Stone artefact production and exchange among the Northern lesser Antilles

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Appendix A Chert and flint sources

A.1 Introduction

Within this appendix, I provide a detailed description of each flint and chert source included within the present study. These descriptions are complementary to the short summary presented in Chapter 2 (section 2.3). The total number of lithic sources included in this study equals 15. Some of these have been already reported by earlier researchers, but for a number of them this is the first time that they are being described.

The sources can be found on three islands: Antigua, St. Kitts, and Puerto Rico. I visited each of the localities at least once, except the chert occurrences at Moca, which were visited and sampled by others (Walker *et al.* 2001). Major attention was directed towards the flint occurrences on Antigua. Therefore I visited Antigua on three occasions in 1997, 1998, and 2000. The 1998 field-trip lasted two weeks and was primarily directed toward mapping and sampling flint and chert sources. Hans Zijlstra, a sedimentologist and geo-chemist, then working for the Earth Sciences faculty of the University of Utrecht, accompanied me during the 1998 trip. He provided help in interpreting the flint occurrences and explaining the stratigraphy. I visited St. Kitts once during a one week stay in 1994, and chert sources on Puerto Rico were inspected in 1998 during a three day trip to the southwestern region, accompanied by Jeff Walker and Reniel Rodríguez Ramos who were familiar with the chert sources in this area.

A.2 Antigua

A.2.1 Long Island

The most widely known flint occurrence within the Antigua Formation lies on Long island, a small islet about a mile to the north of the main island of Antigua (see figure 2.5). It is a very flat island, which extends about 2 km east-west, and 1.5 km north-south. The bedrock solely consists of limestone.

Long Island has been long considered as a major source of flint within the northern Lesser Antilles by Caribbean archaeologists (Bartone & Crock 1998; Crock *et al*. 1993; Walker 1980a). Preliminary studies on characterisation and sourcing of this material and small-scale archaeological research on the island have supported this idea (Knippenberg 1995, 1999a; see Chapter 4 for a discussion on archaeological research there).

Despite its archaeological significance, the presence of flint is not reported in geological reports concerning Antigua (Martin-Kaye 1959; Mascle & Westercamp 1983; Weiss 1994). Archaeologists, however, have noted the easy availability of the material several times (Nicholson 1974; Olson 1973). Van Gijn (1996) and Verpoorte (1993) were the first to provide a detailed description of the natural and prehistoric flint scatters. Based on their descriptions and my fieldwork in the seasons of 1998 and 2000, the following general characteristics of the natural occurrence can be summarized.

On Long Island, natural flints can be found in primary context; that is, as nodules in the limestone host-rock, as well as secondary deposits of eroded material on the beach and more inland, both within the dark soils and scattered on their surface. In addition, flint is commonly present in a tertiary form, evidenced by numerous flake and blade scatters spread over the island. From the present-day secondary distribution of the material, it is hard to elucidate the situation in which the prehistoric populations encountered it, as several episodes of construction and land clearing during historic times have altered the landscape, especially in the past twenty years. Large artificial piles of flint situated in the centre of the island, erected as collecting spots after clearing some areas are one of the most obvious examples of modern disturbance (Van Gijn 1996). Still, a general assumption can be made about the original distribution: basically flint occurs everywhere on the island, except on the extended rock outcrop at Cistern Point (see figure 4.1). However, flint is most rare in the southern portion, in the area below an imaginary line from Jumby Bay to Cistern Point. Although excavations there have revealed that natural flint blocks are present in the topsoil, the concentration is low and the blocks generally can be considered as poor raw material for lithic tool production. This low frequency of flint gradually changes as one moves to the north. There, flint becomes more abundant and larger in size. The surface and the topsoil within the areas just behind the Flinty Bay coast are full of different sized cobbles of flint, with a characteristic brown cortex, including many boulders suitable for flaking. The highest concentrations are located on the Flinty Bay coast itself, which literally consists of flint. Along the western and eastern coasts, it is more rare but still easy to locate.

In addition to the enormous amounts of secondary flint, Van Gijn also describes some places where flint still resides in the limestone host rock. During the 1998 field trip, these localities were inspected. The most significant one is along the north coast between the Flinthouse and the Flinty Bay site, where exposed limestone ledges contain circle shaped, or "stirred" flint (Van Gijn 1996: 189). According to Hans Zijlstra, these flints are concentrated cylinders around mm thin and metre deep vertical syn-sedimentary burrows of *Bathichnus paramoudrea* (for similar examples, see Clayton 1986 and Zijlstra 1994). Another primary locality extends from the north of Pond Bay to just around the corner with Pasture Bay, where isolated nodules can be found. A third in-situ source is situated along the east coast between Cistern Point and Buckley Bay, where a shallow rock section exposes small layers with flint nodules in them.

In comparison to the secondary surface material, these in-situ sources are very restricted and few in number. This suggests that significant coastal erosion has occurred, which can be considered responsible for the almost total disappearance of all original flint bearing limestone. In this scenario, the vertical burrow flint cylinders must be seen as the lower part of the original flint-bearing limestone deposit. The eroded upper part possibly contained horizontal nodule layers. The fact that most of the limestone that nowadays surfaces at Long Island contains high amounts of foraminifers supports this view, as field inspections at other flint bearing rock sections on Antigua revealed that this specific limestone deposit always underlies more or less directly the flint bearing limestone deposits.

Long Island flint itself has a variable appearance, which mainly can be attributed to the effect of chemical weathering of the rock. Flint from a primary context displaying its original colour has a characteristic very dark grey hue defined by the colour code 10YR 3/1, 2.5Y 3/1, as described in Munsell Soil Color Charts (1990). Just underneath the cortex, it can have a very thin (2-5mm) light olive brown (2.5Y 5/3), greyish brown (10YR 5/2) to brown (10YR 5/3) coloured band. At first sight, the matrix looks homogeneous, but closer inspection reveals that the matrix of the flint exhibits a typical light coloured irregular shaped pattern or "haze", of very fine white inclusions. These appear to be remnant calcite crystals when viewed under a microscope. In secondary context, the colour can have different hues. Flint along the cobble beach of Flinty Bay predominantly keeps this dark colour, whereas within more inland soils the colour has changed. Usually this change is only restricted to an outer band, averaging 1-2 cm in thickness, with the core remaining dark coloured. Sometimes, the complete rock has altered colour. In general, the colour has become lighter, the hues including light grey (10YR 7/2), (very) pale brown (10YR 7/3, 6/3), (light) yellowish brown (2.5Y 6/3, 10YR 5/4), brown (10YR 5/3), light brownish grey (2.5Y 6/1), and grey/greyish brown (10YR 5/1-2). The brown to yellowish brown hues are often referred to as "honey-coloured" by some scholars (e.g., Haviser 1987).

Five predominant cortex types occur. Cortex around primary flints is clear white, chalky in appearance.[1] Flint with this cortex can be found on the beach and in some inland parts of the island. A second frequent cortex type is the typical brown "rusty" cortex, which can be found on the flints that are scattered within the soils, notably in the northern part behind Flinty Bay. Seen from the outside this cortex has the typical brown colour, a result of iron staining on the rock. When cut, however, the cortex may still preserve its original white colour, although fully brown examples also occur. On the beach, the flint has a water-worn outer surface; usually the typical outer white cortex rind has disappeared and the inner flint surface is exposed. Depending on the colour of the flint, this type of cortex can have many colours.

The remaining two cortex types are actually not true cortex types, but have formed as a result of natural breakage of the rock. Within the soils of especially the northern area many examples occur of naturally broken flints. As a result of chemical weathering, two main types of patina developed on the broken surfaces. One is a white patina, also commonly encountered on the Preceramic Age artefacts, and the other is a brown patina, probably the result of iron staining. The brown patina occurs in those areas where the brown cortex has also developed, which are the dark soils just behind Flinty Bay coastline. The white patina can be found in the white clayey subsoil, the weathering horizon of the limestone bedrock. These two patina types are mentioned here, as they should be considered as a specific type of outer surface when analysing the artefacts.[2]

In thin section, the matrix of the flint has a somewhat dirty appearance, with remains of calcite, fragments of fossils (bioclasts), and dark coloured particles scattered throughout the rock (see figure 2.15a,b). Such a "dirty" matrix is very typical for the limestone cherts of the Antigua Formation and indicates incomplete silification of the original carbonate host-

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[1] Although this cortex looks like limestone, it is actually flint. Under the microscope, it is built up by the same crypto-crystalline quartz as the flint portion.

[2] During the analysis of lithic artefacts from the different habitation sites on the surrounding islands, it appeared that occasionally the Amerindians collected cobbles, that were partly covered with patinated surfaces.

rock. The crystal size of the crypto-crystalline quartz in the matrix is fine compared to the other sources. It exhibits a mixture of very fine quartz, with low concentrations of coarser quartz grains (up to 0.05 mm in size). This mixture is commonly encountered among the other Antigua Formation flint sources as well. Chalcedony (fibrous crystal variety of quartz) is rare to absent, and only occurs as filling of some fossils or fossil fragments. The concentration of calcite varies considerably. Primary samples taken from the host-rock still contain significant amounts of calcite, whereas within the majority of the secondary samples this calcite is (partly) lost due to dissolution after being exposed to chemical weathering (see figure 2.22d). Bioclasts (fossils or fragments of fossils) occur within the samples, although in varying concentrations. In general, the bioclast concentrations are low; only in those cases where flint around the burrows formed within the foraminifera-rich limestone layers is the concentration higher. Fossils can both be composed of original carbonate or re-crystallised quartz. Some samples still exhibit ghosts of ooids (oval grains commonly present in limestone), which probably were present in the original limestone host-rock. Iron in the form of oxides is predominantly visible within the secondary samples. In these samples, veins with high concentrations of iron are situated in the rim areas of the rock (see figure 2.22a,b).

A.2.2 Little Cove

The Little Cove Bay is situated on the east coast of Antigua, where steep cliffs arise from the sea (see figure 2.5). All cliffs are part of the Antigua Formation. Martin-Kaye reports the occurrence of brown flints in the limestone rock at this bay (Martin-Kaye 1959). David Watters from the Carnegie Museum of Natural History was the first who noted its possible archaeological potential. In the company of Desmond Nicholson and geologist Jack Donahue from the University of Pittsburgh, Watters visited the locality in the late 1970s and took samples as reference for the determination of the provenance of flint artefacts found on Barbuda (Watters & Donahue 1990).[3]

By foot, the locality is only accessible from the south end of Half Moon Bay. After passing the Half Moon Bay resort, approximately 40 m of bush have to be crossed before a cobble beach in the northeastern area is reached. Unfortunately, one cannot wander to the other sides of the bay, as they are only accessible with a boat during calm weather.

The cobble beach in the northeastern area is approximately 50 m long and on both sides enclosed by limestone section walls. Between these sections, modern alluvium hit upon the beach. Flint can be found in primary and secondary contexts. It is still present in nodule layers in the northern limestone section, it can be found as eroded water-worn cobbles on the beach and it is also scattered within the alluvium. Upon close inspection, the limestone section revealed six mutually varying layers of flint nodules in a fine-grained carbonate mudstone. Two represent clear layers, that continue all the way through the section, and the other layers only include sparsely scattered flint nodules by approximation situated in a single layer. A striking feature is formed by a shallow cave, that has cut the section. Clear crack lines suggest a natural collapse of part of the section and the subsequent forming of the cave.

On the beach, flint predominates. It has well-rounded shapes and in most cases lacks any original chalky cortex. In the alluvial deposit, consisting of eroded clayey limestone, flint is very scarce and only occurs as irregularly sized and shaped rocks.

Any signs, that may point to the prehistoric exploitation of this flint are absent at the locality itself. On the small beach, no scatters of artefacts were identified. Also the limestone host rock did not exhibit any cut marks from taking the flint out of the limestone. However, such possible marks might have been blurred by later erosion events. Within the vicinity, one unreported prehistoric Ceramic Age site was located along the beach at the south end of Half Moon Bay. A short collection from a ploughed field in the site area produced numerous flint artefacts along with pottery and shell remains. The flints exhibit close similarity with the nearby source material. Material from other sources, in particular the Long Island source, was identified as well at this site.

The Little Cove flint generally is fine-crystalline and exhibits a dull homogeneous matrix, in which a relatively low number of inclusions can be seen. However, these are more numerous than within the Long Island flint. The primary flint is darker coloured than the secondary beach cobbles. Usually, these lighter secondary samples possess small darker coloured areas. Overall, this flint is lighter in colour than the primary Long Island material. Colour varies from (dark) brown (10YR 3/3, 4/3, 5/3) to (dark) grey (5YR 4/1, 5/1) for primary samples, and from light brownish grey (2.5Y 6/2), (pale) brown (10YR 6//3-

[3] The same samples were included in the 1997-series of ICPAES analyses, that I conducted to extend my earlier 1993-1995 research (see section on geochemical results).

5/3), to (dark) greyish brown (10YR4/2-4/3) for secondary samples. The cortex is white for primary samples and the water-worn samples have largely lost this cortex and exhibit water-worn flint surfaces.

In thin-section, this flint exhibits a dirty matrix similar to the Long Island samples, with the same mixture of very fine quartz crystals and coarser ones (see figure 2.15c). Exceptions, however, occur in which the grain-size is finer, or in which chalcedony makes up significant parts. A sample with chalcedony also differs macroscopically from the other samples by being slightly translucent. Unlike the Long Island source, the secondary material at Little Cove does not exhibit a clear decrease in the amount of calcite compared to the primary material, either suggesting shorter exposure to weathering or less intensive forms of weathering. In general, the amount of bioclasts is low (similar to Long Island), but samples may contain higher concentrations, both in re-crystallised quartz as well as original carbonate form. These samples exhibit a dirtier matrix, in which again the original limestone structure of the rock is still preserved.

A.2.3 Soldier Point

Soldier Point is a small rock mass about 3 m in height, that extends clearly from the northwestern coast of Antigua (see figure 2.5). Two sandy beaches surround the rock point: Langford Bay on the south side and Blue Waters Bay on the north side. This extended rock cliff is part of the Antigua Formation. Martin Kaye (1959) reported the occurrence of flint at Soldier Point.

Flint can be found scattered on both beaches, but also in the limestone of Soldier Point itself. Unfortunately, no extended sections are accessible and only occasional nodules are discerned on the point. The flint and limestone host rock are similar in colour and texture to the varieties found at Little Cove and the quarry site of Piggot’s Hill near the airport. This suggests a common origin and provides support for the restricted occurrence of limestone with flint in it.

At Blue Waters Bay the construction of a hotel, as seen progressing during the first visit in 1997, had severely reduced the beach area and blurred the original natural distribution of flint on it. There is only a small corner on the east side of the sand beach covered with pebbles among which a high concentration of flint can be seen. In addition, large limestone boulders have eroded out of the host rock and are scattered along the shoreline. These occasionally contain some flint nodules. During a second visit in 1998, the outline of the beach had further been reduced and the limestone boulders were taken away.

At Langford Bay, the situation is totally different. Due to the absence of any past or current construction activities, two limestone cliffs still enclose an undisturbed sandy beach. Only at the north side, where the beach borders Soldier Point, can water rounded flint pebbles be picked up. The distribution of flint is very limited. On the south side, flint is absent and the cliff basically consists of the limestone deposits with foraminifera in it, similar to the limestone, that underlies Long Island. The slope of the cliff, dipping in direction toward Soldier Point and its closer geographical proximity to the older Central Plain group, suggest the same stratigraphical relation of foraminifera limestone with the flint-bearing limestone, as at Piggot’s Hill.

Neither at Blue Waters Bay nor at Langford Bay is there any evidence of prehistoric exploitation of flint. The major disturbing activities at Blue Watters Bay, however, may have destroyed any such evidence.

The Soldier Point flint strongly resembles the Little Cove material in colour and grain-size; only the amount of inclusions is on average higher within the Soldier Point flint. Samples exhibit a more heterogeneous matrix as well, with some large carbonate grains and bioclasts. The colour does not vary much between primary and secondary material. It ranges from dark greyish brown (10YR 4/2), greyish brown (10YR 5/2), brown (10YR 5/3) to pale brown (10YR 6/3), with the first two hues predominating. The cortex is white chalky or water-worn.

In thin-section, this material exhibits on average a dirtier matrix than the other Antigua Formation sources, with still a lot of carbonate in the form of micrite and coarser-grained calcite preserved (see figure 2.15d). The concentration of bioclasts varies. Quartz crystals in the matrix have similar size ranges to the other Antigua Formation flints, with fine grains and coarser ones mixed. One secondary sample exhibits clear voids, which were probably formed after the dissolution of calcite.

A.2.4 Blackman's Point

Desmond Nicholson was the first to identify the natural occurrence of flint at Blackman's Point during his early 1970s archaeological fieldwork at a multi-component site situated along the northeastern coast of this extended point (see figure 2.5) (Nicholson 1976). Although he did not report it then, Nicholson later showed the archaeological site and the natural distribution of flint cobbles to the Leiden field crew working at Long Island in 1989 (see Chapter 4).

Blackman's Point is named after a mill, that is situated in the middle of this peninsula. The area is uninhabited nowadays and can be crossed by a dirt road, which runs along the eastern coast. This area of the island lacks extended sandy or cobble beaches. In general, the coastline is a low, rocky shore, that is covered by vegetation. Soils in this area are clayey, which can be probably related to the presence of former salt ponds, still existing along the eastern coast in some areas.

During two visits in 1998 and 2000, the entire eastern coastline including the salt ponds, the area in the immediate vicinity of the dirt road, and the neighbouring coast to the southeast and southwest of Blackman's Point were inspected for flint. The more inner landward parts of the "point" were only superficially looked at, as impenetrable bush and the absence of clear rock sections or outcrops made it very unproductive. It appeared that basically along the entire eastern coast natural flint rocks are scattered about. The concentration of flint differs significantly and is highest in the southern area, in the middle part of the area surrounding one of the dried salt ponds, and the northern area of the peninsula adjacent to the archaeological site. In the southern area flint cobbles are generally small, with a maximum length of 20 cm or less. More to the north adjacent to the archaeological site locality, flint blocks become significantly larger. Some exceed 60 cm in maximum length. The material there is different in nature, as the flint is lighter in colour.

Apart from Blackman's Point, flint can be also found at neighbouring Brian's Wharf parallel to a small dirt road crossing an extended dried part of its shoreline. The flint scatter is probably artificial and must be related to the foundation of the dirt road. Local Antiguans likely collected rock material from somewhere in the Blackman's Point area and dropped it on the slightly clayey bottom of the dried shoreline to preserve the road.

The absence of bedrock cross-sections as a result of flat topography in this part of the island inhibits the search for primary flint deposits and complicates its stratigraphic placement within the local limestone sequence, as identified elsewhere. Most probably, the original limestone host-rock containing flint nodules has been eroded and dissolved leaving the more persistent flint. This view is supported by the significant degree of weathering on the flint, evidenced by its coarser grain-size and lighter colour. Thin-section analysis revealed that this chemical weathering is responsible for the almost complete dissolution of the original calcite crystals making the flint more porous and hence, lighter in colour. The more extensive calcite dissolution relative to Long island flint, for example, suggests a longer period of weathering.

Close to the salt ponds possible evidence of local flint exploitation was encountered in the form of sparsely distributed artefact scatters. Further proof of the use of the local flint is found within the multi-component Blackman's Point site. Analysis of archaeological material excavated by Fuess in 1993 (Martin Fuess, personal communication 2001; see Chapters 5 and 6) showed that the Post-Saladoid inhabitants made extensive use of this local flint in addition to Long Island flint, whereas the earlier Preceramic Age people there neglected the local Blackman's Point flint and only worked Long Island flint.

Blackman's Point flint varies in appearance, including colour, texture, and the number of inclusions. In general, it is a dull flint, relatively light in colour, especially when one compares it to the dark grey Long Island flint variety. A very striking characteristic of this material is its reddish to pinkish colour on many pieces, which must be associated with an increase of iron in the rock as a result of chemical weathering, as has been shown by the geochemical analysis. The large variation in colour is clearly evident from the different hues identified among collected lithic samples. Grey varieties vary from light grey (10YR 8/2, 2.5Y 7/1), grey (10YR 6/1, 2.5Y 6/1), to dark grey (10YR 4/1). Brown-yellow flints vary from light brownish grey (2.5 6/2), pale yellow (2.5 Y 7/4), very pale brown (10YR 7/2, 7/3, 7/4), (light) yellowish brown (10YR 5/4, 6/4), to brown (10YR 5/3). The reddish and pinkish hues are pinkish grey (10YR 7/2), pink (7.5YR 7/3, 7/4), (light) reddish brown (2.5 R 5/3, 5YR 6/3), weak red (10R 4/4), and pale red (10R 6/2). These hues do not necessarily represent different groups of rock pieces. Individual flint specimens may consist of different coloured bands or areas, that have hues both within the grey, brown as well as pink to red ranges.

Blackman's Point flint generally does not contain clearly visible inclusions, giving it a homogeneous appearance. However, exceptions occur, with rare specimens containing many inclusions. Two main types of inclusions are present: round white clasts and re-crystallised fossil fragments.

Blackman's Point flint is on average coarser grained than the other Antigua Formation flints. This is attributed to chemical weathering and the formation of voids. On the other hand however, some exhibit a fine grain-size, suggesting less alteration. The flint cortex of the flints is generally water worn and (dark) (yellowish) brown (7.5 YR 3/3, 4/4, 10YR 4/3, 4/4) in colour on the exterior.

In thin-section, Blackman's Point flint is similar to the primary Antigua flint occurrences regarding typical quartz grain-size, in which the matrix predominantly consists of very fine particles, with larger particles (up to 0.05 mm) scattered through it. Blackman's Point flint differs, however, in the absence of calcite leaving clear voids, which in some cases are filled by iron oxides giving them a dark appearance in plain light, or in other cases left blank (translucent in plain light; see figure 2.22c). This makes the rock a relatively pure quartz chert. These samples also lack the typical dirty matrix seen in other Antigua flints. However, some specimens do exhibit re-crystallised bio-clasts, which are often built-up by a fibrous chalcedonic variety of quartz. No detrital minerals are present in the samples.

