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Technological persistence in ceramic production in the southeastern Hispaniola. The case study of El Cabo (600–1502 CE)

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ABSTRACT

This research aims to provide a better understanding of the diffusion of ceramic morphological traits in the Greater Antilles and how communities experienced and integrated new ideas into their manufacturing traditions. The *chaîne opératoire* approach together with the communities of practice theory produce a holistic methodology to unveil social and temporal connections between artifacts, sites and communities. A detailed petrographic and macro-trace analysis of the ceramic manufacturing techniques for the site of El Cabo (Dominican Republic) is provided. Results evidence a complex homogeneous assemblage characterized by one major techno-group but petrographic heterogeneity. The communities, who lived in El Cabo, experienced and integrated changes in vessel shape and style (from Ostionoid to Chicoid features), though maintained conservative and stable traditions in the main technological steps. The petrographic heterogeneity implies that the inhabitants of El Cabo were probably involved in a broader regional network of interaction and were thus not limited to their community for the production of their pottery. Communities from different locations were, as shown by the presence of raw materials from various and distant geological environments, affiliated with a common ancestor represented by the persistence of one shared technical tradition.

1. Introduction

In Caribbean archaeology establishing pottery typologies has a critical role in untangling large-scale socio-cultural processes. The sharing of similar artifact traits is used to create links between sites and discuss social and cultural interactions within temporal and spatial frameworks (Chanlatte Baik, 1981, 2013; Rouse, 1992; Wilson, 2007; Rodríguez-Ramos, 2013; Keegan and Hofman, 2017). The social dimension of the identified stylistic boundaries however is still under discussion (e.g. Curet, 2002; Curet et al., 2006; Hofman, 1993; Rodríguez-Ramos, 2013). On the one hand, it is accepted that the homogenization of material cultures outlines areas of cultural interaction. On the other hand, it is difficult to assess a direct relationship between cultural boundaries and communities' social identities. Interaction can involve the movement of people, ideas or objects (Hofman et al., 2010). Therefore, questions are still debated on the nature of the spread of cultural traits within the region, such as a direct or indirect transmission. Stylistic traits (decoration and morphology) for instance are more easily transmissible between people. They tend to follow consumption demands and can be easily imitated by potters across wide geographical areas, spreading faster than technological traditions, which are more rooted in the cultural identity of the communities that manufactured the object (Gosselain, 2000; Gelbert, 2003; Roux, 2015; Roux et al., 2017).

Genetic studies traced the origin of the Indigenous Caribbean populations back to Central and northern South America. Two main migrations have been genetically confirmed: a first migration of Archaic Age peoples between 6000 and 4000 years BCE and a second of Ceramic Age peoples between 800 and 500 BCE (Fernandes et al., 2021; Nägele et al., 2020). Fernandes et al. (2021) also concluded that all changes in ceramic style which happened in the islands are a product of local developments and cannot be attributed to new migrations from the mainland. The high level of connectivity experienced by communities that lived in the Greater Antilles promoted the diffusion of goods, ideas and stylistic traits. Therefore, due to the homogenization of stylistic attributes, on a macro-scale perspective the predominant use of morphometric variables to build evolutionary models constrains the

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understanding of small communities' identity and their response to broader social and cultural changes.

This research aims to provide a better understanding of the diffusion of ceramic morphological traits in the Greater Antilles and how communities experienced and integrated new ideas into their manufacturing traditions. This study considers the *chaîne opératoire* approach as a comprehensive methodology to unveil social and temporal connections between artifacts, sites and communities. This approach involves the technological analysis of the entire artifact manufacturing process from raw material procurement to finished product (Lemonnier, 1993; Dobres, 2000; Roux, 2016, 2019a). *Chaîne opératoire* interprets technological traits related to the production and use of ceramic materials as a social activity embedded within one or more communities, viewing ceramic manufacturing traditions as a durable result of a community's cultural and social expression (Keller, 2001; Joyce et al., 2015; Roux, 2016). Drawing on the concepts of situated learning and communities of practice, technological traits are considered to be socially learned and thus culturally transmitted (Lave and Wenger, 1991). Learning and mastering a technique or a way of working a certain material involves long-term contact between a teacher and a learner, creating a sense of identity and relationship between certain technological knowledge and the artisans. Examining practices (the ways of working materials), provides a tool to investigate how the diffusion of ideas, styles and technologies were perceived on a sociological micro-scale level and embodied into local manufacturing traditions (*sensu* Creswell, 1983; Dietler and Herbich, 1998). The learning process can occur within the household, within one or even various communities, creating a sense of shared identification between people that have a common practice (Joyce et al., 2015; Roux, 2016). Therefore, a practice-oriented approach that focuses on objects of daily use from a technological point of view, is well suited to explore cultural traits, and answer questions relating to processes of historical changes, such as expansion of groups, interaction between groups, and cultural continuity or discontinuity.

1.1. Case study: El Cabo

The site of El Cabo (cal. 500–1502 CE) situated on the most southeastern part of Hispaniola is an ideal case study to test this approach (Fig. 1). The site is in the geographical area of the Mona Passage, west of Mona Island and Puerto Rico. The occupational period spanned for circa 1000 years until the first decade of European contact (Hofman et al., 2008b; Samson, 2010). Different interpretations proposed the Mona Passage as a reception area for migration groups, consequently leading to hybridization between Archaic and Ceramic Age 'Saladoid' populations (*sensu* Chanlatte Baik, 2000, 1986, 1981; Curet, 2005; Keegan, 2000; Veloz Maggiolo, 2003, 1991). On a macroscale, Irving Rouse (1992, 1986) described the Mona Passage as a major cultural hub with the advancement of political hierarchies and social complexity. Whereas Fernandes et al. (2021) highlights a strong genetic continuity in this part of Hispaniola between ca. 500–1500 CE, yet archaeologically speaking, the area experienced changes in material culture production (Rouse, 1992). Typical Ostionoid and Chicoid ceramic morphological traits appeared sometime around 600 CE and around 800–1000 CE, respectively. These stylistic attributes, after appearing in the eastern side of Hispaniola, diffused broadly into the western Greater Antilles (Keegan, 2000; Sinelli, 2013; Ting et al., 2016; Ulloa Hung, 2014).

A detailed analysis of the ceramic manufacturing techniques for the site of El Cabo is provided to understand technological changes and continuity in the manufacturing process. The target focus are ceramic samples that were retrieved from three different excavation units (26, 34 and 50) which have been radiocarbon dated (Table 1). The selection was intended to perform qualitative analysis to clarify the production process from the (early and late) Ostionoid to Chicoid occupational phases. Results suggest a continuity in the pottery production across different typologies and styles (Ostionoid and Chicoid). The community who lived in El Cabo, experienced and integrated changes in vessel shape and style (from Ostionoid to Chicoid), though maintained conservative and stable traditions in the main technological steps.

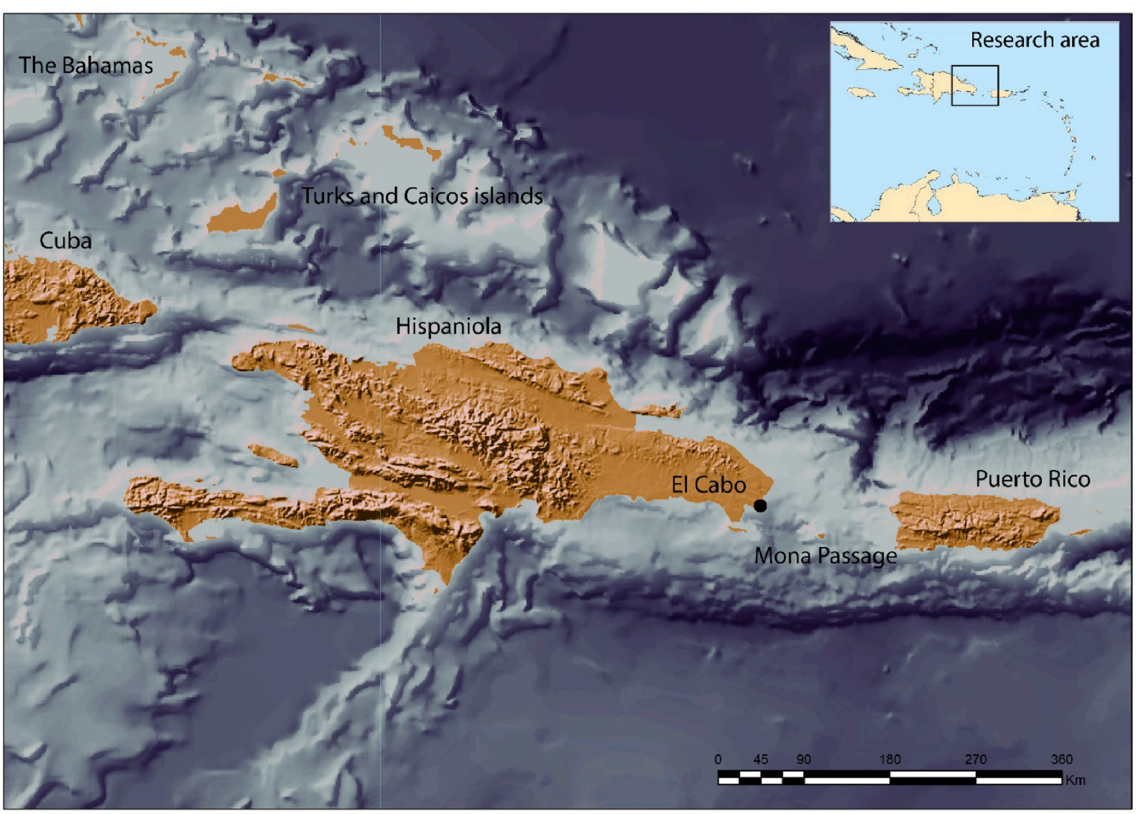

Fig. 1. Location of the site of El Cabo within the Greater Antilles.

Table 1
Overview of the radiocarbon dates for the selected units from El Cabo. The samples were calibrated using Calib 8.20 (Stuiver, M., Reimer, P.J., and Reimer, R.W., 2021, CALIB 8.2 [WWW program] at http://calib.org, accessed 2021–7-13). Citt. pica samples were corrected with a Delta R of 0 and a Delta R of −319 ± 24. This value is the weighted mean of two Samaná samples from Di Napoli et al., (2021).

Lab nr	Unit	Material/species	conv. BP	2-sigman calibration (AD) (95%)	Cal AD ΔR = 0	Cal AD ΔR = -260 ± 30
GrN-31413	26	Citt. Pica	1705 +/- 20		710–987	440–710
GrN-31414	26	Citt. Pica	1435 +/- 20		1015–1260	710–1005
GrN-31412	26	charcoal	1230 +/- 40	684–887		
GrN-31415	34	Citt. Pica	1520 +/- 20		905–1180	650–910
GrN-31416	34	Citt. Pica	1745 +/- 20		680–945	410–680
GrN-31417	50	charcoal	915 +/- 20	1035–1170		
GrN-31418	50	charcoal	925 +/- 30	1025–1175		

1.2. Site background

Hispaniola is characterized by a heterogeneous and complex geological picture composed of fault-bounded igneous, metamorphic and volcano-sedimentary rocks (Ayala et al., 2017; Carl, 1975; Mann et al., 1991). There are two main metamorphic belts, one that diagonally

Fig. 2. Left: examples of the ceramic fragments retrieved in El Cabo (not scaled): (A) Ostionoid and (B) Chicoid (Photos by Corinne Hofman and Menno Hoogland). Right: vessels reconstructions based on the archaeological remains of the 3 investigated units. The reconstruction were done by Finn van der Leden with the software MeshLab 2020.12.

crosses the island northeast direction and the other that develops in the northeast along the Samaná peninsula characterized by high-p rocks such as amphibolites, eclogites, metagabbros and mafic schists and gneiss assemblages. The eastern part of Hispaniola is made up of extensive Plio-Pleistocene limestone platforms, consisting of an accumulation of coral reefs and lagoons with karst features characteristic of the Caribbean Coastal Plain. The central-north area of the eastern part comprises cretaceous volcanic rocks and limestones. El Cabo is situated on the extreme eastern point of Hispaniola on a dry coastal plain made up of coral limestone. The environment is characterized by caves, sharp cliffs and groundwater layers (Ayala et al., 2017).

