain. The preservation of edges is variable overall, with roughly equal presence of sharp, medium dull, unusable dulled, and completely destroyed rims.

Re-use activities can also be separated into two main groups. Several celts had been repurposed through modification of the edge, either by percussive roughening or abrasive faceting (Figure 40, f; Figure 42, g). Unlike at the other sites, the bevels retain petaloid morphologies. However, traces of wear from use from hypothetical prior edge-ground usage were not observed on most, so that the interpretation of reworked celts remains somewhat elusive. It may also connote a purpose in (re) sharpening processes instead.

The re-use of rejected high-pressure rock fragments as hammerstones may be argued for PG 010, a blank of which the edge displays crushing impacts, but was not equivocal for other specimens. Though originally considered common at the site *(*Knippenberg (2012), this probably referred to the wear patterns presently interpreted as associated with manufacture. Such re-use would make perfect sense considering the extreme suitability of hard and tenacious jadeitite pebbles for the percussion of high-pressure rock types (cf. Pétrequin *et al.* 2012a). Nevertheless, there was only a single case where re-use as hammerstone was biographically evident for a production fragment at Playa Grande.

Finally, the blade of a large-sized greenschist petaloid (PG 063) had been flaked from the distal direction and the resulting edge given semi-abrupt backing. This configuration allows the object to fit in hand easily, although no clear subsequent wear had been observed.

7.3.6 Depositional context

The depositional context of the materials is not well recorded for individual artefacts. Most seem to derive from layers comprising waste lenses or secondary landfills, overlaying earlier house floors. The stratigraphic reliability was discussed in section 6.1.3. Fragmentation is rife within the assemblage, and many specimens appear associated with a fragmentation event (Figure 43). Only eight (out of 163) remain in usable or repairable condition. Edge related fractures and mistakes in production are independent factors, both overlapping with transverse fracturing in the medial zone.

Eleven times had an edge broken in half along the longitudinal or skewed longitudinal axis and six times more one fractured in multiple places. In both events the result is irrepairable. Detachment of the flake from the edge has been observed once, and as noted, there are four edge flakes that resulted from either use fracturing or rejuvenation practices, currently considered indistinguishable. Most of these fragments are (severely) dulled or battered beyond usability. Otherwise, most edges in the assemblage are medium dull to sharp, though micro-retouch is common.

A total of 79 specimens displays transverse fractures in the medial zone. These can be either straight and fluid bending-initiated fractures (36 artefacts), or display irregular skewing and slanting of the direction, including bumps and angular horizontal ridges (43 artefacts). Such ridges or fissures are common for rocks with anisotropic fabrics (blueschists, foliated greenschists), which may splinter from the force rather than permitting a smooth oblique-transversal trajectory. Fractures of this kind are typical of in-haft breakage and account for most of the sharper edges in the assemblage, including eight specimens where the fracture intersects hafting wear and all instances where the direction is oblique to the transverse plane.

However, other biographical trajectories are observed to induce such fractures, most of which

Figure 43: Fragmentation patterns in Playa Grande. Hinge fissures over a transverse medial break indicating heavy bipolar hammering to split the jadeitite now medial-distal fragment PG 013. The fully ground and biographically exhausted PG 028 shows impact craters near the break. Jadeite-bearing PG 114 and undetermined PG show geometrically concave fragmentation and blocky fragmentation respectively.

involve the intentional destruction of the artefact. Eleven specimens were exhausted by regular means, including edge fracturing or a standard transverse medial break. Twelve more are roughouts rejected for unrelated production mistakes (commonly flaking accidents).[38] This is clearly illustrated in Figure 39, 011, where a severe step fracture destroyed the ability to hold an edge. Subsequent to that a small part of the butt was removed, almost as an afterthought, that cannot be associable to the initial breakage. Further evidence for the intentionality of this act rests in the frequent presence of impact marks from bipolar percussion. These are often located near or on the spot where the break occurs, opposed by 'counterblow' impact damage, most resulting scars terminating as step or irregular fractures. One extreme case displays fissures from repeated transverse hammering on one side that reduced the mass of the roughout until the split occurred, with further impact crushing inside of this area (Figure 43, 013). The actual number of occurrences is probably much higher, but in many cases the impact points were singular or considered unclear given extensive traces from transversal hammering from production.

38 The destroyed roughouts are distributed fairly evenly between flawed and non-flawed specimens, to be expected when pieces with mistakes on one part are broken in two. Observed reasons for rejection include the destruction of the (intended) edge by flake removals interrupting the bevel, deep thinning, and overzealous hammering of the sides resulting in unintended flakes, all of which remove critically important mass.

Most remaining cases concerns fragments from the complete collapse of an object (13), unclear fragmentation patterns for which no specific origin could be found (11), and schists collapsing in a rectilinear pattern (4, not counting edges). There are a few massive rocks that fractured in blocky or geometrically concave shapes (Figure 43), but the origin of these patterns remains unclear.

8

Summary and analysis of inter-site biographies

Having presented the results from the analysis of the data, what remains is a comparison of the biographies from each celt assemblage. This chapter summarises and integrates the results from Chapter 7, drawing biographical connections between phases, sites, and spatial contexts where pertinent (Table 13). It forms a step-up to the discussion of Chapter 10, where particular topics are examined from a more theoretical and regional perspective.

8.1 Conception

All three sites made use of distinct lithic complexes, and certain differences in the composition of each assemblage potentially reflect uneven access to raw materials as well as uneven positioning in interaction networks. Nevertheless, general biographical pathways do align, since each assemblage strongly reflects the regional geological availability of rock materials. The Pearls collection is for the most part comprised of volcanic lavas and shells, presumably reflecting utilisation of local and nearby regional availability. El Flaco is characterised by a spectrum of basaltic–low-grade overprinted–greenschist-facies rocks, ranging from dark grey-black with occasional blue and olive to light green colours. The inhabitants of the site were able to ensure access to nearly all of these in the form of raw materials from alluvial beds, though appear to have been doing so primarily for flake reduction (see below).[39] Playa Grande contains mostly high-pressure rock types, which stem from nearby serpentinite mélanges and are locally sourced at the streams of the Río San Juan drainage basin. These areas are within a day's reach of the site (Knippenberg 2012; Schertl *et al.* 2012) and provide materials in secondary condition, having developed cortex due to water (rolling) action. Smaller pebbles were regularly selected in sizes suitable for celt manufacture, but most of the raw materials required more extensive processing.

The primary materials are all fine-grained, granoblastic, massive, cohesive, tough, hard, not or weakly foliated, and lacking quartz. All of these properties are typically sought after for edge-ground macro-lithic artefacts since they allow shaping by hammering and grinding while resisting the stresses and loads of (percussive) functional use. The full range of rock types is broader and includes rock types which do not share this set of material properties. Blueschists have pronounced foliation and acicular matrices, resulting in different fracture behaviour and formation of wear. Low amounts of other types of metamorphic rocks, phaneritic igneous rocks (mostly plutonics), carbonaceous rocks (limestone),

39 Though flaking industries are commonly expected to centre on knappable fine-grained or siliceous materials such as chert, flake production using volcanic materials has been argued for Caribbean assemblages before (Bérard 2008; Pantel 1988; Rodríguez Ramos 2005a, 6).

Table 13: Collated observations of at least moderate confidence on analysed macro-lithic materials.

	Pearls	***n*=21**	**El Flaco**	***n*=80**	**Playa**	**Grande**	***n*=160**	
	HP rock types	Total assemblage	Igneous to low-grade	Total assemblage	HP rock types	Preforms (*n*=64)*	Complete biographies (*n*=82)*	Total assemblage
HP metamorphic rocks	-	13 (61.9%)	-	6 (7.5%)	-	49 (76.6%)	37 (45.1%)	97 (60.6%)
Metamorphic low-grade/ unspecified	-	3 (14.3%)	-	32 (40%)	-	8 (12.5%)	26 (31.7%)	34 (21.3%)
Igneous/light overprint	-	4 (19%)	-	34 (42.5%)	-	1 (1.6%)	2 (2.4%)	3 (1.9%)
*Other & unidentified***	-	1 (4.8%)	-	8 (10%)	-	6 (9.4%)	17 (20.7%)	26 (16.3%)
Internal defects	5 (45%)	5 (23.8%)	-	Absent	-	-	-	Absent
Cortex – alluvial	1 (7.7%)	1 (4.8%)	8 (12.1%)	9 (11.3%)	30 (30.9%)	28 (43.8%)	1 (1.2%)	32 (20%)
Cortex - other	-	Absent	2 (3%)	2 (2.5%)	3 (3.1%)	6 (9.4%)	0	7 (4.4%)
Blanks, preforms, debitage	1 (4.8%)	2 (9.5%)	4 (5%)	4 (5%)	46 (47.4%)	-	-	64 (40%)
Celts with reduction evidence	9 (75%)	12 (57.1%)	29 (43.9%)	33 (41.3%)	25 (25.8%)	-	-	50 (31.3%)
Reduction 'non-linear´	-	Unclear	-	Unclear	5 (5.2%)	9 (14.1%)	Unclear	10 (6.3%)
Surface abrasion total	12 (57.1%)	19 (90.5%)	50 (62.5%)	61 (76.3%)	40 (25%)	13 (8.1%)	76 (92.7%)	90 (56.3%)+13
*'Dull' technique total**	4 (33.3%)	9 (47.4%)	42 (84%)	50 (82.0%)	19 (47.5%)	-	33 (43.4%)	41 (45.5%)
*'Sand-ground' traces**	3 (25%)	5 (26.3%)	16 (32%)	18 (29.5%)	5 (12.5%)	-	8 (10.5%)	10 (11.1%)
*'Bright' technique total**	9 (75%)	13 (68.4%)	16 (32%)	19 (31.1%)	15 (37.5%)	-	23 (30.3%)	28 (31.1%)
*Wet grinding traces**	2 (16.7%)	4 (21.1%)	13 (26%)	14 (23.0%)	14 (35%)	-	23 (30.3%)	27 (30%)
*Polishing techniques**	7 (58.3%)	9 (47.4%)	2 (4%)	3 (4.9%)	1 (2.5%)	-	0	1 (1.1%)
Hafting indications total	9/12 (75%)	14/18 (77%)	26 (44.8%)	31/58 (53.4%)	19 (26.4%)	-	-	38/72 (52.7%)
*Axe hafts**	3 (33.3%)	5 (35.7%)	8 (30.8%)	9 (29%)	4 (21.1%)	-	-	6 (15.8%)
*Adze hafts**	3 (33.3%)	4 (28.6%)	5 (19%)	7 (22.6%)	6 (31.6%)	-	-	8 (21.1%)
*Other types**	2 (22.2%)	3 (21.4%)	5 (19%)	5 (16.1%)	2 (10.5%)	-	-	3 (7.9%)
Repecking for haft	4 (33%)	4 (23%)	5 (19%)	5 (16.1%)	0	-	-	2 (2.8%)
Use total	12/13 (92.3%)	16/17 (94.1%)	24/28 (85.7%)	26/28 (92.9%)	22/35 (62.9%)	-	-	42/66 (63.6%)
*Woodworking general**	9 (75%)	12 (75%)	19 (79.2%)	20 (76.9%)	13 (59.1%)	-	-	23 (54.8%)
*Woodworking exp. range**	3 (25%)	5 (31.3%)	7 (29.2%)	7 (26.9%)	3 (13.6%)	-	-	5 (11.9%)
*Woodworking exceeding**	5 (41.7%)	5 (31.3%)	4 (16.7%)	5 (19.2%)	2 (9.1%)	-	-	3 (7.1%)
*Soft material working**	0	1 (6.3%)	1 (4.2%)	1 (3.8%)	5 (22.7%)	-	-	10 (23.8%)
Repurposed	1 (8.3%)	1 (4.8%)	3 (4.5%)	3 (3.8%)	3 (3.1%)	-	8 (9.8%)	8 (5%)
Resharpened	0	1? (4.8%)	5 (7.6%)	5 (6.3%)	2 (2.1%)	-	4 (4.9%)	4 (2.5%)
Useably intact	11/12 (91.7%)	15 (71.4%)	3 (4.5%)	3 (3.8%)	6 (6.2%)	-	8 (9.8%)	8 (5%)
Transverse medial fractures	1 (8.3%)	1 (4.8%)	29 (43.9%)	34 (42.5%)	53 (54.6%)	35 (54.7%)	34 (41.5%)	79 (49.4%)
*Intentional destruction****	0	0	14 (21.2%)	14 (17.5%)	17 (17.5%)	12 (18.8%)	13 (15.9%)	25 (15.6%)

Totals of relevant specimens provided where applicable. 'Complete biographies' refers to celts with wear trace or fracture patterns associated with hafting or use. Hafting 'other types' includes verified chisels, wedges, and distinctive attachment systems. * Percentages reference the relevant total and not the site total. ** Includes 'volcanic –or– blueschist' rocks from Playa Grande. *** Counts both reasonably certain points of impact and secondary transverse medial fractures that accompany clear use/production associated deaths. Since unclear entries are excluded, subdivisions in this table do not necessarily add up to percentages provided in the text.

and non-carbonaceous sedimentary rocks (shales) are also present.

What classifies as an exotic rock is different for each of the sites, courtesy of the regional geographies. The same primary rock types of volcanic, low-grade, and high-pressure metamorphic are encountered in all, but apparently for different reasons. In terms of absolute distance, a rock like

jadeitite is not intrinsically more exotic than for instance particular greenschist varieties. Both are local at Playa Grande, or will have travelled the same itinerary to arrive at Pearls if coming from the Greater Antilles. There are certainly qualifications to be made, such as differentiating origins and routes for specific greenschist varieties from the El Yaque del Norte river at El Flaco. However, that can only be done once the entire lithological variety of the assemblages is better understood. The circulation of celts is better framed as a flow of many diverse material types with numerous and overlapping points of entry and exit.[40]

This explains the contrast between the biographies of high-pressure rocks and low-grade rocks at Playa Grande. Though low-grade metamorphic rock types are readily available in the RJSC terranes, the artefacts made from such materials all likely originate elsewhere. There is no evidence of local production at the site, and their operational sequences are distinctive in the far higher degree of abrasion. This situation inverts the generally expected pattern in which jadeitites travelled the farthest from their sources, assumedly the most socially valued material. Despite having first choice access to high-pressure rock types, the community of Playa Grande was actively acquiring celts made in other rock types via social interaction rather than manufacturing them themselves.

El Flaco similarly relied upon social interactions with suppliers for the acquisition of its 'local' materials, despite the community displaying the means and ability to manufacture macro-lithics. There is some evidence of local manufacture (both formal and expedient), probably drawing as needed upon the existing raw material flow supporting a flaking industry focused on the same rocks. However, the general absence of reduction debitage and the presence of a variety of regional rock types suggests that the majority of celt materials originated from elsewhere as preforms or ground specimens. The multitude of abrasion signatures and existence of large lithic and biface production sites such as Aminá south of the El Yaque del Norte (Ulloa Hung 2014) suggest that celt materials circulated on at least a regional scale in the wider Cibao Valley. The community of El Flaco apparently placed a significant reliance on this network, and were to some degree socially integrated with sites and places south. Connections to the north, procured or handed down through the Paso de los Hidalgos, may account for some materials. This is the most direct route for the nearest source areas of both the excavated marine animal resources (Section 9.2) and the high-grade metamorphic rocks (pending geochemical analysis). Except for the recrystallized omphacitite, the latter closely resemble artefacts produced at Playa Grande. [41] Otherwise, these materials must have entered circulation from the northwestern termination of the Cibao valley at the Atlantic coast of the Monte Cristi province, or were indirectly routed via central Hispaniola. They were evidently brought in as objects already worked since no debitage or flake products accompanied these artefacts.

The situation is less clear for Pearls. Neither the measure of production in local materials nor the potential existence of unassuming debitage (likely passed over in the assembly of the private collection) are knowable. The greenschist materials may originate regionally (present and used in LCA Tobago, Boomert and Rogers 2005), or from the greenstone belts of the Dominican Republic and the Guiana shield. The Guiana shield is in closer proximity, and mainland connections are attested in the

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40 Some of these rock types may on average indeed reach farther than others, but it has yet to be demonstrated that this is the case for high-pressure rocks specifically vis-à-vis other celt materials. It may well be an erroneous assumption spurred by the fact that jadeitite is a high profile material, for which distant origins are more easily noticed and established than for other materials.

41 (Recrystallized) omphacites will not have been recognised as such by myself amongst the assemblage of Playa Grande, but only few dark green coloured rocks of unidentified material were present.

olivine-bearing ultramafic semi-lunar axe and suggested for lapidary materials. However, the abrasive techniques resonate with the assemblages from the Dominican Republic (below). The origin of the (jadeite-bearing) high-pressure rocks is under geochemical study, but some of these materials arrived at Pearls as blanks. Even if the provenance turns out to be solely the RSJC (the nearest source area), numerous biographical discrepancies still arise with technological (below) and procurement practices for LCA jadeitite celts.

The jadeite-bearing materials at Pearls display a wider variety of colourations than seen at Playa Grande. There, most rocks display paler greens, and often mottling from blue minerals. Pearls also contains specimens of a white-ish jadeite (018, cf. 020), or darker colours (001, 009, 021), not encountered at Playa Grande at all. If these celts do originate from the Greater Antilles, it suggests that a shift took place in aesthetic selectiveness between the two time periods. Furthermore, the internal defects seen on several jadeitite celts are biographically unique amongst the entire assemblage of abraded surfaces. These cracking and mineral ejection features are not encountered in the celt materials manufactured or in circulation at either Playa Grande or El Flaco, in high-pressure rocks or otherwise. There, depressions in ground surfaces are invariably related to percussive or abrasive manufacturing techniques, which do not produce comparable stigma.[42] Such stigma may be associated with thermal shock, and therefore propose the possibility of mining from primary context through fire-setting (Lozano *et al.* 2017; Pétrequin *et al.* 2008; 2012a). However, other signs of this technique (curved profiles, rubefaction) were absent and minor sub-surface crack lines are not distinguishable from foliation stigma since they occur infrequently in all three assemblages, including in alluvial-sourced high-pressure rocks. The evidence for fire-setting is indirect at best, and is therefore not claimed, but these stigma are visually distinctive, characteristic only of Pearls, and therefore do mark the biographical trajectory as different from any other.

Otherwise, the relevant communities invariably procured their raw materials from secondary context, mainly alluviums. The community of Playa Grande selected specific raw materials from the beds, inspecting the individual blanks by briefly abrading small facets on the surface near the intended edge. This practice provided an assessment of the internal properties of the rock, including structural integrity and mechanical behaviour, as well as its surface texture and colouring. These activities were probably carried out at or near the source streams, to pre-empt the transportation of heavy pebbles some of which would assuredly turn out objectionable or defective. For instance, certain physicalities may have been regarded as spiritually discordant, and matrix quartz appears to have been selected against in RSJC jadeitites (Schertl *et al.* 2018). However, most discarded specimens with evidence from this biographical possibility were actually rejected at a later point, on the grounds of subsequent production flaws. A good amount of structurally flawed rocks were brought to Playa Grande regardless, given the amount of production debris at the site. A secondary purpose in the abrasive inspection may have been a demonstration of quality. This could imply an exchange of the procured material itself (as argued for chert in LCA Aruba, Rostain 1997, 228-230), apprenticeship with a senior producer, or dialogue with a potentially subjective interiority at this biographical stage. What is clear is that these edge facets never display microwear from use and are thus not related to expedient functionality (contra Knippenberg 2012). Furthermore, such facets will be erased during the roughing out phase and are not easily recognised without a full biographical study.

42 However, a number of specimens from the Gutmund Hatt collection in the Nationalmuseet Copenhagen do possess such stigma (a.o. O 9121, O 9124, and ODIg 4, all waxy lustred green rocks – catalogue observation).

8.2 Birth

As far as the early stages of reduction go, most studied artefacts followed fairly straightforward and broadly comparable operational sequences. Following the phase of the procurement of blanks (and any technological actions that may belong in it), they were flaked insofar needed resulting into roughouts, and subsequently hammered and pecked to preforms with level outlines. However, there is significant variation in the quality and thoroughness of the work conducted, beginning with the skilful usage of different material affordances of blueschists in Playa Grande. Smaller differences within and between sites are also observed in the reduction path, finesse of pecking preforms, dealing with invasive scarring, and the percentage of surface polishing. Differences between the sites are clearer for the sets of abrasive techniques. Here, the assemblage from Pearls is clearly distinct in its high percentage of applied bright lustred techniques and for the clearest evidence of polishing techniques following prior grinding. These are often one and the same for the mineral-based lustres of El Flaco and Playa Grande, which also have fewer specimens modified in such a way. At El Flaco most specimens were whole-body abraded whereas abrasion of only the edge and faces was most prevalent at Playa Grande, and both are characterised by an array of subtly differing wear trace signatures. Whether for reduction or abrasion, the associated technological activities were sometimes carried out at different location. Different people may have been involved at different biographical phases, of which the relation with the community in which the artefacts were found is not always evident.

Early reduction

The best baseline with which to contextualise a comparison is the group of equigranular high-pressure rocks (granoblastic jadeitites) from Playa Grande. The production of this assemblage represents a meshwork of actually followed production pathways, characterised by a fairly regular inversion or (partial) eschewal of the 'standard' succession of actions. This may be related primarily to blank pebble morphologies, requiring bifacial mass reduction while approximating the intended outline. Direct percussion is dominant and employed primarily for thinning and the removal of cortex, secondarily for the shaping of edge and butt profiles. Most thinning blows initiate from the side over the bifacial axes; some bipolar percussion occurs interchangeably for the reduction of bifacial mass also. Though some pebbles did not require flaking, nearly all were hammered from the side in order to create the tapering outline; this results in the smaller scars and hinge fissures that remove further mass, but may create weak points. Both actions form a clear continuum in the process, and together probably correspond to what Rodríguez Ramos (2010a) terms 'lateral intrusive flaking' in Puerto Rican celt production. Pecking ranges from coarser to finer, graded in the regularity and degree of surface roughness. It represents changes in the type of hammerstone or gesture aimed towards lessening impact stress and material removal in favour of increasing smoothness by more regularised crushing of surface asperities. Despite sometimes co-existing on the same artefact, there are numerous instances in which coarse pecking was directly followed by abrasion, or fine pecking occurs at early stages. This may reflect a variety of things, including the preparation of striking platforms, the fruits of apprenticeship, not considering finer pecking worth the effort, having only smaller hammerstones at hand, and so on. Conversely, subsequent flake scars are mostly associated to edge shaping or spalling from lateral hammering. Water-worn cortex is rarely seen on roughouts and preforms. There are only rare cases in which the notion of direct grinding of pebbles, foregoing percussive processes, retains (potential) validity.

Blueschists at Playa Grande are reduced using the same techniques, and approached similarly except that bifacial thinning occurs through splitting across foliation planes, as opposed to attempted flake reduction on their anisotropic fabric. As such, these artefacts reflect a flexibility in edge-ground macro-lithic manufacture that is in part contingent on craftsmen skilfully negotiating the constraints of raw material affordances. All of these various steps are also present in the granoblastic materials from El Flaco and Pearls. However, the use of percussive motions for performing surface finishing is of a much higher quality in particular at Pearls, there seen in high evening out of topographic relief, little pitting, and smooth, sharp-bounded overall appearance. Finer grades of percussion are also seen to a greater extent than heavy lateral hammering in the assemblage from El Flaco. It contains much less evidence for early reduction activities on finished celts overall than at Playa Grande, where large portions of the faces remain deeply scarred and not otherwise modified. This tendency can be summarised as the propensity for the Playa Grande community to manufacture celts to a degree that is below the common standard of edge-ground celts in the archipelago, suggesting that exchanged celts are reworked at later stages of their biographies.

As indicated by the lack of blanks, roughouts, and preforms evidencing systematic local manufacture, the community at El Flaco must have tapped into the regional circulation of celt materials to meet their needs. The majority of (meta)volcanic debitage pertains to a flaking industry, indicating the capability for working such rocks, but there are very few pieces associable to celt reduction. This implies that reduction traces in this assemblage actually reflect work conducted at source sites such as Amina. Some of the blanks seen at this site evidence more complex core reduction strategies than argued for currently, including the use of irregularly shaped pebbles as well as large-sized (>20cm) blanks with triangular flaked cross-sections (personal observation). For the assemblage of El Flaco itself there is no evidence to assume more complex working than the baseline of systematic flexibility, but this is primarily due to the state of completion (and exhaustion) of the materials. Together with the apparently common practice of resharpening, this suggests that celts were considered highly valued objects, not to be discarded lightly and perhaps not easily replaced. The presence of two expedient celts may reflect an immediate need for tool materials as a result of breakage by others, that would not have been met by supply from the network in time. The same argument extends to igneous and low-grade metamorphic rocks at Playa Grande. These are largely ground whole displaying little evidence for previous activities, and are not accompanied by production debris in the assemblage. Since the profile of a LCA celt manufacturing industry is clearly illustrated in high-pressure rocks at the site, the other celt materials represent imports. Also in terms of manufacturing evidence, the high-pressure celts from El Flaco closely resemble artefacts produced at Playa Grande with the exception of the darker omphacitites.

In terms of observed technical operations the assemblage from Pearls is mostly comparable to the described repertoire, but with differences of note. For one, it contains angular morphological shapes (a.o. P 010 and P 021) which are not characteristic outcomes amongst the later materials. Most of these have thicker biconvex almonoid outlines and none sharp angles. One of the jadeitite celts (P 009) bears bilateral scars characterised as resulting from a 'burin blow' approach to the percussion, biographically unique amongst the present assemblages.[43] Apart from the finer degree of finishing, most jadeitite celts from Pearls are also characterised by more severe flaws in reduction (evidenced

43 Comparable surface features are rarely seen on other celts from throughout the Antilles, one example of which is known to me from St. Vincent (NMAI catalog no. 2/5346, accessed 02-2018).

through invasive thinning scars). One possible explanation is that the community received a limited supply of jadeitite and was unable to negotiate a consistent quality. Either poorly manufactured celts were exchanged to them, or received blanks were knapped despite a relative inexperience in working with – anticipating the mechanical and structural behaviour of – the rock. Certainly, the scars seen on P 009 (Figure 23) and to a lesser extent P 022 would have led to rejection or repair following the criteria exhibited at Playa Grande (cf. Perlès 2007). The high prevalence of internal defects must again be highlighted in this regard, and such apparent contrariety is not observed in the other greenstones or rocks local to the region. That said, the comparability of these data is limited since internal relations within the Pearls assemblage are not clear and realistic indicators of how other sites at this time span operated lack. Given issues of sampling and context, the scale in which celt manufacture took place at the site cannot be estimated.

Abrasive manufacturing

The most common practice in all three sites, and thus the biographical standard, is abrasion using techniques that result in a dull lustre. The 'sand-ground' spectrum of traces figures most prominently, especially when including signatures intermediate to the dry ground experiments, and is spread across all rock types. This spectrum reflects the used of grainy materials mixed with water, including at least both sandstones with poor cohesion that naturally shed rounded quartz grains under load and sand as abrasives (mixtures of quartz-rich and rounded grains) on any hard platform. Even if producing a similar mode of wear they are in fact different techniques, more so than one could consider different varieties of grossly comparable grinding stones to be. The use of suitable sandstones may be preferable for ease of use, or suitable abrasives preferred for the lessened impacts of striations (these were experimentally associated with static asperities, Section 5.1). However, the factor of availability determines whether such a technological choice can be made in the first place.

Each assemblage also contains celts (from all rock types) that were ground against distinctive other platforms resulting in dull lustred surfaces. Matches with the experimental results from using matrix-cohesive sandstone (exp. 3047) and 'dry grinding' on the quartz arenite (exp. 2497) indicate that such sandstone varieties were also used when available. Furthermore, a number of wear trace patterns from different spectra conceivably indicate still other rock types (or abrasive recipes), perhaps based around igneous mineral suites instead. These result affirm that different 'dull' abrasive techniques (as choices in abrasive platform) existed side by side in the Caribbean, and found themselves part of the same biographical assemblages. Most specimens at Pearls were intermediate to 'sand-ground', as is more than half of the assemblage from El Flaco. By far the largest variation in dull lustred signatures occurs at Playa Grande, in particular when including wear trace patterns with intermediate lustres (not added in Table 13, but best understood as distinctive reduction-oriented grinding techniques). As discussed, high-pressure rock type celts are not clearly separable from other celts on these grounds, and this picture is complicated by the fact that we do not fully know how each mineral assemblage reacts under equivalent technological circumstances. Given that the former group is assumed to be of local production, with fine-grained sandstone platforms being common at Playa Grande, this is surprising.

The situation is opposite with respect to bright lustred techniques. Polished surfaces are uncommon at Playa Grande and El Flaco, and principally associated with water-aided abrasion on hard lithic platforms. There are significant variations in the texture and distribution of wear polishes

and striations, indicating a heterogeneous assembly of tool rocks. Multi-stage polishing strategies are very rare. Conversely, Pearls demonstrated a strong correspondence between polished surfaces and high-pressure rock celts (site prevalence is unassessable due to sampling bias). Furthermore, no less than six distinct techniques were applied to obtain bright lustred surfaces, most of which represent the final application during a multi-stage process. Some were made using water-aided abrasion on hard lithic platforms, including very strong correspondences to the quartz arenite experiments. Other production processes utilised organic or highly specific fine-grained mineral-based polishing materials. The situation clearly reflects the employment of a large variety of techniques aimed at creating beautifully lustrous and reflective polished surfaces on exotic raw materials.

The primary tool materials are quartz-rich sandstones, which have a regional availability in the Greater Antilles (including the northern Dominican Republic) and the Windward Islands (at least Barbados and Tobago, Section 6.1.1). These of course exhibit a variety of working properties (most of the experimental platforms are broadly classifiable as quartz-rich sandstones), and selecting adequate variants obviously mattered a good deal. Regional variation in sandstone properties may in part explain some of the differences seen within the assemblages at each site, irrespective of the macroscopic lustres, but further qualification is required. The principal issue becomes the location in which celts are ground vis-à-vis the biographical stage at which they are exchanged. This includes questions of whether a locally produced assemblage should logically display a dominant signature of abrasive wear, since it appears there is much biographical heterogeneity within each of the sites.

At Pearls, most polished celts were ground before, and these signatures are homogeneous corresponding to tools from what are probably regionally available materials (Section 6.1.1). This would seem to favour the arrival of those specimens prior to abrasion, subsequently ground using sandstones, quartz sand mixtures on local *polissoirs*, and high quality quartz arenites sourced from Tobago.[44] However, since 'sand-ground' traces comprise an equifinal signature of appropriate and probably widespread grinding techniques, it may be expected from many different places and so cannot exclude exotic origins, particularly if all exotic rocks originate from the same source area. Furthermore, the jadeitites with evidence of poor quality working do not cluster around a specific grinding technique, but do exhibit similarly high *savoir-faire* in abrasion as the other celts. Some continuity exists between dull and bright lustre techniques in that quartz arenite can be used for both. Strong correspondences with the experimental traces were found, including plutonic P 017 which still displays both 'dry' and 'wet' patterns. Otherwise, the great variety of polishing techniques does not convince of a local application. It can suggest multiple non-exclusive scenarios, including exchange derivations from numerous origins, technological changes over time, differential treatment of certain raw materials, contemporary dissimilarities in the valuation of techniques, or different communities congregating. Another possibility is cross-craft interaction with the extensive lapidary production seen at Pearls, which does affirm that the community frequently exchanged for suitable tools and obtained raw preforms and materials. While it may be the case that most were (re-)polished at Pearls itself, it is impossible to approximate which specific specimens were without knowing the technological baselines and supply routes both for Pearls and its potential source areas.

It was previously suggested that most materials in El Flaco reflect exchange flows rather than local production, and probably largely from within the Cibao valley. Such a model would expect an

44 The selection and import of high-quality grinding platforms over more closely available possibilities is seen in Scandinavia (Carlsson 2007) and potentially Thailand (Frieman *et al.* 2017).

overall cultural consistency in the choice of abrasive techniques, but some degree of regional variation in whichever properties in lithic platforms are available. The assemblage does exhibit more variance than Pearls, but this rests primarily within the intermediate to 'sand-ground' and wet lithic grinding spectra. Both are associated with fine-grained sandstones of various degrees of cohesion. The most likely hypothesis is thus that the variation in abrasive wear patterns exceeds what could be sourced locally, and reflects the regional signature of technological choices for celt production. The majority of artefacts probably entered the site as ground or polished celts. Those that entered as preforms and were abraded at the site itself can account for only a portion of the assemblage.

Furthermore, the levels of finishing at El Flaco vary significantly and indicate different levels of know-how or considerations for aesthetics. For dull surfaces, striations are abundant and frequently noticeable on the faces, whereas grinding efforts beyond the blade were regularly of lesser duration and often not seen all the way through. The lustres are not macroscopically distinguishable when attentive (but not experienced) to such distinctions. For brighter surfaces, many of the trace patterns remain dull and poorly spread, in polish intensity more comparable to the initial phases of the experiments than the developed phases thereof. Nevertheless, several specimens were fully and laboriously polished. Due to the increased variables of wear it is clearer that the variety of wet lithic grinding techniques contains as of yet unidentified innovations, (local geological) constrictions, or time-spatially specific approaches. Similarly, running the assumption that some polishing capacities were available to the community and enacted by its members, others must still have been ground to a bright lustre at their source or by intermediaries in the exchange network. The evidence indicates that there are multiple trajectories by which celts could be obtained by the community, and that celts were obtained through different relationships and at different, and perhaps personalised, levels of value.

The situation is different regarding the wood-polished tools, since the capacity to do so is certainly present at El Flaco, but almost never enacted. Their intense, greasy lustres contrast strongly with the other materials and evidence heightened attention and time investment to the appearances of these objects. Wood-polishing was demonstrably applied to FL 2279-03 after that specimen was repurposed upon losing its edge, and FL 945 shows a similar succession. It thus occurred late in their biographies, and was likely carried out by a member of the local community. The special circumstances surrounding these events strongly suggest that there were ontological requirements for such a technique to be permitted that have nothing to do with the technological capacities of the community, and everything with the biographical recontextualisation of a curated object.

The variation in 'dull to intermediate lustred' signatures is greater at Playa Grande than at either other site. At first glance, these results are discrepant with the certitude of local production and the ubiquity of fragmented abrasive platforms from (what were described as) a single type of sandstone. In fact, there is a complete overlap between the abrasion wear trace patterns on high-pressure and non-HP rock types at the site. The only differentiable exception consists of ground high-pressure rock surfaces matching the experimental topography of 2782 (and 2513 at 60 minute interval), linked to a fine-grained cemented cohesive sandstone. It is possible this is the wear trace signature linked to the specific sandstone variety found at the site, but this needs to be verified given potential equifinality and mineralogical differences in the blanks. The same uncertainty exists for the sandy sediment found at the beach regarding the scintillating and rounded microtopographical 'sand-ground' trace patterns.

For the non-HP rock types, which are as variable in abrasion traces and lack corresponding debitage in the assemblage, the same argument may be advanced as was done for El Flaco. At least part

of this signal must derive from more regionally shared techniques or tool materials, which found their way into the site. The transportation of grinding platform from elsewhere is particularly interesting since it might explain better the congruence with the variation in the high-pressure rock assemblage. It is also conceivable that some of the high-pressure rock materials found at Playa Grande originated at other sites: the dark jadeite-bearing PG 118, potential omphacitite PH 070, and most blueschists with alterations are all candidates thereto, since they are distinct from the production debitage at the site and display mostly distinctive wet lithic grinding signatures. Furthermore, they group together with the non-HP rock materials in levels of finishing. These surfaces are all finely pecked and much more completely abraded, including side and distal aspects, with increased effort in the erasure of reduction scars, hinge fissures, and stereoscopic striations. The technological finesse is much higher than that of the effort seen on locally produced high-pressure rock types, and is comparable to the better made specimens at Pearls. Since a number of these specimens do display the potentially local abrasion patterns, it is possible that they arrived in un-abraded shape. If these specific high-pressure rock celts are indeed exotic to Playa Grande, very few specimens remain that would qualify as both probably locally produced and subjected to proper abrasive procedures. Those that were, were subjected only to the functional minimum of grinding the blade (bevel and proximal face). That is to say, it appears as if the locally manufactured rocks circulated out from Playa Grande in preformed states.

The near total absence of non-abrasive bright lustred techniques lends further credence to the idea of that polishing signifies values not related to the functional biography. Brighter polishes were not applied by the manufacturing community, attempting to increase the exchange value of pieces, but during a multi-stage process primarily involving recipients elsewhere. There are some issues of temporal sensitivity, however. The various bright lustred grinding techniques are represented only in layers 0 to 2, with none from layer 3 (starting at ca. AD 1200). Moreover, the single bright mineral polish occurrence is a chance sample deriving from pre-AD 1200 layer 4. Though Playa Grande was a long time centre for the production of edge-ground celts from high-pressure rocks, and many core practices and beliefs remain biographically stable, these patterns indicate potential shifts in stone polishing techniques at the site.

8.3 Life

Axe hafts using a male attachment must have been common at the three sites, since they were used for a variety of head sizes. Where the distribution of use wear is observable it is symmetric, strengthening the inference that these pertain to orientations of a lateral transversal direct parallel nature, corresponding to axes in straight handles. Though such handles have been known for quite some time from the archaeological record (Section 2.3), they use fully perforating split slots meaning that celt-head butt would protrude from the rear opening (cf. monolithic examples). This specific sub-type is uncommon, actually, and occurs primarily on (also uncommon) larger sized celt fragments of greenschist or jadeitite supported by adhesives. The association raises the possibility that this entails a separate indigenous objects class consisting of large hafted greenstones, geared towards the heaviest tasks and representable in 'ceremonial' media. More data from large-sized specimens is obviously needed to substantiate or refute that impression, however.

The majority of studied celts are medium sized (7-10 to 10-12 centimetres) and these are instead embedded in their hafts with the polls enclosed by wood on all sides (supported by adhesives at Pearls). This size/slot combination will in most cases require an embossed handle 'head', to surround it with

sufficient woody material so as not to critically weaken the haft. This type of slotting is not evident from direct archaeological evidence, though somewhat common in ethnographic materials (the Héta, Zoé [with heated tree resin], Aikuro [with rubber-tree gum and bindings], and others). Presumably they also refer to lateral parallel systems (axes), since no wear asymmetries were observed to indicate theoretical alternatives. Importantly, there is no clear correlation between hafting arrangements and celt morphologies, nor is the symmetry of the cross-section a reliable indicator.

Male embedded hafting with a terminal axial orientation, indicative of chisel-like usage, was conclusively observed once (P 001). Small to medium-sized celts displaying an elongated morphology were relatively rare at Playa Grande, and present but consistently uninterpretable at El Flaco. The non-observation of this type of hafting is arguably a result of its relative rarity and need for optimal preservation of distal ends and directional wear indicating the kinematics, rather than actually being absent in the LCA Dominican Republic.

When accepting all probable interpretations, adzes that are hafted in juxtaposed attachment systems are nearly as common as axes in the three assemblages (Table 13). The base plan of the juxtaposition is invariably the same: the celt head rests on a wooden base at the terminal end of an elbow-shaped handle (cf. Jardines Macías *et al.* 2013; 2015). (Vegetal) ligatures are tied around it and usually strengthened by adhesives, for which some material variation exists. The set of residues in particular seems to indicate the standard use of what is interpreted as a treated resin at Pearls and El Flaco, but also a variety of other compounds in the Dominican sites. The relative abundance of juxtaposed arrangements is at odds not only with the scant evidence from the archaeological record (in spite of frequent allusion to adzes as elementary for canoe making and asymmetric forms), but also with tropical lowland ethnographies more broadly. To my knowledge, Pearls is the earliest Caribbean context for which parallel-juxtaposed adze hafting systems have been identified. Comparisons with New Guinea show that the potential for variation in this theme is significant (e.g. Crosby 1977; Pétrequin and Pétrequin 1993), existing alongside adze designs of the type described in the previous paragraph, and that these may be coded with information on regional or ethnic origins. Apart from head morphology, however, design variation along the lines of organic joints (and cordage patterns) cannot be retrieved through wear trace analysis.

Few other types of hafting arrangements were noted. Foremost is the absence of one, which is a biographical eventuality for wedges and celts repurposed into pestles. Both types were observed in the assemblages of Pearls and El Flaco, whereas Playa Grande contained neither obviously used or remade in such ways. Otherwise, every analysed artefact with wear from use also displayed traces associable to hafting. Two large blueschist almonoids from Playa Grande (028 and 086) exhibited wear indicative of them being wrapped in softer material, while also in static contact against a wooden slotting (Figure 41). Another blue rock celt was hafted in a distinct manner (possibly inserted in an axial cleft and secured with bindings) that does not seem to correspond with any type of arrangement previously discussed. It is the sole specimen that somewhat approximates the type of attachment indicated by Oviedo (Section 2.3), though the uninterrupted band of wear from ligatures suggests an axial and not lateral orientation. The only other type of hafting arrangement with ethnographic correspondence is a male parallel (axe) arrangement with supporting ligatures, very common in Amazonia, here indicated on a single specimen (FL 210). None of the other ethnographically or ethnohistorically reported types of hafting arrangements discussed in section 2.3 were observed – most are unsuited to the slender tapering outlines of petaloid celts.

Use

Use is evidenced through wear on nearly every single finished edge, irrespective of context, and many appear well-worn and intensively used. The analysis demonstrated different categories of tools to exist within the selection, including such forms as large-sized intact petaloids and small 'micro-axes'. Woodworking is the principle activity inferred, as wear indicative of contact with woody materials comprise over half (Playa Grande) to the vast majority (Pearls) of observed trace patterns. Percentages are generally lower at Playa Grande, part of which stems from the lower inferential resolution admitted for that analysis. The associated wear is characterised by high internal variability, however, and this spectrum permitted four subdivisions for specimens with sufficiently characteristic patterns.

Wear trace patterns conforming to the characteristics developed in the experimental work indicate the working of (semi-)green hard-to-work tropical woods in the specific density range of broadly 0.6 to 0.9 g/cm^3. Correspondences thereto are found in all three sites, at ca. 20-30% of woodworking traces from Pearls and El Flaco (Table 13). There is no obvious correlation with other biographical particularities. The second subdivision is described as exceeding those characteristics in the spatial density and structural intensity of the polish, which is essentially, smoother, flatter, and brighter. These occur on a few specimens in each site, between ca. 15-35% depending on the measure, and more often on metamorphic rock celts (though Pearls is obviously a bias). These traces are provisionally associated with contacts with harder woods (specific densities above 0.9 g/cm^3), and probably with longer work durations. Both severe micro-retouch and low measure of invasiveness argue against the alternative model, that of a softer wooden to siliceous plant-like contact material (Section 5.2.2).

Traces of woodworking contact that grade towards rougher textured and more invasive polish form the third group. These traces are better correlation with more traditional patterns of wear on edge-ground macro-lithic tool types from woodworking, thus indicating softer woods (specific densities up to 0.5 g/cm^3) if not at earlier stages of development. Such patterns of wear were relatively common at Playa Grande and El Flaco, but not seen at Pearls. The fourth, distinct variety of woodworking traces appears to match the experimental range of results in developmental maturity but clearly differs on other characteristics (Section 7.2.5, Figure 42, c). It may reflect the working of wood in a different state, but this is at the moment not clear. The wear pattern is observed only at El Flaco and Playa Grande (several specimens each), commonly in association with greenschist celts.

The absence of either wear trace pattern from Pearls could be related to economic or environmental differences between the settings, but it is just as likely a selection bias. If it is indeed associated with non-HP rock celts, it might also be an issue of recognition stemming from particularities in the tribological behaviour of the different mineral suites. It needs to be emphasised that the divergent spectra of woodworking traces are otherwise observed across different material groups. This indicates that a wide and diverse set of activities with a host of different wood types was undertaken with edge-ground macro-lithic toolkits. At the very least, the suite of wear variables far exceeds those obtained experimentally, indicating different woods, in different states, and different activities (felling, shaping, splitting, modelling), which equates to a diversity of woodworking aims and strategies. The combined biographical profile of several individual artefacts (shape, hafting, use) permits a tentative association of these particular tools with specific use activities. These are drawn in section 10.2.4.

Other types of use wear signatures are uncommon. Part of the remainder were inferred as contact with indeterminate hard-pliable materials or as general indeterminate contact. Realistically, these

traces could indicate woodworking activities also (at insufficient confidence, or specific work such as harvesting palm heart), or local hard-pliable materials whose associated wear trace signatures are unknown (such as hard-shelled fruits). They were never particularly indicative of contact with mineral or hard animal materials. Indeed, the functional evidence does not contain traces related to soilwork, butchery, or hide processing, activities not infrequently found elsewhere in the world. The former would have been recognised if present, as they form part of the Laboratory reference collection.

Traces indicative of contact with pliable-soft or softer contact materials were incidentally observed, and appeared to be somewhat more common at Playa Grande. These are distinct from wear associated with woodworking, and sometimes corresponded to wear more commonly seen from (plant-based) hafting ligatures. Siliceous plant materials are thus more likely than soft animal materials, but these patterns are on the whole quite variable. This suggests that the activities they were involved in included multiple classes of contact materials, but the divergence in topographic characteristics has not been experimentally investigated. A biography of non-use is strongly implied for P 009 only. This intact jadeitite specimen lacked any type of potential traces of use (dulling, retouch, striations, micro-polish, interrupted manufacturing wear patterns), nor was there any wear from hafting.

Re-use

All three assemblages contain celts which were repaired throughout their use life, or repurposed as functional implements towards the end of it. Repair is evidenced through two separate methods, one the resharpening of a dull edge by abrasion, the other the re-shaping of a (presumably more damaged) edge by flaking. Neither are commonly seen, with a rejuvenation rate of ca. 10% in the assemblage of El Flaco the most frequent of the three sites. However, these numbers probably understate the biographical prevalence since neither method of repair is likely to remain evident for long when executed successfully. A chipped edge must be subsequently reground and will thus disappear behind new manufacturing wear. This may not contrast the original surface well, and will in any case become overlain by traces from use. A more useful measure is to consider that both the assemblages of El Flaco and Playa Grande were practically exhausted and offered few, if any, onsets for the repair and re-use of the analysed fragments. Techniques such as (string) sawing that permit greater control in the repair of celts are not present.

The re-shaping of celts is evidenced in three different modes. Most common is the remodelling (pecking) of the fracture planes of suitably sized medial-distal fragments into pounding heads, commonly sporting multiple facets. A very large distal fragment from Pearls was repurposed in this manner, and at El Flaco it was applied to several petaloids with shattered bevels. Second, the edges of several proximal fragments from Playa Grande were smoothly blunted by impacts, but unlike the first mode not further redesigned. It is less clear whether this represents an adaptation to a different mode of use, since wear proved inconclusive. The third type concerns a special case from Playa Grande, where a very large-sized blade was backed for hand-held operation of its edge, though again with inconclusive functional data. The general stratigraphy of technological traces and hold-over wear from previous use confirm that these artefacts were edge-ground prior to rejuvenation. Clearly, they do not reflect different primary ground tool designs that merely converge with celt biographies in certain respects. Other types of repurposing known from Caribbean contexts (Section 2.3) were not attested in the presently studied assemblages, though anvil percussion markings do occur in the wider context of El Flaco (personal observation). Percussive stigma are common on butts, but usually relate

to production scars or in-haft counterforce impacts during regular use, not to re-use. Where active impacts are clear, as in FL 1218 which displays an impact rounded concentric sequence of seven overlapping flake scars distally imposed over the abraded surfaces of the faces and sides, the artefacts in question are wedges.

8.4 Death

Celts eventually break or become exhausted in various ways as a result of functional behaviour. The dulling, chipping, and potential fracturing of the edge and bevel is commonly observed, as are transverse medial fractures associable to use. The assemblages from both El Flaco and Playa Grande are overall exhausted, and only few objects therein could still be used or repaired to a functional sense. For Pearls the situation is unassessable due to collection biases, but would seem to represent efforts at curation also. The situation is so pronounced that the only useable or repairable tools excavated from the 2013-2015 collections of El Flaco would be the three repurposed celts. All of these materials were simply discarded off-mound in conjunction with house floor sweeping, opposing biographical possibilities such as burial association that are also seen at the site (Section 6.1.2).

The dulling of edges is extremely variable in the assemblages, with sharp to dull angles occurring both on intact fragments and on broken fragments (which may have fractured relatively quickly), and quite evenly so. Many duller edges are rounded to a degree that they can be presumed inefficient for cutting wood (following Mills 1993). However, none are dull to the point that it would not be easily remediable, and the common occurrence of sharp edges on use retouch spalls suggests that celt usability was usually maintained. Though smaller feather flakes may have also resulted from the repair practices discussed previously, certainly larger edge-surface flakes and the lateral corners of edges indicate breakage during use.

Transverse medial fractures are the most common cause of breakage. In part of the specimens, these are smooth bending-initiated compressive fractures from when the articulation of the haft arrests the trajectory of forces propagated by the percussive impacts from use. In celts with anisotropic fabrics (primarily blueschists and foliated greenschists) the fracture profiles are irregular or splintered, but the general pattern is the same. Importantly, there are a number of artefacts where such fractures are not associated to in-haft use breakage at all. Rather, they indicate the deliberated destruction of artefacts.

Both El Flaco and Playa Grande contain exhausted specimens with typical in-haft medial breakage or fragmentation of the blade, which are characterised by a second straight transverse medial fracture. At Playa Grande, this includes numerous roughouts with clear and critical production flaws which were still broken in half through a transverse fracture in the medial area. Both groups sometimes bore traces of points of impact on the sides, suggesting bipolar percussion, more commonly seen on the roughouts than on exhausted materials. The fractures are always perfectly transverse and often indicate a clean path of force from one bilateral side to the other. The presence of traces in juxtaposition to the overall biographical profiles suggests that celts were liable to be intentionally broken upon exhaustion, or when an envisioned biographical progression could not be materialised. I do not know of any experimental conditions in which such a specific double breakage was replicated under accidental (use) circumstances, and even if possible by chance this does not explain away the unhafted and unused celt debitage. Significantly, it indicates the relational engagement with celts as things in possession of sociality. Not just after outliving their biographical potential, but already long before they become functionally 'finished'.

9

Individual biographies of paraphernalia

The current chapter presents the reconstructed artefact biographies for the various paraphernalia studied in this research, 30 in total. In contrast to Chapter 7, it emphasises the connected biographical trajectories of each individual artefact, while the technical description and interpretation of data patterns are relegated to Appendix 4. This organisation highlights the biographical approach towards interpretation of the individual artefacts, the interpretation of which is in many ways less straightforward than the edge-ground macro-lithics of the previous chapter. It also avoids undue repetition, since the large heterogeneity of these artefacts in types, materials, and biographies, as well as in analytical complications, necessitate a full description of the traces for nearly every artefact. Ultimately, some of the resulting biographies are again grouped according to object type when they are seen to largely converge and pose shared social implications. The structure subsequently follows a division according to raw material.

9.1 Shell paraphernalia

The majority of shell objects derive from the site of El Cabo, where such materials were abundant. For each the identification of the shell material results from discussion with dr. A.T. Antczak after microscopic examination. By contrast, shell paraphernalia are rare in Playa Grande and El Flaco, and only from the latter site is one object included. Furthermore, this section contains a large carved shell face from east Grenada.

9.1.1 Inlays

Object C 276

One solitary inlay with a bulbous triangular outline in the form of an eye (C 276) was recovered from El Cabo (Figure 44). The light-coloured base is made of nacreous shell, with a sub-rounded element of a black-coloured material appearing in the centre the centre. Although the surface is smooth and shiny, one point was broken in the past and another damaged, and sediment encrustation is found in some areas. A fresh chip is observed on the intact point. It was retrieved from outside of the main excavated and surveyed areas.

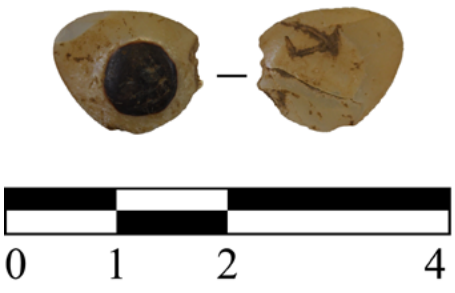

Figure 44: Eye inlay C 276.

The probable raw material identification is Cittarium pica. This nacre developing black-and-white patterned

shell can be procured from shallow waters, especially around rocky shores, which are found in the vicinity of the site. The most salient reconstruction of the operational sequence then entails the blank having been scraped (and/or abraded) down from the exterior around the central black spot, until the nacreous inner layer was reached. While different techniques may have been applied previously to separate the piece from the shell, the wear traces convey only abrasion with a single coarse-grained asperite tool. Traces that could relate to function were not observed. Since use wear studies on bivalves have demonstrated ample evidence of nacreous material developing interpretable wear traces, an explanation must be sought with the associated function of inlaying. After insertion into a well-fitting socket the object would remain unmoving, a state in which wear modes (apart from corrosion) do not operate. The damage on the tips could have been incurred at any time, including the phase of manufacture, event of insertion, or afterwards; there are no reasons to assume a direct link with the deposition. Whether it was deposited when still embedded into its socket or not, and the context in which this event transpired, is unclear.

Objects C 1359, 1527, 2694, 2214, 3104

Five more inlays were recovered from El Cabo, shaped as ovals or triangles with incised bared-teeth motifs and the fifth a non-incised piece with oval outline (Figure 45). C 1359 originates in an Ostionoid midden context, the other four are associated with the sweeping deposits found alongside house trajectory floor areas. Of these C 1527 dates to the 9th to 10th century AD, with the remainder are associated with the later Chicoid occupation. The specimen lacking incisions, C 2694, is broken near the side and interpreted as a preform discarded during manufacture. C 3014 is fragmented, the other inlays are intact. Sediment encrustation persists in two of these, which visually enhances the incisions of their motifs.

These mouth inlays are made from both bivalves and gastropods, locally procured, and thereafter follow an operational sequence that appears consistent despite the fact that the studied pieces are not contemporaneous. They seem to be separated by cutting, as opposed to percussion, after which the surfaces are levelled through abrasion and the sides smoothened out. The bared-teeth motifs are all created by first sawing the elongated groove with a coarse-edged lithic tool, cross-cutting it with grooves to space out the individual teeth (on the social significance of this motif see Samson and Waller 2010). The four finished ones are of different style, with C 2214 suggestive of being inserted in such a way that it would be visible from different angles, and C 1359 possibly being mirrored with another inlay given its asymmetric triangularity and the fact that it only shows enough teeth for one quadrant of the jaw. The shape and wear is consistent with inlaying cavities in other objects, despite the deterioration of the surface microtopography. However, rather than the typical association with sculpted wood, stone bodies, or ceramic adornos, the softness of the traces instead suggests incorporation into masks or idols made out of softer and perishable materials, as suggested by some readings of the

Figure 45: Mouth inlays from El Cabo. Top row C 1359, 3104 (bivalve made). Bottom row C 1527, 2694, and top and side views of C 2214 (*Lobatus sp. made).*

ethnohistoric record (Pons Alegría 1979). This association opens up an alternate path towards the context of deposition for the complete specimens retrieved from the edges of the house plans. In it, the inlays would remain within the masks or other 'smiling' objects which were stored or hung from the outer rafters of the house, those objects having been deliberately left to rot after use or when the house trajectory moved ahead. Leaving masks to rot in the house must be considered as a justifiable biographical possibility, given that it is observed among numerous Amerindian societies (e.g. Barcelos Neto 2009, 147-148; Van Velthem 2003, 214). However, it is obviously a hypothesis that requires biographical and contextual analysis of far greater number of inlays to substantiate, given that soft masks are otherwise not archaeologically known and extant cotton idols are not inlain within the mouth.

9.1.2 Plaques

Objects C 882, 1401, 1718, and 3678

A third category of paraphernalia concerns engraved plaques, of which four formal examples were excavated from El Cabo. These are small elongated plates with square or rounded borders, perforations located towards the lateral ends, and often carrying incised patterns on the frontal aspect (Figure 46). All engraved plaques from El Cabo are of two-dimensional design. The engravings occur through three zones, one central element and two mirrored lateral elements. Three of the plaques derive from the main excavation unit, whereas C 1718 originates in an early Ostionoid midden deposit. C 1401 lacks a lateral element and displays severe etching of the main surface. The preservation of the other shell plaques is similar to the inlays described above. This includes erosion of the microtopography resulting in the absence of expected striations, and exposure of the lamellar layering. The stratigraphy of wear polishes is somewhat unclear and includes structures that appear authentic, whereas others probably resulted from PDSM. Conversely, the nacreous C 1718 is in excellent condition.

Gastropod lips served as the hosts for all the shell plaques, juvenile *L. gigas* for two out of the three. These materials appear to have been made into blank shapes through recurring cutting of the rectangular shape and abrasion wear to smoothen them down, as it was for the nacreous plaque. Angular lithic edges were used to saw the checkerboard pattern and incise shorter grooves, and points to chisel out the wider, drawn-out grooves and shapes on all the shell plaques, specifically on the natural exterior side. Lean pointed lithic-tipped palm drills are the most likely tools to have produced the perforations, which were drilled primarily from the back side. In the case of the nacre plaque the process proceeded from the exterior through the intermediate shell layers, a strategy also seen in the eye inlay (C 276). The technique used for its large central perforation remains unclear. At least part of these activities appear to have been carried out on-site, given the

Figure 46: Engraved plaques from El Cabo. Top row C 1718 and 3678 (front and back). Bottom row C 882 and 1401.

association of half-fabricates with structural features at the site (Samson 2010, 216). Abrasion traces on the nacreous plaque are indicative of a coarse grained stone platform, though additional contacts with a scraping edge or a coral with sand are not ruled out. Local variants of such tool materials are in principle available.

In spite of consistency in design and manufacture, different ways of use are observed. The wear pattern on plaque C 882 indicates two unconnected strings oriented outwards along the long axis, one veritably fluctuating in its axis of suspension. Principally, this would leave the engraving free to be seen at all times. Assuming the premise that only a single use type is reflected, this then also suggests a vertical orientation in the suspension where the upper side hung tense. The string attached to the lower side had freer movement, perhaps floating other objects (such as tinklers) suspended against the plaque on one end only. Conversely, the orientation of the suspension facets on C 3678 indicate that it hung from two strings at equal height, in the fashion of a pendant. While there is minor gloss on the other orientations, the larger dimension of the perforations suggests there may have been comparatively thicker strings in this piece. The frontal areas bear strongly developed wear trace polishes that suggest contact with softer materials, although it is not clear if this relates to the composition in which they were suspended, unrelated contacts against that composition during its use, and these traces may have been altered by PDSM still. The nacreous plaque was used in a different manner, but this could not be further specified. Its deposition deep within a midden micro-context likely preserved the features on its surface whereas the habitation palimpsest of the other three proved diagenetically detrimental.

Object C 2193

One three-dimensional plaque (C 2193) was recovered from El Cabo (Figure 47). The morphology is modelled as a rectangular plaque with rounded corners, with the flat ventral surface beset by a perforation on both ends, and the dorsal side carrying a ridge which ends in blunt protrusions flaring outwards. It is associated with an earlier Chicoid house floor. C 2193 is fractured on the axis of the distal row of perforations, and the surface is affected by erosion.

The object is made of *L. gigas*. No traces are preserved from the shaping of the design, but it was clearly given four sideway perforations met by two additional ones from the ventral surface. A string was held in place through these perforations in sideways orientation, but not enough evidence remains to further reconstruct the style of fastening, or associated use activities. Though the biography of this specimen is inconclusive, the regional hypothesis of this type of artefact being fishing lures still seems less likely than proposed ornamental functions.

Figure 47: Three-dimensional plaque C 2193.

9.1.3. Face-depicting shells

Object C 2154

Two small gastropod shells with elaborate engravings were recovered from El Cabo, and are included in the analysis (Figure 48). C 2154 is a tinkler with a geometric patterning, the only engraved specimen out of roughly two dozen recovered from El Cabo.

This includes a number of preforms characterised only by removal of the apex, and finished/ broken specimens with perforations produced by wide abrasion, puncture, and in one case sawing. The object in question is associated with an earlier Chicoid house floor and is severely eroded, displaying pitting and signs of microbial attack.

Figure 48: Modified gastropod shells C 2154 and C 726.

C 2154 is an aged *O. reticularis* that was collected from an older sediment and manufactured into a tinkler. Its apex was removed by abrasion, a perforation placed by unidentifiable method, and it had several incisions set with a solid broad edge at geometric angles. The perforation technique does not match the other tinklers from El Cabo, which are all sawn. Perforations of such morphology are not common amongst the Caribbean assemblages, amongst which sawing and abrading are most common. Heavy wear of original percussion traces remains theoretically possible, however, and examples of drilled tinklers are seen in e.g. north-central Venezuela (Falci 2015c, 107-108). The object exhibits clear signs of suspension and a breakage from an impact at the rim, both of which conform to the biographical expectations of tinklers. Discard and sweeping under the house cleaning rhythm is likely to have followed the breakage having 'ruined' the acoustic properties. While it may be tempting to ascribe this failure to structural weaknesses related to its eroded state, the extensive wear development and occurrence of such fractures in other discarded tinklers argue against this implied 'bad choice' of blank material.

Object C 726

The second small whorl, C 726, appears to be a preform of a less common variant (Figure 48). It has been given the impression of a stylised face and can thus be classified either as a proto-*guaíza* or as a variant of a highly carved tinkler (of which examples are known). Some minor pitting and other PDSM is observed.

C 762 was probably gathered from the beachfront, and processed in the habitation area. Its side perforations were made through a percussive technique, but this does not indicate a lack of control or crude finish. Rather, this technique is probably the most efficient way to open up larger apertures, and here was subsequently used to widen and partially round out the opening. No manufacturing activities were undertaken afterwards nor are any signs of use detected, leading to the conclusion that the biography was abandoned at that stage. A possible rationale can be found in some potential flaws in the eye production (the right eye being too square-ish) that relate to structural crack propagation in the shell. Accordingly, C 762 may be a *guaíza* preform. While this interpretation of the perforating technique is congruent with the microstructural properties of the shell, it does need to be experimentally corroborated.

Object 1339

Another unusual artefact concerns C 1339, a fractured ring-like object with an addendum made out of the umbo (Figure 49). The fracture crosses both the outer ring as well as a smaller perforation set in the umbo. Otherwise, the shell surface is very rounded, and experienced erosion of the microtopography. Further, certain areas are tainted by recent graphite stains from pencil contact. It was found in a Chicoid house floor sweeping accumulation.

The preservation of the object necessarily limits the biographical narrative to one of meagre content. It was manufactured out of a bivalve using smoothening, incising, drilling, and potentially other techniques. A large ring opening was created, which is somewhat oval in shape, and presumably is the functional portion of the object. A second perforation was placed in the umbo area above, of which the technique matches numerous other artefacts discussed previously (a hard lithic drill bit used in rotary motion). The spatial relation of the other engravings in this area give the impression of a stylised face, with the prognathism characteristic of monkeys. Some indications pertaining to a use remain, but the data is not clear enough to warrant further interpretation. For one, there are no indications that point towards an ornamental kind of use. After breaking in use or accident, the ring was swept towards the backside of the house.

Figure 49: Ring-like object C 1339.

Object C 3107

The final piece of shellcraft from El Cabo is C 3107, a face-depicting carved shell associated with the typological *guaízas* (Figure 50). This object derives from an abandonment deposit associated with the late Chicoid-period House Trajectory 2, rich in paraphernalia and ultimately early colonial material culture (Samson 2010, 288-289). The frontal aspect of C 3107 is in decent shape, with only a minor flaw in the chin. However, the interior of the shell which doubles as the backside of the face is pitted and cracked, which relates to the age of the shell material.

The object derives from an aged conch shell which was fragmented prior to human intervention, with part of its columella ending up at a storm terrace. At this point it underwent taphonomical alteration (erosion) and obtained patina across its sides and back. Only at a subsequent moment was it recognised as suitable for the criteria of a *guaíza*, collected, and given further shape. Approximation of the gross morphology probably required little modification; some excision is observed to have taken place by repeated sawing in crossing angles, and the finishing touches included scraping out remaining rugosities. The engravings were all set using the same technique and varying intensity,

Figure 50: Face-depicting *guaíza shell C 3107.*

with an unknown tool type that contrasts grooves set with angular chert edges. This may still be the same technique as used for the previous shell materials, different only in the incisions on C 3107 being of a generally more shallow nature. However, this is not entirely certain and would require further experimentation. The eye sockets were chiselled/whittled out and subsequently given a shallow perforation using a rotary tool, probably hand-held, but also of unknown material.

There are multiple indications for the integration of other materials during the use life. The soft wear polish present on the protruding areas is indicative of a sustained or continuously renewed contact with the main surface (not further interpreted), since it is somewhat dissimilar from the more extensive natural patination on the sides and back. Yet its absence of the eyes and mouth area indicates these were potentially covered with inlay-like material. This is strongest for the eye sockets, which are depressions, lack wear and smoothening, and have an inset for pinning the inlay. However, there are no residual or material remains corroborating this hypothesis (despite such residues occasionally surviving in other *guaízas*, such as examples from sites across Anguilla; Crock and Petersen 1999). The black tar-like residue on the back suggests that it was glued against another surface with the intent of sustained adherence. Headdresses or belts are known biographical possibilities from the literature, but there are no wear traces that would confirm such interpretations or point at different supports. This is consistent with the eroded broken backside of the object, which was left unmodified probably because it was never meant to be seen. The reddish residue raises questions, as it is also an adhesive. It may have been applied for its colour rather than adhesive capacities, but this still contends the use of the black adhesive. Possible answers may be sought in different contexts of application (generational, spatial, or techno-cultural boundaries) or in differences in the capacities of the recipes (whether mechanical or ontological). A characterisation of both residues is required before these and other inferences can be weighed.

The depositional context is that of a depression in the bedrock. Though potentially simply swept there, it is more likely to have entailed the active caching of the object given the association with features and other paraphernalia. Given the secure excavated context, it is probably that the perceived adherents were removed prior to this event. Potential inlays were not recovered with it, nor were quantities of seed beads or other forms of appliques to belts, headdresses, and other object types. Only if all were made of perishable organics which were placed there with the presumed recognition that they would rot can this be congruent with the depositional context. Post-excavation it has been washed and is regularly exhibited as the face of the El Cabo investigation project, accumulating some scratches and modern residues in the process (Figure A19, f).

Object p001

This face-depicting carved shell artefact (p001) is also a *guaíza*, and is the southernmost-known example of its kind (Figure 51). It was recovered from eastern Grenada, and is attributed to the second millennium AD. The object is in macroscopic good condition, although incipient erosion on the topography affects the resolution of microscopic detail. Some minor contaminations from modern starches was also seen. Due to size and morphology, interior angles and lateral areas including the natural crown could not be reached with the metallographic instrument.

The strombid shell was obtained in (relatively) fresh state and subjected to an extensive manufacturing operation which included several different production technologies. Percussive techniques dominate the roughout phase as these were used to break and peck out the spire, columella,

Figure 51: Face-depicting *guaíza shell p001 (Willcox collection).*

lip, and probably the eye sockets. This is the only finished shell artefact in which these techniques were observable. This stage was followed by an extensive interplay between abrasive smoothening and excision with lithic edges. The maxillary canines, zygomatic processes, and brow ridges were delineated by sawing and any extraneous shell material removed by scraping, whittling, or pecking. In most areas these traces were abraded over, while the ragged percussion scars and prongs on the upper whorl were similarly removed and smoothened out. No traces remain that indicate the specific abrasive technique.