A.2.5 Coconut Hall

During my first field-trip to Antigua in 1997, Reg Murphy, government archaeologist on Antigua, mentioned to me the Coconut Hall locality (Reg Murphy, personal communication 1997). This locality is situated on a small peninsula on the north coast of Antigua (see figure 2.5). The area is flat, except for a small hill at the northeast end overlooking Coconut Hall and the neighbouring islet of Guard Point. Today, the little hill exposes evidence of recent quarry activities. However, this quarry was not being used during both of my field trips. The surrounding coast is very irregular, with numerous bays and inlets, covered with dense mangrove vegetation. The underlying geological formation is the Antigua Formation.

Surface inspection revealed that on the fallow grassland to the southwest of the hill and on the north side of a dirt road small concentrations of different sized flint blocks are scattered across the surface along, with chalk rock. Today dirt piles erected by local farmers to clear the land of bush, wood, and large stones, have resulted in artificial higher concentrations of flint. The extension of the scatter of flint blocks is around 100 m to 200 m. The area where flint can be found is low in elevation, but moving towards the southwest, the land slowly rises and the ratio of chalk rock to flint increases significantly, with only chalk and no flint at the highest points. Unfortunately, clear bedrock sections are almost absent and can be only inspected for flint nodule layers at the quarry site. No such layers can be discerned at the quarry, however.

The flint blocks are angular in shape and do not exhibit signs of considerable erosion. This suggests that natural movement has not occurred. Local limestone bearing flint nodule layers were probably eroded, leaving the more resistant flint blocks, similar to the situation at Blackman's Point and on Long Island. This would suggest that in the higher areas the flint bearing chalk may still be in its original deposition and that with the help of excavations the flint bearing rock could be unearthed to localise its exact stratigraphic position. This would be a time consuming enterprise and therefore, was beyond the means of my field trips.

Just at the foot of the quarry hill, the remains of an extensive Amerindian settlement site can be discerned. Recently, Martin Fuess did survey work and small-scale testing at this site (Fuess 1995; Fuess, personal communication 2001). From Fuess' report, it is evident that recent bulldozing has destroyed large sections of the northern part of the site. Preliminary conclusions about the site's chronology state that it is dated to the Late Ceramic Age, two shell samples producing a calibrated date between AD 935 – 1190 (95% confidence intervals) (Fuess 1995, personal communication 2001). Brief inspection of excavated material from Fuess' test-excavations revealed that the inhabitants of the Coconut Hall site exploited both the local flint and the Long Island material (see Chapters 5 and 6).

Coconut Hall flint varies considerably more in macroscopic and microscopic appearance than the other Antigua Formation flints. Three general varieties can be distinguished. One variety consists of semi-translucent flints that contain many inclusions, giving the rock a heterogeneous appearance. Predominant colours are dark greyish brown (10YR 4/2), brown/dark brown (10YR 4/3), brown (10YR 6/3), to pale brown (10YR 6/4). The second variety includes dull light coloured banded flints, containing small amounts of inclusions. Colours vary from yellowish brown (10YR 5/4), light brownish grey (2.5Y 6/2), greyish brown (10YR 5/2), light grey (2.5Y 6/2-7/2, 10YR 7/1), to pale brown (10YR 6/3). The third variety is a dull, coarser grained flint, with few inclusions. It has a light colour, which ranges from grey (2.5Y 6/1), light grey (2.5Y 7/1), to white (5YR 8/1). This latter variety, especially distinguishes itself from the other two.

In thin-section this latter variety appears to be a non-complete silicified flint, in which high amounts of carbonate remain (see description of St. Kitts material for other similar examples). The other varieties display diverse matrix and quartz types under a microscope. Unlike the majority of Antigua Formation flints, many of these flints do not exhibit the typical dirty matrix of fine quartz, with a small number of coarser crystals. A large group has a coarser crystal size, or significant parts of a radial fibrous chalcedony (see figure 2.17e,f and Schubel & Simonson 1990 for a similar example of this type of chalcedony). Another recurrent and distinct feature is the presence of many veins in the Coconut Hall rock, with a distinct quartz filling within the matrix (see figure 2.15f). This quartz filling is solely chalcedony in the case of thin veins, or additionally filled with macro-quartz crystals when wider. This type of filling suggests later silicification of the veins and voids. In addition, some veined areas also contain very fine crypto-crystalline quartz.

The presence of different quartz crystal fillings suggest different phases of silicification and it clearly distinguishes Coconut Hall flint from other Antigua Formation flints. In this regard, they display some similarity to the Puerto Rican cherts. However, it is unclear how the exact trajectory of the silicification of the Coconut Hall flints can be explained. From the presence of bioclasts, it is minimally clear that silicification started as a replacement process within limestone host-rock, similar to other Antigua Formation flints. It is unclear whether the voids were formed as a result of deformation of the initially formed chert or represent areas of incomplete silicification.

A.2.6 Shirley Heights

The Shirley Heights locality is the only chert occurrence known within the Basal Volcanic Suite on Antigua (see figure 2.5) (Weiss 1994). Christman (1972) reported the occurrence of tuffs in this area. Outcrops of irregularly shaped inclusions of chert in brown and lighter coloured tuff deposits can be seen close to the road that leads to the main building of the Shirley Heights fortification and also on the northern flank of the hill adjacent to the fortification.

There, the concentration of eroded secondary cherts is very small and no signs pointing to prehistoric exploitation were discerned. Only limited field-walking was conducted in the immediate Shirley Heights region. Therefore, this means that additional outcrops may be present there. Furthermore, secondary deposits may occur in the low-lying areas surrounding the Shirley Heights hills, especially near the English Harbour Bay to the west or in the Indian Creek valley to the north.

This chert generally has a slightly translucent and light coloured appearance. Some rocks exhibit a homogenous single coloured matrix without discernable inclusions. Other samples are mottled in colour and have dark coloured inclusions. The colour can vary from white (10 YR 8/1, 2.5 Y N8) to (light) grey (7.5 YR N6/ ; 10 YR 5/1, 7/2; 2.5 Y N5/, 7/1-2).

In thin-section, this chert is very pure (see figure 2.16a). The matrix exclusively consists of homogeneously distributed and relatively coarse-grained crypto-crystalline quartz crystals that are clearly larger than the general crystal size among the Antigua Formation and St. Kitts flints (see below). Inclusions in the form of calcite crystals, micrite, bioclasts, iron oxides, or other lithoclasts are completely absent. The absence of bioclasts and calcite suggests formation within a non-carbonate host.

A.2.7 Corbison Point

The Corbison Point locality is an extended rock along Antigua's northeastern coast (see figure 2.5). Like Dry Hill (see below), it has been well known for a long time among geologists and rock collectors for its abundant silicified wood (K. Earle 1923; Nugent 1821; Purves 1884). In addition, a cliff there exposes several chert layers that are inter-bedded with mudstones and calcareous tuff. Weiss (1994, 17) reports, from study by Marek (1981), that the fossils in the different rock strata point to both marine and freshwater origins, and probably the cherty layers were formed close to the coast. They represent secondary chertification with the silica probably originating from inter-bedded volcanic muds and soils, as both marine and fresh water deposits were silicified.

Corbison Point has become the geological type-site for the chert beds that can be found at numerous places within the Central Plain Group, notably at Dry Hill. Chert and petrified wood have a very restricted occurrence, basically corresponding to the extension of the rock point. Siliceous materials are absent along both the adjacent northern and southern beaches. Only on the northern side is the point accessible and samples were taken from different beds as well as from secondary material lying on the small cobble beaches. No signs of human exploitation in the form of flaking debris were identified.

The primary chert is dull and has a (very) dark grey (7.5YR 3/1, 4/1, 10YR 3/1, 4/1) colour. Secondary material is lighter and exhibits a wider variety of colours, ranging from white (5YR 8/1), (light) grey (5YR 7/1,6/2,5/2) to pinkish grey (7.5YR 6/2). Both primary and secondary material is fine to medium grained, exhibiting a coarser size than the Antigua Formation flints. In general, these cherts contain varying amounts and types of inclusions. Some samples display clearly distinguishable and relatively large fossils, whereas in others only small white unidentifiable grains are seen. Rare samples exhibit no inclusions at all. The bedded nature of the chert is also clearly evidenced by variation in clast contents following this bedding and parallel orientation in chert samples.

The variable origin of this chert is also visible on a microscopic level. Thin-section analysis demonstrates considerable difference in quartz size, fossil content, and bedding between samples. Four groups can be distinguished on a microscopic and chemical level (see Chapter 2). These include: (A) a bioclast rich and carbonate poor chert (see figure 2.16b); (B) a bioclast rich and carbonate rich chert; (C) a pure quartz chert without inclusions; and (D) a dirty bioclast poor chert, much resembling some of the Antigua Formation flints. The last three groups each correspond with a different chert layer, suggesting significant inter-layer variation. This contrasts to the absence of such variation among flint nodule layers of the Antigua Formation flints. Furthermore, most of the secondary materials can be classified to one of these groups as well, clearly indicating that they originated from one of these layers. Only the pure quartz samples are all secondary in nature and probably originated from a layer of chert, that is currently not exposed.

A.2.8 Dry Hill

The elevated rock cliff at Dry Hill is situated only 1.5 km to the south of the Corbison Point locality and adjacent to the sandy beach of Fort Bay (see figure 2.5). There, an approximately 10 m high cliff exposes a sequence of chert layers inter-bedded with muddy limestones (Weiss 1994, 17). Martin-Kaye considered these beds to be the same as those found at Corbison Point, which is confirmed by microscopic and chemical analysis (see Chapter 2). In general, the beds are not thicker than 1 m at Dry Hill and I identified three beds. In addition to these beds, eroded chert material is lying at the foot of the cliff in the form of rounded and angular cobbles. No signs of human exploitation are evident along the cliff.

This material generally exhibits a close similarity to the Corbison Point cherts in macroscopic appearance. The primary chert is generally dark in colour, whereas the secondary material is lighter. In most cases, this chert is homogeneous, without clearly identifiable clasts. Some samples contain clearly distinguishable fossils. Colour ranges from (very) dark grey (10YR 3/1, 4/1), grey (10YR 5/1), greyish brown (10YR 5/2), to light brownish grey (10YR 6/2). Secondary samples display a similar range, with the lighter hues predominating.

Dry Hill chert has less variation on a microscopic level than Corbison Point. Basically, the samples correspond with groups C and D of the Corbison Point chert. These include the bioclast rich and carbonate rich variety (C), and the dirty bioclast poor chert (D) (see figure 2.16c).

A.2.9 Other chert localities in the Central Plain and Basal Volcanic Suite regions

In addition to the chert sources described above, samples were taken from two additional Antiguan localities, at Willis Freeman near the small village of Table Hill Gordon, and at the village of Buckeys and its surrounding (see figure 2.5). Both places where chert was collected expose artificial outcrops or scattering of chert material. Therefore, they were not likely exploited by Pre-Columbian Amerindians. Analysis of a limited number of samples revealed that both chert varieties macroscopically display differences with the other cherts from other geological regions of the island. Under a microscope the chert from Buckleys appears to be similar to the Shirley Heights chert in quartz matrix features and the absence of calcite and fossils. Willis Freeman chert to some degree shares these features, although one sample likely is a silicified coral, preserving some of its original structure.

These data show that chert in this part of the island is relatively variable, particularly when the Corbison Point and Dry Hill localities are set against the other cherts. A close reading of available geological reports shows that still other chert outcrops exist on Antigua, notably in the Central Plain region of the island.

A.3 St. Kitts

A.3.1 Flint occurrences

Though unexpected due to the island's volcanic character, natural scatters of flint occur on St. Kitts. They were first identified, mapped and described by an archaeological team of Arizona State University during several field-campaigns in the 1970s. They reported a total of five such localities (Armstrong 1978; Walker 1980a, 64). K. Earle (1924) mentions a possible sixth occurrence of chert-like rock at Goodwin Gut, in St. Kitts. Walker (1980a) however, was unable to locate this chert-like material during his fieldwork. All other sources can be considered secondary and any associated limestone host-rock is absent (Walker 1980a). Most of them, including Great Salt Pond, Banana Bay, and White House Bay, are situated on the southeastern peninsula (see figure 2.6). The other two occurrences, Sugar Factory Pier and Bird Rock are located to the east of the capital Basse Terre along the southern shore of the island, adjacent to the Amerindian site of Sugar Factory Pier. Flint at White House Bay, Banana Bay, and Sugar Factory Pier can be found in the form of small nodules scattered among volcanic pebble beaches. At Bird Rock flint is found below the cliffs forming the coastline, and at Great Salt Pond flint pebbles are lying among volcanic cobbles on an artificial dam that has been erected to divide the salt ponds. I visited St. Kitts during a short stay in 1994 and collected flint at Great Salt Pond and Sugar Factory Pier.[4]

Despite efforts by Walker and me to find primary flint depositions at Brimstone Hill and other limestone outcrops, the origin of the St. Kitts flint remains unclear. Except for Earle's information on the Goodwin Gut jasper, none of the geological reports mention the occurrence of flint in any of the limestone outcrops. The only additional remark on the presence of flint on the island is made by Branch, which probably relates to one of the four coastal occurrences, mentioned above, when he states that flint can be found in the "shingles of some beaches" (Branch 1907, 322).

This lack of a clear primary depositional environment raises many questions. The most important ones include: should the material be associated with limestone host-rock, or does it represent chert or chalcedony material from a volcanic origin? Is the material natural to the island, or can its occurrence be considered artificial, e.g. the dropping of ballast loads during historic times?[5] If it can be considered a flint natural to St. Kitts, how is its occurrence explained within the volcanic structure of the island?

The first question regarding the type of chert can be answered straightforward. Thin-section studies (see below) clearly show that this chert material contains carbonate fossils and other biogenic clasts, and a variable amount of carbonate in the form of calcite and micrite. Such features point to a marine carbonate environment during genesis that is not found in volcanic materials. Furthermore, the occurrence of carbonate fossils excludes a non-carbonate marine environment of origin, commonly encountered among bedded cherts.

The second question can be only answered indirectly. Walker (1980a) saw a close similarity between two types of chert used at the Pre-Columbian Early Ceramic Age site of Sugar Factory Pier and the materials that he collected from different local flint localities. This implies that the flint was available to the Amerindian populations who inhabited St. Kitts before Columbus and that the flint cannot be a relict of historic activities.

Still some questions remain in relation to this issue. These include: (a) chemical analysis of two artefacts, that may be local to the island did not produce a St. Kitts origin (see Chapter 2). Furthermore, most of the Sugar Factory Pier artefacts within the small sample provided to me by Walker did not resemble the St. Kitts material more than they did some of the Antigua sources, other than Long Island. Walker did not know about these other Antigua sources at the time of his work on the Sugar Factory Pier material; (b) the percentages of flint within the archaeological collection of the Sugar Factory Pier settlement, for which Walker assumed a local origin, are five times lower than the percentages of exotic Long Island flint. Such a low percentage is strange for locally available material and they suggest that it too is exotic; (c) the Preceramic Age people at Sugar Factory Pier prior to their Saladoid successors did not use presumably local St. Kitts flint. Instead, they only used volcanic material for the production of flakes, as Armstrong reported (1978, 1980), and (d) Flaked material from other sites on surrounding islands either produced no material that resembled the St. Kitts material, or only very small amounts that were doubtfully attributed to St. Kitts. So far, I have not encountered a single site, where a significant number of artefacts can

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4 I did not visit Banana Bay, Bird Rock, and White House Bay, as I was unaware of the fact that flint was present there. In Walker's Proceedings article (1980b, 73), the only reference I had in my possession at that time, he mentions flint at Majors Bay, Great Salt Pond, and Sugar Factory Pier. At the latter two, I collected flint, but at Majors Bay I was not able to find any flint nodules. This absence was later confirmed by my reading of Walker's Master thesis (1980a), in which no mention is made of this location.

5 See Appendix B on Hughes Bay for a possible example of an artificial flint occurrence on Antigua. Westermann (1957) and Langemeyer (1937) report an example of stone ballast droppings on St Martin.

be assigned to one of the varieties that definitely belong to the St. Kitts material.

These four points cast serious doubt on a natural origin for flint on St. Kitts. However, I was not able to conclusively disprove such an origin, keeping in mind the fact that Walker, who had seen much more of the Sugar Factory Pier material, discerned strong similarities between these artefacts and the natural material. Therefore, I still consider the flint on St. Kitts natural to the island, until proven otherwise.[6] Including source material with a doubtful origin may well have serious consequences in the end for understanding raw material distribution. Given the rare occurrence of artefact materials that can possibly be related to the St. Kitts sources, such consequences in this case will be only limited. Incorrect assignments will only result in slight changes of the distributions obtained and will not likely alter the overall picture of raw material procurement and exchange among the islands.

Given these conditions, and assuming that the flint is natural to the island, how should its occurrence be then explained? Definite solutions cannot be provided at present and only possible options can be suggested. It is noted that all the localities where flint is found on St. Kitts lie in the areas where the older deposits of the island are present on the surface. These belong to the southeast peninsula group of volcanic rocks. This suggests that if limestone formations were present within these areas, then they would have been subject to a longer period of erosion than elsewhere. Furthermore the later eruptions of the Mount Scenery centre may have had very disturbing effects on the visibility or availability of any such formations at present. From this the following scenarios emerge:

1) A submarine carbonate platform was present at the time of the first volcanic eruptions on St. Kitts around 2.3 Ma. These eruptions lifted part of the limestone up, after which it became exposed to weathering and erosion. The limestone was largely dissolved and the more resistant flint remained. This would mean that the carbonate platform pre-dates volcanic activity in this area, which is very unlikely considering the depths of the ocean. Usually, carbonate platforms evolved after the formation of volcanic islands, as is the case with the Brimstone Hill Formation on St. Kitts, and the White Wall Formation on St. Eustatius (Westerman & Kiel 1961). It also accounts for the Miocene limestone formation in the St. Martin/Anguilla area and the Antigua Formation on Antigua (Christman 1953; Multer *et al*. 1986).

2) Therefore a logical second solution states that after the first volcanic eruptions, a submarine carbonate platform was formed in the vicinity of the newly arisen island. This marine platform was lifted by later eruptions or tectonic activity, which still predated the volcanic activity at the South East Range, Middle Range, and Mount Scenery centres, and became exposed. This uplifted limestone was later eroded, dissolved and the flint remained. Flint remained only accessible for exploitation in the southeast area of the island, where later volcanic activity did not cover the earlier formed igneous rock.

These scenarios would entail that the occurrence of flint should not be related with the present occurrence of limestone on the island, as this limestone is related to younger depositional events. Brimstone Hill, for example, was formed during the Pleistocene epoch prior to the eruptions of the Mount Scenery centre, but probably after the Middle Range eruptions (Westerman & Kiel 1961). This younger age explains the unsuccessful attempts by Walker and me to locate the flint in the Brimstone Hill Formation.

A.3.2 Macroscopic and microscopic characteristics

After macroscopic inspection, and microscopic and geochemical analysis it became clear that the flints from the Great Salt Pond and the Sugar Factory Pier localities in St. Kitts are very similar and probably originate from the same geological setting. Therefore, the characteristics of both localities are treated here as one.

The material itself is variable in nature. Generally, the pebbles do not exceed 10 cm in dimension and are heavily rounded due to water erosion. Limestone cortex is lacking, although some pebbles exhibit a white outer surface. Basically, two types of flint can be distinguished macroscopically: predominantly a semi-translucent flint with a homogeneous matrix,

[6] A possible option to test its natural origin would be an analysis of dinoflagellates. Past study has shown that these one-celled organisms are well preserved in flint due to their resistant tests. This resistibility makes it possible to extract these tests from the flint and study them under the microscope. The analysis of European flints has shown that they may be a good stratigraphic marker (Rademakers 1995; Verhoeven 2002). This provides a good means to test a local or exotic provenance for the St. Kitts flints, as the island's geological age is much younger than the age of, for example, the European flints, Europe being the most likely origin in case of an artificial Historic occurrence of flints on St. Kitts.

in which occasionally relatively large light inclusions occur. Colours range from black, (very) dark grey (2.5Y N3, 10YR 3/1, 4/1), (very dark) greyish brown (2.5Y 4/2, 10YR 3/2, 4/2, 5/2), brown (10YR 5/3), light olive brown (2.5Y 5/3), brownish yellow (10YR 6/8), to light yellowish brown (2.5Y 6/4, 10YR 6/4). The other type consists of light coloured dull flint, ranging from (light) grey (2.5Y N6/, 10YR 6/1) to light brownish grey, (2.5Y 6/2, 10YR 6/2). Some samples in this latter type are homogeneous, corresponding with calcite rich samples, whereas mottled ones, containing white inclusions, are more of a pure quartz type.

Under the microscope, the matrix consists of very fine crypto-crystalline quartz, which is considerably finer than the quartz within the Antigua Formation flints (see figure 2.16e). All analysed samples exhibit this fine crystal size, pointing to a similar origin. The dull light coloured rocks are actually poorly silicified flints. The samples still contain a lot of calcite homogeneously distributed throughout the rock (see figure 2.16f). The semi-translucent flints can be divided into two groups. One is a very pure chert, with only very small numbers of bioclasts (fossils), that all occur in a silicified (quartz) form. The other is a bioclast rich rock, in which both re-crystallised and carbonate fossils occur. This type also has a dirtier matrix, with more micrite preserved. The large lighter coloured inclusions under the microscope appear to be areas in which the concentration of micrite is higher.

A.4 Puerto Rico

A.4.1 Cerrillos

Pike and Pantel (1974) were the first to report on the occurrence of chert at Cerrillos. In their contribution to the Proceedings of the fifth International Congress for the study of the Pre-Columbian cultures of the Lesser Antilles, they mention the presence of a high concentration of worked chert material and natural nodules at this locality. They interpret Cerrillos as a workshop area, where knapppers collected and pre-worked flint material. Later research by Pantel showed that Cerrillos probably was visited during the Preceramic Age as is suggested by the use of a blade technology and early radiocarbon dates (Ortiz 1976).