Between 2005 and 2008 a team from Leiden University led by Menno Hoogland and Corinne Hofman conducted excavations at the site in the context of the NWO-project Houses for the Living and the Dead. El Cabo revealed the unique preservation of ancient postholes directly dug into the limestone bedrock. Fifty structures were identified, 30 of which were of a very regular circular shape and were interpreted as houses and subjected to periodical rebuilding (Samson 2010). Each house was inhabited by a group of circa 6 to 14 individuals and the settlement is estimated to have been composed of between 5 and 7 similar house agglomerations that co-existed for 1000 years (ca. 500 CE to 1500 CE) (Hofman et al. 2006, 2008b; Samson 2010; Samson and Hoogland, 2007). Apart from the structural remains, archaeological materials include ceramics fragments (Fig. 2), griddles, paraphernalia (trigonoliths, stone/bone collars, beads and bodily ornaments), marine shell remains, and remarkably, European colonial period materials (see Ernst and Hofman, 2019; Cortney St Jean, 2008; Guzzo Falci et al., 2020; Hofman et al., 2008b, 2006; Hofman and Ulloa Hung, 2007; van As et al., 2008; Samson, 2010). Based on the material culture distribution, ceramic styles and radiocarbon dates, three main occupational phases are identified. The early Ostionoid (600–800 CE) and late Ostionoid (800–1200 CE) occupations are situated on the north end of the site,

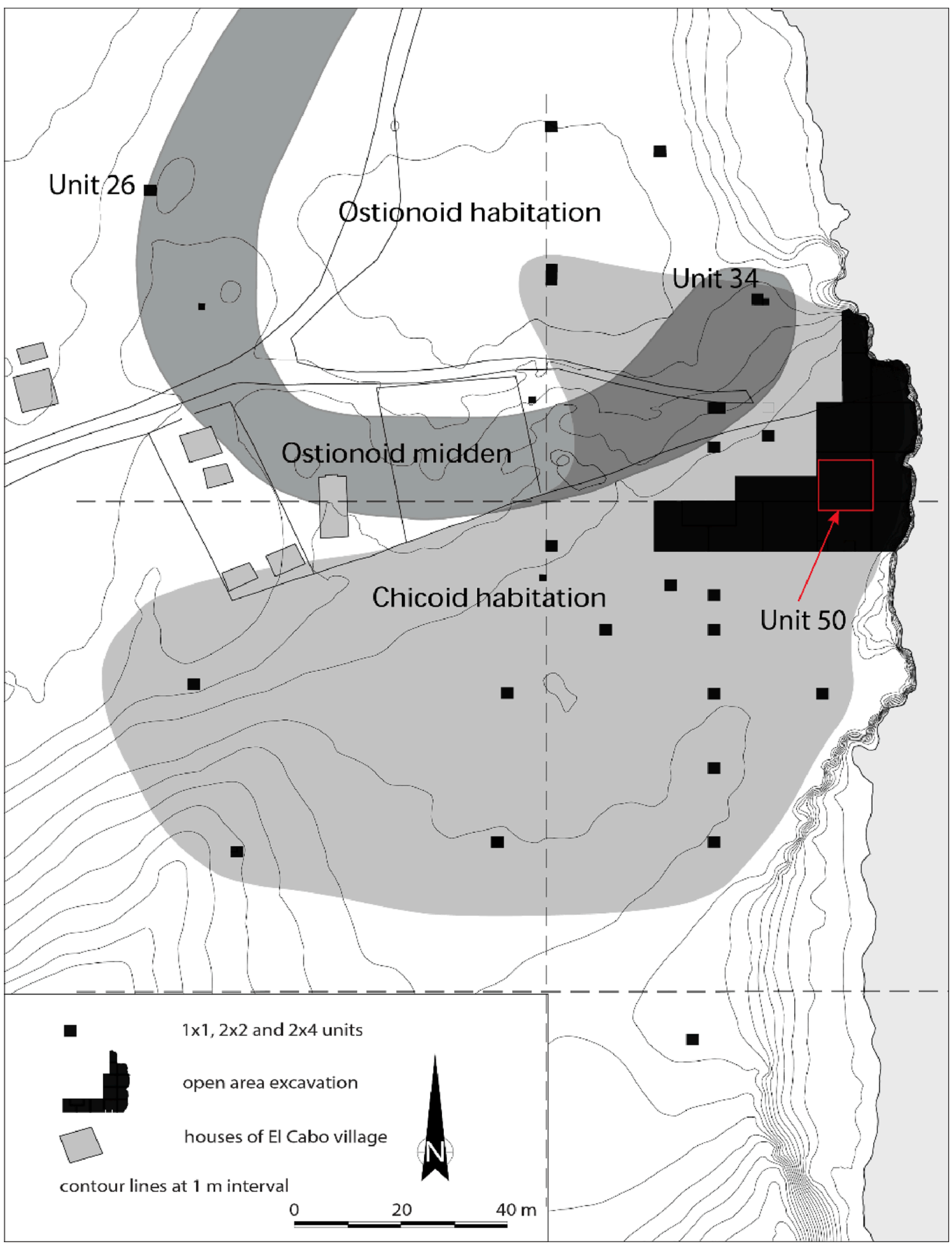

Fig. 3. The site plan of El Cabo (after Samson 2010).

characterized by ring-shaped midden deposits. The later Chicoid (900–1502 CE) occupation is located in the southern part of the site and includes early Spanish materials (Ernst and Hofman 2019; Samson 2010). A surface survey identified no clay in the vicinity of the site but three suitable clay outcrops for ceramic manufacturing are located within a 40 km radius, suggesting that pottery materials were imported directly or produced *in situ* with non-local clay material (van As et al., 2008).

2. Material and methods

Fig. 3 shows the site plan of El Cabo. The first two units, 26 and 34, are both 2x2m, and are situated in the northern section of the site. They both contain material associated with early Ostionoid and late Ostionoid periods. Unit 50 measures 10x10m in surface area, and is located in the center of the site. This unit is a Chicoid habitation context. The total assemblage analyzed includes 10,339 sherds. For units 26 and 34 the assemblages consist of 65.4% unrestricted vessels and 34.6 % restricted vessels (St Jean, 2008). Unit 50 yielded 27.9 % of unrestricted vessel, 47 % restricted vessels, and 25.1% of an undefined shape. The sherds comprise slipped and un-slipped fragments, incised decoration, handles, lugs, adornos and appliqué. Because of the methodological approach taken in the study, focus was laid on the main technological steps of shaping the ceramic body (clay procurement, paste preparation, fashioning, finishing, surface treatment, decoration and firing practices), therefore handles, supports, adornos and lugs were not included in the selection.

Generally, the manufacturing process is divided into four main steps and several sub-steps: (1) Clay procurement and preparation which includes: drying, pounding, sorting, hydrating, adding temper, and wedging. (2) Fashioning, in which the clay is shaped into the desired form. This phase entails two stages: (a) 'roughing-out' - hollow form that does not present the final geometrical characteristic of the container; (b) 'pre-forming' - container with its final geometrical characteristics but without finishing operations. (3) Finishing, surface treatment and decorative techniques include working on wet clay (smoothing) or brushing, smoothing on leather hard clay, and application of the final decoration. (4) Firing, during which ceramics reach their final physicochemical properties. Following Roux's (2019a, 2019b, 2016) methodology, this study focuses mostly on three steps of the manufacturing process: clay preparation, roughing-out and pre-forming. The latter two steps are considered the most stable in time and strongly transmitted through generations. Roughing-out is seen by most potters as the core operation of their technical tradition (see Gosselain, 2008, 2000; Manem, 2020), and thus the operation that is least likely to be subject to change. The manufacturing process of the ceramics was analyzed by means of observation of the sherds with a stereomicroscope as well as through petrographic analysis of the ceramics paste. This procedure gives succinct information of the manufacturing process that helps to reconstruct technological identities and knowledge transmission.

First, a classification based on technical groups was created based on the identification of macro-fabric and micro-trace marks. The roughing-out and pre-forming processes involved a combination of handwork, tools and specific movements, which leave technical marks on the surface and body structure of the ceramics, such as striations and irregular topography. The interpretation of those traces leads to the reconstruction and identification of different techniques to shape the body of the ceramics. The next step is to complement the classification with further petrographic analysis. Petrography is a well-established technique to glean additional technological insights and information on the fabric structure which includes minerals and rocks (Quinn, 2013). In Caribbean archaeology petrography has advanced our knowledge on the production and origin of Indigenous and colonial ceramics. Studies mostly discussed provenance and preparation of the raw materials used for the ceramic paste and firing methods (e.g. Curet, 1997; Ferguson et al., 2008; Hofman et al., 2008a; Isendoorn et al., 2008; Pavia et al., 2013; Ting et al., 2018, 2016; Scott et al., 2018; Casale et al., 2021; Stienaers et al., 2020; Lawrence et al., 2021). To clarify on clay procurement and paste preparation, 36 samples from representative sherds were analyzed my means of a polarizing microscope (Leica DM750P).

3. Results

The manufacture analysis of the selected ceramics identified one main technological tradition involving roughing out with assembled elements (coiling by pinching), followed by pre-forming, with frequent percussion for the Ostionoid ceramics and less frequent for the Chicoid pottery (Table 3). There are three sub-traditions that diverge in the finishing and surface treatments steps, but which are identical in the roughing out and preforming. The petrographic analysis identified six main petrographic groups (Fig. 4), showing an origin of raw material from volcanic, limestone coral reef, and metamorphic geology (Table 2). Petrographic group 1, 2 and 3 are stable in time and were used for the entire occupation period of El Cabo. Group 4 is related to only the Ostionoid period and group 5 and 6 are related to only Unit 50 and to a specific type of ceramic that has a white/beige clay body.

3.1. Petrographic analysis

3.1.1. Group 1 intermediate volcanic fabric

Group 1 is composed of 13 samples. The group is heterogeneous and is divided in three subgroups. The main characteristic of those fabrics is the presence of coarse angular to rounded intermediate volcanic fragments and chert inclusions. In general, vessels were fired in an oxidizing environment and in some cases incomplete firing occurred as indicated by the different in colors between the core and the margins. The matrix is optically active and indicates a firing temperature lower than 800 °C. Fabrics are characterized with long stretch voids that together with coarse inclusions are partially aligned with the surface. The stretched relic coils suggest preforming with assembled elements by coiling, followed by percussion activity to a certain frequency but not uniform within all the subgroups.

3.1.1.1. ***Subgroup 1.A*** *(CA-06, CA-07, CA-10, CA-13, CA-21, CA-22, CA-25).* The fabric of this subgroup is heterogeneous and poorly sorted. The more abundant inclusions are plagioclase (andesine and labradorite), quartz, and amphibole, followed by the common occurrence of intermediate igneous rock, chert and sandstone. These inclusions are characterized by a wide range of grain size: plagioclase with euhedral shape measures between 200 and 500 μm; amphibole varies between 200 and 400 μm; and quartz is between 100 and 400 μm. Volcanic rock inclusions are coarse and vary between 400 and 1000 μm, whereas sandstone measures between 100 and 300 μm, chert between 100 and 500 μm, and clay pellet varies between 100 and 1500 μm. Olivine (100–400) and biotite (200 μm) are present as single minerals. In general, the inclusions appear to be sub-angular to round in shape and often have superficial alterations to sericite. The groundmass has a brown to light brown color and indicates an iron-rich component.