Having completed the preform, lithic points were used to incise and cut the bared-teeth motifs, and to incise the curvilinear engraving between the brow ridge and the natural prong pattern. Lithic drill bits were used in systematic rotary action to produce four lateral biconical perforations, as well as the conical nose (unreachable from the other side). A different technique was used for creating decorative perforations, which likely came last. The outcome was a highly sculptured *guaíza* with elements evocative of a monkey (large canines, facial prognathism, anthropomorphic orientation of the eyes). It was suspended as part of a larger composition through its upper lateral perforations, while the lower lateral perforations were probably used to facilitate a different string laden with other decorative elements. Generic soft contact polishes on various areas of the surface further emphasise a long lasting and interactive use life.

The artefact sustained two main breakages, one concerning the nose bridge of which the scars seem rounded down by later wear, the fresher one being the fracture of the jaw. It was deposited in the archaeological record at a subsequent point, and sustained some micro-erosion as is commonly observed on other shell artefacts interred in Caribbean sites. Having been uncovered in modern times by collectors, possibly in the general area of Pearls, the object was transferred through an unknown itinerary to the Willcox private collection where it is currently housed.

9.2 Wearable dental elements

The studied dental pendants are divisible into two groups, terrestrial mammals and marine animals. Despite their rarity in site assemblages, several such objects were excavated from sites in the Dominican Republic and St. Vincent, subsequently analysed in order to compare their biographical patterns to previously determined origins and potential routes of provenance. Since these will prove to diverge, each is discussed separately.

Object S615

The first perforated tooth of the two from Brighton Beach is an automorphic pendant (Figure 52, S615), provisionally identified as the lower canine of a jaguar (J. Laffoon, pers. comm. 2018). The crown is worn with a patch of dentine showing on a lateral side, and the root is wholly present but for damage at the distal tip. There are several dents in its surface, and as discussed one side shows a differential and more severe weathering pattern (Section 6.2.4). The root is also riddled by small cracks and one fissure exposes the inner pulp cavity, but this is likely taphonomical and exacerbated by recent changes in the atmospheric environment in which it is held. It was recovered from a midden layer in closed association with Cayo style pottery.

Figure 52: Perforated dental elements S615 and S208 from Brighton Beach.

Multiple lines of evidence indicate that the pendant originated in an adult jaguar ranging the South American mainland. There, the tooth was obviously removed from the respective socket, though no evidence remains as to the technologies involved. This probably occurred while the tooth was in a relatively fresh state (whether freshly killed or obtained from a decomposing carcass), given what appear to be marks of scraping applied to clean off tissues and perhaps regularise the surface. The perforation for suspension was entered from both sides, using a rotary drill with a solid bit of at least certain size but ultimately no distinct tool material. From that point onwards, the perforated tooth had been enjoined in multiple configurations. Most likely, the final mode of suspension was relatively free-hanging, given the wear patterns on the perforation at the darker side (Appendix 4), but in an asymmetric position (i.e. laterally from the axis of gravity). At least one previous mode of suspension is clear, in which the tooth was tightly woven into a composite piece and probably worn in that state for an extended duration. This explains the severe smoothening on the apical sides and labiolingual deformation of the perforations. Supposing a lateral orientation in the final mode of suspension seems the best explanation for how the two perforation profiles ended up different from one another. In this mode the sharp rimmed perforation on the darker side would be subjected to increased wear and at least partially hollow out pre-existing facets and deformation from previous modes of suspension. Such wear would become even more pronounced if the static lighter side was resting on a knot. It is possible to hypothesise additional phases of suspension on the basis of the observed bead-on-bead wear facet, itself worn over, but there are no clear indications otherwise.

This change in attachment systems at some point later in the biography of the piece is emphasised by the cut-marks. These are well positioned to indicate a detachment operation to facilitate a switch from a tightly woven system to a new one. As to why a tooth was originally cut loose from tight integration with a complex piece of adornment, there are numerous scenarios that may be envisioned. Salvaging a broken ornament, taking it out for exchange, after raiding, and so forth, but these are all contextually specific and thus for the moment speculative. Nevertheless, it is quite possible that

some of the observed re-attachment actions were linked to recontextualisation events as a result of circulation, travelling from the mainland to (ultimately) the island of St. Vincent. Upon deposition, site formation processes induced differential weathering before eventual complete burial.

Object S208

The second perforated tooth of the two from Brighton Beach is also an automorphic pendant (Figure 52, S208), provisionally identified as the incisor of a pig (J. Laffoon, pers. comm. 2018). The incisal edge is worn and the root is also wholly present but for possible damage at the distal tip, further exposing the pulp cavity. As with S615, a series of cracks now run along the long axis of the root, and the microtopography is weathered. This object was recovered from the surface in an area with dense deposits of Cayo pottery both on and below the surface.

This pendant originated in an adult pig. This could possibly have been a feral hog then recently introduced into the Lesser Antilles, but also a domesticated pig reared by early settlers or an introduction from an isotopically similar area. Radiocarbon dating is forthcoming to better place the historical timing of the specimen. Traces from its initial removal from the mandible are no longer clearly present, though it may have been treated in a similar fashion as element S615. The thin dentine walls were perforated from one side each using a very thin and pointed bit, though its material and rotary technique are unclear. The tooth seems to have been suspended as a pendant, with its enamel-displaying surface occasionally contacting a red pigmented surface, though the exact nature of the suspension – including any evidence for a larger composition – could not be reconstructed. The enamel-displaying surface occasionally contacting a red pigmented surface, however; indigenous body paint commonly used red and to the 'Island Carib' this colour phonemically invokes masculine strength and dexterity (Breton, in Petitjean Roget 1961). Chiefly, no indications were observed for a multi-stage biography undergoing spatial and perhaps cultural recontextualisation as it moved from its place of origin to its active destination at Brighton Beach. This suggests that – especially when compared to S615 – its biography may indeed have been quite local. At that point, site taphonomy including prolonged surface exposure acted to a substantial weathering of its surface.

Object FL 1748

The first dental element from El Flaco is a fragment of a pendant (Figure 53), made from the possible incisor of *Trichechus manatus* (D. Weston, pers. comm. 2016). A worn incisal edge is present, and two circular perforations are paired on the transverse plane from the labial to the lingual aspect. The pendant is fractured through the walls of these perforations, and most of its surface was covered by persistently adhering soil at the time of analysis. The artefact was excavated from a mound layer.

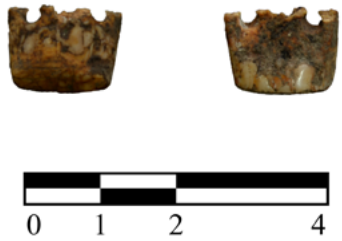

Figure 53: Modified dental element FL 1748.

The tooth was probably procured from a coastal area in the Greater Antilles, either from *T. manatus* or another large sea mammal. There are no unequivocal traces pertaining to procurement techniques or the potential shaping of the tooth. The drilling of the perforations was performed using a hard solid drill bit, however, resulting in comparable biconical profiles. Both perforations facilitated a stringing material, through which the pendant was suspended as part of a larger composition. The exact configuration is not retraceable due to the fracture it sustained,

probably related to the heavy wear from its use life. However, since the wear facets are not developed towards the laterodistal (outwards) point, it was held by a more complex type of attachment than simple pass-through suspension as the (sole) centrepiece of a necklace. It was most probably discarded upon breakage, after which it was swept away following the depositional taphonomy of the site (Section 6.1.2). It sustained some erosion while within the archaeological record.

Object FL 023

The second dental element from El Flaco is a pendant with dual off-centre perforations as well (Figure 54), made from the jaw of a parrotfish (Scaridae). It fractured into three pieces during recovery owing to its fragility, and is quite worn overall. As a result, the excavators wrapped it in protective paper (a practice potentially harmful to traces of wear; Graziano 2013). It remains dirty and was obtained from an artefact-containing lens within a mound.

The pendant was made from the lower pharyngeal grinder of a parrotfish (Scaridae), and mostly retains its natural shape. Only the distal end displays signs of shaping by breaking away extraneous material. Two perforations were drilled from the backside using a large lithic flake, resulting in wide cones and unequal exit perforations. A string passed between them on the frontal aspect, exiting on the backs; FL 023 was probably suspended in this manner, with relative freedom of movement. Damage and wear on the perforations imply it was worn for a substantial period of time. Why it was discarded remains unclear. Taphonomic processes weakened the pendant while eroding the microtopography, and it fractured upon excavation.

Figure 54: Modified dental element FL 023.

Object FL 115

The final pendant from El Flaco was made from the dentary palate of a species from the Myliobatoidei suborder (the stingrays) (Figure 55). Though worn, it is intact and in relatively good condition. However, the microtopography appears to be mostly eroded. It was recovered from the fill of a feature at the edge of a habitation platform. A comparable artefact had been recovered from El Flaco in 2016.

The pendant is made from the dentary palate of a stingray, logically procured from a coastal or maritime setting away from El Flaco. The techniques of detachment and shaping are unknown, but the outcome consists of smoothened lateral sides and a depression parallel to the perforations on the convex surface. The perforations were placed using a flint-like hafted micro-drill, with the dominant initiation from the occlusal surface. Traces indicating wear from use are not well developed; instead, the surface shows a clear and spatially confined band of erosion that is interpreted as tracking the original extent of stringing materials. Accordingly, these must have been tightly wound around the circumference, with little load exerted on the perforations themselves. Additional contacts must have existed

Figure 55: Modified dental element FL 115.

against the top and bottom aspects, leaving both the flat occlusal and convex opposing surfaces in view. It could have been incorporated either in a necklace using complex fastening techniques, or into some sort of woven object. It is unclear how the pendant ended up in a feature fill, but perhaps it was lost.

Object C 2420

A second pendant made from the dentary palate of a Myliobatoidei species was recovered from El Cabo (Figure 56). It is in good condition, though one of its flat surfaces is bleached in comparison to the other, indicating exposure at the surface. Its context has been mixed up, but the documentation suggests it originates with the habitation palimpsest of the site.

Figure 56: Modified dental element C 2420.

Just as FL 115 this pendant is made from the dentary palate of a stingray, originating from a maritime setting and potentially the nearby coast. Initial techniques of detachment and shaping are unknown, since the artefact was abraded to a flat plate afterwards. Its perforation technique is most probably a rotary drill using a lithic bit, initiated strongly from one side but finished as a biconical perforation. The same approach was seen for the shell plaques of the site. The pendant shows moderate development of wear around the rims of perforations, sufficiently to deform the holes and connecting bridge. A string was wound around this bridge and may have looped around the upper side as well, though this is not clear. This would entail a stronger fastening than simple entry, wound-around, and exit, but either system would be relatively sturdy and fit well within an extended necklace or woven composition. The morphological integrity and contextual uncertainty do not permit inferences concerning the deposition of the object, but it was probably exposed to the surface for a period of its deposition.

Object Lup 090

Also classified as a wearable from a marine vertebrate is Lup 090, presumed to be a flared earplug (Figure 57). It is an elongated cone with similar dimensions on all sizes, with a flattened wide 'head' that tapers towards a narrow end, now missing due to a fracture. The object is macroscopically well preserved, but bears PDSM on its microtopography.

Figure 57: Modified osseous element Lup 090.

The biography of Lup 090 is difficult to reconstruct, as a result of uncertainties with the identification of the material, the mode of use, and possible PDSM having altered the polishes. The bone is from a marine animal since there are no terrestrial vertebrates that match its characteristics (A.T. Antczak, pers comm 2014), but which remains unknown. The early stages of the manufacturing sequence are unclear, but it appears to have been finished through scraping or hand-grinding with a coarse-grained material. It bears well developed traces of contact afterwards, that wore down a depression in the surface close to the head. The distribution of those traces indicate that contact frictions acted only on the sides, not on the head, and from the tip down to this circumference. What use this was remains

uncertain. The traces are currently consistent with the field interpretation of an ornamental plug inserted into a pierced earlobe or similar body piercing, but different interpretations cannot be excluded since the tip is missing and the contact polishes were not fully interpretable.

9.3 Osseous instruments

This section reconstructs the biographies of the five carved long bone artefacts from the Lesser Antilles, up to their contemporary itinerary. They encompass three fragmented end-blown flutes and a fourth missing its mouthpiece, two from the site of La Poterie and two bearing iconographic sculpture from Telescope Point. The fifth is a similar but non-perforated bone pipe from the latter location. All are associated with the early colonial period. The materials from Telescope Point were found stored amongst a number of incised bones that were clearly modern forgeries. Those bones either derived from domesticated animals introduced to the Windward Islands much later, were themselves fresh, and/or the engraving marks exposed fresh, unweathered bone contrasting extant patination. This collection originally fostered scepticism regarding the authenticity and the unfamiliar iconography on the three bone pipes. However, inspection revealed their manufacturing to appear to be of age and a number of details to be consistent with the early colonial materials previously discussed. For these artefacts, p005, p006, and p007, the present analysis aimed to establish the degree of authenticity through the configuration of the artefact biography.

Object LP-01

The first bone flute from the site of La Poterie is the nearly intact LP-01 (Figure 58), currently in the collection of D. Charles. The bone is thoroughly cleaned from adhering sediment and seems macroscopically preserved, appearing fairly solid and fairly smooth. Nevertheless, the microtopography has been severely altered by erosion and etching. It had suffered both a midshaft break and an endshaft rupture at some point, which are presently mended with glue. Petitjean Roget and Charles (2015, 102) described three flutes from La Poterie in 2015, perhaps indicating the midshaft break to be an old break presently refitted. Moreover, there are several modern residues adhering to the object, the most prominent of which are an ink fingerprint stain and loose ink drops in several areas. The flute has been handled often, and due to its factual fragility was protectively wrapped (and regularly un- and re-wrapped) in a thick mass of kitchen paper. Unfortunately, this type of handling is experimentally demonstrated to

Figure 58: Flute LP-01 (Charles collection).

be highly damaging to the surface microtopography (Graziano 2013). This would greatly complicate high magnification analysis, but regardless no surfaces could be reached with the incident light beam beyond the areas around the tone holes without risking the stability of the object.

The biography of LP-01 is heavily influenced by the post-taphonomic phase, but reasonably clear evidence for the preceding phases remains. The long bone was obtained from a large mammal of mainland origin, probably a deer. The epiphyses were removed using a sawing technique, and the outer surface abraded smoothly against a fine-grained but unspecified contact material. The medullary cavity appears to have been cleaned out and enlarged as well. Three tone holes were perforated in measured spacing from each other by means of a rotary drilling technique using other-than-lithic tools. Finally, a single notch was set for the mouthpiece and widened with a broad-angled blunt organic tool carrying abrasives. Remaining traces indicate that the flute may have been (partially) coated with an unidentified substance, and that a decorative groove emphasised the foot.

The mouthpiece identifies the pipe as a notched end-blown flute and the patterns of pressure are consistent with standard use gestures for such instruments. However, the analysis could not verify a matching intensity of traces of handling on the surface itself. The durable bone pipe is probably capable of producing sound, but whether perishable additions originally modified the distal opening cannot be known due to surface erosion in these areas. The possible manipulation of airflow in the mouthpiece with wax or resin needs to be further assessed. At a certain point in the biography the proximal tone hole was destroyed by two damaging incisions, carefully placed so as to not break the circumference at this thinnest part. This seems to have been an attempt at rendering it useless while preserving its outward appearance. The event may be linked to the end of the biographical life phase and perhaps interlinked with the death of the artefact, but a more informed estimation at the depositional context from future research at La Poterie is necessary to temper these inferences. During its deposition in the archaeological record, most of the surface of the flute was strongly eroded destroying most of the wear traces and their internal organisation. Upon collection in 2010, the flute endured much renewed activity, including cleaning of soil, staining with ink, other unidentified residues, and pencil markings, and multiple episodes of transport, breakage, refitting, gluing, and (un) wrapping in thin abrasive paper.

Figure 59: Flute LP-02 (Charles collection).

Object LP-02

The second flute from La Poterie (LP-02) is a mouthpiece fragmented from the foot to where its circumference is thinnest (Figure 59). Its cultural association and collection history are shared with the flute already discussed, and it accumulated the same modern residues although in lesser quantity. The surface appears to be in good condition, showing less signs of erosion and fragility than LP-01 though here also the topography is degraded.

LP-02 is a notched end-blown flute, but the design and biography of the instrument are somewhat different from that of LP-01. It is made of a smaller bone and displays marks that seem to be indications of anthropogenic defleshing, probably preceding the removal of the epiphysis with a sawing technique.

Alternatively, they could relate to modifying the bony surface. Compared to LP-01, however, abrasive techniques were not clearly identified on the outside and internal sedimentation prevents a view at modification of the medullary cavity. That said, issues with the analytical resolution remain and these hypothetical reconstructions should not be taken to reflect technological differences. The perforation was placed using the same technique as seen in LP-01, but oriented on the narrow lateral aspect of the bone. The groove was placed using what was likely a percussive method, and unlike LP-01 not widened out with an organic tool.[45] Finally, the fragment evidences three sets of circumferential lines which have been placed as embellishment.

The traces of wear are more strongly developed in this flute, both in rounding and in the size of the pressure fractures. They include crack propagation which potentially forced the loss of acoustic capacity and eventual deposition of the object. Otherwise, the midsection fracture could have formed due to an accident during the use life, but equally have been a prerequisite performance for deposition or an old taphonomic break. Notable is that the notch and the first perforations are slightly misaligned, potentially indicating an off-centre position of the flute to its player. The instrument has not been subjected to erosion in the same way as LP-01 has been, nor has its collection history left such extravagant residual accumulations on its surface. Nevertheless, it exhibits some signs of deterioration, modern residues, and probable abrasion from protective wrappings.

Object p005

The first bone pipe from Telescope Point, p005 (Figure 60), is a notched edge-blown flute bearing an anthropomorphic sculpting. Though intact apart from fracture damage on its distal end, the bone is in a bad state of preservation. The surface is heavily eroded, characterised by rough pitting and a leeched white colour. The collagen contents have degraded completely (M.L.P. Hoogland, pers. comm. 2016), which render the long bone very fragile and inhibit the application of isotopic analyses. Its presumed mouthpiece is intact, but the sculpted foot is fractured in a way that feigns a second notch. The inner area remains filled with a loosely kitted sandy sediment, which has been not removed for fear of removing support sustaining the structure. External features were also not cleaned given the fragility of the piece.

Figure 60: Flute p005 (Willcox collection).

The biography of this flute shares certain similarities with those from La Poterie, but differs in several other ways. It was made of an unidentified long bone fragment with sufficient bony mass to support excision of a figure. The earlier stages of the production sequence remain unknown, with the exception of evident abrasive

45 Due to preservation issues it remains unclear whether percussion preceded the widening for LP-01, bereaving LP-02 of the follow-up process, or not, in which case both manifest different technologies.

smoothening of the flat surface to bear the tone holes. This instrument also had its mouthpiece widened with a sharp-angled organic tool carrying abrasives, although the angle is more narrow, probably resulting in a distinct sound capacity. The five tone holes were produced with the same technique as the flutes from La Poterie. On the basis of unfinished onsets left from the tuning, this technique is now tentatively interpreted as the rotary use of a hollow reed.

A number of different techniques were applied in the production of the iconographic elements, including excision, incision, drilling, and chiselling. The proximal groove and digits of the extremities were produced using lithic edges, and these are also implied in outlining the excision although are too eroded to make certain the distinction from sharp alternatives such as bamboo, shell, metal, and so on. The other excised shapes are probably all chiselled, which is most clear for the eye and mouth depressions, while an added abrasive process is postulated but not provable. Solid lithic drills were used for unfinished perforations, in contrast to the tone holes. The iconographic elements come together as a squatting figure, bearing its own face and adorned by a headband. Several of the iconographic elements are consistent with motifs frequently encountered among Greater Antillean material cultural repertoires. These include the shape of the nose, positional arrangement of the face, side and back appearance of the squatted figure, and the presence of a headband. However, the crown-like shape of the headband is to my knowledge unique, however, nor are the eyes and brows of the figure frequently repeated in the Antillean stylistic inventory. Further thought on potential iconographic hybridity is offered in section 10.1.4. The thin grooved lines that characterise both the La Poterie flutes are absent, yet it is possible that a similar coating was applied to some portions of it.

The disposition of the tone holes, onsets and notch indicate that the instrument was played in a sideways position, and in a way that is acoustically different from the La Poterie flutes. Not only do these elements evidence a highly developed expertise in creating musical instruments, they also enabled the iconographic elements full participation in the performance by orienting them towards the audience. Its depositional circumstances are unknown, but its modern itinerary commenced upon recovery from its original context by looters who subsequently sold the piece to the current owners. The surface was exposed to strongly erosive conditions while in the archaeological record, which affected both worked and non-worked surface acting to obscure all finer technological details. Only the thin groove of the headband seems less affected, and the technique and origin of this feature are not entirely certain. All other biographical characteristics are consistent with an early colonial origin.

Object p007

The second flute from the Willcox collection, p007 (Figure 61), was encountered in the same setting as p005 and studied with the same rationale. Both the mouthpiece and the foot end are missing, and the midsection includes iconographic embellishments of a similar design but executed in a different style. Furthermore, the sediment filling the medullary cavity and adhering to the surface is much more cemented than that in p005, indicating a different micro-context. Some PDSM is observed, as well as heavy erosion in a few places and impact marks resulting in cortex detachments that appear to be of more recent origin in other areas. Overall, the surface topography is much better preserved.

Due to damage on the ends and extensive iconographic shaping, no traces remain that are indicative of procurement or of functional modifications. Rather, the observable biography begins with the excision of the squatting figure, which was performed using partially overlapping technological methods from p005. Sharp edged angular tools were used to delineate the figure through incision and

engrave the digits, and tools of the same material were applied in chiselling, scraping, and whittling out the lower areas. Probably these were lithic instruments, although a measure of uncertainty remains: prime variables such as wall striations and irregularities are difficult to verify given erosion and resolution issues with the digital imaging used in the field. Notably, the clear evidence for these techniques voids the need to postulate abrasive techniques, inferred for the other bone flutes. The iconographic motif consists of a familiar squatted figure, depicted in a somewhat blocky manner. Notable are the thickened bulbs appearing on the legs, which are associated with the bound calves of Lesser Antillean communities (first observed by Chanca in 1493, in Hulme and Whitehead 1992, 33) though not necessarily foreign to the sabre-shinned treponemal individuals of the Greater Antilles (Reid 2009; Schats 2011; Stevens-Arroyo 2006). The face is carved almost as if it were a mask, and possesses a single ʊ-shaped slit that links both eyes and mouth. This is to my knowledge a style not known from elsewhere in the Antilles. Only thereafter were three tone hole perforations set, perfectly spaced along the axis of the bone through the same technique also used for the other flutes.

Figure 61: Flute p007 (Willcox collection).

Signs of use are precarious due to the damage. The most evident trace signature is the golden-brown patina, though the resolution and preservation is not sufficient to promote human prehension over simple smoothening with soft material, or other explanations. However, it adds another element to the perception of an ancient biography, which seems clear in any case. Breakage of the mouthpiece or foot may have spurred deposition, or be taphonomical in origin, and impacts on the bone – either deliberate or the result of careless handling – occurred at some point presumed to be late in the biography. The breakage of the top perforation may be taphonomical, as this is the most heavily eroded location on the piece. Some areas are more affected by erosion than others which could indicate diagenetic micro-climates within the sediment of its deposition. It was taken from the site of Telescope Point in recent times and ended up in a collection of similar bone objects together with modern forgeries.

Object p006

The final long bone object discussed here has the designation p006 (Figure 62), and concerns a decorated but unperforated bone shaft. The sediment seems to indicate an origin in the same stratigraphic context; all remaining surface soils are adhered in place due to the presence of residue. Both the proximal and distal ends are rough fractures. PDSM has acted to round out any fresh features and angles as well as to erode the microtopography, though the dissolution seen in p005 is absent.

p006 is made of a human left tibia, the provenience of which is unclear. Two main biographical possibilities qualify. The first is exhumation from a grave context, secondary burial manipulation being a common feature of indigenous Caribbean funerary practices (Hoogland and Hofman 2013).

Figure 62: Bone pipe p006 (Willcox collection).

This is also the most likely possibility in the event the object is inauthentic. The second is being taken off a deceased individual, in which case it could be a war trophy (Petersen and Crock 2007). Both scenarios are otherwise associated with ancestor veneration, ethnohistorically known from throughout the Caribbean. Material evidence capable of distinguishing the recently deceased possibility would need to be sought in traces of butchery and defleshing on the bone, none of which were observed. However, this could be attributed to the taphonomic circumstances and the absence of the diaphysis, or to the reliance upon natural or induced decay of soft tissue. There are thus no biographical indicators conclusive for either provenience.

The bone has not been severely modified in manufacture. A few areas display abrasive striations indicating that osseous rugosities were flattened. The diaphysis was engraved with relatively shallow patterns that do not alter the three-dimensional morphology of the bone. These were all filed using a single type of tool, whose use is not recorded in the other osseous instruments. Finally, several incomplete perforations were placed by hand using a solid blunted point. The resulting iconography assumes the shape of a figure, facing forwards with all elements mirrored off of the anterior crest. The motif in between the face and the distal body is the most notable aspect of the engraving, entailing six symmetric perforations, enclosed by a curved double groove. They are reminiscent most of the

buttons on a coat, although these bear no relation to colonial period uniforms, and remain a mystery.

No traces of use remain, but this cannot be taken as affirmative of the absence of physical use given the eroded, fractured, and sediment-filled state of the object. Potential wear associated with use motions may have centred on the now missing proximal end, or have been relatively brief and worn away. For instance, the pipe may have formed part of a static composition, in which case a lack of relative motion will have failed to produce traces, or it may have functioned as a cylindrical container, traces of which are unobservable.

The medullary cavity gradually filled with loose sediment upon deposition, much of which is still present within the vascular spaces. The surface has eroded, with the outer areas being affected more strongly than sunken features. If the pinkish residue is modern, this means the object has been in contact with sediment from its depositional context afterwards, either through reburial in order to artificially age the bone or from showers of grains falling out of the medullary cavity. This raises doubt as to the modern itinerary of the object. However, the spotty distribution and apparent nonfunctionality of the residue in a forgery context render the modern hypothesis unclear as well. The notion of an ancient origin is reinforced by the fact that all perforations have residue stuck inside of them, presumably because of the residue being present underneath in light of the loose cohesion of the sediment otherwise. It is also possible that the residue was recently glued on an original find to enhance the visual iconography, which is difficult to perceive in the cleaned state. In all, the authenticity of the object must remain inconclusive until further scientific analyses can be conducted.

9.4 Wood carving

Object p004

The final artefact to be discussed is a small face sculpted out of a wooden branch, p004 (Figure 63). It was recovered washed up on the beach, and presumably originates with a submerged and slowly eroding archaeological site. The object is in relatively good condition, despite several cracks showing in the wood. However, its depositional context has left sediment adhering to all lower areas, for which no cleaning was attempted given concerns on the preservation. This affects the decorative grooves of the frontal aspect in particular, obstructing the analysis thereof, as well as other potential toolmarks.

Figure 63: Wood carving p004 (Willcox collection).

The object was shaped from a circular extract, probably of heartwood, using various techniques to arrive at a sculpted hollow face which subsequently became part of a composite artefact. While angular lithic implements alone could in principle suffice for debarking, sawing and snapping the blank, rough shaping of the cylinder (presumed stages), scraping of the sides, chiselling the internal cavity, and excising the facial features (confirmed stages), this nevertheless evidences a great degree of forethought and skilful application of a range of shaping gestures. Iconographically, the face closely resembles typical Greater Antillean motifs, including the goggled eyes, the headband, as well as the

tear-drop motif which structuralist allegories associate with the Boinayel character (e.g. Arrom 1975; Stevens-Arroyo 2006). This configuration is produced by the carved excision of its features, probably cut with angular blades but not confirmable given the sedimentary encrustation. The large socket perforations were not shaped by drilling but hollowed out with a carving implement (though an initial perforation may have been drilled). Conversely, the smaller and decorative holes are thin cylindrical unfinished perforations that were made using a fine and presumably organic tool with abrasives in rotary motion. The perceived size differences between the ear and nose holes may relate to widening contiguous with a deeper tubular perforation, or a slightly larger bit of the same type.

Following manufacture, the artefact became part of a bigger composition. The traces point towards a type of suspension in other objects, but this allows for multiple scenarios which can at present not be distinguished. It rested inside an opening within a hard material object, possibly allowing for slight movement, though whether also wood, stone, or different is not known. Stone is more likely to imply specific striations, which were not observed, but this does not rule it out either. Regarding the potential inlaying of perforations and sockets, traces or residues for this were not observed. In fact, providing the object was attached against a flat surface this would allude to the presence of a dark space behind open sockets. Finally, the exposed frontal surface endured contact with soft material over a reasonable duration. This can be attributed to any number of causes, from venerative physical contact to briefly but repeatedly polishing up the wood after manufacture or maintenance.

9.5 Summary

This treatise of complex carved objects underscores foremost the individual character of each. The combined biographical approach has generated a wealth of data, contributing to a comprehensive understanding of the individual trajectories of the objects. This richness will greatly aid the upcoming discussion. Already, the technological, cultural, and social context is brought to the fore by the experiment analyses and the implications of observed use wear traces.

Perhaps the most widely shared trait is the employing of lithic tools in the various engravings. Whilst the cut-marks and incisions are not as sharp as the experimental grooves, they are nevertheless morphologically similar: the discrepancies are best explained by use of a coarser grained material in combination with generally duller edges, rather than another tool material. Brittle lithics also appear to be the standard in perforating, usually through rotary motions. This is significant most for the shellwork industry of El Cabo, where such tool materials must be imported and are only poorly represented in the excavated areas. Cherts, jaspers, and coarse-grained flaked rocks are more abundant in the other study regions, though often not so from the archaeological contexts in which the paraphernalia were found. Nevertheless, several other types of tool materials have been observed, evidencing the value of the experimental programme and its ethnographic footing. Though shell is not seen to have worked the studied objects, organic tools are implicated in some widened grooves and abrasive files for a specific artefact. The non-lithic hollow reed (or pointed tooth) technology of the drilling of tone holes remains remarkably consistent, though additional experiments are recommended. Together, these biographies provide evidence of an expansive artisanal skillset, applying innovative tool materials through a variety of different gestures and approaches to achieve complex outcomes.

10

Discussion

The existence of multi-scale networks of social interaction in the indigenous Caribbean is conspicuous, but it remains mostly unclear in what ways the artefacts serving as proxies were enmeshed with(in) them. Only the fact of their transportation across the landscape has come to be clarified in recent research on isotopic and geochemical provenances. Such materials were also incorporated into new contexts, sometimes reinterpreted across social or cultural boundaries, from functional through ontological domains. Indigenous networks of interaction were organised around such flows, consisting in pre-colonial times of stone celts and carved paraphernalia (amongst other materials). They later constituted an interface with colonial tools and structures. Reconstructing the biographies of these artefacts forms a productive window into the issue, since doing so makes salient the relational movements of things within and between social settings. This premise was sought out on two different scales: the particularities in the biographies of individual paraphernalia (Section 10.1) and the general biographies of celt assemblages (Section 10.2). Such a framework operates on multiple levels (Chapter 3), which prove illuminating in different ways. For one, biographical profiles will typically converge around a shared mean trajectory, which reflects culturally shared notions on what proper social roles of things look like (Kopytoff 1986). This also means they are structured in accordance to native 'common sense', being their understanding of the relational essence of social behaviour, and recursively inform about those very ontologies. Such convergence is not a given, however. Biographies may instead singularise and diverge from the common trajectory as a result over competition between different value sets, which can elucidate cultural concerns over specific interactions by providing contrast. This is particularly salient when these biographies cross cultural boundaries and/or incorporate innovative materials, as may be expected from early colonial interactions. Altogether, the insights that can be derived from biographical patterns and anomalous movements stretch far beyond a renewed appreciation of the artefacts themselves.

10.1 Key symbolic artefacts in Caribbean communities

Each individual group of paraphernalia (as exotica or key symbolic artefacts) displays common patterns in their biographical trajectories. Firstly, shell-carving reflects a coherent and stable technological tradition, even if individual artefacts commenced functional lives more cognisant to their particular type. The community of El Cabo (southeastern Dominican Republic) probably shared this tradition with at least its contemporaneous neighbours in the Chicoid heartland. Secondly, the various types of dental pendants reflect not only a multitude of origins, but also distinct technologies in the production of them. Occasionally, clear recontextualisations of their modes of attachment appear to emphasise long-distance circulation across cultural and social boundaries. Thirdly, the bone

pipe instruments reflect varied tonal spectra and individualistic iconographic presentations, while remaining technologically cohesive. This argues first for the authenticity of the decontextualised windpipes and second for prerequisite repertoires of skill and knowledge, maintained through inter-communal contacts. Lastly, technologically complex objects with larger operational sequences and a greater repertoire of tools and techniques evidence longer biographical trajectories in general. This renders such 'paraphernalia' excellent vehicles to address a series of archaeological concerns with.

The manufacturing procedures differ in specific ways for each group, and thereby indicate significant extant technological diversity and skill. Especially for sawing, incising, and engraving there appears a lot of micro-variation in the types of edges utilised, though all were lithic. This may indicative selectiveness in the types of flakes chosen towards particular aims, but will also depend upon local preferences or availabilities of specific lithic materials. Drilling techniques are even more distinct, sometimes using specialised bit materials for very specific tasks (a.o. wind instrument tone holes). Once taking a step back from the complex solutions applied to individual artefacts, however, common biographical threads connect these seemingly varied operational sequences.

The attentiveness towards raw material affordances seen in each biography expresses technical skills and commonalities in the indigenous strategies towards those materials, exploiting possibilities and negotiating constraints. This is why certain shell microstructures are approached with different techniques than others, and why long bones were selected for possessing sufficient bony mass to carry large excisions. Reductive crafts were clearly based upon conceptual steps shared across media. Blanks were first separated from the host mass whereupon rough and progressively finer shaping could take place through percussion, sawing, and abrasion. Perforations were generally drilled at intermediate to late stages, as were functionally superfluous engravings. Additional abrasive/lustre-inducing techniques are only selectively seen afterwards. This pattern holds for the various shell materials, as well as pendants from dental elements and bone instruments. The general repertoire of techniques and the organised succession thereof thus remains similar overall. It reflects the existence of at least broadly comparable technological systems in each case study area, if not more direct connections in the transposition of skillsets and technical applications across materials and communities.

10.1.1 Seashell technologies

The shellwork industry at El Cabo displays the highest rate of technological similarity. The timespan of these materials is upwards of 800 years, including affiliation to both the Ostionoid and Chicoid ceramic series. The shell assemblage nevertheless exhibits a strong consistency in technology and approach, beyond the necessary material-specific adaptations to layering and structure (Section 9.1). These similarities indicate a certain degree of shared knowledge and expertise in shellworking that was maintained and transmitted between members of the community.

Shell is itself a biomineralic aggregate that can exhibit many structural varieties, each adapted to defend against stresses from the natural environment (Section 4.4.4). That this also results in differential resistances against stresses induced by pre-modern technological processes is known (Debruyne 2014; Szabó 2004; 2008; Szabó *et al.* 2007; Weston *et al.* 2017). The indigenous artisans of the Caribbean were aware of the resultant behaviours, and took them into account. Percussion techniques are observed only on C 762 and p001 (Figures 48, 51), in both cases placed on the spiralling architecture of gastropod shells composed of a three-layered complex cross-lamellar microstructure. This structure is extremely fracture-resistant and bridges cracks easily, rendering it a tough material

that withstands structural deformation under manufacturing pressure. In practice, extraneous shell was probably pulverised without structurally affecting adjacent surfaces, and semi-circular apertures could be opened in the body whorl without cracks radiating outwards from it. Direct pressure techniques to remove thinner columellas in *Oliva* spp. tinklers were also exercised within these constraints.

The contrast with blanks made of different shell architectures and/or microstructures could not be clearer. The various flat shell objects made both from bivalves and from the lips of *Lobatus* sp. shells utilised the natural sculpting of the exterior shell to attain three-dimensional detail. Bivalves often contain prismatic layers, which guide perpendicular force downwards to inhibit horizontal crack propagation but are less proficient at this than cross-lamellar structures, and sometimes weaker foliated structures. Since percussion might thus induce unwanted crack propagation, all objects identified as made from bivalves were indeed made into blanks by laborious sawing. Their forms are modelled around the natural flatness and curvatures, followed by further shaping through abrasion using stone platforms. *A. palmata* coral was not utilised, in spite of it producing aesthetically superior surfaces on shell in experimental work (Breukel and Falci 2015; Lammers-Keijsers 2007). Perhaps the smooth, bright, macroscopically non-striated appearance was less valued, but it is also possible that harder grinding materials were needed to efficiently overcome the anti-wear properties of the exterior ribs. Other plaques and inlays were made from strombid lips, always of juvenile specimens so as to select the desired thickness. Though these lips may first have been separated from the whorl by percussion, the actual acquisition of the blank shape took place through sawing as well. The operational sequences and suites of techniques otherwise converge, even for the production of three-dimensional engraved designs which included additional filing and chiselling activities.

Bivalve nacre consists of a resilient brick-wall structure of sheets, which is very resistant to point pressure but splits easily along parallel (horizontal) planes. In gastropods, these nacreous sheets are stacked in tapering columns that are less susceptible to this horizontal weakness. There are two elements in the production strategy that probably served to meet structural challenges posed by nacre. Artefacts of both types were first shaped using the techniques outlined above, thereby placing stress on the stronger extraneous shell layers to avoid breakage of the fragile nacre. Thereafter the outer cross-lamellar layers were scraped away until the first nacreous layer was reached, which is a manner of separating the internal nacre layer from the other shell layers without risking splitting the structure. Further elaboration of the objects then progresses similarly as the other shell materials.

Altogether, the community at El Cabo successfully tapped into indigenous spheres of carved shell consumption, and likely produced some of these materials domestically. A plausible scenario is the continuous transmission of practical knowledge within the community, or a social level intersecting with it (age, gender, kinship, etc.). This scenario considers the presence of both roughouts and completed artefact forms, and the timespan in which these remain technologically and biographically consistent. Diverging biographies consist of the use of aged shell as raw material for C 2154 and 3107 (Figures 48, 50), possibly different incision tools for the latter, and a distinct level of technological complexity for the large *guaíza* p001 (Figure 51). While the sequence of p001 includes the repertoire of techniques seen at El Cabo, it contains additional scraping and whittling and a much greater variation of operations. Though its making would not have strictly required higher levels of technological specialism on the part of the shell-carver, such experience would have contributed significantly towards meeting the challenge. Its later biographical trajectory as centring a belt-like adornment is congruent with the socio-political context of such rare artefacts (Section

2.4). Depending on the mode of existence assigned to *guaízas*, the creation of such artefacts probably required sufficient social stature of the maker, complete with the ritual knowledge and capacity to navigate the relational enterprise of fulfilling such a project. Such restrictions are not apparent in the remainder of the materials, even if it is not improbable that levels of qualification did exist.

10.1.2 Dental wearables

Tooth pendant biographies are configured along entirely different lines. The raw materials make clear through geographic distance that the pendants are exotica, and technological differences indicate they also crossed significant social distances. Each 'birth' is distinctive, whether on the basis of perforation techniques or approaches to shaping – no two are the same. Nevertheless, the broad coherence in design and use indicate recognition of the same biographical ideals throughout, though with detailed attachment modes being contextually contingent. The most sensible corollary is that the pendants were procured and manufactured by different social groups (communities) with locally preferred technological practices, and later circulated to others.

The final social context in which these artefacts were retrieved does not necessarily equate the first stage of reception. A multi-stage trajectory is suggested at least for Cayo-associated S615 from Brighton Beach (St. Vincent, Figure 52), which originates from distant South America, since it displays a complex sequence of attachments and dislocations from the ornamental compositions. Recontextualisation events always loomed in the forms of exchange, incorporation in a different wearable, or as trophy, and it is not unimaginable that the pendant in question moved between different communities a number of times. Since it found its way into 'Island Carib' context, the itinerary may also have included the coastal regions of Guyana and it was possibly carried *en route* via human mobility. Linearly drawn directionalities between source area and find context indeed obscure more organic, contextual, and historically contingent pathways of interaction (Pollard *et al.* 2014). Conversely, the pig pendant may surreptitiously be the most local pendant of all. Nevertheless, it clearly represents the ontological negotiation of new animal lifeforms into classifications familiar to the circum-Caribbean world. The maritime ornaments from the Dominican Republic ultimately evoke the same notion of local production and wider circulation, but on a more regional scale. The coastal zones are in relative vicinity, and exchange networks more geographically dense (Section 10.2.2). Still different in shaping techniques and stringing styles,[46] these pendants do appear more consistent in the general idea of utilising elements from various sea animals and through comparable executions of perforations.

The standard tooth pendant in the LCA Greater Antilles is made from the canine of a dog, sometimes with engraved roots. Their ubiquity has been linked to relational engagements with this animal and the social status they enjoyed in indigenous communities (Section 2.4). The introduced dog occupies an apex predator position in the impoverished fauna of the islands, and may metaphorically substitute the affects of jaguars for that reason (Roe 1982; 1989; 1993). The donning of feline canines often connotes particular properties into the corporal constitution of its wearers in Amazonia (Santos-Granero 2012), and marine animal dentitions probably acted in similar capacities (but endowing different affects). It is unclear if tooth pendants formed a sphere of exchange

46 Though unmodified elements are present as dietary refuse in El Flaco (Section 6.2.2) and could thus have been 'sourced' from foodstuffs obtained via other connections, it is unlikely to have been the case for all modified pendants for this reason.

on their own, but the present results reinforce the impression that their circulation formed a widely shared custom throughout the Ceramic Age. To name two scenarios, pendants could derive from a few dominant producers of note, or represent communities tapping into relevant interaction spheres using Caribbean-wide locally available materials needing relatively little technological investment. Though thousands of dog tooth pendants are known, mainland mammals are rare finds restricted to a few archaeological contexts (cf. Giovas *et al.* 2012; Laffoon *et al.* 2014; 2016) and distributions of marine animal dental element pendants appear to be limited also. Consequently, by virtue of their material form, but explicitly not their technology, the present artefacts must have been culturally cognisant while standing out as (exceptionally) deviant.

10.1.3 Tracing tunes

The biographies of the four end-blown flutes from Grenada evidence a well developed musicological tradition and the technical capacities to translate this knowledge into elaborate and individualistic material forms. All of them are made from large-bodied mammals which are not native to the insular Caribbean but instead connect the instruments to continental South America. Their biographies display a strong consistency in the means of design, production, and use, though not without individual variation in some of these aspects. In particular, procedures for the cleaning of the shaft alternate between abrasion and scraping, and the decorative aspects emphasise different gestures. It suggests different artisans were at work, tapping from a shared pool of technological capacities and notions on how to achieve the desired tonal spectra all the while acting out independent trajectories with respect to acoustic properties and surface embellishments. Making, using, and curating such objects probably required significant skill in communicating with and manipulating the subjective affects and qualities enclosed in or by them. This is nearly always the case in ethnographic parallels on the social, ceremonial, and relational aspects of indigenous musicality and instrument usage, at least (Hill and Chaumeil 2011a and papers therein). However, such parallels require further exploration of windpipe technologies and biographies.

The cohesion between the biographies of the four artefacts is strong, but not absolute. This implies that they derive from the same cultural context, but were not made by a single person. The majority of technical gestures in the operational sequences were performed using solid thin-edged tools. These traces have in certain instances been interpreted as made with medium to coarser grained lithic flakes, but this level of inference cannot be substantiated for the majority due to surface erosion and fill-in with sediment. A few cuts were exceptionally straight and narrow, though not deep, and may have been enacted through metal edges instead. This should not be an unusual situation, considering that metal knives formed an exceptionally desirable trade good in early colonial times. Many of the early European seafarers and chroniclers reference the value of metal knives alongside axes and a few other materials in obtaining goods from Amerindian communities (Hulme and Whitehead 1992), as well as for their quotidian use and inter-communal exchange wealth (Moreau 1990). Though metal artefacts are rare in early colonial contexts in the Windward Islands, to my knowledge only recovered from Argyle, so are flaked lithics.

The cultural sameness of the windpipes is demonstrated by their musical designs. The shaping of the mouthpieces and deliberation of tone hole placement are completely consistent, and will have resulted in broadly similar production of sound. This routine evidences an expertise shared between the flute makers, which points towards the existence of a craft tradition with set rules and controlled

transfer of knowledge. However, there are crucial differences in the details that likely endowed each instrument a unique acoustic range. For one the bones are not of equal dimensions and were possibly made of different elements, which means that the resonance in the sound chamber is not the same (Safa *et al.* 2016). This variable may be further modified through beeswax props closing the chamber on both ends with the further possibility of (fiddle) inserts. The size and angles of the V-shaped notches differ from windpipe to windpipe, which affects how much of an airflow can be directed into the sound chamber and at what frequencies it vibrates. Their alignment with the tone holes and the bone shaft also varies. While the spacing of the tone holes is always internally coherent, it differs from flute to flute both in the distance from the extremities and between the tone holes themselves. Notable is that the tone holes are standardised and were probably drilled into the shafts by a tubular hollow drill, such as a reed, though a hafted tooth cannot be excluded. Either is entirely different from what is conventionally understood regarding perforating techniques in the insular Caribbean. This implies shared technological solutions to the specific requirements of placing functional tone holes in thin cortical bone.

All of the factors discussed above indicate that the practice of flute-making formed a cultural tradition in which the artisans exercised control over and experimented with the bone pipes to manipulate their musical capacities. It is obvious that such a tradition is not based upon four sole extant specimens, but that a much richer musical dimension and associated know-how must be seen to have existed behind these artefacts. Such dimensions – and associated central roles in (the ever overlapping) ceremonial, ritual, and festive performances – are well established ethnographically, and present in the ethnohistoric records from the Lesser Antilles (Section 2.4). Wind instruments may be 'sacred', 'secret', and may frame shamanic activities and social rejuvenation through their music. More generally, they occupy a communicative position between opposite actors in relational spectra, from living persons to the dead and mythical beings (Hill 2013; Hill and Chaumeil 2011b). The channelling of breath is a transformative performance, and the elaboration of flutes is often connected to the animal species with which they must enter into contact, as well. Though the sheer variety of common themes renders it impossible to assess what applies to the Grenadian instruments specifically at this point, their biographies do connect with expressions from the northern mainland.

Broadly speaking, there are three possible spatial trajectories for distinguishing where and under what conditions the flutes were manufactured, used, and deposited. The first is local production and use in eastern Grenada after having obtained the raw material from (contacts with) elsewhere, the second is that it was manufactured in northern South America (a.o. coastal Venezuela or the Guyanas) and at some point brought into the islands, and the third is that the biography played out between the islands and the mainland with no specific direction. Lacking regional data on technological choices and iconographic modelling, these cannot be distinguished at present. A better way of dealing with their itinerary is to reframe how the concept of local-ness is to be understood within a – potentially migratory – archipelagic setting. The argument that all derive from the same cultural collective in practice indicates either 'Island Carib' society itself *or* its broadly carried exchange relations with producing communities.[47] Such inter-group interactions are historically well documented for the region, in the form of socio-political gatherings (*cayounage*) and military alliances. Perhaps community members of the Grenada settlements had obtained brocket deer bones at Tobago or Trinidad during

47 For instance, the Waiwai from the Guyanese-Brazilian border area were known as expert flute-makers in historic to recent times, and neighbouring groups sourced their flutes from them (Coudreau 1887, 379).

one of those many such social contacts, or flutes were brought by related groups of men moving from the mainland into the insular Caribbean. The particular routes followed by specific instruments can only attest to their participation in a social context composed of continuous human mobility from regional to (argued by some) migrational scales.

10.1.4 Iconography, functionality, and performance

Thus far the discussion has focused largely on materials and technology as social domains. This section will provide some additional thoughts on the active biographical profiles of paraphernalia, and explore how they relate to their functioning in society. The aim is not to reconstruct the totality of the functional and ceremonial domain of these paraphernalia within Amerindian society (sample sizes and contexts simply do not permit this), but to gain deeper understanding of how these objects might behave under certain circumstances.

Most of these paraphernalia were not originally the objects that they currently are. Instead, they formed part of assemblies of materials joined in a composition, ranging from central elements (the pipes) to one out of several (teeth pendants), to minor yet crucial addendums (the shell inlays). All face-depicting *guaiza's* were suspended and joined with other materials: one (p001, Figure 51) was likely strung into a beaded belt, another (C 3107, Figure 50) adhered to an unknown surface, and the wooden carving (p004, Figure 63) also served as the face-piece of a larger arrangement. These modes conform to certain hypotheses regarding face-depicting portable artefacts (Section 2.4), and confirm that this class actually contained multiple viable biographies with relatively distinct connotations of status and purpose within society. The plaques appear to be connecting elements within strung compositions, although what and how complex these compositions are remains unclear. The interpreted attachment systems are dissimilar from one another, indicating tension coming from dissimilar angles. Other paraphernalia are now like skeletons of their former selves, since they were once embellished with fills, coatings, and perhaps also adornments. For instance some of the mouth inlays were possibly rubbed with clay to render them legible. The white lines that comprise rows of teeth are hardly visible otherwise, and some of this 'sediment' adhered across multiple cleaning episodes over the years (following photographic documentation). Surface deposits on some of the flutes also indicate the original presence of coloured substances. Ethnographic wind instruments are commonly decorated with feathers and carrying straps, though such possibilities were not fully assessable on the archaeological pipes due to preservation and visualisation issues.

It is also apparent in some cases that the iconographic potential of the paraphernalia is realised on biographically specific raw materials. The engraved tinkler is an aged (fossil?) shell and the smaller *guaíza* is also coaxed out of an older, worn fragment of *L. gigas*. Similarly, it appears plausible that the longbone made into flute p005 was pathological, in light of the original extent of the bony mass into which to sculpt its carvings (Figure 60). Their sculpted motifs are not mere decorations to an isolated core functional essence of objects, but contain an iconographic potential that is biographically established since the very conception of these things. In lithic materials, too, the embellishments that render an artefact recognisable as paraphernalia are sometimes no more than technological 'clothing' (*sensu* Viveiros de Castro 1998) enveloping the extant natural form and shape of a stone, apparently already having pre-decided its existence-to-be. Here, Caribbean examples comprise one of the carved pestles from El Flaco (personal observation), threepointers to varying degrees (Breukel 2013), as well as various rock art, stelae, and other objects having undergone what Peter Roe describes as 'naturefact

transformation' and later 'appropriation' (e.g. Roe 1989; 2013). Though rare in the present work, this mode of existence continues to recur in Caribbean (figurative) portable art.

I place the term figurative in brackets here, since the paraphernalia figure two distinct design groups. The first consists of the faces of beings (with or without bodies), and the second comprises geometric and curvilinear patterns. Most of the geometric designs are found on wearables, and stylistically Chicoid designs coexist as adorning engravings on *guaíza* p001. Each of these designs can be eminently visible, and they are always prominently displayed when use wear patterns indicate the original orientation within their compositions. Such display would also include properties such as colours, contrasts, and when in movement also sounds and motions to the performance of these objects. The aforementioned shell carving does not simply depict the face of a monkey, but was likely strung on a beaded belt. Judging by what is known of such objects, it was therefore displayed amidst wavy strings of bright white and red softly clattering with every motion.

The design of bone pipe p006 (though of unproven authenticity, Figure 62) is also comprised of stylised incisions, which evoke notions of hybridisation similar to the other sculpted bone pipes. Their depictions are built up of typical Amerindian elements, such as bent extremities – squatting legs – and headdresses/masks, but are stylistically unique. They also contain colonial period contrasts in the forms of what resembles a buttoned uniform (p006) and a crown (flute p005). If this was indeed the original intent, there are a host of relational modes that could engender precisely such results. One is the taking and display of enemy trophies, for which there are endless examples with myriad local cultural variations in the New World (Chacon and Dye 2007 and papers therein). An alternative mode is that of things which originate in mimesis and appropriate their subjective capacities by reference to the Other (Section 3.2.2). This may form a special case of musicalising the Other as a ritual engagement with not-entirely-human beings for flute p005, even (Hill and Chaumeil 2011b, 17-19). Though none of these speculations can be substantiated at this point, they accentuate ways to approach European (and African) influences in the biographies of Amerindian artefacts.

10.2 Edge-ground celt biographies through time and space

The direct biographical observations for each of the three sites had been initially explored in Chapter 8. Here, these results are considered in light of a number of concepts and topics that are concurrent in Caribbean archaeology today. The focus will first be on the issue of social jade and the materiality of (non)-green stones (Section 10.2.1), and axe-making technologies in the indigenous Caribbean (Sections 10.2.2 and 10.2.3). These themes are biographically connected and will navigate through subtopics such as bluestones and probable modes of celt being in indigenous Caribbean ontologies. The remaining sections assess what the functional capacities of edge-ground macro-lithic tools represented to communities living in (insular) tropical environments.

I will summarily recapitulate the three main sites. Pearls is located on the Atlantic coast of Grenada, the southernmost Windward Island, and dates to the Early Ceramic Age, probably the full extent of the later part of it. The studied selection comprises 20 celts including twelve jadeite-bearing rocks, and various rock types of both local and exotic origins otherwise. Most celts are morphologically intact, all have been used, and they exhibit a variety of technological procedures and hafting systems. El Flaco is located inland, located in the Cibao valley on the flanks of the Cordillera Septentrional of the northern Dominican Republic, and dates to the later part of the Late Ceramic Age – the studied assemblage to the 13th to 15th centuries AD specifically. It consists of 80 macro-lithics comprising

numerous local and regional rock types, and represents a largely exhausted edge-ground tool complex of axes and adzes. Some of the fragments derive from limited on-site production, evidence for repair is present, while manufacturing is in general relatively straightforward and the functionality geared towards woodworking. Playa Grande is located on the Atlantic coast of the northern Dominican Republic and dates from the Late Ceramic Age to the early colonial period, nearly all 160 studied specimens from AD 1200 onwards. The assemblage represents the local production of celts in blueschist and jadeite-bearing rocks to a low level of completion, and includes evidence that indicates relational engagements of a non-technical character within this process. Hafting and use practices are characterised by the presence of axes, adzes, and tools for detailed processing predominantly geared towards the working of wood, but also softer contact materials.

10.2.1 Greenstones and bluestones

What can be said about the valuation of the raw materials used in celt production, and the degree to which they circulated through the Antilles in the Ceramic Age? How do they relate to one another, is this hierarchical and do some substitute for others, or do unranked materialities exist side by side? Is it possible to reach a conclusion as to which hues, shades, or other aspects of appearance were desired above others on the basis of the archaeological evidence (cf. Andrieu *et al.* 2014)? Such questions are frequently posed for jadeitite but only rarely for other celt rock types, however extensively varied these were (Section 2.3). The social jade debate focuses on the circulation patterns of objects with pan-Caribbean iconographic parallels that are carved out of sourceable, semi-precious green stone materials. These patterns are temporally sensitive with spheres of distribution expanding and contracting alongside other social, cultural, and political changes defining the archaeological history of the archipelago. The present state of knowledge rests upon mineralogical identifications and archaeological contexts, and includes little other types of information that could contribute to a biographical profile. As such, and in line with the orientation on material properties, the present discussion will commence from the tenet that the right beginnings determine for a large part the appropriateness of consequent biographical trajectories.

Jadeitite is the benchmark of this discussion. It appears to have one of the most restricted occurrences, yet is seen as the most widely distributed and best contextualised material. Though one of the most difficult rocks to work, jadeitite is considered as amongst the most appropriate materials for celts and their functional application. Its commonly deep green hues, semi-translucency, and what is referred to as 'its ability to take a polish' are similarly touted as reasons that make the rock stand out amongst its many alternatives. The association of green with fertility in all its facets is particularly common amongst tropical lowland communities (Boomert 1987). Another property highlighted in work on jadeite symbolism amongst the Classic Maya is its ability to absorb solar heat. According to Taube (2005, 37), a polished surface left in the sun "is both burning to the touch and fully capable of producing vapour if moistened".[48] For all of such emphasis, however, most of these properties are not unique to jadeitite alone. Different combinations thereof are also seen on the other main rock

48 A brief experiment with dull lustred surfaces indicated that jadeitite rocks did not differ noticeably from other rock types. This experiment involved a jadeitite s.sr., jadeitite s.l., two jadeite omphacitites, two blueschists, three greenschists of varying shades (pale, average, dark), a (meta)basalt, and an unidentified pale green rock, and was conducted from 11:00 to 14:00 hours under a winter sun and cloudless sky in the Dominican Republic in January 2018. The only noticeable difference was that darker rocks and large ground surfaces grew hotter quicker; none evaporated water droplets.

types of the study, which behave largely comparable to jadetitite. These rocks are tough, compact, fine-grained, and of comparatively high density, and nearly all are good materials for the purposes of celt making and using in their own right. The overall suitability of some may even be greater. Economically, the superior flaking properties of massive greenschists (and St. Martin greenstones) may outweigh the somewhat higher hardness and toughness of jadeitite, as it permits the manufacture of much larger celts much more easily. An important question is why other highly suitable and comparable rock types, such as eclogite, amphibolite, serpentinite (outside of ECA Puerto Rico), and perhaps omphacitite (pending finer classification of jadeitic specimens), are not identified from the archaeological record. Any of these rock types is capable of 'taking a fine polish' with the right technique so this cannot be seen as a reason to separate jadeitite at face value. Due to its exceeding tenacity, jadeitite would actually rank amongst the more laborious to polish.

Colour variation is diverse within any of the rock types and overlaps between them, which makes it rather difficult to rank rocks on that property alone. Significantly, blue hues appears as desirable as greenness. The numerous blueschist facies fragments at Playa Grande and El Flaco, as well as the bright lustred surfaces of volcanic lavas that are found at all of the sites, together comprise a distinctive dark blue-grey spectrum. This spectrum may be as well represented as greenstones generically depending on the perception of colour of volcanic lavas, while the production of jadeitite celts in Playa Grande is matched in quantity by blueschist. However, the variation in greenness is greater, and selectiveness more clearly expressed in the current materials. A significant majority of the jadeitites at Playa Grande have a pale green hue when ground, with colour ranges resulting in mottles, slight yellow influences, and roughly half also displaying (dark) blue shades (Figure 64).

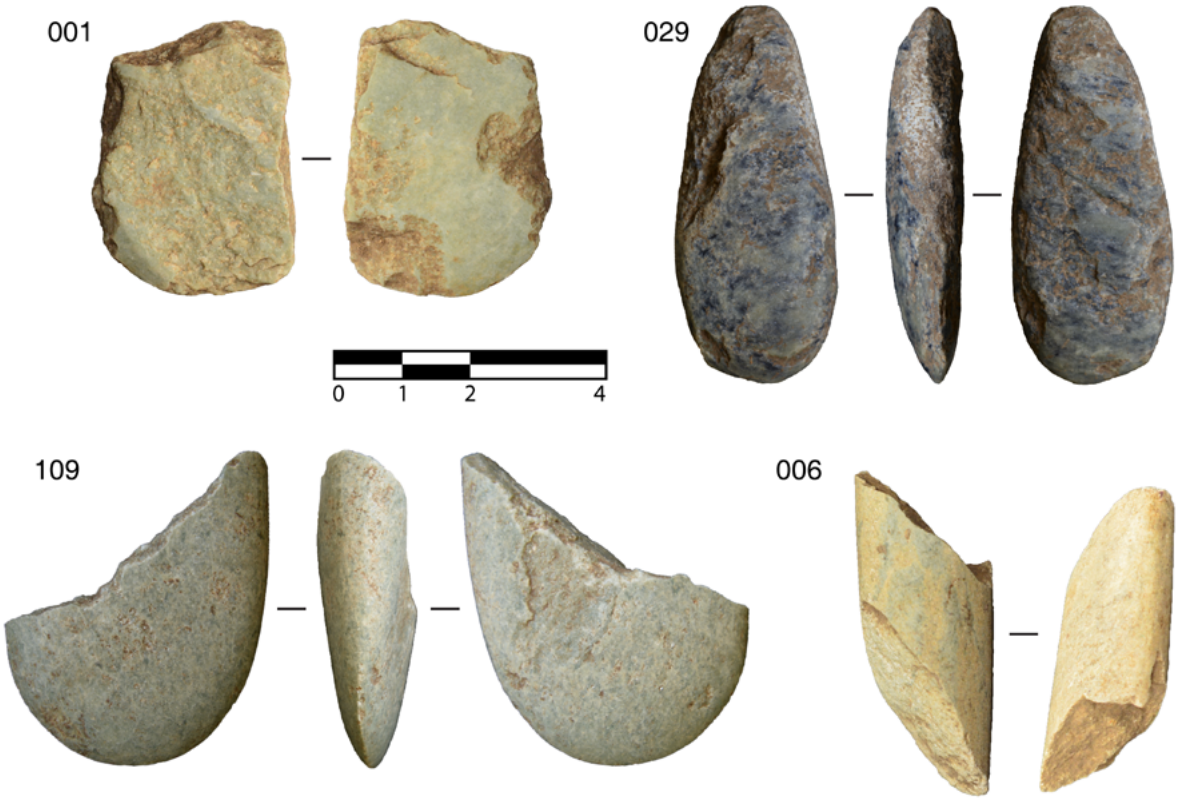

Figure 64: Colour range of jadeitite in Playa Grande. PG 001 is pale green with a a yellowish tinge. PG 006 is pale green to yellowish, with blue streaks. PG 029 is a high-pressure metamorphic rock bearing darker green minerals in a blue glaucophane matrix. PG 109 is light green with a slight mottle.

Cortices are on average very pale, and exposed matrices slightly darker with a sugary texture. Given that the site also yielded evidence for examination of the texture of ground surfaces during the phase of conception, it is conceivable that this reflects indigenous preferences for this specific appearance. Greenschists also come in several distinctive colour varieties, of which the medium green rock that sometimes bears garnets was found at all three sites and also at El Cabo and El Carril (Figure 16, 015, 016). It is contrasted by for instance the light green metatuff fragments from El Flaco (Figure 18, 253) and some of the much darker greenschists present at El Carril and El Cabo (cf. Figure 36, 2318). The absence or presence of schistosity in the rock seems to have mattered not so much during selection, as long as any pronounced foliation was oriented parallel to the faces.

When the findings are juxtaposed against the archipelagic distribution of archaeological jadeitite and other potential social jades (following García-Casco *et al.* 2013; Knippenberg 2012; Rodríguez Ramos 2010b; 2011a; Schertl *et al.* 2018; cf. Knippenberg 2006; Hofman *et al.* 2007; Rodríguez Ramos 2011b; 2013), several patterns emerge. Foremost is that the procurement selectivity of Playa Grande is not compatible with that community as the source of all circulating jadeites, a contrast which is more pronounced for materials pre-dating ca. AD 800/900. The site currently post-dates that period, while the variety of jadeitite colourations in circulation is much greater. This is clear for the assemblage from Pearls (Section 8.1), and also for other identified jadeitites in early contexts. Variants such as 2A, 2B, and 2H from Antigua (Harlow *et al.* 2006) and GR4-FIII.4 from St. Eustatius are not common at assemblages I have examined, and the darker GR24-J-IV.05 is visually discrepant (personal observation, Figures 3D and 3B respectively in García-Casco *et al.* 2013). Such darker specimens may well be more consistent with recorded darker green, omphacite-rich jadeitite varieties from the Sierra del Convento area in Cuba (García-Casco *et al.* 2009a; 2009b; cf. Rodríguez Ramos 2011a, 120). Still, numerous specimens from Pearls are not biographically congruent with that scenario either. One possibility is that those jadeitites date even earlier. In that case they would be linked into the networks of long-distance lapidary exchange that characterise the period until ca. AD 400, and disappeared together with the cessation of other green materials such as nephrite, malachite, aventurine, turquoise, to an extent serpentinite, as well as most translucent hues.

Only St. Martin mudstone persists as a (grey-)green coloured material until ca. AD 600/700 (Knippenberg 2006), and only in the northeastern Caribbean. Volcanic rocks and shell are the main raw materials for celt-making, while metamorphic rocks are identified only rarely. Green-coloured rocks become common in the Late Ceramic Age (AD 800/900-1500), at which point greenschist comes to circulates in great quantities and several colour shades. Production sites such as Amina are associated with Ostionoid ceramic assemblages (Ulloa Hung 2014) and provide production evidence of greenschist-like rocks ranging from grey-green and green to several shades of (very) dark green. Though high-pressure rock celts are manufactured in greater numbers, they do not travel as far as before. Possibly, demand from larger populations and the increasingly complex nature of the political game locked up the supply within the Greater Antilles. Their absence from the literature seems to reflect foremost the non-identification of materials in the field, as they appear regularly in sites across the Cibao Valley.[49]

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49 Surveys conducted on sites located in the provinces of Monte Cristi, Puerto Plata, and Valverde Mao located a fair amount of blueschist artefacts (E. Herrera Malatesta and A.C.S. Knaf, pers. comm. 2016; personal observation, 2018). At the site of El Carril, nearby and contemporaneous to El Flaco, sizeable quantities of blueschists and several omphacitites and jadeitites are present.

The primary question is how to rightfully position the community of Playa Grande within this largely unknown, but somewhat estimable picture. This can only be answered in full with attention to the complete biographies of the materials there, but some preliminary predictions can be made following trends in raw materials. The materials sourced and manufactured at the site include several varieties of jadeitites (mainly pale green s.sr. rocks, Schertl *et al.* 2018; or with blue mottling) and blueschists (predominantly dark blue glaucophanites, secondarily with white alterations or with mottling in varying greens). These types may match with a significant number of materials in circulation on purely visual terms, but they do not completely cover the observed varieties at a site like El Carril. Rocks consisting dominantly of omphacite are almost completely absent from the assemblage of Playa Grande while present at El Carril and El Flaco (2016 collection, including large-sized specimens), for instance. This decentralises the importance of Playa Grande as a key site and suggests that more attention needs to be given to the RSJC as a whole (cf. Knippenberg 2012), as well as to high-pressure rock production and exchange from eastern Cuba. For that matter, low-grade metamorphic materials were imported at Playa Grande, as opposed to local production or a total reliance upon mechanically superior high-pressure rock types. This shows obvious connections between the circulation dynamics of all of these raw materials. Moreover, it implies that the exchange current of low-grade rocks interlocked with other potential source areas for those materials, and/or that they were circulated over the same longer distance as rarer rocks were.

In this light it may be instructive to consider once more the case of the grey-green mudstone from the northeastern Caribbean. This rock crops out in St. Martin, but was in this time span exploited by a number of communities chiefly from the polity on neighbouring Anguilla who crossed the channel between the two islands to do so (Crock, 2000; Crock and Petersen, 2004; Knippenberg, 2006). The situation in the RSJC area may well have been similar, with a number of settlements involved in the exploitation and production of various high-pressure rocks at the same time as part of a larger combined (or mandated) effort to establish regional socio-political prominence. Considering that the distribution of RSJC high-pressure rock outcrops is heterogeneous, that may even account for the implied focus on certain sub-types and colour ranges of these materials. Such a scenario seems more in line with ideas on the political organisation in the LCA, than alternative analogues such as the Brownsberg network in AD 1000/1200-1500 Surinam. This model, which draws from Guyanese geography and ethnography, proposes that communities from the interior operated largely independently when funnelling manufactured (green)stone celts towards the coastal areas, following local river channels (Boomert and Kroonenberg 1977).

Clearly, the variety is such that considering only the greenstones in a discussion on edge-ground macro-lithics does a great disservice to the entirety of the edge-ground archaeological record. In the parallel case of ECA personal ornaments the quantities of amethyst, carnelian, and diorite have successfully expanded this view, and interestingly, in these material categories a shift to red, white, and salt-and-pepper occurs in the LCA as green disappears. Illustrative in this respect is the transformation that occurred in Mesoamerica from the Early to the Middle Formative period (at 900 BC uncal.). Here, Olmec axe-makers favoured at first a colour spectrum consisting of darker, 'cool' colours such as blue (jadeite varieties, metagabbro, igneous rocks), but shifted preferences towards lighter yellow-green coloured rocks (jadeite varieties, serpentinite) (Jaime-Riverón 2010). This may be associated to contemporaneous changes in agricultural practices, chiefly the movement away from aquatic sources towards a land-based economy of maize and tuber crops.