Geologically, the locality is situated within the Guanajibo Formation dating to the Miocene, which is surrounded in this area by Tertiary Quartz Sand deposits (see figure 2.7) (Volckmann 1984b). In both geological units, the primary occurrence of chert is not mentioned. The Guanajibo Formation consists of loosely cemented calcirudite and calcacerite, while the quartz sand deposits do not contain large clasts. In a personal communication to Ortiz, Volckmann explained the occurrence of the chert at Cerrillos by the complete weathering of limestone rock after which the chert residing in it remained (Volckmann, personal communication to Ortiz, 1976).

At the time of my visit to Cerillos, it was obvious that road construction and house development during the past few decades had considerably affected the area, and only left a small portion of the original flint distribution and the archaeological work-shop site (Walker, personal communication 1998). On a small field, not extending more than a few hectares, chert material is scattered across the surface. This includes clear artefacts and natural cobbles in a moderately dense concentration. Superficial inspection revealed that the artefacts can be associated with the blade technology identified by Pantel and Ortiz (Ortiz 1976; Pike & Pantel 1974).

A very characteristic feature of the chert material at Cerrillos is its reddish colour on the exterior, varying from yellow (10YR 7/6), reddish brown (7.5YR 6/6), to brown (7.5YR 5/4). Both the artefacts and the natural material possess this same colour. That this represents a form of iron staining on the flint, related to the high iron contents of the surrounding red soil, is evidenced by the different colour that they exhibit when freshly flaked or cut. In general, the chert is dull and exhibits variation in colour within the stone. Cut specimens expose light coloured medium-crystalline chert. Generally the matrix of the chert is heterogeneous, displaying veins of different texture and colour, as well as different coloured areas. Some specimens, however, exhibit a more homogeneous chert matrix. The boundary with the outer surface is irregular and occasionally iron minerals, probably pyrite, are visible. The colour may vary from white (10YR 8/1, 2.5Y N8/), light grey to grey (2.5Y N7/, 10YR 5/1), very pale brown (10YR7/3), pale brown (10YR6/3), light yellowish brown (10YR 6/4, 2.5Y 6/3) to brown (10YR 5/3), and in rare occasions, red (2.5YR 5/6, 4/8) occurs as well.

Thin-section analysis showed that this chert is a pure quartz chert without any carbonate, bioclasts, or lithoclasts (see figure 2.17a). The iron staining of the flint is clearly evident under microscope as a high concentration of red iron-oxide in the rim area. The structural absence of carbonate and fossils does not make this a typical limestone flint, as was hypothesized. Also, the crypto-crystalline quartz matrix clearly differs from the ones encountered among the Antigua and St. Kitts flints. The matrix generally displays a homogeneous distribution of crystals, which are generally coarser than the Antigua flints and in particular, the St. Kitts ones. In rare areas, the rock differs in crystal size. These areas may be finer than the Antigua flints, for example, but coarser parts also occur. All rock samples are veined, in which vein filling is different from the surrounding matrix. In most cases macro-quartz fills these veins, surrounded by a chalcedony rim, which marks the boundary between the matrix and vein filling. In some cases, veins are either completely filled with chalcedony or very fine quartz similar to the St. Kitts matrix. Similar to the Coconut Hall flint, these veins represent later phases of silification relative to the matrix.

A.4.2 Las Palmas

Las Palmas is the southernmost chert occurrence, situated in-between the villages of Las Palmas and Pole Ojea and lies approximately 3.6 km from Puerto Rico's southern coast (see figure 2.7). A similar situation exists there relative to Cerrillos. Natural chert material is scattered over an extensive area at Las Palmas, approximately a few hectares, of slightly sloping terrain. Among many natural pieces, clearly flaked material was found as well. Artefact scatters clearly differ in concentration and density. A superficial inspection of the artefacts revealed that a blade technology was used to reduce the material. This occurrence at Las Palmas has not been studied archaeologically to my knowledge, leaving the geographical extent of the site, its function, and period of usage unclear. The presence of blades suggests that it was minimally exploited during the Preceramic Age.

From the geological map of the area, it is clear that this locality is situated within the Ponce Limestone and Juan Diaz Formation, which has an Oligocene to Miocene date (see figure 2.7) (Volckmann 1984a). Volckmann (1984a) reported about the rocks associated with this formation, including:

"(1) Yellowish-white to yellowish-orange poorly cemented, somewhat friable calcirudite and calcerenite (...). Commonly capped by 1-3 m of caliche which contains abundant fragments of underlying calcirudite and calcerenite. (2) Reddisch-brown to reddish-orange, interbedded sand and medium-to coarse-grained gravel poorly cemented with calcite and hematite. Gravel 2.4 km west of Las Palmas consists of rounded clasts of chert derived from the Sierra Bermeja. Gravel in the area northeast of Corozo contains clasts of limestone, volcanic rock, and chert."

The described gravel occurrence 2.4 km west of Las Palmas refers to the locality where we found chert pebbles and some artefacts. Although it is obvious that the area consists of limestone, Volckmann states that the chert was not formed herein, but that it likely originated from the Sierra Bermeja, more to the east, which lies within the Mariquita Chert Formation (see figure 2.7) (Lower Cretaceous and Upper Jurrasic). This formation consists of:

"Yellowish-red, brownish-red, greyish green, black or white, fine-to medium-grained bedded chert and silicified limestone (KJml)" (Volckmann 1984a). "Chert typically consists of an interlocking mosaic of microcrystalline quartz which in many areas has been partially to completely recrystallized and generally is fractured or brecciated; quartz and (or) calcite and limonite-hematite commonly fill fractures and voids between breccia fragments. Radiolaria and locally Forminifera are abundant constituents. Locally Radiolaria are completely recrystallized and may be selectively stained by iron oxide" (Volckmann 1983a).

Careful inspection and microscopic analysis of collected rock pieces demonstrated that the Las Palmas chert can be divided into two broad distinct varieties, each possessing characteristics that point to different geological origins. The large group, which is also associated with the artefacts, has a very variable macroscopic appearance. The majority has a very heterogeneously or mottled looking chert surface, displaying irregular and differently coloured and textured patterns in the matrix and veins that crosscut the rock. Less frequently occurring are more homogeneous cherts, which can be dull and slightly translucent. Many chert pieces exhibit signs of iron oxidation in the form of red coloured bands or red inclusions. The colours are broadly variable. Most fall in the range from white (10YR 8/1 8/2), light grey, light brownish grey, greyish brown (10 YR 7/2,6/2,5/2), very pale brown to pale brown (10 YR 8/3, 7/3, 6/3). Among the homogeneous cherts, dark and light colours both occur, including: dark grey (7.5YR 4/1); white (N8/); yellow (10YR7/6, 8/6); and white-pinkish white-pale red (2.5YR 8/1-2, 7/2).

From microscopic study, it is clear that these rocks almost exclusively consist of quartz. The matrix of micro- to crypto-crystalline quartz in this chert has a heterogeneous appearance, in which coarse and fine-grained crystals co-occur, as well as significant amounts of fibrous chalcedony. These cherts strongly resemble the cherts from the other Puerto Rican localities in thin-section, and the secondary flint from Coconut Hall on Antigua.

The second variety macroscopically distinguishes itself by a dark grey-green colour (dark greenish grey 10BG4/1), and it is a bedded chert. Under the microscope, it exhibits a much more homogeneous quartz matrix, which consists of fine micro- to crypto-crystalline quartz. Very distinctive features of this chert are the presence of radiolarian fossils and detrital amphibole fragments. In particular, the presence of this latter mineral is not shared with any of the other cherts and flints studied in this dissertation work, and clearly suggests a different geological relation.[7]

Comparison of these characteristics with the description of Volckmann suggests that this latter grey-green chert originates from the Mariquita Chert Formation. Similarly coloured cherts can be found there, but more importantly an amphibolite formation underlies the Mariquita chert, clearly explaining the presence of this mineral in the present chert. Considering its distinctive green colour, this latter chert type will be left out of the following description and discussion of the macroscopic, microscopic and chemical characteristics (see objectives stated at the beginning of Chapter 2).

As already noted, the first variety of Las Palmas chert shares many similarities with the Cerrillos and the other Puerto Rican cherts under the microscope. It is a pure quartz chert without bioclasts and lithoclasts. The presence of carbonate could not be clearly identified. Similar to Cerrillos, the absence of carbonate does not suggest a common limestone flint. Iron-oxide forms a variable component of this chert.

Furthermore, the chert samples exhibit considerable variation in the quartz matrix and structure of the rock. Two samples are silicified breccias, having a texture like a graywacke. The original grain structure is still visible as different coloured quartz areas in the rock. Furthermore, the fillings between the grains have a different quartz composition (usually in the form of chalcedony) than the fillings of the grains themselves. To some extent, these cherts follow Volckmann's description of the Bermeja chert, although the presence of fossils was not identified.

Other samples are very homogeneous looking quartz chert, in which size of the crystals does not vary much. Generally, size of the quartz is coarser than among, for example, the Antigua flints; some samples even contain some areas with macro-quartz. In addition to these types of quartz, a very distinct form of chalcedony was identified, which resembles the radial fibrous type identified among the Coconut Hall flints (see figure 2.17e,f and Schubel & Simonson 1990 for another example). Again, the chalcedony building occurs from a centre point, in contrast to length-slow chalcedony, in which chalcedony growth is along a boundary. This length-slow chalcedony was also present in vein fillings. In addition, veins can sometimes contain very fine crypto-crystalline and macro-quartz, similar to the Cerrillos chert.

A.4.3 Villa Taina

The Villa Taina locality is situated a few hundred metres from an archaeological site of the same name that was excavated by Goodwin and Walker (1975), approximately 2.5 km to the west of the village of Boqueron (see figure 2.7). In a small gut coming from the adjacent hill, occasional large blocks of chert are scattered on the surface. The size of the locality is small and the amount of material is low. The quality of the material is poor, because the blocks contain many irregularities in texture. Archaeological work at the nearby Late Ceramic Age settlement of Villa Taina by Goodwin and Walker (1975) showed that the inhabitants used the local material for producing flake tools (Walker, personal communication 1998).

With regard to the geological formation, the area surrounding this locality is largely covered by Boqueron Basalt, but also Cotui Limestone Formation crops out nearby, more uphill (see figure 2.7) (Volckmann 1984b). About the Boqueron Basalt, Volckmann states that some of the weathered outcrops of lava contain amygdules (cavities) filled with silica. These amygdules do not exceed 3 cm in size and therefore, the chert is not likely related to these filled cavities.

The Cotui limestone Formation may be a more likely origin, considering the common relation between limestone and chert. Volckmann reports that the dense bioclastic limestone contains minor constituents of authigenic quartz. It is not clear whether this authigenic quartz stands for chert nodules or it only concerns small-sized quartz grains. However, the presence of authigenic quartz makes it likely that flint was formed within this limestone formation. The gully, which cuts the slope of the hill, may have been responsible for the erosion of the chert out of the limestone bedrock.

Despite my argumentation in favour of an association with the Cotui Limestone Formation, the characteristics of the chert itself do not point to a limestone host. The most important evidence is the total absence of fossils or other features

[7] The chemical analysis of one sample of this green type of chert also produced distinct values compared to the other cherts. In general, the material contains much higher concentrations of most of the elements sampled. This higher concentration is ascribed to the presence of the detrital amphibole.

pointing to a biogenic carbonate formation. In this respect the chert from Villa Taina resembles the tuff cherts from Shirley Heights, as well as the other Puerto Rican cherts, more than the limestone flints.

Studied macroscopically, the rock is very heterogeneous. It is dull and relatively coarse-grained when compared to the limestone flints. The matrix of the chert exhibits variation. A closer look at some pieces reveals that they resemble a conglomeratic rock, in which rounded dull grains, still preserved in a chert matrix but for which their original nature cannot be determined, are floating in a slightly translucent chert matrix. This granular structure may represent the texture of the original host-rock. Other specimens, however, do not display this “conglomeratic” structure. The matrix in these samples can be very homogeneous, or it displays veins or veined areas. The colour is generally light. Dark rock also occurs. The colour varies from almost white (10YR 8/1), light grey (10YR 7/1-7/2), light brownish grey (10YR 6/2), to grey (10YR 5/1), and greyish brown (10YR 5/2).

Under the microscope, this rock is a pure quartz chert, with varying amounts of iron-oxide, similar to the other Puerto Rican cherts. The matrix and structure of the samples exhibit a similar variation as well. Crypto-crystalline quartz in the matrix is generally coarse (see figure 2.17c), but areas with a finer size also occur. In addition, the radial fibrous type of chalcedony is present in the matrix of two samples. Furthermore, veins that have a chalcedony or macro-quartz filling in a number of samples point to different phases of silification.

One sample displays some of its original structure in non-crossed polarized light. It consists of oval to round clasts that could be ooids or peloids. If these round clasts are indeed ooids or peloids, then this original structure points to a carbonate host. On the other hand, these round clasts, alternatively may be heavily rounded detrital mineral grains.

A.4.4 Pedernales

The chert occurrence referred to as Pedernales corresponds to a relatively large scatter of chert boulders and cobbles located in the northwestern part of the Barrio Pedernales, which is indicated on the geological map of the Puerto Real quadrangle (see figure 2.7) (Volckmann 1984b). Chert material is scattered across an area of approximately 1 km², part of which is disturbed by house development in the small village El Cerro. We inspected and sampled only a small portion of the entire surface distribution. This portion was situated toward the eastern end. Large irregularly shaped chert blocks of varying quality were encountered there. They exhibit poorly silicified as well as true chert varieties. The blocks vary in size and can reach up to 50 cm. To Walker’s knowledge, no evidence of Pre-Columbian exploitation has been identified so far and also our field inspection did not yield any artefacts (Walker, personal communication 1998).

Underlying these silica blocks is the Miocene dated Guanajibo Limestone and Gravel Formation, similar to the chert at Cerrillos (see figure 2.7). Volckmann (1984b) does not provide an explanation for its occurrence in the description accompanying the geological map. Given the association with the same limestone Formation as at Cerrillos, a similar erosion process to that of the Cerrillos chert may be responsible for this chert.

The large blocks expose a very varied textured rock, giving it a heterogeneous appearance to some degree resembling the Villa Taina cherts. Areas of clear chert material alternate with coarser and duller looking material, strongly resembling the texture of cortex rinds in limestone flint. Like these other flints the Pedernales textures consist of less completely silicified rock. The transition from chert to these areas and the outer surface is often very gradual, making it difficult to discern where the actual chert matrix starts and ends.

The chert textures are light in colour, but exhibit variation between different blocks. The material exhibits a varied grain-size, which is generally coarser than the limestone flints from Antigua, for example. The matrix is homogeneous in most cases and contains very few inclusions. The colour of the chert varies from white (10YR 8/1), light grey (10YR 7/1, light brownish grey (10YR 6/2), to brown (10YR 5/3). Other areas are generally lighter in colour, mostly resembling the (10YR 8/1) white hue.

Under the microscope this chert displays similar features to the other cherts from Puerto Rico. Again, material does not possess any clear characteristics pointing to a limestone origin, as calcite was not identified and fossils are absent. Furthermore, varied matrices occur (see figure 2.17d), consisting of a fine to coarse crypto-crystalline quartz type, and a macro-quartz or radial fibrous chalcedony type. In addition, the rock can be veined with length-slow chalcedony in it, in some cases surrounding macro-quartz filled centres.

A.4.5 Moca

Recently, Walker *et al*. (2001) reported the presence of natural chert in the valley of the Culebrinas River in the municipalities of Moca, San Sebastian and Lares, all in the northwestern part of Puerto Rico (see figure 2.7). Surface inspection revealed dispersed but distinct surface scatters of chert material, varying in quality from very good to poor. Associated with these natural occurrences, flaked material was identified as well, but the artefacts could not be dated.

The researchers point to the San Sebastián Formation as the possible geological source for this chert. Dated to the Oligocene and Miocene, this formation primarily consists of clay and sand beds, with conglomerates at the base. Some limestone lenses occur as well. Three components of this formation are of interest to the chert occurrences. These include a deposit of a silica rich conglomerate, mainly built up of chert and quartz (referred to as geological unit Tscq), a clay deposit with chert cobbles (Tscc), and a (Tsch-) unit containing jasper and petrified wood (Walker *et al*. 2001, 14-16).

The chert is coloured brown generally, but varying in darkness. The chert matrix often displays veins and on rare occasions a clastic appearance, consisting of densely concentrated round inclusions. This probably represents the texture of the original host-rock. A portion of the samples, however, consists of a more homogenous chert matrix, slightly translucent in appearance. Colours range from white (10YR 8/1), yellowish brown (10YR 5/4), to brown (7.5YR 5/3, 10YR 4/3).

Under the microscope, the Moca cherts display a very pure quartz content, although in some cases some mud of the original sediment is present. The composition of this mud could not be determined. Its dark brown colour suggests that iron in it had been oxidized. One sample originally is a layered brecciated rock or a grain-supported pack-stone, which may have been silicified during different phases. The quartz filling of the original clasts was different from the areas between the clasts (see figure 2.17b). Another sample is a veined chert, similar to some of the chert samples from the other Puerto Rican sources. The vein-fillings are very fine crypto-crystalline quartz, macro-quartz, or chalcedony. Similar to the other Puerto Rican cherts, the Moca-samples do not contain any bioclasts or carbonate, which suggests a non-carboneous environment of formation, not related to limestone.

Appendix B Hughes Bay flint scatter, Antigua

B.1 Artificial flint scatter at Hughes Bay

Field-walking along the coast of Hughes Bay and Brown's Bay in northeastern Antigua, identified a cluster of large blocky flint nodules scattered on a cobble beach between these bays (see figure 2.5). This flint concentration includes many chalk pebbles as well. The shape of the flint blocks is angular and the cortex sometimes looks fresh, that is, not water-worn. A subsequent search for in-situ flint along both beaches did not produce any additional finds. Also, examination of an extended limestone rock section at Hughes Point, part of the Antigua Formation, did not yield any layers with flint nodules in it, despite a reference to it by Mascle and Westercamp (1983).

The relative angular form of the nodules, a characteristic not to be expected on a beach where rounded cobbles predominate, and the discovery of many igneous rock pebbles on the same beach, rock types unlikely in an exclusive limestone environment, are both signs of an artificial occurrence. Closer analysis of the flint revealed that it generally is very dark in colour, varying from black (7.5YR N2/) to (very) dark gray (7.5YR N3/, N4/, 10YR 3/1), which is different from other Antigua formation flints. Also, the type and size of the inclusions differ from the local flints. Furthermore comparison of geochemical data from one sample analysed with average values from Antigua Formation flints showed that Al and K values are lower. More importantly, the Hughes Bay sample has a lower Al/K ratio, which is relatively constant among the primary flint sources on Antigua.[1] This all strongly supports a non-Antiguan origin. In this light, the former habit of cargo ships being loaded with stone ballast on the way to the Caribbean islands and then dropping the ballast somewhere along their shores might explain the presence of this flint. Such a case has been reported for "de Groote Baai" on St. Martin, where exotic stones can be picked up (Langemeyer 1937; Westermann 1957).

In case of a historical origin, England would be the most likely source for the stone ballast, considering its colonial occupation of the island during 17th, 18th, 19th and 20th centuries (Murphy, personal communication 2001; Desmond Nicholson, personal communication 2001). Therefore, some samples were sent to Mark Edmonds, Sheffield University, who is familiar with English and other northwestern European flints. Edmonds stated that the material is very similar to English material, but also exhibits strong similarities with flints from the Atlantic fringe of Northwest Europe. As a consequence, he was not able to pinpoint a specific source location, but generally speaking, he supported the idea of a European, most likely English origin for this flint (Mark Edmonds personal communication 2001).

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1 The trace-element concentration values from the Hughes Bay sample have not been compared with the more weathered secondary Antigua Formation flint sources, such as Blackman's Point and Coconut Hall. If the flint were natural to the island, it would have to be a relatively "freshly" eroded flint, considering the limited water rounding it demonstrates. This would make it comparable to the primary Antigua Formation flint sources.

Appendix C Geo-chemical analysis and data

C.1 Introduction

In this appendix, the results of the Inductively Coupled Plasma Emission Spectroscopy (ICPAES) analyses are listed for each rock and artefact sample (tables C.1-C.18). After collection and selection, samples were prepared following a standard procedure.

C.2 Sample preparation and analysis

A small rock sample with unexposed fresh surfaces was sawn from a larger block with a diamond impregnated saw. This sample was crushed with a steel hammer into small grains. The grains were then washed for 3 minutes in aqua regia to remove any possible contamination resulting from the sawing and crushing. After this, they were washed with aquabidest four times and dried for 36 hours in an oven at 60° C. From these small grains, 1.5 g was carefully weighed. This sample was then put in a Teflon pot and hydrofluoric acid (20 ml, 40%), and a mixture of nitric acid (65%) and perchloric acid (70%) (10 ml)[1] were added. This mixture was heated for 24 hours at a temperature of 92° C to dissolve the rock. The solution was next evaporated on a 180° C sand bath. The obtained residue was then dissolved in hydrochloric acid (1.0 N, 25 ml) and heated for 4 hours at 92° C. After cooling the Teflon pot containing the solution was carefully weighed and the solution was poured into a small tube for ICPAES analysis.