3.1.1.2. ***Subgroup 1.B*** *(CA-02, CA-03, CA-04, CA-12).* The fabric of this subgroup is characterized by abundant small inclusions and common coarse plagioclase (andesine) with extensive sericite alteration. These inclusions occur in a wide range of sizes. Quartz varies between 200 and 400 μm, while plagioclase measures between 200 and 1000 μm. Amphibole is rarer than in subgroup 1.A while orthopyroxenes are presents. These inclusions occur with a size between 100 and 300 μm. Fine and medium rock inclusions and cherts occur commonly measuring between 200 and 1000 μm while rounded iron-rich clay pellets are rare. The nature and shape of the inclusions points to a less weathered clay than subgroup 1.A though to a similar parent rock. The groundmass presents elongated and thin voids that are parallel and partly oriented

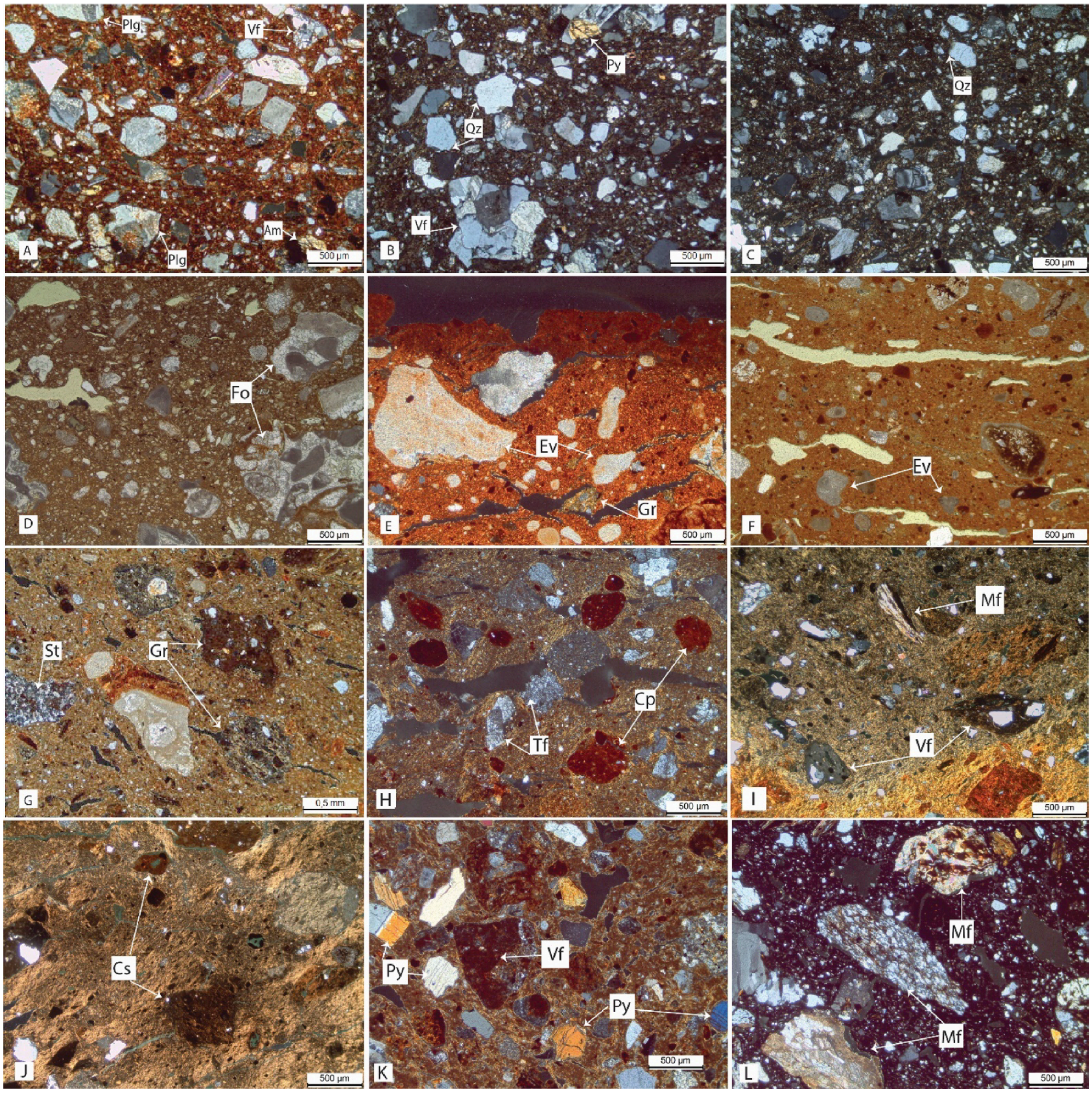

Fig. 4. Petrographic groups identified in Unit 26, 34 and 50. (A) subgroup 1.A; (B) subgroup 1.B; (C) subgroup 1.C; (D) subgroup 2.A; (E) subgroup 2.B; (F) subgroup 2.C; (G) group 3; (H) group 4; (I) group 5; (J) group 6; (K) Outlier SC31; (L) outlier SC25. Abbreviations: Plg = plagioclase; Am = amphibole; Qz = quartz; Py = pyroxene; Vf = volcanic fragment; Fo = microfossil fragment; Ev = evaporite; St = sandstone; Gr = grog; Tf = tuff; Cp = clay pellet; Mf = metamorphic fragment; Cs = clay streak.

with the sherd's edge. The coarse and long inclusions are also oriented and often parallel with the margins of the sherds. The matrix is less optically active and suggest a higher firing temperature than the previous groups.

3.1.1.3. ***Subgroup 1.C*** *(CA-11, CA-19).* This subgroup is characterized by a well sorted and homogeneous matrix, dominated by the abundance of single quartz inclusions that measure between 200 and 400 μm and sandstone fragments (mode of 400 μm). Plagioclase feldspar (andesine and labradorite) occurs commonly either as a single minerals or in volcanic rock fragments. These inclusions generally measure between 200 and 400 μm and often show weathering to sericite. Very rare sanidine are also present. Chert occurrences are rare and measure between 200 and 500 μm. Amphibole appears rarely measuring 200 μm. Biotite and olivine are very rare. The major difference with the other subgroups 1.A and 1.B is the size of the inclusions, which measures between 200 and 400 μm on average.

3.1.2. Group 2 – Marine limestone groups

This group is formed by 10 vessels manufactured with carbonaceous clay rich in shell/coral and evaporite inclusions. Often but not always samples have horizontal and long voids (1–3 mm) and coarse inclusions partially aligned with the margins of the body. Relic coils, identified as circular and semi-circular disposition of inclusions, are recorded as well in the matrix. The firing temperature is lower than 800 °C as indicated by the optically active matrix.

3.1.2.1. ***Subgroup 2.A*** *(CA-01, CA-05, CA-20, CA-27).* The fabric is characterized by a range of rock inclusions composed of marine shell and corals. Inclusions measure between 200 and 3000 μm. Evaporite (mostly gypsum) inclusions are rare. CA-27 has a higher frequency of evaporite inclusions and less fossil fragments. There is also the rare presence of single quartz inclusions (100–300 μm). The fresh nature of the quartz inclusions that vary between angular to rounded suggests a natural presence in the clay outcrop. The voids are rare and semi-rounded and vesicular not preferentially oriented with the margins.

Table 2
Summary of the petrographic analysis.

Petrographic description								
Groups	Firing	Abundant (50%)	Common (30%)	Few (10%)	Rare (<10%)	samples	Unit	Dates
Group 1								
Subgroup 1.A	< 800 °C	Plagioclase (andesine and labradorite) with euhedral shape (200–500 µm), quartz (100–400 µm), amphibole (200–400 µm)	Intermediate igneous rock (400–1000 µm), chert (100–500 µm), sandstone	Olivine (100–400 µm), biotite (200 µm)		CA-06, CA-07, CA-10, CA-13, CA-21,	26–34	CE 550–1000
						CA-22, CA-25	50	CE 1000–1200
Subgroup 1.B	< 800 °C	Plagioclase (andesine) (200–1000 µm), quartz (200–400 µm)	Rock inclusions (200–1000 µm), chert (200–1000 µm)	Amphibole (100–300 µm), orthopyroxene (100–300 µm),	Iron-rich clay pellets	CA-02, CA-03, CA-04, CA-12	26–34	CE 550–1000
Subgroup 1.C	< 800 °C	Quartz (200–400 µm), sandstone (400 µm)	Plagioclase (andesine and labradorite) (200–400 µm)	Intermediated volcanic rock fragments	Sanidine, chert (200–500 µm), biotite and olivine	CA-11, CA-19	50	CE 1000–1200
Group 2								
Subgroup 2.A	< 800 °C	Rock inclusions of marine shell and corals (200–3000 µm)			Evaporite rock inclusions, quartz (100–300 µm)	CA-01, CA-05, CA-20, CA-27	26–34 50	CE 550–1000 CE 1000–1200
Subgroup 2.B	< 800 °C	Evaporite rock inclusions (micrite) (100–5000 µm)		Two types of clay pellets: 1) composed of chert, clastic quartzite and plagioclase 2) composed of fine groundmass with rounded evaporite inclusions		CA-09, CA-18 CA-28	26–34 50	CE 550–1000 CE 1000–1200
Subgroup 2.C	< 800 °C	Evaporite rock inclusions (100–600 µm)			Chert (200 µm), clastic quartzite fragments (200 µm), quartz (200 µm)	CA-15, CA-26	26–34 50	CE 550–1000 CE 1000–1200
Subgroup 2.D		Chert (200–300 µm), sandstone (200–300)	Quartz (100 µm)	Evaporite rock inclusions		CA-24	50	CE 1000–1200
Group 3	< 800 °C	Ceramic tempers (500–2000 µm), clay pellets (500–1500 µm)		Sandstone (100–400 µm)	Chert (3000 µm), limestone (400–1000 µm)	CA-14, CA-17	26–34	CE 550–1000
Group 4	< 800 °C	Metamorphized tuff single and in rock fragments (300–600 µm)	Volcanic rock inclusions (500–700 µm),		Pyroxene (300 µm), amphibole (300 µm)	CA-08, CA-16	26–34	CE 550–1000
Group 5	< 800 °C	Metamorphic and volcanic rock fragments (300–400 µm)	Quartz (100–150 µm)	Plagioclase, amphibole, clay pellets	Pyroxene, biotite	CA-34, CA-31, CA-32	50	CE 1000–1200
Group 6	< 800 °C	Clay streaks (200–2000 µm)			Chert (500–3000 µm), volcanic rock fragments (300–500 µm), quartz, sandstone	CA-36, CA-35, CA-30, CA-33	50	CE 1000–1200

3.1.2.2. ***Subgroup 2.B*** *(CA-09, CA-18, CA-28).* The fabric has a reddish color, and it is characterized by very coarse inclusions of evaporite rock fragments, composed mostly of micrite. The fragments are rounded and sub-rounded and have a variable size measuring between 100 µm and 5000 µm. There are also two types of clay pellets and low fired ceramic tempers easily spotted from the different matrix composition from the groundmass. One is characterized by chert, quartzite, quartz and plagioclase inclusions, the other has a fine groundmass with rounded evaporite inclusion. Both types have a different composition from the general groundmass.

3.1.2.3. ***Subgroup 2.C*** *(CA-15, CA-26).* The fabric is dominated by evaporite inclusions with very coarse rounded and semi rounded fragments. There is rare chert, clastic quartzite fragments and single quartz minerals. The rare non-evaporite inclusions have irregular and sub-angular shape and a medium fine size (<200 µm), with one exception of rounded quartzite of 2000 µm. The shape and size suggest the likely natural presence of the inclusions in the clay.

3.1.2.4. ***Subgroup 2.D*** *(CA-24).* The fabric is rich in rounded and sub-rounded, medium-fine inclusions of chert and sandstone that measure between 200 and 300 µm. Quartz occurs commonly and measures circa 100 µm. The fabric is also characterized by the seldom occurrence of coarse and very coarse evaporite inclusions with irregular and sub-rounded shape. The groundmass is optically active and characterized by a dark reddish brown color.