Colour shifts in the Caribbean involve different spectra, but are of comparable magnitude. Whilst lithic tools and ornaments share materials in the ECA, later developments in the Greater Antilles essentially establishes two distinct spheres of material ranges. Ornament raw materials consist primarily of softer, paler materials mixed with contrasting colours. Though calcites, bone, teeth, and old shell range from white to green-yellowish, much shell was probably used fresh so that bright pink and red varieties must be considered. This is in line with early ethnohistoric descriptions by Bernáldez of the complex colouration patterns in 'Taíno' chiefly adornments, that also include reddish alloys, green or white feathers, and 'green stones' of which the artefactual correlates are unclear (Oliver 2000, 205-209). Conversely, celt-making was restricted to harder, tougher rocks in grey-blue colours and certain greens. In the present work there is also a fair amount of salt-and-pepper like appearances from phaneritic rocks, distinct from the coarse, white diorites used as ornaments, with other rocks more notable for the appearance of reticulated veins (a.o. altered blueschists such as FL 2143), or layered banding (P 005).

Both colour schemes, as defining certain regimes of things, stand in direct opposition to the palettes used for the regimes of bodies. Early ethnohistoric accounts emphasise the colours of red, black, and yellow for body paint in the Greater Antilles and red, black, and white in the Lesser Antilles (a.o. Hulme and Whitehead 1992; Moreau 1990; Parry and Keith 1984). Du Tertre (in Petitjean Roget 2015a, 332) even notes that the indigenous inhabitants of the Lesser Antilles had words only to describe red, black, yellow, and white, and thus lacked the vocabulary to indicate the spectra of green and blue altogether (conversely, Breton comments that 'axes of green stone' were linguistically defined as *tacoua;* Petitjean Roget 1961). Since these observations pertain to Kalinago living in the mid-17th century I dare not guess whether this is not an outflow from their cariban pidgin in a historical context, in which edge-ground lithic tools had not featured for generations. However, it is a decidedly curious matter that celt materials stood in colourful contrast to the even more colourful decorated bodies in contact times.

10.2.2 Indigenous methods and techniques

Indigenous craftsmen were well capable of working with tenacious rocks. They employed a variety of technical choices and gestures to achieve intended outcomes, following the affordances of the raw materials. These approaches reflect requisite technical know-how for each distinct raw material employed, resulting in converging operational sequences. For instance, the overall reduction schema of jadeitite is not differentiable from that of greenschist and basalt (detailed in Section 8.2). Biographical differentiation does seem to exist for early reduction phases elsewhere, since greenschist materials at Amina in fact indicate the working of larger blocks using more complex flake reduction strategies (personal observation).

Rostain *et al.* (2005) observed a reduction dichotomy at diabase quarry of Coashiati, Aruba between roughouts below 20cm, which were predominantly flaked using direct percussion, and roughouts above that size, for which bipolar reduction becomes prevalent. Most present materials do not meet the indicated size range, but there does seem to be an inclination towards more use of the bipolar technique for the bifacial shaping of larger specimens. No doubt, the use of anvils needs to be ascribed at least partially towards the sheer tenacity of the rocks worked. The types of hammerstones varied; metamorphic hammerstones were clearly present at El Flaco, but I did not personally observe these in the assemblage from Playa Grande. That macro-lithic assemblage includes several hand-

sized 'cores' of quartz with battered ridges. These are likely candidates for the working of jadeitite, though probably for pecking: the mineral exceeds jadeite in hardness, and its brittle nature ensures the continuous renewal of sharp edges. Rejected jadeitite roughouts were apparently not re-used as hammerstones despite being one of the few materials eminently suitable to do so (cf. Alpine jadeite production, Pétrequin *et al.* 2008).

Other proxies for extrapolating the different hard- and soft hammerstones that may have been in employ for percussion are lacking. It seems clear that different hammerstone types, materials, and intensities were used to produce the range of pecking traces observed, but we can currently only guess about their nature. Selection on these criteria is known to induce different rates of attrition (Dickson 1981, in Olausson 1982/1983; Pétrequin *et al.* 2012a), of which some would irrevocably have been more suitable for volume reduction and creating roughness, others for preparing surfaces to be ground.

Importantly, the flexible manner by which reduction strategies were revised or improvised as needed implies that the technical achievement of manufacture formed the primary concern. That is, there is no evidence for any enforced rigour over a specific, 'culturally proper' (i.e. standard) sequence beyond the restrictions of a reductive craft at Playa Grande. There are no indications for top-down control of production, whether as political institution or through a master directing an atelier, nor for any ritual sequence of motions and gestures needed to obtain a subjective understanding of the blank. This latter possibility may have been the case only in the prior procurement of high-pressure rock materials, since these show evidence of assessments of what were judged to be the right qualities (Section 7.3.1).

Grinding was commonly done using one of several basic techniques, resulting in a uniform, dull to weakly expressed lustre. From a technological standpoint, the spectrum of specific sandstone varieties to sand-based abrasives obviously comprises (numerous) different techniques, but the wear trace patterns cannot be well distinguished and the resulting surface aesthetics overlap greatly. Both options are conventionally referred to as the primary technique/choice for grinding celts (Section 5.1). The data evidence that such techniques were indeed commonly chosen (even if the exact platforms remain to be archaeologically identified), and apparently seen as efficient, capable, and appropriate methods to attain the 'right kind' of topographically level surfaces.

The actual procedure of celt-making is not captured by the simplified model of flaking → pecking → grinding, however, but entailed a much more extensive meshing of attrition techniques. There is a high incidence of ground surfaces that remain characterised by evenly and regularly spaced small pits, explainable only as representing the deepest cavities from prior pecking.[50] The amount of material removed from the faces abrasively is below a millimetre in penetration, indicating that final grinding events did not last for an extended amount of time (cf. data in Olausson 1982/1983). Many of the archaeological wear trace patterns do not exceed the experimental settings of 90 minutes in intensity. Re-pecking increases the roughness of already smoothened surfaces, and therefore continuously re-creates the conditions for maximal removal of surface matter through grinding (Pétrequin et al. 2012a). Not only does this greatly lessens the time investment in monotonous abrasion (opposing exaggerations of days to weeks), it maintains a heightened level of interaction between the craftsmen and the material. Knowing when to cease grinding and prepare the surface again in such a way that

50 The main alternative hypothesis is that they represent spaces from mineral ejections, such as garnets for certain greenschists, but this does usually not match up with fabric sizes and patterning as seen in breaks.

previous efforts are reinforced, and how these choices interact with the structural properties of the individual rock, are hallmarks of indigenous skill and expertise. Conversely, the model that water-worn pebbles were directly ground down on their cortex as a means of saving effort is simply not representative of the majority of materials.

In and of itself, grinding is a functional requisite only for the bevel. The continued application of any abrasive technique is therefore at least in certain ways linked to considerations of a different nature, beginning at the level of general aesthetics. It acts to open up colourations, texture, and vein patterns specific to the internal physicality of the rock. All of these ultimately reflect interactions of a certain kind between the nature of the artefact and human interlocution. The aesthetic argument generally emphasises an individuality derived from visual characteristics in the study of celt-heads made in striking rock varieties (e.g. Cooney 2002; Tsoraki 2011). Considering the ontological baseplan of any artefact as that of a relational entity (Chapter 3), however, the material exposure of such affects appears as a type of interrogation of the receptivity to subjectification. It associates with the specific benevolences (autonomous or passive) of soul stuffs or beings dressed in lithic forms. Practically speaking, this inter-subjective potential is realised through relational enmeshments when operating within the social context of human communities. It is usually connected to the persons most involved in the interactions, which are technological in the broad sense in that they may also involve the temporary observation of social restrictions, or be subjected to ritual procedures such as social seclusion, song, or smoke-blowing. Such procedures are as intrinsic to the process of manufacture as the gestures of grinding are, which thus also achieve relational results (i.e. an understanding of the nature of the rock-to-be-fashioned, and the transmission of skill, creativity, moral qualities, cosmic energies, and the like).

Thus, I regard it as plausible that the act of transforming an unfinished preform into a functional celt head entailed the most important event in the biography of a thing. It is a transformation that fundamentally altered its relational potential and capabilities, moving from a hammered rock towards a tool in need of a haft and applied purpose. From a naturalist point of view, the sense of satisfaction from the completion of a project alone instils values from personal connections. Within an indigenous context this process must have transformed the person completing the celt equally, and quite literally (Section 3.2.2). The process of making establishes a shared connection between maker and thing, and any according investments of (technical) skills, (moral) qualities, and (social) vitalities, ultimately render this an act of intersubjective co-construction (Santos-Granero 2012). This has implications for the way in which exchange and interaction processes can be modelled through such material cultural expressions, since things simply cannot circulate free of social obligation (Godelier, 1999; Weiner, 1992). Regardless of whichever specific relation or nature such bonds consisted of within indigenous Caribbean ontologies, they typically need to be broken – desubjectified and objectified – in order to prevent attacks or harmful aftereffects for the previous owner (Turner, 2009b). It is common for Amerindian groups nowadays making art(efacts) for trade with Westerners to do this in such a way that they are considered as objects (a.k.a. non-subjects), both inert and harmless (Barcelos Neto 2009). Within the regime of relational things this is clearly an exception, but the (partial) objectification of (potentially) subjective celts must have been commonplace in indigenous contexts, given how it resulted in the present archaeological record.

The most unassuming and perhaps best fitting mode of being for regular axes and adzes is that of being ensouled. This is a very wide classification that pertains to the majority of Amerindian

artefact types, including most tools (Santos-Granero 2009b). They are evidently brought into being by workmanship and will invariably bear some type of connection with owners (current or past), evidencing their potential sociability (Section 3.2.2). That said, even in the mode of ensoulment there are clear differences in how high a degree of subjectivity could have been realised. Viewed as an index of aesthetic appearances a hierarchy is visible already at the (current) stage of reduction and grinding. Ultimately, specific celts were produced with an exceeding variance in their workmanship, yet remain basic in their lustre. The section on brighter surfaces and polishing techniques will delve deeper into the actual ramifications of these ideas (Section 10.2.3).

While it is always possible that more powerful modes of being applied to regular tool celts, there is no compelling evidence from ethnohistory or reconstructed biographies that underpins such claims. The situation may be different for idiosyncratic forms such as monolithic and engraved axes, but the potential for such modes of being is heavily informed by mythological narratives. For instance, the polished axeheads of indigenous societies in New Guinea were considered as living pieces of primordial beings, or already complete physicalities still encased in earth bones (Pétrequin and Pétrequin 2011), both scenarios analogous to the mode of cosmologically transformed objects.[51] That high-pressure rock types were assessed on their potential interiority during procurement might point towards such ontological hierarchies, but more lines of evidence are needed. These ultimately defer to discussions on *zemiism*, constrained to very limited source materials of uncertain correlation with artefactual forms.

The point of objectification is important, since it points towards the need to re-subjectify a received object to again render it socially operable.[52] This can be perceived in the biographical trajectory if it – like most other interactions up until that point – consisted of technological alteration. The most probable biographical point for this is the recontextualisation event of (or leading to) the early stage of abrasion, as this would explain several observed discrepancies (Section 8.2). A large number of high-pressure rocks at Playa Grande are not or only minutely abraded, while all specimens with use-wear are partially to strongly ground and exhausted. So are its non-HP rock celts. The lack of usable/little used, but well-ground specimens strongly indicates that they were primarily exchanged as preforms with edges, not as fully abraded and aesthetically pleasing specimens. This dichotomy between local production and import has been observed elsewhere (Rostain *et al.* 2005) and seems to be the case quite generally in the Late Ceramic Age, especially for jadeitite and other high-pressure rock celts. Most celts are wholly abraded (and often polished) when found in contexts other than their sites of production. The one intact preform at El Flaco may also have arrived as roughout, since there are little other indications of such on-site working, but never ground as its mass has arguably been thinned too far. However, the relative variety of dull grinding signatures at that site is higher than would be expected if all were abraded on-site, so it is not a conclusive explanation. Perhaps these refer to differential treatments for specific raw materials (separating high-pressure rock types from overprinted/metavolcanic materials), or to the use of a different method for establishing

51 This is also the main reason that these artefacts survived in their social functions in New Guinea until recent times, in spite of losing the functional competition to metal tools decades earlier.

52 Discounting the unlikely scenario in which every exotic artefact represents an instance of human mobility taking along mostly inalienable personal belongings. This type of artefact mobility was probably not uncommon, but the ethnohistoric records clearly describe other types of artefact mobility as well. Objectification and re-subjectification protocols could also facilitate the exchange of technologically completed celts (and other objects) quite conceivably, but corresponding strategies may not be as evident biographically.

relationality (hafting being a prime contender). More fluid object mobility patterns, less selectiveness in the community towards abrasive platforms, and the existence of substantial differences in object ontologies can also not be excluded.

10.2.3 Subjective lustres, lustrous subjectivities

Polishing, as a technological choice, must have amplified extant subjective potencies and relational significance. Previous works have emphasised how shininess and aesthetics mattered during particular regions and periods (e.g. Berman 2011; Oliver 2000; Rodríguez Ramos 2010b; 2011b), but they primarily reference exotic raw materials and morphotypes (including nacre and metals as materials with natural lustre). Technological applications have the capacity to extend these deliberations to (nearly) any type of material culture. The utilised techniques are for the most parts clear: specific lithic platforms (~sub-metallic to metallic lustre), bright mineral mirror polish (~metallic to vitreous lustre), wood friction (~dense greasy lustre), and contact with varying soft materials (~mild greasy lustre). I will not discuss polishing with soft materials independently, since it occurred only at Pearls and not in clear connection with other biographical data.

The use of hard stationary lithic platforms is by far the most common technique. Its potential extends to all materials and biographical trajectories, was applied to both preformed and pre-ground surfaces, and forms the only (set of) technique(s) practiced to polish lithic materials at Playa Grande (Section 8.2). The associated microwear patterns are heterogeneous, however. Some closely match the experiments conducted with water on quartz arenite and the cohesive fine-grained sandstone, whereas the variation of others must be ascribed to lithological differences (notably immature sandstones and igneous *polissoirs*). Such deviancy reflects technological distinctiveness, in some cases by choice and others by availability, and this must have been partially recognisable by gradations in the macroscopic lustre. However, those aesthetics may be equally manipulated and enhanced through personal skill and the effects of duration, seen in the high degree of microwear development on specific polished specimens from all three sites. Similarly, some of the inter-site variety in polishing on lithic platforms must be attributable to the particular responses of celt blanks, which do not always develop wear in the same manner. For that reason the hypothesis that much polishing actually took place 'after exchange' in the local community remains a fitting model. Not all artefacts excavated as one assemblage represent stationary itineraries; there may still be significant 'undetected' flow as part of longer use lives or as possessions following their owners across the landscape. It also remains to be seen if communities would set their technological preferences in stone based upon only local availability and optimal mechanical characteristics.

The bright mineral mirror polish is both macroscopically and microscopically distinctive. Surface microtopographies display low internal relief and asperities appearing as medium to large plateaus, frequently interlinking. These carry an extremely flat and bright polish, which is sharply bounded from the interstitial space (or internal pits) and absolutely non-invasive. Lower-lying asperities remain unaffected (Figure 65; cf. Table 2, *Flat*) The dense covering distribution of such wear clearly points towards evenly paced abrasion on a hard platform itself of very low relief, inhibiting alteration of (abrasive wear located on) areas lower than the highest asperite plateaus. Groups of faint, parallel striations are occasionally present, indicating the presence of very fine-grained intermediate particles in such cases.

Such bright, flat, non-invasive polish spots are typical of mineral contact, three examples being

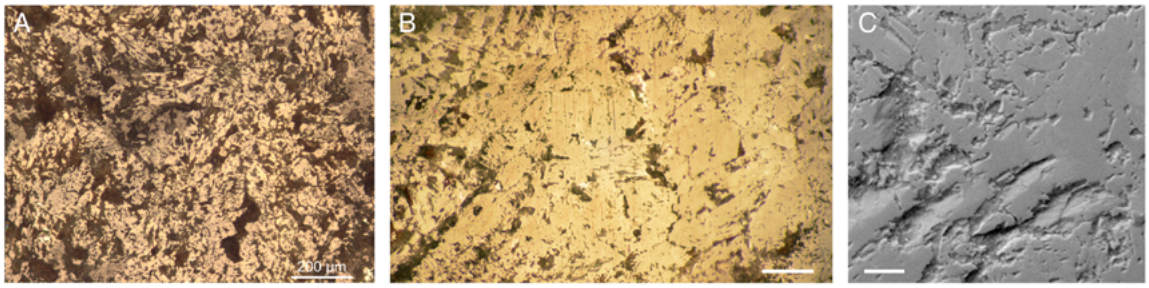

Figure 65: Various examples of bright mineral mirror polish on archaeological specimens. A) interlinking small plateaus on C 1880. B) large plateau with striations on CA 554. Original magnification 100x, white bar approximately 200µm. SEM raw data image (north light) of C 82-1. Original magnification 2450x, white bar approximately 20 µm.

bright spots from hafting (as incidental spots or streaks; Rots 2010), pebbles used for burnishing wet clay (heavily striated), and strike-a-light traces from certain minerals (locationally restricted, usually striated; Sorensen *et al.* 2018). One possibility is an abrasive consisting of a fine clay, perhaps rich in iron oxides, but this needs to be experimentally investigated. The Héta polished used white clay (kaolin?) in a mixture with sand and water, mixed in a leaf container (Kozák 1972; 1979, 400), and Rostain (1994, 345-346) suggests the use of loam in *polissoirs* also. The Maori used flat mudstone as basins to obtain high lustres (Beck and Mason 2002, 108; and cf. Groman-Yaroslavski and Bar-Yosef Mayer 2015). Abrasives such as emery and carborundum that exceed 7 on Moh's scale is suggested in Neolithic contexts elsewhere (Sections 4.4.3 and 5.1.2.3), but there is no evidence that these were ever procured or used in the Antilles. Flint polishing pebbles, which may produce comparable traces (Melgar Tísoc and Andrieu 2016) are similarly lacking from the Caribbean archaeological record.

The technical execution of a 'bright mineral mirror polish' was common at Pearls, and present at Playa Grande on the bevel of one otherwise unground specimen from a strata predating AD 1200. I also observed this technique on materials at the LCA sites of El Carril and El Cabo (Breukel 2015). Significantly, these observations pertain to celts made of (jadeite- and omphacite-bearing) high-pressure rock types, which together with the data from Pearls indicates that this technique is applied primarily towards such materials, and only uncommonly towards other green rocks. This also suggests that high-pressure materials have at least a certain likelihood of being treated with this particular technique, once having left the production site. In other words, there is an obvious biographical connection between starting as jadeite- to omphacite-bearing rocks and (eventually) obtaining a highly lustrous surface. The complete absence of the technique at post-AD 1200 Playa Grande strongly suggests that this type of modification was applied late in the biography, following circulation to different places, contexts, and presumably recipients.

A similar trajectory is proposed for 'glassy' Alpine jadeitite celts found between northwestern France and the British Isles. These are interpreted as having been polished in stages between episodes of circulation until crossing the English channel (Pétrequin and Pétrequin 2016; Pétrequin *et al.* 2013; Sheridan 2011), but not by the original manufacturers or final recipients. Clear analogues to the cultural correlation between high-pressure rocks and polishing techniques endowing metallic to vitreous lustres include the *polies à glace* described on 'overpolished' celts in Neolithic Europe (e.g. Brea *et al.* 2012; Pétrequin *et al.* 2012c), ethnographic Papua New Guinea (Boleti *et al.* 2015; Pétrequin and Pétrequin 1993, 376-380; 2012), so-called burnishing traces on celts and other objects from Mesoamerica (e.g. Foshag 1957; Melgar Tísoc and Andrieu 2016; Melgar Tísoc *et al.* 2013; Solís

Ciriaco *et al.* 2016), and probably many other places as well. The techniques in question have not been convincingly identified, though flint pebbles and powdered obsidian or jadeite are candidates in Mesoamerica.

Polishing through friction against wood makes an appearance at both Pearls and El Flaco. The macroscopic lustre is greasy but deeply (darkening) and brightly (reflecting) so, creating an attractive and easily discernable uninterrupted gloss. Notably, the distribution of wear includes zones out of association with use edges or hafting areas. At El Flaco there are indications a very fine-grained abrasive may have been involved whereas at Pearls this was not evident. Irrespective of that, polishing by wood cannot be applied in isolation from prior grinding. Its application is not commonly recorded, contrary to the ethnographic wealth that exists for softer plant and animal materials. Even so, Sahagún observed that wood polishing formed part of the operational sequence for jadeite working in Mesoamerica (Foshag 1957, 45), and Beck and Mason (2002, 108) suggest the use of hardwood burnishers by the Maori to polish nephrite. It was also used (with abrasives) as a finishing technique in carnelian bead production in India until recently (d'Errico *et al.* 2000). The possibility of polishing with wood has been considered in the methodological literature (Groman-Yaroslavski and Bar-Yosef Mayer 2015; Procopiou *et al.* 2013), but to my knowledge not been archaeologically established before.

As a tool for inducing biographical transformations, it is significant that some petaloids (FL 945, 2279-03) are reworked from edge-ground celt to pounding implement. This not only indicates that polishing by wood occurred late in their biographies and was carried out by a member of the local community, but also that its performance was tied up in the re-negotiation of the physicality of these artefacts. It is synchronously a technology of curation, since it reflects a more complete transformation of the artefact than simple reworking. These circumstances suggest that the intersubjective and social values associated with those individual artefacts were perennial and entwined with the contextual extent of their biographical trajectories. That they were previously quite regular objects, i.e. made from overprinted volcanic materials and originally broke during use, testifies that such biographical potential resided in *every* material subject and not merely those made in (social) jade. Conversely, another petaloid (P 009) is characterised by a multitude of biographical alterities (tear features, off-colouration, bilateral scars, lack of use and hafting) that set it apart from other Caribbean celts altogether. Since polishing with wood can in practice be performed anywhere and at any time, its rarity and association with biographically deviant celts strongly suggest that social or cultural restrictions existed on its application. Specific tree species or categories may have been used in the negotiation of their own relational capacities, in association with specific properties (e.g. sensual, aromatic, medicinal) and preparatory treatments. There are precedents in Amazonia for such association of specific woods with particular purposes both in historical ecology (Balée 1994) and archaeology (Robinson *et al.* 2017).

The archaeological materials display significant gradations in lustre, which altogether go far beyond the categorisations of dull, intermediate, and bright. As it stands, these lustres have different and often distinct textures which are distinguishable by the naked senses, visually and also palpably. Perhaps the tangy smells from abrading bore significance as well, as the *tureygua* odour did for coppery metals (Oliver 2000). Well developed lustres can even be used to predict the presence of use wear and the extent of hafting friction (cf. Rostain 1986/1990, 202), and these biographical details must also have been appreciable in the past. The ability to distinguish such signatures reflects a certain sensorial acuity, however, that one would need to master: tactile dexterity signalled expert craftsmanship in

India and intelligence in ancient Greece (Procopiou *et al.* 2011; 2013).[53] The ability to manufacture lustrous surfaces perhaps entailed similar connotations in a Caribbean context, but connected more specifically to subjectification and the manipulation of sociocosmic energies apparently involved in the creation of resplendent brilliance.

The totality of aesthetic appearance constitutes a defining element of the physicality of relational entities, as the bodily exterior. The creation of beauty is generally emphasised as constitutive of the Amerindian body (and therefore the human condition, e.g. Lagrou 2009; Overing 1989), but it is equally applicable to manufacturing artefacts, and ultimately as constituting society more generally. Making is applying technological skill and ritual/relational know-how to capture and express a beauty, that is often already somehow inherent. It becomes integral to the constituted subjective capacity of both the maker and the made. While colour may encode this potential as something inherent, smell, form, and especially lustre can be bestowed upon rocks or drawn out by subjective manipulation through technological means. Comprising the physicality of the stone, these qualities may be seen as analogous to the skin paint, dress, and adornments of people (Bilhaut 2006). According to Saunders (2003, 21), "making shiny objects was an act of transformative creation, trapping and converting—in a sense recycling—the fertilizing energy of light into brilliant solid forms via technological choices whose efficacy stemmed from a synergy of myth, ritual knowledge, and individual technical skill" (cf. Saunders 1999, 246; 2004). Amerindian cultures place a strong emphasis on the visual, for instance on the perception of normally invisible spirits through their luminous intensities. Exuberant shininess and translucency often characterises associated objects – such as shining mirrors, in Yanomamï thought, on which the spirits descend dancing – which thus illuminate and multiply the spiritual affects that exist in the distance between entities (Viveiros de Castro 2007). As such, the growing chromatic character of a surface does not only refract cosmological essences and supernatural energies, but its gloss constitutes a concretisation of it and becomes so through technological and relational manipulations.

The indigenous attraction to copper-alloyed metals is evident in Caribbean ethnohistory, by virtue of the combined smell, colour, and resplendence of these materials. The corresponding word, *guanín*, encodes allusions to concepts of brilliance and likeness to sky, stars, and heavens (Oliver 2000, 209). No such information survives for lithic materials, whether (social) jade or bluestones, but extrapolating the ontological structures is a straightforward exercise. The transformations from rough to dull to shiny establish the polished object as a complete(d) subjective being, its physicality replete with allegories to the domains of mythological origins and celestial qualities. Properties such as lustre form the multi-layered 'bundles of affects and capacities' of Caribbean artefacts (*sensu Viveiros de Castro, 1998).* Different gradations in the index of aesthetic appearances may have connoted different iridescent allegories, associated with the applied procedure of technological and ritualised/relational know-how. Depending on the social context or biographical history, surface aesthetics would likely code for different sets of ascribable valuations, potentially extending to the persons owning and using them.

Would polished celts have remained electable for exchange upon moving into the luminous

53 While archaeologists are generally aware, the variation in vocabulary used to communicate such differentiations is generally subjective and not easily comparable. Besides my own terms inspired by gemological lustres, often-seen examples are glassy, mirror polishes, burnishes, and so forth. With the exception of *polissage 2 to 6 in Neolithic Europe* (Pétrequin *et al.* 2012b), those only highlight remarkably resplendent surfaces.

domain? This cannot be ruled out entirely, as it would go some way towards explaining the diversity in hard platform technical choices. It is likely that such specimens moved into different spheres of exchange, for instance towards the vested political competitions over highly desirable shiny possessions (e.g. Helms 1987; Oliver 2000; 2009). Leaving aside whether the interpretation of lustres would remain constant between various space-time contexts, the growing importance of highly polished surfaces – the 'burnishing', that Rodríguez Ramos (2011a) argues appears from ca. AD 1000 onwards – might have encouraged political competition over the demand and supply of such celts analogous to the dynamics of later Neolithic Alpine networks (Thirault 2004; 2005).

The degree of shared bright lustres actually appears higher amongst Early Ceramic Age materials I have examined (including the jadeitites of Golden Rock 1). This phenomenon first consolidates with strata containing early Saladoid pottery, contrasting Huecoid material culture (Rodríguez Ramos 2001). It may be the case that technological notions of relational resplendence arrived in the archipelago as part of the Saladoid 'veneer'. If so, then appreciation for it probably developed via the ECA lapidary complexes in which naturally refractive materials were combined with lustre-inducing treatments of earthy lustred rocks.

Throughout the Ceramic Age, abrasion and polishing technologies remain cultural expectations in the domain of ornaments, celts, and specific object types from within the ceremonial inventories. The application thereof is highly variable, however, and seems to depend more upon the local contingencies of individual sites and ultimately of the persons engaging with the materials, than it does upon more communal norms. One contrast that arises from the present materials is that 'soft lustres' appear of relatively minor significance, while the less diffuse and more mirror-like lustres obtained through polishing with harder materials were apparently favoured. It seems ill-advised to scatter the potential intimacy of such deeply embedded relational intersubjectivity across all-encompassing time-space semantics without a better understanding of the archaeological record. That said, one biographical eventuality that was certainly not influenced to any degree by polishing is evidently the functional potential of celts.

10.2.4 Reconstructing stone axe use lives

The overall image of the life phase is that nearly every single finished edge bears traces of wear, irrespective of context. The majority corresponds to woodworking. These traces have been repeatedly described as constituting a spectrum of trace patterns that impress contact against woody substance of diverging characteristics. Nearly all functioned in combination with a leverage system (the haft), and these patterns pertain to specimens of all types, sizes, and morphologies. The combined interpretation of use wear, hafting strategies, and tool design indicates that a multitude of different activities was carried out at each site. Indeed, this includes forms such as large-sized intact petaloids or small 'micro-axes' which the wider literature not uncommonly regards as ceremonial in nature. To be used is the cultural expectation beyond doubt. Otherwise, there are no specific biographical trajectories associated with either particular hafting systems, or specific uses. Indigenous Caribbean edge-ground tool complexes practically contain a number of tool types which are superficially similar in nature (edge-ground celts), but specifically geared in design and material towards a variety of conceivable tasks and purposes. Some might have been specialist in nature, others probably not so much. The resulting toolkit provides a glimpse into the complex and prolific indigenous workmanship that existed during pre-colonial periods.

I previously distinguished five major activity groups involving the felling and working of wood on the basis of published archaeobotanical and ethnohistorical data (Section 5.2, Appendix 2.3). Activities in craft and domestic spheres prioritise selective tree species based upon qualities of a mechanical (wood properties), ecological, or relational nature. Conversely, land clearance and management of woody resources may average towards indistinguishability, but be differentiable on tool design and relative proportions within an assemblage. Both canoe-building and house construction are constrained to woods of specific densities. Most trees utilised in the construction of canoes are characterised by soft to very soft woods (combined specific density range of 0.25-0.45 g/cm^3) for buoyancy, and ideally resistance to maritime weathering. Ethnohistoric sources indicate that Spanish cedar and ceyba were specifically sought out. The majority of work would be carried out using adzes and wood carving tools, and potentially on charred material. Woods identified as construction timber are diverse, strongly indicating the utilisation of local environments, but always selected for suitability. Straight-growing woods with strong heartwoods, resistant to weathering, underground decay, or insect attacks and possessing good load-bearing properties will be preferred. Specific densities range between 0.7-0.9 g/cm^3, 0.8-1.0 g/cm^3, and 1.1-1.2 g/cm^3 (*Guaiacum* spp.), presumably felled and shaped using primarily large to medium-sized axes.[54]

The clearing of land and pathways for horticulture or habitation space entails felling a diverse forest community. The selection of woods will not be entirely arbitrary, since it may be predisposed towards green (standing) trees leaving aside the largest trunks of tougher wood. This is unlikely to affect wear trace patterns much, however, as they will be arbitrarily average. Burned wood may be worked in some cases, if fire is used in the swidden. Otherwise, larger, heavy-duty chopping tools are expected to be the instruments of choice. Axes are kinematically superior to adzes for treefelling; though the latter are ethnographically documented (e.g. Burton 1984; Crosby 1977; Pétrequin and Pétrequin 1993), this partially reflects cultural customs regarding hafting arrangements. Fuelwood gathering may target both dried out woods as well as quality firewood, high calorific values being correlated with denser woods. Other silvicultural practices that potentially involve edge-ground tools include management techniques such as firewood coppicing, pruning lianas and shade plants, or particular harvesting activities (gums and resins, bark, honey, etc.).[55] The woods involved will be arbitrary, or in significant overlap with woods used for other purposes. By way of example, guayacan (*Guaiacum* spp.) is the most commonly identified firewood (Newsom and Wing 2004). My estimation is that such activities were preferentially carried out with smaller tool compositions than those geared towards the felling of trunks, since more precision is involved (cf. Las Casas 1566, 194). Medium to small-sized compositions and special-purpose designs (chisels and wedges) are also the principal categories employed for the carving of portable objects. Identified wood species diverge in characteristics otherwise. Not counting the common *Guaiacum* spp., normalised specific densities

54 Published shaping traces on the bottom end of posts at Los Buchillones (Valcárcel Rojas *et al.* 2006, Fig. 9) closely resemble traces of posts cut to size during the experiments at Argyle, albeit with larger facets (Figure 10, e). Others less so, however (Righter 2002, 317), which merits investigation if the use of tools with different designs and use modes can be distinguished from felling axes.

55 Honey collection amongst the Héta involved opened beehives using the sharpened bottom end of the haft, rather than the stone blade (Kozák *et al.* 1979). However, trees may needed to be cut down in other contexts, or hollow trunks opened with an axe. The tribe of honey bees (apis) originates in the Old World, but the related stingless bees (meliponini) are native to the Neotropics and several of its species also produce honey. The prolific *Melipona beecheii* currently occurs in Cuba and Jamaica, though it is not clear whether this represents its native range or an introduction, by either indigenous peoples or in the colonial period by Europeans (Genaro 2008). Bark gathering is noted as an activity involving stone axe blades by Kästner (2007) for the Zoé.

range between 0.5 and 1.0 g/cm^3 and are therefore not very discriminant.

These distinctions and predictions permit a number of relatively intact artefacts from the three analysed sites to be associated with particular activity groups. The clearest associations are for working with construction elements. One very large square axe (P 021) was almost certainly employed for felling large hardwood trees. Axes such as 179-01, 1002, and 1913 from El Flaco fit well the requirements of working with medium-sized circumferences, and if not used in felling then at least for shaping architectural joints or other elements on hard to very hard wooden poles. The use wear from medium to hard wood on a large rehafted adze from Pearls (P 022) is perhaps associated with construction as well, though making smaller watercraft of harder woods (mahogany) or later use as an axe in land clearance are equal possibilities. Celts used for shaping portable objects also stand out. This appears to be the last purpose for specimens such as FL 1244, a small (ca. 5-7 cm) adze, and the smaller, slender petaloid axe PG 057. Their size alone suggests they were inserted in small handles for single handed usage, and therefore for tasks requiring precision over force. Hafting wear patterns reflect this degree of insertion, and both celts display traces of woodworking in the experimental range (specific densities of roughly 0.6 to 0.8 g/cm^3). Similarly, two smaller almonoid specimens (adze P 007 and axe PG 124) display wood-like traces from pliable to softer contact materials that may indicate more precise woodworking and carving activities of portable objects from softer wood. A smaller wide-edged axe (P 002) displays wear of the variety exceeding the experimental woodworking range. It may have been used to chop out rougher outlines for objects in exceptionally hard woods, but would also function well for maintaining smaller coppices.

The other activity groups are less clearly present. Regarding the construction of large canoes, traces indicating the working of pliable-softer materials (some of which woody) were statistically more present at edges on coastal Playa Grande, though also at inland El Flaco. However, while medium-sized (ca. 8-12cm) and some larger adzes occur at all sites, fragmentation is ubiquitous: not a single juxtaposed hafted specimen of Playa Grande retained its use area. None of these tools could be assigned to hewing dugout watercraft specifically. In the sample of Pearls such traces are absent altogether. One medium-sized adze (P 013) displayed rougher and striated polish that may have developed from working charred wood, however. A few remaining specimens interpreted as adzes do show traces of incipient development (FL 2151) or the 0.6 to 0.8 g/cm^3 specific density range. These may have been employed to make smaller canoes from denser woods such as the harder, stronger, and exceptionally stable mahogany (see Appendix 2), but could also have been applied to any other task. Morphologically, they are similarly suitable for object shaping or silvicultural activities. Adzes and axes of medium to small size are quite common in all three assemblages, even if most lack their used areas. None appear exclusive to a type of use such as described, but silvicultural management entails a wide-ranging set of activities that most likely involved general, all-purpose tool designs that were at hand anyway. Fuelwood remains a specific focus since El Flaco and Playa Grande yielded evidence for significant use of fires, and Pearls produced pottery on a massive scale (Chapter 6). Still, it is not known how much of this required active gathering, as opposed to deadwood gathering or using leftover wood from land clearance more generally.

Typical land-clearance tools include P 018, a relatively large axe that displays traces of typical woodworking, and the large rehafted tool P 022. There were numerous examples in all three sites of large-sized axes suitable to clearance, but most were severely fragmented. The few that were not display more specific trace patterns that rather point to other activities. The lack of complete tools

in this respect may simply mean that upon breakage these were abandoned in the field. Traces of underbrush clearance, distinct in that they partially evoke types of wear associated with soil working as a result of cutting stems close to the ground, were not seen. This suggests that at least in the two LCA communities of the northern Dominican Republic, any potential land clearance probably did employ fire-setting to clear out smaller bush growth. Activities such as agricultural tilling and landscape construction were, if practiced, carried out using other tools.

A few specimens have intelligible biographies but are not readily associable with the activity domains. Both wedges from Pearls (010, 019) display wear traces characteristics of the 0.6 to 0.8 g/cm^3 specific density range (wedge-like tools from the other sites lacked bevels). Since this range consist of woods of higher specific densities than woods suggested as suitable for canoe sideboards (see Appendix 2), whichever purpose the timber and planks they split served remains up to debate. Second, the combination of use wear and hafting patterns have demonstrated 'micro-chisel' P 001 to have been a functional implement, suitable for the detailed carving of patterns and forms in hard material objects. Most other small elongate artefacts also display traces of a biographical life, but were indeterminate on hafting and use as a result of fragmentation. The most common interpretation of use is that of indeterminate hard contact materials, suggesting unidentified nuances in use domains. Third and finally, a common combination is the medium-sized celt with probable juxtaposed hafting systems, displaying woodworking traces (far) exceeding the experimental range. P 004, 013, 020 and LH-style adze FL 2279-06 are all characterised as such. Given that such traces are interpreted as reflecting the working of very hard woods (above specific density 0.9 g/cm^3), such as guayacan, there is actually a wide range of activities they could be associated with (Appendix 2). Such wear traces appear in every site and, though common on jadeitite, are not necessarily in conjunction with that material. *If* woodworking wear development is modelled reversely (Section 5.2.2.1, third model), then these specimens were instead used on woods softer than 0.6 g/cm^3 which would suggest canoe-making. This would also imply that most house-building tools were used for agroforestry and vice versa. If one extrapolates away from the high requirements of necessary biographical information for this level of interpretation, it does appear as if all three sites practice all five activity groups to substantial degrees.

10.2.5 Long lives and valued deaths

Significant values were invested into these edge-ground macro-lithic artefacts over the course of their biographies. The evidence for resharpening technologies indicates that the inhabitants from all sites curated their tools by devoting continuous effort into repairing their functionality in whatever way possible. Additionally, the extent to which these assemblages had been exhausted suggests celts were highly valued objects not to be discarded lightly. If certain stones were considered as (inhabited by) entities capable of engendering social relationships, they may have required such reciprocal behaviour over the long term to maintain those relationships. Practical outcomes could be that disuse is to be avoided, (technological) curation to be emphasised, and discard subjected to strict social axioms. The re-shaping of celts into blunted implements when possible fits well into this paradigm.

The resulting pathways of remodelling have implications for the typo-morphologies encountered in the archaeological record. The abrasion and/or chipping of edges, whether from resharpening or minor active flaking during use,[56] alters edge symmetries. Consequently, and depending on the

56 The counterparts to edge flakes are intact celts with shallow feather-terminated flake negatives on the

severity, celts may recede in length and axe-or-adze assessments lose reliability. The more lopsided attempts at rejuvenation are, the greater that asymmetry in bevel inclinations will become (Adams 2013, 170). All of this occurs during the biography of regular celts, irrespective of any original constraints on design, morphology, and typology. The fact that most fragments with traces of repair are derived from medium to large-sized celts, which are otherwise infrequently seen amongst finished and exhausted artefacts, is also suggestive of a decrease of average size during life. A second pathway of remodelling is the re-pecking of ground bilateral sides to facilitate hafting. While uncommon, and not currently seen to overlay previous hafting events, repeated episodes would eventually transform almonoid morphologies into petaloid outlines.

At some point during their life celts fractured in unrepairable ways, or roughed out rocks cracked during birth. The current patterns of deposition indicate these materials ended up in refuse strata. Many use activities would take place outside of the direct habitational space, and the overall lack of debitage at Playa Grande indicates its celt blanks were also reduced elsewhere – likely outside of excavation bounds. However, some of these materials still ended up in habitational refuse strata, a significant number of them also evidencing intentional destruction. Apparently, a proper biographical trajectory demanded closure after the rock refused to proceed further. This would conventionally defer to methods of dispelling the spiritual agency of such animated materials by killing the body (Section 3.1.3.4). Also for animistic or perspectivist reasoning this is a perfectly acceptable framework to operate within, since the disposal of an artefactual subject is simultaneously an endeavour into the severance of extant relational dependencies (to avoid threats to the integrity of one's personhood and bodily capacities).

Further, either the act of destructing or the act of depositing was apparently required to occur within the boundaries of the village. Because of that the whole situation points towards the use of ritualised space to scaffold the performance of intentional destruction, specifically the existence of conditions that could not be fulfilled outside of the village. Late Ceramic Age villages formed a concentric dichotomy between the sacralised centre and the domestic expanse, examples of the former being plaza structures (Siegel 2010) and caciqual or *zemi houses (caneys,* Oliver 2009). Both of these also offer access to ritual specialists, ceremonial toolkits, and other-than-human actors, if they did not accompany the reduction or use itself. Indeed, residues found on discarded roughouts also raised the possibility that additional performances were played out before discarding (Section 7.3.3), and these may well tie in with the disposing performances. The subsequent discarding of the fragments in midden layers shows that the significance indeed laid in the act of destruction itself, and that any (volatile) relational potential could thus be successfully dispelled.

10.2.6 Handling axes in ancient and modern times

Some final comments are in order. Conjoining a stone head and wooden handle into a functional composite is rightfully a biographically transformative event, but there is very little information on how this should be viewed. Hafts may be imbued with more social power and importance than the celt-heads they embed, and their joining is never a relation of permanence. However elegantly carved archaeological handles from the Caribbean are (cf. Figure 26), it is impossible to comment upon such

bevel. These are very rare as discarded artefacts, and consequently, many must simply have been repaired after chipping.

matters without understanding the biographies of these leverage systems themselves.

The sheer amount of celts in the archaeological record suggests that the tool type was common in society, and instrumental for indigenous economies. The diversity in archaeological morphologies, skills in stoneworking, hafting arrangements, use wear traces, maintenance and rejuvenation strategies, and concurrent functional modes perfectly explains the stunning range of woodcraft that survives until this day. Such edge-ground tool complexes had developed by at least AD 500, indicated with the comparatively dense biographies of the Pearls assemblage. It must date to at least some extent deep into the Archaic Age, given the technological necessity of seaworthy watercraft for the first entry into the insular Caribbean.

The complexity exhibited by these toolkits is not congruent with ethnographic cases of stone axe use. With recent histories consisting of upheaval, loss, displacement, persecution, and cultural extinction (Section 3.2.3), it should not come as a surprise that such cases reflect indigenous contrivance forced in the face of isolation due to overbearingly hostile conditions. What they achieved is a craft that is perhaps a mixture of remembrance, recognition, and innovation wholly contingent to a historical trajectory of over 500 years. It seems unlikely to me that these reflect traditional technologies and skillsets that somehow survived centuries of colonial encounters, marginal or not.

Because of that, we cannot overlook the obvious inexperience of the indigenous experimenters which provided the basis of the estimations that the efficiency difference of stone versus steel exceeds an order of magnitude (e.g. Carneiro 1974; 1979a; Denevan 1992; 2001). Based on my own experience (with specific densities comparable to those reported by Carneiro), cutting through the sapwood of tropical hardwood trees is certainly not difficult. Much depends on the skill of the user and design of the tool, both of which could be significantly improved also in my case. Wider circumferences increase felling time primarily because of the increased contact with heartwood and the necessity of opening up more vertical space to allow the blade to penetrate deeper. However, stone axe (and fire) technologies do not form an insurmountable obstacle to the felling of woods. At worst, they only force different frames on the social organisation (cooperation) and approaches (directed treefalls, plot selection) to the task at hand. I have no doubt that systematic land clearance was well within the capacities of organised communities in the Caribbean. Such questions have more to do with the selection of trees with specific dimensions towards particular ends, than with the intent of felling the biggest tree of the forest. And even though these should not be conflated with more general agroforestry practices, the survival of large duhos made fully out of *Guaiacum* sp. heartwood evidences that such challenges were met in the past.

11

Conclusions and new questions

Indigenous social interaction networks operated on multiple intersecting levels. Different types of objects have different exchange potentials with respect to the direction and range over which they circulate, and probably also had different values attached to them. Using jadeitite as the example, these celts have potential to be exchanged over long distances and to receive technological treatments of higher subjective charge than other green- and bluestones. Nevertheless, not all jadeitite celts follow such paths, and these biographical possibilities are not totally closed off to specimens from other rock types and sources either. Those materials also shared a capacity for moving between spheres of exchange and valuation, which is likely correlated to subjective events and relations to others enmeshed with their biographical trajectories. As the data indicate, celt exchange in the Ceramic Age is not so much an inter-connected macro-network. It is probably more correct to speak of large-scale currents that in fact consist of a multitude of local to regional interactions. Some sites acted as suppliers for particular materials (but not for others), while other communities chose only to receive these materials and not to contribute celt materials themselves (in spite of the capacity for local production).

The drive towards exchange and circulation is expressed differently amongst Amerindian object regimes more generally. This contrast is clearest when comparing jadeitite celt production at Playa Grande to the manufacture of shell paraphernalia at El Cabo. Nearly all of the former were exchanged while celts from other rock types were imported, whereas current evidence for the latter indicates that these carved objects simply remained within the community. There is persuasive evidence that the circulation patterns of celts are shaped by relational and intersubjective considerations, in light of the place and effort of their grinding and polishing. Nevertheless, none were non-functional valuables that served only as tokens of wealth (with the possible exception of P 009). Even over long distances the biographies of intact celts continue to reflect good caretaking of useful tools, or curation as defined in relation to utility (Section 3.1.3.3). As a result, the majority of celt materials are fully exhausted.

Somewhat haphazard pathways are reflected in the itineraries of tooth pendants, which oscillate between long to regional distances. Traces from multiple suspension methods could form evidence of used pendants being recontextualised between different cultural contexts. By contrast the marine animal pendants reflect single suspension events and somewhat coherent technologies, and provide no indications for socio-cultural differences in coastal to inland interactions. As with celts, the majority of the materials found in the northern Dominican Republic were also manufactured there and circulated amongst the communities inhabiting that region. Most importantly, the potential closeness of such ties and sheer volume of exchange relations between communities close by cannot be understated in view of rarer connections unfolding over larger distances. Since we cannot distinguish whether the paraphernalia from the Windward Islands were exchanged from the mainland with established recipient communities, or were personal possession brought along through human mobility (the

migration model), care should be taken so as not to misjudge the social dynamics of those biographies either.

These conclusions represent the temporal range of the respective case studies, being AD 1200-1500 for the northern Dominican Republic and the late pre-colonial to very early colonial period for the Windward Islands. Even so, the deeper extent of long distance celt circulations originates in the Early Ceramic Age. Many later possibilities from each of the biographical phases – materials, hafting arrangements, various uses, repurposing – are already present at that time. The assemblage of Pearls is in fact richer in polishing varieties than the Dominican sites. Conversely, the primary diachronic contrast is the arrival of the Spanish in 1492 with the subsequent social upheavals and colonial encounters that followed. The repercussions thereof are not well seen in the object biographies from the northern Dominican Republic, since the vast majority predates this juncture. The stratigraphic disturbance of the upper layers at Playa Grande makes it difficult to verify whether the manufacture of jadeitite and blueschist celts continued after contact, though I see no compelling signs of immediate cessation. Especially in the first few years the quantity of metal axes the Spanish ships could have brought in would not have sufficed to overtake the pan-regional circulation of celts. Furthermore, it remains unclear whether these grey metals could compete with jadeitite and blueschist in their respective exchange spheres.

11.1 Objects lead interesting lives

The ideal configurations of the cultural biographies of both celts and paraphernalia were essentially unknown at the start of this research. Now it is evident that their biographical profiles are homogeneous only at the broadest scale, and dissolve into a series of site and context-specific possibilities. It is thus somewhat presumptuous to return and generalise an 'ideal' biographical trajectory of a Caribbean celt (or any other object). Nevertheless, certain observations do convince of being more broadly shared.

Between Pearls, El Flaco, and Playa Grande, celts began their biographical trajectory as blanks of a suitable raw material selected (primarily) from alluvial contexts. Several rock types could be chosen most of which are hard and dense, have medium to fine-grained granoblastic textures, and massive to weakly foliated fabrics. Isotropy depends on the material in question. Complex core reduction strategies were not seen in Playa Grande, the main techniques being bifacial thinning/foliation splitting, hard hammer percussion on the sides, and pecking at various scales applied in a flexible and sometimes recursive process. The indigenous craftsmen unquestionably possessed the skillsets and know-how to capitalise on varying rock properties to shape the desired designs. Though edges and bevels were abraded before exchange, celts were only fully ground elsewhere, presumably by the recipient. The microwear data indicates knowledge of various efficient stone grinding platforms and recipes, though this will reflect local availability to some degree. Specialised polishing techniques and procedures existed in the cultural repertoires, but were applied only under selective circumstances. The resulting artefacts were all functional tools that were hafted in several ways. The two main modes are axe and adze-type orientations, which occur in different sizes (one- or two-handed) and with further variations on the details of the attachment systems. The functional domain is dominated by woodworking activities, which were extraordinarily varied and comprise woods of vastly different properties. Some further questions on the differences in contacts remain, though, and instances of other types of use were also seen. Finally, celts were repaired and maintained until usage breaks led to exhaustion, and even then the fragments were reshaped towards (primarily) pounding tools if their

shapes permitted it.

These patterns are very general, since it is impossible to state how specified nuances would hold up if additional assemblages were to be studied. From these ideal cultural expectations apparent shifts in celt biographies could evidence a recontextualisation from one cultural setting to another, but such events have not materialised. The main reason is that it is exceedingly difficult to conceptualise any individual celts as representing culturally distinct biographies, since contextual links are not widely demonstrable in the complex and sometimes intermingled stratigraphies of the sites. However, artefacts also recontextualise when moving into new biographical phases, which allows for enquiries into changing social perceptions of things and the ontologies of object lives. The most important corollary is that technological manipulations are proportionally relational actions.

Common celts likely had some capacity towards forming semi-dependent interiorities, subjectified in the process of shaping their artefactual physicalities. Exact degrees may differ, for instance on the technological treatment of their surface lustres engendering resplendent forms of interactions with cosmic energies, subjectivities, spirits, and so on. Perhaps certain rock types were more potent than others, though indications of subjective treatments are shown by most lithologies. Since these are co-constitutive processes, it also explains the disjunction from the general context of production, and offers a mode of exploration for the various different polishing techniques seen at sites. Once established, even quotidian activities such as tree felling continue – with the right gestures –to uphold proper modes of being. The inclination towards embodying an interior soul is again revealed in the death of a biography, with intentional destruction likely performed for jadeitite celt roughouts at Playa Grande and possibly also for certain greenstones and metavolcanic rocks (Section 8.4).

The various paraphernalia share the broad constitution of the toolkit and skillset used to create them. Highly developed indigenous know-how is again evident in the exploitation of structural behaviours particular to certain materials. The group of paraphernalia otherwise constitutes a series of diverse objects with divergent biographies in lives and deaths (Chapter 9 and Section 10.1), evidencing various scales of production. There is thus little ground for assessing normative biographical trajectories even if some samples currently represent all what is known on the respective types from within the Caribbean. Rather, the principal object of inquiry was to what degree their biographies were defined by the potential to circulate.

That the face-depicting artefacts in shell have significant exchange potential was well known (Mol 2011; 2014; Oliver 2009), but several findings enhance this view. The aged quality of the raw material of one *guatíza* (C 3107) indicates a relational conception, and the specimen from Grenada (p001) expands on the technological style of shell-working at El Cabo with a richer and more complex assembly of technical actions and gestures. Both were probably potent subjectivities in their own right. The other shell objects are technologically coherent, but provide no biographical evidence of itineraries outside of the community of El Cabo. Lacking independent forms of evidence for distant origins (e.g. ethnohistory), the expectations of circulation for these materials have not been met. This is not the case for the tooth pendants. Though the potential for exchange has been demonstrated previously (Laffoon et al. 2014; 2016), the present study provides an independent line of evidence for the reception and incorporation of such materials into new social settings. The specimens from Brighton Beach provide the clearest indications of the incorporation of extra-cultural materials within the native insular setting, including re-attachment to other forms of bodily adornment. The cultural ideal of tooth pendant biographies is thus to circulate, but it is expressed differently for materials of

diverse shapes and origins. Large mammal teeth from the South American continent again travelled up into the archipelago, and from the coastal areas of the Dominican Republic pendants from various marine animals moved towards communities inland.

Finally, from the four wind instruments it is clear that a cultural tradition of musicality existed amongst the communities inhabiting the early colonial Windward Islands, with strong ties to the mainland. Such were registered from various 17th century ethnohistoric sources, but up until now no archaeological correlates or early colonial evidence of it was known. The technical process of making proceeded along equivalent lines for the acoustic core, though individual design choices were enacted regarding the final sound range. Musical instruments are crucial in the reproduction of the social fabric, but may communicate, negotiate, or subjectify other actors in various ways. Similarly, access to their performance must have been contingent upon social rules.

11.2 Indigenous values and interactions

In Chapter 2, the prediction was made that the circulation of celts as a component of indigenous interaction networks was both more substantial and more complex than that only considering the case of jadeitite as socially valuable greenstone indicated. Jadeitite is easily recognisable as an exotic rock, but it is plainly only one material out of a circumscribed selection and not proven as the most dominant valuable. In reality this group includes greenschist and blueschist, low-grade to unaltered mafic volcanic rocks, and outside of my study areas also materials such as St. Martin mudstone. Specific colour varieties from within these geological classifications appear to have been preferred for production over others, even if these preferences are no longer reflected at recipient communities. Both selective procurement at Playa Grande and the variety of greenschists at El Flaco, of which some recur at other sites, imply this. Consider also the sheer volume of these materials being moved around the landscape, the evidence that most sites are not exercising their potential self-sufficiency, and the economic indispensability of such tools. All this demonstrates that the general material group of ground stone celts forms the most constitutive element of LCA interaction networks that is archaeologically preserved. This status probably extends well beyond the northern Dominican Republic.

Different celt materials all experienced comparable biographical trajectories, but there is one aspect in which jadeitite celts still maintain biographical deviancy. This is in their manufacturing, specifically between the stages of preforming and complete polishing. Jadeitite celts were exchanged from Playa Grande without being abraded, this presumably occurring by the recipient actors. Chiefly, there appears a strong correlation between this raw material and the technique that produces a 'bright mineral mirror polish', that is macroscopically separable from other types of polishing seen thus far (Section 10.2.3). Whether blueschists were also exchanged from Playa Grande without being abraded is not as clear due to interpretation issues with the acicular fabrics, though most probably were. Strong variations in the wear trace signatures indicate that not all rocks imported to El Flaco or Playa Grande were abraded only there either (whether blueschist, greenschist, igneous, or otherwise), though specimens of these did circulate as roughouts also.[57] Perhaps the final grinding is something that occurred *en route*, with abrasion platforms or slurries at hand, or non-HP rocks were abraded during production in many different places. This warrants more investigation, but as it stands

57 As a recipient community El Flaco held no major ties to the network supplied by Playa Grande. Its members instead obtained several material varieties that were procured from the El Yaque del Norte and its tributaries, and occasionally manufactured a tool themselves.

the combination of preform exchange and technological investment from 'bright mineral mirror' polishing remains distinct for jadeitite only.

Because of this, jadeitite-like rocks might comprise a potentially higher capacity to accumulate subjective energies that render it more socially capable partners than other rock types. This capacity would be fuelled in the context of making (primarily polishing), an intersubjective process exercised through technological skill and relational savoir-faire. It is even possible that certain objects (such as monolithic or engraved celts) obtained [partial] autonomies from linkages with mythological transformations. Does this mean that the expanded concept of 'social jades' indeed makes sense in the context of an indigenous ontology? Caribbean jadeitites certainly vary in colour and texture, grade into impure compositions of jadeite + omphacite ± other minerals, and the correlation with the 'bright mineral mirror polish' is not entirely exclusive. Rather, though, the label seems not conductive to clear up perceived differences between greenstones and bluestones, or grades in translucency and natural lustre. Many of the other rock types and tool forms must have displayed degrees of inherent economic value and attractive subjectivities, not uncommonly to equal heights. These are not derivatives of jadeitites, but of common ontologies on things, subjects, and materials.

It is more difficult to get a view at which point in their biographical lives the paraphernalia were exchanged, and if these reflect external (new) cultural circumstances. A primary issue in this respect is that 'biographical maps' of the areas are lacking. Though tooth pendant S615 (originating in northern South America) was restrung from a complex weaving at least once, it is unclear whether such re-attachments are common over larger (cultural) distances or not. Until such datasets become available, it remains quite difficult to better define what kind of relations were implied by the exchange of these artefacts. The aerophones are more persuasive as indices of mainland material culture brought into the islands, than they are as biographies mixing influences from contact situations. The best evidence is, ironically, tooth pendant S208 representing the incorporation of exotically natured (European) large mammals in local culture.

The spatial context of Chicoid-style artefacts like p001 and p004 in Grenada represents an extraordinary distance, but is actually in line with the biographies of Greater Antillean paraphernalia (Hofman *et al.* 2008a). Such objects are often found outside of their native cultural context, though to have been exchanged with communities beyond (or emulated by them) to maintain social connections and strengthen political ties; *guaízas* in particular played a defining role in these interactions. At least for p001, the proposed reconstruction as the centrepiece in a beaded wearable is also one that implicates a use life in the Greater Antilles. Though woven bands may also have existed in the Late Ceramic Age communities of the Windward Islands, they are nevertheless typical of Greater Antillean political competition. This to the point that several were presented to Columbus upon his landfall (Dunn and Kelley 1989, 263).

11.3 Methodological reflections

Reconstructing artefact biographies proved to be an exceptionally suited methodological framework for the objectives of this study. The combined biographies of celt assemblages easily circumscribed the functional and technological dimensions and have produced the insights needed to address the broader issues originally raised. Conversely, the focus on the singular biographies of hitherto ambiguous artefacts has proven to be immensely valuable for fleshing out both matters of authenticity and matters of functionality. Microwear analysis is a universally applicable method, as long as the

cultural and environmental variables are properly incorporated. The primary concern of the present work in this field was to chart how material properties affect interpretative resolutions.

The way rocks interact with processes of wear is a factor of their structural compositions, and thus changes for rocks of different fabric, texture, mineral contents, or mineral properties (Adams *et al.* 2009). Given fairly stable modes of wear and fabric/texture properties for Caribbean celts, the influences of mineralogical differences on wear stood out most. Both the experimental programme and heterogeneous archaeological materials confirm that wear develops and displays at different rates on different minerals (Figure 66). Broadly circumscribed categories remain interpretable at that level (e.g. stone on stone contact), but wear trace patterns will develop certain attributes differently. Glaucophane matrices in euhedral mineral phases posed issues in the present work, since the associated acicular surface textures appeared not to develop interpretable wear until at a very late stage. It was often not possible to distinguish wood from mineral contact (both being fairly hard material categories). Wear developed along mostly similar lines for granoblastic to anhedral matrices, by comparison, with sufficient similarities to draw out the general categories of contact materials. Since macro-lithic materials contain a much greater variation in properties than cryptocrystalline materials, it is even more important here to progressively eliminate equifinality from inter-material differences through experimental programmes. With proper descriptions of the structures and characteristics of the materials in actual use, comparable levels of interpretative resolution should be methodologically achievable.

Better interpretative resolutions are possible for the contact with various wood types and on the contact with various types of abrasive platforms. The current experimental programmes represent selective combinations from a vast range of variables that urgently need to be expanded upon.

The grinding experiments affirmed a basis for distinguishing sandstones of different fabrics and textures from one another. The key parameters were cohesiveness and angularity of the grains, though all were composed of silicates with varying levels of cementation. In turn, the most important wear trace attributes were the degree of microtopographical levelling (a roughness coefficient) and polish characteristics. The spatial distribution of polish is primarily determined by the texture of the host rock. The 'sand-ground' wear trace signature (indicating free-moving rounded silicate grains added as slurry or dislocated from an a-cohesive sandstone matrix) explained a portion of the assemblage. Even within this range, questions of nuance appeared. These probably have to do with mineralogical differences between the celts or exhaustion of the platform. Such results imply there

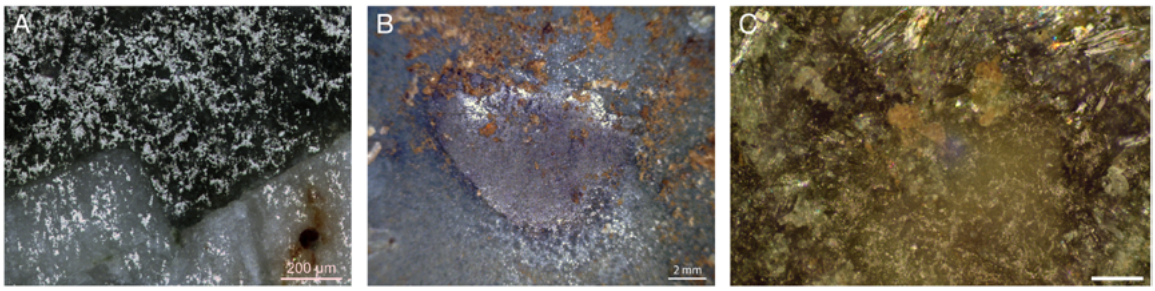

Figure 66: Differential wear development in areas of heterogeneous compositions. A) Experiment 2511 after 90 minutes, showing a plagioclase (bottom) and greenschist matrix minerals. B) Greenschist PG 063, showing a large worn garnet with rounded edges protruding from the softer matrix. C) High-pressure rock CA 1436, showing green pyroxene (probably jadeite or omphacite) surrounded by glaucophane. Original magnification 100x, white bar approximately 200µm.

must be also grounds for interpreting other grinding stone types from the wear. Intermediate to mafic igneous materials, black sands, immature sandstones, and limestones all form important variables in Caribbean context. The local geological conditions of the islands or regions would indicate a variety of primary materials for experimentation, that can be expanded upon with adjustments in platform compositions, use of lubricants, and so on. The main archaeological problem is that there is a dearth of knowledge on what rocks were used in indigenous craft. More information is needed on lithic grinding stones at archaeological sites, as well as possible *polissoirs* and sand compositions, to address the variation in traces.

The issue with traces of woodworking is somewhat comparable. There is a tremendous amount of arboreous species in the Neotropics each with their own set of wood properties, resulting in a large potential variability of contact materials. This alone implies a potential for distinguishing these on the basis of traces of wear, though most available-published reference material is limited to temperate broadleaf and mixed forest species with specific densities of up to ca. 0.6 g/cm^3. The fresh experimental woods average between roughly 0.55 to 0.8 g/cm^3, which corresponds both to several important Caribbean species and (the resulting traces) to a portion of the archaeological wear, emphasising the methodological value of exploring these variables further. The first matter at hand is to address harder to very hard woods through experimentation, to deal with the present issue of having wear that 'exceeds' or 'appears softer than' the result of the present experiments. Beyond that, the principal variables to take into account are the main states of the wood (sapwood or heartwood, and fresh, soaked, or charred) and its main properties (at the very least grain type [or texture], silica content, oil content, moisture levels, various stress resistances, and direct hardness measures). Specific density values continue to form a useful middle ground for ranking timbers since they are derivatives of the mechanical properties averaged for the general state of the wood.

In both cases the methodological descriptions need to be developed more explicitly, especially for traces from contact with solid mineral bodies. Metrological approaches (LSCM, interferometry, and rugosimetry) will experience difficulties with the subtle heterogeneities between archaeological and experimental rock properties, but can still quantify sensory distinctions of lustrous reflectance. Doing so may reveal both cross-cultural standards (cf. Procopiou et al. 2013) and address observer bias.

Previous research into figurative mobile art has been heavily insistent upon lithic tools for the implementation of cutting, engraving, or drilling techniques. Thought is rarely given to the plethora of alternatives available to pre-metal societies, some of which have been proven viable and methodologically distinguishable over the course of the present work. Animal eeth as carving tools in particular have a strong ethnographic representation (Section 5.3.2), and the absence of their consideration in common questions of 'predator marks' versus 'human-made stigma' is methodologically problematic. More generally, the microstructural make-up of particular shells as leading to different mechanical behaviours has again been demonstrated to prompt operational adaptations (cf. Szabó 2004; 2008; Szabó *et al.* 2007). The same can probably be expected for the other hard animal materials worked by knowledgeable indigenous craftsmen (cf. Margaris 2014). Further study of larger assemblages is required to obtain the Caribbean perspective.

11.4 Additional directions for future research

The present work has hopefully demonstrated the value of reconstructing artefact biographies for refining and refocusing existing ideas, and bring forth new dimensions of research. All suggestions

of the previous paragraph have obvious applicability to the improved understanding of indigenous culture, economy, society, and worldview, and not just in the Antilles either. However, much more work needs to be done. The principle pathway is to expand on the technology and use of Caribbean macro-lithics and paraphernalia, and combine these aspects with further research on their provenance, circulation, and wider biography. The scales need to be increased towards regional and ultimately multi-regional perspectives by incorporating additional site assemblages, whether the topic is celt circulation in the Cibao valley or shellwork from the Chicoid heartland. The section proposes several more specific research contexts with particular potential for furthering the study of circum-Caribbean artefacts, technologies, and interactions.

Tooth pendants, as the type with the best evidence for endemic and long-distance circulation, form a very promising category for an expanded study. Variation appears in the trajectories of pendants deriving from different spatial and chronological contexts, which may reflect distinct cultural biographies in the original sense. The utilisation of maritime dental elements requires further exploration, in part to obtain more insight into little-known indigenous human-animal relations, but the ubiquitous dog tooth pendants also need to be incorporated. Biographical indicators that are potentially culturally sensitive (e.g. specific attachment systems) need to be mapped on a wider scale. Further, there is room for a broader appraisal of the working of carved bone artefacts in the indigenous Caribbean. Many remain scattered amongst old fieldwork reports and grey literature (with the notable exceptions of Roe 1989 and Giovas 2017), whilst carved bones are socially, ceremonially, and technologically highly significant objects. Research on wind instruments specifically may be expanded through experimental replication, morphometric and archaeoacoustic analysis, attempted dating and/or chemistry on adhering residues and sediments, and juxtaposition with examples from the Greater Antilles.

Edge-ground macro-lithic percussion tools – celts – have the appearance of being somewhat reasonably understood, as far as the main types, raw materials, and uses are concerned. However, there are much more biographical nuances and local to regional variations than currently accounted for. This greatly hampers a proper understanding of the circulation and valuation of 'stand-outs' such as jadeitite petaloids, since other material groups are simply not known to the same resolution. What is needed foremost is better contextual/chronological control for all relevant rock materials, types, production contexts, etcetera. Both the RJSC and the Sierra del Convento area were densely inhabited in the past, and other communities must have been involved in the exploitation and manufacture of high-pressure rock celts. Such questions also need to investigate whether the lack of evidence towards particular biographical trajectories represents preference. For rock materials these include omphacitite, eclogite, amphibolite, and serpentinite, which are known as exceptionally suitable rocks with long histories of use elsewhere. Issues in production may focus on the relations with knapping technologies for other Caribbean artefacts (below) as well as the potential exchange of grinding materials. The toolkits for non-woodworking heavy percussion tasks such as hoeing and butchering of large carcasses from marine animals remain unclear, and the ceremonial associations of engraved celts and monolithic axes need to be tested within this framework.