C.3 Data

The following tables list the trace-element concentration values for geological samples from the different chert and flint sources discussed in this dissertation (see tables C.1-C.5, C.7-C.9, C.12-C.17). In addition, some geological samples from currently exposed rock outcrops, which were not available to the Amerindians were analysed and are tabulated as well (see tables C.6,C.10-C.11). Table C.18 lists the trace-element concentration values for a series of analysed artefacts originating at a number of archaeological sites within the studied area for comparison.

number	Al	K	Na	Li	Ti	Cr	Fe	Mn	Ca	Mg	Ba	V
ANLI-01.2	1242.26	399.45	539.13	11.98	51.73	5.52	365.58	1.76	336.04	26.68	7.09	2.28
ANLI-02.2	1806.17	511.32	980.88	13.33	84.73	10.45	542.99	< d.l.	549.46	129.65	8.43	4.50
ANLI-02.2.2	1488.61	437.36	832.97	11.56	68.85	8.15	536.02	2.05	353.28	117.42	12.81	4.05
ANLI-03.2	1796.54	509.36	829.39	14.68	84.00	8.36	997.47	< d.l.	375.62	97.95	219.06	5.43
ANLI-04.2	1499.61	410.51	830.68	12.51	61.02	5.62	439.49	2.90	6269.93	602.32	1.41	1.65
ANLI-05.2	1062.45	361.54	649.34	9.52	46.04	5.30	333.27	1.89	576.31	71.41	45.55	2.51
ANLI-06.2	1588.79	485.48	848.59	16.89	72.21	6.28	776.07	2.55	1628.49	487.39	1.68	2.13
ANLI-08.2	1736.67	480.97	1045.85	12.66	70.39	7.62	475.91	3.81	442.59	167.90	16.62	3.32
ANLI-09	1606.15	510.30	694.85	15.36	67.81	7.17	313.03	2.33	711.46	74.50	9.01	1.98
ANLI-10	1738.32	556.18	1273.63	17.77	75.74	8.38	253.61	2.82	436.74	57.23	253.23	3.79
ANLI-11	2284.90	664.33	1199.16	19.26	94.49	9.76	384.46	2.62	750.65	235.05	20.46	3.94
ANLI-12	1693.91	569.25	705.58	15.96	73.08	7.47	320.44	1.01	292.44	70.38	77.10	2.74
ANLI-12.2	1704.05	585.30	741.39	15.35	78.33	6.95	460.28	< d.l.	308.34	67.06	78.58	2.34
ANLI-25.1 (pri)	1685.16	553.63	1124.28	13.85	70.77	5.77	638.67	2.06	4134.38	1492.28	11.00	3.22
ANLI-25.2 (pri)	1740.02	541.21	1101.97	13.80	68.15	5.69	558.21	2.06	3904.07	1323.21	14.32	3.05
ANLI-25.3 (pri)	1816.02	553.98	1097.43	14.30	75.51	6.34	542.70	2.24	3613.26	1365.43	6.41	3.28
ANLI-51a.1 (pri)	1741.12	567.19	945.51	15.34	51.61	7.38	632.66	12.74	2658.83	181.19	6.16	2.25
ANLI-51a.2av (pri)	1688.34	533.24	974.90	14.78	57.13	5.84	514.46	2.74	3352.39	186.63	13.48	2.03
ANLI-53a.1 (pri)	881.59	344.34	942.56	8.63	41.23	4.81	432.97	< d.l.	209.57	78.78	19.74	4.20
ANLI-53a.2 (pri)	1059.69	352.75	811.85	9.66	46.59	4.83	237.71	1.22	198.71	70.78	10.27	2.92
ANLI-70 (pri)	1260.13	399.89	1236.80	11.58	54.00	5.71	301.89	1.98	8352.88	3010.40	30.02	2.39
ANLI-75	1717.11	547.06	966.54	16.77	69.26	5.48	396.86	2.38	1889.61	555.89	< d.l.	1.84
ANLI-76	1738.35	496.18	888.99	13.79	72.26	5.57	116.14	1.20	186.80	47.49	43.86	1.72

Table C.1. Long Island, Antigua Formation, Antigua. Trace-element concentration values in flint samples (in mg/kg (ppm)). "-av" denotes average value from a multiple analysis; "pri" denotes samples from primary contex; < d.l. = value is below detection limit.

[1] Volume ratio of mixture: (water)/(nitric acid)/(perchloric acid) : (1)/(2.5)/(6.5)).

number	Al	K	Na	Li	Ti	Cr	Fe	Mn	Ca	Mg	Ba	V
ANLC-01	968.28	283.09	452.00	8.43	25.27	5.25	100.61	0.60	1064.64	69.25	7.99	2.94
ANLC-02	1199.69	349.38	669.38	17.63	32.25	4.26	169.70	0.69	2124.65	94.03	38.49	2.35
ANLC-03	1254.36	374.13	900.74	13.23	44.23	6.15	331.94	0.72	2530.54	111.80	121.07	4.11
ANLC-04	1482.84	405.20	684.43	17.82	34.55	2.12	52.07	0.61	1533.00	102.94	11.92	2.50
ANLC-05	1323.59	365.26	701.04	16.20	33.97	4.21	153.44	0.54	948.53	78.28	14.69	2.27
ANLC-06 (pri)	1206.10	368.59	1037.80	15.78	38.25	5.23	261.66	0.48	1055.93	87.32	73.31	3.33
ANLC-07 (pri)	1204.11	362.70	975.44	16.58	40.50	5.39	178.03	< d.l.	840.96	85.57	17.10	3.36
ANLC-08 (pri)	1341.74	400.66	960.27	16.81	49.75	4.99	89.00	0.51	877.80	126.80	7.73	3.66
ANLC-09 (pri)	558.93	181.66	320.58	5.78	23.40	5.09	107.97	< d.l.	715.16	58.79	1.24	3.79
ANLC-10 (pri)	534.80	145.19	327.05	6.40	11.39	2.88	< d.l.	< d.l.	1151.43	123.90	1.31	1.99
ANLC-20a (pri)	1242.63	379.43	1097.36	14.29	44.94	4.29	365.31	< d.l.	3363.17	112.30	125.80	2.74
ANLC-24a (pri)	1099.32	327.94	943.43	16.25	37.65	3.77	309.18	1.35	11426.93	184.87	11.87	1.74
ANLC-26a (pri)	1104.97	343.07	914.57	12.65	41.06	4.46	333.65	< d.l.	5535.95	158.94	25.58	2.93

Table C.2. Little Cove, Antigua Formation, Antigua. See table C.1 for description.

number	Al	K	Na	Li	Ti	Cr	Fe	Mn	Ca	Mg	Ba	V
ANSP-01 (pri)	861.03	288.95	689.73	8.96	32.44	2.92	224.16	1.03	1457.39	82.72	4.02	1.68
ANSP-02[a] (pri)	1075.53	368.36	652.12	10.97	35.44	3.06	320.87	< d.l.	888.59	68.84	5.85	1.29
ANSP-04	952.59	330.03	672.83	11.06	52.93	4.59	371.75	< d.l.	1661.21	58.76	1.65	3.24
ANSP-05	1067.70	288.39	807.58	11.54	32.08	2.52	170.37	0.73	638.19	63.04	5.01	0.83
ANSP-06	657.20	232.90	500.32	9.55	27.82	2.96	200.46	2.18	3122.82	64.17	1.36	1.44
ANSP-09 (pri)	769.82	288.35	376.53	14.45	31.89	3.49	238.65	< d.l.	2225.81	59.83	2.55	1.70
ANSP-12 (pri)	1066.90	386.19	439.77	11.57	44.34	3.39	222.30	0.86	562.36	52.93	3.74	1.99
ANSP-13	850.10	290.04	628.25	13.30	34.70	2.98	207.79	< d.l.	3614.43	89.42	1.39	1.91
ANSP-14	862.51	273.54	792.83	11.33	25.69	5.05	255.66	< d.l.	613.67	84.10	2.25	1.69
ANSP-30 (pri)	604.17	152.61	482.05	10.20	16.62	3.82	130.17	1.82	12715.01	116.13	2.23	1.05

Table C.3. Soldier Point, Antigua Formation, Antigua. See table C.1 for description.

number	Al	K	Na	Li	Ti	Cr	Fe	Mn	Ca	Mg	Ba	V
ANBP-01.2	411.37	73.95	428.60	17.97	15.66	5.73	2333.40	18.76	141.40	43.86	2.80	2.92
ANBP-02.2.1	450.58	94.01	276.68	14.40	16.21	4.58	954.20	5.33	289.77	40.56	2.34	1.11
ANBP-02.2.2	560.61	92.46	271.20	14.39	13.89	4.14	793.16	4.23	261.39	40.48	1.81	1.08
ANBP-03.2	425.61	130.91	176.33	5.25	23.00	4.64	1334.91	3.03	138.28	27.97	4.37	1.69
ANBP-04.2	374.68	103.22	138.54	8.14	12.15	4.08	799.18	3.34	281.03	21.76	8.62	2.14
ANBP-05.2	484.66	137.03	155.30	2.94	13.61	4.43	355.51	1.83	150.21	28.45	3.76	1.54
ANBP-14	735.47	181.96	217.12	3.29	15.70	3.96	631.15	2.84	503.86	24.45	26.49	1.62
ANBP-17	1148.84	356.12	1256.35	11.38	47.36	3.75	420.23	1.74	471.17	86.62	4.86	2.64
ANBP-44	544.39	67.77	182.14	18.08	17.67	7.94	4978.95	30.32	165.39	37.47	17.28	7.83
ANBP-48	458.59	136.59	581.77	5.14	12.51	3.99	813.15	3.63	138.47	193.94	52.14	2.96
ANBP-49	519.74	175.93	160.77	5.43	12.55	4.16	579.70	1.40	165.68	19.26	5.91	2.21
ANBP-53	315.02	55.22	780.89	20.13	11.90	4.04	332.28	1.66	283.23	243.11	4.07	1.72
ANBP-60	319.97	56.21	575.99	9.46	11.23	4.03	322.71	1.48	476.66	125.25	2.98	1.30

Table C.4. Blackman's Point, Antigua Formation, Antigua. See table C.1 for description.

number	Al	K	Na	Li	Ti	Cr	Fe	Mn	Ca	Mg	Ba	V
ANCH-01	296.25	115.28	160.92	1.41	7.53	3.41	637.42	5.29	120.98	9.82	9.04	1.00
ANCH-02	301.04	85.49	119.57	11.53	13.55	6.91	616.85	11.48	1039.35	21.57	18.11	1.41
ANCH-12	139.45	55.68	56.75	< d.l.	1.22	< d.l.	256.84	1.69	150.55	3.66	0.73	< d.l.
ANCH-17	162.86	111.86	146.97	1.44	5.08	< d.l.	506.24	1.12	65.69	6.02	5.21	0.87
ANCH-24	444.78	128.71	148.28	1.47	16.47	< d.l.	1116.85	434.98	< d.l.	1409.91	1.47	3.85
ANCH-40	339.41	128.47	146.34	2.22	13.15	5.97	2234.83	6.98	150.45	20.13	1.20	1.78
ANCH-41	277.51	70.62	161.12	< d.l.	6.13	1.91	117.88	2.02	155.99	9.71	1.12	< d.l.
ANCH-42	199.82	40.70	81.15	2.63	6.24	3.34	1036.85	9.94	1121.42	20.07	6.98	3.77
ANCH-43	482.77	137.35	161.98	6.18	170.35	5.58	1433.39	6.79	549.33	21.10	11.53	2.16
ANCH-44	737.73	192.21	256.11	3.74	80.05	2.99	1022.34	4.25	208.92	20.48	28.83	2.70
ANCH-50	360.47	76.84	271.98	2.66	3.54	< d.l.	209.02	11.00	42.75	2.77	12.83	< d.l.
ANCH-51	287.76	135.82	152.73	1.62	12.54	2.26	276.54	1.74	101.47	12.74	< d.l.	< d.l.

Table C.5. Coconut Hall, Antigua Formation, Antigua. See table C.1 for description.

number	Al	K	Na	Li	Ti	Cr	Fe	Mn	Ca	Mg	Ba	V
ANPG-01 (pri)	796.86	188.20	406.44	8.90	28.97	2.89	183.67	< d.l.	2736.56	36.92	5.08	1.65
ANPG-03 (pri)	833.14	194.50	387.35	6.68	26.41	3.10	161.74	< d.l.	822.97	39.22	3.61	1.39
ANPG-05 (pri)	827.64	237.30	472.41	7.57	32.07	2.91	418.63	< d.l.	858.52	42.98	4.41	0.88
ANPG-06 (pri)	848.03	267.04	604.65	6.77	42.25	4.66	348.50	< d.l.	1689.21	63.72	3.53	1.39
ANPG-07a (pri)	940.30	273.95	463.90	5.95	33.47	3.58	359.90	< d.l.	2837.69	83.27	16.56	2.11

Table C.6. Pigotts Hill (present-day limestone quarry site), Antigua Formation, Antigua. See table C.1 for description.

number	Al	K	Na	Li	Ti	Cr	Fe	Mn	Ca	Mg	Ba	V
ANSH-01 (pri)	4168.17	649.80	576.40	14.16	133.55	5.24	198.54	2.46	489.71	62.72	76.08	1.58
ANSH-03 (pri)	1659.95	331.37	331.25	8.05	24.95	0.88	93.13	3.03	253.96	45.51	198.87	< d.l.
ANSH-04 (pri)	2555.28	444.66	420.12	9.58	175.98	9.59	145.99	3.78	240.02	24.70	84.61	2.03
ANSH-06 (pri)	910.27	262.79	341.54	3.36	26.05	< d.l.	35.20	0.81	106.80	26.56	13.30	< d.l.
ANSH-09	2192.11	458.93	410.40	9.09	126.39	7.48	93.64	2.53	227.15	39.84	42.63	1.57
ANSH-11	1735.30	374.60	357.56	6.72	109.90	3.92	71.06	2.51	229.23	36.07	41.36	0.96
ANSH-12a	232.95	77.53	99.95	1.67	3.81	< d.l.	2560.12	12.15	88.15	18.35	5.98	2.78
ANSH-12b	278.89	93.92	97.16	1.44	2.66	< d.l.	18.10	1.11	123.09	8.21	11.12	< d.l.

Table C.7. Shirley Heights, Basal Volcanic Suite, Antigua. See table C.1 for description.

number	Al	K	Na	Li	Ti	Cr	Fe	Mn	Ca	Mg	Ba	V
ANCP-01	1871.12	378.17	672.78	28.08	85.98	0.93	184.69	5.04	340.76	46.60	48.95	21.73
ANCP-02	773.59	227.34	488.46	17.22	113.53	0.89	532.74	5.85	695.73	96.00	69.86	90.74
ANCP-03	148.57	21.87	156.82	1.86	23.98	0.87	< d.l.	1.59	80.24	61.57	13.33	5.22
ANCP-04	169.98	26.80	103.89	1.58	10.90	< d.l.	< d.l.	2.30	54.91	54.56	3.95	4.79
ANCP-05	2332.44	420.80	861.35	33.73	110.10	1.44	444.05	15.75	437.77	99.01	75.78	32.88
ANCP-06	81.08	12.11	52.78	< d.l.	< d.l.	< d.l.	< d.l.	1.51	18.27	14.64	42.78	1.36
ANCP-10 (pri)	58.18	25.58	356.56	0.77	8.43	< d.l.	27.66	13.07	8714.55	220.78	1.39	1.62
ANCP-11.1 (pri)	1551.94	348.72	1077.58	23.81	82.63	1.78	950.28	18.70	6434.20	205.41	20.35	75.68
ANCP-11.2 (pri)	1611.41	374.63	1128.09	25.40	80.17	1.80	1118.17	24.72	9579.71	267.19	14.81	81.05
ANCP-12 (pri)	831.65	236.35	1328.97	12.32	39.26	1.83	927.02	26.87	37884.83	693.99	4.08	70.84
ANCP-13	570.29	154.08	1299.00	11.36	33.43	< d.l.	108.00	203.40	30698.85	554.58	3.88	34.10
ANCP-20	51.76	29.02	252.78	0.93	12.02	< d.l.	21.22	14.04	8828.38	238.62	1.53	1.60
ANCP-21	1393.51	293.44	641.92	20.97	107.94	1.66	583.55	2.77	329.58	59.60	129.21	156.98

Table C.8. Corbison Point, Central Plain Group, Antigua. See table C.1 for description.

number	Al	K	Na	Li	Ti	Cr	Fe	Mn	Ca	Mg	Ba	V
ANDH-01 (pri)	385.16	95.71	584.90	3.34	13.28	< d.l.	286.55	8.75	2384.38	222.07	2.23	44.70
ANDH-02 (pri)	332.63	22.40	586.38	1.93	4.43	< d.l.	464.85	40.53	32548.82	787.52	4.53	1.53
ANDH-03 (pri)	469.89	134.59	552.27	8.48	24.28	< d.l.	95.73	19.80	4215.05	230.59	2.61	11.28
ANDH-04a (pri)	286.68	86.48	583.20	9.72	10.94	< d.l.	1730.72	716.83	34894.30	895.84	4.07	9.53
ANDH-04b (pri)	395.16	108.01	749.67	11.24	18.08	< d.l.	2784.04	653.86	34735.57	1050.64	14.61	13.91
ANDH-09	175.95	63.88	379.07	0.92	6.76	< d.l.	6563.67	2.80	191.55	73.57	2.01	8.77
ANDH-11	204.34	46.16	165.72	6.41	5.41	< d.l.	32.05	39.65	2280.79	1295.47	0.94	29.48
ANDH-12	422.18	164.71	558.28	1.13	11.69	< d.l.	146.81	1.08	65.43	72.10	1.43	< d.l.
ANDH-13	113.90	39.77	260.97	1.43	22.26	< d.l.	229.28	11.40	4028.34	161.75	3.18	17.95

Table C.9. Dry Hill, Central Plain Group, Antigua. See table C.1 for description.

number	Al	K	Na	Li	Ti	Cr	Fe	Mn	Ca	Mg	Ba	V
ANWF-02 (pri)	728.18	61.16	324.05	1.74	5.77	< d.l.	61.03	2.13	319.49	10.66	9.26	< d.l.
ANWF-03 (pri)	508.11	73.51	146.13	2.20	2.34	< d.l.	48.55	1.42	226.63	7.16	2.98	< d.l.
ANWF-07 (pri)	412.74	73.35	166.87	4.55	5.40	< d.l.	115.81	1.28	1562.72	7.80	2.96	< d.l.
ANWF-08 (pri)	485.52	103.38	231.61	1.57	2.91	< d.l.	72.43	1.21	101.44	5.58	< d.l.	< d.l.

Table C.10. Willis Freeman (present-day quarry site), Central Plain Group, Antigua. See table C.1 for description.

number	Al	K	Na	Li	Ti	Cr	Fe	Mn	Ca	Mg	Ba	V
ANBU-02	255.86	51.09	143.12	2.02	5.31	< d.l.	54.36	1.29	48.90	5.12	5.75	1.66
ANBU-04	556.27	94.94	193.15	11.03	28.66	< d.l.	944.74	8.32	1568.92	66.58	250.61	42.73
ANBU-20	448.64	67.60	222.19	4.69	20.18	1.25	67.59	2.59	335.94	16.88	7.83	10.25
ANBU-21	488.58	31.24	90.56	10.87	13.53	< d.l.	580.90	10.20	1041.88	26.46	31.27	9.68

Table C.11. Buckleys, Central Plain Group, Antigua. See table C.1 for description.

number	Al	K	Na	Li	Ti	Cr	Fe	Mn	Ca	Mg	Ba	V
PRCE.a-01.1.1	618.25	43.49	29.04	4.73	18.76	50.54	1953.11	18.86	20.30	311.82	4.88	7.95
PRCE.a-01.1.2	274.46	43.78	31.36	5.92	7.37	50.16	1850.27	10.59	35.29	302.06	6.07	8.05
PRCE.a-01.1.3	178.33	41.61	30.61	3.54	5.66	39.42	871.46	9.15	18.73	287.68	3.18	3.89
PRCE.a-01.2av	283.68	35.93	40.88	5.32	9.83	48.91	1392.62	11.17	22.93	371.55	3.23	6.28
PRCE.a-02	127.48	45.12	94.49	1.15	3.97	39.24	724.39	5.15	25.72	326.04	2.90	4.79
PRCE.a-06	221.44	50.99	67.59	2.64	5.52	201.23	1056.47	8.08	29.98	186.73	3.40	7.78
PRCE.a-07	395.94	109.37	71.76	24.53	12.53	33.50	1264.54	8.18	14.24	1056.05	3.07	6.72
PRCE.a-13	258.97	69.40	138.17	1.61	6.69	1.71	177.82	3.28	34.71	109.09	8.37	1.29
PRCE-01	247.15	67.96	72.66	5.32	7.96	4.80	146.98	2.28	25.82	83.15	41.78	2.33
PRCE-04	507.06	105.06	77.89	5.42	22.92	83.67	5833.65	14.28	347.10	409.88	7.29	15.23
PRCE-05	279.65	48.10	63.25	3.90	5.86	26.62	2856.59	3.40	38.19	253.40	13.63	6.02
PRCE-06	272.87	77.09	58.03	14.89	9.81	30.45	1206.72	6.12	18.67	559.60	1.91	3.83
PRCE-07	66.99	20.04	18.15	4.27	3.86	4.24	149.76	2.77	14.53	331.24	5.11	2.34

Table C.12. Cerrillos, Guanajibo Formation, Puerto Rico. See table C.1 for description.

number	Al	K	Na	Li	Ti	Cr	Fe	Mn	Ca	Mg	Ba	V
PRPE-01	259.00	124.28	150.65	3.35	13.89	25.91	246.95	< d.l.	194.52	108.43	2.59	5.37
PRPE-02	139.28	63.54	25.33	4.61	3.27	2.34	134.92	1.14	58.84	22.24	1.17	1.32
PRPE-03	321.83	265.47	200.33	< d.l.	10.41	4.11	298.41	1.11	67.96	35.36	< d.l.	2.81
PRPE-04	121.53	72.59	79.69	0.92	3.51	7.31	58.35	1.00	159.54	93.45	0.89	4.13
PRPE-06	200.09	89.42	52.27	2.93	5.08	4.14	127.63	1.05	49.57	23.41	1.10	1.38
PRPE-07	176.85	32.17	38.21	2.41	26.63	3.21	380.25	4.31	487.70	291.99	10.32	1.84
PRPE-08	198.42	102.40	100.53	1.86	7.52	7.09	174.68	1.90	73.65	46.14	5.18	3.77
PRPE-09	299.95	144.47	184.80	1.76	15.27	6.32	394.05	5.23	65.57	71.45	2.15	8.13