3.1.3. ***Group 3*** *(CA-14, CA-17)*

This petrographic groups consists of three samples characterized by the presence of different types of ceramics tempers (500–2000 µm) and clay pellets (500–1500 µm) as major inclusions. Rare very coarse inclusions of chert (3000 µm) and limestone (400–1000 µm) occur in the matrix with rounded and sub-rounded shapes. Sandstone fragments occur occasionally and measure between 100 and 400 µm with sub-angular to sub-rounded shape. Voids are elongated and vesicular, some oriented parallel to the margins of the sherds and with the coarse inclusions. The matrix is optically active and suggests a low firing temperature (<800 °C).

3.1.4. ***Group 4*** *(CA-08, CA-16)*

This group is characterized by frequent inclusions of heavily weathered and metamorphized tuff that occur either in single inclusion (300–600 μm) or in rock fragments and common rounded iron-rich clay pellets (300–600 μm). There is the occurrence of volcanic rock inclusions (500–700 μm), rare pyroxenes (300 μm) and amphibole (300 μm) inclusions. Tuff inclusions show extensive pitting alteration and evidence of weathering of the amorphous phase. The fabric is composed of moderately sorted medium-coarse size inclusions. The groundmass presents a fine texture and is composed of two clays, one more calcareous and one less, as it can be noted by the differences in color from yellow-brown to dark brown.

3.1.5. **Group 5** (CA-34, CA-31, CA-32)

This petrographic group consists of three samples with metamorphic and volcanic rock fragments (mode of 300–400 μm). The medium-coarse metamorphic rock fragments are composed of quartzite and muscovite-schist. The volcanic rock inclusions mostly occur with quartz, feldspars and in some cases biotite. Quartz appears commonly and measures between 100 and 150 μm. In addition there is the presence of few plagioclase and amphibole and rare pyroxenes and biotite. Clay pellets occur sparsely through the matrix with a rounded and sub rounded shape. Voids and coarse inclusions tend to be partially oriented parallel with the margins. The matrix is optically active and points to a low firing temperature (<800 °C).

3.1.6. **Group 6** (CA-36, CA-35, CA-30, CA-33)

This petrographic group is characterized by a fine matrix with frequently occurring of clay streaks with highly variable composition and colors (dark black to grey/brown to red). These inclusions occur with an irregular shapes and measure between 200 and 2000 μm, with a mode of 500 μm. Within these clay streaks inclusions can be observed, which are partly similar to the general groundmass of the ceramic body. There is the occurrence of rare coarse chert (up to 3000 μm), and volcanic rock fragments, measuring between 300 and 500 μm. In addition quartz and sandstone occur rarely. Olivine occurs only in samples CA-30. The firing took place in an incomplete oxidizing atmosphere at a low temperature (<800 °C). Voids and inclusions do not show a preferential orientation.

3.1.7. Outliers

CA-29: The ground mass is very fine and brown. The matrix is well-sorted and the majority of the inclusions are between 300 and 500 μm in size and angular to sub-angular. The matrix shows a frequent presence of minerals of mafic origin, namely pyroxenes and rare olivine. Olivine size varies between 300 and 500 μm. Pyroxenes are either orthopyroxenes, augite and diopside blue, measuring between 300 and 500 μm. In addition to those inclusions there are few quartz inclusions which measure between 400 and 1000 μm, with a mode of 500 μm. The shape is irregular and varies between angular to sub-angular. Chert is rare as sub-rounded inclusions and measures between 300 and 500 μm. Very rare is the occurrence of plagioclase (200 μm). Few sub-rounded weather volcanic rock inclusions are present (500–600 μm). Fe-rich clay pellets occurred commonly with oval and rounded shape that measures between 400 and 600 μm. There is the presence of a reddish grog inclusion. The fabric shows a very fine ground mass with an input of medium-coarse inclusions of angular and sub-angular shape and some sub-rounded inclusions. The general matrix composition points to a mafic and ultramafic igneous origin and to a short weathering process as is clear from the presence of coarse micas and accessory minerals. Voids are elongated and partially parallel, slightly oriented with the margins. It shows the presence of relic coils. The matrix is optically active and indicates a firing temperature lower than 800 °C in an oxidizing firing environment.

CA-23: The matrix is rich in metamorphic rock fragments with coarse quartzite inclusions and schistose muscovite and chlorite-rich rock inclusions, possibly from greenschist or amphibolite formations, that measure between 400 and 2000 μm. The fabric is heterogeneous and rich in coarse and angular to sub-rounded inclusions. Quartzite is frequent either with a fine granulometry or with coarse quartz inclusions. The shape of the inclusions varies from round to angular and the size is irregular measuring from 500 to 800 μm. Sandstone inclusions occur with a fine granulometry and irregular in shape and size (400 to 2000 μm). Coarse inclusions of calcite, probably related to fossil, are rare. Voids are elongated and vesicular. Inclusions and voids are partly oriented and parallel with the margins. The vessel was fired in a reduced environment as indicated by the dark groundmass. The matrix is optically active suggesting a low firing temperature.

3.2. Fashioning, finishing and surface treatments

3.2.1. Unit 26 and 34 (CE 550–1000)

Vessels show a high variability in the raw material selection, varying from using clays from a limestone/ sedimentary environment, characteristic of the landscape of eastern Hispaniola, to clays weathered on a non-local intermediate volcanic and metamorphic geology. Four main petrographic groups (group 1, 2, 3 and 4) were recorded. In general, the preference is for a medium coarse fabric that is poorly sorted. The mean firing temperatures is lower than 800 °C. The shapes recorded among this tradition are unrestricted and restricted bowls and serving plates.

The bases of the vessels were modelled from a ball of clay flattened by percussion until it is sufficiently thin. The shape is circular, and the thickness is variable. Two flat clay discs are assembled superimposed. The clay disc has a coil placed around on the periphery. The base is connected to the body with an internal coil/clay slurry. The coil/clay slurry is placed at the junction between peripheral coil and the first part of the body on the inner surface. The coils are joined and thinned by discontinuous pressures (Fig. 5).

The diagnostic traits are visible in the radial section where the base presents horizontal elongated subparallel voids that evidence percussion action. Evidence for two assembled clay discs is a long horizontal void in the middle of the radial section and beveled fracture between the two clay discs. In the radial section on the peripheral part of the base, there are oblique to vertical fissures that indicate the presence of a coil. Concentric over thickness on the inner base of the recipients indicates the place of a peripheral coil. On the inside surface on the connection between body and base there are digital hollows and clay slurry that indicates the addition of clay to reinforce the junction.

Roughing-out: bodies were manufactured with assembled elements by coiling (coil size 0.9–1.5 cm). The coil structure is evidenced macroscopically by the combined presence of horizontal fissures (partly hidden by the high burnishing), undulated walls and preferential fractures (trapezoidal shape of the sherds and beveled fractures), coil junctures are also often visible. The coils are superimposed and alternated beveled, positioned equidistantly and in an oblique fashion (Fig. 6 A, B and C). Rims were coiled, as shown by the combination of fissures, undulations, over-thicknesses (often an extra clay layer is added on the top of the lip), oblique voids and fissures (microscopic scale, radial sections). Lip coils were positioned either from the outside or inside and were smaller than body coils. The assemblage has also sherds of unrestricted oval vessel shapes (boat shape) from the parallel superimposition of coils along its length. There is a large central coil (1.5 cm) and smaller parallel lateral coils (0.9–1.1 cm).

Pre-forming: coils are likely modified by pinching, then the surface is evened out by percussion with a beater or by hand. The percussion action is evidenced by the presence of cupule marks, depressions, micro pull outs and often inserted grains on the external surface. On a microscopic observation of the radial section there are horizontal fissures aligned with the margins of the body and the coarse inclusions are partly oriented with the margin and close to the surface (Fig. 6 D).

Finishing: smoothing was carried out when the body was still humid with or without adding water on the entire vessel. In some cases, there is evidence of working on a dryer body. Diagnostic features include: fluidified micro-topography, ribbed and threaded striations, and semi

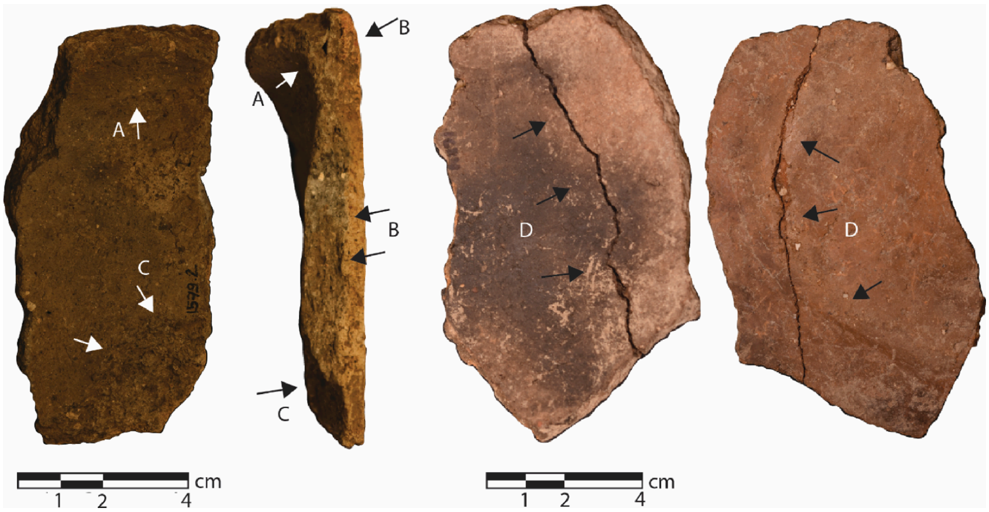

Fig. 5. Diagnostic traits of base manufacturing. (A) clay slurry to reinforce the junction between the base and the body; (B) horizontal fissures; (C) beveled fractured; (D) fracture along the peripheral coil, on the left the top part and on the right the bottom part of the base (photos by S. Casale).

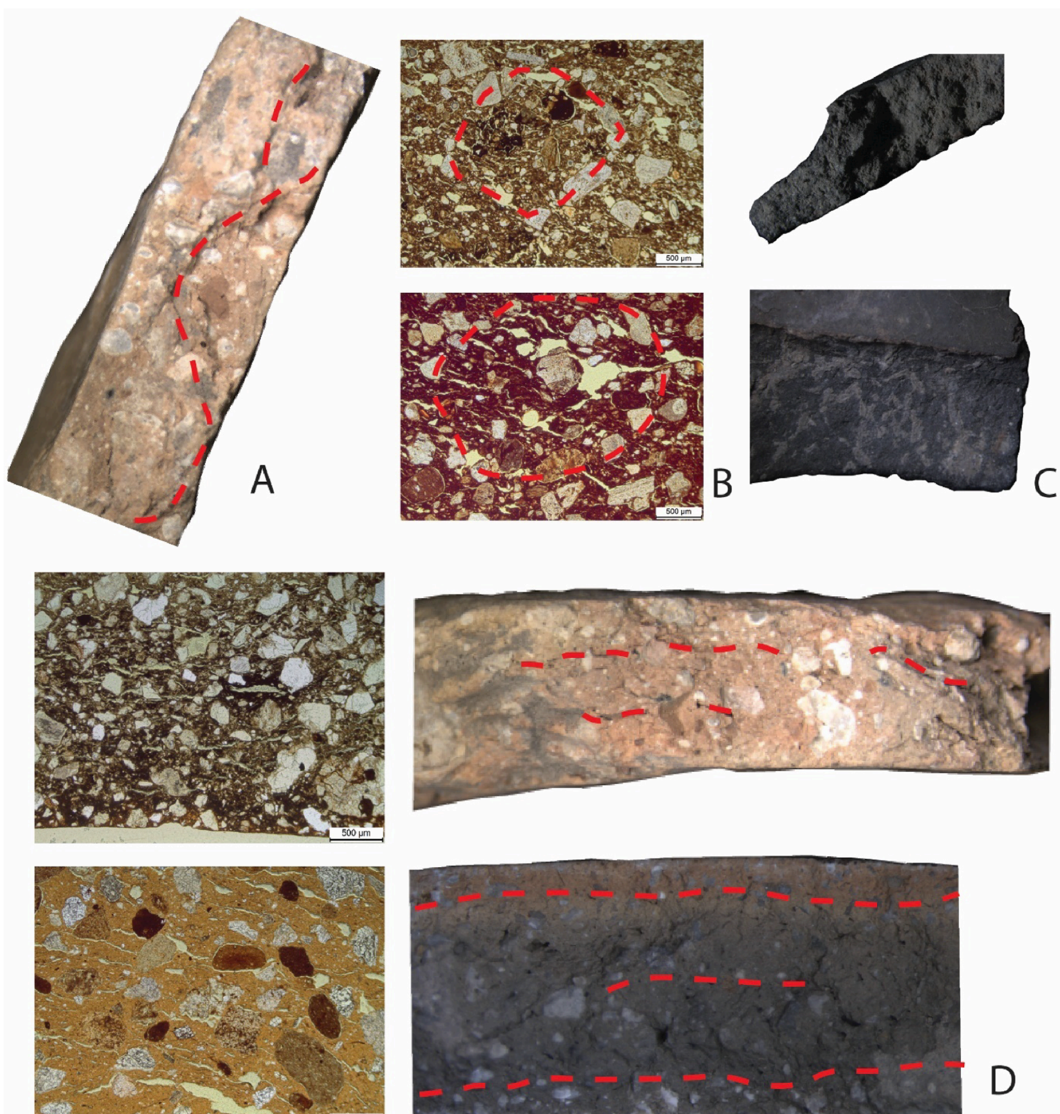

Fig. 6. Diagnostic features on a macro and micro scale of the fashioning step of the manufacturing process for unit 26 and 34: (A), (B), (C) coiling, and (D) beating (photos by S. Casale).

covered protruding grains.