The approach to juxtapose woodworking tools, wear, gross morphology, and hafting arrangements towards distinguishing specific functionalities and applications is promising. In a 'Wood Age' technological context, the benefits of better understanding different wood-related crafts and practices are obvious. As seen in celt assemblages from other parts of the world, this integration may reveal

revolutions in land use and exploitation, and is ultimately instructive on responses to (human-induced) environmental and climatic change (Yerkes and Barkai 2013; Yerkes and Koldehoff 2018; Yerkes *et al.* 2014). The present state and goals for additional experimental work were outlined above. Such a study must then expand towards assemblages from different environmental regions and time periods, and ultimately also other edge-ground macro-lithic tool materials and types.

The most challenging of those materials, in functional terms, is the European metal that swept into the New World and – according to some – transformed local economic potentials. To reappraise past scales of indigenous land use in the Caribbean, Amazonia, or anywhere else it is absolutely necessary to comprehensively re-do earlier experimental programmes (e.g. Carneiro 1979a; 1979b). Not only by using good quality sharpened rocks, but especially through the involvement of woodcutters knowledgeable in the use and maintenance of edge-ground macro-lithic percussion tools, using realistic goal assessments (factoring in plot selection, treefalls, and fire-killing or avoidance of the largest trunks). The assumption of rapid replacement of indigenous material culture after the introduction of steel axes is a stereotype more generally, that in spite of universal impacts on the long-term says little about the dynamics of local interactions (Cobb 2003). A high attractiveness of metal tools is 'evident' from the earliest colonial sources onwards (Las Casas 1875, 105, 111, 124, 359), but how their adoption actually unfolded in the indigenous Caribbean vis-à-vis traditional stone tools awaits resolving.

Beyond celts and paraphernalia, the compositions of Caribbean toolkits are not well understood (with few exceptions; Lammers-Keijsers 2007). Regional variations and local solutions are exceptionally poorly documented. There are no analyses that methodologically demonstrated artefacts from the present contexts as associated with the grinding and polishing of celts (Playa Grande sandstone fragments remain an open question). Likewise for the sharp lithic edges used in the incising and engraving of paraphernalia. This has severely complicated any connections drawn between the produced materials and the toolkits available to manufacturing communities. At El Flaco it is obvious that coarse-grained igneous rocks should be targeted as potential tool flakes, since such materials are present. Arguments have occasionally been made for this interpretation at other sites, e.g. ECA Vivé, Martinique (Bérard 2008), but doubts have been voiced about such claims based on the examination of their technology (Knippenberg 2006). Fortunately, functional analysis is obviously capable of solving these issues.

Some of these ideas represent distant predictions that will take years of research to materialise, while others call region-wide issues of Caribbean material culture to attention. The most important immediate steps are to expand the present datasets in order to move the inferences beyond pilot research. The biographical trajectories of edge-ground celts extend beyond the northern Dominican Republic, and their interface with 'Archaic Age' macro-lithics represents a particularly interesting gap of knowledge. A good understanding of the wider macro-lithic inventory is needed, since most of the activities not conducted in the domain of subsistence will in some ways cross into the crafts involving celts. Paraphernalia continue to remain, for the most part, sets of ambiguous and opaque artefacts that require in-depth study to unravel. Given the high profile of such material culture in the socio-political landscape of the islands (before and after Columbus), that topic continues to remain of high interest. To conclude, social interaction perspectives and biographical perspectives are highly complementary, since they address two sides of the same coin: humans and things constructing society together.

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Appendix 1

Experimental grinding of stone surfaces

This appendix contains the technical information from Chapter 5 for the experiments in the abrasive manufacturing of hard stone surfaces. It consists of the textual description and depiction of the progression and outcomes of each experiment. The order they appear in is derived from Table 1 (Section 5.1.2), with experiments of comparable parameters grouped together. Table A1 lists all experiments conducted (collaboratively) in the context of this study, keyed to the reference collection of the Leiden Laboratory for Artefact Studies.

A1.1 Experimental results from grinding lithic material

Exp. 2494 – volcanic sediment on quartz arenite (2497) – 90 minutes, added water

In this experiment the surface underwent rapid abrasion against the platform, with the consistent loss of material preventing any build-up of microwear. The macroscopic surface became heavily striated (closed/connected distribution), whereas microscopically, very few rudimentary polish spots (dull and rough texture) appeared on select harder grains. Otherwise, the micro-topography retained a ploughed appearance. The disparity in hardness and cohesion between the interacting rocks is clearly too high to allow the formation of a smoother surface, resistant enough to develop polish structures on its asperities. Accordingly, it shows how the selection of grinding and polishing platforms is not simply a matter of obtaining the hardest and toughest rocks available. Rather, it stands in relation to the type of rock that is being worked, and to possession of the necessary knowledge for and informed selection of the tool material. A final observation is that the intended curve of the sides proved attainable with the motion of grinding, resulting in a shape more closely approximating archaeological types.

Exps 2510, 2512, 3797 – greenschist-facies overprinted volcanic, basaltic, and jadeitite blanks on quartz arenite (2497) – 30, 60, 90 minutes, no additives*

The dry grinding of greenschist, basaltic, and jadeitite blanks quickly produced a highly levelled surface composed of flat plateaus harbouring comparatively minor interstices (Figure A1). By this is meant a heavily minimised roughness and strong reduction of interstitial space shared over all topographical highs, which essentially become flat plateaus. Continued work steadily expanded the levelled surface to the lower valleys, but failed to produce a higher intensity of traces. Indeed, the macroscopic appearance of the greenschist and basaltic blanks remains dull to lacking lustre, while their microtopography bears a faint scintillation deriving from the tops of crushed asperities (Table 2, *Dull fatigue*). Only in some spots do somewhat larger patches develop, but these remain dull, rough, and isolated. Conversely, the jadeitite microtopography developed denser, brighter scintillation (Table 2, *Bright fatigue*). In certain areas it looks more like a dull, rough textured coat of polish,

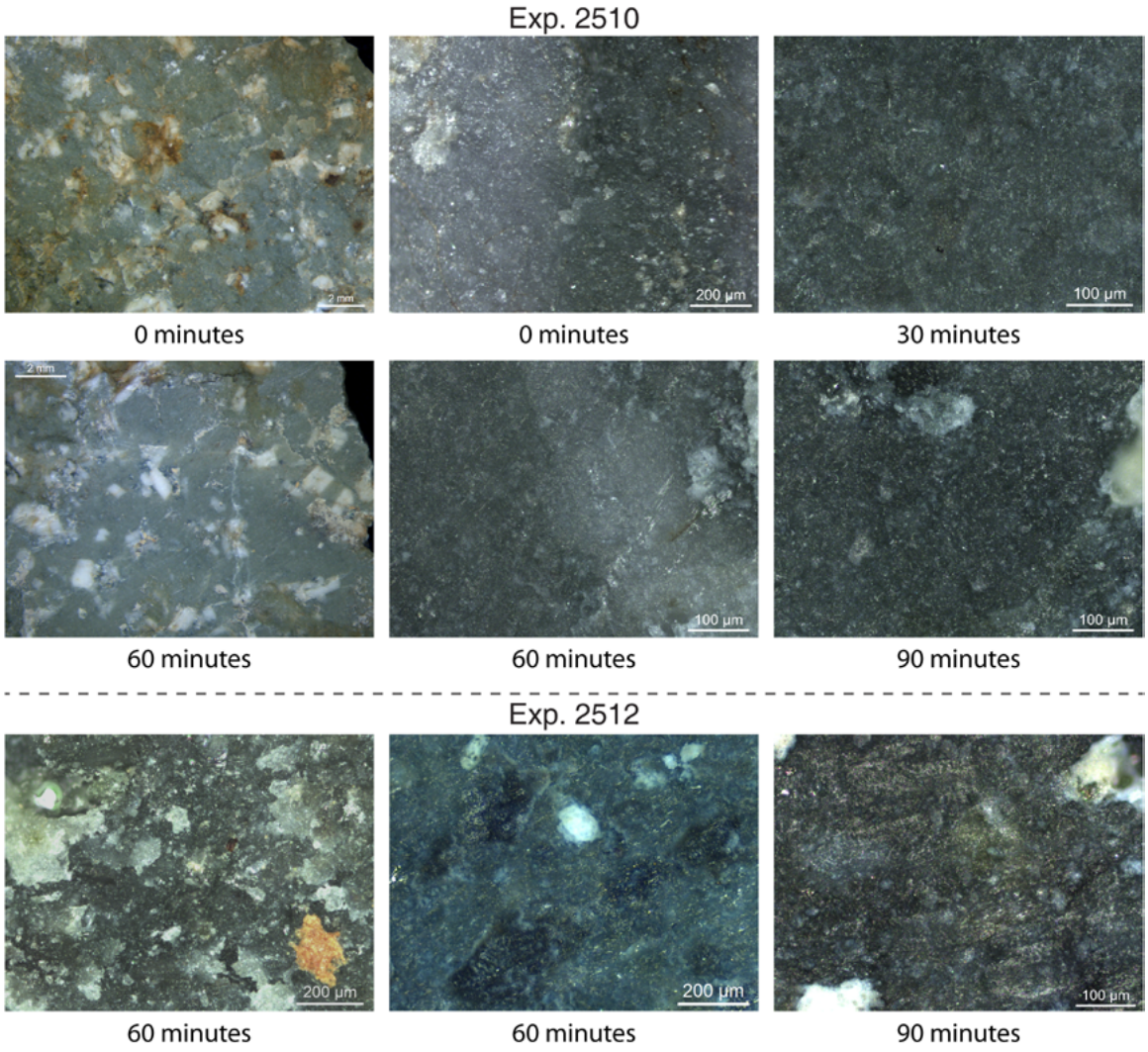


Figure A1: Sequence of surfaces from greenschist-facies overprinted 2510 and basaltic 2512 ground against quartz arenite 2497 without lubrication.

but that may be due to the interference discussed below. It can still be distinguished from the 'sand-ground'-type of polish-scintillation (see exp. 2550) by its complete spatial coverage and the absence of micro-topographic relief. Both factors indicate this wear signature still results from the evenly spread alteration of mineral texture under fatigue stress.

The basaltic blank registered a clear directionality after 60 and 90 minutes of work. Under high magnification, stone scratches (bright ploughing marks with internal striations embedded in the surface, sometimes interrupted) containing incipient rough dull polish were occasionally observed (Figure A1). The greenschist-facies altered rock was only lightly affected by this type of trace and then predominantly in the relict feldspar (Table 2,"*Stone scratches*). Its matrix remained smooth and virtually clear of other wear trace features. Some directional organisation appeared early on in the jadeitite blank, which developed into linear bands of polish at the 60 minute mark that run parallel with the executed grinding motion (the blank was not abraded until the 90 minute mark). They are observable as bright streaks using a stereomicroscope and are located in association with the perforation of the ring, suggesting they may in fact relate to jadeite particles breaking off from its rim. These polish structures are of (semi-)smooth texture on single asperities that link up as bright but rougher plateaus within the band, with some invasiveness unto the upper slopes (Table 2, *Upper*

slopes).

Abrasive wear appears to have been the dominant wear process during these experiments, producing a fine powder which thereafter acted as intermediate particles in the process, accompanied by a poignant smell. Fatigue wear likely played a secondary role by initially crushing the rougher asperities and continuing to exert pressure on the broken crystals, perhaps inducing minor particle ejection as well. The plateaus of the less well cemented basaltic rock are slightly less evenly levelled than on the other blanks, but nevertheless, polish developments from contact with the quartz arenite grinding platform are absent on all. Altogether, this grinding mode outpaced the other set-ups and attained one of the higher degrees of levelling, but failed to impart a significant gloss on the surface.

Exps 2511, 2513 – greenschist-facies overprinted volcanic and basaltic blanks on quartz arenite (2497) – 30, 60, 90 minutes, water additive

The levelling of the surfaces proceeded well in both experiments, though slowing down when larger surface areas became affected. Due to the continuously added water mixing with the stone powder produced by abrasion, a vestigial shimmer developed within minutes. Already at the 30 minute interval did this correspond to typical microwear polish from stone contact, i.e. flat, dull, and rough polish that is limited to the asperities, with a closed/covered distribution and density (Table 2, *Dull*; Figure A2). The greenschist matrix accrued fine striations at low magnification (closed/loose), but these were not observable under higher magnifications and remained stable throughout the duration of work. Conversely, striations on the basaltic groundmass became more prevalent and denser as work proceeded, than was the case with greenschist, also affecting the polish.

Upon 60 minutes of work the polish had intensified on both surfaces (Figure A2). Though they remain rough and do not significantly expand in size, the spots become brighter and denser to the point of a connected distribution over the matrix. Polish on the basalt appears directional in some areas, but this variable is not systematically patterned due to differences in the microtopographic relief. The tactility of these surfaces becomes smoother than those of the previous, dry-ground experiments, while a sub-metallic lustre captures and reflects natural light on both ground rocks.

Upon 90 minutes of work the traces seen on the greenschist matrix intensify slightly, likely indicating that an equilibrium in wear development was reached somewhere at this point where material loss and polish formation even out. In this case the breaking up of very bright polish (Table 2) with a loss of material provides an upper limit to smoothness and size of developed polish structures. The particle ejection, likely involving some fatigue stress, and stereoscopic striating both ensure the continuous presence of unaffected interstitial space in the on-going surface reduction. Furthermore, while the polish develops strongly on the matrix, most softer plagioclases develop only minor directional distribution that corresponds to the striated pattern seen only at low magnification. This situation displays very well how the inclusions respond differently to wear, with little polish formation but retention of directionality otherwise not perceivable on the chlorite matrix. The basaltic groundmass is affected differently. Here, the wear trace intensity actually reduced in size, brightness, and density from the previous observation at 60 minutes. Apparently, a momentary stage was reached in which surface material was torn away faster than crushed peaks could be smoothened out into polish. The texture, distribution, and surface coverage remain similar, and Figure A2 shows maximum contrast between the two phases that was less extreme in other surface areas. Since this regression was not seen in other experiments, the most parsimonial explanation is that dissipation of the lubricant

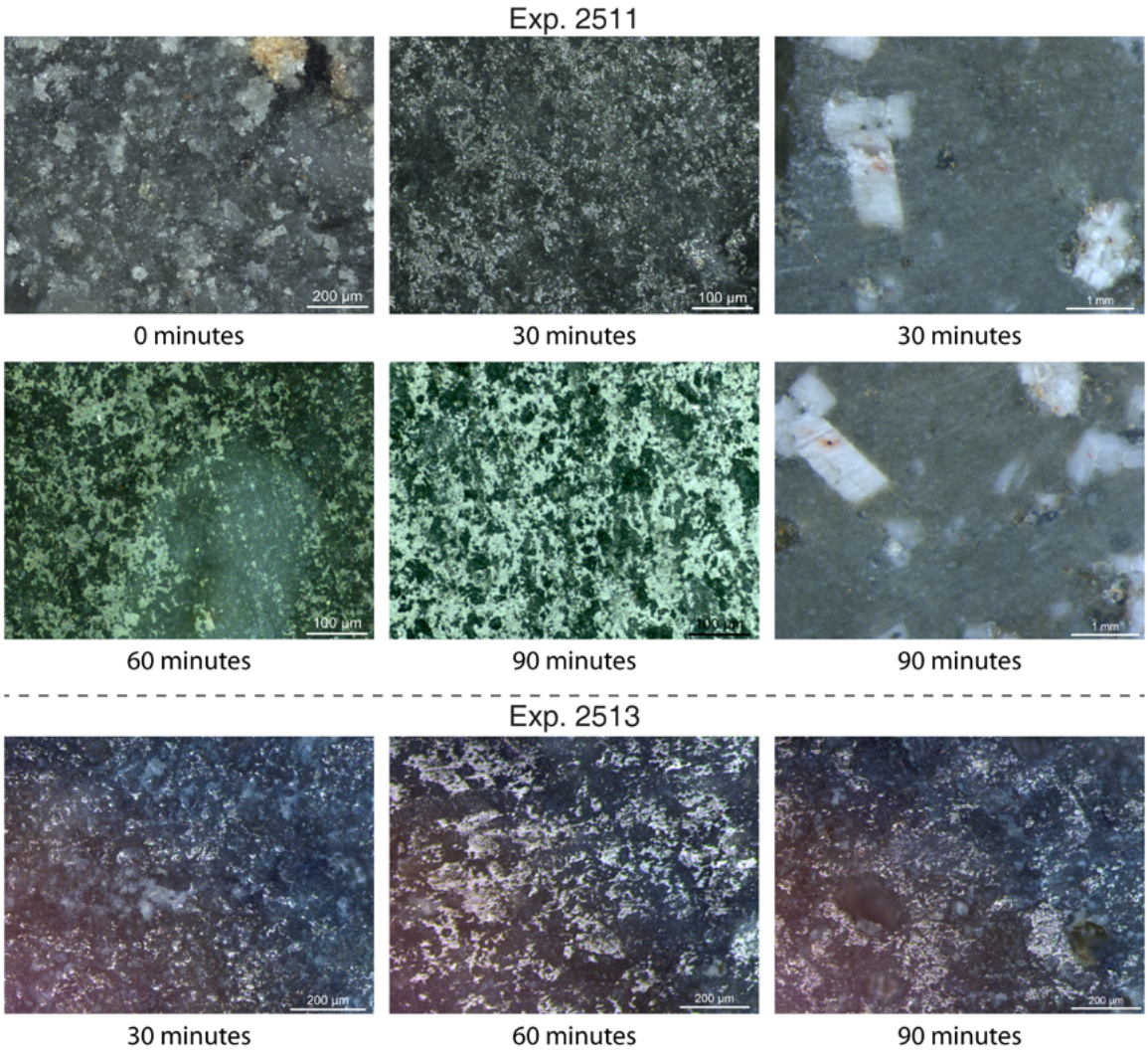


Figure A2: Sequence of surfaces from greenschist-facies overprinted 2511 and basaltic 2513 ground against quartz arenite 2497 with lubrication.

or an unintended change in gesture kinematics (perhaps muscle strain) upset the gradual progression towards a polished surface, and altered what wear processes were at play.

Abrasion remains the dominant wear mode in these experiments, given the reduction of rough surfaces to level plateaus and the continued presence of ploughing striations. Yet the addition of lubricating moisture, which forms a film that spreads the load of force, inhibits unfettered abrasion in favour of excessive polish formation. Such outcomes are in line with methodological expectations. One possible scenario is that the spreading of load by the film of water enables a slight plastic deformation of the molecular structure to occur, but tribometric investigation is needed to understand exactly what happens in the formation of polish on these types of rocks. Some fatigue and/or adhesive processes may act towards maintaining the equilibrium in wear development as well.

Exp. 2550 – greenschist-facies rock blank on fine-grained low cohesion sandstone (exp. SWH) – several hours (unspecified), water additive

This experiment was conducted by D. Pomstra to produce the greenstone axe head that was utilised during the wood chopping experiments (Section 5.2). Initially reduced using modern power tools,

the preform was ground for several hours on a fine-grained sandstone of low cohesion (exp. SWH) with water. The tendency of this sandstone to shed grains indicates it will form a natural slurry when used in conjunction with water, but the exact degree to which this occurs was not reported. Due to logistics the analysis of the manufacturing traces took place only upon conclusion of the functional experiments on both initial casts and the actual surface (Section 5.2).

The abrasion experiment on sandstone exp. SWH produced a fairly well levelled surface, with some striations still visible and a dull to diffuse lustre. The microtopography has a low relief in general, characterised by a (very) rough, dull scintillating texture that brightens to a mild sheen on the upper areas (Figure A3). At first glance this sheen appears to be invasive to a degree atypical of contact with stone. This is more strongly expressed in high-lying areas where the vertical distance is greater, and generally varies somewhat over the surface. Peaks display broadly rounded appearances, there is no angularity to be observed. Actual polish is rare, the few discernable spots are small, bright, rough, and isolated on the peaks, or appear as smears between micro-asperities from the general rough texture. Striations are absent from the polish, but occasional larger stone ploughed striations are observed. Microtopography aside, since this experiment was actualistic it provides a window into the distribution of grinding striations on the stereoscopic view. These are obliterated on the faces but retained towards the periphery of the various surface planes, especially near and on the sides and the edge (Figure A3). Their distribution on the artefact is closed-concentrated (Figure 6), and in this case the striations are also present on the bevel. Typically, they are found in a perpendicular to semi-perpendicular orientation indicating the use of longitudinal grinding motions. It is well possible that striations originally present on the face were removed during the equilibrium of wear development on a flat surface, whereas this state was not attained near the sides and borders, where the motion is less efficient.

The process of wear is markedly different from the previously described experiments. Abrasion does play a role, indicated by ploughing grains, but these traces are limited to those areas where the contact with the platform is more limited. Given that striations were completely erased on the faces, these main

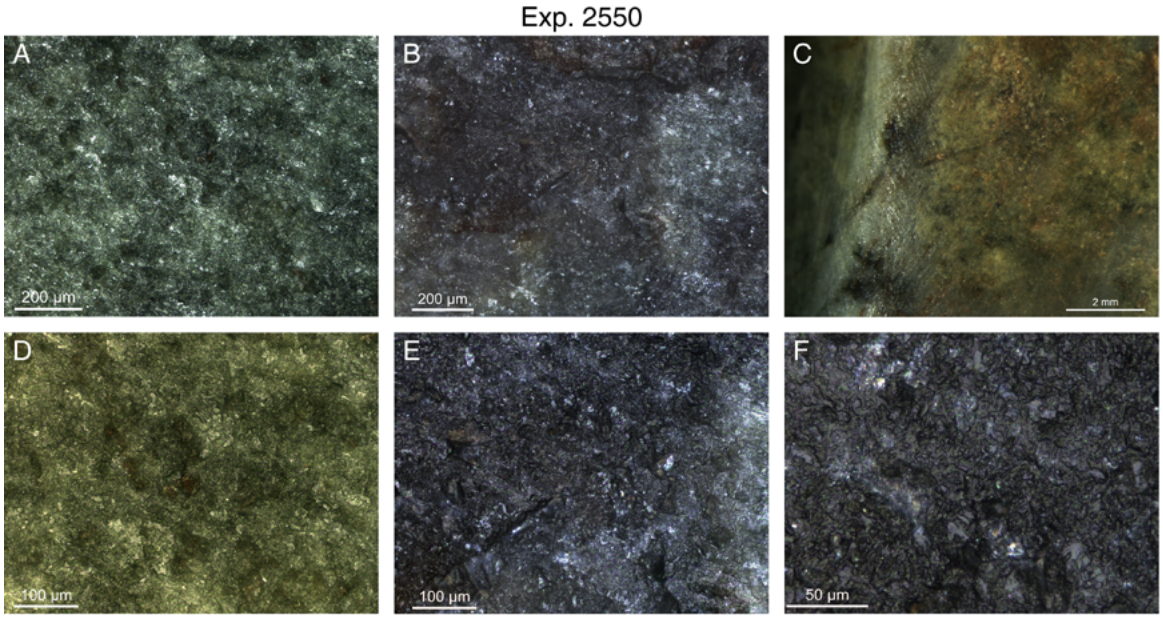


Figure A3: Various surfaces from greenschist-facies rock 2550 abraded for several hours against a fine-grained sandstone of low cohesion (exp. SWH) with water. A and D share locations, as do B, E, and F.

contact areas were evidently subjected to more complex interactions of wear. Fatigue and adhesion are implied by the invasive distribution of a rough textured modification of the microtopography, best explained as crystal grains becoming crushed due to mechanical stress load that is spread into lower areas by the water film. The crucial parameter is the loose cohesiveness, which appears to have permitted grains shed from the platform to become freely moving intermediate particles that were rounding asperities through impact and equally able to affect the topographic slopes. This would also explain the inhibition of polish development in spite of lubrication. Indeed, this interaction produced a wear pattern that is distinctive wholly for its overall effect on the microtopography, not reliant on microwear polish for evidencing contact with stone-like materials. Abrasion apparently plays a more limited role as well, possibly because the surface is continuously weakened by fatigue.

Exps 3036, 3037 – diorite pebbles on coarse-grained sandstone (3048) and Acropora palmata *(2476) – 60 minutes, water and quartz sand additives*

The experiments with diorite pebbles were conducted on different platforms. Since both had proven to be inefficient grinding surfaces in previous experiments, loose quartz sand was added as abrasive. Thereupon the sandstone platform ground efficiently whereas the softer coral performed more poorly, but the wear trace patterns on the blanks resemble each other. The light-coloured constituent minerals are well levelled bearing little polish, whereas the apparently more susceptible dark minerals were abraded more strongly and now appear sunken. The microtopography is rough but rounded, fairly bright, and scintillating, equivalent to the pattern described for experiment 2550 above (Figure A4). This is better visible on the dark minerals than on the higher lying light ones, on which the texture also appears slightly less rough. Stereoscopic striations are absent on either diorite, but incipient stone scratches appear on the blank ground on the coarse-grained sandstone. The surfaces lack lustre from abrasion, though some of their constituent minerals reflect light.

Exp. 2782 – greenschist-facies overprinted volcanic rock blank on fine-grained sandstone (3047) – 30, 60, 90 minutes, water additive

The reddish, fine-grained sandstone platform of this experiment proved capable of abrading the greenschist matrix blank, though it did not reach the efficiency of the quartz arenite. The surface of the blank became well levelled with a faint striated directionality at the stereoscopic scale, which remains unchanged across the observation intervals. Microscopically it corresponds to scattered patches of small, but relatively flat and bright polish with a rougher texture and clear directionality (Figure A5). The density and linkage of the polish increases after 60 and 90 minutes of grinding, evidencing how more topographic highs are reached and abraded in the process. Compared to the traces from

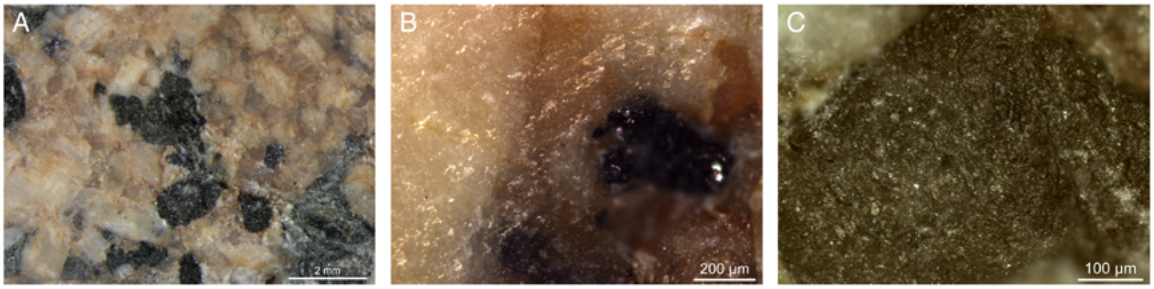


Figure A4: Various diorite surfaces (A-B, 3036; C, 3037) abraded for 60 minutes using a quartz sand slurry on a coarse-grained sandstone (3038) and *Acropora palmata* coral (2476).

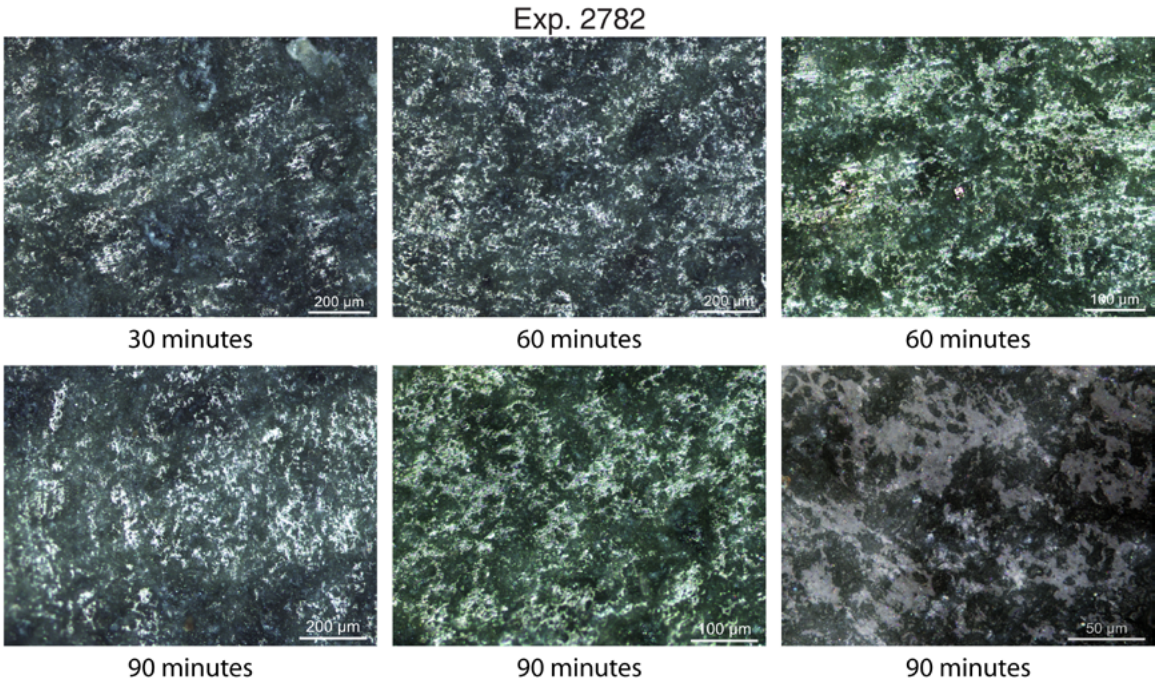


Figure A5: Various surfaces from greenschist-facies overprinted rock 2782 abraded against a fine-grained sandstone of high cohesion (3047) with water.

previously described experiments, however, the distribution of polish is much more irregular and these structures fluctuate in size (Figure A5). Moreover, as the polishes connect, the elongated gouges of the stereoscopic scale are made visible within them, skipping over numerous interstitial spaces in between. The polish itself has become heavily striated in certain areas (Table 2, *Striations in polish*). The macroscopic lustre is patchy and diffuse as a result of the erratic polish distribution, with a moderate shimmer.

This wear trace signature clearly results from abrading asperities wearing down the surface of the blank, striating the polish to a degree not seen in previous experiments. It seems as if the interaction was dependent solely upon hard and cohesive (static) asperite grains to enact abrasion, while the load associated with fatigue failed to materialise. Thus, the topography of the blank was not structurally weakened and crushed to the degree seen before. The absence of intermediate particles shed from the cohesive sandstone platform appears a requirement for this to happen. Other variables involved could be a comparatively lower structural resistance of its matrix, or unnoticed differences in the load exerted by myself compared to the other experiments.

Exp. 2515-A – greenschist blank on coarse-grained sandstone (3048) – 30, 60 minutes, water additive

This particular platform proved inefficient for the abrasion of hard lithics, probably due to the relative coarseness of its grains. The stereoscopic topography of the blank obtained a frosted appearance, as the high points were barely lowered and most of the surface areas, laying slightly lower, remained unaffected (Figure A6). The interaction further resulted in a strongly developed dull microwear polish with roughness and non-invasiveness corresponding to typical contact with a stone. The polish structures are strongly ploughed displaying the pathways created by asperities on the opposing sandstone, revealing the larger size and occasionally sub-angularities thereof. The texture otherwise accords with the crushing of asperities, though with more of a smeared appearance that suggests

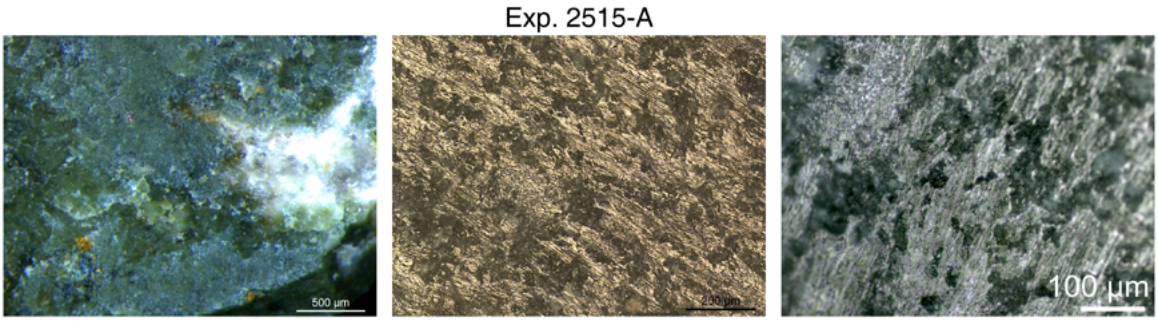


Figure A6: Various surfaces from greenschist-facies rock 2515-A abraded for 60 minutes against a coarse-grained sandstone (3048) with water.

some of it consists of matrix displacement from the abrasion. The macroscopic lustre is fairly dull and interrupted.

Exp. 2514 – greenschist blank on Acropora palmata *(2476) –30 minutes, water additive*

This experiment relied upon the mechanical properties of the stony coral and its tendency to shed slurry-forming carbonaceous powder under load to facilitate the abrasive function. As a result, the greenschist blank abraded the coral platform at great pace while itself sustaining only minor wear. The surface is poorly levelled and shows a frosted appearance, corresponding to a continuously interrupted, almost pearly lustre. The microtopography contains large, rough, and bright stone scratches (see Table 2, *'Stone scratches'*) on the peaks, defined as interrupted ploughing marks consisting of internal striations. There are intermittent flat polish structures (loose and separated distribution). The underlying surface shows some crushing and occasional striations, probably derived from the carbonaceous slurry (Figure A7).

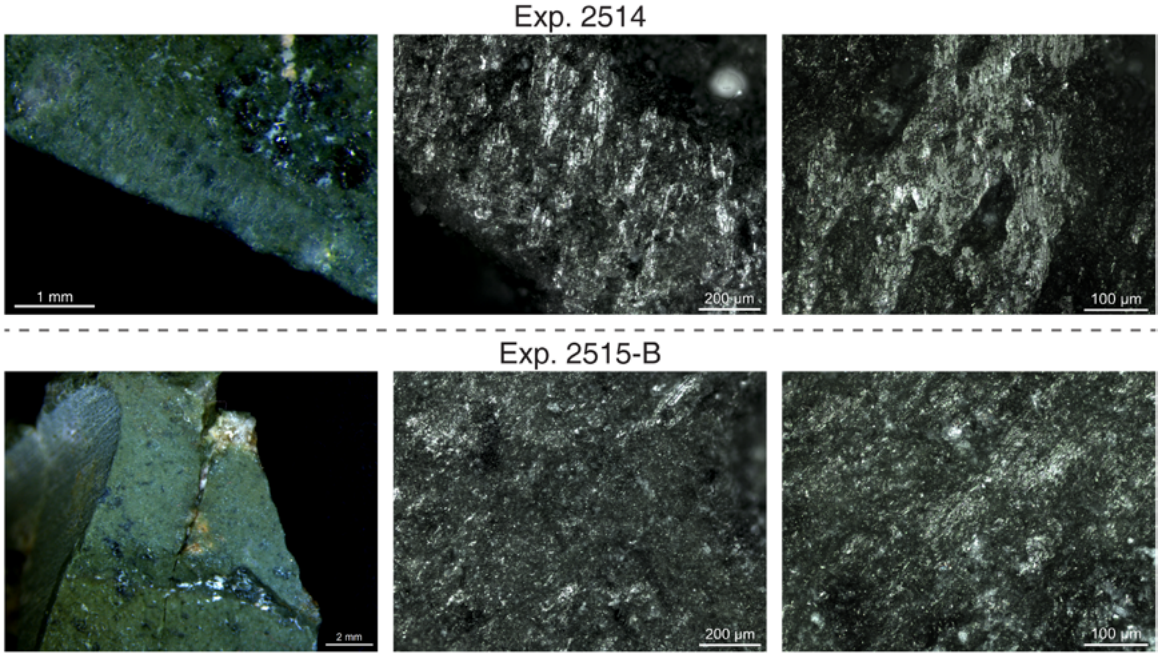


Figure A7: Various surfaces from greenschist-facies overprinted rock blanks abraded for 30 minutes on *Acropora palmata* with water (2514) and water and quartz sand (2515-B).

Exp. 2515-B – greenschist blank on Acropora palmata *(2574) –30 minutes, water and quartz sand additives*

This experiment reduced the surface of the blank at a relatively slow pace. Seen from the stereoscope the levelling is very poor, as it instead retained a gradual sinuous gradient. The primary type of microwear is the evenly spread and slightly wavy bright scintillation draped over the surface topography. A rough and poorly developed polish occurs on the peaks, loosely patterned after the grinding motion (Figure A7). Macroscopic lustre is not exhibited.

This wear evidently result through abrasion from the freely moving quartz grains in conjunction with fatigue load. The presence of some polish is perhaps associable to the presence of carbonaceous particles from the stony coral. Apart from that the microtopography is analogous to that of experiment 3037, and comparable to that of exp. 2550.

A1.2 List of experiments indicated in Chapter 5, Section 5.3

Table A1: Shellworking and boneworking experiments. For a full description and ancillary experiments, see Breukel and Falci (2015), and for *L. gigas* and *Spondylus* sp. also Falci *et al.* (2017b).

Blank material	Activity	Tools	Lubricant	Time	Efficiency	Notes
L. gigas lip	Incising, sawing	Flint blade		20'	Effective	
L. gigas lip	Incising, sawing	Flint flake	Sand, water	135'	Effective	
L. gigas lip	String-sawing	Cotton string	Sand, water	100'	Effective	
L. gigas lip	Grinding	*A. palmata*	Water	30'	Effective	
L. gigas lip	Grinding	*A. palmata*		30'	Very effective	Frictional heat modified surface
L. gigas lip	Palm drilling	Hafted flint bit		-	Effective	
L. gigas lip	Bow drilling	Hafted flint bit		-	Very effective	
L. gigas lip	Mechanical bow drilling	Hafted flint bit		-	Very effective	
L. gigas lip	Bow drilling	*G. officinale* point	Sand, water	103'	Effective	Initial perforation set using flint
Oliva sp.	Incising, sawing	Flint blade		60'	Effective	Perforated
Oliva sp.	Grinding	*A. palmata*		60'	Effective	
Spondylus sp.	Groove-and-snap	Flint flake		63'	Effective	Effective snap
Spondylus sp.	Notch incising	Flint flake		25'	Effective	
Spondylus sp.	Notching	*G. officinale* flake	Sand, water	91'	Effective	Effectively a sawing motion
Spondylus sp.	Grinding	*A. palmata*	Sand, water	35'	Very effective	*Spondylus* sp.
Spondylus sp.	Grinding	Sandstone	Water	80'	Very effective	
Spondylus sp.	Mechanical bow drilling	*Bos taurus* splinter	Sand, water	110'	Effective	
Cervidae canine	Drilling	*Canis familiaris* canine	Probably none	'90	Probably effective	By A. Verbaas
Bos taurus, fresh	Incising, single strokes	Flint		-	Very effective	
Bos taurus, fresh	Incising, single strokes	Cervidae premolar, cusp		-	Effective	
Bos taurus, fresh	Incising, single strokes	*Spicula sp.*		-	Good	Fragmented edge
Bos taurus, fresh	Incising, single strokes	*A. opercularis*		-	Moderate	Notched edge
Bos taurus, fresh	Incising, single strokes	Arcidae		-	Good	Notched edge

Bos taurus, fresh abraded	Incising, single strokes	Flint	-	Very effective	
Bos taurus, fresh abraded	Incising, single strokes	Cervidae premolar, cusp	-	Effective	
Bos taurus, fresh abraded	Incising, single strokes	*Spicula sp.*	-	Good	Fragmented edge
Bos taurus, fresh abraded	Incising, single strokes	*A. opercularis*	-	Moderate	Notched edge
Bos taurus, fresh abraded	Incising, single strokes	Arcidae	-	Good	Notched edge
Bos taurus, cooked	Incising, single strokes	Flint	-	Very effective	
Bos taurus, cooked	Incising, single strokes	Cervidae premolar, cusp	-	Effective	
Bos taurus, cooked	Incising, single strokes	*Spicula sp.*	-	Good	Fragmented edge
Bos taurus, cooked	Incising, single strokes	*A. opercularis*	-	Moderate	Notched edge
Bos taurus, cooked	Incising, single strokes	Arcidae	-	Good	Notched edge
Calcite	Incising, sawing	*L. gigas* flake	4’	Effective	Little tool wear
Calcite	Bow drilling	Flint	27’	Effective	

Appendix 2

Experimental woodworking and review of wood properties and archaeological use

This appendix provides data on various wood species from both experimental and archaeological perspectives. I will first detail what the principle variable of specific density refers to and how it is reported throughout the work, and reference the sources of other measurements in Table 3. Section 1 contains information on the wood species experimented with, and the resulting wear trace patterns are described in section 2. Section 3 contains an overview of wood species that are either archaeologically identified, or emphasised in ethnohistoric sources, as having been utilised towards specific tangible purposes.

Specific density and secondary values

The variable of specific density is calculated after the weight and volume of a wood. The standard notation uses oven dry mass/green volume and provides these values in weighted g/cm^3, of which a value of 1.0 equals the density of water. The Global Wood Density Database (Chave *et al.* 2009; Zanne *et al.* 2009) forms the main source since it compiles much of the values reported in the literature and harmonised the notations. Other types of notations common in the literature are kg/ m^{-3} or lb/ft^{-3}, and the measurement of volume at 12% moisture content, all of which result in different numbers. The specific density of a wood is highly correlated with wood structure, mechanical strength, and various measures of hardness (Chave *et al.* 2009). For instance, they can be used to calculate Janka side hardness values (which measure the resistance to indentation) in N and are calculable using the formulas provided in Wiemann and Green (2007) and the *Wood Handbook* (FPL 2010). Specific density therefore forms an appropriate index to differentiate wood species with in the examination of wear. In any given interaction of wear, different properties of the contact material will lead to distinguishable outcomes. This implies the ability to methodologically distinguish softer, medium, and harder timbers.

Specific densities are here reported by the range averaged from the available values, which are simplified by removing outlier measurements, non-Neotropic measurements, and retracting a level of significance. The purpose of this is to ease the average comparison of various woods as it is not feasible to assess the worth of every single measurement. To illustrate these conditions, of the 33 measurements provided for *Ceiba pentandra*, 17 remain that are taken of specimens in tropical South/ Central America. The lowest measurements are at 0.21, 0.22, and 0.23, whereas the highest are at 0.52, 0.51, and 0.489. In the text, I consider them as ranging from 0.22 to 0.5, and in this case highlight that the average measurement falls between 0.25 and 0.36 since only a single value is reported between the measurements of 0.36 and 0.489. Of the seven measurements for *Guaiacum*

*s*pp., one is of a non-Caribbean species (*G. coulteri*) and another indeterminate, these are at 1.1 and 1.05 respectively. The others range between 1.08 for both Caribbean species to 1.1 (*G. sanctum*, two in total) and 1.25 (*G. officinale*, four in total). The effective specific density range is thus at least 1.1 to 1.2 (the second highest measurement). If no data is available for the species in question, or this is not identified, I compile from the genus if a clear trend exists and indicate otherwise.

These values are therefore averages, sometimes derived of few measurements. The specific densities of the wood in individual trees actually varies depending upon age and the radial trend of the species: in angiosperms, sapwood is usually less dense than heartwood. It is the latter wood that is most often measured for a species value, whereas it is the former wood that accounts for a significant portion of wear contact (Chapter 5). It seems to be the case that this variation is no more than ca. 2 decimals in either radial direction (Woodcock and Shier 2002), but these data are generalised and significant individual fluctuation is noted. On the absolute scale of 0.2 to 1.2 these differences are not large enough to shift the weight between different hardness groups, but future research into this variable for wear trace studies should ideally measure and report the specific density from the experimental wood sample in question. In species accumulating silica, bark and sapwood also contain much higher SiO_2 wt.% (Fullagar 1991).

A second reason to do is that specific density values from the published (and grey) literature are based upon idealised averages of moisture content, in order to render them comparable. In real time, the moisture content of any given part of a given wood from a given species will be the average wt.% of water in healthy living wood minus potential loss from suboptimal health, and once cut affected by environmental conditions, including drenching and continued seasoning. The measure of specific density for a given piece of wood will fluctuate accordingly.

Secondary data regarding the specific density, general hardness, toughness, comparative weight, and texture of the grain are given following the average position between Chudnoff (1980), Little and Wadsworth (1964), Longwood (1971), Pittier and Mell (1931), and Wiselius (2005), supplemented by the online sources wood-database.com and eol.org. Silica content cannot be considered due to the lack of data regarding relevant species. Since these sources do contain this information for other species, it is quite possible that none of them are significant silica accumulators. While Fullagar (1991) demonstrates silica to be a significant factor influencing the development of wear from wood, his results seem to correlate better to the average specific densities of the woods involved. To my knowledge, there are no specific correlations between silica content and specific density. Nevertheless, I would expect woods containing higher silica contents to be tougher and heavier than comparable woods without, so the variable may be indirectly captured.

A2.1 Experimental woods and overview of sequence

Five woods were experimented with, these are described here in greater detail.

Swietenia mahagoni

The West Indian mahogany is native to the western Greater Antilles, but can nowadays also be found in most eastern Caribbean islands (Acevedo Rodríguez and Strong 2012, 563). It is a large-growing tree of the dry coastal forest. Its heartwood is strong, moderately hard, and heavy, resists decay and insect attack very well, and it is known for its workability and lustrous appearance (Little and Wadsworth 1964, 250-252). The specific density of this species stands at 0.75 g/cm^3, though this is

probably an upper value for green wood (cf. Longwood 1971, 83). Considering the secondary sources provides a lower value of ca. 0.55 g/cm^3. A large number of tropical woods are marketed as mahogany due to the positive associations with the name, and in commercial circles 'genuine' mahogany refers to *Swietenia macrophylla* (Honduran mahogany) of which the wood is softer and lighter (Chudnoff 1980; FPL 2010).

West Indian mahogany was historically considered as an excellent ship-building wood due to the exceptional dimensional stability of the wood, preventing it from warping and shrinking. However, overharvesting has led to the extirpation of trees with wider girth, and modern specimens no longer attain historical dimensions. Archaeologically, the wood was used for house construction elements and the carving of objects such as paddles. The smaller 'Stargate' canoe from South San Andros Island is purportedly made of mahogany (Callaghan and Schwabe 2001, cited in Fitzpatrick 2013), and the Kalinago are said to have use this wood for canoes in historic times (Atwood 1791, 24). However, the tree is considered exotic to the Lesser Antilles (Acevedo Rodríguez and Strong 2012, 563). Lovén (1935, 411) identifies *S. mahagoni* as the indigenous tree known by the name *caoba*, a word which has myriad other implications and is connected to sacred ritual.

Calophyllum brasiliense var. *antillanum*

Galba, as it is known in St. Vincent, is native to the circum-Caribbean region (Acevedo Rodríguez and Strong 2012, 203). It is a very large tree that grows best in moist forest from the coast to the lower mountains. The wood is fairly strong, hard, and moderately heavy, and durable to decay but not to insect attack. It fairly easy to work despite being medium to coarse in texture, often with interlocking grain (Chudnoff 1980, 65-66; Little and Wadsworth 1964, 348). The specific density of *C. brasiliense* stands at 0.5-0.7 g/cm^3 in Zanne *et al.* (2009), there are no separate distinctions from *C. b.* var. *antillanum*. Most sources place the range somewhat lower, at ca. 0.51-0.57 g/cm^3, but an upper value of 0.70 is supported by Longwood (1971).

The wood is a widely regarded construction material, and it was regarded as very suitable to this purpose by the local collaborators in the St. Vincent construction project. The common name in the Spanish Islands, (santa) maría, is said to be of indigenous origin (Little and Wadsworth 1964, 350). If so, it may be an early colonial Hispanisation of the tree previously known as *mari-a*, of which the corresponding species is not recorded. Lovén (1935, 411, 419-420) notes the indigenous *mari-a* as a sacred tree, used especially for constructing canoes.

Chimarrhis cymosa

Waterwood is a medium-sized tree endemic to the Greater and Lesser Antilles (Acevedo Rodríguez and Strong 2012, 804), growing primarily in the lower montane rainforest and commonly bordering streams. The wood is strong and durable, moderately hard, and of medium-coarse texture, and reported as easily workable (Longwood 1971, 99). The specific density of *C. cymosa* is reported at 0.71 g/cm^3, which is the average of the 0.65-0.85 g/cm^3 range reproduced in Longwood. It was considered a suitable timber in the construction project, used for overhead beams, but its use is not known archaeologically.

Coccoloba uvifera

Seagrape is a common sight on many of the Antillean coastlines, and is native throughout the circum-Caribbean region (Acevedo Rodríguez and Strong 2012, 774). It is a smaller tree that grows on sandy shores, often with twisting, curving trunks due to constant exposure to the sea winds. It provides a (very) hard and heavy, strong, close-grained wood (Little and Wadsworth 1964, 82; Pittier and Mell 1931, 10-11). The specific density of *C. uvifera* is reported at 0.7 g/cm^3. Seagrape was a recommended material by the local collaborators who praised it as a hard and dense wood, good for construction. Though it is capable of taking a fine polish, is not as often utilised in construction or craft on account of the ill-suited growing conditions. It is, however, a popular fuelwood, and *Coccoloba* sp. has been archaeobotanically argued as such in Ostionoid El Bronce, Puerto Rico (Pearsall 1985, in Newsom 2010).

Prosopis juliflora

Cambrón, which our collaborators in St. Vincent called 'Bleary cedar' or 'coco shade' (unregistered vernacular names), is a xeric tree shrub native to Central and South America. It is commonly found in the Caribbean islands, and considered native by Acevedo Rodríguez and Strong (2012, 454-455) though not by others. Historically, it is described as early as 1598 by López de Castro and under the name algarroba by Fernández de Navarrete in 1680 (Esteban Deive 2002, 271, 298). In St. Vincent, the most likely identification was given based upon the morphology of the bi-pinnate leaves, yellow fruit pods, and paired thorns. The wood is tough and strong, heavy, and moderately hard, being also easy to work and resistant to decay (Little and Wadsworth 1964, 166). The specific density is reported at 0.75-0.8 g/cm^3.

P. juliflora is a quality fuelwood which burns cleanly and produces high energy value charcoal (Oduor and Githiomi 2013). It is occasionally used for fencing and woodcraft, and in St. Vincent is often planted to provide shade. The tree grows on the sites of El Flaco and Argyle today. However, wood from its genus has not been identified archaeologically in the Caribbean.

A2.2 Experimental results from chopping wood and various hafting arrangements

As explained in section 5.2.2, all wear traces described below are taken on the area of the bevel from where it borders the edge to ca. 5 mm behind it, tapering out towards the lateral sides. The locations of consecutive individual micrographs do not correspond across a sequence, however. This is chiefly because they show the most representative and best developed characteristics of the wear traces discussed, of which the location varies. There are no significant differences in wear trace development between the bevels from either opposing face.

Table A2: Biography of experiment 2550.

Stage	Start date	User	Activity	Contact material	Time	Notes
Roughout	-	D. Pomstra	Pre-shaping	Power tools	Unknown	Done with modern equipment
Manufacture	-	D. Pomstra	Grinding, wet	Sandstone exp. SWH	Not measured	See Appendix 1.1, exp. 2550
Unused	25.01	F. v.d. Leden	-	None	0	Cast #1

Hafting 1			Male transv. emb	*S. mahagoni*	30	Broke quickly
Use	26.01	F. v.d. Leden	Felling	*S. mahagoni*	30	
Casting	26.01					Cast #2
Hafting 2			Male transv. emb	*S. mahagoni*	315	
Use	27.01	F. v.d. Leden / T.W. Breukel	Chopping	*S. mahagoni*	12+58+25	Relatively fresh wood
Casting						Cast #3
Use	28.01	T.W. Breukel	Chopping	*S. mahagoni*	34+36	Some contact with heartwood
Casting						Cast #4
Use	29.01	T.W. Breukel	Chopping	*C. b.* var. *antillanum*	54:45	Includes few contact minutes with Spanish Ash (unknown) and *Dicorynia guianensis*
Use	30.01	T.W. Breukel	Chopping	*C. b.* var. *antillanum*	33	Micro nicking, soil particles present in finishing stages
Casting						Cast #5
Use	30.01	T.W. Breukel	Chopping	*C. cymosa*	15	Wood pulp formed
Use	31.01	T.W. Breukel	Chopping	*C. cymosa*	49	Wood few days old
Hafting 3			Male transv. emb	*S. mahagoni*	261	Deeply embedded
Use	02.02	T.W. Breukel	Chopping	*C. cymosa*	27:15	Wood a week old
Casting						Cast #6
Use	02.02	T.W. Breukel	Chopping	*C. uvifera*	39:30	Felling living wood
Use	03.02	T.W. Breukel	Chopping	*C. uvifera*	36:15	Fresh wood, some microretouch formed
Casting						Cast #7
Use	03.02	T.W. Breukel	Chopping	*C. uvifera*	44:45	Felling desiccated wood
Casting						Cast #8
Use	04.02	T.W. Breukel	Chopping	*P. juliflora*	113.30	Felling reaction wood, thereafter most contact against heartwood
Casting						Cast #9

Exp. 2550, phase 1 – chopping Swietenia mahagoni *– 30, 125, 195 minutes (195 consecutive minutes)*

The first observation to be made in this experiment pertains to the smoothening of the manufactured micro-topography, as peaks become less distinctive and the relief is diminished. Some development of use wear traces takes place already after 30 minutes, which occur as isolated patches of rough textured polish that infrequently connects in a reticulating pattern at higher elevations (Figure A8, a; Table 4, *Rough*). On the whole, though, wear is uncommon over the surface and is typically generic and undeveloped. This changes after 125 minutes, when the traces become more wide spread and distinctive. Individual spots of polish have clearly increased in size and begun to connect on the higher areas. These are consistently oriented in parallel or perpendicular bands, interrupted by topographical lows. The texture is smooth, though uneven, and striations appear in the polish following the

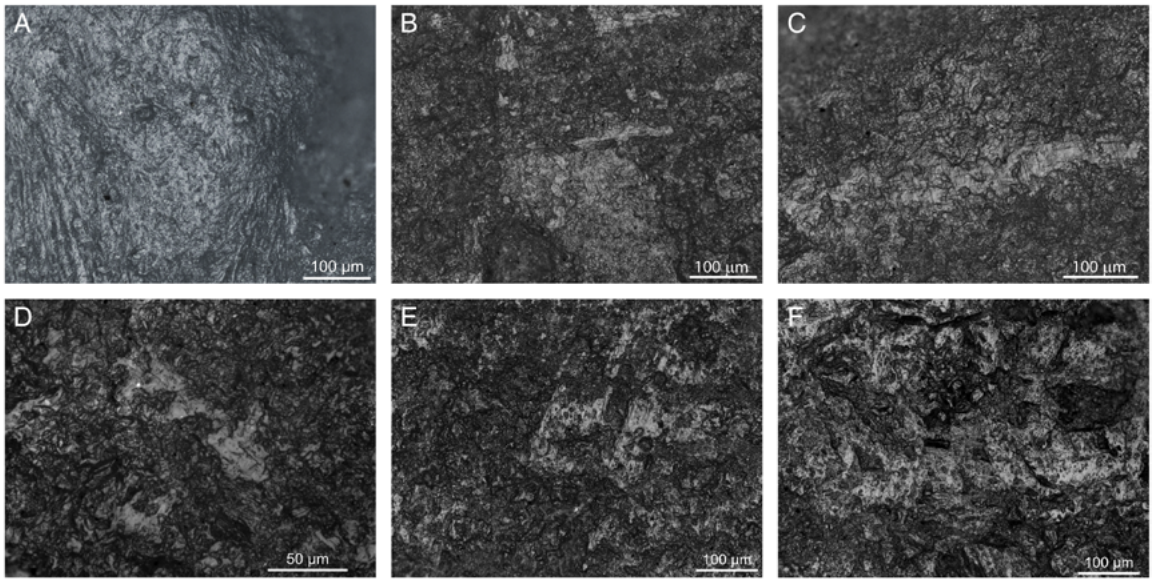


Figure A8: Pronounced developments of microscopic woodworking traces on *S. mahagoni*, seen after 30 minutes (A), 125 minutes (B and C), and 195 minutes (D), and on *C. b.* var. *antillanum*, seen after 88 minutes (E and F).

downward direction of the chopping motion perpendicular to the centre of the edge (Figure A8, b, c).

Some doming in the topography is noticeable, but this characteristic is better expressed after 195 minutes of work. At that point the distribution has grown more extensive and is directional in most places, though it remains low with isolated spots of polish interspaced with polish structures patterned as bands. Pitting is now observable in the larger patches, which are otherwise texturally comparable with only a slight reduction in unevenness (Figure A8, d; Table 4, *Pitting*). Some degree of invasiveness is apparent, shown as scintillation occasionally observed on the slopes, though remnant grease generally interfered in the observation of this characteristic.

Exp. 2550, phase 2 – chopping Calophyllum brasiliense *var.* antillanum – *88 minutes (283 consecutive minutes)*

Upon the conclusion of this phase, the surface microtopography had underwent significant changes. The polish structures are small to medium sized and are spread more evenly and densely over the surface than before (Figure A8, e-f). In some areas they interlink across the topographic heights as larger structures, in others the polish remains mostly on separate asperities. Their texture is mostly smooth and pitted, with a slowly dulling rough-textured scintillation in the lower areas. The topography is domed (Table 4, *Standard*), while both striations and a corrugating directionality are occasionally present. Compared to the preceding traces on *S. mahagoni*, the polish distribution is more evenly developed with larger and smoother structures (Table 4, *Smooth*).

Exp. 2550, phase 3 – chopping Chimarrhis cymosa – *92 minutes (375 consecutive minutes)*

Upon the conclusion of this phase, the surface microtopography had underwent dramatic changes. The distribution, size, inter-linkage and overall intensity of the polish all diminished severely, though the brightness actually increases and the topography remains domed. The traces no longer cover most larger areas, including ridges and higher plateaus as they did before, but occupy isolated peaks instead (Figure A9, a, b). Conversely, the upper slopes are defined by a rough, weak development of

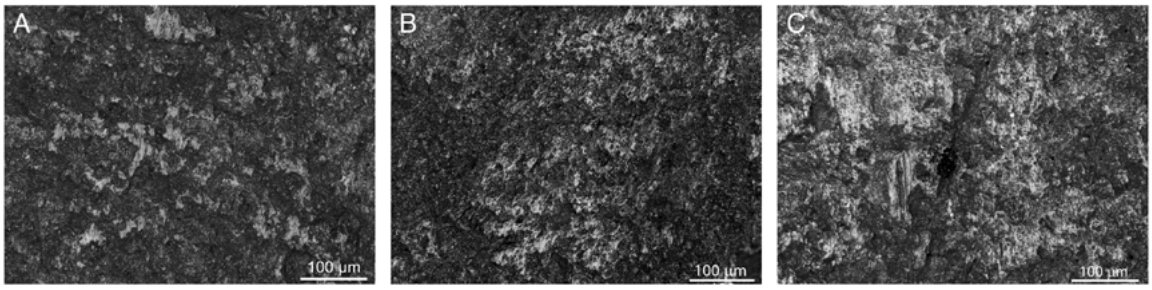


Figure A9: Examples of wear traces on the topography from chopping *C. cymosa*, seen after 92 minutes.

wear (Table 4, *Invasive – upper slopes*). This degree of invasiveness was not seen in previous phases, but perhaps due only to obstructing grease on those surfaces. Otherwise, the appearance of the polish from *C. cymosa* remains comparable (more so to *S. mahagoni* than *C. b.* var. *antillanum*), displaying a smooth and slightly undulating texture. Some directionality has been observed, oriented towards the centre of the edge.

It is clear that the activity induced a higher rate of attrition on the surface and thereby removed the developed traces from the previous experimental phase. This seems associable to the experiential toughness of the wood and perhaps relates to a different balance in modes of wear. However, determining which of those modes operate in woodworking and how they do so is a topic that needs investigation in general.

Exp. 2550, phase 4 – chopping Coccoloba uvifera *– 76, 120 minutes (495 consecutive minutes)*

This phase contains two moments of observation, coinciding with the state-change of the contact material (from felling fresh wood to felling desiccated wood). For the freshly felled state only the appearance of the resulting polish is observable in certain areas, unremovable grease obstructing an assessment of other characteristics (chiefly topography below the peaks, polish distribution, invasiveness, and density). The texture of the polish is rougher than before, and striations are absent (or obscured) though some measure of directionality remains apparent. The topography is more clearly domed, however, and where the topography permits it individual polish structures reticulate (Figure A10, a-b). While it appears that the contrast with the interstices is more gradual and lower elevations display a greater degree of modification, this is impossible to verify for the aforementioned reason. However, the overall density of wear seems to be distinctly greater than seen in previous contact phases.

For the traces resulting from chopping wood in a desiccated state, the casts were free of grease and permitted good view. Here, clusters of well developed, large, connecting polish appear. These are bright and near-smooth in texture, with minor pitting and cratering as a result of reticulation across interstices (Table 4, *Reticulating*). The topography is extensively domed, which contrasts the moderate degree of scintillation seen on the slopes (Figure A10, c); the effect is particularly pronounced where mineralogical differences in the bevel create contrast (Table 4, *Extensive*). However, other areas are rough in texture and carry medium to coarse striations within the polish (Figure A10, d). Further out, deep gouges are sometimes visible (stereoscopic striations) and such locations show linkage only with the nearest structures (Table 4), in spite of a general similarity in the high distribution of polish. These differences are more marked than they are for the experiments with fresh wood, and can be explained by the lower relative moisture level resulting in a less yielding material. Such a body would induce

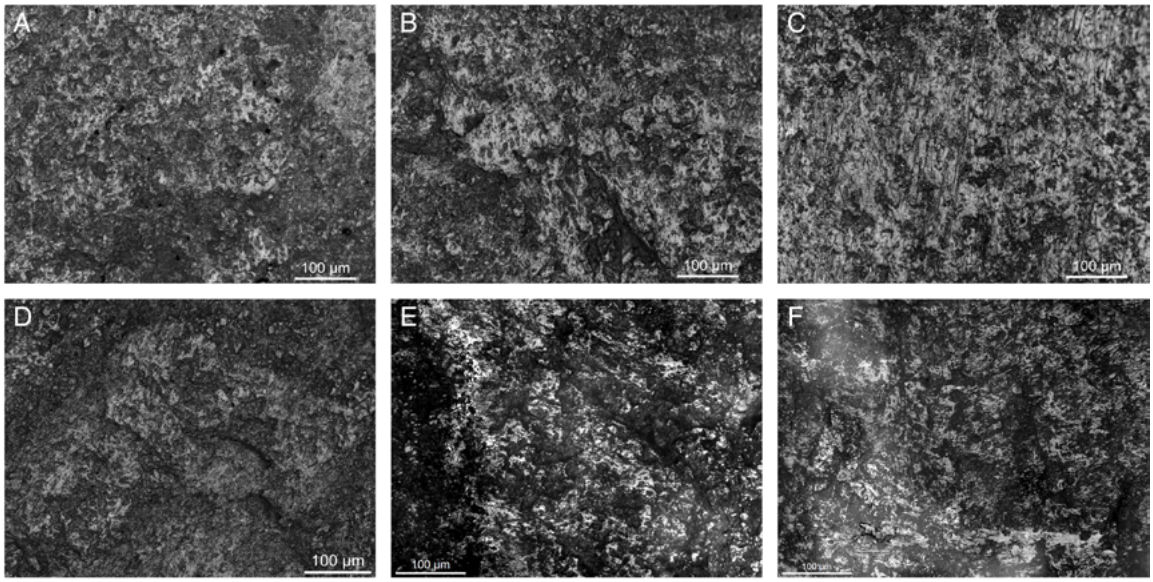


Figure A10: Examples of wear traces on the topography from chopping *C. uvifera*, seen after 76 minutes (A in fresh state) and 120 minutes (B-C in desiccated state), as well as examples from chopping P. juliflora seen after 113 minutes (D from cast, E-F from experimental surface).

heightened abrasive wear on the surfaces in most heavy contact (near the edge, best smoothened out, carrying the most intense development of polish), resulting in a comparatively greater reduction of the topographic relief permitting larger polish structures to form in the centre. This reduction is not as pronounced in surfaces further away from the point of contact, which experience lower friction from the edge sliding into the wood and thus retain higher relief and less further modification from each impact.

Exp. 2550, phase 5 – chopping Prosopis juliflora – *113 minutes (608 consecutive minutes)*
This phase concludes the use of exp. 2550, and the resulting traces were analysed from both the casts and the surface. Compared to previous contact with the other types of wood, the resulting polish consists of smaller structures that are not as domed, only occasionally affecting the upper slopes of the topography. The texture is smooth but more uneven, not quite rough, and pitting is pronounced (Table 4, *Smooth/uneven*; Figure A10, e-h). A high degree of interlinking is observed in certain areas, and the polish is overall well distributed across the zone with wear from use. Directionality is sometimes present, oriented perpendicular to the edge. The surface also contains striations forming a hard material polish considered extraneous to the use on wood, formed either during the difficult de-hafting process or by schoolchildren visiting to the reconstruction project in the final days (which got their hands on the implement at two different occasions and briefly attempted chopping random pieces of wood and soil with it).

Exp. 2550 – hafting with Swietenia mahagoni – *608 minutes*
At the conclusion of the experiment, the lateral sides had developed little to no wear from the haft. Whereas the tension is clearly visible on the haft itself (Figure A11, a), this is not the case on the lithic head. One aspect developed a slight colour difference indicating micro-topographical alteration, while some spots of semi-rough, domed polish was seen on the other. These were not particularly diagnostic, however, in light of the occasional rough flatter polish structures accompanying the manufacturing

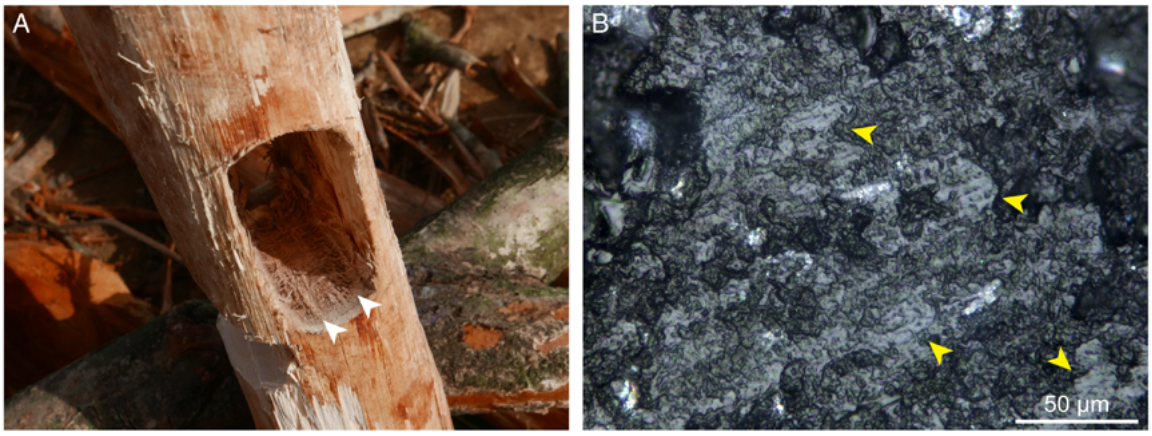


Figure A11: A) Hafting friction inside the haft after 315 minutes of contact and six days of use. B) Incipient wear traces from friction with wood developing on the face.

wear. The greatest development of wear occurs towards the distal facial zone. Here, incipient patches of polish indicating friction with wood are developing over the widespread manufacturing wear (Figure A11, arrows in b; cf. Figure A3, b). The presence of these traces on the faces is best explained by these areas having relative freedom of motion, and making on-and-off contact with woody fibres left inside the perforation. This kind of contact is unlikely to develop much further, yet forms clearer evidence at present than the topography of the areas locked in friction with the haft.