Table C.13. Pedernales, Guanajibo Formation, Puerto Rico. See table C.1 for description

number	Al	K	Na	Li	Ti	Cr	Fe	Mn	Ca	Mg	Ba	V
PRLP.a-04	74.22	93.62	171.88	< d.l.	2.38	< d.l.	177.16	1.30	67.34	22.70	1.47	1.18
PRLP.a-05	311.46	95.59	165.69	0.88	5.21	2.41	4453.88	3.53	136.77	81.67	4.13	8.57
PRLP.a-09	70.89	42.20	71.58	1.23	3.53	42.07	152.55	5.69	900.46	523.95	136.22	26.12
PRLP.a-10	185.40	104.39	191.24	< d.l.	2.61	2.01	796.60	3.79	59.11	85.02	1.37	5.73
PRLP.a-11.1	149.36	83.49	83.18	2.71	5.48	22.11	481.91	4.85	55.96	28.45	4.52	3.95
PRLP.a-11.2av	82.17	49.34	71.31	1.25	2.99	14.67	230.89	3.16	153.46	97.09	6.26	2.15
PRLP.a-11.3av	354.88	175.17	132.44	0.88	34.11	61.88	824.57	41.95	119.94	71.96	55.17	2.99
PRLP.a-13	55.36	100.84	181.97	1.20	2.97	3.53	354.06	1.88	272.27	515.56	8.89	15.24
PRLP.a-16	165.04	47.75	86.32	3.53	1.71	9.16	620.84	2.03	204.91	116.13	3.88	1.84
PRLP-01	115.94	95.02	170.60	< d.l.	2.17	< d.l.	502.84	1.63	65.37	61.07	0.90	4.52
PRLP-16	85.21	51.03	24.34	< d.l.	3.91	< d.l.	59.25	< d.l.	44.94	33.68	0.99	< d.l.
PRLP-20	43.65	18.49	7.99	< d.l.	2.83	< d.l.	116.75	3.54	241.04	325.13	7.52	8.57

Table C.14. Las Palmas, Ponce Formation, Puerto Rico. See table C.1 for description.

number	Al	K	Na	Li	Ti	Cr	Fe	Mn	Ca	Mg	Ba	V
PRVT-01	411.14	41.12	92.16	2.04	3.39	19.02	7641.99	24.09	140.01	82.24	10.15	15.59
PRVT-02	257.45	41.24	104.31	7.42	2.34	9.96	349.62	13.84	622.05	396.70	16.70	17.53
PRVT-03	303.93	47.54	84.22	5.11	4.74	16.18	2270.26	15.22	113.20	50.31	73.95	6.57
PRVT-04	243.27	87.80	110.23	6.55	4.10	19.46	560.22	3.52	85.44	49.93	8.31	3.00
PRVT-05	399.12	34.44	136.63	1.45	4.51	43.68	8732.00	38.02	149.89	137.22	21.59	22.51
PRVT-06	248.10	19.79	62.02	8.87	10.37	18.46	590.12	1.54	26.26	47.64	12.17	7.91
PRVT-07	359.33	66.04	122.92	4.80	4.93	23.60	4288.42	159.05	588.77	343.08	51.37	13.79
PRVT-08	54.79	47.59	87.27	1.19	1.73	27.98	68.72	1.02	104.19	492.31	6.21	3.25

Table C.15. Villa Taina, Cotui Formation, Puerto Rico. See table C.1 for description.

number	Al	K	Na	Li	Ti	Cr	Fe	Mn	Ca	Mg	Ba	V
PRMO-04	62.07	38.41	148.45	< d.l.	3.10	4.41	1427.74	19.65	331.96	152.23	2.96	10.60
PRMO-05	45.81	< d.l.	20.56	< d.l.	1.35	3.42	3405.29	20.13	76.56	21.03	10.25	2.74
PRMO-06	589.24	219.42	297.74	9.41	42.73	46.02	2485.20	33.53	134.97	193.33	25.22	7.89
PRMO-01	550.92	167.17	236.08	10.55	27.81	15.43	1909.96	13.05	77.10	59.21	28.82	10.43
PRMO-08	149.87	46.59	109.02	< d.l.	2.11	4.13	1386.41	8.74	51.76	27.38	1.79	5.85
PRMO-02	289.31	95.93	183.75	4.47	7.60	12.99	340.89	4.56	85.29	663.61	6.01	8.56

Table C.16. Moca, San Sebastián Formation, Puerto Rico. See table C.1 for description.

number	Al	K	Na	Li	Ti	Cr	Fe	Mn	Ca	Mg	Ba	V
StKGSP-01.2	227.33	181.47	387.94	1.27	10.67	< d.l.	108.91	1.12	167.09	37.07	< d.l.	< d.l.
StKGSP-02.2	515.41	211.70	623.22	1.83	12.51	7.95	99.69	3.48	32269.90	528.28	0.96	5.13
StKGSP-03.2	351.33	238.35	408.88	4.73	11.30	< d.l.	70.76	0.85	108.20	153.93	1.05	< d.l.
StKGSP-04.2	452.95	296.84	607.53	1.95	17.89	0.98	226.76	1.42	112.32	94.22	1.67	< d.l.
StKGSP-05	443.99	292.10	733.90	4.21	13.44	< d.l.	509.17	1.48	146.75	195.94	1.48	< d.l.
StKGSP-07	399.05	258.28	741.89	2.27	13.33	0.77	513.02	2.83	74.82	118.10	21.52	1.31
StKGSP-09	449.25	145.92	697.70	5.05	25.08	0.84	398.15	3.53	217.48	107.01	9.42	18.99
StKGSP-10	316.76	258.56	1061.92	2.06	13.53	8.89	103.44	2.05	29297.95	633.28	1.05	5.89
StKSFP-01.2	324.89	261.79	309.52	2.01	13.54	0.77	343.25	9.57	689.69	40.76	3.97	< d.l.
StKSFP-02.2	263.06	166.16	369.15	2.33	8.31	< d.l.	97.07	0.81	92.73	41.70	1.10	< d.l.
StKSFP-03.2	983.20	470.68	529.21	16.62	40.54	1.55	128.81	2.29	79.19	59.59	7.89	1.26
StKSFP-04.2	385.47	281.60	442.05	2.50	15.06	0.93	116.71	2.41	306.53	16.48	3.25	< d.l.
StKSFP-05	433.81	280.02	708.93	3.32	11.66	0.74	491.26	14.82	392.21	736.93	9.64	< d.l.
StKSFP-06	308.17	195.56	508.76	2.11	8.01	< d.l.	57.39	0.87	105.44	54.36	1.37	< d.l.
StKSFP-10	833.59	450.04	664.71	5.55	31.19	1.30	181.50	1.28	73.28	94.00	3.42	1.08
StK-K-1	475.41	244.69	586.60	4.08	11.00	< d.l.	565.95	1.15	56.38	148.99	1.63	< d.l.
StK-K-2	467.00	300.20	471.08	1.55	17.28	0.91	164.63	1.42	171.60	42.25	1.94	1.02
StKWB-01.1av	847.97	363.06	491.82	3.62	30.16	119.34	1217.64	20.38	1103.48	93.84	8.84	1.32

Table C.17. Great Salt Pond and Sugar Factory Pier, St. Kitts. See table C.1 for description.

number	Al	K	Na	Li	Ti	Cr	Fe	Mn	Ca	Mg	Ba	V
Anse à la Gourde												
A-F-GUAAG-01	1831.67	503.36	910.18	15.80	85.21	7.14	721.03	3.12	3532.78	339.86	5.67	1.99
A-F-GUAAG-02	650.37	166.90	346.83	1.53	28.56	3.41	1353.56	17.57	189.81	39.90	18.34	5.47
Morel												
A-F-GUMO-01	1784.03	525.79	938.24	14.07	75.98	7.22	576.79	12.82	982.81	105.05	16.32	2.20
A-C-GUMO-02	80.68	26.77	95.26	< d.l.	1.71	< d.l.	32.15	2.32	164.14	12.18	0.79	< d.l.
A-C-GUMO-03	122.45	32.68	132.30	< d.l.	5.16	< d.l.	118.41	2.08	437.82	27.95	2.09	2.11
Trants												
A-F-MOTR-01	1631.64	474.71	697.83	13.47	71.50	7.35	578.04	2.10	636.33	56.14	25.69	2.16
A-C-MOTR-02	93.48	33.71	87.80	< d.l.	5.35	< d.l.	177.78	77.62	36539.04	503.01	3.20	17.33
A-C-MOTR-03	988.24	246.05	457.79	7.85	12.59	< d.l.	144.46	3.26	488.03	14.30	39.15	2.00
A-C-MOTR-04	385.64	123.11	200.40	2.70	4.91	< d.l.	149.68	3.65	222.00	6.69	1.77	1.74
A-C-MOTR-05	214.06	60.90	63.29	< d.l.	7.20	< d.l.	1022.28	4.90	443.81	20.02	3.16	29.24
A-C-MOTR-06	493.10	135.00	169.57	19.53	20.98	6.12	210.48	1.92	1141.30	42.67	2.20	4.45
Golden Rock												
A-F-StEGR-01	1146.69	368.65	559.08	12.17	49.98	5.72	301.28	1.67	846.82	34.51	46.42	2.24
A-F-StEGR-02	1704.12	466.19	802.00	15.69	71.92	6.62	550.93	3.14	3332.95	118.74	26.12	2.09
A-C-StEGR-04	520.83	96.87	248.04	9.65	3.88	< d.l.	19.27	2.81	265.33	7.76	1.73	6.64
A-C-StEGR-05	92.48	101.41	211.83	< d.l.	4.45	< d.l.	46.64	0.70	343.00	32.96	< d.l.	< d.l.
Sugar Factory Pier												
A-F-STKSFP.a-01	1377.12	524.92	641.39	11.97	57.05	5.71	407.24	1.93	467.54	49.38	4.33	2.74
A-C-STKSFP.a-02	766.63	276.35	309.23	8.72	30.68	3.13	156.81	0.88	838.54	33.11	2.57	1.13
A-C-STKSFP.a-03	822.79	154.55	148.75	3.18	7.23	2.50	16827.98	13.84	248.50	27.59	6.16	1.82
Kelbey's Ridge 2												
A-F-SaKB2-01	1700.90	495.10	746.20	15.21	75.20	6.18	526.00	2.49	762.80	85.70	1.78	2.82
Spring Bay 3												
A-F-SaSB3-01	1323.90	398.70	588.80	13.58	59.90	2.20	470.20	1.55	203.30	50.30	55.78	2.45
Anse des Pères												
A-F-StMAP-01	266.00	182.20	166.20	3.51	11.20	2.62	152.00	1.67	23996.60	197.20	1.34	2.00
A-F-StMAP-02	1528.50	498.40	661.00	13.26	71.30	6.65	429.80	1.40	484.60	51.40	7.42	3.37
A-F-StMAP-03	52.70	115.60	160.50	0.15	4.70	0.85	30.70	0.43	223.30	19.60	0.37	0.52
A-F-StMAP-04	1221.50	358.20	625.60	13.12	55.70	7.19	442.10	2.79	581.30	49.70	62.65	2.67
A-F-StMAP-05	385.00	174.40	207.30	4.28	12.60	2.47	101.30	0.22	595.80	28.00	12.71	2.06
A-F-StMAP-06	1388.30	410.10	619.30	14.73	62.70	6.83	511.00	1.71	326.50	54.90	16.27	1.93
Sorcé												
A-F-VISO-01	1497.33	440.26	667.37	13.46	57.13	6.13	470.03	26.21	576.99	45.81	77.95	2.92
A-C-VISO-02	147.69	35.45	173.49	< d.l.	7.38	4.73	168.38	1.57	134.77	16.86	1.75	2.49
A-C-VISO-03	351.26	252.24	237.11	1.80	17.31	4.04	245.25	1.74	991.58	35.26	8.79	0.97
A-C-VISO-04	20.49	12.33	67.41	< d.l.	1.55	2.23	737.10	11.02	115.49	30.47	1.84	4.64
A-C-VISO-05	757.66	257.56	359.48	7.18	33.76	4.59	382.15	1.24	299.07	14.99	29.39	2.33
A-C-VISO-06	297.33	73.14	213.04	1.28	9.84	4.91	263.65	2.15	194.62	45.24	4.63	2.89

Table C.18. Trace-element concentration values (in mg/kg (ppm)) within flint and chert artefacts from different Ceramic Age sites within the northern Lesser Antilles and Puerto Rico. See table C.1 for description.

Appendix D Attribute analysis of lithic artefacts

D.1 Introduction

As stated in Chapter 3, samples of lithic artefacts were studied following a standardised procedure that was set up at the beginning of this research. This procedure included the coding of a number of attributes for each artefact, which were chosen bearing the initial aims in mind concerning reduction stages. Not all artefacts were analysed for the same attributes, however, depending on artefact category and related technology. Therefore, during the analysis artefacts were assigned to certain groups and each of these groups was studied differently.

At the start of the analysis, each artefact was given an individual number and was analysed for the following attributes: (1) type of raw material; (2) type of artefact; (3) maximal dimension; (4) width; (5) thickness; (6) weight; (7) colour; (8) traces of burning; and (9) likely lithic source.

Then, all flakes and shatter were separated from the core artefacts. Within these flake/shatter and core categories, flake tool associated artefacts were separated from core tool associated artefacts. All flakes were studied for: (10) the amount of outer surface (cortex) on the dorsal face; (11) the type of cortex; (12) whether they were further reduced; (13) on the presence of use-wear in the form of intentional or use retouch; and (14) the location of retouch. After this, flakes that were associated with the flake tool technology were additionally analysed for: (15) the presence of patina/weathering; (16) the type of flaking technique; (17) the number of scars on dorsal face (only for complete flakes); (18) the type of striking platform; and (19) the type of distal end.

All flake cores were studied for the amount of outer surface and the flaking technique. Within the remaining core artefact and core tool group, a distinction was made between complete and non-complete items, between finished tools or artefacts, and preforms. Furthermore any signs of (20) shaping techniques present, such as flaking, pecking, or grinding were recorded. Other attributes included, if possible, the tool's overall shape (21), the edge shape (22), and its type of finishing (23). In the case of the St. Martin greenstone artefacts, the presence of weathering (24) was recorded as well.

D.2 The attribute list

Each attribute is discussed separately in the following section to provide a complete definition in each case.

(1) **Type of raw material**: The rock material the artefact was made is specified in this case. As the variety of rock types within the region is very large and many rock types need in-depth analysis to be fully determined, the specified rock types in this attribute follow broad geological categories and only in certain cases are very distinct materials mentioned.

1) flint (nodular chert in limestone).
2) chert (bedded chert; other types of chert).
3) jasper.
4) quartz.
5) igneous rock (hypabyssal and volcanic varieties).
6) plutonic rock.
7) sandstone.
8) limestone.
9) fine grained rock (possibly sedimentary (non-carbonate)).
10) red ochre (hematite).
11) semi-precious stone.
12) metamorphic rock.
13) pumice.
14) calcite.
15) tuff.
16) calci-rudite (zemistone).

17) unidentifiable due to burning.
18) unidentified.

2) **Artefact type**: The artefact type attribute is divided into three broad groups: (a) flakes and shatter; (b) flake cores; and (c) core tools/other core artefacts. For the flake and shatter, Sullivan and Rozen's (1985) classification scheme is used. The flake core types follow Hutcheson and Callow (1986), including some additional types, and the other core artefacts/core tools category includes many common types found within Caribbean lithic assemblages.

debitage: flakes and shatter

1) complete flake/blade: any piece removed from a larger mass by the application of force. It possesses an interior surface, a platform, and margins; a blade is flake with a length that is larger than twice its width.
2) broken flake: differs from complete flake for not having intact margins.
3) split flake: differs from complete flake for having a sheared axis of flaking.
4) flake fragment: all flakes without a platform.
5) shatter: any piece removed from a larger mass by the application of force without a discernable interior surface.
6) unidentified flake artefact: artefact in which weathering or burning has blurred technological features.

flake/blade core: an item from which flakes/blades were removed. It only bears negative percussion features, lacking positive ones

1) polyhedral: a multi-platformed core, roughly globular in shape, with flaking carried out in any direction and from any platform capable of yielding a usable flake; often exhausted, and sometimes with aretes showing signs of shattering caused by unsuccessful attempts to continue debitage.
2) shapeless/miscellaneous: core formed by a few removals without any obviously preferred orientation.
3) multiple platformed: thinner than the polyhedral cores, but rather similar in other respects (notably in the possession of two or more platforms without evidence of a systematic reduction strategy).
4) discoidal: rather flat core, with more or less radial scar patterns and removals of roughly equal size on both faces.
5) prismatic: a single platformed core. The platform is formed by a natural fracture or an early flake scar at one end of the core; from much of its circumference, parallel-sided flakes or blades were removed.
6) pyramidal/conical: from around a single flattish circular platform flakes have been removed so that their scars meet at the apex of a moderately shallow cone.
7) bipyramidal/biconical: the platform is circular, and peripheral; flaking is on both faces, and alternate, making use of one flake scar as the platform for the next.
8) single platformed, unifacial: core from which flakes have been struck on one face only, from a single platform.
9) single platformed, bifacial: flakes have been removed from two faces, from a single platform. This sometimes results in a core looking rather like a chopping tool, though with an edge too obtuse, or irregular, to be useful.
10) double platformed: core with two platforms which are opposed to each other, on the ends or sides of the cores; from these, flaking had been preformed on either the same or adjacent faces.
11) double platformed at right angles: core possessing two platforms which are perpendicular to each other, more or less adjacent: flaking has been carried out on either the same or adjacent faces. (all definitions according to Hutcheson & Callow 1986)
12) split cobble: core possessing one bipolar flake scar on one surface and the rest of the specimen is still cortex encased (Walker 1980)
13) bidirectional (bipolar): a flat core with usually edged platforms on both ends, from which flakes have been removed in opposite directions.

Core-tools:

1) axe/adze: an implement having a range of shapes from ovoid to rectangular, produced with bifacial chipping, grinding, or polishing, with at least one end tapered to a bit that can be plano-convex or bi-convex in shape (Haviser 1993; with some modifications).
2) edge flake: a flake that possesses a part of the edge of an axe/adze on the dorsal face.
3) core-tool pre-form: an unfinished core tool, that possesses flaking scars and/or signs of pecking and/or grinding; furthermore it usually exhibits a flaw (e.g., breakage, oversized flake removal), that is why it was discarded.
4) butt-end: a ground or polished incomplete artefact with a rounded end, usually the butt of an axe.
5) hammer stone: a mass of lithic material, often round or oblong in shape, with battering on one or both ends, sides, or faces.
6) pestle: an oblong cylindrical mass of lithic material with at least one flat end.
7) anvil stone: a mass of lithic material, flat in shape, exhibiting a battered area on at least one of the faces.
8) polishing stone: mass of lithic material, usually a water-worn pebble, exhibiting areas with polish and/or striations.
9) passive abrading stone (metate, grinding stone): a flat mass of lithic material with at least one concave abraded surface; in the case of a grinding stone, the length of a pronounced abraded surface is usually significantly longer than its width.

10) active abrading stone (manos): an oblong or elongated mass of lithic material with at least one convex abraded surface.
11) other type of abrading tool: any mass of lithic material that has an abraded surface and does not fit the other definitions.
12) water-worn pebble with a flake scar: a naturally rounded lithic item that possesses one or few flake scars and for which the purpose of flaking is unclear.
13) water-worn pebble with narrow indentations (net-weight): Pebble with bifacial flake removals in the middle of both sides to provide points for attachment.

Other core-artefacts:

1) non-modified water-worn pebble: a lithic item rounded by water erosion.
2) flint nodule: a non-modified piece of flint other than a water-worn pebble.
3) natural rock other than water-worn pebbles: unmodified rock (not shaped by flaking, pecking or grinding, and without use-wear).
4) bead: a lithic item ground or polished in a cylindrical object that is perforated.
5) bead-preform: an unfinished bead, typically lacking complete grinding or perforation .
6) pendant: a lithic item with a hole at its end or edge (Steenvoorden 1992).
7) pendant preform: unfinished pendant, typically lacking complete grinding or perforation.
8) zemi: triangular shaped object, representing one of the forms in which zemis were depicted.
9) zemi-preform: unfinished zemi, typically lacking completely ground surfaces.
10) other type of core artefact: any core artefact that does not meet any of the criteria specified above.
11) unidentified core artefact.

3a) **Maximal dimension:** the distance between the two most extreme points (recorded in mm).

3b) **Length**: Length was recorded only for flakes and zemis (in mm).

-flake/blade: the maximal dimension of the artefact while holding the axis of the flake parallel to the callipers.
-zemi: distance between both lower points.

4) **Width**: Width was recorded for all artefacts (in mm) according to the following criteria:

-flakes: side perpendicular to length and parallel to the dorsal and ventral plain/parallel to one of the faces.
-zemi: distance between top point and base perpendicular to its length.
-other artefacts: longest side perpendicular to the maximum dimension.

5) **Thickness**: Thickness was recorded for all artefacts (in mm) according to the following criteria:

-flake: longest distance between the ventral and dorsal sides.
-other artefacts: longest distance perpendicular to maximum dimension and width.

6) **Weight**: weight was recorded for all artefacts (in 0.1 g).

7) **Colour**: the Munsell Soil Color Chart was used to determine colours. Burnt and weathered artefacts were not recorded.

8) **Traces of burning**: absence or presence of traces of burning.

1) no traces.
2) parent piece with the negatives of the ejected potlids.

3) potlids: the ejected pieces.
4) structural change usually resulting in white opacity and a porcelain looking surface (after Schlanger 1992).
5) colour difference.
6) firecracked.
7) unidentified.

9) **Source**: All artefacts received a source designation if they were similar to source material when studied macroscopically. If not, source was specified as “unidentified”. This attribute was mainly focussed on flint and chert sources, since that was the material most available to me.