Surface treatment: the surface treatment operation is burnishing on both internal and external faces. Diagnostic traits: shining surface, inserted and floating grains, compact bands creating facets. Some vessels have no burnishing action on the inside surface and a clay coating on the external surface. Shapes were not identified due to the scarcity and fragmentation of these coated sherds.

Firing: The radial sections of most sherds evidenced a sandwich color (dark core reddish external) and a full red color indicating an incomplete/complete oxidation of the pots.

3.2.2. Unit 50 late period (CE 1000–1200)

The raw material selection shows a continuity with the previous occupation period evidenced by the identification of the same petrographic group 1.A, 2 and 3. In addition, two petrographic group 4 and 5 were exclusively identified for the production of vessel with a specific white/beige clay body.

Roughing out: potters created vessels from a heterogeneous elementary volume. The coils diameters vary between 0.8 and 1 cm on average and are positioned on the top of each other alternated and are merged by pinching action, discontinuous pressure and point pressure. The diagnostic traits of the roughing out are undulating shape in radial section,

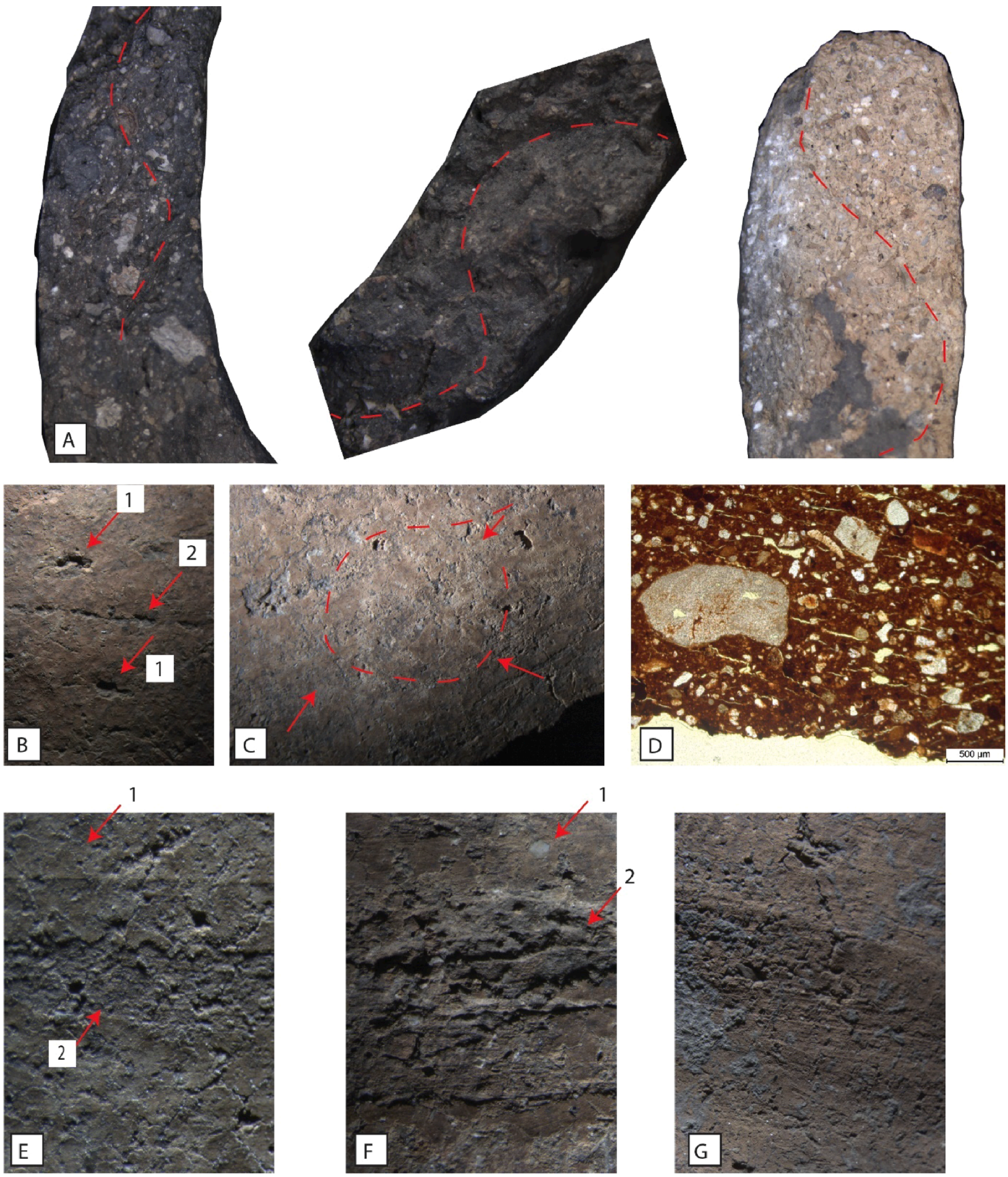

Fig. 7. Diagnostic features on a macro and micro scale of the fashioning steps of the manufacturing process for unit 50. (A) radial section of different samples with visible coiling zig-zag pattern. (B) Horizontal fissures equidistant (1, 2) indicating the coil direction and junction with another coil. (C) zone with percussions depression. (D) Microscopic evidence of percussion with voids and coarse inclusions oriented with the margins. (E), (F) and (G) zones with smoothing on wet clay (E.2 and F.2) with irregular topography, protruding grains and striations. Zone with burnishing (E.1 and F.1) action applied after the smoothing with compact microtopography and inserted and floating grains (photos by S. Casale).

sherds with preferential fracture along the coil, U-fracture and beveled; surface discontinuity where coils merged. Coil discontinuity is more visible on the inside surface suggesting that smoothing or surface treatment on the outside surface were performed while the passive hand holding as a support the inside of the vessel (Fig. 7 A and B).

Pre-forming: due to the composition of the assemblage that yield mostly the upper part of the body and rim, macroscopically there is not strong evidence of beating in the radial section as noted in ceramic bodies from Unit 26 and 34. There are, however, some mild semi-horizontal fissures visible through thin section and the thickness of the body reduces steadily moving down from the rim, which can be related to percussion activities. Vessels manufactured with clays from petrographic group 4 and 5 do not have any evidence of percussion.

Finishing: near the rim section, where the burnishing activities was less homogeneous, inclusions are protruding and semi-protruding, suggesting mostly smoothing on wet clay (Fig. 7 E, F and G). Two types of smoothing were recorded to rub the humid surface.

(1) *smoothing on a wet body with wetted tool/hand*: once the body and rim are assembled, the vessel when still humid was smoothed with a wet tool or a wet hand to homogenize the surface, both inside and outside. The action was made with a soft tool or hands due to the absence of deep striations. The technique is performed with a discontinuous pressure, and multidirectional movements with a preferential horizontal direction on the upper part of the vessel but not predominantly. Evidence for smoothing on a wet body with a wetted tool is the presence of protruding and often semi-covered grains surrounded by clay slurry, irregular topography, and ribbed and threaded striations. The direction of the striations is not preferential and most of the decorated sherds have evidence of work with wet tools.
(2) *smoothing on a wet body with dry tool*: the procedure is the same as for smoothing on wet clay. The difference here is the presence of a more fluidified microtopography characterized by threaded striations and protruding grains. Both smoothing processes are often finished with a leather hard paste scraping, which creates minimal micro pullouts and more inserted grains, however, the action is not uniform on the entire vessel and can be interpreted as a pre-action before burnishing.

Surface treatment: two surface treatments were identified: burnishing and very rare coating. Burnishing is the dominant method, often performed extensively covering the entire internal and external surface of the vessel. Diagnostic traits include: floating grains with minimal pull outs, over thickness and shining and compact microtopography. The coating operation is performed on a restricted number of vessel that are characterized by a white/beige body and linked only to petrographic group 4 and 5. The diagnostic traits are the addition of an extra layer of white clay (slip) can be identified by variations in the thickness of the surface and the whitish color that contrast with that of the clay body.

Decoration: decorated sherds yield a typical Chicoid style incised pattern, characterized by continuous horizontal and curvilinear lines, often with punctuation at the end/beginning of the line (Fig. 8). The decoration is applied on vessels smoothed on wet clay with wet tools/hands or on wet clay with dry tools. Incisions are on the external surface and one vessel shape, an open plate, presents incisions on the inside

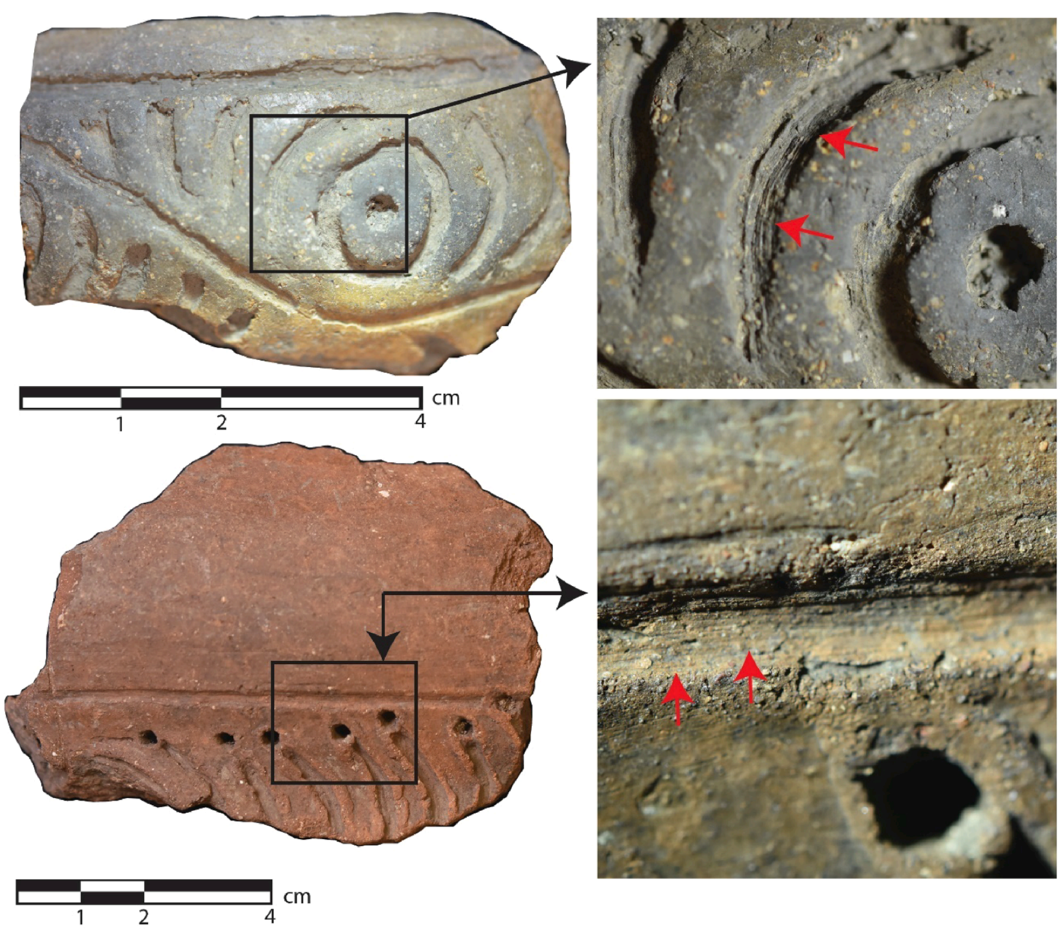

Fig. 8. Decoration traits on a macro scale level of sherds with incised patterns applied with a wet tool on wet clay. Red arrows indicate the inside of incisions with ribbed striations, protruding grains and accumulation of clay slurry on the margins (photos by S. Casale). (For interpretation of the references to color in this figure legend, the reader is referred to the web version of this article.)