Exp. 2551 – prehensile contact on greenschist-facies overprinted volcanic – 135 minutes

The changes that occur on the microtopography correspond to an incipient development of typical prehensile wear, as a soft contact material. The higher points on the surface are covered by greasy polish, while most lower asperities became more rounded and scintillating (Table 4, *Texture – greasy*; Figure A12, a). Macroscopically, the affected areas became darker, partially from the rounding, partially relating to adhesive wear interacting with the oils of the human skin. This result underlines the slow nature of the formation of prehensile polish on fine-grained rocks, of which the experimental replication was exacerbated by physical irritation accompanying the motion. Past actions must instead be conceptualised as an extended period in which multiple short contacts adjoin, in which such an incipient polish as resulting in exp. 2551 would correspond to fairly active and prolonged activity with the piece.

Exp. 2552 – sun-dried P. juliflora *contact on greenschist-facies overprinted volcanic – 30 minutes*

The microtopography is affected by a widespread dull and rough polish on the upper surface, which in some cases develops small domes, brighter but isolated (Figure A12, b). The dull and rough modification has some invasiveness, but the degree to which lower lying micro-elevation is affected differs. The stereoscopic distribution is clearly a factor of which higher ridges on the surface of the blank were in contact with the wood, since the lower lying topographical zones are completely unaffected (Figure A12, c). A slight directionality is present, and a few non-related striations from environmental particles are observed. Wear development seems slow, and most archaeological hafted zones are expected to present more developed traces.

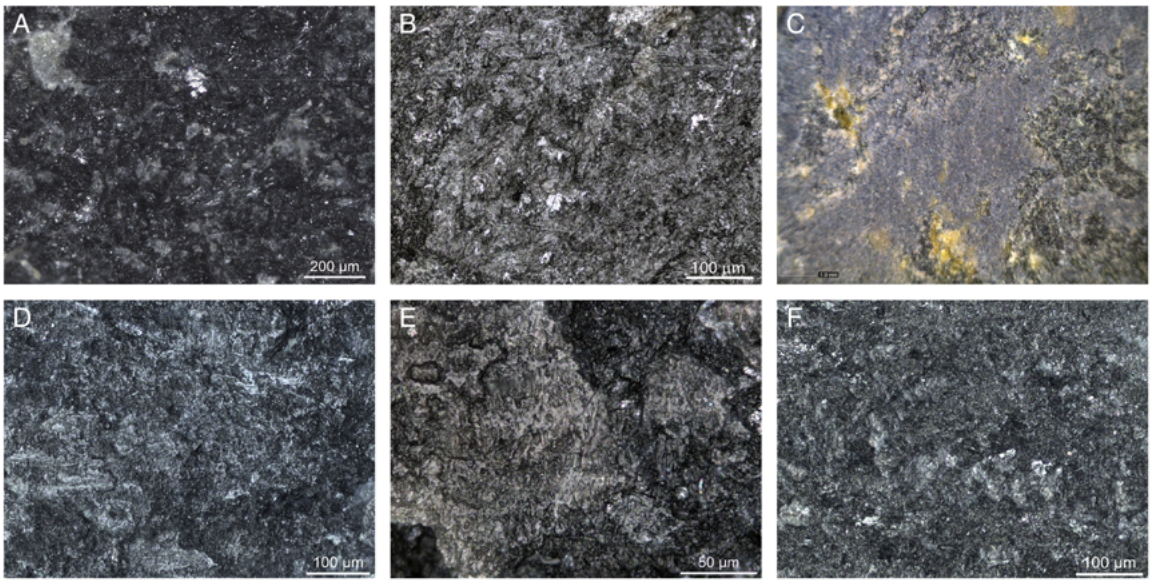


Figure A12: Micrographs of various types of friction on greenschist-facies overprinted volcanic blanks. A) incipient wear from 135 minutes of prehensile contact (exp. 2551). B and C) wear from 30 minutes of sun-dried *P. juliflora* contact (exp. 2552). D and E) wear from 30 minutes of soaked *P. juliflora* contact (exp. 2553). F) wear from 60 minutes of contact with *P. juliflora* bark bindings (exp. 2554).

Exp. 2553 – soaked P. juliflora *contact on greenschist-facies overprinted volcanic – 30 minutes*

The upper micro-topography developed large spots of domed polish, smooth/uneven and with clear corrugation indicating directionality from the load (Table 4, *Corrugation*). These are irregularly distributed over the surface. Elsewhere, the polish remains domed but individual structures are smaller, more rough than smooth/uneven, and dull (Figure A12, d-e). They interconnect across topographical highs but are intensely pitted, and descend towards generic scintillation on the slopes and interstices. Compared to the seasoned wood experiment, the wear affected a much larger part of the macroscopic surface. These were darkened, topographical boundaries were smoothened and particles unaffected from the preparatory grinding were rounded off. The lower laying topographical areas did not develop traces, in spite of the significant adherence of wood pulp therein.

Exp. 2554 – P. juliflora *bark bindings contact on greenschist-facies overprinted volcanic – 60 minutes*

Relatively minor wear developed during this experiment. The affected surface areas are characterised by a connected/covering, rough, and invasive polish that rounds off larger topographical irregularities (Figure A12, f). Small particles and asperities are not affected, and only few brighter peaks developed. The traces do not contrast the underlying 'manufactured topography' well and could also be confused with the 'sand-ground' wear signature. Striations resulting from previous grinding remain visible, if somewhat rounded by the interaction. In all, the wear is considered indistinctive for interpretation of the contact material. However, it is set apart by invasiveness exceeding that of manufacture on lithic platforms. Archaeologically, the spatial association with the original extent of a haft would form a supporting line of evidence.

A2.3 Overview of archaeological data

This paragraph provides a review of identified woods from the archaeological Caribbean. The five main cultural activity groups that involve the physical working of wood are an outcome of this review. These are indiscriminate land clearance, silviculture and harvesting, canoe building, construction work, and the carving of portable objects. Alternative activities, such as medicinal, extractive (dyes etc.), or relational are not the focus since these are unlikely to create traces of wear on the same scale. The selection is restricted to the oceanic islands and excludes Trinidad, Tobago, and the Southern Antilles since these belong to different biogeographical regions. Table A3 provides an overview of the identified species at a glance, whereas the text provides an overview of each activity group and provides additional detail on identified wood species and corresponding references. It contains the most important trees but is not considered representative beyond that, given the limited research that has been done on identifying archaeological woods, themselves subject to preservation biases, and the difficulty in obtaining many sources. Nevertheless, patterns stand out.

Table A3: overview of archaeobotanically and/or ethnohistorically identified wood species. Details concerning these identifications are available in the text.

Wood species	**Common synonyms**	**Common name used presently**	**Specific density range (from *n* weighed measurements)**	**Activity groups**	**Comments**
Swietenia mahagoni		Mahogany, West Indian mahogany, *Caoba*	0.75 (*n*=1)	Construction timber, object carving, canoe building	Secondary sources report values as low as 0.55 g/cm^3
Calophyllum brasiliense var. *antillanum*		Galba, María, Santa María, Ocuje	0.5-0.7 (*n*=14)	Construction timber (modern), canoe building	Possibly the indigenous tree *mari-a*
Chimarrhis cymosa		Resolu, Waterwood, Bois rivière	0.71 (*n*=1)	None	
Coccoloba uvifera		Seagrape, Uva del mar	0.7 (*n*=1)	Fuelwood	
Prosopis juliflora		Cambrón, Bleary cedar, coco shade	0.75-0.86 (*n*=5)	Fuelwood	
Possibly *Inga laurina*		Spanish Ash	*I. laurina*: 0.62 (*n*=1)	None	Briefly used during experimental project, small branch, splintered
Dicorynia guianensis		Angelique	0.47-0.67 av. 0.60-0.68 (*n*=9)	None	Briefly used during experimental project. Strong, durable wood
Bursera simaruba		Copperwood	0.24-0.34 (*n*=6)	Fuelwood	
Trema sp.			Ca. 0.2-0.45	Fuelwood	Genus range (Neotropics)
Krugiodendron ferreum		Black ironwood	0.95-1.35 (*n*=2)	Fuelwood	
Guaiacum spp.		Lignum vitae, *Guayacan*	1.1-1.2 (*n*=5)	Construction timber, fuelwood, object carving	
Cedrela odorata		Spanish cedar, West Indian cedar	0.34-0.45 (*n*=12)	Canoe building	Extratropical values up to 0.66 g/cm^3
Ceiba pentandra		Silk-cotton tree, *Ceiba*	0.22-0.5, av. 0.25-0.36 (*n*=17)	Canoe building	
Hura crepitans		Sandbox	0.28-0.41 (*n*=12)	Canoe building	

Dacryodes excelsa	*Dacryodes hexandra*	Tabonuco, Gommier	0.39-0.53 (*n*=3)	Canoe building	
Zanthoxylum flavum		Satinwood	0.73-0.9 (*n*=9)	Construction timber, object carving	
Erithalis fruticosa		Black torch		Construction timber	No data
Pictetia aculeata		Tachuelo, fustic	0.8 (*n*=1)	Construction timber	Often compared to *guayacan*
Sideroxylon salicifolium	*Achras/Bumelia /Dipholis salicifolia*	Bustic	0.84-0.9 (*n*=2)	Construction timber	
Sideroxylon foetidissimum		Mastic bully	0.9 (*n*=1)	Construction timber	
Gymnanthes lucida		Yaití	1.1 (*n*=1)	Construction timber	
Bonnetia cubensis		Manglesillo		Construction timber	No data
Acacia sp.		Tamarind	-	Construction timber	Large, divergent genus
Elaeodendron xylocarpum	Reported as *Cassine* sp.	Marble tree	-	Construction timber	No Neotropical measurements; Old World *Elaeodendron* are 0.72-0.80
Croton poecilanthus		Maran	0.60 (*n*=1)	Construction timber	Rest of genus ranges 0.39-0.48 in the Neotropics
Bucida buceras		Ucar	0.69-0.93 (*n*=2)	Construction timber	
Bucida capitata	*Buchenavia tetraphylla*	Ucar	0.5-0.7 (*n*=8)		Alternative species ID for ucar
Pouteria multiflora		Almendrón	0.74-0.80 (*n*=2)	Construction timber	Genus ranges from below 0.5 to above 1.0 g/cm^3
Manilkara bidentata	*Manilkara nitada*	Bulletwood, bálata	0.8-0.95 (*n*=14)	Construction timber	
Haematoxylum campechianum		Campêche	0.88-1.00 (*n*=3)	Construction timber	
Guibourtia hymenaefolia	*Pseudocopaiva hymeneaefolia*		1.00 (*n*=1)	Object carving	
Conocarpus erectus	*C. erecta*	Button mangrove	1.00 (*n*=1)	Object carving	A value of 0.69 g/cm^3 is reported from North America
Pera bumeliaefolia		Black ebony	0.55-0.73 (*n*=9)	Object carving	Genus range
Belairia sp.			-	Object carving	No data
Diospyros sp.			0.47-0.88 (*n*=11)	Object carving	Large and wide-ranging genus
Cordia sp.			Ca. 0.35 to 0.7	Object carving	Large, divergent genus
Carapa sp.			0.42-0.61 (*n*=12)	Object carving	
Caesalpinia vesicaria			0.74-1.2, av. 0.9-1.05 (*n*=15)	Object carving	Genus range

Clearance of plots of land

Land clearance can be roughly divided into the opening up of land for horticulture or agroforestry (swidden) and more general purposes (habitation, trail making, etc.). Though such activities are never truly indiscriminate, it is to be expected that the dominant relation with any 'worked woods' refers to a local ecological community, i.e. all species inhabiting the same plot of land. The general

practice of swidden is to cut down all easily felled trees (smaller and younger specimens, probably also certain medium sized species), planning tree falls to take down smaller trees and portions of brush. Subsequent fire setting to the plot clears out most ground level obstacles and fertilises the soil (Oviedo records precisely this in the Greater Antilles, cited in Newsom and Wing 2004, 5-6). Larger trees or those with buttressed roots may be felled with fire or are simply left alone, since the heat of the burning often causes them to lose their canopy. This process therefore entails a series of interactions with green woods of all kinds of specific density measures, without order and probably of fairly short duration for each. The resulting wear trace signature can only be an amalgam of all types of wood contacts, the state of being green the only common factor, and even that is not certain given that there may be working of (partially) charred wood in a subsequent phase.

Theoretically, this activity can be divided into clearing lands in different ecological zones. By way of example, the Kalinago of early historic times located their gardens high up in the mountains (Moreau, 1990), and thus would have to contend with what was probably a multi-story forest rich in species diversity. Little and Wadsworth (1964, 12-17) provide a reconstruction of the dominant species in the main habitats of Puerto Rico, and estimate the coexistence of up to 170 species in its mountainous tropical moist forest. The woods in this type of ecological community are completely different from what is to be expected in the coastal areas and plains, where indigenous habitation sites are located. These types of spaces similarly imply the clearance of land, whilst the untargeted felling of trees may occur for other reasons as well, such as creating space of movement in the form of trails (described in Moreau 1990).

It is not clear if any of these options would result in distinguishable wear. However, it is probable that the later contact woods from the activity will come to dominate the wear trace signature and start to shape it towards its own characteristics. The differences in wear observed from the experimental programme indicate that this likely differs per tree, as it is not known how a 45-minute re-working of mahogany (initially producing weak results) would transform the sequence of traces after e.g. seagrape. The regression induced after working waterwood is notable in this regard, since it shows how the formation of wear is not a simple build-up, and that the equilibrium in which traces develop stably will become upset upon a change in contact materials. The experimental felling times for a single diameter were much shorter than the eventual intervals of sustained contact. This suggest that to obtain a comparable trace formation from a single tree one might look at diameters of at least 20 to 25 cm (to cut in 45 minutes of effort). Considering the factors of teamwork, skill, and gravity induced falls this is probably more.

Silvicultural activities

The main silvicultural activity with archaeobantical evidence for particular wood species is fuelwood, which can be seen partially in the same light as land clearance in its level of discrimination. It stands to reason that untargeted gathering (such as collecting dead branches) would initially result in a representative assembly of local ecological communities. However, there are probably cultural considerations also in selecting woods with higher calorific values or beneficial burning properties (not sparking, fragrance, etc.), and the avoidance of woods with adverse properties such as manchineel (*Hippomane mancinella*). In conjunction with high population densities (e.g. for *Guaiacum* spp.) this may imply the active gathering of living wood as fuel (Cartwright 2018).

Based upon archaeobotanical identifications, there is indeed a large variety of wood species

encountered as charcoaled pieces and/or within hearth features (deFrance and Newsom 2005; Newsom and Wing 2004). These range from soft woods (*Bursera simaruba* and *Trema* sp., specific density at ca. 0.25-0.4) to a series of moderately hard woods (at 0.6-0.8) such as *Coccoloba* sp. to very hard woods such as *Krugiodendron ferreum* (at 0.95-1.35). Lignum vitae (*Guaiacum* spp.) in particular has been identified as fuelwood at a number of archaeological sites throughout the Ceramic Age in both the Lesser and Greater Antilles, though decreasing in frequency over time as the apparent result of overexploiting these slow growing species (Newsom and Wing 2004). Woods such as lignum vitae with high specific densities, and/or large quantities of resins have larger calorific values than other woods, and burn for longer and at hotter temperatures. Nevertheless, these are not the sole fuelwoods; they may simply be overrepresented due to the preservation bias existing for denser, charred, and rot-resistant woods such as them (Newsom and Wing 2004, 169). The archaeobotanical diversity is substantial and includes many woods that have numerous other useful cultural properties. The degree to which any of them are reflected on the use wear traces on an edge-ground tool complex will be the condition of whether specific silvicultural techniques were used, i.e. pruning and coppicing to optimise the output of young growth. Newsom and Wing (2004, 109) notes that dry forest woods respond well to this type of treatment, and many identified fuelwoods belong to that community. For the interpretation of use wear, this does seem to be a significant complication, since the entire range of woodworking spectra could therefore represent fuelwood gathering.

Canoe building

Based upon the ethnohistoric evidence there are restricted types of woods that were utilised in the building of canoes. According to Oviedo and Las Casas, most of the larger canoes in the Greater Antilles were made of cedar and *ceyba* trunks, as well as the sacred *mari-a* (Lovén 1935, 411, 419-420). The first is most likely Spanish Cedar (*Cedrela odorata*), the second *Ceiba pentandra*, and the third potentially *Calophyllum brasiliense* (above). Cedar and *ceiba* both are easily worked woods with low specific densities (0.34-0.66, av. 0.38-0.45 respectively 0.22-0.5, av. 0.25-0.35), their light weight providing them good buoyancy (Little and Wadsworth 1964, 242-244, 332-224, 348-350; Zanne *et al.* 2009). It is entirely conceivable that these soft woods give way to wear trace developments that are distinguishable from those in the experimental range. The wear trace characteristics resulting from working galba fall within that range, however, since it is somewhat harder (Section 5.2.1.2). Mahogany is a suggested tree species due to its original dimensions, and the "Stargate" canoe from South San Andros Island in the Bahamas is reportedly made from this material (Callaghan and Schwabe 2001, cited in Fitzpatrick 2013). Other species indicated by Little and Wadsworth (1964, 276-278, 238-240) as utilised in canoe building are sandbox wood (*Hura crepitans*) and tabonuco or gommier (*Dacryodes excelsa*, often reported as *D. hexandra*), the former comparable to the soft woods above and the latter a slightly harder and tough wood at specific density 0.39-0.53. The Kalinago of Dominica commonly use this tree for the manufacture of their canoes. According to (Atwood 1791, 24), they switched from mahogany at the end of the 18th century since these trees would no longer attain the requisite diameters due to overharvesting of the stock.

Felling and working of construction timbers

For house-building materials the record is similarly oriented towards species with long straight trunks, but its species diversity is much broader. Archaeological woods identified as belonging to posts include

Sideroxylon sp. at Heywoods, Barbados (Drewett *et al.* 2000), satinwood (*Zanthoxylum flavum*), cf. black torch (*Erithalis fruticosa*), and cf. bustic (*Dipholis* sp. [synonymous with *S. salicifolium*]) at Golden Rock 1 (Newsom 1992), cf. tachuelo (*Pictetia aculeata*) at Tibes, Puerto Rico (Newsom 2010), and *S. salicifolium* and *S. foetidissimum* at El Cabo (Samson 2010, 170). The excavations at Los Buchillones uncovered mahogany (*Swietenia mahagoni*) and lignum vitae (*Guaiacum* sp.) for the main posts, and for secondary elements also yaití (*Gymnanthes lucida*) and manglesillo (*Bonnetia cubensis*) (Pendergast *et al.* 2002; Carreras Rivery 2009; Jardines Macías *et al.* 2013; Valcárcel Rojas *et al.* 2006). Lignum vitae and wild tamarind (cf. *Acacia* sp.) are common post materials at Tutu, St. Thomas, with marble tree (*Cassine* sp.) and maran (*Croton* sp.) represented by a single post each (Pearsall 2002). At Luján 1, ucar (*Bucida* sp.) was preferentially used, and almendrón (*Pouteria* spp. e.g. *P. multiflora*) occurs at Maisabel (Newsom and Wing 2004, 136, 162).

According to Oviedo, *carbana* trunks were well suited as posts, since they did not decay in their postholes, but the species is not mentioned Lovén (1935, 411); it is, however, not lignum vitae (cf. Pendergast *et al.* 2002). Breton mentions the use of bulletwood or *bálata (Manilkara bidentata*) in the Lesser Antilles in 1647 (in Lammers-Keijsers 2007, 42), for either canoes or houses but presumably the latter as it is an excellent and durable commercial timber still today. Lammers-Keijsers also mentions the potential use of campêche (*Haematoxylum campechianum*), a suitable wood for posts that was introduced from Central America in the Ceramic Age. It is abundantly clear from this overview that there are no specific tree species that are culturally targeted, with only *Syderoxylon* spp. and *Guaiacum* spp. having multiple occurrences. Instead, it stands to reason that this list reflects local availability and access of woods with suitable dimensions, with as governing principles moderate to high hardness and rot resistance. The lightest genera is *Croton* (averaging at 0.4 to 0.5), with the Puerto Rican species of *C. poecilanthus* at a value of 0.6 (Little and Wadsworth 1964; Zanne *et al.* 2009), but all others average either between a specific density of 0.7 to 0.9 or one of 0.8 to 1.0. Clearly, the selection of hard and dense woods that resist decay and insect attacks for constructing dwellings is backed up by the data. Presuming that such generally hard woods were felled and shaped green, this provides a confined range for the interpretation of wear traces from the working of wood.

Carving of portable objects

It would appear apposite to subdivide portable objects into distinct groups, based upon their potential for divergent cultural properties. The first group concerns objects that would need to endure mechanical stresses such as handles and hunting tools. A second group concerns smaller architectural elements such as planks and rafters for which durability, weathering characteristics, and suppleness are important. A third group would include objects that probably had no requirements in mechanical properties for functioning such as bowls and sculptured idols. Some of the latter may have necessitated particular trees in relation to potential sacredness or particular relational qualities, more so than other object types. One example would be if the arrestment described in Ramón Pané concerns woods from particular species, specifically known to (sometimes) act as a disguise for entities of a different nature (Pané 1999, 26).

As it turns out, however, the archaeobotanical record shows no distinctions between any of these. *Guaiacum* sp. is incredibly common for all kinds of artefacts from both groups of objects, though far from the only wood in use. It is quite possible that its superior conservation qualities are somewhat responsible for this situation, though the contextual derivation of the other identified woods includes

the same range of waterlogged sites and dry aired caves. For functional and sculptural portable objects, the set of woods from Los Buchillones includes – besides a majority of *Guaiacum* sp. – *Guibourtia hymenaefolia* (as the *Pseudocopaiva hymeneaefolia* synonym), *Conocarpus erectus*, *Pera bumeliaefolia, Belairia* sp., and *Diospyros* sp., used frequently for the manufacture of both, notably including hafts (Jardines Macías *et al.* 2013; 2015). Amongst carved stools (*duhos*) from the Bahamas *Cordia* sp. and *Carapa* sp. were also regularly utilised (Ostapkowicz 2015), and other instances of identified objects that were not made out of *Guaiacum* sp. include a *Cuban* baton from *Caesalpinia* sp. cf. *vesicaria* and a Jamaican zemi from *Swietenia sp.* (Ostapkowicz *et al.* 2012) as well as a Dominican cohoba stand from *Carapa* sp. (Ostapkowicz *et al.* 2013) and paddles from various islands in *Swietenia* sp. and *Carapa* sp. (Ostapkowicz *et al.* 2012) as well as *Zanthoxylum* sp. (Newsom and Wing 2004, 51-52, 183). The paddle of purported cedar is probably the aforementioned *Swietenia* sp. specimen, as the provenance is identical. The Kalinago of Dominica formerly used *Pimenta racemosa* for war clubs, and thereafter for other tools and small posts (Hodge and Taylor 1957). For architectural elements specifically, whether as parts of structures or as canoe sideboards (cf. Callaghan 2013), there is very little archaeobotanical evidence. Relatively softer woods such as white cedar (*Tabebuia heterophylla pallida*) and trumpet wood (*Cecropia schreberiana*) are suggested to have useful purposes in that range, however (Lammers-Keijsers 2007, 42-43).

The main thing to note in this selection is that it is rather broad, but that there appear no truly soft trees (below 0.4) or very hard woods (above 1.0) with the exception of *Guaiacum* sp. This is the case both for the whole, as well as for specific object groups. The alternative woods utilised in the fashioning of *duhos*, for instance, rank between specific densities 0.4 and 0.7 within their genus (following Zanne *et al.* 2009 and excluding measurements from beyond the Neotropics, data on Caribbean species being poor). The selections also clearly reflect ecological differences, with many of the woods from Los Buchillones not (yet) identified elsewhere in the Caribbean and not represented in the Global Wood Density Database. Here, genus ranges are between 0.45 and 1.2 with most actual woods probably between 0.6 and 1.0, and thus to a degree accounted for by the range of experimentally worked woods. The specific densities of *Caesalpinia* spp. range dominantly between 0.9 and 1.2, and thus represents the use of another harder wood in the paraphernalia it was used for.

Appendix 3

Tabulation of edge-ground macro-lithic assemblages

Measurements are given in millimetres. The particular wear trace signature matched by exp. 2550 manufacture and the quartz sand abrasives is coded as 'sand-ground', but obviously represents an equifinal collection of different techniques. The flat, bright, non-invasive polish is coded as 'mineral mirror polish' though the technological recipe remains unknown. Traces from friction with wood are presumed for all fully identified hafting arrangements in the distributions discussed in the associated sections. Other types of wear, such as traces from ligatures, bindings, or technological alterations are noted since their observation remains optional. The wood use wear signatures refer to the experiment mixtures they are likened too, as these at present are not differentiated in their physical properties. Blank fields (e.g. -) indicate no assessment could be made or the field has no relation to the object (such as use wear for established preforms), whereas the absence of a particular kind of biographically expected data will be noted (e.g. absence of grinding for hafted/used celts). In addition, the hafting field records no relevant surfaces or fragmentary relevant surfaces and the use wear field records no edge surface. This serves to better distinguish the various qualities of absence of data as a result of a lack of contact/failure to develop versus the often occurring situation that such wear is located on surfaces now missing from the artefact. Material groups fields marked by an asterisk (*) contain the preliminary groupings made by myself based upon broad similarity with materials identified by specialists.

Site	Fnr	Type	Material group	Material description	Context	Length	Width	Thickness	Procurement	Early reduction	Abrasive manufacture	Hafting	Use	Deposition	Comments
Pearls	001	Chisel, rectangular symmetric	Metamorphic, high-pressure	Jadeite-bearing, slight foliation, green-black	-	42	15	8	-	-	Coarse grooves. Soft material polish A	Terminal-axial parallel-male	Hard material contact, polish striated. Edge heavily chipped	-	GRD 006
Pearls	002	Petaloid, slight asymmetry	Metamorphic, jadeitite	Dark green	-	75	41	16	-	Flaking, pecking	Inferred prior stage. Soft material polish A	Lateral-transversal parallel-male, embedded, resin. Repecked sides	Woodworking, 'exceeding'. Edge chipped	-	GRD 007
Pearls	003	Petaloid, slight asymmetry	Metamorphic, jadeitite	Pale green	-	76	40	18	Internal defects	Bifacial thinning, pecking	Dry grinding traces, seasoned wood polish	Unsure, possible re-polishing. Rougher sides	Woodworking, experimental range (cf. galba, mahogany), polish striated. Edge heavy rounding, asymmetric distribution	-	GRD 004
Pearls	004	Biconvex, slight asymmetry	Metamorphic, prob. jadeitite	Dark green, banded	-	63	34	18	-	-	Inferred prior stage. Mineral mirror polish	Uneven wood friction, poss. perpendicular-juxtaposed	Woodworking, 'exceeding'. Edge rounded, heavily chipped, strong asymmetric distribution	-	GRD 008
Pearls	005	Biconvex, asymmetry	Sedimentary	Volcanoclastic, banded green	-	62	32	21	-	Flaking (butt)	'Sand-ground' traces, mineral mirror polish	Lateral-transversal parallel-male, embedded	Woodworking, experimental range (cf. waterwood, seagrape, bleary cedar). Symmetric distribution	-	
Pearls	006	Semi-lunar axe, symmetric	Volcanic	Ultramafic (olivine-rich)	-	102	84	18	-	Flaking of roughout. Possible pecking	Dry to 'sand-ground' traces	Unsure, unknown traces, symmetric distribution	Hard material contact, poor development. Edge heavily rounded, chipped	-	
Pearls	007	Plano-convex, asymmetric	Metamorphic, low-grade	Metatuff, grey-brown	-	66	32	14	-	-	Dry to 'sand-ground' traces	Latero-distal, transversal, perpendicular juxtaposed. Resin	Potential pliable-soft material contact, potential resharpening, thus unclear. Polish striated, asymmetric distribution	-	
Pearls	009	Petaloid, asymmetric	Metamorphic, jadeitite	Green	-	98	50	23	Internal defects	Bifacial thinning, burin blow scars, pecking	Inferred prior stage. Wood contact polish	Re-pecked sides, no friction traces	No traces. Edge sharp	-	GRD 002

Pearls	010	Wedge, symmetric	Metamorphic, jadeitite	Green	-	65	33	14	-	Pecking, not erased	Coarse grooves. Wet grinding traces, striated (hard lithic platform)	Resin, no friction traces. Repecked sides	Woodworking, experimental range (cf. bleary cedar), heavily striated. Edge heavily rounded, chipped. Asymmetric distribution	-	GRD 005. Evident craqueler
Pearls	011	Pounded (reworked), symmetric	Metamorphic, high-pressure	Jadeite-bearing, green-black	-	61	43	23	Internal defects	Pecking, not erased	'Sand-ground' traces with polish, mineral mirror polish	Unsure, possible re-polishing. Repecked sides	Reworked (pecking), pounding soft matter, rounding and chipping	-	GRD 011
Pearls	013	Petaloid, symmetric	Metamorphic, jadeitite/ omphacite	Slight foliation, medium-grained	-	83	33	21	-	Pecking, not erased	Inferred prior stage. Soft material polish B	Uneven adhesive, poss. perpendicular-juxtaposed	Woodworking, 'exceeding'. Possibly wood in dry or burnt state. Symmetric distribution	-	GRD 009
Pearls	014	Petaloid-like roughout	Volcanic	Phonolite/ trachyte	-	235	121	33	Alluvial context	Direct bifacial thinning, bipolar lateral intrusive flaking	-	-	-	Following mistakes during production	
Pearls	015	Body flake	Metamorphic, greenschist	Green with white lines, slight schistosity	-	60	37	32	-	-	'Sand-ground' traces with polish	Lateral-transversal parallel-male split	-	Following fragmentation	
Pearls	016	Petaloid butt fragment, symmetric	Metamorphic, greenschist	Green	-	61	45	7	-	-	'Sand-ground' traces, mineral mirror polish	No traces (relevant surface fragmented)	-	Following fragmentation	
Pearls	017	Edge fragment	Plutonic	Dark with white minerals	-	51	52	30	-	-	Coarse dry grinding traces, fine grinding traces, wet grinding traces (quartz arenite)	Edge fragment lacking posterior surface. Rougher sides	Woodworking, usnpecified. Edge heavily chipped	Following fragmentation	

Pearls	018	Petaloid, symmetric	Metamorphic, jadeitite	Pale green, mica-bearing	-	105	52	28	Internal defects	Bifacial thinning	'Sand-ground' traces	Lateral-transversal parallel-male, embedded, resin, bright spots	Woodworking, usnpecified. Edge rounded	-	
Pearls	019	Wedge, symmetric	Volcanic	Ultramafic	-	74	47	11	-	Possible pecking	Coarse grooves, fine grinding traces. Wet grinding traces (hard lithic platform)	No friction traces	Woodworking, experimental range (cf. galba, mahogany). Edge sharp, heavily chipped. Symmetric distribution	-	
Pearls	020	Petaloid, symmetric	Metamorphic, jadeitite	Mottled green	-	100	47	22	Internal defects?	Bifacial thinning, butt flaking, not fully erased	'Sand-ground' traces	Unsure, unknown traces, asymmetric distribution, bright spots? Rougher sides	Woodworking, 'exceeding' and experimental range (cf. waterwood, seagrape bleary cedar). Edge chipped. Strong asymmetric distribution	-	
Pearls	021	Rectangular, symmetric	Metamorphic, jadeitite	Black-green, dark colour	-	154	83	24	-	-	Coarse grooves. Wet grinding traces (quartz arenite)	Lateral-transversal parallel-male, probably split	Woodworking, 'exceeding' on edge, typical elsewhere. Edge heavily rounded, chipped. Symmetric distribution	Following fragmentation?	Evident craqueler
Pearls	022	Petaloid, symmetric	Metamorphic, jadeitite	Green	-	145	60	30	Internal defects	Flaking (butt). Pecking, not erased	'Sand-ground' traces	Latero-distal, transversal, perpendicular juxtaposed. Poss. also lateral-transversal parallel-male split. Resin, rougher sides	Woodworking, typical	-	
Pearls	023	Pebble	Metamorphic, jadeitite	Pale green	-	75	41	16	Alluvial, internal defects?	-	-	-	-	-	

Site	Fnr	Type	Material group	Material description	Z-S-s	Layer	Unit	Feature	Length	Width	Thickness	Procurement	Early reduction	Abrasive manufacture	Hafting	Use	Deposition	Other	Comments
El Flaco	0020	Butt fragment	Metamorphic, low-grade	Strong overprint, grey-green	63-64-05	4	77		41	44	17	-	Pecking traces	'Sand-ground' traces with some polish, incomplete grinding, wet stone variant 1a	No traces observed (relevant surface fragmented)	-	Full fragmentation		
El Flaco	0029	Butt fragment	Volcanic, overprinted	Brecchia protolith, grey-green	63-64-84	6	1		42	33	10	-	Not seen	'Sand-ground' traces with some polish	No traces observed (relevant surface fragmented)	-	Full fragmentation		
El Flaco	0083	Edge fragment, preform	Volcanic, overprinted	Degree unknown, greenish	63-74-44	2	6		42	30	16	Rough natural surface, unknown	Step/hinge terminations shape the edge, direct percussion	-	-	-	Production fracture		
El Flaco	0094	Medial-butt fragment	Metamorphic	Possibly garnets	63-74-34	1	7		74	46	23	Alluvial	Expedient. Slight coarse pecking on lateral side	Expedient: none but slight dry grinding traces	Latero-distal, transversal, perpendicular juxtaposed. Traces of bindings and treated resinuous adhesive	-	Medial-edge fragmentation from use impact		
El Flaco	0102	Edge-medial fragment	Metamorphic, low-grade	Plutonic protolith, green	63-75-60	1-3	2		59	47	29	-	-	Dry grinding traces (striated), wet stone variant 1b	Indeterminate traces (relevant surface fragmented)	Woodworking, experimental range (cf. seagrape, bleary cedar). Potential resharpening. Edge sharp, micro-chipping. Asymmetric distribution	Skewed transverse fracture during use		
El Flaco	0113	Butt fragment	Igneous	Dark blue-grey	63-75-40	0	2		40	38	29	-	Flake ripples, overlain by fine pecking traces	Not seen	Male embedded	-	Transverse medial fracture with point of impact on side		
El Flaco	0134	Flake, preform	Metamorphic, low grade	Basaltic protolith, green-grey	63-74-55	3	6		76	33	9	-	Flaking unspec., fine pecking traces	-	-	-	Production fracture		

El Flaco	0179-01	Petaloid	Volcanic, gabbro	Dark blue	63-74-35	5	7		93	49	16	-	Marks from pecking persist	'Sand-ground' traces, wet stone variant 1a, potential interference from contact with wood	Male, probably split	Woodworking, 'exceeding (but cf. dry seagrape)', directional. Symmetry unclear	Edge fully destroyed, fragmentation probably use-related		
El Flaco	0179-02	Butt fragment	Metamorphic, uncertain	Silicious shale? Pale green	63-74-35	5	7		49	25	21	Heavily weathered	Not seen	Incomplete grinding, unknown technique, dull lustre	Traces from friction with wood, distribution unspecified	Probable impact craters on butt, unclear association	Skewed transverse fracture	Granular red mineral residue	
El Flaco	0210	Medial fragment	Plutonic	Dark blue-black	63-64-64	2	10		63	50	29	-	Marks from pecking persist	'Sand-ground' traces, duller range	Probably male embedded, possibly supporting ligatures. Repecked sides	-	Two transverse medial fractures	Residue of uncertain origin	
El Flaco	0223-01	Flake	Plutonic, overprinted	Slight overprint, grey	63-64-74	3	10		45	35	17	Alluvial	Conchoidal flake, scars from direct percussion	Not seen	Indeterminate; see other	-	Fragmentation unsure	Indeterminate friction traces from a pliable material present	
El Flaco	0232	Butt fragment	Metamorphic, high-pressure?	Jadeite-bearing? Very pale green.	63-74-26	2	9		39	24	21	-	Unsure	Unknown abrasive technique/platform, dull lustre	Red-black grainy residue, but association unclear since occurs in sectioned surface. No wear traces observed (relevant surface fragmented).	-	-		Thin-section
El Flaco	0241	Medial fragment	Volcanic tuff, overprinted	Degree unknown, green	63-74-26	4	9		45	45	18	-	Marks from pecking persist	Unsure, possibly 'sand-ground' traces overlain by soft wear, or abrasives. Included as unspecified	No traces observed (relevant surface fragmented)	-	Two transverse medial fractures, points of impact unknown		
El Flaco	0253	Edge-medial unifacial fragment	Metamorphic, greenschist	F-g tuff protolith, lighter green	63-67-74	5	1		79	41	12	-	Not seen	Dry to 'sand-ground' traces	Indeterminate traces (relevant surface fragmented)	Woodworking, experimental range (mahogany). Edge battered dull	Destructive edge removal from use		

El Flaco	0544	Edge fragment	Metamorphic	Lighter green	63-75-10		2		30	35	14	-	Not seen	Dry to 'sand-ground' traces	Indeterminate (rel. surf. absent but treated resin deposits present)	Woodworking, experimental range (cf. fresh seagrape, mahogany). Resharpening (flaking). Edge rounded, chipped. Symmetric distribution	Resharpening impact destroyed edge, followed by transverse medial fracture		
El Flaco	0717	Butt fragment	Igneous, over printed	Dark grey, light overprint, volcanic or f-g plutonic	63-74-17	4	9		41	37	26	-	Flaking unclear, fine pecking traces	'Sand-ground' traces, short duration contact	Parallel male embedded, traces of friction with hard wood	-	Transverse medial fracture, unsure if point of impact	Unspecified blackish residue	
El Flaco	0766	Butt fragment	Metamorphic, greenschist	Tuff protolith, white veined green	63-85-88		12	Split Find	41	35	24	-	Marks from pecking persist	'Sand-ground' traces, duller range	Treated resinuous residue, hafting bright spots, system unspecified	-	Skewed transverse fracture		Thin-section
El Flaco	0772	Medial fragment unifacial	Metamorphic, greenschist	Tuff protolith, white veined green	63-85-99		12		79	31	8	-	Not seen	Dry grinding traces	Single bright spot, system unspecified (relevant surface fragmented)	-	Full fragmentation		Not an edge despite sharp morphology
El Flaco	0798	Medial-butt fragment	Metamorphic, low-grade	Black-grey mottled. Very fine-grained, metatuff?	63-96-00		12	Split Find	67	47	34	-	Flake scars remain, heavy impacts on sides	Dry to 'sand-ground' traces, well developed unspecified wet stone polish	Latero-distal, transversal, perpendicular juxtaposed. Traces from ligatures present, potential blackish residue. Bright spots, flake damage on butt, hammered sides	-	Transverse medial fracture		
El Flaco	0819	Edge flake	Metamorphic, greenschist	Tuff protolith, dark green		0	East of 13		19	31	6	-	Not seen	Wet stone variant 3	No traces observed (relevant surface fragmented)	Woodworking, distinct (glistening, pitted, isolated domed polish). Edge sharp	Use retouch or rejuvenation flake		

El Flaco	0945	Butt-medial fragment, biconvex?	Volcanic, overprinted	Degree unknown, dark blue-black	63-57-94	6	20		55	35	21	-	Fine pecking of facets post-grinding	Coarse grooves. Wood polish, potentially with abrasive	Potentially repecked sides, some grain rounding but no interpretable traces	-	Medial-edge fragmentation from use impact		
El Flaco	1001	Unsure (butt?)	Volcanic	Grey	63-67-40	3	23		24	35	28	Alluvial	Unsure	Not seen	Not interpretable	-	-		Included as blank
El Flaco	1002	Edge-medial fragment	Volcanic	Dark blue-grey	63-66-39	3	23		71	42	23	-	Pecked surface persists	Wet stone variant 2	Male, probably embedded. Sides may have been reworked	Woodworking, 'exceeding (but cf. galba, bleary cedar)'. Symmetric distribution	Edge fully destroyed but unsure if use, transverse medial fracture		
El Flaco	1004	Butt fragment	Undetermined stone		63-67-30		23	67-07	36	31	26	Unsure	Unsure	Unsure	-	-	Transverse medial fracture, possible point of impact		Surface analysis not possible
El Flaco	1056	Other; curved elongate	Volcanic	Schistose overlay, platy	63-93-09		18		117	29	29	-	Coarse pecking marks persist on side	Unknown abrasive technique/platform, dull lustre	-	-	Fragmentation		
El Flaco	1108	Edge-medial fragment	Volcanic	Greyish	63-92-17	7	28		83	58	31	-	Lateral intrusive flaking, pecking of sides	Not ascertainable	Uncertain	Friction polish, indistinct. Symmetric distribution. Edge battered	Transverse medial fracture		
El Flaco	1119	Edge-medial fragment	Volcanic			0	x=1339,41; y=5713,82; z=326,96		58	30	21	-	Not seen	Not analysed, dull lustre	Not analysed	Not analysed	Transverse medial fracture		
El Flaco	1213	Medial fragment unifacial	Volcanic	Blue-grey, alt. carbonate?	63-56-97	Combined	30		21	38	10	-	Not seen	Uncertain	No traces (relevant surface absent)	-	Full fragmentation		Not an edge despite crescent morphology
El Flaco	1215	Medial fragment unifacial	Volcanic, overprinted	Slight overprint, dark blue	63-56-98	Combined	30		38	39	9	-	Not seen	Striated, stone scratches, retains roughness, but uncertain technique	Wood friction overlaying manufacture, a-typical distribution, system unspecified	-	Full fragmentation		

El Flaco	1218	'Wedge'	Volcanic	Blue-grey	63-56-38	Combined	30		63	37	27	-	Fine pecking persists on sides	Dry grinding traces	No traces	Woodworking, typical (cf. mahogany, to weak reticulation). Distributed deep into medial zones. Hammering traces on butt. Slight asymmetric distribution	Edge fully destroyed		
El Flaco	1226-02	Butt fragment	Volcanic	Greyish		0			38	30	27	-	-	-	-	-	Transverse medial fracture with point of impact on side		Not analysed
El Flaco	1233	Edge fragment?	Metamorphic, low-grade	Siliceous shale, grey	63-85-32	Combined	12		49	44	10	-	Not seen	Traces conform to dry grinding, but unclear if comparable	No traces observed (relevant surface fragmented)	Unclear, see other	Fragmentation unsure	Thin rim has retouch, but probably trampled rather than (re)used	
El Flaco	1244	Wedge-like celt	Metamorphic, greenschist	Plutonic protolith, green white veined	63-85-20	Combined	12		54	35	27	-	Fine pecked facets	'Sand-ground' traces, brighter range, with striations	Perpendicular juxtaposed on wood, bright spots, red-black grainy adhesive over repecked sides	Woodworking, experimental range (bleary cedar, galba, to weak reticulation), with striations. Asymmetric distribution	Edge fully destroyed, transverse medial fracture	Heat cracking?	
El Flaco	1250	Edge-medial fragment	Volcanic	Greyish	63-86-20	Combined	12		57	25	16	-	Lateral intrusive flaking	'Sand-ground' traces, brighter range, with grooves	Bright spot streaks, possible traces from friction with wood (relevant surface fragmented)	Soft material contact. Edge sharp, with impact retouch. Symmetric distribution	Skewed transverse fracture during use		
El Flaco	1254	Edge fragment	Volcanic	Greyish	63-67-24	3-5	19		24	26	15	-	Not seen	'Sand-ground' traces, slight contact with wood probable	No traces (relevant surface absent)	Unanalysable (PDSM), sharp and symmetric	Skewed transverse fracture during use		
El Flaco	1258	Butt fragment	Metamorphic, low-grade	F-g volc protolith, green-grey	63-67-23	5-6	30 (sic)		29	27	18	-	Marks from pecking persist	Dry grinding traces, slight inclination towards 'sand-ground' range	Male embedded in wooden handle, presence of grit?	-	Transverse medial fracture		

El Flaco	1677	Flake	Metamorphic	Green, very fine-grained. Metatuff with greenschist overprint?		0	x=1374,694; y=5636,494; z=319,407		48	38	10	-	Not seen	Dry to dull 'sand-ground' traces	Presence of distinct black viscose residue, but traces unclear	-	Fragmentation unsure		
El Flaco	1787	Blunted celt	Metamorphic?	Dark grey-black, fine grained. Possible metasiltstone	63-49-76	3	39		90	46	26	-	Marks from pecking persist	'Sand-ground' traces, wet stone variant 1a?	Traces from contact with a soft to pliable material, red-black stains on distal area, mild flaking of butt. System ultimately unspecified	Holdover wear, wood friction traces unspecified. Reworked facets carry residue	Unsure (intact)	Coarse pecked facets not analysable under high magnification	
El Flaco	1795	Blunted celt	Metamorphic, low-grade	Light grey-green, very fine-grained	63-37-__	0	38	37-35	85	39	26	-	Not seen	Dull scintillation, unspecified	Male embedded, >6cm in handle of unknown material. Treated resinuous residue on distal area, mild flaking of butt	Reworked facets: rounding observable (not analysable under high magnification)	Unsure (intact)	No clear indications if ever a celt, or directly manufactured as blunt percussion tool	
El Flaco	1833	Medial-butt fragment	Metamorphic, low-grade*	Light green, sugary, white vein patina. Very fine-grained. Metatuff or metasiltstone	63-36-87	6	40		124	62	30	-	Thinning scars persist	'Sand-ground' traces, slight striations	Perpendicular juxtaposed attachment. Possible traces of ligatures present, pristine? resinuous residue	-	Medial-edge fragmentation from use impact	Various taphonomic residues, interfering elongated surface flake	
El Flaco	1913	Edge fragment	Volcanic, overprinted	Dark grey basalt with medium-grained phenocrysts, some green minerals	63-55-51	3	44		45	47	26	-	Not seen	Gouged, wet stone variant 3, short duration contact	Probably male, entered as unspecified. Fractured in the haft (relevant surface absent)	Woodworking, distinct (irregular development, from intense cf. experimental range to early development). Potential resharpening, asymmetric distribution	Transverse medial fracture		Morphology is plano-convex in spite of haft interpretation.

El Flaco	1967	Medial fragment	Metamorphic, low-grade*	Green mottled	73-13-13	1	47		30	16	26	-	Not seen	Dry grinding traces, slight inclination towards 'sand-ground' range	No traces observed (relevant surface fragmented)	-	Full fragmentation		
El Flaco	1999	Other; unsure morphology	Metamorphic, high-pressure	Blueschist, blue-pale green	63-65-47	1	45 (sic)		48	22	23	Alluvial	Unsure	Wet stone unspecified contact, mineral mirror polish	No traces observed (relevant surface fragmented)	-	Full fragmentation		Fracture patterns is rectilinear, indicative of bipolar percussion?
El Flaco	2012a	Edge-medial fragment	Metamorphic, low-grade*	Greenschist, light green	63-68-16	2	49	68-01	64	31	19	-	Not sure	Dry or 'sand-ground' traces	No traces (relevant surface absent)	Woodworking, typical (mild development cf. mahogany). Edge destroyed. Symmetry unclear	Skewed transverse fracture during use		
El Flaco	2012b	Butt fragment	Sedimentary	Brownish mudstone	63-68-16	2	49	68-01	17	25	22	Alluvial	Not seen	None	Wood friction, overall indeterminate	-	Fragmentation unclear		
El Flaco	2014	Medial flake	Metamorphic*	Green	63-68-05	2	49		23	12	5	-	Not seen	'Sand-ground' traces	Wood friction, overall indeterminate	-	Full fragmentation		
El Flaco	2039	Edge-medial fragment	Plutonic	Black/white, rel. fine-grained, quartz-poor?	63-68-28	2	49	68-01	41	41	17	-	Lateral intrusive scars persist	Possibly wet stone variant 2?	Male (indeterminate), hafted in wood	Woodworking, experimental range (cf. fresh seagrape). Edge dulled, chipped. Asymmetric distribution	Transverse medial fracture, unclear if point of impact	Slight asymmetry	
El Flaco	2052	Flake	Volcanic, overprinted	Blue-grey, fine-grained	63-68-16	3	49		23	14	7	-	Marks from pecking persist	Dry grinding traces, short duration contact	No traces observed (relevant surface fragmented)	-	Full fragmentation		
El Flaco	2054	Butt fragment	Undetermined stone*	Greyish, possibly carbonaceous	63-68-26	3	49	68-01	52	36	28	-	Marks from pecking persist	Dry grinding traces, but unspec. for potential carbonaceousness	Male embedded, >6cm in wood	-	Transverse medial fracture	Slight asymmetry	
El Flaco	2096	Medial fragment	Metamorphic, low-grade*	Greenschist, green	63-75-__		2	Face F	56	75	25	-	Not interpretable	Not interpretable	Not interpretable	-	Transverse medial fracture and fragmentation		

El Flaco	2098a	Butt fragment	Metamorphic, low-grade*	Greenschist, green		0			66	45	20	-	Flake scars persist	Dry or 'sand-ground' traces with coarse striations	Distal traces from friction with a hard material, but overall indeterminate	-	Medial-edge fragmentation from use impact, followed by transv. medial fracture		
El Flaco	2098b	Butt-medial fragment	Metamorphic*	Green-blackish		0			88	43	25	Alluvial	Lateral intrusive flaking, incomplete, technique unclear. Partial pecking	-	-	-	Fragmentation during production?		
El Flaco	2114	Butt fragment	Metamorphic, jadeitite*	Darker green-blue mottled, sugary, coarse-grained	73-33-79	1	54		30	25	18	-	Marks from pecking persist	'Sand-ground' traces	Pristine? resinuous residue, traces from friction with a pliable-hard material, but, system unspecified	-	Full fragmentation		
El Flaco	2120	Medial fragment	Metamorphic, greenschist*	More schistose, dark green. Very fine-grained	73-35-__	0			70	50	27	-	Possible marks from pecking	Dry or 'sand-ground' traces	Male split or deep embedded, fresh wood?	-	Medial-edge fragmentation from use impact?		
El Flaco	2141	Edge-medial fragment	Volcanic*	Dark grey	63-67-38	1	57		69	49	25	-	Thinning flakes, marks from pecking persist	Densely striated, unspecified	Red and black resins on broken facet, feather-terminated scars (relevant surface fragmented)	Friction polish (not examinable). Edge rounded, chipped. Asymmetric distribution	Skewed transverse medial fracture	Attempted rehafting after breakage?	
El Flaco	2142	Edge-medial fragment, chisel	Undetermined	Grey-bluish, poss. blueschist or basaltic volc.	63-67-19/29		56					-	Fine pecking	Unspecified grinding	Not analysed	Not analysed	Transverse medial fracture	Not analysed	
El Flaco	2143	Edge fragment, chisel?	Metamorphic, high pressure	Blueschist with alterations	63-67-47	1	57		33	37	11	-	Not seen	Possible wood polish	Indeterminate, with possible traces of binding (relevant surface fragmented)	Woodworking, distinct (smooth, non-pitted polish). Edge dulled, chipped. Slightly asymmetric traces	Transverse medial fracture		
El Flaco	2147	Medial fragment	Metamorphic, high pressure	Blueschist with alterations?	63-67-48	1	57		38	31	14	-	Not clear	Not interpretable	Not interpretable (relevant surface fragmented)	-	Full fragmentation		

El Flaco	2151	Edge-medial fragment	Igneous*	Grey-blue	63-67-37	2	57		47	50	27	-	Thinning flakes, marks from pecking persist	Wet stone polish, unspecified	Perpendicular juxtaposed attachment. Possible traces of bindings, residue stain (relevant surface fragmented)	Woodworking, unspecified (early stage). Edge battered dull, symmetric distribution	Transverse medial fracture		
El Flaco	2170	Medial fragment	Metamorphic*	Grey-green	73-34-49	4-5	53	34-01	68	40	19	-	Coarse pecking persists	'Sand-ground' traces, striated sides	Black grainy unspecified residue, isolated woody friction, but system unspecified (relevant surface fragmented)	-	Full fragmentation		
El Flaco	2171	Butt fragment	Metamorphic*	Green, likely greenschist	73-15-__	4	50	15-04	42	37	20	-	Not seen	Dry or 'sand-ground' traces, coarse striations	Treated resin residue, butt supported against wood, either male embedded or juxtaposed with spalls	-	Transverse medial fracture	Asymmetric	
El Flaco	2173	Butt fragment	Undetermined	Dark, fibrous/ glimmering minerals. Might be blueschist	73-15-__	5	50	15-03	60	54	21	-	Pecked surface	Slight dry grinding traces	Perpendicular juxtaposed attachment. Contains treated resinuous residue	-	Full fragmentation	Asymmetric	
El Flaco	2195	Other; unsure morphology	Undetermined	Dark grey-blue/ white acicular minerals. Possibly blueschist	63-67-16	3	43	25-01	58	36	28	-	Coarse pecking	Traces of most likely dry grinding	-	-	Fragmentation unsure		
El Flaco	2219	Edge-medial fragment	Metamorphic, low-grade*	Dark green, likely greenschist	63-67-37	6	67	67-20	59	43	18	-	Not seen	'Sand-ground' traces, good match to brighter range	System unspecified. Black tarry undef. Residue present, clear traces from friction with wood (relevant surface fragmented)	Woodworking, experimental range (smooth, pitted doming cf. invasive galba, waterwood). Attempted resharpening (edge removed)	Transverse medial fracture and longitudinal fracture after failed resharpening	Viscose residue stain near edge	

El Flaco	2231	Edge-medial fragment, chisel	Metamorphic, low-grade*	Greenschist, light green, schistose	63-38-18	1	60		55	26	15	-	Not seen	'Sand-ground' traces, abrasives?	Black tarry undefined residue, overlaying potential traces from the haft	Patination only (edge completely broken away)	Edge fully destroyed, transverse medial fracture, possible point of impact		
El Flaco	2279-01	Medial flake	Metamorphic, low-grade*	Greenschist, light green	63-21-__	5	59	21-10	40	35	4	-	Pecking marks persist	Dry grinding traces, striations	No traces observed (relevant surface fragmentary)	-	Full fragmentation		
El Flaco	2279-02	Petaloid preform	Volcanic, overprinted	Dark grey-green, metabasalt?	63-21-__	5	59	21-10	69	39	10	-	Bifacial thinning, lateral intrusive shaping. Edge bears fine impact crushing, sides hinge terminated scars. All direct percussion	-	-	-	Blank inoperable following thinning accident		
El Flaco	2279-03	Blunt celt	Igneous, overprinted?*	Light overprint probable, dark bluish	63-21-__	5	59	21-10	94	39	27	-	Not seen	Brighter lustred (wet) stone grinding with striae, heavy wood contact polish (exceeding type) with micro-striations	Clear polish from friction with wood, but association indistinguishable from manufacture	Reworked facets, display traces of contact from hard materials	Unsure (reasonably intact)	Application of bright lustre may be part of reworking process -> potential earlier haft absent.	
El Flaco	2279-04	Medial fragment	Metamorphic*	Darker green	63-21-__	5	59	21-10	52	47	17	-	Not seen	Seasoned woodish contact, but attribution unclear – not included	No traces observed (relevant surface fragmentary)	-	Edge fully destroyed, transverse medial fracture		
El Flaco	2279-05	Edge fragment	Volcanic, overprinted	Dark green-grey, metabasalt?	63-21-__	5	59	21-10	48	39	5	-	Not seen	Dry grinding traces?	Indeterminate wear towards medial fracture	Woodworking, 'exceeding' with directionality. Edge dull	Use retouch or rejuvenation flake		
El Flaco	2279-06	Adze	Metamorphic, high-pressure	Dark blue-grey, with white fibrous minerals, blueschist	63-21-__	5	59	21-10	83	43	18	-	Not seen	Dense striations, traces likely from 'sand-ground' contact	Perpendicular juxtaposed, traces from bindings present	Woodworking, 'exceeding (but cf. galba)'. Edge battered dull, asymmetric distribution (sharp bounded patina)	Transverse medial fracture from haft	Mediodistal residue unclear	

El Flaco	2294	Edge-medial fragment	Metamorphic, low-grade*	Dark green greenschist, garnets	63-45-91	8	61	45-11	71	42	25	-	Thinning remnants potentially	Wet stone contact polish, unspecified	Probably perpendicular, traces of binding and wood friction present, but direction and slotting unclear. Friction indicates transversal motion. Repecked sides	Woodworking, well developed to possibly 'exceeding' (glistening, smooth, domed polish), abrasive resharpening, woodworking, unspecified (early stage but cf. bleary cedar). Edge battered dull. Asymmetric distribution	Skewed transverse medial fracture from haft	Asymmetric	
El Flaco	2317-01	Butt-medial fragment	Metamorphic, high-pressure	Blue-green, blueschist with omphacite recrystallization		0			52	33	18	-	Pecking marks persist potentially	Unsure, possibly 'sand-ground' traces overlain by soft wear, or abrasives. Included as unspecified	Black tarry residue, seasoned wood friction in asymmetric distribution	-	-		Thin-sectioned
El Flaco	2318	Edge fragment, tranchet	Metamorphic, low-grade*	Grey-green, very fine-grained. Metatuff or metasiltstone		1	Boring 15		59	61	40	Alluvial	Lateral flaking impacts, tranchet blow	Absent	Indeterminate traces (relevant surface fragmentary)	Indeterminate contact (pitted, rough to smoother polish). Edge chipped	Transverse medial fracture		
El Flaco	2320	Medial fragment	Volcanic*	Dark blue-black	63-45-__	4	63, fill 1		55	34	12	Alluvial	Not seen	Wet stone contact polish, unspecified (could be variant 1, but unsure), striations	No traces observed (relevant surface fragmentary)	-	Full fragmentation		
El Flaco	2343	Edge fragment	Volcanic, overprinted	Brownish, fine-grained. Metabasalt?	63-48-92	2	34		69	53	28	-	Unclear	Dull, but greasy 'sand-ground' traces – unspecified	Repecked sides and possibly face. No traces observed (relevant surface fragmentary)	Modifications present but not further interpreted	Edge fully destroyed, distal fracturing unclear		
El Flaco	999999 (90001)	Edge fragment, preform	Volcanic	Greyish		0			68	84	42	-	Small scars shape blunt edge, direct percussion; minor pecking	-	-	-	Transverse medial fracture with point of impact on side		

El Flaco	999999 (90002)	Edge flake	Metamorphic, greenschist	Tuff protolith, small garnets, pale green white veined		0			36	34	-	-	Not seen	Polish from contact with stone, but overall unclear dull	Indeterminate (relevant surface absent). Presence of treated resinuous residue	Woodworking, experimental range (waterwood, cf. mahogany). Edge sharp	Use retouch or rejuvenation flake		
El Flaco	999999 (90003)	Medial fragment	Metamorphic, greenschist	Tuff or f-g volcanic protolith, dark green white veined		0			62	48	33	-	Flaking present	-	-	-	Two transverse medial fractures	Not analysed	
El Flaco	999999 (no tag b)	Butt fragment	Plutonic, overprinted	Dark/white, some alteration		0			62	73	45	-	Lateral intrusive flaking	-	-	-	Two transverse medial fractures, one point of impact	Not analysed	

Site	Nr	Type	Material group	Material description	Corte	Layer	Length	Width	Thickness	Procurement	Early reduction	Abrasive manufacture	Hafting	Use	Deposition	Other	Comments
Playa Grande	001	Edge fragment	Metamorphic, jadeitite	Uniform pale green	7 (A-H)	0	31	41	13	Heat cracking of surface? Stage unsure	-	Dull, not striated. Weak scintillation with minor 'stony polish' development. Subsequent 'dry' whetting of edge	Polish indicative of plant-like material contact near posterior break Black tarry residue towards medial area	No traces from use. Possible flake remodelling of edge	Fractured along cracked lines, coinciding with potential edge flake remodelling. Also a transverse medial fracture	Some PDSM possible.	Biographical trajectory currently not sensible, unless in a very advanced stage of remodelling (explaining hafting traces and location) with the second-to-last event directly preceding the last (explaining absence of use and both whettings)
Playa Grande	002	Debitage flake	Metamorphic	Not identified, green-yellow cortex	7	6	75	19	32	Alluvial	Impact traces, significant (cortex removal) flake	-	-	-	-	Yellow-brownish anorganic residue present	Sampled for destructive analysis, likely at least HP/ jadeite-bearing (but unconfirmed to me)
Playa Grande	003	Edge-medial fragment	Metamorphic, high-pressure	Grey to bluish, acicular fabric	7 (A-H)	1-2	79	46	17	-	Side shaped by hammering, followed by fine pecking	Mostly dull. Traces from contact with stone, but incomparable (acicular matrix). Inconsistent distribution. Probable abrasive whetting	Unclear (relevant surface fragmentary)	Woodworking, early stage. Probable abrasive whetting. Reworked facets, used for pounding but lack of microwear. Internal crack propagation.	Transverse mediodistal fracture	Starch grain present on edge.	
Playa Grande	004	Medial-distal roughout	Metamorphic, high-pressure	Blue-greyish, foliated	7 (A-H)	1-2	77	42	18	Unclear	Foliation splitting, hammering of sides	-	-	-	Transverse medial fracture		
Playa Grande	005	Edge blank	Metamorphic, jadeitite?	Pale green	7 (A-H)	1-2	53	54	36	Alluvial is probable. Testing of texture (dry grinding traces)	-	-	-	-	Transverse medial fracture (fluid)	Point of impact on edge (percussor?)	Surface provisionally water-worn due to subpar imaging and description
Playa Grande	006	Medial fragment, elongated	Metamorphic, jadeitite?	Pale green, blue streaks, of partial fibrous texture	7 (A-H)	17	48	21	15	-	-	'Sand-ground' traces on sides, brighter range. Faces unclear (interference)	Unclear (relevant surface fragmentary), see Other	-	Two skewed medial fractures	Early stage wood polish (possibly from a haft) overlays faces. Fine-grained black residue on depression	

Playa Grande	007	Medial-distal fragment	Metamorphic, high pressure	Blueschist? Blue, schistose, white mottles, fibrous fabric	7 (A-H)	17	53	31	9	-	Unclear	Dull lustre, asymmetric intensity. Rough, flat, and striated stone polish cf. exp. 2782, but unsure if comparable (acicular matrix)	Unclear, presence of potential bright spots	-	Unclear		Fracture pattern not interpretable, possible haft traces not indicative
Playa Grande	008	Medial-distal fragment	Metamorphic, high pressure	Blue and green mottled	7 (A-H)	17	68	48	11	-	Coarse pecking	Dry grinding traces (jadeite on quartz arenite)	-	-	Unclear		Fracture pattern not interpretable
Playa Grande	009	Edge-medial fragment	Metamorphic, jadeite?	Jadeite-bearing, blue and green mottled	7	3	60	20	15	-	Fine pecking, possibly preceded by coarse	Dull lustre, scratched. Dull, rough, flat, and striated polish from stone contact (cf. exp. 2782), possible presence of scratching particles	No clear traces (relevant surface fragmentary)	Traces from contact with a soft abrasive material (siliceous plant over hide). Edge appears sharp	Longitudinal fracture during use	Apparent asymmetry	
Playa Grande	010	Edge-medial fragment	Metamorphic, jadeitite	Pale green, blue mottle	7	3	66	45	27	Possibly alluvial	Sides shaped by hammering, fine pecking	Possibly limited abrasive contact with stone or abrasives, but unsure	-	Use of edge in percussion	Transverse medial fracture (fluid) with impact point	Both pristine resinous residue and treated resinous residue	Use is probably repurposing
Playa Grande	011	Edge-medial roughout	Metamorphic, jadeitite	Pale green, blue mottle	7	3	59	39	13	-	Direct percussion thinning, bipolar percussion shaping (hammering) of outline	-	-	-	Thinning flake destroyed edge. Subsequent transverse medial fracture		
Playa Grande	012	Polisher preform (reworked?)	Metamorphic, jadeite	Pale green and blue colours	7	3	50	33	11	-	Flaking (bipolar?, foliation splitting?), hammering, then fine pecking	-	-	No clear traces	No indications		
Playa Grande	013	Medial-distal roughout	Metamorphic, jadeite	Pale green and blue colours	7	3	72	44	24	-	Limited thinning and hammering, most is fine pecking	-	No traces (confirmed as roughout)	-	Transverse medial fracture with impact fissuring		
Playa Grande	014	Discoid roughout (other)	Metamorphic	Green, fine-grained	7	3	53	50	12	-	Bipolar percussion shaping sequence	-	-	-	No indications		
Playa Grande	015	Roughout fragment	Metamorphic, jadeite?*	Jadeite-bearing, blue and green mottled	7	3	45	34	12	Alluvial	Flaking unspec. hammering with counter, and pecking	-	-	-	Fractured unclear		
Playa Grande	016	Edge fragment, roughout	Metamorphic, high-pressure*	Blue with slight green mottling	7	3	58	83	25	Alluvial. Testing of texture (Gouged, small 'stony polish' structures)	Probable bipolar hammering of shape and thinning flakes (counter impacts, hinge fissures)	-	-	-	Minor fissure of intended edge. Transverse medial fracture (fluid) with probable impact point		Large-sized celt

Playa Grande	017	Edge fragment	Metamorphic, low-grade?*	Fine-grained, green, schistose	7	3	33	16	5	-	-	Grinding of sharp facets. Dull, deep gouges, 'dry' scintillation of micro-topography	-	Edge rounded. Traces indicate softer contact material cf. plantish, but unclear	Probable use retouch flake		
Playa Grande	018	Edge flake	Metamorphic, low-grade*	Greenschist of darker green	7	3	22	32	6	-	Heavy/coarse pecking	'Sand-ground' traces, brighter range. Incomplete coverage, deep gouges	-	Woodworking, distinctive (well developed). Edge battered dull, chipped.	Use retouch or rejuvenation flake		
Playa Grande	019	Medial-distal fragment	Metamorphic, low-grade*	Greenschist	7	3	105	58	32	-	Bifacial thinning, shaped through hammering, pecking	Intermediate lustre, technique unspecified. Bright scintillation mixed with rough, dull, greasy? 'stony polish', topography striated	Asymmetric, deep attachment, wood friction versus unclear with resin-like residue	Edge flaked out to both sides, probable rejuvenation. Possible weak use traces persist	Rejuvenation invasive? One side has been spalled thereafter		Side not observable under high magnification working distance.
Playa Grande	020	Medial fragment	Metamorphic*	Dark blue to pale grey	7	3	49	38	14	-	Unclear	Intermediate lustre, technique unspecified. Rough, dull, greasy? 'stony polish', topography striated	Traces of unclear wear, spatially suggestive	-	Fractured rectilinear unclear	Has impact marks on surface surrounded by pecking, below the level of grinding	
Playa Grande	021	Edge fragment	Metamorphic, low-grade*	Greenschist	7	3	22	49	16	-	-	'Sand-ground' traces, duller range, striations	Unclear	Woodworking, unspecified (blade zone). Edge light to medium dulling, no traces	Slanted medial break (fluid) behind edge	Transverse oriented cracks on both edges	
Playa Grande	022	Edge-medial roughout	Undetermined*	Volcanic or metamorphic	7	3	78	62	33	Secondary context?	Possible bifacial thinning, shaping through hammering, coarse pecking	-	-	-	Edge shaping mishap, transverse medial fracture (fluid) with possible impact point		
Playa Grande	023	Medial-distal fragment	Metamorphic, low-grade*	Greenschist of darker green	7	3	68	35	19	-	Fine pecking	'Sand-ground' traces, unspecified with higher relief. Short-term abrasion of facets	Asymmetric, directional friction from insertion but contact type unclear	-	Skewed medial break (use related)		
Playa Grande	024	Edge-medial roughout	Undetermined*	Volcanic or metamorphic	7	3	79	67	26	Secondary context	Coarse pecking, flaking/ shaping through hammering	-	-	-	Skewed medial unclear fracture		