Flint/chert sources:

Antigua

1) Long Island.
2) Little Cove.
3) Soldier Point.
4) Shirley Heights.
5) Hughes Bay.
6) Coconut Hall.
7) Blackman’s Point.
8) Corbison Point/Dry Hill.

St.Kitts

9) Great Salt Pond.
10) Sugar Factory Pier.
11) Whitehorse Bay.

Puerto Rico

12) Cabo Rojo.
13) Las Palmas.
14) Pedernales.
15) Cerillo.
16) Villa Taina.

Other sources:
17) jasper: La Désirade.
18) greenstone: St.Martin.
19) calci-rudite: St. Martin.

20) unidentified.

10a) **Amount of cortex/outer surface on the exterior face**: amount of cortex/outer surface (in %) on the exterior surface, including the striking platform.

1) 100%
2) 75-99%
3) 50-74%
4) 25-49%
5) 1-24%
6) 0%

10b) **Amount of cortex/outer surface, including old patina on the exterior face**: This attribute was included for flint and chert, as it appeared that artefacts might have a patinated surface as their outer surface. This patina formed when natural cobbles were broken, after which a patina developed on the broken surface. In addition, it was noticed in rare instances that ancient artefacts (likely dating to the Preceramic Age) were scavenged. Usually these artefacts were patinated and as such, the patinated surface had to be considered as the outer surface. Therefore within this attribute the sum of the amount of cortex/outer surface and the amount of the patina on a natural surface or patina on the exterior face of an artefact including striking platform is estimated (total in %).

1) 100%
2) 75-99%
3) 50-74%
4) 25-49%
5) 1-24%
6) 0%

11) **Type of cortex**: nature of cortex/outer surface indicative of the collecting environment.

1) irregular: could be freshly quarried.
2) worn: inland (irregular but has little worn areas).
3) water-worn.
4) unclear.
5) no cortex.

12) **Reduction of debitage**: This attribute relates to the intentional modification of flakes, other than typical retouch.

1) non-modified.
2) modified: flake that has been modified, that is flakes have been removed from it after its formation. This could have been done to shape the flake, but also modification is included when it was not clear what the purpose of the modification was.
3) modified: core on flake: flake has been used as a core from which small flakes were removed.
4) modified: bipolarly split: flake has been rested on an anvil with the flat face (either ventral or dorsal) facing the anvil, after which it has been struck into two, leaving a (negative) of bulb of force and cone of percussion at the “broken” end.

13) **Retouch**: absence or presence of use or intentional retouch. A general distinction between use-wear and intentional retouch was based on the size of scars, in which use retouch is defined as a pattern of flake scars originating from an edge of a flake indicative of use wear, with scars not exceeding 1 mm in size. In intentional retouch, these scars are between 1 and 5 mm in size.

1) no retouch.
2) use retouch.
3) intentional retouch.

14) **Location of intentional and use retouch**:

1) unifacial.
2) bifacial.
3) at pointed end.
4) unifacial with steep edge angle.
5) unifacial at curvate edge.

15) **Patina**: absence or presence of patina (naturally weathered surface).

1) not patinated.
2) patina all over.
3) patina on one face.
4) patina: flaked afterwards: reduction took places after a patina had formed.
5) differential patination: flaked in between: reduction took place after one type of patina had formed but before a second type formed.
6) unidentified.

16) **Flaking technique**:

1) bipolar.
2) direct freehand percussion (hard hammer).
3) direct freehand percussion (soft hammer).
4) pressure flaking.
5) unclear.

17) **The number of scars on the exterior face**: the number of scars larger than 2 mm on the exterior face, excluding the platform associated scars. The number is filled in on the sheet.

18) **Type of striking platform**:

1) cortical/outer surface.
2) outer surface with scar.
3) single scar.
4) two scars.
5) three scars.
6) four scars.
7) more than four scars.
8) pointed.
9) edge.

19) **Distal Part**: Type of flake termination.

1) feather.
2) hinge.
3) step.
4) plunge.
5) end of core.

All core-tools and core artefacts are analysed for:

20) **Type of modification**: All human modification that has been applied with the aim of shaping the tool

1) none: water-worn rock.
2) none: natural rock (other than water-worn).
3) flaked.
4) pecked.
5) ground.

6) flaked and pecked.
7) flaked and ground.
8) pecked and ground.
9) flaked, pecked, and ground.
10) can not be identified.

All axes/adzes are analyzed for:

21) **Shape**: shape of the axe/adze.

1) petaloid.
2) rectangular.
3) rectangular with indentations.
4) butterfly.
5) other.
6) unidentified.

22) **Edge**: shape of edge when seen from aside.

1) asymmetrical (plano-convex).
2) symmetrical.

23) **Type of finishing**:

1) totally ground.
2) totally polished.
3) only edge ground.
4) only edge polished.
5) edge and medial part ground.
6) edge and medial part polished.
7) partially ground.

24) **Weathering**: presence or absence of weathering on greenstone artefacts.

1) non-weathered.
2) partially weathered.
3) completely weathered.

Appendix E Mesh size and sample size bias

E.1 Mesh size bias

This study uses data on average flake or core size dimensions to compare the degree of efficiency among flake production from different sites. Therefore, it compares samples of lithic artefacts excavated at these sites. The samples were obtained using different excavation methods, of which especially the use of different mesh sizes for screening is assumed to have a significant influence on the size dimension data. Artefacts vary in shape and size and therefore, I believe that samples do not become similar just by subtracting all items with a maximal dimension, that is smaller than the largest mesh size used. Instead, to know how samples should be treated, a simple test was invented using archaeological data from this study. It was tested by using residue samples from different sized mesh-screens to assess the representation of different size classes of artefacts and therefore which ones would produce similar average results. In other words, the question was asked: from which minimum size class onwards both sample residues would contain the same numbers of artefacts, if one could duplicate the excavation of a test-unit and one would sieve the first attempt with a mesh-size of 3.2 mm and afterwards do the same excavation with a 6.4 mm mesh-size.

As such a duplicate excavation cannot be done in reality, a case was sought in which part of a test-unit was excavated using one type of mesh-size and another part of the same unit was excavated using a different type of mesh-size. This situation exists for the excavations at Anguilla sites, done by John Crock and Jim Petersen (Crock 2000; Crock *et al.* 1995). They systematically reserved a 0.5 x 0.5 m subunit within their 1.0 x 1.0 m test-units for fine mesh screening. The smaller square was sieved through a 1/8 inch (3.2 mm) mesh, while the remainder of the unit was sieved through a ¼ inch (6.4 mm) mesh. From their excavations, I chose the Barnes Bay site for further analysis, since the test-units at this site were excavated most systematically using this methodology and the largest number of artefacts were recorded enabling comparison of larger samples, and thereby improving reliability.

The first step was to group the artefacts into size classes. As a criterion for constructing such a class, I took the combination of maximum dimension and width (being perpendicular to maximum dimension). This combination of the largest two dimensions (thickness is in general smaller than width) was chosen because with such a combination it is possible to be certain that an object will not go through a specific mesh opening. For example, an item where both the maximal dimension and the width is larger than 10 mm will never pass through a round opening of 10 mm. However, if the width is smaller, then it is possible to pass through. This does not necessarily have to be the case, if one considers, for example, a very long but narrow and thin object, which is not likely to go through due to its long maximal dimension.

I grouped the artefacts into the cumulative classes as tabulated in table E.1. In this table, 6 x 6 mm stands for all items where both the maximum dimension and the width are larger than 6 mm, and 7 x 7 mm stands for all items where these dimensions are larger than 7 mm, etc. The difference between these two classes is formed by the artefacts where both maximum dimension and width are exactly 6 mm. This means that by increasing size the number of artefacts included will decrease. The next step was to count the number of artefacts within each mesh residue for each size class. For example, 106 artefacts were counted from the 1/8 inch mesh residue sample that had both a maximum dimension and a width larger than 6 mm, and there are 88 artefacts for which this was 7 mm, indicating that the number of artefacts with a maximum dimension and a width both equal to 6 mm being 18. As usual the sample square (3.2 mm mesh) and normal square (6.4 mm mesh) were not equal in size, so the ratio of [(number within size class X from 3.2 mm)/(number within size class X from 6.4 mm)] was calculated. Both residue samples are considered similar from the point on, when this ratio remains constant. In theory, this ratio should remain constant until the largest size class, but due to the small sample size of the large size classes, sample bias influences the outcome.

From the table it is clear that for Unit 402/423 the size class from where the ratio becomes constant is (13 x 13), with class (12 x12) being close. Unit 401/418 produced somewhat different results. As the overall sample size is smaller than for unit 402/423, the ratio values differ more and make it hard to draw the line. From the numbers, it is clear that the point should be between the size classes (10 x 10), (11 x 11), and (12 x 12).

This means that when using both a 3.2 and 6.4 mm mesh size, residues become comparable from around the 12 x 12 mm size class onwards, which is 5 to 6 mm larger than the largest mesh size. If one takes into account that for the 6.4 mm rectangular mesh size, the largest opening equals 9.1 mm[1], which is the diagonal between the corners, then the discrepancy

[1] Using Pythagoras: $(6.4)^2 + (6.4)^2 = (9.1)^2$

Size category	Unit 401/418				Unit 402/423			
	N 3.2 mm	N 6.4 mm	Ratio (6.4)/(3.2)	average[a]	N 3.2 mm	N 6.4 mm	Ratio (6.4)/(3.2)	average[a]
6x6	84	134	1.60	-	106	102	0.96	-
7x7	59	133	2.25	2.38	88	101	1.15	1.53
8x8	37	122	3.30	2.94	74	97	1.31	1.34
9x9	29	95	3.28	3.41	55	85	1.55	1.51
10x10	22	80	3.64	3.55	44	73	1.66	1.78
11x11	18	67	3.72	3.91	28	60	2.14	2.00
12x12	14	61	4.36	3.94	24	53	2.21	2.32
13x13	12	45	3.75	4.29	20	52	2.60	2.56
14x14	8	35	4.75	4.50	17	49	2.88	2.72
15x15	6	30	5.00	4.64	16	43	2.69	2.76
16x16	6	25	4.17	4.39	14	38	2.71	2.67
17x17	6	24	4.00	3.99	13	34	2.61	2.74
18x18	5	19	3.80	3.87	11	32	2.91	2.81
19x19	5	19	3.80	3.47	10	29	2.90	2.80
20x20	5	14	2.80	3.07	10	26	2.60	2.65
21x21	5	13	2.60	2.72	9	22	2.44	2.56
22x22	4	11	2.75	3.62	8	21	2.63	2.57
23x23	2	11	5.50	-	8	21	2.63	2.50
24x24	-	-	-	-	8	18	2.25	-
Total	125	135			139	102		

Table E.1. Barnes Bay, Anguilla. Number of artefacts that at least is larger or similar to a certain size category within the residue of 3.2 or 6.4 mm mesh-screens. So 8x8 designates all artefacts that have maximum dimensions as well as widths larger than 8 mm. For example an artefact with maximum dimension of 14 mm and width of 6 mm does not belong to this size class. [a] At this column the values of three subsequent size classes are averaged.

is only 3 mm. If, for example, a 10 mm mesh residue is compared to a 6.4 mm, the largest opening would be 14.1 mm, and preferred size class from where residues would be comparable becomes 17 x 17 mm.

E.2 Sample size bias

This study makes use of samples of lithic artefacts to determine to what extent Long Island flint was used at a number of different sites within the northern Lesser Antilles. In relation to this aim, a number of parameters were considered to be useful, for example, the percentage of Long Island material as part of all flake tool material, or the average length or weight of a certain artefact class. To evaluate the effect of sample size (number of artefacts) on the accuracy of these parameters, and as estimators of the true population values, I decided to study this in detail for one site. The Early Ceramic Age Golden Rock site on St. Eustatius was considered most useful for this purpose. The reasons for choosing this site include: (a) the relatively large number of artefacts analysed; (b) the fact that excavation work there involved the almost complete uncovering of a distinct area used as discard location; (c) the systematic procedure in which the excavation occurred; and (d) the relatively small period during which discard was dumped in this area (Versteeg & Schinkel 1992).

The excavators divided this area of the site into large 4 x 4 m units, which were then subdivided into sixteen 1 x 1 m test unit squares. Material was collected following this 1 x 1 m grid-system. This systematic excavation procedure enabled me to quickly construct sub-samples of varying sizes in a systematic manner. For example, I could easily select only the material from the first 1 x 1 m square within each 4 x 4 m unit, or the material from two squares, the first and the ninth, etc.

In this manner, I constructed four types of sub-samples: (1) one square per 4 m unit, making up a 6% sample; (2) two squares at the same distance per 4 m unit, including approximately 12.5% of the total sample; (3) one 2 x 2 m square (four 1 x 1 m squares) in each 4 m unit, including approximately 25% of the total sample; and (4) two 2 x 2 m squares in a chess-board pattern (so eight 1 x 1 m squares) within each 4 m unit, including approximately 50% of the total.

For each of these sub-samples, I determined four parameters: (1) percentage of Long Island flint among all flake tool

sample	N total all flint and chert	% LI-flint (average)	sd average % LI- flint	RSD average % LI- flint	average difference with value from complete sample	sd average difference	relative average difference with value from complete sample	maximum relative difference
complete	672	71,70	-	-	-	-	-	-
50% samples	approx. 336	71,73	0,38	0,53	0,28	0,21	0,38	0,70
25% samples	approx. 168	71,73	3,18	4,43	2,43	1,50	3,38	5,72
12,5 % samples	approx. 83	71,68	5,55	7,75	4,32	3,18	6,03	11,85
6% samples	approx. 42	71,80	7,06	9,83	6,13	3,13	8,54	15,06

Table E.2. Golden Rock flint and chert artefacts. Comparison of artificial sub-sample values of the percentage of Long Island flint artefacts with the true value of the Golden Rock assemblage (the complete sample). RSD = Relative Standard Deviation.

sample	N total Long Island	average maximum dimension of debitage except shatter	sd average maximum dimension	RSD average maximum dimension	average difference with value from complete sample	sd average difference	relative average difference with value from complete sample	maximum relative difference
complete	482	31,49	-	-	-	-	-	-
50% samples	approx. 241	31,49	0,33	1,05	0,24	0,18	0,76	1,27
25% samples	approx. 120	31,49	0,13	0,43	0,10	0,07	0,31	0,64
12,5 % samples	approx. 59	31,63	0,67	2,13	0,49	0,46	1,54	4,38
6% samples	approx. 30	31,48	1,65	5,24	1,28	0,99	4,06	8,16

Table E.3. Golden Rock flint and chert artefacts. Comparison of artificial sub-sample values of the maximum dimension of Long Island flint debitage with the true value of the Golden Rock assemblage (the complete sample). RSD = Relative Standard Deviation.

related material; (2) percentage of cortical flakes among all Long Island flakes; (3) average maximum dimension of all Long Island flake material; and (4) average weight of all Long Island flake material. Following that, I calculated the absolute and relative difference of the sub-sample value with the value for the total sample. As I selected multiple sub-samples for each sub-sample type, I also determined the average relative difference and the maximum relative difference.

Tables E.2-E.5 present the different results. It is clear from these tables that the four parameters were affected differently by variation in sample size. The average maximum dimension is least affected; even in case of the smallest sub-sample (approximately 30 artefacts), the maximum relative difference with the total sample average is below 10%, with a mean value of a little above 4%. This suggests that samples of 30 artefacts in this case provide a fairly accurate estimator of the true value. The percentage of Long island flint differs more from the true value for the smaller samples, although the averages of the relative differences stay well below 10%.

The other parameters are considerably more affected by sample size. In particular, the percentage of cortical flakes becomes significantly less accurate when samples below 100 artefacts are used. Looking at the average weight, it is noted that this parameter generally varies more than the other parameters. This is due to the considerable variation in weight between the different flint artefacts, indicated by a much higher standard deviation in all samples than, for example, in case of the average maximum dimension. Also, the accuracy of this parameter is poor in case of the smallest sample.

In conclusion it can be stated that samples with more than 100 artefacts provide fairly accurate results, but in the case of smaller samples, the weight values and the percentages of cortical flakes, should be treated with caution.

sample	N total Long Island	average weight of debitage except shatter	sd average weight	RSD average weight	average difference with value from complete sample	sd average difference	relative average difference with value from complete sample	maximum relative difference
complete	482	57,78	-	-	-	-	-	-
50% samples	approx. 241	57,73	2,73	4,73	2,36	0,10	4,09	4,34
25% samples	approx. 120	57,82	4,95	8,56	3,36	3,08	5,81	11,75
12,5 % samples	approx. 59	57,68	6,06	10,50	4,70	3,49	8,14	22,05
6% samples	approx. 30	57,51	14,33	24,92	10,97	8,78	18,98	56,25

Table E.4. Golden Rock flint and chert artefacts. Comparison of artificial sub-sample values of the average weight of Long Island flint debitage with the true value of the Golden Rock assemblage (the complete sample). RSD = Relative Standard Deviation.

sample	N total Long Island	% cortical flakes (average)	sd average % cortical flakes	RSD average % cortical flakes	average difference with value from complete sample	sd average difference	relative average difference with value from complete sample	maximum relative difference
complete	482	48,60	-	-	-	-	-	-
50% samples	approx. 241	48,65	0,53	1,09	0,45	0,13	0,93	1,23
25% samples	approx. 120	48,65	1,33	2,73	0,95	0,75	1,95	3,91
12,5 % samples	approx. 59	46,46	6,87	14,79	5,70	4,03	11,73	31,48
6% samples	approx. 30	48,51	13,20	27,20	11,01	6,70	22,65	54,32

Table E.5. Golden Rock flint and chert artefacts. Comparison of artificial sub-sample values of the percentage of cortical Long Island flint flakes with the true value of the Golden Rock assemblage (the complete sample). RSD = Relative Standard Deviation.

Appendix F Archaeological sites and related lithic sample

F.1 Introduction

In the following section, each of the archaeological sites from which a sample of stone artefacts was analysed are briefly described. In addition, the provenience of the studied sample is specified, along with the methodology employed during its excavation.

F.2 Martinique

Samples from three sites on the island of Martinique are included within this study. These are Vivé, Dizac au Diamant, and Anse Trabaud (see figure 3.12).

F.2.1 Vivé

Vivé, an early Saladoid settlement site, is situated along the fertile northeastern coast of Martinique. It is one of the oldest Ceramic Age sites on the island and it has been dated between cal AD 144 - 440 (1730 ± 100 BP) and cal AD 400 - 660 (1530 ± 75 BP). Vivé has been the subject of several archaeological projects, of which the one by Mattioni during 1970s and more recent research by Giraud, Bérard, and Vidal can be considered the most significant (Giraud *et al.*1999; Mattioni 1971, 1974). They established that Vivé was minimally occupied during two phases. The oldest one corresponds with the early date of cal AD 144 – 440 (95% confidence interval) and falls within the Early Ceramic A phase. This occupation predates an active volcanic period of Mount Pelée. Sudden volcanic eruptions surely forced the inhabitants to abandon the Vivé site. Volcanic flows also covered the area with ash and debris, protecting finds from later post-depositional processes and perfectly preserving occupation remains just prior to the eruption. The second phase is dated after AD 400, falling within the Early Ceramic B phase and corresponding with the end of the volcanic activity. People then settled on the previously deposited ash layer. Data from this second occupation phase are scanty, as recent banana growing activities have largely disturbed the remains.

In total, a sample of 327 lithic artefacts was analysed from this site (table F.1). The sample originated from two systematically screened test-units: nr. 8 and 9, excavated by Giraud and co-workers during the 1996 field-season. Only the artefacts from the oldest occupation phase below the volcanic ash deposit have been included in this study. Materials identified include flint, red and yellow varieties of jasper, chalcedony (transluscent chert), chert, igneous rock and pumice. A larger sample, including the material from these two units, was previously studied and reported by Benoit Bérard in earlier publications (Bérard 1999a,b, 2004; Bérard and Giraud 1998).

raw material	flint chert jasper	quartz	igneous rock	pumice	unidenti-fied rock	total
artefact category						
artefact type						
flaked stone						
flake	219	-	20	-	2	241
shatter	37	-	-	-	-	37
flake core	21	-	-	-	-	21
water-worn pebble with flake removal	-	-	1	-	-	1
fragment axe preform	-	-	1	-	-	1
ground stone						
fragment of axe	-	-	1	-	-	1
used water-worn pebbles						
complete hammerstone	-	-	1	-	-	1
complete hammerstone anvil	-	-	1	-	-	1
fragment metate	-	-	2	-	-	2
non-used water-worn pebbles						
non-modified water-worn pebble	2	-	4	-	-	6
fragment waterworn pebble	1	-	2	-	-	3
other used rock						
fragment metate	-	-	3	1	-	4
other rock						
fragment natural rock other than water-worn pebble	2	1	1	-	-	4
fragment unidentified core artefact	-	-	-	1	-	1
unidentified	3	-	-	-	-	3
total	285	1	37	2	2	327
%	87.2	0.3	11.3	0.6	0.6	100.0

Table F.1. Vivé, Martinique. Number of lithic artefacts by raw material by artefact type.

raw material	flint chert	green-stone	lime-stone	quartz	igneous rock	plutonic rock	pumice	fine-grained rock	uniden-tified rock	total
artefact category										
artefact type										
flaked stone										
flake	130	-	1	6	63	-	-	-	3	202
shatter	21	-	1	2	-	-	-	-	-	24
flake core	14	-	-	-	-	-	-	-	-	14
complete axe preform	-	-	-	-	1	-	-	-	-	1
fragment axe preform	-	-	-	-	1	-	-	-	-	1
ground stone										
fragment of axe	-	1	-	-	3	-	-	-	-	4
fragment of an axe/adze: edge flake	-	-	-	-	2	-	-	-	-	2
complete bead	1	-	-	-	-	-	-	-	-	1
used water-worn pebbles										
complete hammerstone	-	-	-	-	3	-	-	-	-	3
fragment hammerstone	-	-	-	-	2	-	-	-	-	2
complete polishing stone	-	-	-	-	-	-	-	1	-	1
non-used water-worn pebbles										
non-modified water-worn pebble	-	-	-	-	3	-	-	-	-	3
fragment water-worn pebble	-	-	-	-	1	-	-	-	-	1
other used rock										
complete active abrading stone	-	-	-	-	1	-	-	-	-	1
fragment active abrading	-	-	-	-	-	-	1	-	-	1
fragment metate	-	-	-	-	2	-	-	-	-	2
other rock										
natural rock	1	-	-	-	-	-	-	-	-	1
fragment natural rock other than ww pebble	1	-	-	-	1	-	-	-	-	2
unidentified core artefact	1	-	-	-	-	-	-	-	-	1
fragment unidentified core artefact	-	-	-	-	2	1	-	-	-	3
total	169	1	2	8	85	1	1	1	3	271
%	62.4	0.4	0.7	3.0	31.4	0.4	0.4	0.4	1.1	100.0

Table F.2. Dizac au Diamant, Martinique. Number of lithic artefacts by raw material by artefact type.