surface on the rim. Incision thickness varies between 2.5 and 4 mm, with 3 mm the most common width. The tool is probably a medium hard stylus, perhaps a feather shaft or wooden stick. The decorations were made on wet clay with adding water or previously wetting the tool. The movement is continuous and steady. Usually after the decoration was applied, vessels were burnished as a final step. The diagnostic traits are a microtopography that is highly fluidified, characterized by ribbed striations and less common threaded striations. The grains are protruding and semi protruding with often clay slurry around grains showing the movement of the tool with the direction of accumulation of clay. The edge of the inclusions are regular and often present accumulation of clay slurry on the edge side of the incision.

Vessel morphologies are more variable than in the previous occupation phases. The forms identified are restricted and unrestricted bowls, open plates, bowls with straight borders and bowls with undulating borders and bottle/jars with a long tight neck (*potiza*).

4. Discussion

The results of the analysis demonstrate that one main *chaîne opératoire* with some variations is present at the site of El Cabo (Fig. 9). The choice of the raw material does not seem to be standardized either for some certain vessel morphologies, or during a specific occupation phases. The only exception is for the white/beige vessels that were manufactured with exclusively clay belonging to petrographic groups 5 and 6. These vessels make up only a small amount of the studies assemblage and occur as<1% of the total assemblage. The assemblage shows a low level of standardization in the clay procurement practices and clay preparation, as was noted already by Ting et al. (2016) for two contemporaneous sites, El Flaco and La Luperona located in the north-central of Hispaniola. Clay fabrics are generally composed 20–30% of a medium-coarse components. Clays used vary from originating from a marine limestone-rich to clays originating from different geological volcanic and metamorphic origins. The latter are not related to the eastern region of Hispaniola (e.g. petrographic group 1, 3, 4, 5 and 6 and outliers). Van As et al., (2008) described the environment surrounding El Cabo as poor in good workable clay, with the closest suitable outcrop located approximately 7 km from the site.

There are several possible locations from which the clays found at the site could have been sourced. The composition of the inclusions of petrographic group 1 points to an origin associated with an intermediate volcanic parent rock. One possibility can be the area of *Sabana del Mar* and *Miches* located on the north coast that face the south of the Samaná peninsula in Hispaniola (Ayala et al., 2017; Wilson et al., 2019). Another option can be the central northwest coast of Puerto Rico where intermediate volcanic rock is documented (Wilson et al., 2019). Petrographic group 2, however, is composed of carbonaceous clay, that typically occurs in the eastern region of Hispaniola with coralliferous and evaporites inclusions. For some of those vessels, grog temper was intentionally added in both Ostionoid and Chicoid ceramics. The presence of grogs is a technological choice to obtain a working clay with 20–30% of medium coarse inclusions which would have made the raw material more workable, and more similar to the other available clays used in the assemblage. The use of grog was already documented by Ting et al. (2016) for contemporaneous decorated Meillacoid ceramics from the site of El Flaco in the Valverde province.

4.1. Implications

The technological tradition (Fig. 9) that was common amidst the Ostionoid potters (600–1000 CE) was maintained among the Chicoid ones (800–1200 CE) and is characterized by a coiling where coils were assembled, alternated and merged by pinching. Percussion was used to uniformize the body during the Ostionoid phase whereas this technique seems to be less frequently used in Chicoid ceramics. Smoothing is done preponderantly in wet conditions (wet clay body and wet tool/hand), and was followed by burnishing operation. Early Ostionoid pottery shows a variation with the application of a clay coating on the outer surface, which is recorded in Chicoid ceramics exclusively for the small group of white/beige calcareous vessels. As a result of these analyses, El Cabo evidences a complex homogeneous assemblage (*sensu* Roux, 2019b) characterized by one major techno-group but petrographic heterogeneity. This petrographic heterogeneity implies that the inhabitants of El Cabo were probably involved in a broader regional network of interaction and were thus not limited to their community for the production of their pottery or the acquiring of pots. Similar networks of exchange of goods and ideas involving the El Cabo community were also recorded through the microanalysis of ornaments and greenstone

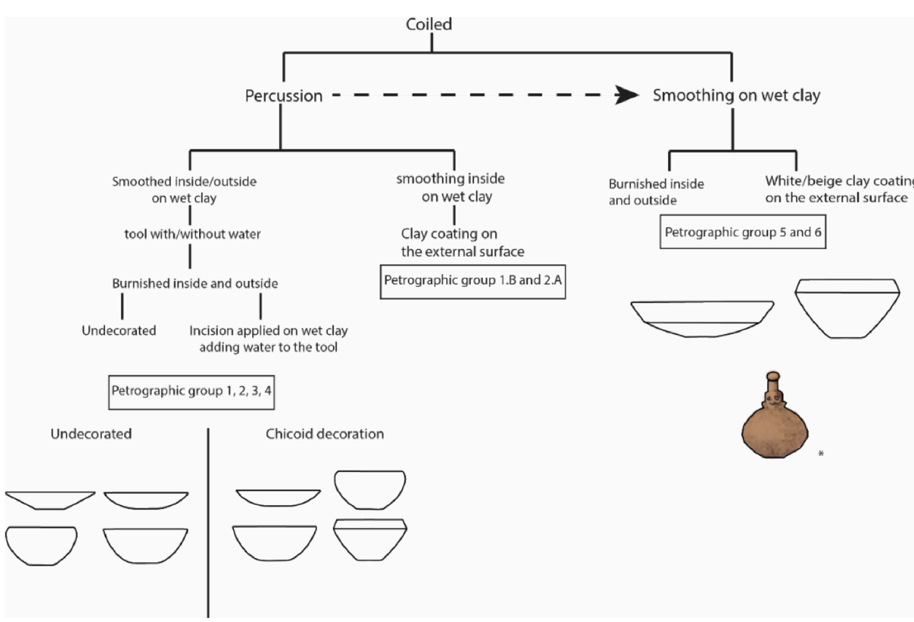

Fig. 9. Description of the chaîne opératoire with morphological and petrographic data; (*) the shape of the potiza was adapted as example from Rouse 1939. The dashed line indicates that analysis on a more complete vessels are needed to clarify the presence/absence of percussion in the production of white/beige vessels present in unit 50.

Table 3
Main diagnostic traits identified from the ceramic assemblage of El Cabo (Roux, 2019a, Quinn 2013, Rice 2015, Rye 1981).

Chaîne Opératoire steps										
Unit/time	Roughing out			Preforming			Finishing		Surface treatments	
	Technique	Diagnostic features		Technique	Diagnostic features		Technique	Diagnostic features	Technique	Diagnostic features
		Macroscopic scale	Microscopic scale		Macroscopic scale	Microscopic scale		Macroscopic scale		Macroscopic scale
Unit 26 and Unit 34	Coiling by pinching	Horizontal fissures on the surfaces, uneven walls, preferential fractures along the coils, U-fracture, segment coil junctures are visible, zig-zag shape in radial section	Random and oblique voids, presence of relic coils	Percussion with a beater on wet clay	Cupule marks depressions, micro pull outs, inserted grains on the external surface, clay slurry	Horizontal elongated and thin voids parallel with the margins, coarse inclusions partly aligned with the margins and relic coil partly stretched and elongated	Smoothing on wet clay	Fluidified microtopography, ribbed and threaded striations, semi-covered protruding grains	Burnishing	Shining surface, inserted grains, compact bands creating facets
									Coating	Floating and inserted grains, bumps, regular and compact surface, color difference between the coating and ceramic body
Unit 50	coiling by pinching	Horizontal fissures on the surfaces, uneven walls, preferential fractures along the coils, U-fracture, segment coil junctures are visible, zig-zag shape in radial section	Random and oblique voids, presence of relic coils	Percussion with a beater on wet clay	Mild horizontal fissures in radial section, thickness of the body reducing from the rim down to the lower part of the body	Less common horizontal long and thin voids parallel with the surface, coarse inclusions partly aligned with the surface direction and relic coil stretched	Smoothing on wet clay with wet tool/hand	Protruding and semi-covered grains with clay accumulation around, irregular topography, ribbed and threaded striations	Burnished	Floating grains and minimal pull outs, over thickness, shining, compact microtopography
				Pinching (white/beige vessels)			Smoothing on wet clay with dry tool/hand	Fluidified microtopography ribbed and threaded striations	White Coating	Floating and inserted grains, bumps, regular and compact surface, color difference between the coating and ceramic body

artifacts. These studies suggest the presence of different production centers on Hispaniola which were shared by different communities across the island (Guzzo Falci et al., 2020; Hofman et al., 2006).

Changes in morphological and stylistic ceramic features between the Ostionoid to the Chicoid occupation phases suggest social transformations or a request for new ceramic products in the Mona Passage between 800 CE and 1000 CE. The introduction of new morphologies and styles (e.g. Chicoid decoration and white vessels) evidences a possible social request for a renovation of ceramic material. The introduction of a new morphology, however, partly overlapped with a continuity of the "way of doing" which remained stable between the Ostionoid and Chicoid phases. The stable manufacturing tradition suggests a cultural continuity in the communities that lived in El Cabo over a period of 600 years and with other communities that shared the "way of doing" and that were embedded within the same social networks. The shaping stage during the manufacturing process is considered the most stable and longest to learn requiring a direct transmission from a tutor to an apprentice (Gosselain, 2000; Roux, 2019a). On the contrary, the presence of various clays in both occupational phases shows the continuity of El Cabo as a node of a wide network of socially related communities that had access to different environments/geological areas. Clay recipes can be adapted to the immediate needs likely because of the exhaustion of particular clay outcrops or because of moving to new locations (Roux, 2019a).

The only outlier tradition is the techno group of white/beige vessels that were manufactured solely with clays from petrographic group 5 and 6. These vessels are characterized by a whitish/beige color, either because of the use of buff-firing clay or in seldom cases the addition of a white clay slurry (slip) to the vessel surface. This manufacturing tradition includes a particular morphology such as effigy bottles with a neck (*potiza*) that often have a modeled faced on the top (VanderVeen, 2011). The highly fragmented nature of the sherds, in addition to the peculiarly restricted morphology of those vessels can be the reason for not having observed the presence of percussion action. In contrast with the rest of the assemblage, those vessels show an intentional selection of specific clays to produce a body with a white/beige color. The record of these vessels extends to other sites of Hispaniola (e.g. El Flaco, El Carril and En Bas Saline) and to the Lesser Antilles (Kelbey's Ridge and Saba) (Deagan, 2004; Hofman et al., 2008c), but always as a minor component. The presence of those vessels suggest the existence of a specific network of ceremonial or elite materials could have existed which favored these vessels with their uniform morphologies and color (García Arévalo, 1977; Veloz Maggiolo, 1972; Wilson, 1997).