Playa Grande	025	Adze	Metamorphic, high-pressure?*	Blueschist? Blue, schistose, fibrous fabric	7	3	72	32	22	-	Bifacial thinning, fine pecking	Absent	Latero-distal, transversal, perpendicular, juxtaposed. Bindings, in wooden rest	Edge destroyed	Damaged use		
Playa Grande	026	Medial fragment	Undetermined*	Ranges from black to grey and green	7	3	40	44	25	-	Fine pecking	Grinding contact against stone (unspecified)	No clear traces (relevant surface fragmentary)	-	Two transverse medial fractures (fluid both, one possible impact point)		
Playa Grande	027	Medial-distal fragment	Metamorphic, high-pressure*	Jadeite bearing	7	3	59	41	23	-	Hammering to coarse pecking, some fine pecking	Absent	Asymmetric, flat ventral face displays traces of exceeding wood friction and unknown residue (pristine resin?)	-	Transverse medial fracture		
Playa Grande	028	Edge-medial fragment	Metamorphic, high-pressure*	Jadeite bearing, blue and pale green mottle	7	3	82	53	27	-	-	Dull, striated sides. Weak scintillation with 'stony polish' development	Faces and side display well developed polish from soft plantish contact, other side displays traces from strong wood friction	Traces from mildly abrasive, soft-pliable contact material. Edge battered dull, catastrophic impact fracture	Edge fractured in use. Then transverse medial fracture with point of impact	Morphology symmetric	
Playa Grande	029	Chisel	Metamorphic, high-pressure*	Jadeite bearing, green-blue mottle	7	3	56	23	11	-	Hammering of sides, fine pecking	'Sand-ground' traces, typical	Documentation unclear	Traces from abrasive, soft-pliable contact material. Edge sharp besides a blunted facet	No indications		
Playa Grande	030	Medial-distal fragment	Metamorphic, high-pressure*	Green and blue minerals in matrix	5	1	41	29	17	-	Coarse pecking	Bright lustre, polish, dense striations: wet grinding traces (cf. quartz arenite). Scant development	Asymmetric, wood-like traces of friction and treated resinous compound dorsally, traces from abrasive plantish contact ventrally	-	Oblique medial fracture	Butt has schist-derived step fracture, possibly from shaping through hammering	All hafting indications are at low confidence individually
Playa Grande	031	Medial fragment	Undetermined*	Grey-green, fine-grained	5	1	54	32	33	-	-	Wet grinding traces (unspecified), poor levelling	Wood friction traces on one face	-	Fragmentation rectilinear		

Playa Grande	032	Medial-distal fragment	Volcanic	Black-grey, probably a basalt	5	1	51	26	19	-	Bifacial thinning, fine pecking	Absent	Unclear friction traces on faces	-	Medial fragmentation use-related		
Playa Grande	033	Edge-medial fragment	Undetermined*	Blueschist or volcanic	5	1	71	52	14	-	Unclear	Wet stone variant 1a, moderately level, striated	No traces (relevant surface fragmentary)	Edge battered and fractured. Use wear present, but not interpretable	Use-related edge fracturing, medial fragmentation		
Playa Grande	034	Edge-medial roughout	Metamorphic, high-pressure*	Jadeite bearing, green-blue mottle	5	1	64	41	23	-	Shaped through direct flaking (edge) and hammering (sides), fine pecking	-	-	-	Transverse medial fracture with possible impact point		
Playa Grande	035	Edge fragment	Volcanic*	Grey-black, fine-grained, possibly a basalt	5	1	41	43	15	-	Shaped through direct flaking and thinning, coarse pecking, fine pecking	Intermediate lustre, one face only. Possibly abraded on hard coarse-grained sandstone, heavily striated (cf. exp. 2515-A)	-	Edge sharp but has obtuse blunting. Thin strip of polish indicates plant materials. Abrasively resharpened	Use retouch, transverse medial break with point of impact		
Playa Grande	036	Medial fragment	Metamorphic, high-pressure*	Blueschist with alterations, characteristic blue /white pattern	5	1	50	51	15	-	Unclear, foliation splitting?	Technique unclear	No clear traces	-	Two transverse medial fractures, one fluid with point of impact		Rock type responds poorly to metallographic analysis
Playa Grande	037	Complete celt, heavily damaged	Unsure	Grey-green colour, fossils?	5	1	87	43	17	-	Hammering into shape	Heavily striated, dry grinding traces. Facets present	Some residue deposits, but no clear wear	Woodworking, experimental range (rough, invasive polish cf. green seagrape). Edge completely destroyed	Edge/face shattered on impact, second impact made on side		
Playa Grande	038	Edge fragment	Metamorphic, low-grade*	Greenschist	5	1	32	54	21	-	-	Wet grinding traces (quartz arenite, ca. 45-75 minutes)	Male slotting (wood friction on sides)?	Traces from soft contact material, distinctive (possibly animal)	Transverse medial fracture (fluid), points of impact	Reworked by blunt pecking of edge, but no traces of wear	
Playa Grande	040	Adze	Metamorphic, high-pressure*	Jadeite bearing, green-blue colours	5	1	51	26	12	-	Invasive flaking	Bright lustre. Cf. wet stone polish variant 1a at far exceeding intensity	Traces of binding and treated resin on the sides, bright spots? on dorsal face; likely asymmetric juxtaposed	No clear traces. Edge blunted with 'sand-ground' technique	No indications		

Playa Grande	042	Elongated fragment	Metamorphic, high-pressure*	Blue, green, and accessory minerals	5	1	83	18	15	Testing of edge (no signature)	Medium pecking, flaking longitudinal axis	-	-	Unclear	No indications	Underdeveloped friction traces from softer materials occur around the proximal half	
Playa Grande	043	Medial flake	Metamorphic*	Dark green to brown	5	1	21	27	5	-	-	Technique unclear	Traces from friction with seasoned wood	-	Fracturing flake		
Playa Grande	044	Edge fragment, roughout	Metamorphic, high-pressure*	Green-blue colours, jadeite bearing	5	1	51	76	7	Probably alluvial, testing (dull scintillation, gouged, some polishes)	Shaped through flaking or hammering, possibly bipolar	-	-	-	Transverse medial fracture (fluid), impact point unclear	Few other smoothened patches on the blade, with softer polishes – significance unclear	Large-sized celt
Playa Grande	045	Medial flake	Undetermined*	Black-grey-blue and fairly fine-grained, could be volcanic or possibly blueschist	5	1	55	25	5	-	Coarse pecking, then removed as flake product	-	-	-	Debitage	No actual reason to assume a mishap over intended debitage	
Playa Grande	046	Medial flake	Metamorphic, low-grade*	Dark green-blackish	5	1	37	38	5	-	-	'Sand-ground' traces, unspecified	Traces from friction with seasoned wood	-	Fracturing flake		
Playa Grande	047	Core?	Metamorphic, jadeite*	Pale green	5	1	26	19	12	-	Pecking, rectilinear breaking (bipolar percussion?)	-	-	-	No indications	Treated resin present to fasten lower circumference	Most likely a core for a small object, seems unrelated to debitage from celt production
Playa Grande	048	Uncertain	Metamorphic, jadeite*	Pale green, sugary; some blue	5	1	78	38	26	Unclear	Flaking unclear, pecking possible	-	-	-	Unsure	Presence of small treated resin deposits	Biography largely not interpretable
Playa Grande	049	Medial flake	Metamorphic*	Various green minerals	5	1	32	22	5	-	Hammering/coarse pecking	Dull, technique unclear: gouged, little trace signature, possibly of short duration	Overlaying friction, including on the pecked area	-	Fracturing flake	Presence of treated resinuous residue in hafting zone	
Playa Grande	050	Blank	Metamorphic, jadeite*	Pale green, a hint of blue	7	1	70	29	26	Alluvial, testing (dry grinding traces, striations)	Partial pecking, direct flaking on the long axis	-	-	-	Apparent flaking mishap		
Playa Grande	051	Edge-medial fragment	Metamorphic, jadeite*	Pale green, a hint of blue and mica	7	1	43	15	17	-	Unclear start, fine pecking	Bevel only. 'Sand-ground' traces, unspecified	-	Woodworking, early stage. Edge sharp	Transverse medial break; edge scarred	A dense streak of treated resinuous residue is present	Strong craqueler near edge scar and in other areas, possibly burnt

Playa Grande	052	Edge-medial roughout	Metamorphic, jadeite*	Pale green, a hint of blue and mica	7	1	53	52	18	-	Bifacial thinning (bipolar?) and hammering of sides (coarse pecks, ridges); flaking along long axis of edge	-	-	-	Severe production mishap, followed by transverse medial fracture (fluid) with point of impact		Glimmer minerals were confused for PDSM wear (or contact while resting)
Playa Grande	053	Celt blank	Metamorphic, jadeite*	Pale green, acicular/fibrous minerals	7	1	97	46	31	Alluvial	Shaping and cortex removal including by bipolar percussion	-	-	-	Flaking mishap		
Playa Grande	054	Celt blank	Metamorphic, jadeite*	Pale green, a hint of blue	7	1	75	39	29	Alluvial	Shaping of edge by direct percussion longitudinal axis	-	-	-	Transverse distal fracture (fluid), possible point of impact		No clear signs of flaking mishaps present
Playa Grande	055	Edge-medial fragment	Metamorphic, low-grade*	Greenschist with darker (unaltered?) veins	7	1	69	37	12	-	-	Striated, dry to 'sand-ground' traces	-	Used, contact unclear. Edge sharp but chipped	Fragmentation unclear		
Playa Grande	056	Medial fragment	Metamorphic*	Dark green, lithology unclear	7	1	78	47	14	-	Flaking longitudinal axis, coarse pecking	-	-	-	Fragmentation unclear	Some abrasive stony contact noted, but no technical activity seen	Either production related fragmentation all, or an invasive flake and medial blow
Playa Grande	057	Axe	Metamorphic, high-pressure*	Blueschist, fairly typical, some green present	7	1	84	34	14	-	Hammering scars remain	Traces from contact with stone, but incomparable (acicular matrix)	Male embedded, likely perpendicular. Use traces symmetric. Strong friction, prop is possible	Woodworking, experimental range	Skewed edge fracture (use)		
Playa Grande	058	Edge flake	Metamorphic, low-grade*	Greenschist, typical	7	1	52	30	8	-	-	'Sand-ground' traces, dull range, striated	-	Woodworking, unclear. Few small domes, largely rough texture and scintillation. Seasoned wood contact? Extensive development	Use flake OR rejuvenation debitage, unclear		Dimensions and use wear extent suggest large-sized celt
Playa Grande	059	Medial fragment	Metamorphic, high-pressure*	Blueschist with alterations	7	1	54	42	15	-	Hammering of sides, otherwise unclear	Wet grinding traces, unclear	Asymmetric distribution of traces. Friction contact with wood, early stage, opposed by contact with a soft abrasive material	-	Two transverse medial fractures		

Playa Grande	060	Edge-medial fragment	Metamorphic, high-pressure?*	Blue-blackish, schistose, acicular minerals	7	1	53	45	7	-	Hammering of sides, otherwise unclear	Facets around the edge only, striated. Technique unclear, possibly inefficient	Traces present, but relation unsure	Woodworking, 'exceeding'. Smooth/flat, bright, and interlinked polishes with no pitting and barely invasive. Patination visible. Edge mostly sharp, some nicks	Transverse medial fracture		
Playa Grande	061	Medial-distal blank fragment	Metamorphic, high-pressure*	Jadeite bearing, green-blue colours	7	1	65	42	30	Alluvial	Direct flaking (cortex removal?), possibly limited pecking	-	-	-	Transverse medial fracture (fluid)	Strong traces of wood friction on one side, presence of adhesive residues; fastening or wooden anvil? unclear	
Playa Grande	062	Distal fragment	Undetermined*	Dark grey with white crystal mottle	7	1	59	55	30	-	Thinning scars, hammering of sides	Striated, dry to 'sand-ground' traces	Friction spots, traces unclear	-	Transverse medial fracture with point of impact		
Playa Grande	063	Edge fragment	Metamorphic, low-grade*	Greenschist typical, with large garnets	7	1	61	68	16	-	-	'Sand-ground' traces, typical, heavily striated	-	Woodworking, distinctive (well developed) on one bevel. Subsequent contact with softer/fresher material on other bevel. Edge battered dull	Originally fractured, if reworked then no indications for later discard	Reworked through hammering a semi-abrupt backed edge. Use uncertain, though note asymmetric wear.	Large-sized celt fragment.
Playa Grande	064	Medial fragment	Metamorphic, low-grade*	Greenschist, greyish-green	7	1	73	54	30	-	Thinning scar, pecking	Dull lustre. Weak scintillation with rough polish, striated on sides	Wood friction indicates male split, black tarry residues	-	Two transverse medial fractures, one haft split other unknown		
Playa Grande	065	Edge-medial fragment	Metamorphic, low-grade*	Green-blackish rock, fine-grained	7	1	52	36	28	-	-	Dry to 'sand-ground' traces, higher relief	Distal wood friction present	Woodworking, unspecified (small, rough, and reticulating polish structures). Edge dulled	Rectilinear fracturing	Strong craqueler present	
Playa Grande	066	Edge blank	Metamorphic, jadeitite*	Very pale green	7	1	54	62	21	Alluvial	Cortex flaking	-	-	-	Flaking mishap, transverse medial fracture		

Playa Grande	067	Edge fragment	Metamorphic, high-pressure?*	Dark green to blue, sugary	7 (A-H)	1-2	21	42	13	-	Unclear, fine pecking	Dull, rough, flat, and striated polish from stone contact (cf. exp. 2782)	-	Wear traces from soft material (invasive, greasy, rough, non-abrasive). Edge sharp, sinuous	Transverse 'medial' fracture		
Playa Grande	068	Edge fragment	Metamorphic, high-pressure?*	Blue-blackish, schistose, acicular minerals	7 (A-H)	1-2	49	39	12	-	Unclear	Dull to diffuse. Traces from contact with stone (rough polish), but unspecified	-	Woodworking, unspecified. Edge partially destroyed	Rectilinear fracture, use related?	Non-broken edge pecked blunt	
Playa Grande	069	Medial-distal roughout	Metamorphic, high-pressure*	Very pale green to blue, schistose appearance	7 (A-H)	1-2	82	47	12	-	Unclear, foliation splitting? Hammering of sides	Wet stone grinding, unspecified, short duration of contact	-	-	Transverse medial fracture		
Playa Grande	070	Distal fragment	Metamorphic, high-pressure*	Dark-green minerals with bands/veins of blue and white minerals. Probably omphacitic	7 (A-H)	1-2	34	27	19	-	-	Wet stone grinding (quartz arenite, high intensity). Sides of lower intensity	Possible bright spots	-	Transverse medial fracture		Square-ish conical outline
Playa Grande	072	Medial-distal roughout	Metamorphic, high-pressure*	Jadeite-bearing, with glaucophane vein	7 (A-H)	1-2	68	45	28	-	Hammering of sides, coarse pecking; some longitudinal thinning	-	-	-	Transverse medial fracture with point of impact		
Playa Grande	073	Medial-distal fragment	Metamorphic, high-pressure*	Blueschist with alterations	7 (A-H)	1-2	53	36	18	-	Hammering of sides, coarse pecking	Traces from contact with stone, but unspecified; short duration, heavy striations	Traces of one or more friction contact types	-	Transverse medial fracture (haft break?)		
Playa Grande	074	Blank	Metamorphic, high-pressure*	Blueschist with alterations	7 (A-H)	1-2	77	38	15	Alluvial	Direct flaking, longitudinal thinning and cortex removal	-	-	-	No indications		Possibly an old thinning flake of a large sized core
Playa Grande	075	Edge roughout	Metamorphic, jadeitite*	Pale green	7 (A-H)	1-2	53	58	37	Alluvial	Shaped through hammering (sides and edge)	-	-	-	Production mishap		
Playa Grande	076	Celt fragment	Metamorphic, high-pressure*	Blueschist with alterations	7 (A-H)	1-2	64	42	10	-	-	Dull scintillation, some 'stony polish' with striations	Friction traces on faces	Wear traces present, unspecified contact. Edge rounded	No indications		
Playa Grande	077	Edge fragment, blank	Metamorphic*	Grey-bluish colour	7 (A-H)	1-2	39	53	30	Alluvial	Sides hammered, including cortex flaking	-	-	-	Transverse medial fracture with potential impact point		

Playa Grande	078	Medial fragment	Metamorphic, low-grade*	Green-blackish greenschist	7 (A-H)	1-2	33	50	19	-	-	Dry to 'sand-ground', unspecified	Unspecified traces, asymmetric in intensity. Pecking of sides	-	Curvilinear fracturing	Craqueler also present, burnt?	
Playa Grande	079	Medial fragment	Sedimentary?*	Carbonaceous? Beige	7 (A-H)	1-2	29	45	9	-	Pecking	Traces from contact with stone (dull scintillation, bands of polish)	-	-	Fragmentation unclear		
Playa Grande	080	Medial fragment	Metamorphic, low-grade*	Dark green, probable greenschist	7 (A-H)	1-2	52	62	28	-	-	'Sand-ground' traces, brighter range	Friction contact apparent on sides	-	Two transverse medial fractures, unclear cause		Possibly large-sized celt
Playa Grande	081	Medial fragment	Undetermined*	Probably volcanic, grey-black groundmass	7 (A-H)	1-2	37	23	20	-	Coarse pecking	Dull scintillation, striations on side, probably short duration (dry to 'sand-ground', unspecified)	Probably male, wood friction gloss on faces and more intense on side	-	Fragmentation unclear		
Playa Grande	082	Edge-medial fragment	Sedimentary*	Carbonaceous? sediment	7 (A-H)	1-2	46	24	15	-	Unclear	Traces from contact with stone, unspecified	-	Traces present, appear as pliable or hard material contact. Striated. Edge battered	Skewed edge fracture (use)		Rectilinear morphology, likely a chisel
Playa Grande	083	Edge fragment	Undetermined*	Grey-green banded, possibly a volcanoclastic sediment	7 (A-H)	1-2	40	37	24	-	Possible thinning scar persists	Dull, rough, flat, and striated polish from stone contact (cf. exp. 2782)	Unclear	Woodworking, 'distinct' extremely well developed. Edge battered dull	Skewed edge fracture (use) and transverse medial break		
Playa Grande	084	Edge roughout	Metamorphic*	Possibly jadeite, green sugary	7 (A-H)	1-2	38	43	6	Debitage flake from earlier sequence	Shaped through flaking and hammering of sides, pecking near edge	Wet grinding traces, unclear. Short duration, small edge facets	-	Not used	Transverse medial break unclear		
Playa Grande	085	Edge fragment	Metamorphic, low-grade*	Greenschist, typical	7 (A-H)	1-2	41	49	17	-	Thinning scars persist	Well levelled, dry ground near edge, further dull scintillation with fine striations	-	Edge battered dull, use retouch, but no traces of wear	Transverse medial break (fluid) with point of impact	Resharpening could explain lack of wear, but there is no good evidence for this.	
Playa Grande	086	Medial fragment	Metamorphic, high-pressure*	Evenly mottled green and blue minerals	7 (A-H)	1-2	65	43	16	-	Hammering/pecking of sides, fine pecking	Well levelled, dull scintillation (dry to 'sand-ground', unspecified)	Faces and side display well developed polish from soft plantish contact, other side displays scintillation from possible wood contact, and unspecified residue	Edge completely destroyed	Transverse mediodistal break (fluid)		

Playa Grande	087	Edge-medial fragment	Metamorphic, high-pressure*	Jadeite-bearing, pale green	7 (A-H)	1-2	59	33	15	Alluvial	Cortex removal flakes, possibly coarse pecking	Traces from contact with stone on edge, dull technique unspecified	Unclear	Unsure	Distal fracturing (production?)	Unclear friction polishes present on several surfaces, including the edge	
Playa Grande	088	Petaloid roughout	Metamorphic, high-pressure*	Dark blue to black schist with glaucophanes and some micas	7 (A-H)	1-2	98	49	21	-	Shaped through hammering of sides, splitting of schistose layers, and pecking of faces	-	-	-	Production fracture along schistose layering		
Playa Grande	089	Edge-medial fragment	Metamorphic, jadeitite*	Pale green	7 (A-H)	1-2	44	29	15	Alluvial	Unclear	Traces from contact with stone on bevel, dull technique unspecified	Friction traces present in medial zone, but poorly characterised	Traces indicates wood (early stage) to a softer contact material. Edge sharp, but retouched	Distal fracture along transverse plane	Significant cracking present	
Playa Grande	090	Edge-medial roughout	Metamorphic, high-pressure*	Blueschist, typical	7 (A-H)	1-2	77	41	24	-	Flaking indet., hammering of sides, fine pecking	-	-	-	Transverse medial fracture with possible point of impact	Light friction polishes on dorsal surface, indicate resting during pecking of ventral side?	
Playa Grande	091	Edge-medial roughout?	Metamorphic, jadeitite*	Pale green	7 (A-H)	1-2	58	17	19	Alluvial, tested (dry grinding traces [match with exp. 3797, jadeitite])	Imperfect pecking	-	-	-	Skewed medial fracture		
Playa Grande	092	Edge fragment	Metamorphic, low-grade*	Greenschist, darker green, garnets	7 (A-H)	1-2	65	51	25	-	-	Wet grinding traces, unspecified	-	Woodworking, below/ experimental range (rough polish, little doming). Edge sharp	Rectilinear fracture (haft break)		
Playa Grande	093	Edge-medial fragment	Metamorphic, high-pressure*	Blue acicular minerals with presence of green	7 (A-H)	1-2	50	49	15	-	Hammering of sides, fine pecking	Wet grinding traces, heavy striations, but incomparable (acicular matrix)	No clear traces (relevant surface fragmentary)	Woodworking, experimental range (rough, bright polish with little doming). Edge battered, retouched	Transverse medial fracture		
Playa Grande	094	Blunt celt	Metamorphic*	Shades of lighter green, schistose	7 (A-H)	1-2	33	53	20	-	Hammering/coarse pecking of sides	Wet grinding traces (quartz arenite)	Unsure, impact rounding of distal end	Unsure	No indications		
Playa Grande	095	Edge-medial blank	Metamorphic, jadeitite*	Pale green	7 (A-H)	1-2	69	48	15	Alluvial	Flake thinning unclear, limited hammering and coarse pecking of sides	-	-	-	Production mishap, followed by transverse medial fracture with point of impact		

Playa Grande	096	Edge preform	Undetermined*	Beige-green	7 (A-H)	1-2	30	27	20	-	Fine pecking	-	-	-	Fragmentation unclear, in production		
Playa Grande	097	Medial-distal fragment	Undetermined*	Blueschist or volcanic	7 (A-H)	1-2	67	46	18	-	Hammering of sides	Wet grinding traces, striated polish, dense macro-striations (otherwise unspecified	Faces display traces from friction with wood, sides from plant bindings. Pecking of sides	More intense wood friction directly behind fracture, original use extent unclear	Transverse medial fracture (haft break?)		
Playa Grande	098	Distal fragment	Undetermined*	Lighter green, carbonaceous?	7 (A-H)	1-2	35	40	27	-	-	Traces from contact with stone, unspecified	Asymmetric traces of binding and wood friction	-	Haft fracture (oblique)	Residue present, looks like treated resin adhesive	
Playa Grande	099	Edge fragment	Sedimentary*	Carbonaceous? Pale brown	7 (A-H)	1-2	35	57	13	-	Flaking? Light pecking	Dry to 'sand-ground' traces, unspecified	-	Traces from contact with soft material, developed. Edge sharp	Transverse medial break unclear		
Playa Grande	100	Medial-distal fragment	Metamorphic*	Green-grey schist	7 (A-H)	1-2	83	45	17	-	Thinning scars persist	Meagre scintillation, high relief, striated, ground dry using abrasives?	Traces present but not well developed. Black tarry droplet residue	-	Haft fracture (oblique)		
Playa Grande	101	Edge roughout	Metamorphic, high-pressure*	Jadeite-bearing, pale green	7 (A-H)	1-2	70	62	30	Alluvial, testing of bevel (dry grinding traces)	Hammering of sides, limited pecking	-	-	No traces	Transverse medial fracture with possible point of impact	Treated resinuous compound present near the fracture	
Playa Grande	102	Medial-distal fragment	Undetermined*	Pale green-beige rock, fine-grained	7 (A-H)	1-2	57	32	9	-	Thinning scar persists	Dry grinding traces	No clear traces (relevant surface fragmentary)	-	Haft fracture (oblique)		
Playa Grande	103	Medial-distal fragment	Metamorphic, high-pressure*	Dark blue to black schist with glaucophanes and some micas	7 (A-H)	1-2	64	35	14	-	Flaking/foliation splitting scars, hammering impacts on sides	Absent	Male slotting, embedded; seasoned wooden haft	-	Transverse medial fracture (haft break?)		
Playa Grande	104	Wedge blank	Metamorphic, high-pressure*	Jadeite-bearing, pale green with blue	7 (A-H)	1-2	53	28	20	Alluvial	Very limited shaping	-	-	-	Production flaw due to craqueler		
Playa Grande	105	Edge-medial preform	Metamorphic?*	Dark blue to black with white mottle, possible blueschist with alterations	7 (A-H)	1-2	50	36	18	-	Hammering of sides, fine pecking	Wet stone variant 4, bevel and distal zone only	No traces (relevant surface fragmentary)	Edge unfinished, no traces	Transverse medial fracture		
Playa Grande	106	Medial fragment	Metamorphic, low-grade*	Typical greenschist	7 (A-H)	1-2	30	20	16	-	-	Wet grinding traces, unspecified, dense striations	No traces (relevant surface fragmentary)	Possible re-use	Two medial fractures, one unclear		

Playa Grande	107	Edge-medial fragment	Metamorphic, high-pressure*	Glaucophane matrix, with green minerals present	7 (A-H)	1-2	41	18	10	-	Unclear	Wet stone variant 3, bright and well developed	No clear traces	Probable use unclear, including soft material? Edge blunt and chipped	Transverse medial fracture (haft break?)		
Playa Grande	108	Edge-medial blank	Metamorphic, high-pressure*	Jadeite-bearing, pale green	7 (A-H)	1-2	70	27	17	Alluvial, testing of texture (contact unspecified)	Coarse pecking of sides	-	-	Edge 'retouch' likely result of grinding motion, no use traces	Transverse distal fracture		Edge damage may have rendered the blank indesirable, but unclear
Playa Grande	109	Edge fragment	Metamorphic, high-pressure*	Jadeite-bearing, pale green with blue tinge	7 (A-H)	1-2	47	43	16	-	Coarse pecking?	Rough, striated polish, well developed (cf. exp. 2782)	Traces unclear (relevant surface fragmentary)	Woodworking, experimental range (uneven smooth, bright polish, doming and reticulating). Edge slightly dulled	Skewed transverse medial fracture (haft break)		
Playa Grande	110	Edge fragment, roughout	Metamorphic, high-pressure*	Jadeite-bearing, green with acicular blue and mica	7 (A-H)	1-2	100	85	44	Alluvial, testing (dry grinding traces)	Hammering of sides (producing partial thinning), coarse pecking	-	-	-	Transverse medial fracture	Treated resin present on one face.	
Playa Grande	111	Edge-medial fragment	Metamorphic, high-pressure*	Jadeite-bearing, pale green with blue and mica	7 (A-H)	1-2	61	56	25	Unclear	Hammering of sides, coarse pecking	Wet grinding traces, unspecified	No clear traces (relevant surface fragmentary)	Trace signatures unclear, likely multi-use including several soft materials and 'unspec. distinct'. Edge destroyed	Fragmentation unclear		
Playa Grande	112	Distal blank fragment	Metamorphic, high-pressure*	Jadeite-bearing, pale green with blue and mica	7 (A-H)	1-2	45	30	19	Alluvial	Light flake shaping	-	-	-	Transverse medial fracture (fluid)		
Playa Grande	113	Edge-medial blank	Metamorphic, jadeitite*	Pale green	7 (A-H)	1-2	71	33	28	Alluvial, testing (dry grinding traces, poor platform)	-	-	-	-	Oblique fracture (fluid, unclear)	Resin attached to surface during or after fracturing	
Playa Grande	114	Medial fragment	Metamorphic, high-pressure*	Jadeite-bearing, unspec.	7 (A-H)	1-2	40	42	25	-	Coarse pecking	Dull lustre. Traces from contact with stone. Implied dry on poor platform	Traces of soft abrasive contact on side, binding?	-	Rectilinear and skewed medial fractures		
Playa Grande	115	Medial flake	Metamorphic, high-pressure*	Jadeite-bearing, pale green with blue and mica	7 (A-H)	1-2	42	35	6	Unsure	Unsure	Dull lustre. Traces from contact with stone. Implied dry on poor platform	-	-	Fragmentation unclear		

Playa Grande	116	Debitage or blank fragment	Metamorphic, high-pressure*	Jadeite-bearing, pale green with acicular blue	7 (A-H)	1-2	74	26	20	Alluvial	-	-	-	-	Fragmentation long axis		
Playa Grande	117	Edge-medial fragment	Metamorphic, high-pressure*	Blueschist with alterations	7 (A-H)	1-2	73	32	22	-	-	Wet grinding traces, striated polish (unspecified)	Unsure	Edge destroyed, traces unsure	Rectilinear breakage	Strongly to weakly developed wood polishes present in various locations, a relation with manufacture, haft, or use could not be determined	
Playa Grande	118	Edge fragment	Metamorphic, high-pressure*	Distinct darker green 'jadeitite', probably contains significant omphacite. Also contains mica	7 (A-H)	1-2	47	51	22	-	Pecking (coarse) preserved on sides	Wet stone variant 2 (matt, striated polish), scintillation underneath (unclear if preceding technique)	-	Woodworking, unspecified (holdover). Edge destroyed	Transverse medial fracture (fluid) with point of impact		
Playa Grande	119	Edge flake	Metamorphic, high-pressure*	Glaucophane matrix, with green minerals present	7	2	28	37	7	-	-	Wet grinding traces, intensely developed bright, striated polish (unspecified due to acicular matrix)	-	Woodworking, 'exceeding.' Edge fairly sharp	Use flake		
Playa Grande	120	Medial flake	Metamorphic, low-grade*	Typical greenschist	7	2	52	34	9	-	-	Densely striated. Wet grinding traces, densely striated, unspecified (cf. quartz arenite, 30 minutes)	Sole surviving side bears traces indicating wood friction	-	Fragmentation unclear		
Playa Grande	121	Biconvex celt	Undetermined*	Volcanic or HP metamorphic?	7	2	72	29	15	-	Pecking coarse to fine	Unclear	Male embedded, deep, in seasoned wood	Edge destroyed, some unclear polishes on bevel	No indications (resharpening would have been possible)		
Playa Grande	122	Medial fragment	Metamorphic, high-pressure*	Blueschist with alterations and jadeite vein	7	0	23	32	22	-	-	Intermediate lustre. Cf. 'sand-ground' traces, but brighter and greasier	No traces (relevant surface fragmentary)	-	Fragmentation unclear		
Playa Grande	123	Edge roughout?	Metamorphic*	Schistose, with dark blue–green–mica mottle	7	0	46	48	21	Unsure	Bifacial thinning, hammering of sides	Unsure	Unsure	-	Skewed transverse medial fracture unclear	Unclear dense hard material friction polishes, PDSM?	

Playa Grande	124	Petaloid axe	Metamorphic, high-pressure*	Blue and green mottled	7	0	62	34	11	-	Bifacial thinning, hammering of sides, coarse pecking of sides	Wet stone variant 1b, bevel only	Friction polishes in symmetric arrangement, indicating male slot	Traces from contact with pliable material, unspecified. Edge sharp but nicked	No indications		
Playa Grande	125	Distal roughout	Metamorphic, jadeitite*	Pale green, glinstering	7	0	41	32	16	Alluvial?	Hammering of sides, pecking of surface	-	Unsure	-	Transverse medial fracture	Slight friction smoothening on face	
Playa Grande	126	Medio-distal blank	Metamorphic, high-pressure*	Green and blue mottled	7	0	63	41	25	Alluvial	Direct flake thinning longitudinal, some hammering of sides	-	-	-	Transverse medial fracture with point of impact		
Playa Grande	127	Edge fragment	Metamorphic*	Dark green and blue interwoven	7	0	64	44	25	-	-	Wet stone variant 1a	-	Woodworking, 'exceeding.' Repurposed (pecked blunt)	Transverse medial fracture (haft breakage)		
Playa Grande	128	Edge-medial fragment	Metamorphic*	Blue-black-green schist	7	0	61	52	20	-	Hammering of sides	Wet grinding traces, possibly multiple signatures. Ultimately unclear	Traces unclear, presence of pristine resin	Edge repurposed, hammered blunt. Possible soft material wear traces remain behind it.	Transverse medial fracture, cracking along foliation		
Playa Grande	129	Edge-medial fragment	Metamorphic, high-pressure*	Blueschist with alterations	7	0	55	36	15	-	Hammering of sides into coarse pecking (induced foliation splitting), followed by fine pecking	Wet grinding traces, well developed bright, striated polish (unspecified due to acicular matrix)	No traces (relevant surface fragmentary)	Edge dulled. Well developed soft material polishes (covering, rough, greasy, invasive)	Transverse medial fracture unclear		
Playa Grande	130	Edge-medial fragment	Metamorphic, high-pressure*	Blueschist, typical	7	0	45	33	17	-	Hammering of sides, fine pecking	Traces from contact with stone on bevel, dull technique unspecified	-	Edge dulled. Well developed soft material polishes (matt, rough, concentrated, striated, fairly invasive)	Transverse medial fracture		
Playa Grande	131	Medial-distal fragment	Metamorphic, high-pressure*	Dark blue schist, with pale grey zone	7	0	54	41	11	-	-	Dull lustre. Gouged scintillation, relief present, possibly dry on hard sandstone?	Friction traces present, wood/ plant indet.	-	Oblique fragmentation (hafting?)		
Playa Grande	132	Medial-distal fragment	Undetermined*	Grey, fine-grained massive, isotropic	7	0	56	50	27	-	Hammering of sides, pecking	Traces from contact with stone, dull technique unspecified	-	-	Longitudinal impact scarring, transverse medial fracture		
Playa Grande	133	Flake	Metamorphic, high-pressure*	Blueschist with minor alterations	7	0	58	42	5	Alluvial	Debitage flake, split along foliation plane	-	-	-	Debitage		

Playa Grande	134	Medial fragment	Undetermined*	Brown-beige	7	0	84	52	13	Unclear	Unclear	Unclear	Unclear	Unclear	Unclear		
Playa Grande	135	Celt roughout	Metamorphic*	Green with dark minerals	7	0	59	28	10	Secondary context, testing (dry grinding traces)	Hammering of sides	-	-	No traces	No clear indications, possibly due to over-invasive impacts	Unclear residue present on one side (distally)	
Playa Grande	136	Medial fragment	Metamorphic, high-pressure*	Blueschist with alterations	7	0	50	32	14	-	Unsure	Wet grinding traces, unspecified (short duration)	Traces of wood friction present	-	Rectilinear fragmentation		
Playa Grande	137	Distal fragment, roughout	Volcanic*	Dark grey to black, fine-grained	7	0	48	39	10	Unclear	Shaped through bipolar hammering of sides	Unclear	-	-	Transverse medial fracture unclear		
Playa Grande	138	Flake	Metamorphic, high-pressure*	Blue schist with some mica and green minerals	7	0	61	26	8	Secondary context	Thinning/foliation splitting flake, with overlapping scar	-	-	-	Debitage		
Playa Grande	139	Medial fragment	Metamorphic*	Darker green	7	0	51	26	19	-	Pecking marks remain	Traces from contact with stone, dull technique unspecified	-	-	Fragmentation unclear		
Playa Grande	140	Biconvex roughout	Undetermined*	Volcanic or blueschist	7	0	70	41	19	-	Fine pecking of shape, direct longitudinal flake thinning, bipolar hammering of sides	-	-	-	No indications		
Playa Grande	141	Edge-medial roughout	Metamorphic, high-grade*	Blueschist, typical	7	0	59	38	11	-	Thinning unspec., bipolar hammering of sides, fine pecking	-	-	-	Shaping mishap		
Playa Grande	142	Medial-distal roughout	Undetermined*	Volcanic or blueschist	7	0	77	40	20	-	Splitting of foliation layers from sides? Fine pecking, hammering of sides incl longitudinally, counterblow present	-	-	-	Splitting mishap longitudinal axis, transverse medial fracture with point of impact		
Playa Grande	143	Edge-medial fragment	Undetermined*	Volcanic or blueschist	7	0	58	48	9	-	Thinning scar persists, with fine pecking	Wet grinding traces, unspecified	-	Edge nicked and battered, but usable. Polishes unclear or absent	Haft fracture (oblique)		
Playa Grande	144	Edge-medial fragment	Sedimentary*	Brown with white, porous	7	0	74	41	25	-	Hinge scars from lateral hammering remain	Traces from contact with stone, technique unspecified	-	Edge slightly battered. Woodworking 'bleary cedar'	Use fracture oblique		
Playa Grande	145	Medial-distal fragment	Metamorphic, high-grade*	Probable blueschist. Medium-grained, even mixture of dark blue and white minerals	7	0	86	43	30	-	Shaped by light lateral flaking	Unclear	-	-	Edge portion fractured away		

Playa Grande	146	Edge-medial fragment	Metamorphic, high-pressure*	Blueschist with alterations (probably)	7	0	62	37	27	-	Fine pecking on intact medial surfaces	'Sand-ground' traces with high relief, bevel only, dense gouging	-	Edge abrasively blunted, no wear traces from use present	Rectilinear fracturing		
Playa Grande	147	Edge fragment	Undetermined*	Volcanic or blueschist	7	0	39	41	13	-	Unsure	Unsure	Unsure	Edge abrasively blunted (sand-ground), otherwise unsure	Transverse medial fracture		Wear is present and recognised, but too many uncertainties in too many biographical phases to value the analysis
Playa Grande	148	Edge-medial preform	Undetermined*	Volcanic or blueschist	7	0	60	29	17	-	Scar negatives indet., medium pecking	'Sand-ground' traces with high relief, bevel only, dense gouging. Rest of ground surface possibly abraded on hard coarse-grained sandstone, heavily striated (cf. exp. 2515-A)	-	Edge still blunt, no wear traces from use present	Fracturing unclear (in shaping?)		
Playa Grande	149	Fragment	Metamorphic*	Green, schistose	7	0	71	39	8	Secondary context	Unsure	-	-	-	Fracturing unclear		
Playa Grande	150	Distal fragment, possibly preform	Metamorphic, high-grade*	Blueschist, typical	7	0	43	36	19	-	Scar negative indet., coarse pecking, fine pecking	-	-	-	Transverse medial fracture	Wear friction polishes indet. on faces	
Playa Grande	151	Distal blank fragment	Metamorphic*	Pale green, mica-bearing, possible jadeite	7	0	50	24	21	Alluvial	Limited cortex flaking	-	-	-	Transverse medial fracture		
Playa Grande	152	Medial-distal fragment	Metamorphic, high-grade*	Blueschist, typical	7	0	63	42	16	-	Flake thinning unspec., hammering of sides, pecking	Absent	Multiple friction contact types present, but lacks straightforward distribution	-	Transverse medial fracture (largely fluid)		
Playa Grande	153	Edge-medial roughout	Metamorphic, high-grade*	Blueschist, lighter coloured	7	0	88	50	21	Secondary context	Direct bifacial thinning, hammering of sides, pecking	-	-	-	Potential production mishap, transverse medial fracture		
Playa Grande	154	Edge-medial fragment	Metamorphic, high-grade*	Jadeite-bearing, pale green	7	4	-	-	-	Unsure	Unsure	Mineral mirror polish on bevel, including micro-striations	Unclear	Sharp, no use traces	Transverse medial fracture		

Playa Grande	155	Edge-medial fragment	Metamorphic, blueschist*	Dark blue, fine-grained	-	-	47	31	8	-	Flaked, shaped through hammering, partial fine pecking	Dull, striated, mainly bevel. Scintillation with minor 'stony polish' development	No clear traces (relevant surface fragmentary)	No clear traces	Edge fracture, unclear if use related? Transverse medial break		
Playa Grande	156	Medial-distal blank	Metamorphic, high-grade*	Jadeite-bearing, pale green cortex	-	-	75	41	21	Unsure	Bifacial cortex removal flake, craqueler	-	-	-	Transverse medial fracture (fluid)		Type of natural surface is unsure
Playa Grande	157	Medial-distal blank	Metamorphic, high-grade*	Blueschist with green/pale mottle	7	6	67	52	15	-	Unsure reduction, coarse pecking	-	-	-	Fragmentation anisotropic unsure, coarse pecking	A short-term smoothening of a few facets on one face, but phase and intent uninterpretable	
Playa Grande	158	Edge-medial blank	Metamorphic, high-grade*	Jadeite-bearing, light pale green	7 (A-H)	1-2	59	33	20	Alluvial. Testing of texture (presence of polish, cf. exp. 2782)	Coarse pecking of sides, followed by flaking attempts	-	-	-	Fragmentation during manufacture, skewed transverse medial break		
Playa Grande	159	Flake debitage	Metamorphic, high-grade*	Blue-coloured schist	7 (A-H)	6	65	40	7	-	Thinning flake, foliation split?	-	-	-	Debitage		
Playa Grande	160	Edge-medial blank	Metamorphic, high-grade*	Jadeite-bearing, light pale green	7 (A-H)	6	44	40	22	Alluvial	Limited hammering or pecking of shape	-	-	-	Transverse medial break (fluid), possible point of impact		
Playa Grande	161	Edge-medial fragment	Metamorphic, high-grade*	Blueschist, typical	7	4	57	45	15	-	Hammering of sides, fine pecking	Scintillation, with dull, rough, flat, and striated polish from stone contact (cf. exp. 2782, but short duration)	Unclear	Woodworking, distinct (higher pliability), low intensity over whole blade. Edge battered	Skewed edge fracture from use, transverse medial break	Possibly a wedge	
Playa Grande	162	Roughout flake	Metamorphic, high-grade*	Jadeite-bearing, light pale green with blue tinge	7	4	41	39	11	Testing of texture (dry grinding traces, mild directionality)	Coarse pecking	-	-	-	Point of impact indicates flaked as production fracture	-	
Playa Grande	163	Distal blank	Metamorphic, high-grade*	Jadeite-bearing, light pale green	7	4	54	38	33	Alluvial	Bifacial flaking of cortex	-	-	-	Transverse medial fracture (fluid)		

Appendix 4

Analytical descriptions of paraphernalia

This appendix contains the technical and contextual analyses for the paraphernalia whose biographies were reconstructed in Chapter 9. Tables A4 and A5 provide basic overviews of the artefacts and their contexts in the same order and grouping as they appeared in Chapter 9, followed by a descriptive analysis of each artefact in the corresponding order.

Table A4: overview of materials with contextual data. Measurements are given in millimetres.

Fnr	Object	Material	Site	Z-s-s	Unit	Layer	Length	Width	Thickness	Section
276	Eye inlay	Nacre	El Cabo	90-92-70	-	1	13	11	n.a.	9.1.1
1359	Mouth inlay	Bivalve shell	El Cabo	75-26-73	-	-	24	11	02	9.1.1
1527	Mouth inlay	*Lobatus* sp.	El Cabo	84-59-85	-	-	23	09	03	9.1.1
2214	Mouth inlay	*Lobatus* sp.	El Cabo	85-50-63	-	-	14	08	03	9.1.1
2694	Mouth inlay	*Lobatus* sp.	El Cabo	85-31-28	-	1	21	13	n.a.	9.1.1
3104	Mouth inlay	Bivalve shell	El Cabo	85-51-42	-	-	36	07	02	9.1.1
882	Two-dimensional engraved plaque	*L. gigas* subadult	El Cabo	84-49-58	-	-	40	11	04	9.1.2
1401	Two-dimensional engraved plaque	Gastropod Shell	El Cabo	84-59-08	-	-	26	13	04	9.1.2
1718	Two-dimensional engraved plaque	Nacre	El Cabo	85-34-91	-	9	28	13	04	9.1.2
3678	Two-dimensional engraved plaque	*L. gigas* subadult	El Cabo	n.a.	-	-	48	11	06	9.1.2
2193	Three-dimensional plaque	*Lobatus* sp. body whorl	El Cabo	85-50-83	-	-	47	15	13	9.1.2
2154	Engraved tinkler	Old *Oliva reticularis*	El Cabo	85-50-92	-	-	36	19	16	9.1.3
726	Face-depicting shell preform	*Conus* sp.	El Cabo	84-39-111	-	-	33	22	20	9.1.3
1339	Engraved ring-like object	Bivalve shell	El Cabo	84-59-39	-	-	27	16	03	9.1.3
3107	Face-depicting shell	Old *L. gigas*	El Cabo	85-51-82	-	-	39	27	16	9.1.3
S615	Tooth pendant	Pantherine cf. *Panthera onca*	Brighton Beach	-	A	1	64	17.5	17	9.2
S208	Tooth pendant	*Sus scrofa*	Brighton Beach	-	-	0	58	9	10	9.2
1748	Tooth pendant	Cf. *Trichechus manatus* incisor	El Flaco	63-82-F13	32	-	11.5	15	7	9.2
023	Dental pendant	Scaridae pharyngeal grinder	El Flaco	63-64-85	1	5	39	23	7 (teeth), 4 (plate)	9.2

2420	Dental pendant	Myliobatoidei dentary palate	El Cabo	-	-	-	20	13	02	9.2
115	Dental pendant	Myliobatoidei dentary palate	El Flaco	63-74-45	6	2	31	17	10.5	9.2
090	Earplug	Bone, probably marine	La Luperona	64-16-08	4	1	40	14	13	9.2

Table A5: overview of materials lacking contextual data. Measurements are given in millimetres.

Int. no.	Object	Material	Collection	Provenience	Provenance	Length	Width	Thickness	Section
p001	*Guaíza*	*Strombus pugilis*	Willcox	Local collector	East Grenada	76	54	41	9.1.3
LP-01	Flute	Cf. deer long bone	Charles	Cliffside	La Poterie	203	-	27	9.3
LP-02	Flute	Cf. deer long bone	Charles	Cliffside	La Poterie	95	-	18	9.3
p005	Flute	Unidentified long bone	Willcox	Local collector	Telescope point	182	21	27	9.3
p007	Flute	Possibly deer long bone	Willcox	Local collector	Telescope point	148	-	23	9.3
p006	Tube	Human tibia	Willcox	Local collector	Telescope point	318	-	42	9.3
p004	Face-depicting object	Wood	Willcox	Fort Jeudy beach	South Grenada	34	31	11	9.4

A4.1 Shell objects

Object C 276

Object C 276 originates from south of the excavated and surveyed areas, the recorded zone extending over the cliffs. It is unclear what this means and whether the recording is not inexact, but one possible explanation is that it represents erosion of the midden deposits.

Procurement and manufacture

The base consists of columnar nacre, with the opposing surface sporting a depression with unmodified surface, suggesting that was the internal side of the mollusc. The affix material is unclear, but an organic and carbonaceous nature is suggested by biologically patterned elements visible under magnification (Figure A13) and by SEM-EDAX compositional measurements: these showed calcium, carbon, and oxygen as the major elements for both areas. Two possible identifications commence from here on. The first is that the base was made out of the nacreous section from a large bivalve, upon which an extraneous affix adheres. The second option presumes that both base and affix are made of the same *Cittarium pica* shell, a black and white patterned gastropod. Detailed examination further shows that the reddish coloured boundary between the affix and the nacre is texturally similar and connects

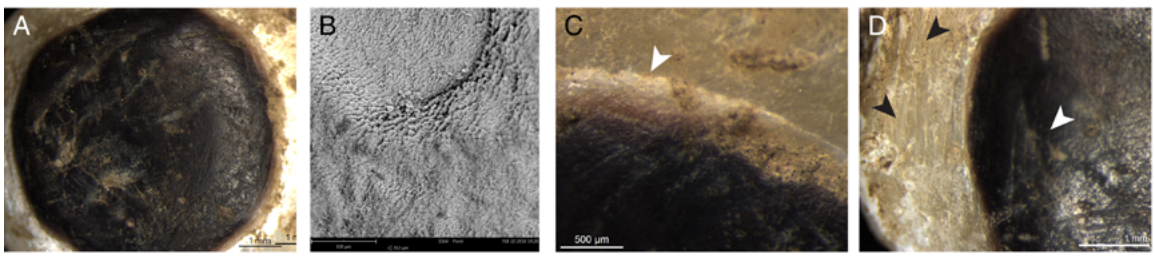


Figure A13: Views of C 276. A) close view of the affix. B) SEMgraph of the nacreous sheet structure. C) conjoining of the two aspects. D) longitudinal striations on both at several intersecting parallels.

the two seamlessly, giving no indication of a boundary between materials or an adhesive fill (Figure A13, c). Manufacturing traces on the object also favour the latter identification. The nacreous base is characterised by elongated coarse grooves associated with abrasive wear, which are most probably associated one of the local lithic materials (coarse sandstone, beachrock) as handheld abrader, used in a scraping or single-stroke abrasion motion. These grooves are the only traces visible, and extend to the black 'affix' (Figure A13, d). Here they are present on the walls and associated with the facetted appearance of the outline, as well as the flat surface itself. The inner side of the nacreous base bears the same traces, but the retention of an original depression in the centre indicates that abrasive contact here was brief, and probably focused on flattening taxon-specific protuberances. Finally, analogous coarse parallel grooves were seen on the sides of the object, rounding off the production of the inlay. In an earlier stage these were thought to be cutting traces related to the separation of the blank from the shell, but this interpretation did not hold. If such an activity had taken place, subsequent abrasive wear to fit the piece into its intended socket has erased the evidence.

Use and deposition

Wear traces resulting from use are not observed on this piece. Residues were not directly observed either, though there may still be an unverifiable presence underneath the x-shaped configuration of soil seen on the back. The damage located on two of the three points is consistent with forces acting on the fringes of the object, but could result from multiple actors. Forceful insertion is one possibility, as are mistakes during manufacture of a fragile object. Deposition into the midden may have followed the breakage of the object in the case this would have rendered it unsuitable for the task of inlaying. Otherwise, value recontextualisation concerning the composition artefact itself may have been at play, with the inlay being deposited as part of a larger event now lost to degradation.

Objects C 1359, 1527, 2214, 2694, 3104

C 1359 originates within a 2x2 test pit with both early and late Ostionoid ceramics and including some mixed 10th century Chicoid materials in the upper layer (Samson 2010, 126-127). C 1527 is located centrally in Structure 2 of House Trajectory 3, which belongs to phase *a* of the Chicoid occupation dating to the 9th and 10th century AD (Samson 2010, 248-251). C 2214 is located on the border of a phase *a* house plan that is overlapped by House Trajectory 2, dating from the 11th century to the early colonial period (Samson 2010, 258), and could have been associated with either. C 3104 is recovered from the northern border of House Trajectory 2 plans, some meters away from other paraphernalia. Finally, C 2694 was recovered from the top layer of a partially excavated house floor west of the main excavation area (Samson 2010, 131-132), and is probably associated with the later Chicoid occupation.

Procurement and manufacture

Two of the inlays are made of white bivalves with three layers and a cross-lamellar central microstructure, which is evidenced by the internal curvature still present on the backside (Figure 45, A14, a). The other three are made of the white, heavy shell of a *Lobatus* taxon, and are uniform on all sides. These raw materials can be obtained nearby the site. Evidence regarding the separation of the preform from the shell is lacking in most, but persisting inflections around some of the edges suggest that the blanks may have been separated by sawing originally (cf. shell blank separation in Breukel and

Falci 2015). The sides have all been abraded afterwards, with a fracture occurring in C 2694 leading to the abandonment of that piece. There the facets from different abrasion angles are still present, these have been smoothened in the others (showing it was not simply a white oval inlay). The front and backside are abraded against hard non-coral mediums, given the sharp boundary with the natural depression in C 1359 and semi-hard rough material polish in C 3104 (Figure A14, b).

The engraving sequence appears consistent between the four pieces, and was applied after the abrasive phase as indicated by a gradual boundary with the surface. The elongated incisions are placed first, and the parallel incisions afterwards, crossing its depth in some instances and failing to reach it in others. The main incisions are all sawn deep and mostly sport steep V-shaped walls while the bottoms are variable, ranging from sharp to flat and bowl shaped (Figure A14, c-g). Blunt edges perhaps made of coarser lithic tools were likely used for all, as the bottom is only slightly wider than that of the *L. gigas* sawing experiment. Though striations would be expected, the microstructure has deteriorated negating this variable (Figure A14, h). Further, misplaced onsets with a V-shaped profile are observed on C 1359, whose profile matches a solid edge and is less affected by the modelling effect deeper sawing has. These grooves are unlike any of the organic tool results discussed in section 5.3.2 and lack the inflected surface of subsequent widening. Only in C 3104 is a teeth a potential alternative for two shallow furrow grooves (Figure A14, e), but the V- shape of the other grooves is typically lithic.

Use and deposition

C 1359 and C 3014 displayed a polish on the centre portions of their backsides that is potentially associated with use friction. There is a correlation with a macroscopically observable darkened patina,

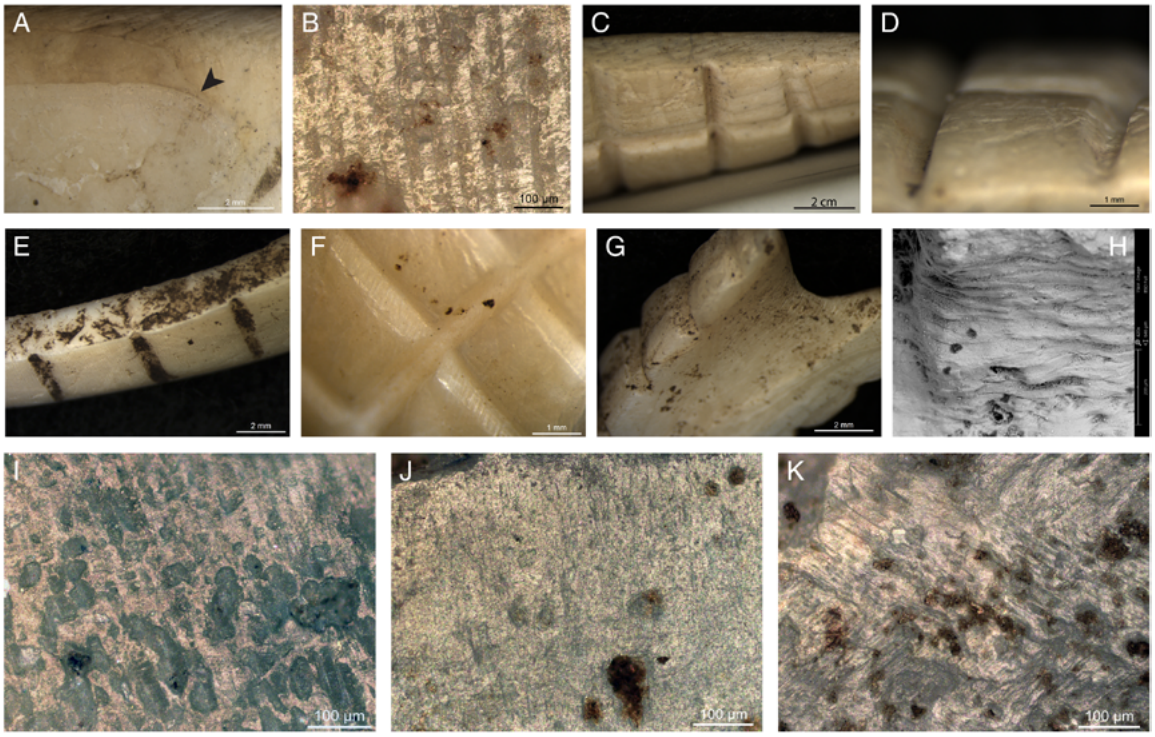


Figure A14: A) backside of C 1359 showing internal surface. B) semi-hard material polish on the frontside of C 3104. C-G) stereographs of incisions on C 1359, 1359, 3104, 1527, and 2214. H) SEMgraph of eroded bottom of an incision on C 1359. I & J) micrograph of polish associated with soft material contact on the backside of C 1359 and C 3104, the latter also showing PDSM near the top. K) micrograph of side of C 3104 showing comparable traces.

especially on C 1359. The polish is present fairly evenly in this area, crossing the structural laminas which are organised in a consistent ridge-furrow topography (Figure A14, i-k). With a dull and rough texture and fairly invasive, vertical development it indicates a soft contact material, rather than mineral or coral (probable manufacturing abrasives) or wood (a typical socket), and the lack of corrugation argues against ceramic contact. Rather, a material such as skin/hide or a spun fabric of cotton fibre is implicated. A related modification is found on the side of C 3104. Whilst potentially characteristic, at present there is not enough to go on about regarding the contact and if it is consistent with use as an inlay. The front displayed no traces of wear. With respect to the depositional context, the broken half-fabricate was in all likelihood discarded to end up in a domestic sweep accumulation. Similarly, the midden context of C 1359 indicates such a depositional trajectory. The other three specimens might have been caught up in a process of discard and sweeping, or have left the hosting object in-situ in the spatial contexts in which they were found (this possibility is further expanded in the biographical reconstruction).

Objects C 882, 1401, 1718, 3678

C 882 was found inside House Trajectory 4, which Samson (2010, 259) considers as probably contemporaneous with House Trajectories 1 and 2 dating anywhere between 1000-1504 AD. C 1401 was found at the edge of Structure 7 from House Trajectory 3, likely associated with a sweep accumulation from the Chicoid occupation. C 3678 is associated with the habitation area (Samson 2010, 278), but not further specified. Finally, C 1718 is derived from layer 9 in the 2x2 excavation unit 85-34 north of the habitation area, inside Ostionoid midden deposits rich with paraphernalia (Samson 2010, 125). The deepest layer directly below it is dated to 550-691 cal. AD (2σ, GrN-31416) and layer 4 above it to 729-938 cal. AD (2σ, GrN-31415), indicating that the finds in between date to the 7th Century AD (Samson 2010, 120).

Procurement and manufacture

The two intact plaques retain a wavy elevation of the internal layer, indicating they are made of a specific part from *L. gigas* subadult lips in which this morphology is naturally present. The broken piece is unidentified, but the host shell has a cross-lamellar structure and so could be from a similar species. Some cutting motions are implied in the separation of the plaques by the irregularities of the lateral borders, but most evidence of this stage is removed by later reworking. They all display the same sharp boundaries between the sides and the back, unworn by use related contact or rounding gestures during later smoothening phase (Figure A15, a-c). Whichever specific abrasive technique was used could not be reconstructed, but its application is evidenced by the sharp angle between the flattened backside and its interior depressions, best seen on 882. A wear contact polish seen on both sides is discussed below.

The engraving and perforation steps came after. Both intact shell plaques share a checker-board pattern as their central element (Figure A15, d). This is formed by three incisions on the short axis bounded by a deeper one on each end, cut through by four or five incisions on the long axis. These 'checkers' were probably intended to have had consistent square dimensions, but some incisions are slightly offset. Nevertheless, there is a good control of depth, width, and avoidance of overshooting into the lateral elements. The grooves have angular V-shaped walls, though the bottom is not sharp anymore (Figure A15, e). Their morphology is well comparable the flint experiment but they are

slightly broader, suggesting sawing with a coarser-grained chert or another rock. However, the grooves separating the central and lateral elements are much wider still and show some inflection on the side. These were probably set with a different tool, or alternatively, briefly enlarged with a file. Unfortunately, soil encrustation and erosion of diagnostic variables prevent an inference at the tool material.

The central element of C 1401 bears some faint chert-made incisions, but the lateral elements of all bear differently made engravings. In C 3678 they are elongated M-shapes produced by three wide grooves, and in the other two they are open chevrons turned sideways produced by an excised hourglass running along the long axis paralleling additional wide grooves (Figure A15, f-h). Crossed cut-marks on 1401 show its hourglass cuts to have been set with incision, after which the superfluous material was probably removed by chiselling with a lithic point. The wavering pathway and homogeneous walls of the grooves in the other two, as well as the furrowed topography of the excised areas, are indicative of such a technique. Side notches forming the chevron openings of C 882 are probably filed similar to above. None of the grooves now bear internal striations or wear polishes.

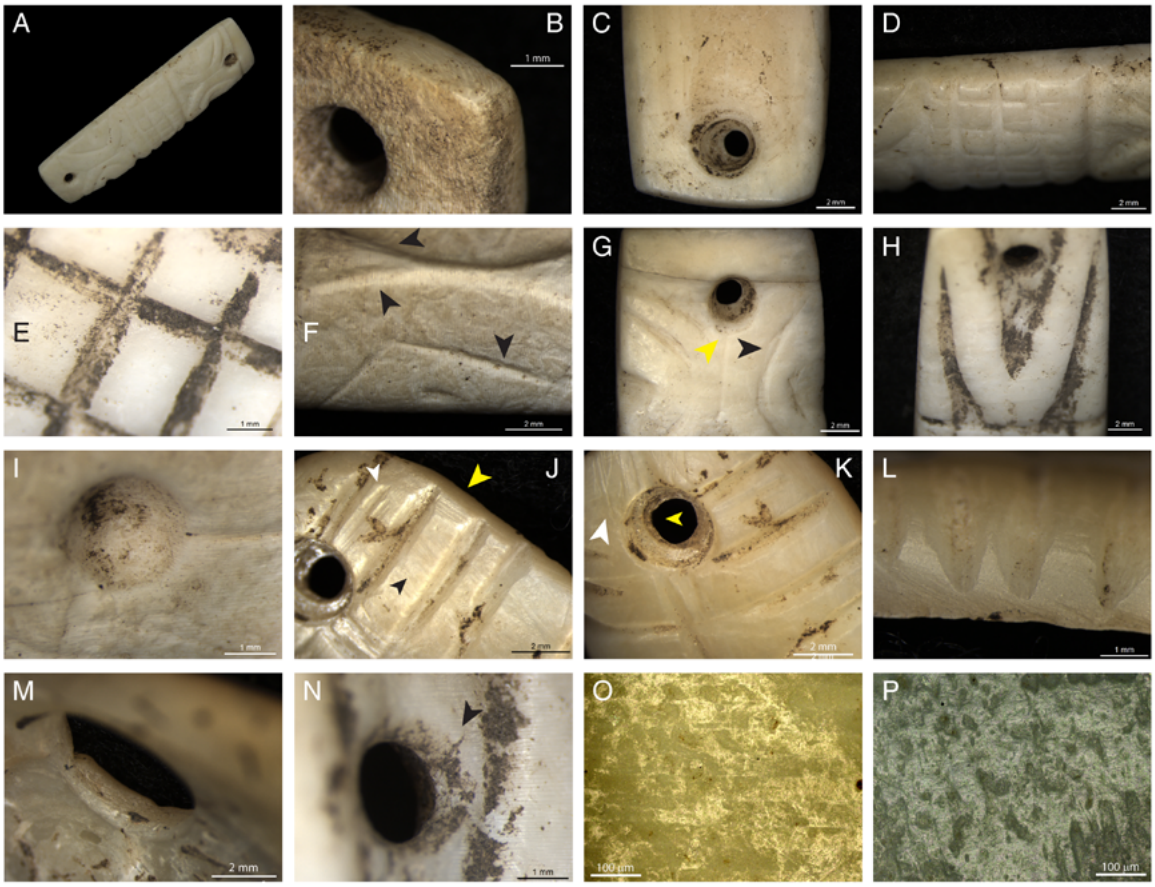


Figure A15: A) Side view of C 882. B) Corner of C 1401. C) Smoothened back view of C 882 with abrasion level and lower perforation. D) Side view on chess-board pattern incisions on C 882. E) Close-up of centre element of C 3678. F) Sideway view of the hourglass incisions and parallel cuts in C 1401, individual strokes marked by black arrows. G) Front view of half-moon cuts and upper perforation on 882, use-wear deformation facet marked by yellow arrow. H) Close-up of lateral element of C 3678. I) Unfinished perforation in the centre of C 1401. J & K) Direct and oblique light views of incised side of C 1718 evidencing sawing (yellow arrowhead), abrading (small black), incising including misplaced cut-marks (small white), scraping traces (large white), the perforation profile, and a wear facet inside it (small yellow). L) Side view of C 1718 showing sawing, interlaced abrasion, and groove profiles. M) View of the central perforation inner profile. N) Wear facet in the ridge of upper frontal perforation in C 3678. O) Wear on the back of C 882. P) Well developed wear from softer material contact on the front of C 882.

Although the perforations in C 882 are slightly narrower than in the other two plaques, the perforation technique is consistent between the three (Figure A15, g-i). All display a biconical profile, where a shallow onset originates at the front whereupon it was met by a second back onset perforating through for most of the distance. The deep conical profile and thin concentric striations in asymmetric clusters indicate that solid conical drill bit bits were used in this process, probably palm drilling with a lithic tip (cf. Lammers-Keijsers 2007, 63).

The nacreous piece has a different origin, for which the host shell is not identified. As with 276 above, the intermediate layers appear to have been removed down from the exterior surface. The back side retains parts of what appears to be a foliated structure, probably the original intermediate shell layer, whose removal involved both cutting and abrasive contact. The sides show clear evidence of lithic sawing retained on one side, whereas the other three bear clear marks of abrasion (Figure A15, j-l). Traces of abrasive contact remain on the engraved surface, and it is clear also on the back side as a shaping technique. It appears a coarse grained stone platform was used, based on the overall regular alignment of the striations. There are many clusters of more erratic striations superimposed that could indicate later contact with a coral with sand or a scraping edge, though the relation to manufacture remains a question. The engravings are all incised with a tapered lithic edge or point, indicated by the straight V-shaped walls, elongated striations therein, and smooth bottoms. They compose a single horizontal line intersected by various vertical lines as in a teeth pattern motif, though in fact the lines 'interrupted' by the perforations were set at different moments. The side perforations are biconical and were drilled with a lithic bit. The main perforation is straight-walled internally, but bearing inflections on either side (Figure A15, m). This probably indicates bi-cylindricality for which one possibility is a hollow or tubular bit, the counter placed to avoid fracturing the shell layer despite the short distance. However, it may also have been an originally smaller perforation which was widened using a straight tool, such as the tip of a staghorn coral (*A. cervicornis*). Not enough microwear traces remain to reach a conclusion on the actual tool material involved.

Use and deposition

The main evidence of use pertains to the method of suspension, evidenced by deformations within the inner rim of the perforations and surrounding polish from string wear (Figure A15, c, g, k, n). In C 882, small disfigurations in the concentric outline are starting to show. In one it is oriented outwards along the long axis, whereas the other shows two deformations along the short axis. Both exits have polish development indicative of string wear oriented along the long axis, with some more to the sides matching the disfigurations, and some corresponding polish on the inner ridges. In 3678, rather, both perforations have a single suspension facet both of which are oriented equally along the short axis. String wear polishes are also most strongly associated with this orientation, though spread a bit further. The nacreous plaque has one suspension facet oriented towards the central perforation, and another outwards 45° offset from the long axis, neither corresponding to a groove. String wear polishes were not identified here, and for none is the material of the strings interpreted. The central perforation showed no convincing development of wear traces. Finally, no wear could be recorded on C 1401.