F.2.3 Dizac au Diamant

Dizac au Diamant, a late Saladoid settlement site, is situated along the southwestern coast of Martinique, facing the famous Rocher du Diamant. From excavations carried out by Nathalie Vidal during the early 1990s, remains belonging to an Amerindian occupation were found within an extensive dune deposit, roughly dated to the Early Ceramic B phase between AD 500 and 700. Vidal classified the site as “Modified” Saladoid based on the pottery characteristics.

The sample from this site totalled 271 lithic artefacts (table F.2). This sample originated from one large 50 m² unit, which was excavated in 18 different arbitrarily 5 cm levels, using 2 mm mesh screens (Vidal 1992). Rock materials include flint, chert, jasper, chalcedony, dull white quartz, petrified wood, St. Martin greenstone, igneous rock, plutonic rock, tuff, pumice, limestone and fine-grained siliceous materials.

	raw material	flint and chert	quartz	greenstone	igneous rock	total
artefact category						
	artefact type					
flaked stone						
	flake	37	-	-	5	42
	shatter	5	-	-	-	5
	flake core	5	-	-	-	5
	flaked piece	-	-	-	1	1
	flaked pebble	-	-	-	1	1
	fragment axe preform	-	-	-	1	1
ground stone						
	fragment of axe	-	-	1		1
	fragment of an axe/adze: edge flake	-	-	-	1	1
	fragment axe preform	-	-	-	1	1
used water-worn pebbles						
	complete hammerstone	-	-	-	2	2
	complete active abrading stone	-	-	-	1	1
	fragment active abrading stone	-	-	-	1	1
	complete polishing stone	-	-	-	3	3
	fragment polishing stone	-	-	-	1	1
	complete passive grinding stone	-	-	-	1	1
non-used water-worn pebbles						
	non-modified water-worn pebble	-	-	-	18	18
	fragment water-worn pebble	-	-	-	5	5
other used rock						
	fragment metate	-	-	-	6	6
	fragment other type of abrading tool	1	-	-	-	1
other rock						
	natural rock	1	-	-	-	1
	fragment natural rock other than water-worn pebble	-	5	-	-	5
	fragment unidentified core artefact	-	-	-	5	5
	total	49	5	1	53	108
	%	45.4	4.6	0.9	49.1	100.0

Table F.3. Anse Trabaud, Martinique. Number of lithic artefacts by raw material by artefact type.

F.2.4 Anse Trabaud

Anse Trabaud, a Late Ceramic Age habitation site along the southeastern coast of Martinique, is situated only a few kilometres to the east of La Savanne des Pétrifications. Louis Allaire and Mario Mattioni studied this site during two field-seasons in 1983 and 1984. Following the excavation of 16 test-units, they classified this site as Suazoid. Louis Allaire distinguished two pottery styles, one clearly Suazoid and the other somewhat distinctive from that, but late in its characteristics (Allaire 1997). Unfortunately, radiocarbon dates have not been obtained for this site to support this possible distinction. Generally, the Suazoid period is dated between AD 1000 and 1500, which extended from the later part of the Late Ceramic A phase well into the following Late Ceramic B (Hofman 1993).

From the Anse Trabaud site, 108 lithic artefacts were studied (table F.3). I only analysed the material from the 1984 field-season, including seven 1 x 1 m test-units, named I to O. These were excavated in arbitrary 20 cm levels, using 10 mm mesh-screens (Allaire 1997). Lithic raw materials include red and yellow jasper, St. Martin greenstone, translucent chalcedony, petrified wood, crystal quartz, tuff, and igneous rock.

F.3 Guadeloupe

Samples from three sites lying on the northern island of Grande Terre in Guadeloupe were included within this study. These are Morel, Anse à la Gourde, and Anse à l'Eau (see figure 3.11).

F.3.1 Morel

Morel, a large multi-component site situated along the northern Atlantic coast of Grande Terre and near the town of le Moule, has been subject of several archaeological research campaigns. In relation to this, the excavation work of Edgar Clerc during the late 1950s and early 1960s needs mentioning since Clerc set up the first chronology of the site (Clerc 1964, 1968, 1970; see a summary for Morel in Arts 1999). From a number of test-excavations, Clerc identified a very long occupational history, which he divided into 4 phases, Morel 1 to 4. Later, Ripley and Adelaide Bullen confirmed this distinction when they performed tests at Morel (Bullen and Bullen 1973). Based on their typology, Petitjean Roget (1981) summarized the phases as follows: Insular Saladoid (Morel 1), Modified Saladoid (Morel 2), Terminal Saladoid (Morel 3), and Suazey (Morel 4), respectively. These phases formed the basis upon which the entire chronology of prehistoric Guadeloupe was founded (Rouse 1986, 1992).

Later rescue work by the Archaeological Service of Guadeloupe and Leiden University during the period from 1995 until 1999 confirmed the importance of Morel, although not all phases identified by Clerc were found. An important aspect that became clear was the significant disturbance caused by coastal erosion, which also affected other sites on the northeastern coast of Grande Terre. Erosion has been responsible for the disappearance of a large part of the archaeological remains, leaving only segments of the occupations dating to the Morel 1, 2, and 3 phases.

Field-work carried out in 1999 provided the lithic sample studied in the scope of the present research (Hofman *et al.* 2000). The field-work in 1999 concentrated on the western part of the site still present, corresponding with the Morel 1 and 2 phases. The occupation deposit within this site area was large. It was extensively excavated. In addition to the collection of artefacts and subsistence remains, the research was also aimed at mapping posthole features and burials. Initial results indicate that this area corresponds with a habitation zone, which was located near an old saline pond. The deposits are dated somewhere between AD 200 and 600, and the ceramics exhibit both characteristics of the Huecan and Cedrosan Saladoid subseries. This places the site within the Early Ceramic A phase.

A sample of 2339 artefacts was studied from this site and only included material collected during the 1999 field-campaign (table F.4). Frank Stevens (2002), doing his Master's thesis work at Leiden University, analysed the sample under my supervision, following the methodology used in this dissertation. Considering my knowledge of many lithic samples and stone sources in the region, I identified the raw materials myself. The sample originated from the large units excavated at the site. These units were subdivided into 1 x 1 m squares, which were systematically excavated in arbitrary 10 cm levels using 10 mm mesh-screens. We identified the following raw materials: flint, chert, St. Martin greenstone, jasper, petrified wood, limestone, carnelian, amethyst, quartz, different varieties of igneous rock, pumice, plutonic rock, fine grained non-carbonate rock, metamorphic rock, and red ochre.

F.3.2 Anse à la Gourde

Anse à la Gourde is another major site along Grande Terre's northern coast, approximately 13 km to the east of Morel. It lies at the Anse à la Gourde Bay, which is a sandy beach protected by a shallow reef. The site itself covers parts of the sandy dune and the areas more inland. It extends over an area 500 metres by 1 kilometre in size (Hofman *et al.* 2001). First studied in the early 1970s by Father Barbotin and Edgar Clerc, it was the subject of several other small field campaigns during the following years, led by different researchers (e.g., Bodu 1984). These studies showed that the site is a large multi-component habitation site, with significant occupation phases during the Post-Saladoid period.

Considering its presumed significance and the constant threat of costal erosion and clandestine sand collecting, Anse à la Gourde was subject to a multi-year excavation campaign led by the local DRAC and Leiden University (Hofman *et al.* 2001). The first outcomes of the research showed that it experienced a long history of occupation, from the Late Saladoid, around AD 500-700 followed by three post-Saladoid phases: Troumassoid 1 (AD 700-900; Mill Reef style), Troumassoid 2 (AD 1000-1150; Mamora Bay style), and Suazan Troumassoid (AD 1250-1300) (Hofman *et al.* 2001; Hofman, personal communication 2001). This extensive period of settlement corresponds with the Early Ceramic B and Late Ceramic A phases. Coastal erosion had significantly affected the site, destroying large parts of the original Saladoid occupation deposits. The most significant remaining archaeological deposits are attributed to the Troumassoid 1 and 2 phases. These include a

raw material	flint chert jasper	quartz	semi-precious stone	greenstone	igneous rock	plutonic rock	pumice	fine-grained rock	meta-morphic rock	lime-stone	red ochre	uniden-tified	total
artefact category													
artefact type													
flaked stone													
flake	1200	3	2	-	23	-	-	1	2	16	-	5	1252
blade-like	36	-	-	-	-	-	-	-	-	-	-	-	36
shatter	63	2	3	-	11	-	-	2	-	1	-	-	82
flake core	89	2	-	-	-	-	-	-	-	-	-	-	91
ground stone													
complete axe	-	-	-	1	2	-	-	-	1	-	-	-	4
fragment of axe	-	-	-	3	4	1	-	-	-	-	-	-	8
complete bead	-	-	1	-	-	-	-	-	-	-	-	-	1
fragment bead	-	1	3	-	-	-	-	-	-	1	-	-	5
bead preform	-	1	4	-	-	-	-	-	-	-	-	-	5
fragment pendant	-	-	-	-	-	-	-	-	-	-	-	1	1
used water-worn pebbles													
complete hammerstone	1	1	-	-	5	-	-	-	3	-	-	-	10
fragment hammerstone	-	-	-	-	15	-	-	-	2	1	-	-	18
complete hammerstone anvil	-	-	-	-	-	-	-	1	-	-	-	1	2
fragment hammerstone anvil	-	-	-	-	3	-	-	-	-	-	-	-	3
complete active abrading stone	-	-	-	-	1	-	-	-	-	-	-	-	1
fragment active abrading stone	-	-	-	-	26	-	-	5	-	1	-	-	32
complete polishing stone	-	-	-	-	-	1	-	-	-	-	-	-	1
pebble with black residue	-	-	-	-	21	-	-	-	1	1	-	-	23
non-used water-worn pebbles													
non-modified water-worn pebble	1	-	-	-	406	52	-	1	18	16	-	1	495
fragment water-worn pebble	-	-	-	-	23	-	-	1	5	-	-	3	32
other used rock													
other rock													
natural rock	2	-	-	-	6	-	1	1	-	-	-	-	10
fragment natural rock other than ww pebble	-	-	-	-	14	-	-	-	-	3	-	-	17
fragment unidentified core artefact	3	2	-	-	70	2	-	9	1	3	-	5	95
unidentified core artefact	-	-	-	-	-	-	-	-	-	2	-	-	2
unidentified	2	4	3	-	75	-	1	4	2	12	1	9	113
total	1397	16	16	4	705	56	2	25	35	57	1	25	2339
%	59.7	0.7	0.7	0.2	30.1	2.4	0.1	1.1	1.5	2.4	0.0	1.1	100.0

Table F.4. Morel, Guadeloupe. Number of lithic artefacts by raw material by artefact type.

habitation and burial area, where several house plans and over 80 burials were found, encircled by a donut shaped refuse zone. The remains from the latest Suazan Troumassoid phase are scanty and suggest that habitation areas were moved to a different location more inland (Dorst *et al.* 2001; Hoogland & Panhuysen 2001; Jansen *et al.* 2001).

A sample of 1222 artefacts was studied from the Anse à la Gourde site, originating only from the systematically excavated and screened test-units. These were predominantly 2 x 2 m in size, and were excavated in 10 cm arbitrary levels using 6.4 mm mesh-screens. Based on stratigraphy and ceramic typology each level within these units is attributed to one of the different occupation phases. Within some units, it was not possible to differentiate the Troumassoid 1 from the Troumassoid 2 phase. To avoid small samples by excluding mixed deposits, the artefacts from both phases have been lumped. Therefore, a distinction was made between three broad phases: the Saladoid (early phase), Troumassoid 1+2 (middle phase), and Suazan Troumassoid (late phase). Unfortunately a portion of the studied artefacts had to be excluded from further analysis, as their provenience would not let them be dated to one of these three phases exclusively. The excavation of large units for investigating post-hole and burial features yielded many more lithic artefacts. Information from these unscreened contexts was incidentally used to support existing data or provide additional data to the results from the test-units. This extra information mainly has a qualitative character.

raw material	flint chert	plutonic rock	igneous rock	fine grained rock	limestone	beach rock	uniden-tified	total
artefact category								
artefact type								
flaked stone								
flake	12	-	-	-	3	1	-	16
shatter	2	-	-	-	-	-	-	2
flake core	-	-	-	-	1	-	-	1
water-worn pebble with flake removal	-	-	-	-	-	-	-	
ground stone								
axe	-	-	1	-	-	-	-	1
used water-worn pebbles								
complete hammerstone	-	-	9	-	1	-	-	10
fragment hammerstone	-	1	-	-	-	-	-	1
complete hammerstone anvil	-	-	-	-	-	-	-	
complete active abrading stone	-	-	1	-	-	-	-	1
other used rock								
complete active abrading stone	-	-	-	-	-	-	1	1
fragment manos	-	-	1	-	-	-	-	1
fragment metate	-	-	4	-	-	1	-	5
complete passive grinding stone	-	-	1	-	-	-	-	1
non-used water-worn pebbles								
non-modified water-worn pebble	-	-	22	1	9	1	-	33
fragment water-worn pebble	-	-	1	1	1	-	1	4
other rock								
natural rock	-	-	-	-	3	-	-	3
fragment natural rock other than ww pebble	-	-	-	1	8	1	-	10
fragment unidentified core artefact	-	-	-	-	4	1	-	5
unidentified core artefact	-	-	-	-	-	-	1	1
total	14	1	40	3	30	5	3	96
%	14.6	0.1	41.7	3.1	31.3	5.2	3.1	100.0

Table F.5. Anse à la Gourde, Guadeloupe, early occupation phase (Early Ceramic B). Number of lithic artefacts by raw material by artefact type.

Saladoid (early) occupation phase

The sample of artefacts that could be ascribed to the late Saladoid occupation phase comprises only 96 lithic specimens (table F.5).[1] Out of these 96 specimens, 68 can be considered definite artefacts, while the remainder include unmodified local limestone rock, for which it was not possible to determine with certainty whether they are artefacts (see Chapter 3 for definition). The sample includes the following materials: flint, beach-rock, limestone, tuff, igneous rock, plutonic rock, and siliceous sedimentary rock, along with some unidentified materials.

The Troumassoid 1 and 2 (middle) occupation phases

The excavations at Anse à la Gourde largely focused on the extensive occupational remains during these two phases. This emphasis is also evident in the larger number of lithic artefacts attributed to this phase and analysed for this study. The total number of items includes 834, of which 496 can be classified as definite artefacts (table F.6). This leaves 338 rock specimens

[1] In contrast to the material from the other phases that came from clear refuse deposits, this sample originated from within an occupation floor, that was identified in the lower levels of the 2 x 2 m test-units in the dune area.

raw material	flint chert	greenstone	igneous rock	sandstone (?)	pumice	fine-grained rock	meta-morphic rock	tuff	lime-stone	beach-rock	calcite	red ochre	uniden-tified	total
artefact category														
artefact type														
flaked stone														
flake	134	2	16	2	-	4	1	-	60	8	1	-	5	233
shatter	10	-	2	-	-	1	-	-	6	1	-	-	3	23
flake core	13	-	2	-	-	-	-	-	3	-	1	-	-	19
water-worn pebble with flake scar	-	-	2	-	-	-	-	-	9	1	-	-	1	13
ground stone														
complete axe	-	1	-	-	-	-	-	-	-	-	-	-	-	1
fragment of axe	-	4	-	-	-	-	4	-	-	-	-	-	-	8
fragment of an axe/adze: edge flake	-	-	1	-	-	-	-	-	-	-	-	-	-	1
zemi	-	-	-	-	-	-	-	-	1	-	-	-	-	1
fragment zemi	-	-	-	-	-	-	-	-	-	1	-	-	-	1
zemi preform	-	-	-	-	-	-	-	-	2	-	-	-	-	2
complete bead	-	-	1	-	-	-	1	-	-	-	-	-	-	2
fragment bead	-	-	-	-	-	-	-	-	-	-	1	-	-	1
bead preform	-	-	-	-	-	-	-	-	1	-	-	-	-	1
used water-worn pebbles														
complete hammerstone	-	-	6	1	-	-	-	-	4	-	-	-	-	11
fragment hammerstone	-	-	7	-	-	-	-	-	2	-	-	-	-	9
complete hammerstone anvil	-	-	1	-	-	-	-	-	-	-	-	-	-	1
complete active abrading stone	-	-	1	-	-	-	-	-	1	2	-	-	-	4
fragment active abrading stone	-	-	1	-	-	-	-	-	-	-	-	-	-	1
complete polishing stone	-	-	4	-	-	1	-	-	1	-	-	-	-	6
complete possible polishing stone	-	-	14	-	-	-	-	-	-	-	-	-	-	14
fragment possible polishing stone	-	-	2	-	-	-	-	-	-	-	-	-	-	2
complete manos	-	-	-	1	-	-	-	-	-	-	-	-	-	1
fragment metate	-	-	2	-	-	-	-	-	-	1	-	-	-	3
fragment metate/manos	-	-	1	-	-	-	-	-	-	-	-	-	-	1
complete possible manos/metate	-	-	1	-	-	-	-	-	-	-	-	-	-	1
non-used water-worn pebbles														
non-modified water-worn pebble	-	-	66	1	1	18	-	-	191	1	-	-	12	290
fragment water-worn pebble	-	-	15	-	-	-	-	-	21	1	-	-	3	40
other used rock														
fragment active abrading stone	-	-	1	-	-	-	-	-	-	-	-	-	-	1
fragment other abrading stone	-	-	1	-	-	-	-	-	1	1	-	-	1	4
fragment manos	-	-	-	-	-	-	-	-	-	1	-	-	-	1
fragment metate	-	-	5	-	-	-	-	-	-	2	-	-	7	14
other rock														
natural rock	1	-	-	-	-	-	-	-	17	-	-	-	1	19
fragment natural rock other than ww pebble	-	-	1	-	-	-	-	-	34	1	-	1	-	37
fragment unidentified core artefact	-	2	2	1	-	-	-	2	45	7	-	-	3	62
unidentified core artefact	-	-	1	-	-	-	-	-	-	-	-	-	-	1
unidentified	-	-	1	-	-	-	-	-	4	-	-	-	-	5
total	158	9	157	6	1	24	6	2	403	28	3	1	36	834
%	18.9	1.1	18.8	0.7	0.1	2.9	0.7	0.2	48.3	3.4	0.4	0.1	4.3	100.0

Table F.6. Anse à la Gourde, Guadeloupe, middle occupation phase (Late Ceramic A). Number of lithic artefacts by raw material by artefact type.

as disputable artefacts, of which the majority is made out of local rock and does not have any clear signs of modification. Rock materials used are for a great part similar to the ones identified within the Saladoid phase sample and include the following: flint, St. Martin greenstone, jasper, fine-grained varieties, calcite, limestone, beach-rock, red ochre, igneous rock, plutonic rock, pumice, tuff, and metamorphic rock along with a number of unidentified pieces.

raw material	flint chert	jasper	quartz	green-stone	igneous rock	fine-grained rock	meta-morphic rock	calci-rudite	lime-stone	beach rock	unidentified	total
artefact category												
artefact type												
flaked stone												
flake	26	1	1	-	3	-	-	-	2	-	1	34
shatter	6	1	-	-	-	1	-	-	-	-	1	9
flake core	2	-	-	-	-	-	-	-	1	-	-	3
water-worn pebble with flake removal	-	-	-	-	1	-	-	-	-	-	-	1
ground stone												
fragment of axe	-	-	-	2	-	-	1	-	-	-	-	3
fragment of an axe/adze: edge flake	-	-	-	-	-	-	-	-	-	-	-	
zemi	-	-	-	-	-	-	-	2	-	-	-	2
fragment zemi	-	-	-	-	-	-	-	1	1	-	-	2
used water-worn pebbles												
complete hammerstone	-	-	-	-	6	-	-	-	-	-	-	6
fragment hammerstone	-	-	-	-	3	-	-	-	-	-	-	3
complete active abrading stone	-	-	-	-	1	-	-	-	-	-	-	1
complete polishing stone	-	-	-	-	-	-	-	-	1	-	-	1
complete manos	-	-	-	-	-	-	-	-	-	-	1	1
water-worn pebble with narrow indentations	-	-	-	-	-	-	-	-	1	-	-	1
other used rock												
complete other abrading stone	-	-	-	-	-	-	-	-	1	-	-	1
fragment metate	-	-	-	-	3	-	-	-	-	-	1	4
non-used water-worn pebbles												
non-modified water-worn pebble	-	-	-	-	14	1	-	-	4	-	3	22
fragment water-worn pebble	-	-	-	-	12	1	1	-	1	-	-	15
other rock												
fragment natural rock other than water-worn pebble	-	-	-	-	-	-	-	-	2	-	-	2
fragment unidentified core artefact	-	-	-	-	1	1	-	-	4	-	1	7
unidentified core artefact	-	-	-	-	-	-	-	-	-	1	-	1
unidentified	1	-	-	-	-	-	-	-	-	-	-	1
total	35	2	1	2	44	4	2	3	18	1	8	120
%	29.2	1.7	0.8	1.7	36.7	3.3	1.7	2.5	15.0	0.8	6.6	100

Table F.7. Anse à la Gourde, Guadeloupe, late occupation phase (Late Ceramic A). Number of lithic artefacts by raw material by artefact type.