The technological information gleaned at El Cabo supports the hypothesis that only one main migration likely occurred to the archipelago during the Ceramic Age, and a continuity of people with no major cultural changes but extensive networks until the European invasion (Fernandes et al. 2021; Hofman et al., 2011). The inhabitants of El Cabo were rooted in these networks and shared knowledge on the pottery manufacturing process with other communities. Communities from different locations were, as shown by the presence of raw materials from different and distant geological environments, affiliated with a common ancestor represented by the persistence of one shared technical tradition. This continuous contact between groups has been put forward in several studies on human mobility and exchange of goods and ideas (e.g. Fitzpatrick 2015; Hofman 1993, 2019; Hofman et al. 2010, 2011, 2014; Hofman and Hoogland 2011; Mol 2014; Laffoon 2012; Rodríguez Ramos 2010), and has been also recently evidenced by Fernandes et al. (2021) in their findings based on a-DNA. They found family relatives that were buried 75 km apart on the island of Hispaniola and also saw a high rate of connectivity between Hispaniola and Puerto Rico together with a restricted population size. Periodic visits to each other communities, where perhaps direct family members lived, may be one explanation for the sharing, stability and persistence of manufacturing knowledge through time and space. Another may be the existence of production centers that were serving a broader network as Guzzo Falci et al. (2020) suggested for the manufacturing of bodily ornaments, or a combination of both. Further analysis is needed including contemporaneous sites in the region and different materials and objects to explore the validity of the concept of communities and social identity and to what extent knowledge was developed and shared.

5. Conclusion

The geographical position of El Cabo, situated on the southeast coast of Hispaniola and facing western Puerto Rico has a key role to shed light on the cultural identity of the ancient inhabitants and what types of social and environmental interactions they experienced. This research contributes to the understanding of pre-colonial Indigenous social life by integrating manufacturing practice theory with petrographic analysis and *chaîne opératoire* approach. The results propose a continuity in the pottery production at the site of El Cabo over 1000 years of occupation. The El Cabo inhabitants maintained the core of the ceramic production, *roughing out* and *preforming*, based on coiling by pinching and further percussion over centuries. Small differences in size of coils and further *finishing* (smoothing on wet clay or dry clay) and *surface treatment* (burnishing and coating) steps are recorded. These changes go along with the transformation of pottery morphology from Ostionoid to Chicoid styles, suggesting that likely at a certain point between 800 and 1000 CE there was a renovation/innovation in the decoration pattern with the introduction of the Chicoid styles. These changes pushed potters at El Cabo and related communities to adopt the Chicoid incised decoration into their production repertoire, while maintaining stable their core tradition of coiling and percussion. This stability of the *roughing out* and *preforming* stages evidences a cultural link between the people who lived in El Cabo and the people that traded ceramics with the community of El Cabo for centuries. These networks of shared practices that were established and maintained between different communities, evidence the same technological traditions, but also show that different clay sources were used. It is hypothesized here that a macro-regional network existed of which El Cabo was part of and which finds its roots in a common ancestral social network. Locally micro-variations may have emerged over time prompted by the socio-cultural behavior of individual communities and potters.

This specific El Cabo case study has shown the effectiveness of the technological approach not only for identifying continuity but also to explore contact and interaction between communities (exchange of goods and ideas) as indicated by the imported ceramics or raw clay materials in conjunction with the exchange of bodily ornaments (Guzzo Falci et al., 2020) and other objects (Hofman et al., 2006; Hofman et al., 2008b). These results also confirm the extensive of networks established across the Mona Passage (Rouse, 1992; 1982; Samson 2010).

The presented approach can be confidently applied to broader investigations of ceramic traditions from different spatiotemporal context across the Caribbean. Information from more sites will allow us to reveal the persistence of technological boundaries and to better understand the level of social interaction that occurred between geographically close communities, and to more distant settlements.

CRediT authorship contribution statement

Simone Casale: Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Software, Investigation, Writing – original draft, Writing – review & editing. **Kwintin van Dessel:** Methodology, Investigation, Data curation, Writing – review & editing, Visualization. **Menno L.P. Hoogland:** Project administration, Data curation, Investigation, Funding acquisition, Writing – review & editing, Visualization. **Patrick. egryse:** Supervision, Writing – review & editing, Visualization. **Corinne Lisette Hofman:** Project administration, Data curation, Investigation, Funding acquisition, Writing – review & editing, Visualization.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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References

van As, A., Jacobs, L., Hofman, C., 2008. In search of potential clay sources used for the manufacture of the Pre-Columbian pottery of El Cabo, Eastern Dominican Republic. Leiden Journal of Pottery Studies 24, 55–74.

Ayala, C., García-Lobón, J.L., Escuder-Viruete, J., Rey-Moral, C., Pérez-Estaún, A., Padín-Debén, A., 2017. Caracterización de los dominios tectónicos de la República Dominicana, con especial énfasis en la Cordillera Central, mediante datos aeromagnéticos de alta resolución, gravimetría regional y petrofísica. Bol. Geol. y Min. 128, 611–631. https://doi.org/10.21701/bolgeomin.128.3.005.

Bowin Carl, 1975. The geology of Española, in: Naim, A Stehli, F. (Ed.), The Ocean Basins and Margins: The Gulf of Mexico and the Caribbean, Vol 3. Plenum Press, New York, NY, pp. 501–552.

Casale, S., Jean, J.S., Capelli, C., et al. 2021. Transatlantic Connections in Colonial and Post-colonial Haiti: Archaeometric Evidence for Taches Noires Glazed Tableware Imported from Albissola, Italy to Fort Liberté, Haiti. Int. J. Histor. Archaeol. 25, 423–447. https://doi.org/10.1007/s10761-020-00559-3.

Chanlatte Baik, L.A., 2013. Huecoid Culture and the Antillean Agroalfarero (Farmer-Potter) Period. Oxford Handb. Caribb. Archaeol. 1–15. 10.1093/oxfordhb/9780195392302.013.0062.

Chanlatte Baik, L.A., 2000. Los arcaicos y el formativo antillano (6000 AC-1492 DC). Boletín del Mus. del Hombre Dominic. 28, 29–42.

Chanlatte Baik, L.A., 1986. Cultura Ostionoide: Un desarollo agroalfarero antillano. Homines 10, 1–40.

Chanlatte Baik, L.A., 1981. La Hueca y Sorcé (Vieques, Puerto Rico) Primeras Migraciones Agroalfareras Antillanas Antillanas. Santo Domingo.

Cortney St Jean, 2008. Early Ostionan Ostionoid ceramic component of the El Cabo site, Dominican Republic: a morphological, technological and stylistic ceramic examination based on an attribute analysis. Leiden Journal of Pottery Studies 24, 19-54.

Creswell, R., 1983. Transferts de techniques et chaînes opératoires. Tech. Cult. 143–164 https://doi.org/10.4000/tc.1030.

Curet, L.A., 2005. Caribbean Paleodemography Population, Culture History, and Sociopolitical Processes in Ancient Puerto Rico.

Curet, L.A., 2002. Issues on the diversity and emergence of middle-range societies of the ancient Caribbean: a critique. J. Archaeol. Res. 11 (1), 1–42.

Curet, L.A., 1997. Technological changes in prehistoric ceramics from Eastern Puerto Rico: An exploratory study. J. Archaeol. Sci. 24, 497–504. 10.1006/jasc.1996.0133.

Curet, L.A., Newsom, L.A., deFrance, S.D., 2006. Prehispanic social and cultural changes at Tibes, Puerto Rico. J. F. Archaeol. 31 (1), 23–39. https://doi.org/10.1179/009346906791072115.

Deagan, K., 2004. Reconsidering Taíno Social Dynamics after Spanish Conquest: Gender and Class in Culture Contact Studies. American Antiquity 69 (4), 597–626.

Dietler, M., Herbich, I., 1998. Habitus, techniques, style: an integrated approach to the social understanding of material culture and boundaries. In: Stark, M.T. (Ed.), The Archaeology of Social Boundaries. Press, Smithonian Institution, Washington, pp. 232–263.

Di Napoli, R.J., Fitzpatrick, S.M., Napolitano, M.F., Rick, T.C., Stone, J.H., Jew, N.P., 2021. Marine reservoir corrections for the Caribbean demonstrate high intra- and inter-island variability in local reservoir offsets. Quaternary Geochronology 61, 101–126.

Dobres, M.A., 2000. Technology and social agency : outlining a practice framework for archaeology. Social archaeology, Blackwell, Oxford.

Ernst M. & Hofman C.L. (2019), Breaking and Making Identities: Transformations of Ceramic Repertoires in Early Colonial Hispaniola. In: Hofman C.L., Keehnen F.W.M. (Eds.) Material Encounters and Indigenous Transformations in the Early Colonial Americas: Archaeological Case Studies. The Early Americas: History and Culture no. 9: Brill. 124-145.

Ferguson, J.R., Siegel, P.E., Descantes, C., Glascock, M.D., 2008. Pre-Columbian Pottery in the West Indies: Compositional Change in Context. Journal of Caribbean Archaeology 2, 25–44.

Fernandes, D.M., Sirak, K.A., Ringbauer, H., Sedig, J., Rohland, N., Cheronet, O., Mah, M., Mallick, S., Olalde, I., Culleton, B.J., Adamski, N., Bernardos, R., Bravo, G., Broomandkhoshbacht, N., Callan, K., Candilio, F., Demetz, L., Carlson, K.S.D., Eccles, L., Freilich, S., George, R.J., Lawson, A.M., Mandl, K., Marzaioli, F., McCool, W.C., Oppenheimer, J., Özdogan, K.T., Schattke, C., Schmidt, R., Stewardson, K., Terrasi, F., Zalzala, F., Antúnez, C.A., Canosa, E.V., Colten, R., Cucina, A., Genchi, F., Kraan, C., La Pastina, F., Lucci, M., Maggiolo, M.V., Marcheco-Teruel, B., Maria, C.T., Martínez, C., París, I., Pateman, M., Simms, T.M., Sivoli, C.G., Vilar, M., Kennett, D.J., Keegan, W.F., Coppa, A., Lipson, M., Pinhasi, R., Reich, D., 2021. A genetic history of the pre-contact Caribbean. Nature 590, 103–110. https://doi.org/10.1038/s41586-020-03053-2.

Fitzpatrick, S.M., 2015. The Pre-Columbian Caribbean: Colonization. Population Dispersal, and Island Adaptations, PaleoAmerica 1 (4), 305–331. https://doi.org/10.1179/2055557115Y.0000000010.

García Arévalo, M., 1977. El arte taíno de la República Dominicana. Santo Domingo.

Gelbert, A., 2003. Traditions céramiques et emprunts techniques dans la vallée du fleuve Sénégal, Editions d. ed. Editions Epistèmes, Paris.

Gosselain, O.P., 2008. Thoughts and Adjustments in the Potter's Backyard. In: Berg, I. (ed), Breaking the Mould: Challenging Past through Pottery. BAR International Series 1861, pp. 67–79.

Gosselain, O.P., 2000. Materializing identities: An African perspective. J. Archaeol. Method Theory 7, 187–217. 10.1023/A:1026558503986.

Guzzo Falci, C., Ngan-Tillard, D., Hofman, C.L., Van Gijn, A., 2020. The Biographies of Bodily Ornaments from Indigenous Settlements of the Dominican Republic (AD 800–1600). Lat. Am. Antiq. 31 (1), 180–201. https://doi.org/10.1017/laq.2019.101.

Hofman, C.L., 1993. In search of the native population of pre-Columbian Saba. Part One. Pottery styles and their interpretations (PhD thesis). Leiden University.

Hofman, C.L., 2019. Indigenous Caribbean Networks in a Globalizing World. In: Decorse, C. (Ed.), Power, Political Economy, and Historical Landscapes of the Modern World: Interdisciplinary Perspectives. SUNY Press, New York.