A second line of evidence pertains to a wear polish. This is a dull, rough, and invasive soft contact polish connecting through reticulating bands, leaving craters in between (Figure A15, o-p). Both intact plaques had an strong development of this trace signature on the engraved frontal aspects,

and a weak but recognisable development on the abraded back side. Options may include soft plant matter, fabrics and fibre strings, or skin. The nacreous plaque, which is far better preserved, shows a strong rounding development on the sharp angles and abrasion traces on the frontal surface. The distribution would indicate that whichever responsible contact was focused mainly on the engraved front side, which argues against ornamental display. However, the provenience of the polish is not clear. Since the naturally reflective topography of the nacreous layer has deteriorated to a softer and rougher appearance, it must be considered that this PDSM could have broken down different wear contact polishes along similar lines. This would render this type of wear polish suspect, merely evidencing the absence of a contact polish that could include manufacture. The presence of similar softer modifications throughout the shell assemblage argues in favour of this explanation, though, the spatial distributions do appear to correspond to typo-functional explanations. This is certainly not in doubt for the nacreous plaque.

Regarding the deposition, the fractured state of C 1401 in combination with its sweeping deposit association strongly indicate that it was thrown away after losing functionality. The intact plaques are associated with the habitation, but not with informative spatial locations. The nacreous plaque similarly lacks the contextual evidence to infer a depositional pattern from.

Object C 2193

This object derives from a sweeping deposit in the non-overlapped floor plan of the structure 9 in House Trajectory 3. Like structure 2 (above), it has Chicoid associations and possibly dates to the 9th and 10th century AD.

Procurement and manufacture

The object is made from *Lobatus* sp., and it is suggested to be specifically from the space in between prongs as this would facilitate the curvature of the blunt protrusions. No traces remain of material removal, shaping, and treatment of the surface. Although the perforations retain a consistent layer of concentric rings inside, these are not technological but relate to the layered structure of the shell. However, some technological features can be glanced from their outline. Four perforations are placed on opposite sides of the dorsal ridge and connect with their partner (Figure A16). These have a conical outline and a broad leading edge, suggesting they were placed with a solid instrument not quite as angular as a flint-tipped drill, but with a more abrasive lead. From the ventral side a larger perforation crosses into the smaller leading edges (Figure A16). Even though the technical characteristics are the same, the larger dimension implicates a second tool and therewith access to a certain degree of variability in the material technology.

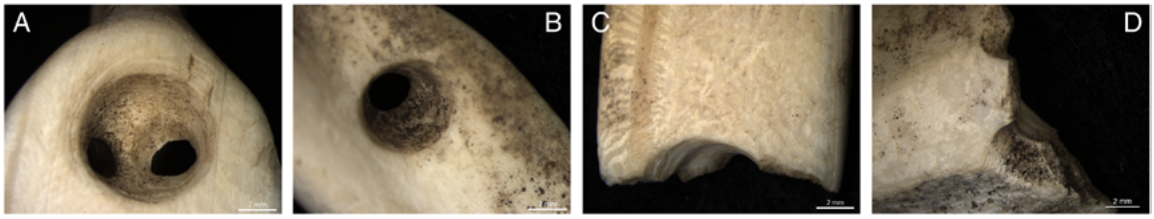


Figure A16: A) ventral view on intact perforations. B) lateral view on small perforation. C) ventral view on broken perforations. D) dorsal view on broken perforations.

Use and deposition

Some traces indicative of use are present on the object. Most promising are deformations in the constricted inner ridges of the small perforations, which are clear indicators of a contact material tugging at those angles. They are located on either lateral side of both perforations, not proximally or distally, indicating that the stress was oriented perpendicular to the long axis of the object. String wear seems obvious, either as multiple string loops tugging or as a double weave. However, this orientation is not conclusive towards either hypothesised use, nor to as of yet unformulated alternatives. Presumably the broken perforations were also subjected to a string, and fractured as a result of tensile stress thereby ending the object's usability.

The ventral side bears a friction gloss, which carried striations oriented along the long axis. The protuberance bears a golden-brownish gloss. Neither of these proved convincing of any specific types of use when examined under high magnification, however. At best, they may correspond to different original contact zones thus indicating a probable functional design behind the object morphology. The ventral surface is etched, but this is probably taphonomic in nature, whereas the remaining surface is generally smooth. This is significant given that it evidences the absence of a major type of use wear associated with lure hooks, namely marks left by fish teeth (Cristiani *et al.* 2016).

Object C 2154

C 2154 derives from a sweeping deposit in the non-overlapped floor plan of the structure 9 in House Trajectory 3, noted to have Chicoid associations possibly dating to the 9th and 10th century AD.

Procurement and manufacture

C 2154 is made of an old *Oliva reticularis* individual, implicated by the erosion to have derived not from a marine context but from a sediment. The erosion inhibits high magnification analysis and the recognition of diagnostic technological features, yet several inferences can be made at the lower level. The first step in modification is the removal of the apex. The rounding observed on the rim is similar to the results of the apex removal grinding experiment, though erosion precludes an inference on the platform (Figure A17, a). While the inner whorl may have partially fractured during this procedure, it was subsequently broken out further through pressure.

The incisions are short, shallow, probably single motion, and present a profile analogous to as seen in the objects discussed previously (Figure A17, b-c). The walls are tapered and the bottom flat to U-shaped. Most probably, a lithic edge was used to place them. The pattern resembles a partial square with two marks inside, but no recognisable motif. Finally, the perforation bears near straight walls, with only a slight taper to the inside (Figure A17, d). The outline is oval and uneven due to advanced wear. The smooth curve seems to imply a rotary technique, though the combination of advanced wear and erosion precludes a clear distinction from careful percussion, since an originally ragged outline could have been completely obliterated since. However, it is clearly not sawn or abraded.

Use and deposition

As noted, the outline of the perforation on the tinkler is misshapen, with a deformity oriented upwards. Similarly, the rim is much more rounded in that segment, and the surface spanning the distance towards the rounded siphonal canal is texturally different from the generic eroded surface (Figure A17, e). This probably indicates wear smoothening with a certain freedom of movement,

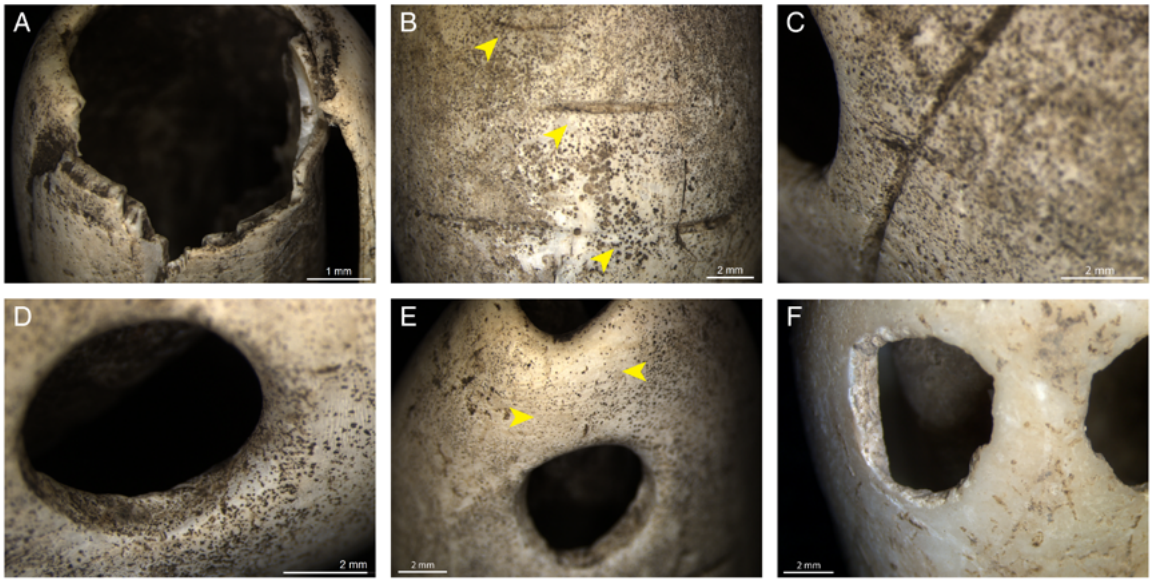


Figure A17: A) opened apex of 2154. B & C) details of incision marks. D) side view of perforation. E) worn facet between perforation and siphonal canal. F) perforation on 0762 (photo by G.C. Falci).

allowing use friction to erase some of the superficial erosion (the structural layering is observable). It matches well with the facets into a string configuration that twists around the siphonal canal, and may have been knotted there, in order to secure the fastening. The most probable event of deposition is discarding after critical failure of the mouth, since this would affect the acoustic properties. The scar shows the force radially dissipating towards the inside (Figure A17, a), indicating the impact point came from the outside, possibly at or near the lip.

Object C 726

C 726 was found near the southwestern part of the main unit, but not in definite association with a House Trajectory.

Procurement and manufacture

C 726 is made of a *Conus* sp. shell, which given the faded colouration and rounding of its features was possibly an empty shell collected at the beachfront, rather than by harvesting a living (venomous) cone snail. The modification consists of two large perforations set at the same height on the part of the body whorl that opposes the aperture (Figure A17, f). The a-concentric shape, lack of abrasive thinning, and jagged walls indicate the use of a percussive technique to break through the shell. This could be indirect pecking, direct hammering, or pressure; the evidence is not clear. Rather, the morphology of the rim and consistent pattern of small impacts leading into the interior suggest that once the holes were opened, these were carefully broken out further to work towards a more rounded appearance. The straight lateral breakage lines indicate that the obtaining of perfectly round holes was prevented by a poor anticipation of the anisotropic properties of the cross-lamellar microstructure of *Conus* (Currey and Kohn 1976), which instead induced a vertical dissipation trajectory of the forces of impact. They are parallel to the growing edge of the lip, consistent with the breakage properties of *Conus* as described by Szabó (2004, 111). The shell does not appear to have been modified thereafter.

Use and deposition

No clear wear traces or residues have been observed on C 726 that could be associated with its use life. Given the incomplete manufacture the most probable interpretation is that it was discarded without ceremony due to perceived flaws in the production of the eyes. The walls of the perforations are unworn and do not match functional use such as found in the double perforated cowry scraping tools from Polynesia (Allen and Ussher 2013).

Object C 1339

C 1339 was found at the back of Structure 7 from House Trajectory 3. It likely derives from a sweep accumulation dating to the Chicoid occupation, but no more precise chronology can be given.

Procurement and manufacture

The object is made of a white bivalve with a three-layered shell, the foliated middle layer wedged by cross-lamellar outer layers. Several technological features are present, but their interpretability is poor. A perforation is set within the umbo near the ring space, while another depression is found above it. The perforation is biconical, with the cone coming from the interior aspect making up most of the length (Figure A18, a). Although the walls are tainted by graphite, the outline of the perforations is similar to those of the plaques and C 2193 discussed previously. A solid lead is thus also implied in this object, e.g. a broader flake or blunt abrasive point. The circular depression on the umbo area bears impact points, indicating it was made by light impacting gestures with a pointed tool, which could be light or indirect percussion or simply pressure. The side of the bulge lateral to it is engraved by two direct incisions, and a third depression delineating the jaw that bears the remnant of a longer notch (Figure A18, b). These, however, are too worn to attempt an interpretation. Some remnants of a potential manufacturing polish are observed in the same area, and appear further down the ring and in between the reflective patches on the interior aspect. These are bright, rough, flat, cratered, located

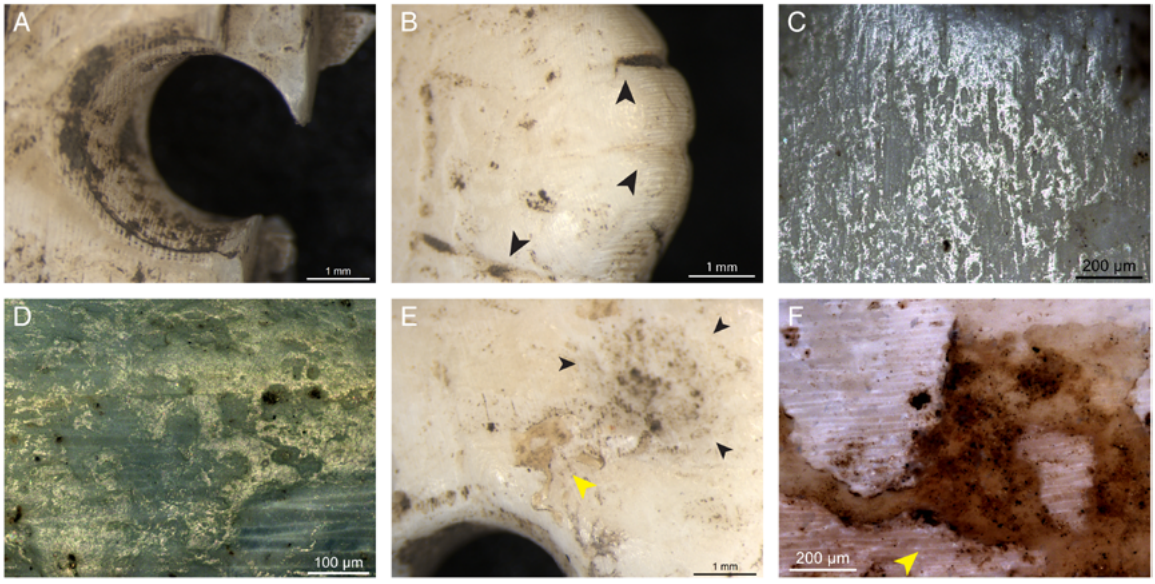


Figure A18: A) interior view of full perforation. B) Side view of incisions with the sediment-filled third groove partially in view. C) bright polish, suggesting a harder contact material. D) matt, invasive polish, suggesting a soft contact material. E) micro-residue on the exterior aspect umbo portion (yellow arrow) and out of focus 'eye' depression. F) High magnification polarizer view of the same residue (arrow matches orientation).

on the ridges created by the lamellar structure, and carry some striations (Figure A18, c). Though it does not correspond to any of the materials discussed and experimented with here, the attributes indicate a hard material contact and locational patterning indicates a widespread modification. Both external layers as well as the side shape have all also been smoothened down. Other manufacturing stages present in the artefact are the broad blank separation, coarse removal of material for the outline, and removal of material internal to the ring, but no traces remain.

Use and deposition

Wear traces are not observed within the circumference of the ring itself, not as polishes nor as rounding or fatigue as a result of friction. The umbo area, in particular the perforation set in it, is likewise devoid of both stereoscopic and microscopic traces of post-manufacture contact. Only the distal outer side of the ring bears wear traces which may be affiliated with a use. This is a dull, rough, and invasive soft contact polish connecting through reticulating bands of the same type as seen on the plaques (Figure A18, d). As before, options include soft plant matter, fabrics and fibre strings, or skin. However, given the lack of a clear spatial distribution and the lack of corroborative traces observed in the inner ring, the nature of this contact will not be further ascertained.

The exterior aspect of the umbo a few concentrations of a resin-like micro-residue, located around the depression interpreted as an eye (Figure A18, e-f). It is light brownish in colour and sharply delineated lacking granularity, as if a viscose fluid, topped by an accumulation of soil. The nature of this residue is unknown.

Finally, the fracture through the centre likely induced deposition. Given the interaction of the shell layering with the propagation of force, the origin and directionality cannot be estimated without reference experiments. While a measure of force is implied in the action, this could have been accidental as well as tension-related structural failure.

Object C 3107

C 3107 was recovered from a natural depression in the bedrock, located just outside of overlapping structures belonging to House Trajectory 2. This is the chief house trajectory rich in both indigenous paraphernalia (frog beads, threepointers) and ultimately in early colonial material culture (pottery, glass beads). Due to its context, it has been interpreted as an abandonment deposit (Samson 2010, 288-289), most likely dating to the 13th century AD.

Procurement and manufacture

The *guaíza* is shaped out of the lower end of a *L. gigas* columella, but not on one deriving from a fresh specimen. Rather, an already broken and eroded piece served as a suitable blank, which was probably obtained from an inland storm terrace (A.T. Antczak pers. comm. 2016). The extent to which the piece had attained its present outline in this context is not entirely clear. Though no traces are present that relate to shell separation, this is true for most of the assemblage discussed hitherto and deemed not a reliable indicator for the absence of this activity. Fortunately, good evidence remains of frontal surface smoothening, the engraving techniques, chiselling of the eyes, and drilling of the pupils. Thus, it is possible that its gross morphology is a product of taphonomy prior to any human alteration.

The early operational sequence is approximated as follows. A moderate amount of material was removed to create the nose bridge and decline the mouth area. This follows from the fact that a normal

L. gigas columella possesses a smooth curve, whereas in the *guaíza* these areas are depressed. However, the techniques involved with the nose bridge have been obscured by later wear or patination, and given the taphonomical provenience it is unclear if any material was removal for sculpturing the outline of the face. The forehead and cheeks mostly follow the natural curvature, and the dimensions of the side are probably the result of natural erosive processes as little wear relates there. The patinated portions of the shell are considered natural, in line with the discoloration on the backside, though differences in their intensity might still relate to wear trace concentrations (in use and deposition).

Two wear trace signatures remain from the techniques used for finalising the shape. Evidence of scraping is observed on the frontal area, running from the centre to the side (Figure A19, a). The band of parallel striations indicate some abrasive edge or matrix being dragged over the surface, but exactly what type of tool is difficult to make out. The motion likely served to smoothen out rugosities remaining from the previous stage. Second, excision through repeated incision was applied at the very least in shaping the underside of the nose (Figure A19, b). Here, two crossed cutting grooves remain,

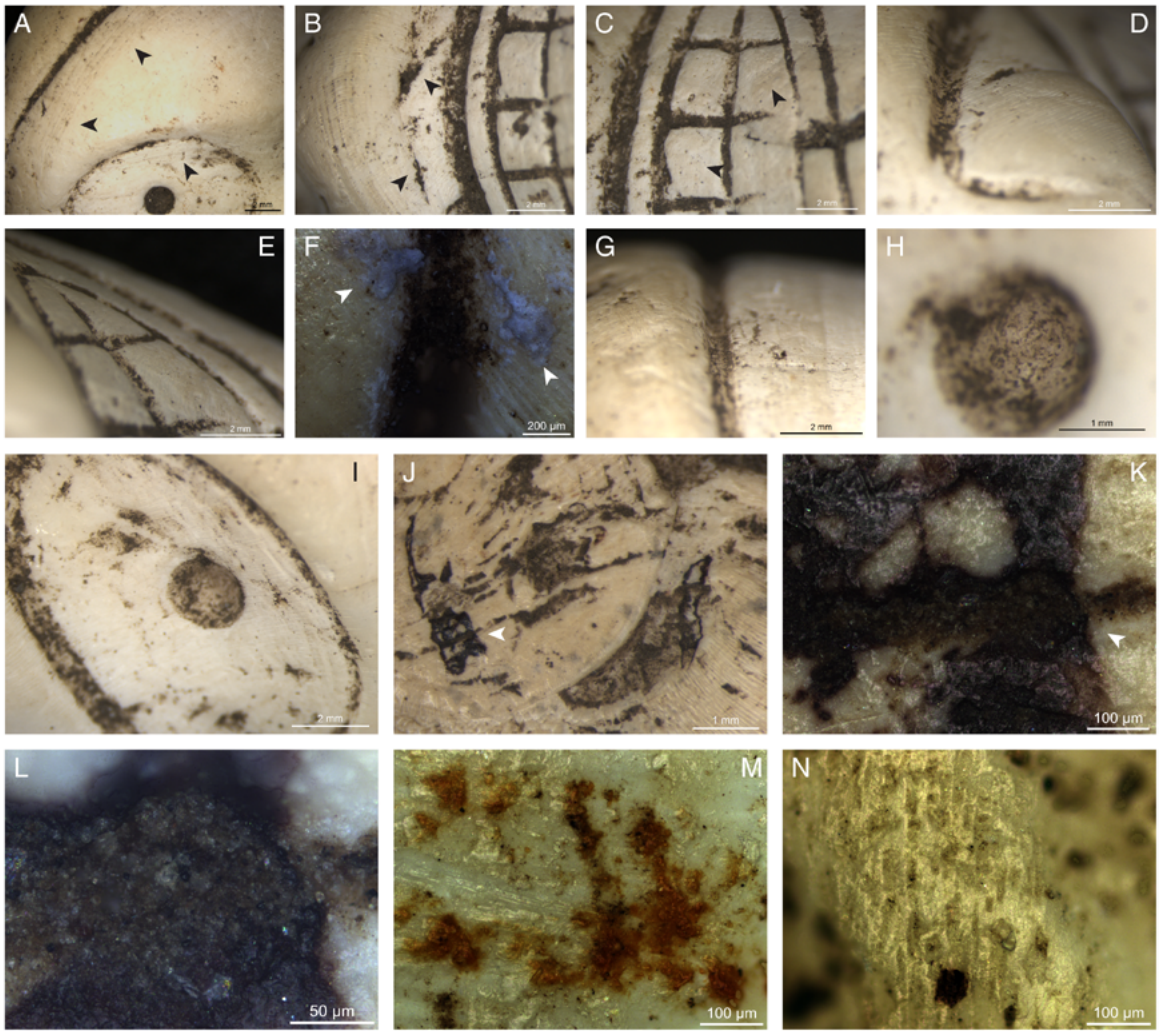


Figure A19: A) scraping or abrasive marks on the forehead. B) incisions crossing underneath the excised nose. C) scraping of the teeth area. D) wider diagonal groove. E) incisions delineating the teeth and lips. F) view of lip groove, with modern residue. G) headband incision. H) leading edge of left eye perforation. I) topography of the left eye. J, K & L) strands of black residue overlain by local sediment, arrows indicate the succession of magnification. M) red residue of the forehead. N) micropolish corresponding to macropatina.

giving rise to the idea that excision entailed sawing through the centre, followed by the breaking or also sawing away of material. Some smoothening is implied in the final surface, though this begs questions both why no high magnification traces were found in this area, and why the scraping traces elsewhere where not erased. The surface of the 'teeth' again bears marks of scraping to finalise its smoothness.

The engravings include one horizontal and six vertical straight incisions delineating the teeth, surrounded by two curved incisions for the lips, as well as two diagonal grooves delineating the cheeks, four incisions shaping the nose wings, and a single curved incision placing the headband. Despite some obstruction of view due to sediment, the incisions are partially observable and appear relatively uniform (Figure A19, b-g). Most are shallow and symmetrical, with U-shaped bottoms and few striations directly discernible. The lip grooves are somewhat wider and deeper, whereas towards the central part of the headband and in the deeper diagonal groove the walls become tapered. Clear onsets are visible in the headband and in several of the sub-incisions of the teeth, ruling out the use of a chiselling motion. A solid point is implied, but the incisions do not match the experimental or published variables expected of flint edges, nor those of the experiments with organic tools. Rather, additional experiments should focus on engraving with sharp teeth and flaked edges of locally available rocks (coarse sandstones and carbonates) to test how well these match.

The eyes both comprise four distinct actions, namely the hollowing out of the general area, the delineation of the rim, the excision of the eye surface, and the perforation of the iris. No traces remain of the initial material removal, and the rim was made by means of the incision technique described above. Its purpose is unclear unless it served to lodge sediment and emphasise the eye outline, which it performs admirably even today. This leaves two techniques to be discussed. The eyes were excised through either scraping/whittling with a point, or chiselling with a gouge, or both: the right eye harbours striated evidence of a perpendicular edge, whereas in left eye retains furrows of a ploughing point. Care was taken to ensure a resulting smooth surface with a gradual concave curvature. Two perforations are set therein, which give the impression of irises even though one is offset from the centre. While both are filled with dirt, enough surface is exposed in the dextral perforation to establish some variables (Figure A19, h-i). It is shallow, made using a rotary motion, and ends with a slight tip in the leading edge. Potential concentric striations are not observable due to adhering sediment. There is some similarity with the perforations in C 1401, 2157, given that the tool appears to be somewhat blunt and not set with a straight angled blade bit, yet here a definite small point is added to the puzzle. Possibilities remain *A. cervicornis*, a pointed tooth, or a sub-angular lithic asperity, used in hand-held motion.

Use and deposition

Evidence for the use of the *guaíza* narrows down to two residues and one wear trace pattern. First is the presence of tarry residues on the backside, and second the observation of a red and black residue on the forehead. The use wear trace pattern is predominant on the cheeks and sides.

The backside evidences remnant residues on the central area as well as the upper border ridge (Figure A19, j-l). These are viscous strands of a chunky yet grain-less black material that appears as a tar-like or (less probable) bituminous adhesive. The stratigraphy with the local sediment at El Cabo certifies the pre-excavation nature of these residues, and the utter absence of it on all other microscopically analysed objects from El Cabo (present study; Breukel 2013; Falci in prep.) strongly

suggests a cultural source applied in the original life of the *guaíza*. The rim of the backside is also flatter and coloured dissimilarly to the remainder, though no wear traces were present. In all, prepared adhesion is a likely reconstruction.

The second residue occurs in even smaller quantities, adhering to the brow of the right eye and the forehead above it. The biggest concentration is interrupted by later striations, indicating the antiquity of the stuff (Figure A19, m). This is a red-brownish residue, going towards black in the concentrated centres, which has a grainy texture. It is somewhat similar to the reddish-black residue often encountered in axe hafts, there interpreted as an adhesive, but that type of residue is usually more viscose in appearance.

The wear trace pattern concerns a micropolish equivalent to that seen on C 1339 (but somewhat different from the inlays) (Figure A19, n). The contact is indicated to have been all around, soft and invasive, and was probably sustained over many episodes or long durations. The polish is well developed on the cheeks and the sides, especially the right side, and developing vestiges are found on the forehead, nose bridge, and chin. It was not found on the backside, despite that area also bearing a macroscopic golden-brown patina, indicating that this is not a good indicator when factoring in natural discolouration. Though the nature of the contact could not be ascertained before, the *guaíza* adds a good view on how its polishes are spatially distributed. The boundaries of the surface incisions carry it to a degree, and lose the association at the walls. Further the teeth and the sunken relief of the eye sockets are devoid of this polish, or any other use-sustained wear trace pattern. Notably, this absence suggests that these areas were covered in such a way as to avoid the relative motion of the contact event.

Regarding deposition, no damage or traces are seen that could reasonably account for its initiation. The depositional context itself has been regarded as a special association, possibly evidencing the intentional caching of this and other objects.

Object p001

This object was recovered in eastern Grenada by local people and subsequently became part of the Willcox family collection. Petitjean Roget (2015a, 150) tracks its context to the beach in front of the site of Pearls. However, it is unclear if this is accurate or merely reflects attempts of his contacts to 'legitimise' the find by associating it with the premier provenience for looted artefacts on Grenada. Since the iconographic decoration of p001 is typical Chicoid and the artefact type itself a Late Ceramic Age phenomenon, the attribution is probably to the second millennium AD.

Procurement and manufacture

The host shell is from the family Strombidae, likely *Strombus pugilis* cf. *Lobatus* sp. While only measuring 76 mm, the thick and well-developed shell indicates the specimen was adult or older, ruling out larger taxa such as *L. gigas* or *L. costatus* (cf. Petitjean Roget 2015b, 303-304). The specimen was likely collected in fresh state or shortly after death, as the surface shows no signs of older diagenesis. It is heavily modified, presenting a long and complex technical sequence of operation. Involved manufacturing processes include, roughly in sequential order, the removal of the apex, outer lip, and inner columella; opening up of the eye sockets; smoothening of the natural elevations on the upper surface; sculpture of the zygomatic and maxillary processes, as well as the canine jugum; engraving of the mouth and the curvilinear pattern; and placement of four functional perforations, one finished

ornamental perforation and several more unfinished ones. At least five different techniques are necessary to complete these actions, being percussion, abrasion, drilling, incising, and chiselling, with a multitude of tools and applications evident.

Blank acquisition and the preliminary shaping of the piece relied upon percussion, probably direct outside and indirect inside as evidenced by the steady and controlled flow of the border (Figure A20, a, b). The internal ridges are smoothened over through later wear, which may include an abrasive technique and is certainly overlain by use friction. This pattern characterises the removal of both the outer lip and inner whorl. The removal of the apex most likely also occurred through percussion, given the presence of internal scars, and was succeeded by abrasive contact to smoothen over the edges (Figure A20, c). Experimental work in St. Vincent demonstrated the viability of *L. gigas* apex removal through pecking with an angular pebble. The shell structure was gradually pulverised down from the spire starting at the protoconch, during which no cracks radiated or other structural defects were formed. A technological alternative can be found in sawing (Velázquez Castro *et al.* 2006), but

Figure A20: A) organised breakage of inner columella and view of the upper whorl. B) view of lower whorl, smoothened over. C) top view. D) inside view of eye socket. E) view of a smoothened over prong structure. F & G) cut-marks and adjoining grooves across an excised space in the curvilinear design. H) view of the frontal teeth. I) view of the left lateral teeth. J) profile of lower perforation. K) profile of unfinished perforation. L) view of upper perforation with deformation. M) left lower perforation with abrasion facet. N) micrograph of wear polish, the directionality of which follows the first order lamellae.

no particular indications of this technique were found.

The eye sockets were also likely created using percussion in the preforming stage. The outlines are not fully circular but retain angles particularly in the upper lateral corners, which as seen in 726 may result from microstructure-induced crack propagation. Moreover, the internal surface retains jagging that has not been entirely smoothened out by subsequent actions (Figure A20, d). These later actions include potential sawing of asperities and thereafter abrasion to smoothen the rim and the boundary with the outer surface, producing an uninterrupted shape.

Abrasive action is clearly seen on several areas. In addition to the aforementioned instances, it was further applied to reduce the sculptured morphology of the outer shell to a smooth, level surface. This is most clearly visible in the case of the prongs, the removal of which has exposed an unusual wavy or curvilinear structure out of the surface (Figure A20, c, e). Its transitional design between the engraved patterns and the removed spire indicates that it was incorporated as a naturally decorative element of the shell. A few lines of crushing indicate that some percussive working was attempted but abandoned early on. No traces remain indicative of the specific abrasive technique(s), but the absence of coarser scratches renders a fine-grained, soft, or material with low asperity more likely.

The curvilinear design above the brow was engraved thereafter. It is composed of two horizontal wavering lines above the brow, the upper one adjoining to two spiral line patterns left and right of the centre. It is capped by a single line, which bears two downward facing triangles. This motif creates four excised circular elements, two smaller ones in the centre and above the centre and two large lateral circles. While some grooves are wider and shallow, individual cut-marks found laterally and inside the excised space display a clear V-shaped morphology and occasionally larger wall striations (Figure A20, f, g). This outline and the uninterrupted curvilinear flow are consistent with incision using a chipped lithic point, used to draw the motif. The width and shallowness is not attributed to later widening, but rather to a more angular gesture and dulling of the point. The lower laying areas of the central portion and groove joints were probably whittled or scraped out after incisions delineated them, since their surface texture remains relatively coarse.

On the lower area, the maxillary canines and zygomatic-brow aspects were excised first subsequent to which the teeth patterns were incised. The canines are bound by deeply sawn grooves, used to demarcate their morphology, and remnant sawing traces are also observed along the zygomatic aspects and brow ridges. Removal of the shell in between is unspecified, possibly chiselled, but is capped by abrasive contact to smoothen out the aspects for the three engraved teeth patterns (Figure A20, h, i). Thereafter horizontal grooves separating the upper and lower jaw were each incised with two or three motions, interrupted by a total of 13 vertical single V-shaped cut-marks. No widening is observed here, and all grooves are devoid of microstriations or polish irrespective of their location.

Finally, perforation techniques were used to drill four lateral, one central, and four unfinished perforations. The lateral perforations are all circular and asymmetrically biconical with a less deep inside (Figure A20, j). They are characteristic of a lithic drill bit and their regularity suggests a rotary device. The deeper central perforation designates the nose and is conical with a corresponding scarred exit point. The stepped outline indicates an irregularly shaped solid bit such as a thicker flaked lithic drill, although the deepest step is smaller than the outline of the lateral perforations. The unfinished decorative perforations are shallow cups that would be more consistent with a handheld blunter material, although no suggestions can be given (Figure A20, k). They bear no traces or striations, and probably appeared after incision or demarcation of the other elements given their centrality in the

motif.

Use and deposition

*E*vidence for use relates to string wear on the upper lateral perforations, a contact polish covering the back rims, and a contact polish affecting most of the upper lying frontal surface. String wear is heavily developed on the upper lateral perforations, indicating an extensive duration of suspension (though its weight likely increases the rate of development). This is particularly prevalent on the left side (Figure A20, l), where the deformation is mirrored indicating the knot was twisted around the open ridge. The deformation is less pronounced on the right side, while associated potential wear polishes have not survived on either side. Altogether, the upper perforations were tied to a knotting system from where the shell face was suspended. There is evidence that the lower perforations were strung as well, in the form of minor deformation and an abrasive facet on the lower left perforation (Figure A20, m). Such traces are indicative of bead-on-bead wear (sustained contact between adjacent elements on a string). Thus, they indicate that the object fastened a second string that fulfilled a different purpose within a larger composite artefact. However, the lower perforations were clearly not loadbearing as they did not develop wear to the same degree as the upper ones. Wear development is also asymmetrically located on the left side, suggesting the attachment was somewhat out of balance.

Previously, contact friction was observed on the backside of the ridges overlaying manufacturing wear that indicated contact against another surface. This is locationally different from the glossy brown patina covering all protruding surfaces on the various frontal aspects, but is otherwise microscopically equivalent. The polish has a rough, dull, and greasy texture and is invasive while lacking abrasive action, further having developed over large swaths of the surface in various degrees of connection (Figure A20, n). However, it is not as soft and grainy as the typical polish found in the El Cabo shellwork, having rather irregularly jutting asperities and smoother reticulation running over it. The polish is only marginally present in the excised areas, suggesting that the contact was pliable enough to reach in there but of larger nature that could not really affect these areas. Similar to before, a range of soft contact materials is attributed to the formation of this trace. It is suggestive of actual hide or of plantish contact rather than handling by human skin, but experimental reference needs to be established to this end.

Residues were present on the artefact, but their relation to the pre-modern biography is uncertain. An interrupted stripe of grainy black residue is located above the right zygomatic, which appears to be relatively fresh. In its vicinity are a few spots of bounded green-orange residue with a resinous texture, of unclear origin. It superficially resembles the residue found on C 1339 and C 3107, though it appears fresher than either of those. Given the inability to examine those areas under higher magnifications, neither residue is considered further.

There are no contextual data that permit an inference to the depositional act. Although the artefact is broken in two places, neither event carries an implied relation to its death. The first is the nose bridge in between the eyes which is lacking, joining together the goggle. This is not a debilitating break, and since minor rounding is seen on the breakage plane, it probably did not coincide with the termination of the use phase. The second break is on the right lateral side below the teeth, where part of the columella has been torn out of. By comparison this must have taken place at a later point in the life of the *guatza*, and some areas of it may have broken further in recent times.

A4.2 Dental objects

Element S615

This object was recovered from the top layer of test pit A, which is a midden layer in closed association with Cayo style pottery indicating a probable early colonial period date.

Procurement and manufacture

The tooth is identified as the canine of a pantherine species, of which the only New World member is the jaguar. This has been verified by recent collagen fingerprinting conducted by M. Buckley at Manchester university, publication of which is forthcoming (J. Laffoon, pers. comm. 2018). The natural range of this species is widely across the South America, and an origin on the mainland of this continent is backed by the isotopic signature of the pendant (Laffoon n.d., in Boomert *et al.* 2015; Laffoon *et al.* forthc.). Though much South American fauna also ranges the continental island of Trinidad, there is no evidence whatsoever that jaguars inhabited this island in historical times (Boomert, pers. comm. 2018).

Regarding procurement technology, there is no clear evidence from the technological traces on how and at what point the tooth was removed from its original socket. Indeed, it cannot be equivocally claimed that it was still embedded in the jaw of the animal at the time or procurement to begin with, though it seems likely (below). There are three parallel cut-marks present located on the apicolabial aspect in oblique direction, in association with the perforation (Figure A21, a). These may relate to the cutting of ligaments and alveolar bony tissue in which case they indicate the tooth was cut loose from the animal jaw at some point before full decomposition of the soft tissue, but there is a competing interpretation that relates to activities during the life of the object (below). More pertinent are numerous long axial striations on the lingual and distal (brown coloured) aspects, which run from the apical point to crossing the cementoenamel junction. Many of these are somewhat overlain by the extensive smoothening on the apical sides indicating that they occurred relatively early in the life phase (Figure A21, e). Given this overlaying and gradually erasure on the apical aspect, a relation to manufacture is likely. The most probable correlation is scraping with an asperite edge to clean off the cementum from the dentine, though it is unclear what tool material. The shape of the root does not seem to be anthropogenically remodelled otherwise.

The perforation is located near the apical tip and along the mesiodistal axis. It sports a subtle connecting ridge on the inside and is thus biconical in nature. However, the perforation is heavily worn and the 'cones' approximate the shape of two U's meeting in the middle. This implies the use of a drill with a solid bit, with the size of the perforation (4mm diameters each) placing constraints on the dimensions of the tool. No traces of technological wear remain that could indicate a particular type of contact material. A comparison with the experimental materials in section 5.3.3 indicates that the outline of this perforation could be obtained by drilling with a tooth, but also by a brittle lithic followed by heavy internal wear. Given that such heavy wear is observed, there are likely also numerous other options that would eventually come to approximate the present morphology.

Use and deposition

The object displays several traces of use, notably signs of wear concentrated on the perforation, rounding and contact facets on the apical tip, and general wear on the surface of the root.

The brown side perforation is deformed, most pronounced towards the lingual side, but does not

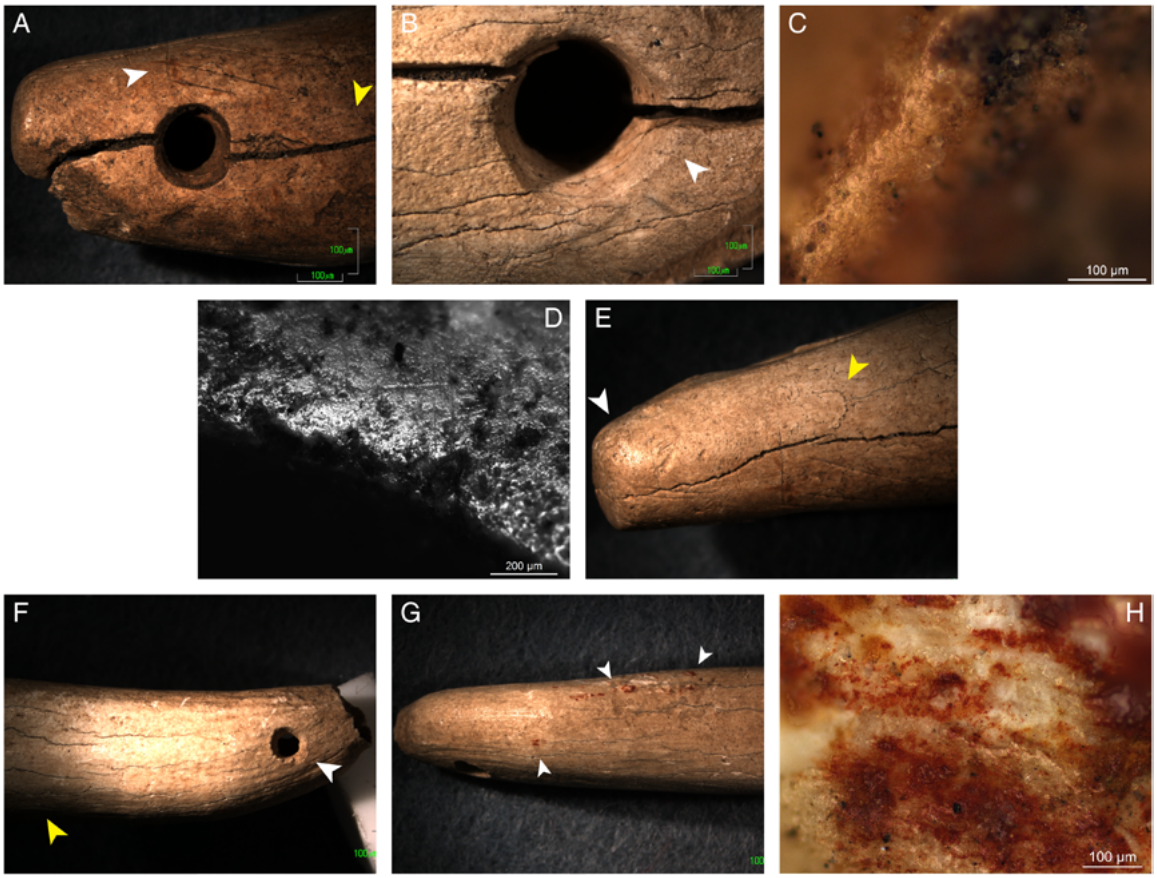


Figure A21: Micrographs of S615 and S208 (yellow scalebars are erroneous). A) profile of brown-side perforation on element S615. Note three parallel cut-marks located above it (white arrow), the abraded facet against the worn apical tip, and heavily worn axial striations from the perforation onwards (yellow arrow). B) profile of white-side perforation on element S615. Note axial wear facet (white arrow). C) dense band of polish located on the otherwise sharp rim of perforation on A21-a. D) microtopography of the rim of perforation on A21-b. E) Lingual view of the apical tip of element S615. Note severe rounding of the tip (white arrow) and smoothening of the striations at the height of the perforations (yellow arrow). F) mesial/distal view of element S208. Note wear facet on the rim of perforation (white arrow) and axial striations (yellow arrow). G & H) stereograph and cross-polarised micrograph of pigment deposits on S208 (white arrows).

have worn facets gradually entering it. Instead the rim of perforation is fairly sharp and characterised by a thin band of densely packed invasive polish structures (Figure A21, a, c). Conversely, the white-side perforation shows rounding of the rim of perforation and inclines towards facets, with a smoothly worn patch towards the lingual side and deformation in apical direction. The microtopography is characterised by a rough and bright polish with frequent striations that does not change noticeably towards the rim (Figure A21, b, d). The overall effect is dramatically different from the brown side perforation and suggests an asymmetrical attachment system or a succession of systems. The alternative explanation for the cut-marks previously mentioned also has to do with a potential succession of attachment systems. These anyhow reflect activities serving to cut loose extraneous material, and if not a part of procurement then this extraneous material had been applied to the root subsequent to it having been taken out of the socket. The cut-mark edges appear slightly worn, indicating that it represents an activity prior to the final stage of suspension. One potential mode is that of a tightly strung band forming a larger composition, such as a bracelet, headband, or apron, another is that of a string-based composition such as a necklace in which the individual teeth are fastened in knots (Falci

et al. 2018). The gross weight of the canine ensures enough pull so as to explain the heavy rounding even within a confined space of movement.

This does not yet explain the different wear profiles of each perforation, but I will get to this in conjunction with the other observed traces of wear. The rounding and overall gloss on the apical tip are in fact consistent with that part of the root being in sustained contact with another medium, but a cave-at is required here. The rounding overlays the sharp angled labial facet that is present on the apical tip (Figure A21, a), which indicates this facet formed previous to that point. It could be technological in nature, but no obvious traces were noted during the analysis; the most likely interaction therefore is sustained bead-on-bead wear with adjacent elements in the configuration. This implies a relative freedom of movement that contrasts the woven band mode of attachment, and it is also unlikely to be congruous with particular knot bindings. Rather, it appears more congruent with a separate, preceding episode of wear (as suspension or manufacture). Finally, there is also some degree of smoothening of the microtopography intermediate on the tooth, and a few of the axial striations noted above are fresher than others. Rather than scraping in manufacture, these may instead relate to use contact with abrasive materials within the composition itself, such as siliceous fibres or strings treated with mineral-based pigments. The current level of documentation makes it difficult to reconstruct, however, so the piece should be revisited in order to better distinguish this hypothesis.

With respect to deposition, there are no critical indicators that would suggest discard after a loss of functionality. A 'non-critical' indicator could be the cracking observed, perhaps relating to threatening or uncontrollable non-human agencies, but such is at this point mere speculation. As noted, slight wear on the edges of the cut-marks was taken to precede later use, though it is also possible that this represents an act of deposition and the wear is taphonomical. Given the provenience of an upper midden layer in an eroding coastal site, I hesitate to attach too much inference to the phase of deposition, other than the notion that the biography is closed.

Element S208

This object was recovered from the surface near test pit A, an area with dense deposits of Cayo pottery both on and below the surface, indicating a cultural association and date coeval with element S615.

Procurement and manufacture

The tooth is identified as a Sus scrofa incisor via the same means of collagen fingerprinting applied to S615. Isotopic analysis returned results originally thought consistent with an origin in northern South America, similar to the previous pendant. Potential locations matching the results include eastern coastal Venezuela, northwestern South America, Central America, and the Lesser Antilles (Laffoon n.d., in Boomert *et al.* 2015; Laffoon *et al.* forthc.), which at the time suggested a mainland origin since the tooth was thought to be of a peccary (*Tayassu* sp.). Though Europeans only officially settled the Lesser Antilles at the beginning of the early 17th century, Watts (1987, 107, 110, 117, 156) writes that the Spanish had already left populations of wild hogs to breed on most of these islands early in the 16th century. This renders them for all intents and purposes also a native resource in early colonial times, and would remain consistent with the returned isotope values. No indications of specific procurement practices were observed on this tooth. As with element S615, there are very faint elongated striations on the longitudinal axis on this piece, primarily on the mesial and distal aspects. These may indicate similar scraping, but given the more advanced erosion of the surface this

can at the moment not be substantiated.

The two perforations are located near the apical tip and along the mesiodistal axis, with 1mm diameters. Their profiles are conical to cylindrical with a strong onset, of which the edges have a ragged appearance. Given the size of the pulp cavity the actual depths of perforation remains quite shallow, and these do not meet in the centre as a result. The state of weathering in conjunction with probable use wear have since erased all traces of manufacture. The profiles suggest a rotary motion but no clear indications of specific technologies or bit materials, nor for potential successive widening, although their dimensions (1mm each) are minute when compared to every other perforated material studied in this work.

Use and deposition

The objects displays some markers of wear, including suspension and contact with a pigmented surface, but the mode of use remains ultimately unclear. With respect to the depositional event the context is inconclusive similarly to element S615.

The rims of both perforations are ragged, which could be consistent with wear depicted as from fixed attachments (Falci *et al.* 2018) but also of certain perforation techniques. On the distal side the perforation displays a restricted facet towards the labio-apical axis from wear (Figure A21, f), or less likely breakage, whereas none is on the opposing side. Both perforations display some signs of internal deformation into the direction of that axis, but here the angle is unclear as it may relate to plastic deformation from the drill bit punching through the shallow dentine wall. From the perforation towards the apice the surface microtopography is somewhat smoothened and displays some small pits, akin to the worn surface of element S615, but on the whole less convincing. If all of these signs indeed relate to use then this surface is differential from the other areas surrounding the perforation, arguing against bead-on-bead contact. Thus, they might indicate a thin string passing once or twice and subsequently winding or being knotted around the apical tip, with the teeth otherwise in (partial) contact with a coated surface (below). However, the state of weathering does not permit the current analysis to substantiate a reconstruction to that degree.

A notable observation is the presence of a strip of small, interrupted residue deposits, intermediate on the labial dentine and oriented along the long axis (Figure A21, g-h). These deposits consist of very small red grains intermixed with black viscose clumps, and are interpreted as a red pigment. If these residues originated from a coating of the pendant their spread would be expected to be more random, and perhaps concentrated in surface depressions; a similar distribution would be expected for a wrapping coated in pigment. Therefore, the orientation of the residues renders more likely suggestions of the tooth resting with the labial aspect on a pigmented surface, such as cloth or body-painted skin.

Object FL 1748

This artefact was recovered from Unit 32 at El Flaco, one of a set of three 2x2 pits west of the primary mounds in the excavation. Its precise stratigraphic context is Feature 82-13, of which no specific cultural information is currently known to me.

Procurement and manufacture

If the identification of *Trichechus manatus* is correct, then the tooth is of maritime origin. Potential

traces indicative of procurement practices would be located on the root, which is missing. There were no traces observed that explicitly affirmed further shaping, although this cannot be ruled out. The incisal edge was rounded flat and may have been modified artificially, though comparisons with reference materials are necessary to assess this option. The inner surface is completely unobservable due to adhering soil, which could not be removed.

The perforations have biconical profiles that were first initiated from the labial aspect, and met by secondary (smaller) cones initiated from the inner lingual surface (Figure A22, a). This perforation profile is common for drilling techniques utilising a brittle lithic bit, though other types of solid tips may create similar outlines. It is not indicative of a hollow drill or a soft organic tip, since these use abrasives to create (near-)cylindrical outlines. No microscopic traces were preserved that could aid further interpretation of the drilling material, due to combined erosion and heavy wear from use.

Use and deposition

Observable wear from use is restricted to the perforations, and is characterisable primarily due to the full view on the inner walls. All four rims of the perforations are severely deformed. The two exiting on the labial (frontal) view are worn most strongly towards a distal point of the centre, now missing, but are rounded overall (Figure A22, b). The two perforations exiting the lingual (inner) aspect are less strongly deformed towards a particular coordinate, but very rounded overall. Potential ridges once located where the leading edges from either conical perforation met are completely erased; the inner surfaces of the perforations (incisal quadrant) are both characterised by a dense cover of polish, which moreover bears heavy longitudinal striations. Together, the combined evidence indicates that the pendant was strung with a flexible material. Beyond that, the string was either moving freely but gravitating towards the broken centre (more congruent with the rounding in all directions), or

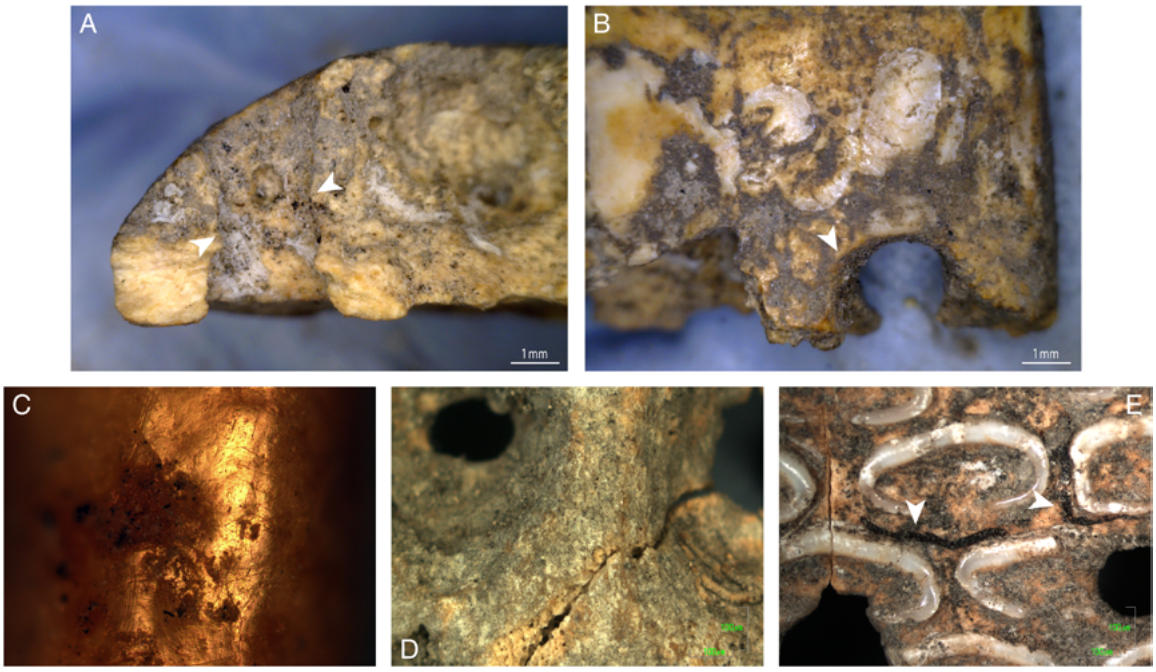


Figure A22: A) distal view of the right perforation on FL 1748. White arrows indicate the biconical constriction. B) labial view of the left perforation on FL 1748. C) striated surface from the lateral side on FL 023 (full width micrograph at 70× magnification). D) external view of the left perforation on FL 023. E) internal view of the perforations on FL 023.

tightened towards the area of breakage by knotting (more congruent with the observed direction in the labial perforation rims). Since the distal portion is missing, any certainty is precluded. It does seem logical to assume that the pendant fractured at the weakened use area under endured stress at some point, and was discarded as a result thereof.

Object FL 023

The artefact was recovered from Unit 1, Layer 5. This is probably one of the artefact-containing lenses within the mound, associated with relatively high concentration of ceramics.

Procurement and manufacture

The specific raw material is the lower pharyngeal grinder from a member of the parrotfish family (Scaridae), as identified by dr. A.T. Antczak. Such bones normally possess large lateral processes for muscular attachment, which are not present in this specimen. It is possible that these had been removed by a manufacturing process such as sawing or breaking followed by abrasion, but potential traces of wear have not been observed. Rather, the lateral sides display a glossy ridge worn from use (Figure A22, c), adjacent to an irregular groove and topography that in macroscopic view appear natural. Adhering soil prevented microscopic analysis of these lower areas. The distal end (near the perforations) appears to have been shaped through a careful breaking away of bone between the worn enamel ridges.

The pendant contains two perforations near the distal end. They are roughly parallel to the lateral axis, but off-set in relation to each other. They consist of very wide cones from the back of the pendant that narrowly penetrate the pendant but at different degrees (Figure A22, d). It is unclear if a brief onset was used to widen the opening from the front side due to wear and erosion. The drilling material penetrated the enamel ridges well and was probably a large lithic flake.

Use and deposition

Observable traces of wear were restricted to the rims of perforation, which is foremost a factor of the state of preservation and cleaning. Both rims are deformed along a continuous axis, consistent with a single string passing through and exiting on the backside. There are no traces that would evidence more complex looping or knotting around the piece. Some strands of a black material are present between the perforations, but it is unclear what it consists of (Figure A22, e). The sides contain multi-directional striations that may be related to use (Figure A22, c), implying freedom of movement, but it cannot be ruled out that part are taphonomic alterations. The condition of the teeth is natural.

Since the fracture is of recent origin, it is unclear why the pendant was discarded. The damage in the left perforation that initiated the recent fracture is probably ancient, since its degree of erosion is consistent with the other surface. Still, that would not prevent its wearing and would be partially obscured by the string.

Object C 2420

The context of C 2420 is unclear as a result of mix-ups during an exhibition. It is indicated to originate from the habitation palimpsest, somewhere near ZSs 85-50-03 which contains early Chicoid structures associated with House Trajectory 3. This specimen was not studied under high magnification due to time limits.

Procurement and manufacture

The pendant is made from the dentary palate of a species from the Myliobatoidei suborder (the stingrays). No traces remain with respect to the techniques of procurement and early manufacture. These have all been erased by the subsequent application of an abrasive technique used to level the surface. All six sides are abraded flat and they display relatively sharp angles against one another, only somewhat rounded as a result of later wear (Figure A23, a). The surface displays some gloss, but since I performed no high magnification analysis, the origins of this gloss (natural or artificial) and the abrasive technique itself cannot be further interpreted.

The two perforations are biconical and made using the same technique, for the most part initiated from the currently dark-coloured surface. They are met with a brief entry from the currently bleached surface. The former initiations display concentric grooves from the displacement of material (Figure A23, b), which together with the biconical outline suggests a solid, uneven drill bit such as a lithic micro-flake used in a rotary motion. One was drilled slightly further resulting in the removal of most of the inner ridge, and consequently a larger appearance.

Use and deposition

The perforation areas display the main evidence with respect to use. All perforation rims display wear and deformation. On the bleached areas, the wear connects the two perforations thereby evidencing that part of a string was suspended in this area (Figure A23, c). A similar facet exists on the opposing (dark-coloured) side, but it is not as well developed Figure A23, b). Deformation of the perforations themselves is light but present, and appears to be oriented towards the upper side. The most parsimonious explanation is that the string wound around the area bridging the perforations once or twice, and was either simply suspended or also wound around the upper side. Finally, prolonged use contact is indicated by the general rounding of the pendant, both near the sharply abraded borders between sides and of the flat topography. There is no specific cause of death to be inferred from the integrity of the artefact, and the contextual uncertainty precludes speculation such as for the shell inlays.

Object FL 115

The object was recovered from the fill of Feature 74-01 at the 2013 season of El Flaco, which is located at the edge of habitation platform 2.

Figure A23: Manufacturing techniques on C 2420. A) abrasion planes. B) Perforations seen from the dark-coloured surface. C) perforations seen from the bleached side. Arrowheads indicate the facets of wear departing from the perforations and meeting in the middle of the connecting bridge.

Procurement and manufacture

The pendant is made from the dentary palate of a species from the Myliobatoidei suborder (the stingrays). Such palates are typically large and connected to the bones of the jaw. Nevertheless, no traces were identified that pertained to the techniques of procurement and of detachment from that bony structure. It is possible that the palate is mostly automorphic, but given the lack of reference material this cannot be stated with absolute certainty. The only clear evidence of shaping pertains to a parallel depression located in between the perforations and the centre of the piece. The surface is heavily eroded as a probable result of use, and no original technique can be reconstructed.

The object contains two perforations in parallel line to the lateral sides. These are of biconical outline and made using the same technique. The primary drilling occurred from the smooth occlusal surface and is fairly deep, met by a short onset from the opposing surface (Figure A24, a). Initial cuts may have been made on the smooth surface first, resulting in the current depression, but this may also be the result of spalling during the drilling process. A few areas within the rim of perforation display concentric striations. These range from small striations to clusters thereof interlaced with ridges in the topography (Figure A24, b), clearly indicating a drill bit with hard, irregularly sized asperities. The wear is entirely consistent with a micro-drill bit of flint or related material. The strong parallel alignment of the concentric striations suggests a mechanical drilling method (bow drill or pump drill) over hand drilling (and perhaps palm drilling), but the perforation surface is too degraded and obstructed to make a definite assessment of the regularity (Bains 2012).

Use and deposition

The perforations on the pendant do not display much wear on the insides, but there is comparatively more 'polish' on the rims of perforation and the bridge between them, than elsewhere on the surface of the artefact. Still, it is unclear if this pertains to the cultural biography: parts of the surface of the artefact retain the original outer layer, which is fairly smooth, glossy, and covered in multidirectional striations that could originate easily from natural wear in life or taphonomically (Figure A24, c).

More notable is the yellowish band of erosion that exits from the occlusal perforations, runs in diagonal direction over the lateral sides with a consistent width of 6 mm, and meets in the parallel depression on the opposing surface (Figure A24, d). The topography is very rounded and heavily pitted in this depression; less heavily eroded surfaces also occur on either distal surface of the pendant. It suggests a chemical reaction spatially restricted to these parts of the pendant, and therefore a differential coverage of the pendant. Given the association with the little worn perforations, a possible

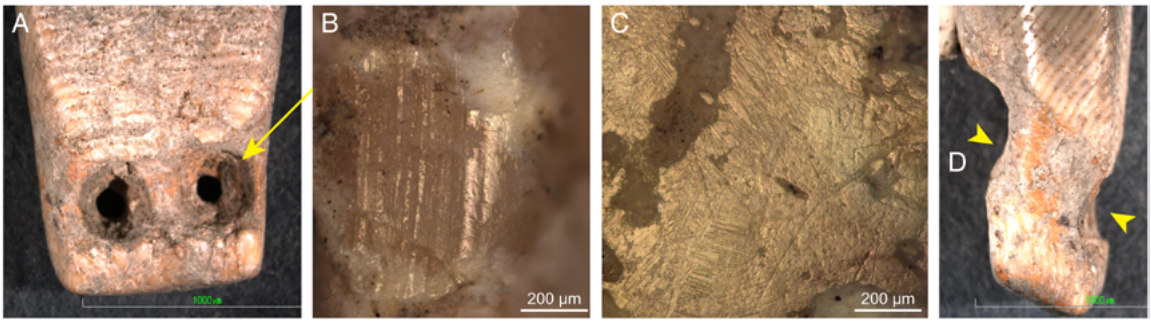


Figure A24: A) Dual perforations on FL 115, occlusal surface. B) striations from drilling in the perforation, location indicated by yellow arrow. C) view of the rough but glossy natural outer layer with striations in multiple directions, including a central band of parallel grooves that is not in association with morphological features. D) diagonal band of discoloured erosion.

reconstruction would be a series of tightly woven circumferential loops that pass the perforations but do not rely on them for tightness. The strings were probably not erosive themselves since the perforation walls and rims are not strongly affected, but will have trapped an erosive agent instead. However, the confidence is low for any reconstruction owing to the damage the surface had sustained.

There are no indications for a specific depositional event.

Object Lup 090

The object – identified as an earplug – originates in the site of La Luperona, dated from the 13th to 15th century (Hofman and Hoogland 2015b), and derives from Layer 1 in Unit 4 (64-16-08). It is associated with Meillacoid style ceramics. Earplugs of various styles in bone, shell, stone, wood, and pottery are also known from Playa Grande, in association with the mixed ceramic content of that site (López Belando 2013), El Cabo (personal observation), and various sites in the northern Dominican Republic (Falci 2015c).

Procurement and manufacture

The object is evidently made out of an osseous element, but it is not clear of what animal. The solid morphology and tissue exclude native insular terrestrial animals, indicating a maritime origin. One potential association is the bony bill of a marlin (family Istiophoridae – A.T. Antczak, pers comm 2014), another the second distal phalange of a marine turtle (superfamily Chelonioidea – G. Shev, pers. comm 2018). The fairly gradual transition between cancellous and compact tissue has been proposed as a diagnostic element of Cetacean bone elsewhere (Margaris 2014). The element was logically obtained by means of a coastal or maritime expedition, but lacking a good identification little can be stated on the techniques of procurement. The issue is compounded by the fact that the original morphology is unknown and altered.

That said, the shaping strategy is not entirely clear. Parts of the side retain coarse striations that are either oriented parallel with the longitudinal axis, or multidirectional (Figure A25, d). These traces appear to relate to an abrasive wear process since there are no modelled processes that would produce them through wear. The earplug could have been shaped through scraping with a coarse-grained edge or abrading against a coarse-grained platform, probably the former. However, since the surface is fairly worn from later use this interpretation is not definitive.

The angle between head and the sides of the earplug is sharp (Figure A25, b, e), but no clear traces remain of the removal operation. Groove-and-snap is a hypothetical option, as it is a commonly used technique in the area (Falci 2015c). Otherwise, the method of potential levelling for the head is unsure. Abrasive smoothening would be logical as it would wear down all previous traces of manufacture, but there is no evidence for it, given that the topography is not entirely flattened, and striations are absent in this area (Figure A25, a).

Use and deposition

The surface is quite worn overall, and the absence of recognisable manufacturing traces in these areas points towards extensive use processes and/or PDSM on the object. Stereoscopically, this wear is mild directly behind the head, becomes strongest around a circumferential depression located about one-third down from the head, and is reasonably well developed on the remaining two-thirds down towards the tip. The topography is smoothened and bears an oily gloss, which correlates to

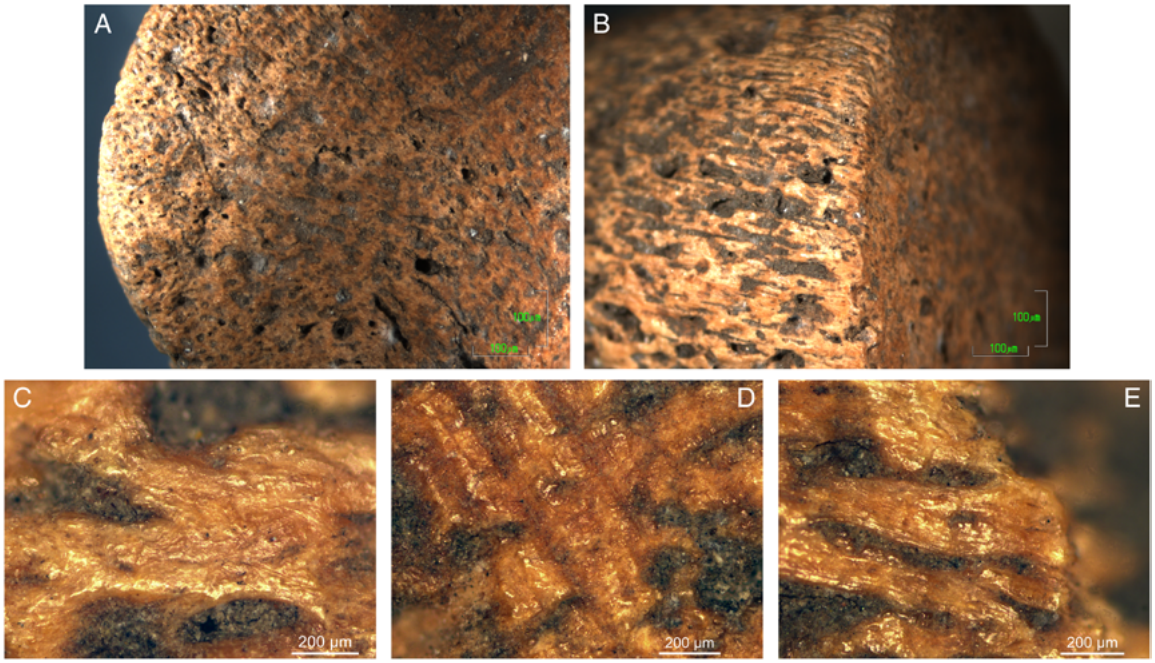


Figure A25: A) view of the rough surface texture on the head. B) view of the angle between head and side, and some smoothening on the latter aspect. C) microwear polishes near the circumferential depression as described in the text. D) micrograph of coarse crossing striations near the angle between side and head. E) close-up of A25-b.

bright microwear polish structures with a greasy texture that is consistent throughout but differs in intensity (Figure A25, c). There are no signs of abrasive contact from a hard medium in this contact, but the polishes may have degraded taphonomically. Concerning the flat surface of the head, the aforementioned polishes appear to dive over the edge of the side into that area, but come to an abrupt end; the head itself is virtually devoid of contact polishes.

Based on the distribution this set of traces is probably associated with wear from use, logically indicating an insertion into a soft medium from the tip onwards with higher tension existing the thicker the circumference becomes. In turn, this would be consistent with the morphology-based identification in the field of the object being an earplug. However, the analysis is best considered inconclusive since the tip is missing. Any competing interpretations, such as an awl-like tool, would have that area be the active use zone and it is now not knowable if the traces on it would be different in kind. It seems probable that this break lead to the deposition of the object, it no longer suitable for either mode of use, but it would have been easily repairable from a technological point of view.

A4.3 Bone objects

Object LP-01

LP-01 is currently in the collection of D. Charles, who reported finding the flute laying loosely on the beachside, having eroded out of the cliffside after storm events. The sediments still within the objects indeed correspond to the deeper stratigraphy of the cliffside (M.L.P. Hoogland, pers. comm. 2017). Little sediment currently remains, as the object has been thoroughly cleaned. This provenience would associate the flute with the disposition of waste over the cliffside, typical for Cayo habitation sites.

Procurement and manufacture

The pipe is manufactured out of a long bone diaphysis now measuring 203 mm in length and 27 mm in maximum width. The long bone has been identified as the femur of a brocket deer (*Mazama* sp.), which includes northern South America in the native range (G. Shev and Z. Ali, pers. comm. 2019). *Mazama americana* occurs in Trinidad and formerly in Tobago, but no large mammals occur naturally within Grenada. Three main manufacturing stages are observed: initial shaping, abrading, and execution of features. The first essentially pertains to the removal of the epiphyses from the bone at large. The mouthpiece flares outward with thinner bone, whereas the foot was dislocated at the metaphysis. There is strong evidence that epiphysis removal was done by sawing with a solid lithic: the outer circumferences are slightly inflected evidencing the remnant groove (Figure A26, a) and there are several onset scratches, including one misplaced cut-mark. A fine circumferential soil-filled groove near the foot is possibly ornamental (see LP-02).