Hofman, C.L., Hoogland, M.L.P., Oliver, J.R., Samson, A.V.M., 2006. El Cabo, oriente de la Rep. Dom. Presencion del sitio y resultados preliminares de la campana 2005. El Caribe Arqueol. 9, 95–106.

Hofman, C.L., Isendoorn, A.J.D., Booden, M., Jacobs, L., 2008a. A tuneful threefold. Combining conventional archaeological methods, archaeometric techniques in the study of pre-colonial pottery of the Caribbean and ethnoarchaeological research. In: Hofman, C.L., Hoogland, M.L.P., Van Gijn, A.L. (Eds.), Crossing the Borders. New Methods and Techniques in the Study of Archaeological Materials from the Caribbean. University of Alabama Press, Tuscaloosa, pp. 21–33.

Hofman, C.L., Hoogland, M.L.P., Samson, A.V.M., Oliver, J., 2008b. Investigaciones arquelógicas en El Cabo, oriente de la República Dominicana: resultados preliminares de las campanas 2005 y 2006. Boletín del Mus. del Hombre Dominic. 289–307.

Hofman, C.L., Hoogland, M.L.P., van Gijn, A., 2008c. Crossing Disciplinary Boundaries and National Borders: New Methods and Techniques in the Study of Archaeological Materials from the Caribbean. In: Hofman, C.L., Hoogland, M.L.P., Van Gijn, A.L. (Eds.), Crossing the Borders. New Methods and Techniques in the Study of Archaeological Materials from the Caribbean. University of Alabama Press, Tuscaloosa, pp. 1–20.

Hofman, C.L., Bright, A.J., Rodríguez Ramos, R., 2010. Crossing the Caribbean Sea. Towards a holistic view of pre-colonial mobility and exchange. *Journal of Caribbean Archaeology* (Special Publication Number 3), 1–18.

Hofman, C.L., Boomert, A., Bright, A.J., Hoogland, M.L.P., Knippenberg, S., Samson, A.V. M., 2011. Ties with the “Homeland”: archipelagic interaction and the enduring role of the South American mainland in the pre-Columbian Lesser Antilles. In: Curet, L.A., Hauser, M.W. (Eds.), Islands at the Crossroads: Migration, Seafaring, and Interaction in the Caribbean. University of Alabama Press, Tuscaloosa, pp. 73–86.

Hofman, C.L., Hoogland, M.L.P., 2011. The multi-scales of mobility and exchange in the pre-colonial circum-Caribbean. In: Hofman, C.L., van Duijvenbode, A. (Eds.), Communities in contact. Essays in archaeology, Ethnohistory and Ethnography of the Amerindian circum-Caribbean. Sidestone Press, Leiden, pp. 15–43.

Hofman, C.L., Ulloa Hung, J., 2007. Juntando las Piezas del rompecabezas. Dándole sentido a la cronologia cerámica del este de la Republica Dominicana. El Caribe arqueologico 10.

Hofman, C., Mol, A., Hoogland, M., Valcárcel Rojas, R., 2014. Stage of encounters: migration, mobility and interaction in the pre-colonial and early colonial Caribbean. World Archaeology 46 (4), 590–609.

Isendoorn, A.J.D., Hofman, C.L., Booden, M., 2008. Back to the source. Provenance areas of clays and temper materials of pre-Columbian Caribbean ceramics. J. Caribb. Archaeol. 15-23. Special Publication 2.

Joyce, R.A., Hendon, J.A., Lopiparo, J., 2015. Working with clay. Anc. Mesoamerica 25 (2), 411–420. https://doi.org/10.1017/S0956536114000303.

Keegan, W.F., Hofman, C.L., 2017. The Caribbean before Columbus. Oxford University Press, New York.

Keegan, W.F., 2000. West Indian archaeology. 3. Ceramic age. J. Archaeol. Res. 8, 135–167. https://doi.org/10.1023/A:1009403127753.

Keller, C., 2001. Thought and Production: Insights of the Practitioner. In: Schiffer, M.B. (Ed.), Anthropological Perspectives on Technologicy. University of New Mexico Press, Albuquerque, pp. 33–45.

Laffoon, J. (2012). Patterns of paleomobility in the ancient Antilles. Leiden: Sidestone Press Dissertations.

Lave, J., Wenger, E., 1991. Situated Learning: Legitimate Peripheral Participation. Cambridge University Press, Cambridge, UK.

Lawrence, J., Fitzpatrick, S.M., Giovas, C.M., 2021. Journal of Archaeological Science : Reports Petrographic analysis of Pre-Columbian pottery from Nevis. Eastern Caribbean. J. Archaeol. Sci. Reports 35, 102741. https://doi.org/10.1016/j.jasrep.2020.102741.

Lemonnier, P., 1993. Technological choices : transformation in material cultures since the Neolithic. Material cultures, Routledge, London.

Manem, S., 2020. Modeling the Evolution of Ceramic Traditions Through a Phylogenetic Analysis of the Chaînes Opératoires: the European Bronze Age as a Case Study. J. Archaeol. Method Theory. 27 (4), 992–1039. https://doi.org/10.1007/s10816-019-09434-w.

Mann, P., Draper, G. and Lewis, J.F., 1991. Geologic and tectonic development of the North America-Caribbean plate boundary in Hispaniola., Geological. ed.

Mol, A. (2014). The connected caribbean a socio-material network approach to patterns of homogeneity and diversity in the pre-colonial period. Leiden: Sidestone Press Dissertations.

Nägele, K., Posth, C., Iraeta Orbegozo, M., Chinique de Armas, Y., Hernández Godoy, S. T., González Herrera, U.M., Nieves-Colón, M.A., Sandoval-Velasco, M., Mylopotamitaki, D., Radzeviciute, R., Laffoon, J., Pestle, W.J., Ramos-Madrigal, J., Lamnidis, T.C., Schaffer, W.C., Carr, R.S., Day, J.S., Arredondo Antúnez, C., Rangel Rivero, A., Martínez-Fuentes, A.J., Crespo-Torres, E., Roksandic, I., Stone, A.C., Lalueza-Fox, C., Hoogland, M., Roksandic, M., Hofman, C.L., Krause, J., Schroeder, H., 2020. Genomic insights into the early peopling of the Caribbean. Science (80-.). eaba8697. 10.1126/science.aba8697.

Pavia, J.A., Marsaglia, K.M., Fitzpatrick, S.M., 2013. Petrography and provenance of sand temper within ceramic sherds from Carriacou, Southern Grenadines, West Indies. Geoarchaeology 28 (5), 450–477. https://doi.org/10.1002/gea.2013.28.issue-510.1002/gea.21449.

Quinn, P., 2013. Ceramic Petrography, the Interpretation of Archaeological Pottery & Related Artifacts in Thin-section. Oxford.

Rodriguez Ramos, R., 2010. Rethinking Puerto Rican Precolonial History (Caribbean Archaeology and Ethnohistory). The University of Alabama Press, Tuscaloosa.

Rodríguez-Ramos, R., 2013. Isthmo – Antillean Engagements. In: Keegan, W.F., Rodríguez-Ramos, R., Hofman, L.C. (Eds.), The Oxford Handbook of Caribbean Archaeology. Oxford University Press, pp. 155–170.

Rouse, I., 1992. The Taino: Rise and Decline of the People Who Greeted Columbus. Yale University Press, New Haven.

Rouse, I., 1986. Migrations in Prehistory: Inferring Population Movement from Cultural Remains. Yale University Press, New Haven.

Rouse, I., 1982. Ceramic and Religious Development in the Greater Antilles. Journal of New World Archaeology 5 (2): 455-55. Los Angeles: Institute of Archaeology, University of California.

Rouse, I.G., 1939. Prehistory in Haiti: A Study in Method; Yale Publications in Anthropology: New Haven. CT, USA.

Roux, V., 2019a. Ceramics and Society, Ceramics and Society. Springer International Publishing. 10.1007/978-3-030-03973-8.

Roux, V., 2019. Modeling the Relational Structure of Ancient Societies through the Chaîne opératoire: The Late Chalcolithic Societies of the Southern Levant as a Case Study. In: Saqalli M., Vander Linden M. (Eds.), Integrating Qualitative and Social Science Factors in Archaeological Modelling. Computational Social Sciences. Springer, Cham. https://doi.org/10.1007/978-3-030-12723-7_7.

Roux, V., 2016. Ceramic Manufacture, in: Hunt, A. (Ed.), The Oxford Handbook of Archaeological Ceramic Analysis. Oxford University Press, pp. 100–113. 10.1093/oxfordhb/9780199681532.013.8.

Roux, V., 2015. Standardization of ceramic assemblages: Transmission mechanisms and diffusion of morpho-functional traits across social boundaries. J. Anthropol. Archaeol. 40, 1–9. 10.1016/j.jaa.2015.04.004.

Roux, V., Bril, B., Cauliez, J., Goujon, A.-L., Lara, C., Manen, C., de Saulieu, G., Zangato, E., 2017. Persisting technological boundaries: Social interactions, cognitive correlations and polarization. J. Anthropol. Archaeol. 48, 320–335. 10.1016/j.jaa.2017.09.004.

Samson, A.V.M., 2010. Renewing the house Trajectories of social life in the yucayeque (community) of El Cabo, Higuey, Dominican Republic, AD 800 to 1504. Leiden University, Leiden, The Netherlands.

Samson, A.V.M., Hoogland, M.L.P., 2007. Residencia Taína: Huellas de asentamiento en El Cabo, República Dominicana. El Caribe Arqueológico 10, 93–103.

Sinelli, P.T., 2013. Meillacoid and the Origins of Classic Taíno Society. In: Keegan, W.F., Rodríguez-Ramos, R., Hofman, L.C. (Eds.), The Oxford Handbook of Caribbean Archaeology. Oxford University Press, pp. 221–230.

Stienaers, A., Neyt, B., Hofman, C., Degryse, P., 2020. A petrographic and chemical analysis of Trinidad pre-colonial ceramics. Sci. Technol. Archaeol. Res. 10.1080/20548923.2020.1771898.

Ting, C., Neyt, B., Ulloa Hung, J., Hofman, C., Degryse, P., 2016. The production of pre-Colonial ceramics in northwestern Hispaniola: A technological study of Meillacoid and Chicoid ceramics from La Luperona and El Flaco, Dominican Republic. J. Archaeol. Sci. Reports 6, 376–385. https://doi.org/10.1016/j.jasrep.2016.02.031.

Ting, C., Ulloa Hung, J., Hofman, C.L., Degryse, P., 2018. Indigenous technologies and the production of early colonial ceramics in Dominican Republic. J. Archaeol. Sci. Reports 17, 47–57. https://doi.org/10.1016/J.JASREP.2017.10.035.

Ulloa Hung, J., 2014. Arqueología en la Línea noroeste de La Española. Leiden University, Leiden, The Netherlands.

VanderVeen, J. M., 2011. Water Storage Jars and the Human Figure: A Reanalysis of Taíno Symbolism. Caribbean Connections.

Veloz Maggiolo, M., 2003. La isla de Santo Domingo antes de Colón. Banco Central de la República Dominicana, Santo Domingo.

Veloz Maggiolo, M., 1991. Panorama Histórico del Caribe Precolombino. Banco Central de la República Dominicana, Santo Domingo.

Veloz Maggiolo, M., 1972. Arqueología prehistorica de Santo Domingo. Singapore: McGraww-Hill.

Wilson, F.H., Orris, G., and Gray, F., 2019, Preliminary geologic map of the Greater Antilles and the Virgin Islands: U.S. Geological Survey Open-File Report 2019–1036, pamphlet 50 p., 2 sheets, scales 1:2,500,000 and 1:300,000, 10.3133/ofr20191036.

Wilson, S.M., 2007. The archaeology of the Caribbean. Archaeol. Caribb. 1–209 https://doi.org/10.1017/CBO9780511816505.

Wilson, S.M., 1997. The Taino Social and Political Order. In: Brecht, F., Brodsky, E., Farmer, J.A., Taylor, D. (Eds.), Taíno: Pre-Columbian Art and Culture from the Caribbean. The Monacelli Press, New York, pp. 46–55.