Abrasion stigma are observed on a few areas on the flute, ostensibly to erase tuberosities, crests, and other rugose sites for muscle attachment from the shaft. As it is, the outer surface is smooth and devoid of naturally rough features, and the combination of erosion and use rounding has removed any obvious signs of the prior processes involved. Still, in some place abrasive traces remain on the microtopography in the form of small clustered striations underneath later modifications (Figure A26, f). The preservation allows no commentaries with respect to the technology and gesture used, other than on the relatively fine-grained nature thereof. The inner surface (the medullary cavity) also appears to have been modified through abrasion. This is best captured closer to the openings (Figure

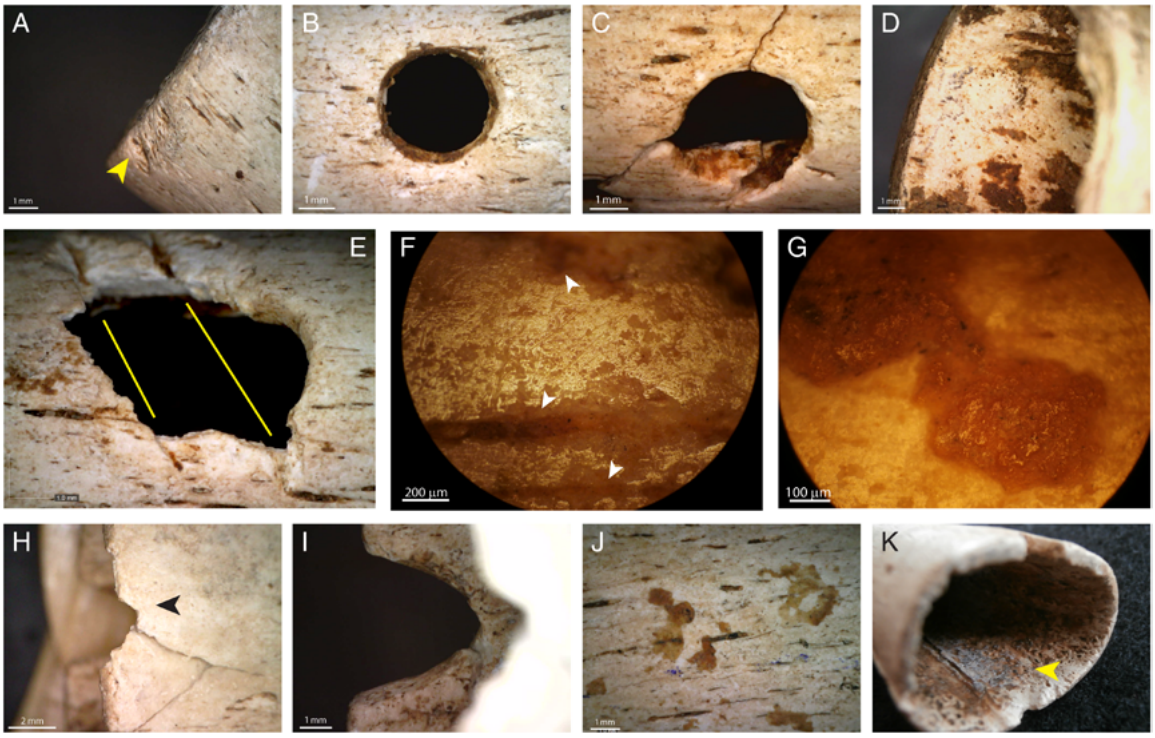


Figure A26: Manufacturing and wear marks on LP-01. A) remnant of an onset to a groove. B) intact tone hole perforation. C) damaged tone hole, internal view. D) internally smoothened surface. E) destroyed tone hole, with motion indicated. F) deep striations amidst a detailed view of the micro-topography. G) high magnification view of red-orange residue. H) break mirroring the V-shaped notch (arrow) and lavish use of glue. I) Internal view of the V-shaped notch. J) low magnification view of the red-orange residue with superimposed soil remains. K) greyish residue of uncertain association.

A26, d), but smooth reflections can be viewed deep within by through-sighting the flute against a bright light source with the naked eye. All of the spongy bone of the medullary cavity has been removed, and possibly parts of the compact bone as well. However, to what extent this was done cannot be established due to the unavailability of reference material. Medullary cavities are expected to be properly hollow for most of the length, but also to contract towards the epiphyses rather than expand as in the present materials. Given the inability to properly examine these unreachable surfaces, the techniques used can only be speculated upon. Possible options include the use of a thin stiff rod to break away spongy matter, and a flexible strip or string with abrasives to smoothen away remaining irregularities affecting the tonal resonance.

Thereafter, the features of the tone holes and mouthpiece were made. Three perforations provide the flute with tone holes, regularly spaced from one another (17.5mm ± 0.5mm). One is intact, the other two display damage (Figure A26, b-c). A rotary drill is clearly implied in the concentric circumference, but the thin bone makes it difficult to observe markers left by different types of bits. Still, the perforation wall is nearly straight but for a minor inflection, not completely worn away with the presumed constant finger action steadily smoothening these areas (cf. d'Errico 1993). The morphology rules out a lithic tool. It is comparable to the animal tooth experiment, but could also be obtained by using tubular bits. The lack of a perforation profile excludes certainty of identification. The damaged perforation was described as identical to the first perforation before the flute broke at the circumference (D. Charles, pers. comm. 2016), and is internally consistent with it. What remains of the ruined perforation also matches the pattern, but this tone hole was deliberately destroyed with two deep incisions breaking away the bone (Figure A26, e).

The flared end forms the mouthpiece, displaying a broad V-shaped notch with smooth curving bottom. The bottom is indented and the groove itself mirrored by a breakage intrusion on the opposing end, which are discussed below. The cross-section matches very well with the experimental wood-widened groove, including the slight outward abrasive facet, and is thus likely the result of a similar technological process (creating an onset with hard material and widening it with a softer tool). This feature is a defining characteristic of notched end-blown flute mouthpieces (alternatively called *quenas*).

Use and deposition

The use and deposition of this flute remains a bit vague, given its not entirely certain provenience and its spotty recent itinerary. It is riddled with gloss and residues of all sorts, most of which are clearly recent in nature or must be dismissed as inconclusive. The most frequently used areas would obviously be the tone holes and the mouth piece, but nevertheless, there are no clear traces of contact observed in these areas. It is plausible that the advanced state of erosion of the microtopography in conjunction with subsequent paper wrapping have erased all interpretable traces from skin contact, a type of wear that is slow to develop to begin with. Nevertheless, it remains problematic.

The best evidence that the flute was used to play music pertains to the notched mouthpiece aperture. As mentioned, here is a wide V-shaped groove with rounded bottom, indented, and mirrored on the opposing end by rough triangular chipping of the edge (Figure A26, h-i). The damage deforms previous features of manufacture, and must indicate a conventional activity since it is observed in the other flutes as well. The fracture propagation indicates that a pressuring force was directed inwards on both sides, coming from an angle. This pattern appears to be consistent with notched end-blown flute

use, in which the notch forms the blowing edge against which the airflow must be directed to produce sound. Like modern musicians, Amerindians are described and depicted to balance end-blown flutes and maintain their sound by pressuring the mouthpiece against their lower lips, sometimes indirectly positioned against the teeth (Figure A27, cf. Aretz 1991; Bianchi 1982, 183; Hernández and Fuentes 1985, 28; Izikowitz 1935, 305; Koch-Grünberg 1921, 192). Such pressure is predicted over time to produce the centred, minor, and inwardly directed fracture seen in the archaeological piece. It does not explain the minor wear seen within the notch itself, but rounding and grease forming on the mouthpiece is to be expected for flutes in general (Miguez *et al.* 2013).

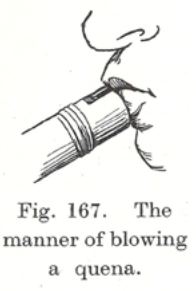


Fig. 167. The manner of blowing a quena.

Figure A27: Figure 167 from Izikowitz (1935, 305) depicting a typical position for playing edge-blown notched flutes.

Mentioned above, the proximal perforation is fractured beyond usability by two parallel adjacent cut-marks. The cut-marks are deep and pronounced V's with narrow bottoms, set using a solid straight-edged tool (Figure A26, e). The profile suggests a lithic flake, but potential micro-striations will have eroded. The hypothetical alternative of a metal tool, possible given the chronological context, cannot be ruled out. Some white surface is exposed, which may indicate further post-depositional breakage. However, the incisions still carry sediment and also expose white bone, and from other angles the bone appears worn. If not a result of micro-diagenetic differences, differences in cut-mark colours still only imply a correlation with different biographical states of bone modification (Krasinski 2018), rather than the absence of weathering.

While some residues are undoubtedly recent, there are two series of residues which are potentially of pre-taphonomic origin. The first pertains to red-orange patches with a smooth, non-grainy texture and mild translucence (Figure A26, g, j). These are best preserved in the central area opposing the perforations, but insignificant remnants are also encountered in other areas, primarily within fossae in the bone. The appearance would suggest an organic nature and it may pertain to remains of a colourant or protective wax. The second residue pertains to a light grey residue present in the internal surface of the mouthpiece, as a thin layer on the side opposing the V-shaped notch and as isolated sub-mm sized clumps on the walls between (Figure A26, k). It was originally considered as modern given that it has a relatively fresh appearance, and in LP-02, appears also on the outer surface. The residue superimposes a reddish brown material with a thicker texture (of unknown nature, but possibly soil). However, a common practice in ethnographic bone pipes is the partial closure of the apertures through beeswax, often mixed with resin. This narrows the paths through which the air stream can escape the resonance chamber, and is done to improve the musical capacities of the instrument (Izikowitz 1935). As such, the modern association is in question and the residue itself needs to be tested.

Object LP-02

The cultural association and collection history of LP-02 are equivalent to those of LP-01. It accumulated the same modern residues in its contemporary life phase, although in lesser quantity.

Procurement and manufacture

The flute is made out of a long bone from a medium-large mammal, deer is again the most probable identification (M.L.P. Hoogland, pers. comm. 2017). It currently measures 95mm lengthwise with a

maximum width of 18mm. Onset cut-marks located on the lateral aspect at the rim of the opening (Figure A28, a, cf. e) indicate that the epiphysis was removed using sawing (as described for LP-01). Further, scraping marks are observed in several areas, particularly towards the midshaft and surrounding the perforation (Figure A28, b). This indicates either sculpting of the bony mass in these areas or defleshing of the bone. Given the presence of a perpendicular cut-mark in the midshaft area, defleshing appears slightly more probable. Although V-shaped in outline this cut-mark is shallow and irregular, and does not match well the angularity that would be expected of a sharp lithic as seen in the experimental morphologies. However, comparison with the published literature on metal cut-marks and the organic experiments still render a solid brittle as the more likely tool, possibly a coarse-grained material or a poor quality edge.

The perforation that remains in this side of the flute is identical to those observed in LP-01. Curiously it is located on the narrow lateral aspect of the bone, rather than the wider anterior aspect, but without the remainder of the object it is impossible to elaborate on the positioning or the use of tuning/direction holes in this technological system. If it pertains a tone hole, it is misaligned with the notch. The concave end of the fracture does not correspond to an intersected perforation. The notch was likely created using a technique that left it with the current fractured edges, as these bear developed wear (below). With pressure having travelled from the outside towards the inside, one potential candidate is chipping and breaking away the bone from the outside by using a solid implement to exert localised pressure. Still, this reconstruction stands at low confidence.

Parallel shallow fine lines occur in various locations. Three are near the metaphysis, two on the midshaft, and two between the perforations. All are perfectly circumferential with the exception of one closest to the opening, where the anthropogenic nature is revealed by a flawed connection of start and end strokes (Figure A28, c-d). Being functionally unrelated to acoustic design, they must be considered as decorative, embellishing the presentation of the flute. Unfortunately, their cross-sections are filled with sediment preventing a view at the incision technique.

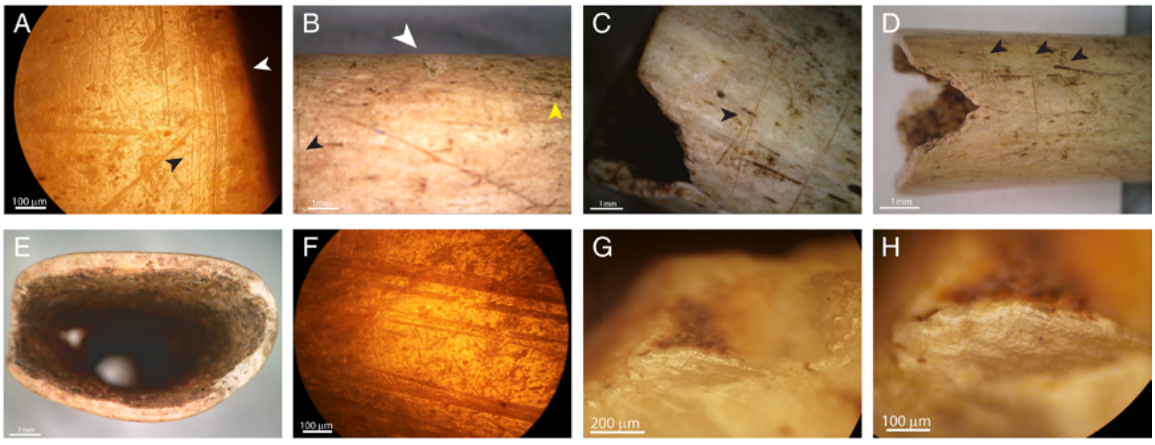


Figure A28: Manufacturing and wear marks on LP-02. A) parallel onset marks from incising motions (black arrow) at the opening of the mouthpiece (white arrow). B) midshaft stereograph with a fine line (black arrow), perpendicular cut-mark (white arrow),and parallel scraping marks (yellow arrow). C & D) poorly connected fine lines (arrows) and view of the large and small notch. E) top view. F) general microtopography of the surface. G & H) micropolish indicating contact with pliable to softer contact materials.

Use and deposition

While this object is far better preserved than LP-01, there is a similar lack of traces from handling and skin contact on the surface. Instead, the general surface shows a flat, abraded view that more than anything reminisces the continuous soft paper (un)wrapping the object has been subjected to in recent years (Figure A28, f). That said, the mouthpiece shows the same wear pattern evidencing sound production as was analysed for LP-01: an artificial notch with post-manufacture modification opposed by a breakage facet produced by inwards-oriented pressure. Here the irregularity of the notch walls has permitted more clearly the development of an extensive rounding, which corresponds to polish development indicative of a softer contact material (Figure A28, g-h). The exact nature is unclear without specified experiments (in)validating sustained wear production during the playing of the flute, as it is also possible that sharp fractures were rounded off after manufacture. However, both notch and (use-produced) facet propagate cracks running along the parallel axis of the flute, which in the case of the notch formed an open fissure in the wall. This fissure must be considered as potentially having inhibited the production of sound of the desired tonal range, since the place of the midsection break within the biographical trajectory cannot be ascertained. Last, the anterior aspect bears a large impact mark of uncertain origin.

Object p005

This bone pipe was recovered from amongst a small collection of forgeries (Section 6.2.6), but deemed to be of potentially early colonial origins. Inquiries with local inhabitants indicated that the provenience is the Telescope Point area, where it may be specifically related to a burial area or sand-blown dunes. However, questions remain as to the nature and location of this site and the potential relation of material culture with this provenience to La Poterie.

Procurement and manufacture

The instrument is made of a long bone of a large mammal, measuring 182 mm in length and 21 mm wide and 27 mm in thickness at the sculpted nose. The bone is probably made from the hind limb of brocket deer (*Mazama* sp.), possibly a tibia (Z. Ali and G. Shev, pers. comm. 2019). The excessive morphology of the excisions indicates the extensive growth thickness of the bony mass, which implies that the bone may have been pathological originally. Most regular bony features were modified or removed. Traces of the techniques used for potential epiphysis removal, defleshing, external abrasion of rugosities, and internal smoothening are no longer recognisable due to the advanced state of erosion. Still these were logically carried out, and the flattened aspect where the tone holes are located (slightly better preserved) forms direct evidence for an abrasive stage.

The mouthpiece bears a V-shaped inset, identifying the instrument as a notched end-blown flute. The notch appears to have been smooth walled before eroding, with the exception of minor breakage in the centre (Figure A29, a). This pattern is comparable to that described for LP-01, except that the angel of the notch morphology is more narrow. By comparison, the incursion in the sculpted end has jagged irregular walls and is the result of the bone fracturing inwards. Further, there are remains of a circumferential groove here with a wide symmetrical V-shaped profile and a thin bottom. It was likely set using a lithic edge, although it has been preserved poorly.

The instrument possesses five finished tone hole perforations and bears possible onsets for two more (Figure A29, b-d). The perforation proximal to the mouthpiece is smaller and located right

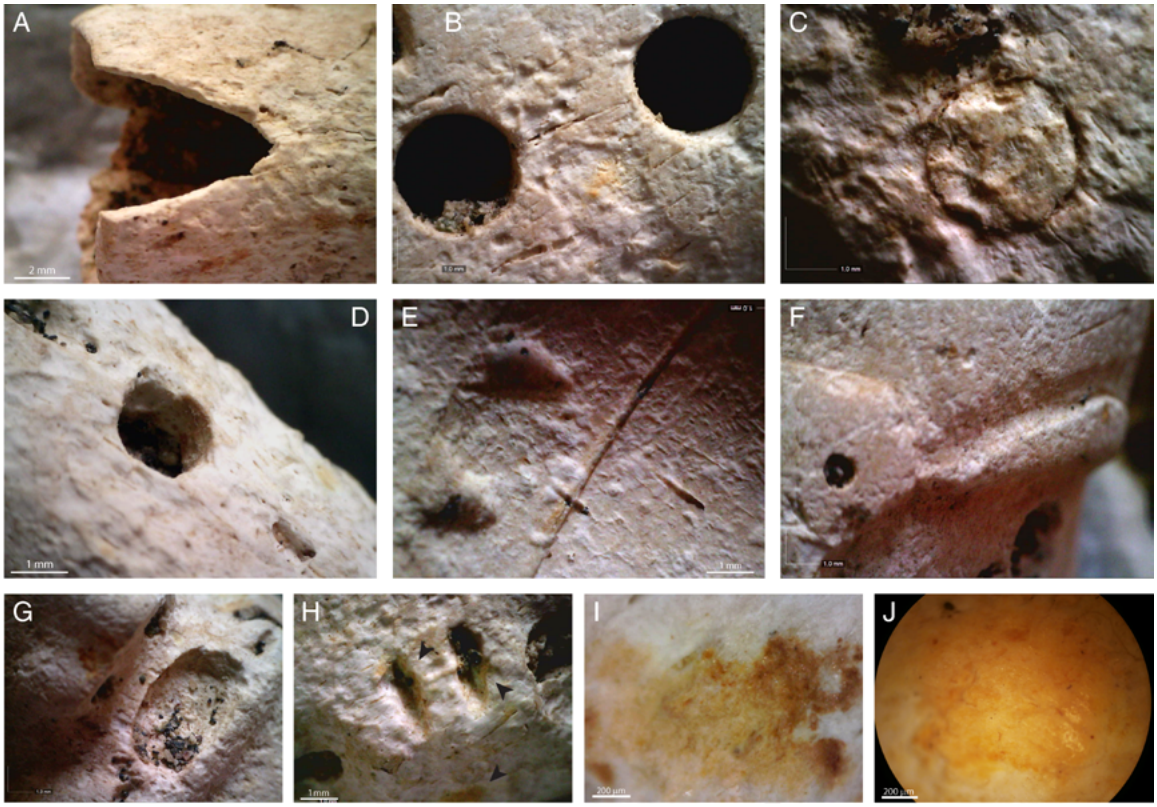


Figure A29: Manufacturing and wear marks on p005. A) mouthpiece notch. B) distal tone holes, closely spaced. C) proximal onset of a tone hole. D) proximal tone hole, with nutrient foramen. E) the headband. F) elements surrounding the eye brow, top left perforation being an ear. G) carved elements around the mouth. H) incisions delineating toe grooves, filled with and surrounded by residue deposits (arrows). I & J) Different views of the residue.

above the nutrient foramen, the other four are consistent in form and positioning. Their spacing from proximal to distal measures 5mm, 20 mm, 23 mm, and 3 mm. The large perforations are identical to those described for the La Poterie flutes, being straight walled near-perfect circles with a slight inflection at the point of entry. The smaller perforation differs in dimension and retains a view of the wall showing some measure of fine circular striations, if also mostly eroded. The onsets are both located in the axis between the intermediate and outer tone holes, and may remain from the prior planning of the intended tonal qualities/frequencies. They appear as fine lined, slightly wavering circles of equivalent shape and dimensions to the perforated tone holes, with tool contact probably only for a very short duration. These aspects favour a thin-walled tubular drill over a tooth bit, with a hollow reed being most likely.[58] The consistent diameter could indicate mature dimensions of the taxon (as they are consistent with the other windpipe tone holes also), and a smaller stem would then have been selected to produce the small perforation.

The squatted figure is excised from the surrounding bone, and the shape of the higher marked by repeated incision. The evidence thereof is found where the eyebrows, arms, legs, body areas, and headband border the lower laying bone, consisting of short, angular V-shaped grooves suggestive of sharp lithics. The extremities are curved in 120° and 90° angles, clutching the diaphysis as it were. They display short deep grooves, the result of sawing with a lithic edge (Figure A29, e). The lower areas in between, notably the cheeks, forehead, and flattened aspect of the tone holes, no longer

58 Reeds as the active drill bits are occasionally considered in the archaeological literature (e.g. Vargiolu *et al.* 2007; Unger-Hamilton *et al.* 1987; Warren 1969; Diehl and Stroh 1978), and are known from ethnographic scenarios. Morero *et al.* (2008) successfully experimented using a bamboo to drill marble, creating a straight tubular perforation with fine lined striations (echoing the observations by Hansford in Sax *et al.* 2004).

show evidence of their production. Hypothetically speaking, a sensible procedure would delineate the features through incision, after which chiselling and scraping was used to reduce the areas in between followed by localised abrasion to even out all frontal surfaces, still slightly smoother than the non-modified eroded parts of the shaft. However, the state of erosion does not permit corroboration of the actual operational sequence in these parts.

The figure contains four partial perforations, two shaping the nose holes and two for the ears, and three chiselled depressions forming the eyes and the mouth. The perforations are consistent in shape despite being of different dimensions, and in contrast to the tone holes, appear set using a lithic drill bit. More internal and less exposed, the eye and mouth depressions retain a surface roughness that is not entirely the same as the eroded bone surrounding it, particularly on the walls of these features. The oval depression could only be created by indirect percussion with a sharp point, similar to surfaces described above, not through a technique relying upon rotary motions.

The headband forms the upper border of the decorative sculpture, and consists of two elements. The first is a single incision that runs from ear to ear while making a wide curve above the eyebrows. This groove has close to vertical walls with a flat bottom, despite being overall narrow, and is slightly wavering over its length (Figure A29, e-g). Based upon the experiments and the literature, this could be formed either with a dulled metal blade, sawn with a shell lamina, or sliced with a lithic blade, but in a manner different from the other grooves. The entry and exit cuts favour a single gesture with a solid implement, but the field microscopic analysis did not permit a finer view. The border has an embossed appearance, characterised by broad notches with a U-shaped bottom, V-flaring walls, and start shallow reaching depth towards the opening of the feature. The eroded surface bears little clue towards the technique applied in obtaining these features. It is probable they are also chiselled, as there are slight morphological differences between the individual notches. Lbova and Volkov (2016) offer the same interpretation for morphologically identical features found in Upper Paleolithic Siberian mobile art, produced using flint burins and experimentally verified.

Use and deposition

One residue pattern is observed which may originate with the pre-taphonomical biography. This pertains to small stains of a light yellow to orange substance, which in a few instances is concentrated in a thicker, darker mass. It is located in numerous places, and most notable in the face and extremities of the excised figure and on the shaft proximal to the mouthpiece (Figure A29, h-j). The residue is a very fine-grained smear, comparable in texture but lighter in colour to the residue found on LP-01. A similar purpose may be postulated, i.e. remnants of a coating that once enhanced the visual appearance, though this inference remains weak without knowledge of the recipe and confirmation of its application on other items of early colonial material culture.

The eye and mouth depressions are well suited to carry inlays, in particular the mouth given that it is transfixed between the hands. However, no such indications were found during analysis. The only observation that pertains to possible modification is a light gold-brown hue that centres around the flattened tone hole axis and is spotty around the facial area. In both the surface is also slightly smoother than elsewhere, which corresponds to less extreme weathering. However, since the overall state of erosion on the piece remains severe it would be contentious to affirm prehensile wear based on only this pattern.

The same pattern of use that characterises the mouthpieces of the previously discussed flutes is also

found in p005. The orientation of the tone holes is slightly offset against the longitudinal axis of the bone, particularly when considering the angle of the notch and the frontal aspect of the iconographic motif. As d'Errico *et al.* (2003) point out in their discussion of Paleolithic wind instruments, this obliquity may be functionally intended and has as effect that the pipe is positioned away from the player's face. If the instrument assumes this position the tone holes are rotated diagonally up and forward, which naturally directs the iconographic aspect to face outwards. d'Errico et al. (2003) further suggest that such pipes are not traditional flutes but function through pressured embouchure, aided with reed voicing insert. As noted in section 2.4, however, an analysis of tone and airflow is beyond the scope of this study.

Given the provenience of the object, nothing can be inferred with any reasonable certainty regarding the deposition phase. The foot end fracture may have induced deposition of the instrument, the crack running between the third and fourth perforation may have harmed its acoustic quality, or both may be post-depositional and a third, unknown reason spurred its entry into the archaeological record. There seems no clear basis for favouring any of these hypotheses over the other ones.

Object p007

The cultural association and collection history of p007 are equivalent to those of p005 and p006.

Procurement and manufacture

The long bone originates with a medium-large mammal, possibly a deer of the species mentioned before (M.L.P. Hoogland, pers. comm. 2017). It measures 148 mm with a thickness of 23 mm, but is fractured on both ends. As such the location and technique of epiphysis removal cannot be ascertained, and tone holes aside all other surface marks pertain to the iconographic modelling.

The carving techniques include excision through incision, scraping, whittling and chiselling. Single incisions consist of thin V-shaped cuts, often with multiple gestures clustered together to excise wider areas (Figure A30, c, g). The most likely tool was a sharp lithic edge, though given the field analysis setting and historical context a sharpened metal edge cannot be ruled out with absolute confidence. The scraping and whittling traces are much more shallow, and both appear as bundles of striations; long and parallel for scraped areas, and overlapping wavy striations for whittled parts (Figure A30, a-b, d). The most probable tool is a serrated rim with small, consistently spaced asperities, variably applied, but the type and material (lithic, shell, another local alternative) cannot be determined without additional experiments. Finally, chiselling is implicated in the removal of material from the neckline below the jaw, given the rougher surface, furrows from slippage of the tool, and absence of sets of scraping striations. An unknown quantity of material has been removed to reduce the original morphology into the present figurative aspects, for which chiselling was probably the most effective means.

The design is that of a squatted figure, but unlike p005, the extremities are bent to 180° angles. Regardless, the sequence of operations is the same: the design is made by incising the outline, other areas are lowered and smoothened by scraping and/or pecking, and digits are again sawn. While the figure has sharp corners and a blocky appearance, the corners are not easily reached using any of these techniques and indeed present the best preserved traces (Figure A30, a, d-f). The face consists of an excised nose in between an ʊ-shaped (upsilon) slit that expresses both the mouth and the eyes, and a headband. The ʊ-shaped slit is the result of short cutting gestures that together create a wide,

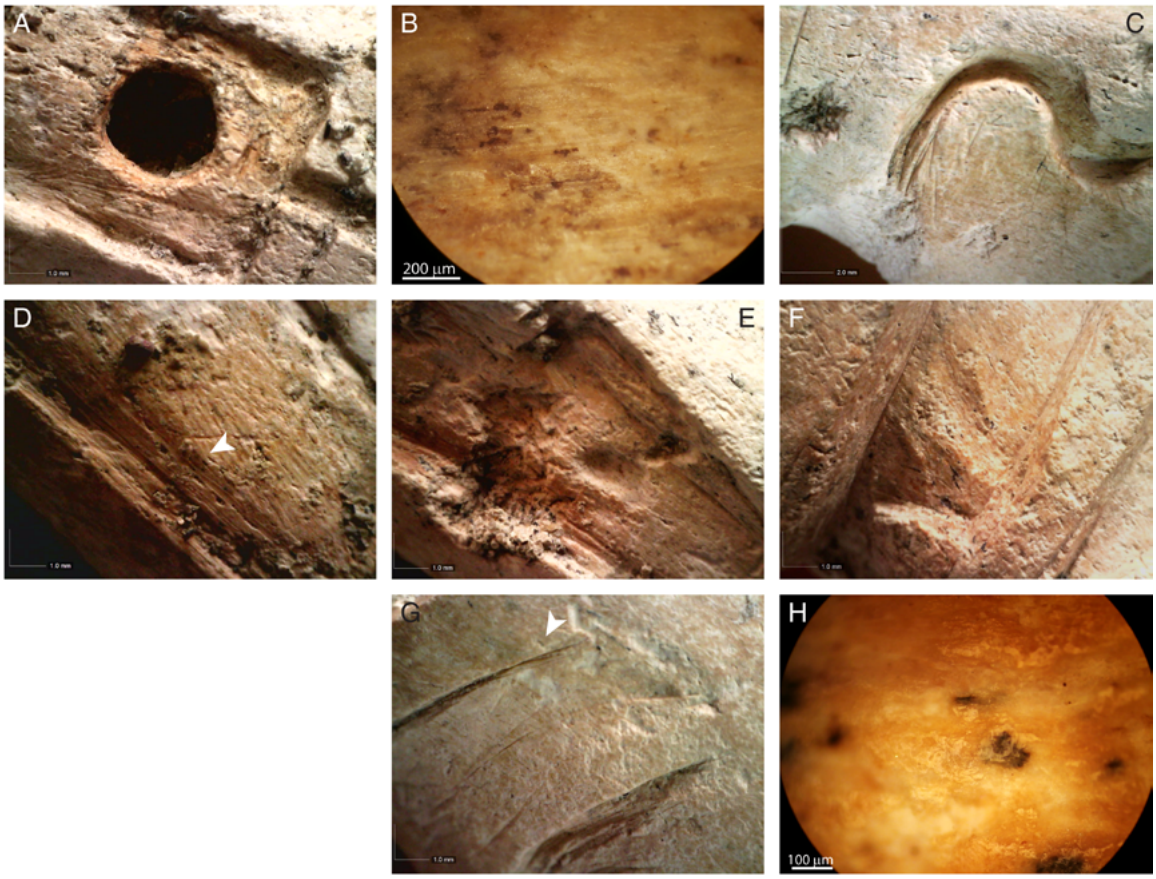


Figure A30: Manufacturing and wear marks on p007. A) distal perforation, excision, and whittled/scraped surface. B) high magnification view of whittling traces. C) left side detail of the facial slit. D) excision and scraping/whittling (white arrow) on the side. E) excision and scraping on the side. F) chiselling furrows in the excised space between chin and shoulder. G) right side detail of the facial slit and headband onset (white arrow). H) high magnification view of higher topography.

meandering groove even if the corners remain slightly angular. The headband consists of a thin groove that evidences the same cutting traces with some misalignment. It is analogous to the line on p005, but sloppier in execution. The circumference of the face is probably chiselled, but finished with a deep incision, perhaps sawn, giving the appearance of a mask applied to the bone shaft (Figure 61).

Three tone holes are set within the diaphysis (Figure A30, a), spaced 22 mm apart and oriented along the long axis of the bone. They are all near circular with straight walls and still possess minor entry inflections, thus indicating they were placed after excision of the area. The morphology is consistent with the perforations seen on the other three flutes, and must be attributed to the same technology. The upper hole is broken with the fracture extending along the same axis, but the fracture walls do not show evidence of another perforation situated in that area. The space between the lower hole and the break is ca. 38 mm, rendering it unlikely that the missing bone hosted additional perforations: not only is this distance far greater than any other tone hole distance seen thus far, it would also be located closer to the approximate mouthpiece than in each previous instrument.

Use and deposition

With both the mouthpiece and the foot having broken, the instrument lacks indications for use beyond displaying the capacity to function through tonal manipulation of an airflow. Briefly observed for p005, a gold-brown hue is reasonably clear on the facial aspect. It is more closely spaced, and the

affected surface is smooth and less affected by deterioration. Microscopic traces remain sparse and not entirely distinctive, but the occasional observation is made of fine striations in thick polishes (Figure A30, h). Patterns of golden-brown patination from presumed use (Section 5.3.4) that are macroscopically evident on bone flutes in related assemblages show similarities in distribution (e.g. Antczak and Antczak 2006, Figure 408). These centre on the entire tone hole area, distinct from the distant opening and not clustered around the tone holes where most finger action takes place. The traces on p007 are still not entirely convincing, despite the better preservation of this instrument. Nevertheless, it is not a stretch by any means to assume regular manipulation of the flute.

The nature and timeframe of the breakages and difficult to ascertain. The fracture near the head follows in part a groove leftover from the excision process, indicating it may have been the result of induced weaknesses in the shaft. The thick bony mass of the face prevented breakage across the motif when the responsible force exerted its weight on the piece. The relation between the distal fracture and the biography is unclear. The perforation break will have rendered the flute useless, but as this part of the flute is heavily deteriorated, it is quite possible that the break is taphonomical.

With regards to the depositional history, two surface aspects stand out. The first aspect is the heavy erosion that appears to be concentrated in a few locations, opposing the otherwise less degraded normal surface and the smoother, slightly patinated areas. The erosion is effected as a loss of bony matter that includes pitting and tunnelling, damaging the structural strength of the shaft. The type of surface modification on p005, which appears to dissolve layer by layer, is not seen here. The second aspect is the presence and distribution of impact craters and damage spread across the surface. The timing and nature of these is uncertain; it is not implausible that a number relate to the modern removal of the strongly adhesive sediment encrustations – and with it, the outermost layer of bone. Otherwise, the impact marks (Figure A30, e) are not dissimilar from published descriptions of carnivore gnawing (Blumenschine *et al.* 2007). However, other marks – including the larger ones on the facial aspect – are almost certainly the result of impact damage, and the ones with sedimentary filling can be taken to have occurred at the time of deposition at the latest.

Object p006

The cultural association and collection history of p006 are equivalent to those of p005 and p007.

Since the iconographic motif is poorly contrasted with the unmodified bone surface and difficult to visualise due to the sharp tibial line, a brief description of the anthropomorphic stylisation is provided. The face consists of delineated eyes, nostrils and a mouth circumscribed by a line following a heart-shape that might index the cheeks, and is topped by a double groove headband running lateroproximally. The distal patterns commence from double grooves descending from lateroproximal orientation, to end at a horizontal double groove. Below it lateroproximal grooves run to the anterior aspect, from where they continue in laterodistal orientation. These latter grooves, alternatively described as sideway chevrons, are most likely the squatted legs of the figure in keeping with Antillean stylistic convention. This would render the horizontal grooves the belt and the lateroproximal grooves above the arms. The motif in between the face and the distal body consists of six symmetric perforations, enclosed by a curved double groove.

Procurement and manufacture

The bone has been identified as the left tibia of an adult human, and measures 318 mm with a

thickness of 42 mm. Given the damage to both sides and lack of reference for indigenous Amerindian populations, stature cannot be approximated. The origin of these breakages is unknown, as there is no technical scheme apparent that relates to opening up the medullary cavity. It is theoretically conceivable that the epiphyses were crudely broken through hard hammer percussion, resulting in the observed propagation, but this is not considered likely. Other bony features such as crests and lines on the medial shaft remain. The sole wider surface modification consists of a field of connected/covered long, coarse striations mediodistally from the (missing) tibial tuberosity (Figure A31, a). This is most succinctly explained by filing using a narrow tool with a homogeneous small-grained texture but no true edge, such as the sandstone sheets found in La Poterie (Section 6.2.5), a potsherd, or against the edge of an abrasive platform: the surface is inconsistent with single asperity motions and the spacing and homogeneity of the striations argue against a scraping edge where (use) retouch would create different sizes and distances between the asperities, not to mention leave sharper striations as with p007.

The engravings of the motif can be subdivided into two types: broad grooves and incomplete perforations.[59] Most grooves are wide and shallow, have almost imperceptible boundaries with the surrounding surface, and possess bands of coarse, elongated striations (Figure A31, b-d). Although banded more closely than the surface striations mentioned before, their size and morphology appear virtually identical. The straight horizontal grooves located medially are more narrow but their internal surface also follows this pattern. In all likelihood these engravings were filed using the same type of tool, operated at an angle. The sunken profile seems to have protected the striations better against surface erosion, which become more faded towards the wider surface.

Twelve incomplete perforations are placed on the bone, two serving as pupils, two as nostrils, two for the ears, and the remainder six arranged below the face in a symmetrical two by two fashion left and right of the anterior crest on the medial and interosseous surfaces. All but the distal two on

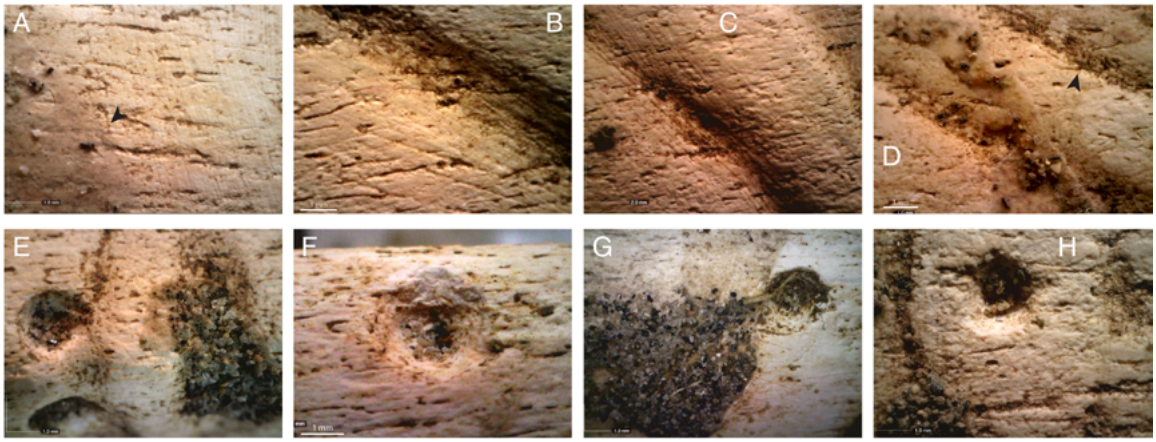


Figure A31: Manufacturing and wear marks on p006. A) clustered striations attributed to filing, and pinkish residue (arrow). B & C) striations in a wide groove. D) striations (arrow) alongside pinkish residue in a narrow groove. E) nasal perforations and mouth, filled with sediment. F & G) 'button' perforations. H) eye perforation and parts of the surrounding outline.

59 Experiments with incising human bone (Ragsdale *et al.* 2016) have provided wear traces identical to those resulting from incising other materials within the same technological complex (Velázquez Castro 2012; Velázquez Castro and Melgar Tísoc 2014). Accordingly, I take wear trace formation on human bone to be not significantly different from the experimental bones for my purposes, not more so than the usual differences of taxon, cancellous/lamellar, and bone density.

the interosseous surface are unobservable due to encrusted sediment; the remainder two show a wide cone with sediment obstructing the view on the leading edge (Figure A31, e-h). One shows concentric striations, the others even pitting, and while some outlines are circular a few others appear subcircular. This suggests that a fairly blunt, solid point was used to produce the perforations, functioning as a hand borer used in twisting and chiselling gestures. A similar tool may have been used in drawing the outline of the eye sockets (Figure A31, h), which otherwise do not share the traces of the grooves.

Use and deposition

No traces of use were evident on the surface, nor in the interior insofar observable. There are no clear traces that relate to the deposition of the bone either. The timeframe of the fractures on either end is not definable and since there are two it is probably not accidental, nor obviously technological as stated before.

Various areas of the flute carried a viscose, pinkish residue (Figure A31, a, d, g). These residues were located on or near grooves, and form thin plaques overlaying the surface, in turn usually overlain by large amounts of adhering sediment. During analysis one such patch broke off the surface, and tore off the outer layer of bone lamellae. The nature of these residues is unclear. It is possible that they are remnants of a coating similar to has been hypothesised for previous flutes, although composed of an entirely different type. Alternatively, they could be more modern in nature. Its transparency allows limited viewing of the bone underneath which appears to have suffered from erosion as much as any other surface area. Conversely, the coherent and sharply bounded structure of the individual patches does not appear to have deteriorated much at all. Testing is needed to verify the nature of this residue, and if of modern origin, the fact that it is overlain by sediment puts to question the entire biographical trajectory of the bone.

Observations on authenicity

The four windpipes are on the whole technologically cohesive, which lends strong support to the thesis that p005 and p007 are authentic, originating from the same cultural context as LP-01 and LP-02. The advanced state of wear of the three specimens from Telescope Point might be emulated by a skilled forger. However, the details of the alterations are quite different for each of the pieces, indicating different micro-environments for each. They also clearly overlay production stigma in all three, even if some sharper corners remain in the best preserved specimen (p007). The production traces are in any case not the result of mechanised work but that of more detailed hand-work, equivalent to the techniques seen in the specimens from La Poterie. In the field, these traces also stood out as clearly different from the fresh, sharp, and deeply sawn engravings on the forgings made on surface-weathered bones from introduced mammals (*Bos* sp. and Caprinae) in the private collection.

The probability that a skilled forger is responsible for the manufacture of these objects is deemed to be very low. That would require the emulation of the use life and of taphonomic degradation in different micro-environments, as well as knowledge of historical indigenous boneworking techniques, iconography, and aerophone design. There are no preceding examples of archaeological aerophones (with obvious economic value to looters) known from the Windward islands that could serve as inspiration, at it is improbable to assume that all of the design specifics converge with the flutes from La Poterie by chance. Furthermore, there are no other examples of objects identified as forgeries from such expertly capable contemporaries. Research is ongoing into the networks of forgers and artisans

of contemporary imitations on the island (J. Hanna, pers. comm. 2015), but thus far there are no plausible cases known of persons on the island working with the kind of materials and skills seen in the windpipes as of yet. Knowledge of indigenous manufacturing technique is more likely to have survived or be closely emulated on the mainland (Venezuela or the Guianas, where also deer bones are more realistically available), but that raises additional questions on provenance routes.

The strength of the biographical evidence for an authentically early colonial trajectory is less compelling for p006, however. It is technologically distinct from the aerophones, evidencing only files for abrading and a hand-held point to drill depressions. There are still no comparable modern materials that I am aware of, but also no comparable archaeological/early historical artefacts that I have analysed. The concept of carved bone pipes is present in the archaeology of the region (if as rare artefacts), but so it is in modern forgery. As such I presently consider proclamation for either biographical trajectory premature. Chronological verification of at least the three bones themselves via means of radiometric dating of the carbon in the collagen is unfortunately not possible, but perhaps there remain avenues to be explored using the sediment adhering to the medullary cavities or the residue deposits still present.

A4.4 Wooden objects

Object p004

This object was recovered washed up from the seawater inlet on the public beachfront of Fort Jeudy in Grenada. The cultural context is unclear, given that materials from both earlier and later ceramic traditions continuously wash up elsewhere along the coastline. In all likelihood there are one or more archaeological sites located in the shallow inlet, which submerged some time after the deposition of the wooden artefact. Stylistically the object may be considered as bearing Chicoid influences in its carvings (Petitjean Roget 2015a, 150), but given how little is known about ECA woodcraft (the dominant cultural phase on Grenada) and the evidence for centuries-long biographies on other wooden artefacts (Ostapkowicz *et al.* 2011; 2012), I hesitate to follow his attribution to the 15th century.

This analysis is preceded by a note on the level of inference, which must be considered as low. Use wear traces are not commonly studied on wooden artefacts, and where done so tend to be restrained to impact traces of use and major technological categories. Examples include the technological analysis of the wooden spears from Schöningen (Schoch *et al.* 2015), research into aboriginal projectile spears from Australia (Nugent 2015), the study of use wear traces on two wooden artefacts from Patagonia (Caruso Fermé *et al.* 2014; 2015), and the analysis of archaeological and historical wooden objects in France (e.g. Mille *et al.* 2014), notably including a radiotomographic study of a Tupinamba mace from the Musee du Quai Branly (Lavier *et al.* 2009). Only Nugent (2015) conducted experiments aimed at supporting functional interpretations, focused on tip damage and gouges (angular marks). She still found these unreliable in the interpretation without supporting residues. Concurrently, I consider the field as lacking established rules for the interpretation of contact materials from the wear traces observed on wooden artefacts (with or without experiments).

Procurement and manufacture

Since the analysis was conducted in private setting, there was no possibility for sampling or consulting with a specialist in wood anatomy. A relatively straight grain is visible diagonal to the face, but potential

growth rings are not. Petitjean Roget (2015a, 150) does suggest the wood to be mahogany based on its light weight and piquant odour, but this was not independently verified. The homogeneous dark brownish colour is nominally suggestive of heartwood extracted from a thick branch or small trunk, but taphonomical alteration is certain given its provenience. The outer rim of the object probably matched the dimensions of the extract, which currently measure 34 by 31 mm with a maximum thickness of 11 mm. Potential traces of sapwood or bark removal are no longer present due to the progressive removal of woody matter from the side. This was accomplished through scraping with a suitable implement, probably lithic, leaving an even surface bordered by a protruding rim on the frontal and distal borders (Figure A32).

The engraving and hollowing out procedures are not fully reconstructable, but some basic suggestions can be offered. The frontal incisions, half-perforations, and socket outlines were likely placed before the backside was hollowed out, in order to benefit from the woody mass sustaining the effort. This would have been removed subsequently to expose the inner surface, although there are no indications as to what method was used. The depressions preforming the eye and mouth sockets were reached first to allow a precise view of the remaining thickness and avoid breaching other incisions and perforations. These were later enlarged from the backside, resulting in the present bevels. Most shaping activities seem to indicate carving or chiselling with a sharp implement, since none of the surfaces are fully levelled. The inside may also have been lightly abraded, considering the surface and walls have generally smooth appearances in spite of persistent micro-relief, but this is difficult to tell given the encrustation of sediment.

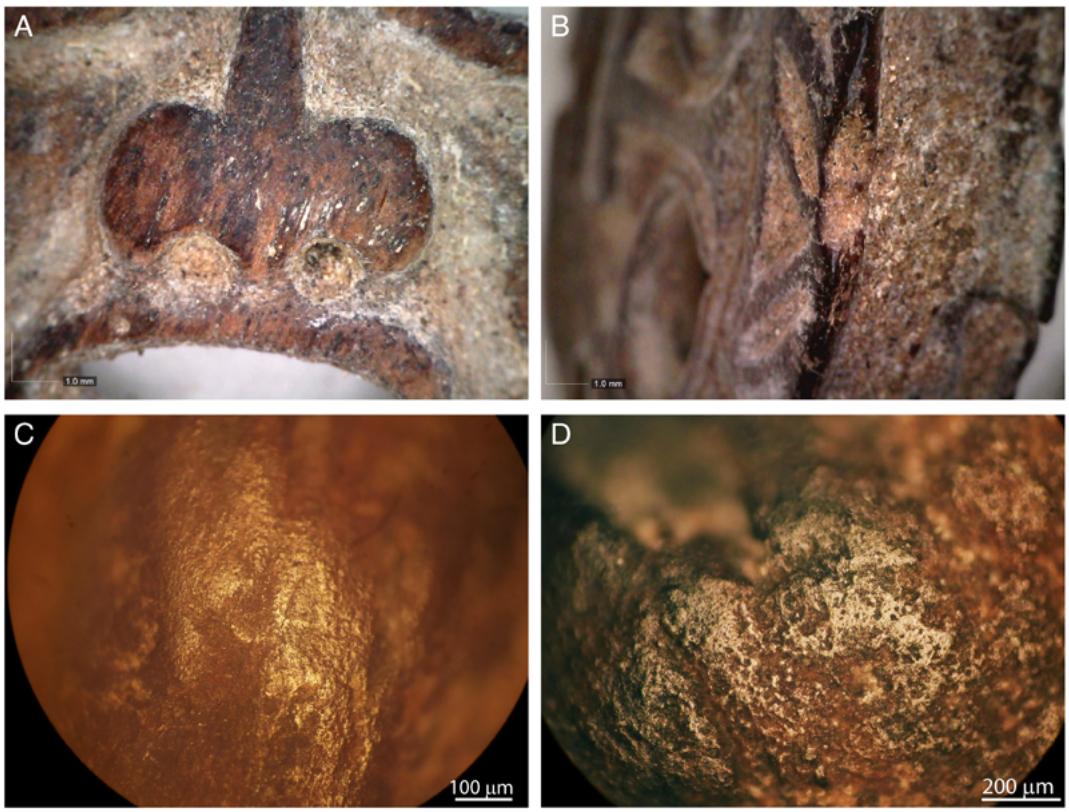


Figure A32: A) detail of the facial engravings, light patination, and extent of encrustations. B) protruding rim of the side, bearing a dark oily patina from wear during use. C) microwear polish in association with the patina on the face. Note the relation to the original topographic elevation. D) different microwear polish in association with the patina on the sides.

A rotary drilling technique is affirmed only for the incomplete perforations of the auditory canals and nasal cavities. The perforations appear to reach ca. 1 mm in the blocked nostrils and ca. 2 mm in the ear canals, and are perfectly cylindrical for as far as they are observable excepting the slight conical onset that distinguishes it from normal cylindrical perforations (Figure A32, a). The most likely bit would be long and thin such as a small fish bone, although any sufficiently shaped bone splinter or wood fibre would work equally. This would be supported by abrasives which would enhance the penetration of the drill into the wood, and further form a puddle near the entry. This was observed during each of the abrasive-supported drilling experiments conducted (Falci 2015c; Breukel and Falci 2015; Falci *et al.* 2017b), and may potentially create the observed conical inflection in the comparatively softer wood. A V-shaped bit from a brittle lithic point, such as flint, is categorically ruled out. To my knowledge this type of perforation profile has not been described for other insular Caribbean objects (Carlson 1993; de Mille and Varney 2001; de Mille *et al.* 2008; Falci 2015c; Lammers-Keijsers 2007; 2008).

Use and deposition

*T*here is one main observation that most likely pertains to contact through use activities. Most of the outer surface areas on the frontal aspect are marked by a darker, glossy patina. The distribution corresponds very well to the outer excised surfaces which would sustain both first and the most extended interaction with a contact material, and opposes taphonomical or chemical alterations given that the lower areas are unaffected (Figure 63; Figure A32, a, c). The wood fibres appear rounded, and there is an adequate correspondence with the distribution of polish in these areas. The polish structures bear noticeable similarities to traces previously reported as use-related (Caruso Fermé *et al.* 2014, Fig 5; 2015, Fig 7). They generally appear in close connection, with a uniformly duller rough-ish texture and deep invasiveness, overlaying but not erasing internal elevation differences. Small striations or a mild directionality were seen a few times, but not in a consistent orientation. The description is suggestive of softer material contact, although given the paucity of knowledge on trace formation on wood a distinction is not made between any candidates. Still, it can be stated that the frontal area was exposed to frequent contact of a softer nature.

The sides of the artefact and posterior rim also display a dark glossy patina, which under microscopic examination this corresponds to a contrasting wear trace pattern (Figure A32, b, d). It is not as invasive, somewhat pitted and reticulated over the higher peaks, and appears to have erased previous elevations. Altogether, it points towards contact with a harder type of material. This pattern is well developed across the posteriorly located side rim and the outer circle of the back. It suggests that the artefact experienced harder material friction on its sides and back. The macroscopic patination may have formed from adhesive wear or tribochemical interaction caused by the oils or similar substances from the wood itself, and are not necessarily incongruent with contact with an unyielding material. The participation of internal lubricants and chemicals in wood use wear has not been explicitly studied before, to my knowledge. Of note is that the lower lying area in between appeared devoid of wear from use, in particularly notable contrast to the soft contact wear developed on the face. This argues against the interpretation of this object as an ear spool, previously made on the notion that the side rims seemed morphological adaptations to prevent slippage in such a mode of attachment (Petitjean Roget 2015a, 150).

It must be noted that the regularised inflection on the inner surface of the oral cavity and eye

sockets is morphologically indicative of an intended joint with another object, such as an inlay, but no traces or residues were found on this area to support such an inference.

Summary

A key research theme today is how patterns of interaction and mobility characterised societies of the past. Networks of interaction are increasingly seen as the social cornerstone of the indigenous Caribbean, connecting local communities up to pan-regional scales. After 1492, these networks shaped how European materials, politics, and economies permeated local societies and ultimately the organisation of indigenous resistance against colonising powers. Such networks were cemented by the exchange of goods, ideas, and people. They form the topic of the NWO-funded Island Networks research project, of which this dissertation is a part. Beyond the transportation of artefacts, however, the manners in which materials were settled and reinterpreted into new cultural contexts are currently not very clear.

The dissertation addresses this issue through two main lines of evidence: ground stone celts and shell and bone paraphernalia. The combination of microscopic analysis of wear with technology, experimental archaeology, contextual analysis, and provenance is used to reconstruct artefact biographies. In doing so, the study traces 'object life' sequences from start to finish: raw material procurement, manufacturing processes, the use of objects, and their eventual deposition. The merging of biographical theories with relational ontologies permits an understanding of these events by approximating an indigenous perspective on the subjective nature of objects. This approach is applied to the Dominican Republic, involving the sites of El Cabo, El Flaco, and Playa Grande (AD 1200-1500), and to the southern Windward Islands, with a focus on pre-colonial Pearls and the early colonial La Poterie and Telescope Point sites.

Ground stone celts were a key factor supporting networks connecting Hispaniolan elites and communities in the years leading up to the European encounter. They were made from a variety of rock materials (a.o. jadeite, blueschist, greenschist, basalt) to be exchanged and used until exhaustion, with a shared understanding by their users of the material properties of each. Not every community produced celts themselves, with sites such as El Flaco obtaining them mainly from local partners. Celt production at Playa Grande shows clear preferences for specific rock types by the community, subsequently exchanged as preforms while trading for celts from other materials. Grinding and polishing were pivotal transformative technologies, executed using an expansive technical repertoire. Conversely, even jadeitite celts imported to Pearls over long distances were hafted and used in conventional ways.

Many carved shell objects belonged to composite ritual artefacts and were produced using standardised technological procedures, generally providing little evidence for long distance circulation. The reverse is true for tooth pendants, which differ greatly in their individual biographies. The acoustic design of bone flutes adhered to traditional standards, in spite of varying executions of their iconography and sound range. They show how indigenous persistence in the early colonial Lesser Antilles reflected both social ties and the preservation of inherited practices.

The biographies of indigenous artefacts are altogether suffused with relational qualities connecting them to the fabric of social life, but in different capacities. Different artefacts also possessed distinct exchange potentials, resulting in the heterogeneous spread of material culture over shorter and longer distances. With these results, the dissertation ultimately aims to provide new perspectives for garnering insights into the dynamics of inter-cultural and colonial encounters. Material culture forms a pivotal element in these interactions and processes of resistance, adaptation, or assimilation cannot be understood without understanding its role therein.

Samenvatting

Een biografische benadering van de interacties van de autochtone samenlevingen in het Caribisch gebied: slijtsporen en materiële cultuur van vóór tot na de historische confrontatie met Europa (1200-1600 n.C.)

Een van de hoofdthema's van hedendaags archeologisch onderzoek is hoe samenlevingen uit het verleden worden gedefinieerd door de toenmalige interactie- en mobiliteitspatronen. De resulterende netwerken, zelf bestaande uit louter sociale verbanden, worden in toenemende mate beschouwd as het fundament van de inheemse bewoningsgeschiedenis van het Caribisch gebied. Deze connecties werden tot stand gebracht en onderhouden door de uitwisseling van goederen, ideeën en mensen. Op deze wijze werden lokale gemeenschappen tot op pan-regionale schaal verbonden. Na de eerste ontmoetingen met de Europeanen in 1492 waren het deze netwerken die de schaars binnensijpelende Europese gebruiksmaterialen verspreidden en vorm gaven aan de economische connecties in de inheemse samenlevingen alsmede de wijze waarop zij zich weerden tegen de koloniserende mogendheden. Hoe deze situatie ontstond en zich voortzette, wordt bestudeerd door het Island Networks onderzoeksproject, waarvan dit proefschrift deel uitmaakt, en dat gefinancierd wordt door de Nederlandse Organisatie voor Wetenschappelijk Onderzoek (NWO).

Een belangrijk vraagstuk is hoe artefacten die over lange afstand getransporteerd werden in nieuwe culturele contexten geherinterpreteerd werden, en welke betekenissen aan deze materialen werden gehecht. Deze problematiek wordt benaderd via twee primaire objectgroepen: geslepen stenen bijlen en parafernalia (of exotische regalia) vervaardigd uit schelp en been. De biografieën van deze artefacten worden gereconstrueerd door middel van de combinatie van microscopisch slijtsporenonderzoek met technologische analyse en experimentele archeologie, met inachtneming van de oorsprong van de materialen en de archeologische context. De gehele levensgeschiedenis van de artefacten wordt op deze wijze getraceerd: vergaring van de grondstoffen, vervaardigingstechnieken en -processen, wijze van gebruik, en uiteindelijke depositie. Deze dissertatie beschouwt het biografisch verloop als een proces gedreven door voortdurende herinterpretatie volgens culturele, sociale, en relationele normen, en neemt als grondslag hiervoor bepaalde kerneigenschappen uit de inheemse wereldbeschouwing (de zogenoemde ontologie) van het tropisch laagland van Zuid-Amerika. Deze principes worden op twee regionale casussen toegepast, namelijk: (1) de archeologische vindplaatsen El Cabo, El Flaco en Playa Grande in de Dominicaanse Republiek (1200-1500 n.C.), en (2) de zuidelijke Kleine Antillen met een focus op de pre-koloniale vindplaats Pearls en de vroeg-koloniale vindplaatsen La Poterie en Telescope Point in Grenada.

Geconcludeerd wordt dat geslepen stenen bijlen een sleutelrol speelden in de sociale netwerken

tussen gemeenschappen uit de Dominicaanse Republiek in de jaren voorafgaand aan de komst van de Europeanen. Deze voorwerpen werden vervaardigd uit hard gesteente (onder andere jadeitiet, blauwschist, groenschist, en basalt) en vervolgens verhandeld en gebruikt tot dit door verregaande slijtage niet meer mogelijk was, de voortreffelijke eigenschappen van deze steensoorten in ogenschouw nemend. Niet iedere gemeenschap produceerde haar eigen bijlen, hoewel zij daartoe zeker in staat was: vindplaatsen zoals El Flaco verkregen deze gebruiksvoorwerpen voornamelijk van lokale partners. In Playa Grande werden bijlen preferentieel vervaardigd uit specifieke steensoorten die daarna als halffabricaten uitgewisseld werden, terwijl bijlen gemaakt uit andere materialen geïmporteerd werden. Slijp- en polijsttechnieken speelden voor deze objecten zonder luster hierbij een transformatieve rol: enige bestaande potentie tot het subject-zijn werd hiermee glanzend vervuld, bijgestaan door een verscheidenheid aan technieken. Daartegenover werden zulke bijlen op algemene wijze van schachten voorzien en gebruikt, zelfs als zij uit jadeitiet vervaardigd en over lange afstanden getransporteerd werden.

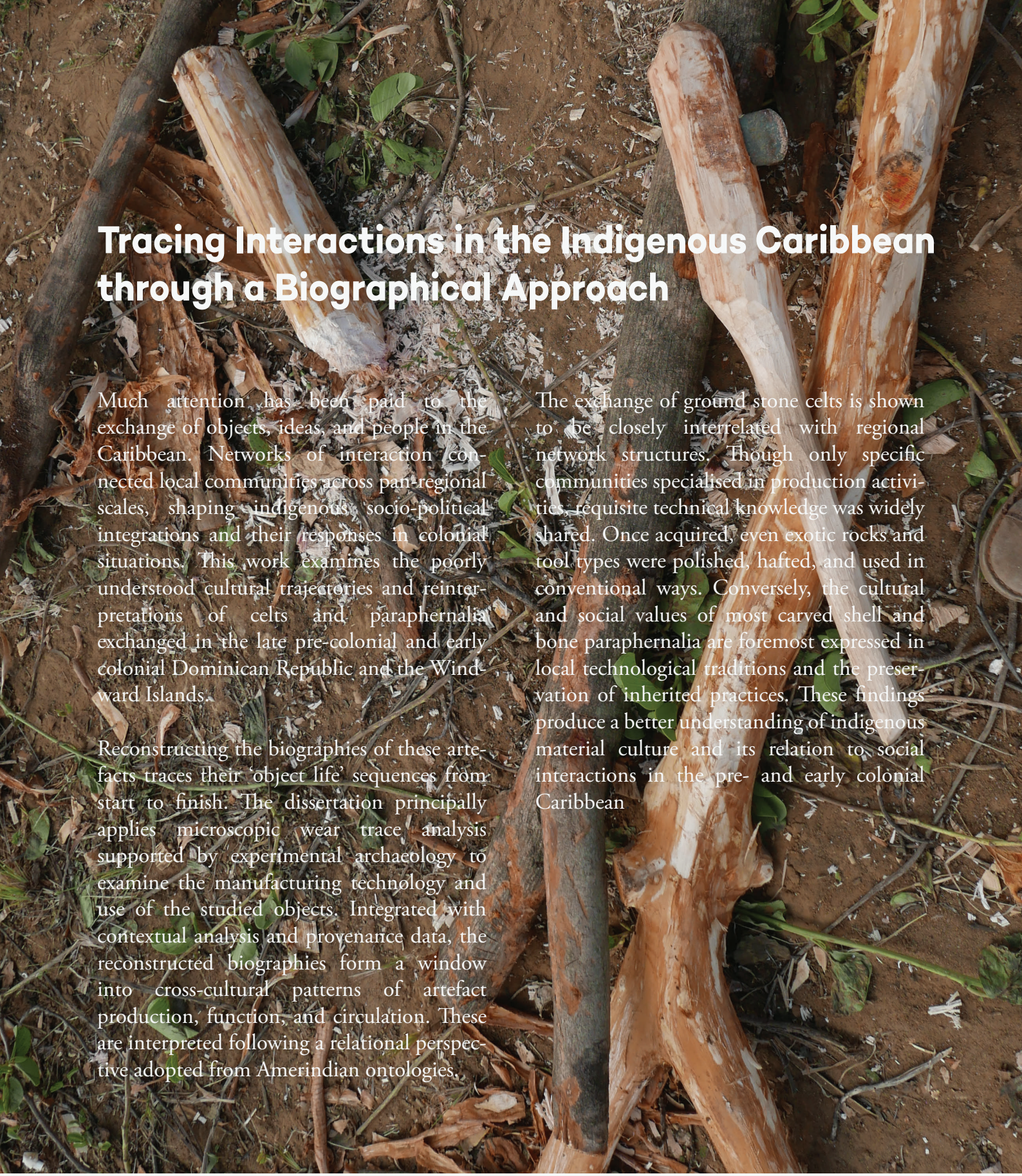
De gegraveerde schelpen objecten uit de Dominicaanse Republiek werden volgens een gestandaardiseerde aanpak geproduceerd, en vormden zelf onderdeel van samengestelde rituele artefacten. Zij geven weinig indicatie voor uitwisseling over lange afstanden. Het tegenovergestelde geldt voor kettingen van doorboorde dierentanden, die grote verschillen vertonen ten aanzien van het individuele biografische verloop. Ten derde was het akoestisch ontwerp van benen fluiten onderworpen aan traditionele eisen, maar bestond er ruimte voor de tenuitvoerbrenging van individuele kenmerken ten aanzien van iconografie en geluid. Deze resultaten illustreren hoe de inheemse gemeenschappen in de Kleine Antillen gebruik maakten van elementen van technologische aard om de vroeg-koloniale situatie te trotseren en overgeërfde tradities en culturele uitingen te behouden.

De relationele biografieën van inheemse artefacten zijn intrinsiek verweven zijn met de sociale interconnecties van de samenleving waartoe ze behoorden, maar elk naar gelang andere capaciteiten. Ieder specifiek object bezat een ander uitwisselingspotentieel, wat wil zeggen dat het circuleerde aan de hand van (soms drastisch) uiteenlopende waarden en verwachtingen. Dit heeft geresulteerd in de archeologisch geobserveerde heterogene verspreiding van materiële cultuur over ongelijksoortige afstanden. Deze dissertatie poogt met de hier gepresenteerde resultaten nieuwe perspectieven te bieden aan de analyse van de dynamiek van interculturele en koloniale contactsituaties, die immer aan verandering onderhevig waren en zijn. Materiële cultuur vormt een cruciaal element in deze situaties evenals in sociaal-culturele processen zoals tegenstand, aanpassing of assimilatie die eruit voortvloeien. Sterker nog, deze processen kunnen niet worden doorgrond zonder een breed begrip van de rol die de materiële cultuur erin speelt.

Curriculum Vitae

Tom Breukel was born in the Noordoostpolder in The Netherlands on August 18, 1989, and attended the Koningin Wilhelmina College in Culemborg from 2001 to 2007. He moved to Leiden in 2007 to study archaeology, obtaining his BA in 2011 with specialisations in Caribbean and European prehistory. Tom developed an interest in the material cultures and worldviews of pre-colonial Caribbean societies, which culminated in a Leiden Research MA thesis on threepointer biographies in 2013. He participated in excavations in The Netherlands, St. Lucia, St. Vincent, and St. Eustatius, and conducted independent collection-based research in Puerto Rico and the Dominican Republic. Tom also attended Honours Classes on the topics of urbanisation and heritage legislation and obtained a minor in human osteology.

In 2013 Tom obtained a four-year doctoral research position in the NWO-funded Island Networks project (project number 360-62-060, directed by Prof. dr. C.L. Hofman) at the Faculty of Archaeology, Leiden University. For this he carried out experimental fieldwork and collection-based research in The Netherlands, Grenada, St. Vincent, and the Dominican Republic as a member of the Caribbean Research Group and the Leiden Laboratory for Material Culture Studies, in collaboration with the ERC-Synergy NEXUS1492 and ERC-HERA CARIB research projects. Tom frequently presented his research at international conferences, gave teaching assistance and guest lectures for numerous classes, and he organised the Leiden Archaeological Forum lecture series in 2016-2017. Currently, Tom works as a post-doctoral researcher in the NEXUS1492 project at the Faculty of Archaeology, Leiden University.



Tracing Interactions in the Indigenous Caribbean through a Biographical Approach

Much attention has been paid to the exchange of objects, ideas, and people in the Caribbean. Networks of interaction connected local communities across pan-regional scales, shaping indigenous socio-political integrations and their responses in colonial situations. This work examines the poorly understood cultural trajectories and reinterpretations of celts and paraphernalia exchanged in the late pre-colonial and early colonial Dominican Republic and the Windward Islands.

Reconstructing the biographies of these artefacts traces their 'object life' sequences from start to finish. The dissertation principally applies microscopic wear trace analysis supported by experimental archaeology to examine the manufacturing technology and use of the studied objects. Integrated with contextual analysis and provenance data, the reconstructed biographies form a window into cross-cultural patterns of artefact production, function, and circulation. These are interpreted following a relational perspective adopted from Amerindian ontologies.

The exchange of ground stone celts is shown to be closely interrelated with regional network structures. Though only specific communities specialised in production activities, requisite technical knowledge was widely shared. Once acquired, even exotic rocks and tool types were polished, hafted, and used in conventional ways. Conversely, the cultural and social values of most carved shell and bone paraphernalia are foremost expressed in local technological traditions and the preservation of inherited practices. These findings produce a better understanding of indigenous material culture and its relation to social interactions in the pre- and early colonial Caribbean

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