Suazan Troumassoid (late) occupation phase

The sample that was ascribed to the Suazan Troumassoid occupation phase only includes 120 rock pieces (table F.7). I consider 108 of these as true artefacts, as the remainder is made out of local limestone and does not exhibit clear evidence of modification, either through use or through shaping of the rock. In contrast to the other two samples, the artefacts from this phase were collected from test-units exclusively ascribed to this last occupation of the site. Therefore the chance of artefacts being attributed to the wrong phase is considerably smaller. Within this sample, I identified the following materials: chert, flint, quartz, St. Martin greenstone, limestone, calci-rudite, igneous rock, metamorphic rock, and siliceous sedimentary rock.

raw material	flint chert jasper	quartz	igneous rock	plutonic rock	fine-grained rock	limestone	uniden-tified rock	total
artefact category								
artefact type								
flaked stone								
flake	91	-	5	-	1	3	4	104
shatter	9	-	-	-	-	-	-	9
flake core	18	-	-	-	-	-	-	18
flaked piece	-	-	-	-	-	1	-	1
water-worn pebble with flake removal	-	-	1	-	-	-	-	1
ground stone								
axe	-	-	2	-	-	-	-	2
used water-worn pebbles								
hammerstone	-	-	4	-	-	-	-	4
anvil	-	-	1	-	-	-	-	1
active abrading stone	-	-	-	-	-	-	-	
polishing stone	-	-	3	1	3	-	1	8
non-used water-worn pebbles								
non-modified water-worn pebble	-	1	14	3	-	-	-	18
fragment water-worn pebble	1	1	-	-	-	-	-	2
other used rock								
active abrading stone	-	-	-	-	-	-	1	1
passive grinding stone	-	-	-	-	-	-	2	2
other rock								
unidentified	-	-	2	-	-	-	4	6
total	119	2	32	4	4	4	12	177
%	67.2	1.1	18.1	2.3	2.3	2.3	6.8	100.0

Table F.8. Anse à l'Eau, Guadeloupe, early occupation phase (Early Ceramic B). Number of lithic artefacts by raw material by artefact type.

F.3.3 Anse à l'Eau

Anse à l'Eau is the third site along Grande Terre's northern Atlantic coast included in this study. It is situated almost perfectly between the Morel and Anse à la Gourde sites. Similar to these sites, Edgar Clerc and Pierre Bodu conducted small-scale archaeological research there during the 1960s and early 1980s respectively (Bodu 1984; Clerc 1964, 1968, 1970). The identification of a significant site that was largely attributed to the Saladoid period, became the reason for planning of a site-survey there by four Master students from Leiden University and the University of Bonn (Boomsma & Isendoorn 2001).

The survey included a systematic auger-test campaign (217 augers) and excavation of 23 test-units of varying size. The results showed that the site extends itself over a considerable area, approximately 80 000 m² in size. Based on pottery typology, two main phases of occupation were identified: a Saladoid (early) one in the northwestern part, roughly dated between AD 300 and 500, and a Post-Saladoid or Troumassoid (late) one in the eastern part. This latter area may also contain Saladoid material, but the small number of diagnostic artefacts impedes proper identification, however. The only radiocarbon date from this site was obtained during the fieldwork of Edgar Clerc. Its ^{14}C age of 1160 ± 100 BP (Rouse *et al.* 1985) places it somewhere in the late Saladoid/early Post-Saladoid period. Unfortunately, the exact provenience of the dated sample within the site is unknown and the most recent work did not produce new dates to supplement this single sample (Boomsma & Isendoorn 2001).

raw material	flint chert	greenstone	igneous rock	plutonic rock	fine-grained rock	calci-rudite	limestone	unidentified rock	total
artefact category									
artefact type									
flaked stone									
flake	6	-	1	-	1	-	-	-	8
flake core	2	-	-	-	-	-	-	-	2
water-worn pebble with flake removal	-	-	1	-	-	-	-	-	1
ground stone									
axe	-	1	-	-	-	-	-	-	1
zemi	-	-	-	-	-	1	-	-	1
used water-worn pebbles									
polishing stone	-	-	1	-	-	-	-	-	1
non-used water-worn pebbles									
non-modified water-worn pebble	-	-	7	1	-	-	-	-	8
other used rock									
active abrading stone	-	-	-	-	-	-	1	-	1
passive grinding stone	-	-	-	-	-	-	-	1	1
other rock									
unidentified	-	-	-	-	-	-	-	1	1
total	8	1	10	1	1	1	1	2	25
%	32	4	40	4	4	4	4	8	100

Table F.9. Anse à l'Eau, Guadeloupe, late occupation phase (Late Ceramic A). Number of lithic artefacts by raw material by artefact type.

The studied sample includes 239 lithic artefacts. It only comprises artefacts excavated within the test-units. These are the Saladoid units 3, 4, 5, 8, 9, 10, 11, 12, 15, 16, 17, 18, 19, 20, 21, 22, and 23, and the post-Saladoid unit 2 (Boomsma & Isendoorn 2001). For a detailed distribution of finds in the test-units and chronology of test-units see Knippenberg (2001c). From this total, 177 artefacts can be attributed to the Saladoid (early) occupation, including the following raw materials: flint and chert, quartz, limestone, igneous rock, plutonic rock, and other sedimentary rock. Another 25 artefacts are attributed to the Post-Saladoid (late) occupation and include flint, St. Martin greenstone, igneous rock, plutonic rock, limestone, and calci-rudite (tables F.8 and F.9). The remaining 37 are from mixed contexts. These latter have been left out of the analysis.

raw material	flint chert	igneous rock	limestone	calcite	total
artefact category					
artefact type					
flaked stone					
flake	40	-	-	-	40
shatter	15	-	1	-	16
flake core	6	-	-	-	6
used water-worn pebbles					
complete hammerstone	-	1	-	-	1
other rock					
natural rock	-	-	-	1	1
unidentified	1	-	-	-	1
total	62	1	1	1	65
%	95	2	2	2	100

Table F.10. Cocoyer, Marie Galante. Number of lithic artefacts by raw material by artefact type.

F.4 Marie Galante

F.4.1 Cocoyer St. Charles

A single site, Cocoyer St. Charles, on the island of Marie-Galante east of Guadeloupe, provided a sample of lithic artefacts for the present study (see figure 3.11). Cocoyer is situated along the west coast of Marie Galante, south of the small city of St. Louis and immediately northeast of the archaeological site of Folle Anse, which is known for its Huecan ceramics (Arts 1999). The site area itself is located between a sandy beach and a swamp area. As part of a multiple site-survey project, the same four master students working at Anse à l'Eau conducted a shovel test (0.5 x 0.5 m) campaign followed by test-unit (1 x 1 m) excavations within the densest artefact areas (Boomsma & Isendoorn 2001).

Hampered by a high natural water table, they were only able to identify a single early Saladoid occupation extending over area 350 x 200 m in size. Based on pottery characteristics, they assume that the site was contemporary with the early phases of the nearby site of Folle Anse, falling in the Early Ceramic A phase, although this latter site produced distinct ceramics in the form of Huecan ware. Due to the lack of radiocarbon dated samples, more precise dating is not possible.

The studied sample only includes a small number of artefacts, 65 in total, recovered from the shovel tests and from the test-units (table F.10). The large majority, 62 pieces (95%), comprise flint and chert artefacts, and a single limestone, calcite, and igneous rock artefact.

raw material	flint chert	greenstone	limestone	plutonic rock	igneous rock	unidentified rock	total
artefact category							
artefact type							
flaked stone							
flake	2	-	1	-	1	-	4
water-worn pebble with flake removal	-	-	-	1	-	1	2
ground stone							
fragment of axe	-	1	-	-	-	-	1
non-used water-worn pebbles							
non-modified water-worn pebble	-	-	-	-	2	-	2
fragment water-worn pebble	-	-	-	-	1	-	1
other used rock							
fragment passive grinding/abrading stone	-	-	-	-	2	-	2
other rock							
fragment unidentified core artefact	-	-	1	-	-	-	1
total	2	1	2	1	6	1	13
%	15	8	15	8	46	8	100

Table F.11. Du Phare, Petite Terre. Number of lithic artefacts by raw material by artefact type.

F.5 Iles de la Petite Terre

F.5.1 Du Phare

Du Phare is situated on Terre de Bas, the larger of the two islets making up Iles de la Petite Terre archipelago near Guadeloupe (see figure 3.11). It lies on "an elevated plain at some distance from the coast, extending from the east from the lighthouse towards the easternmost salina" (De Waal 2006). The site covers an area of approximately 12 000 m^2. Archaeological work was carried out during three different occasions over the past 30 years. Desmond Nicholson excavated a 2 m^2 test unit there in 1975 (Nicholson 1975), Bodu and Petitjean-Roget performed survey work in 1985, and finally De Waal mapped archaeological surface material in the site area and subsequently did test-excavations in 1999. De Waal's 1 x 1 and 2 x 2 m test-units were excavated in two densely concentrated site areas. The former only revealed a shallow archaeological deposit with a 20 cm thickness, while the latter uncovered a thicker deposit of 60 cm.

Radiocarbon samples are not available for this site. Its pottery exhibits strong similarities with Post-Saladoid traditions in the area and the occupation should be placed within the Late Ceramic A phase.

The small sample of lithics only contains 13 artefacts, which originated both from the test-units and surface finds done during the 1999 work (table F.11). Igneous rock predominates within the sample, but other raw materials include chert, St. Martin greenstone, limestone, and plutonic rock.

raw material	chert	local chert	Long Island flint	limestone	plutonic rock	igneous rock	fine-grained rock	uniden-tified rock	total
artefact category									
artefact type									
flaked stone									
flake	1	1	4	-	-	6	-	-	12
re-used pre-Ceramic Age blade fragment	-	-	1	-	-	-	-	-	1
shatter	1	1	-	-	-	-	-	-	2
ground stone									
fragment of axe	-	-	-	-	-	-	1	-	1
fragment of an axe/adze: edge flake	-	-	-	-	-	-	1	-	1
used water-worn pebbles									
complete hammerstone	-	-	-	-	-	5	-	-	5
fragment active abrading stone	-	-	-	-	-	2	-	-	2
complete possible polishing stone	-	-	-	-	-	2	-	-	2
fragment passive grinding/abrading stone	-	-	-	-	-	1	-	-	1
non-used water-worn pebbles									
non-modified water-worn pebble	-	-	-	-	1	31	-	1	33
fragment water-worn pebble	-	-	-	-	-	8	-	-	8
other used rock									
fragment passive grinding/abrading stone	-	-	-	1	-	6	-	-	7
other rock									
fragment natural rock	-	-	-	-	-	5	-	-	5
total	2	2	5	1	1	66	2	1	80
%	3	3	13	1	1	83	3	1	100

Table F.12. Les Sables, La Désirade. Number of lithic artefacts by raw material by artefact type.

F.6 La Désirade

Small samples from three sites lying on la Désirade, northeast of Guadeloupe, are included within this study (see figure 3.11). These are Les Sables, Escalier, and Morne Souffleur.

F.6.1 Les Sables

Les Sables is situated somewhat inland behind the Les Sables beach along the southern coast of La Désirade and to the west of the little capital of Beauséjour. Bodu discovered the site and conducted small-scale excavations in 1984. De Waal surveyed the site in 1999 and estimated its size to be 22 500 m^2 (De Waal 2006.). It is one of the largest Amerindian sites on the small island of La Désirade. Recent house and road construction has diminished its size and the site is clearly being affected by coastal erosion at present.

Bodu excavated a total of three test-units, including one 4 x 4 and two 1 x 1 m squares. These excavations revealed an archaeological midden deposit varying in thickness. Unfortunately, the site has not been radiocarbon dated. The study of the pottery from the test-units, however, reveals strong similarities with late Saladoid pottery, placing this site within the Early Ceramic B phase.

The small sample of lithics includes 80 artefacts, which both originate from the test-units and the surface (table F.12). Igneous rock predominates within the sample, but other raw materials include chert, limestone, plutonic rock, and unidentified fine-grained rock.

raw material	flint chert	greenstone	limestone	calcite	igneous rock	uniden-tified rock	total
artefact category							
artefact type							
flaked stone							
flake	8	-	-	-	20	-	28
flake core	-	-	-	-	1	-	1
water-worn pebble with flake removal	-	-	-	-	1	-	1
ground stone							
fragment of axe	-	1	-	-	-	-	1
used water-worn pebbles							
hammerstone	-	-	-	-	2	-	2
active abrading stone	-	-	1	-	5	-	6
possible polishing stone	-	-	-	-	1	-	1
other type of abrading stone	-	-	-	-	1	-	1
non-used water-worn pebbles							
non-modified water-worn pebble	-	-	-	-	57	-	57
fragment water-worn pebble	-	-	1	-	12	-	13
other rock							
fragment natural rock	-	-	-	1	29	-	30
fragment unidentified core artefact	-	-	-	-	-	1	1
total	8	1	2	1	129	1	142
%	5.6	0.7	1.4	0.7	90.8	0.7	100.0

Table F.13. Escalier, La Désirade. Number of lithic artefacts by raw material by artefact type.

F.6.2 Escalier

The Escalier site is "situated in a cultivated terrain very close to the beach at the southern coastal plain of La Désirade" (De Waal 2006). Archaeological work was carried out during two different episodes. Bodu surveyed the site in 1985, and re-surveying and small test-excavations were carried out by de Waal in 1999 as part of her PhD dissertation work (De Waal 2006). De Waal estimates the site to cover an area of approximately 2400 m^2. The excavation of two 2 x 2 m test units revealed an 80 cm thick archaeological deposit, likely a midden area. Radiocarbon dates and the analysis of the ceramics position this site within the Late Ceramic A phase. Occupation of the site must have been between 1049 and 1243 cal AD, using 95% confidence intervals for a single radiocarbon date.

The sample of lithic artefacts amounts to 142 artefacts and originated from the test-units and survey work by Bodu and De Waal (table F.13). Within the sample, igneous rock predominates, but other raw materials include chert, St. Martin greenstone, limestone, and calcite.

raw material	flint chert	local red chert	greenstone	limestone	igneous rock	conglo-merate	total
artefact category							
artefact type							
flaked stone							
flake	-	3	-	1	4	-	8
shatter	-	3	-	-	-	-	3
flake core	1	1	-	-	-	-	2
ground stone							
axe	-	-	1	-	-	-	1
used water-worn pebbles							
complete hammerstone	-	-	-	-	2	-	2
complete active abrading stone	-	-	-	-	1	-	1
fragment passive grinding/abrading stone	-	-	-	-	1	-	1
non-used water-worn pebbles							
fragment water-worn pebble	-	-	-	-	4	-	4
other used rock							
fragment passive grinding/abrading stone	-	-	-	-	1	2	3
other rock							
fragment natural rock	-	-	-	-	11	-	11
total	1	7	1	1	24	2	36
%	3	19	3	3	67	6	100

Table F.14. Morne Souffleur, La Désirade. Number of lithic artefacts by raw material by artefact type.

F.6.3 Morne Souffleur

The Morne Soufleur site is situated along the southern border of the central plateau of La Désirade and close to the terrain of the windmills (De Waal 2006). It lies approximately 1.5 km to the west of the earlier reported Morne Cybèle site (Hofman 1999). Morne Souffleur was discovered during survey work by De Waal in 1999. The site covers an area of approximately 3150 m^2 and currently erodes along the southern edge of the plateau. Two 2 x 2 m test-excavations revealed a shallow archaeological deposit, almost entirely part of the disturbed topsoil, which immediately overlies the limestone bedrock in this part of the island.

Radiocarbon samples are not available for this site. Strong similarities for its pottery are evident with the very characteristic and unique stylistic traits of the Morne Cybèle site, placing this site within the later part of the Late Ceramic B phase (Hofman *et al.* 2004).

The sample of lithics contains only 36 artefacts (table F.14), These were collected during test-unit excavation and surface collection. Igneous rock predominates within the sample, but other raw materials include chert, local red chert, St. Martin greenstone, limestone, and conglomerate.

raw material	Long Island flint	white chert	Cor. Point chert	jasper	other chert	quartz	car-nelian	calcite	green-stone	igneous rock	uniden-tified	total
artefact category												
artefact type												
flaked stone												
flake	502	229	14	3	108	4	5	-	6	2	2	875
shatter	37	39	-	1	12	4	1	1	-	-	3	98
flake core	20	7	-	1	3	2	-	-	-	-	-	33
ground stone												
fragment of an axe/adze: edge flake	-	-	-	-	1	-	-	-	-	-	-	1
bead preform	-	-	-	-	-	-	2	-	-	-	-	2
other rock												
fragment natural rock	-	-	-	-	-	1	-	-	-	-	-	1
unidentified core artefact	-	-	-	-	1	-	-	-	-	-	-	1
unidentified	14	-	-	-	4	-	-	-	-	-	-	28
total	573	275	14	5	129	11	8	1	6	2	5	1029
%	55.7	26.7	1.4	0.5	12.5	1.1	0.8	0.1	0.6	0.2	0.5	100.0

Table F.15. Trants, Montserrat. Number of lithic artefacts by raw material by artefact type, excluding 16 water-worn igneous rock pebbles.

F.7 Montserrat

F.7.1 Trants

Trants is one of the oldest Ceramic Age sites within the Caribbean, dated back to 500 BC (Petersen 1996). "It is situated east of Centre Hills the only sizeable stretch of relatively flat terrain near sea level along the windward coast " of Montserrat (Watters 1994, 265; see figure 3.10). Finds originating from this site were first reported during the beginning of the 20th century, when Harrington published on numerous beads and pendants made out of semi-precious rock materials (Harrington 1924). It was not until the late 1970s when the first archaeological excavations were performed at the Trants site. David Watters, at that time working on his PhD dissertation, excavated one 2 x 2 m test-unit within one of the densely concentrated areas. This sounding showed extensive and well preserved occupation deposits. Threatened by plans to extend the air-strip in immediate vicinity, the site and surrounding area became the central focus of a multi-year archaeological research supervised by David Watters and Jim Petersen. The work included the mapping of the distribution of archaeological material, systematic shovel testing, followed by test-unit excavations within dense artefact areas, and the opening of large units in order to identify structural remains (Petersen 1996; Watters 1994; Watters & Petersen 1999).

Results of this fieldwork showed that the site at least measures 62 000 m², in which a ring shaped distribution of high concentrated deposits of archaeological material enclose a more vacant plaza-like centre. This configuration resembles village lay-outs of ring-shape Amerindian settlements within the Amazonian rain forest. Multiple radiocarbon dates show that the site was occupied for a considerable time period, between 500 BC until at least AD 400 (Petersen *et al.* 1999), corresponding with the period of the Cedrosan Saladoid subseries and placing the site in the Early Ceramic A phase.

A sample of 1029 lithic artefacts was analysed from this site at the Carnegie Museum of Natural History, Pittsburgh (table F.15). They originate from four 2 x 2 m test-units: N596E571, N405E571, N402E561, and N396E571. These were excavated using arbitrary 10 cm levels within natural stratigraphy, and using 6.4 mm (¼ inch) and 3.2 mm (1/8 inch) mesh screens. Solely flaked stone artefacts from the 6.4 mm residues were analysed. These predominantly belong to flake tool and bead productions. Ground stone and use-modified core artefacts and fragments were not studied, as these were stored in Montserrat. The sample in Pittsburgh, however, contains a small number of 16 use-modified artefacts, made of igneous rock. Although they were studied, their relationship to the larger sample that was not studied, is unknown and so, they will be left out of the quantitative analysis. Material from units N596E571 and N396E571 was first included within the lithic study done by John Crock and Robert Bartone (Bartone & Crock 1993; Crock & Bartone 1998). Radiocarbon dates associated with the units from which material was analysed display a considerable time range, i.e. between 480 BC and AD 410.

raw material	Long Island flint	white chert	other chert and flint	total
artefact category				
artefact type				
flaked stone				
flake	59	-	-	59
shatter	10	-	-	10
flake core	5	-	-	5
other rock				
unidentified	-	74[a]	86[a]	160
total	74	74	86	234
%	31.6	31.6	36.8	100.0

Table F.16. Doigs, Antigua, Early Ceramic A occupation phase. Number of lithic artefacts by raw material by artefact type. [a] The artefact type for white chert and the other chert and flint group has not been determined.

F.8 Antigua

Flaked stone samples from four different sites on the island of Antigua were included in this study, along with the sites studied on Long Island (see Chapter 4). The four Antigua sites are Doigs, Claremont, Coconut Hall, and Blackman's Point (see figure 3.9).

F.8.1 Doigs Amerindian

The Doigs site is situated "within the rear of the isolated broad, coastal valley of Doigs in the southwestern volcanic district of Antigua" (Fuess, personal communication 2001). After initial site recognition by Desmond Nicholson in 1990, Martin Fuess as part of his PhD dissertation work excavated 29 shovel test probes along two transects to investigate the dimensions of the site. It extends approximately 400 m in a north-south direction by 300 m in an east-west direction. The shovel testing was followed by the excavation of a single 1 x 1 m test-unit within a stratified midden area. The test-unit excavation revealed a 1.5 m deep archaeological deposit. Within this deposit, two occupation phases were distinguished. Radiocarbon dating of two shell samples produced a cal AD 110 – 405 age for the early phase, corresponding with the Early Ceramic A, and a cal AD 595 – 800 age for the later phase, corresponding with the Early Ceramic B (Fuess, personal communication 2001).

A sample of 526 lithic artefacts has been studied from the Doigs site (tables F.16 and F.17). This sample originated from the 1 x 1 m test-unit, which was excavated in arbitrary 10 cm levels, using a 3.2 mm mesh-screen. The sample has been divided into two sub-samples, corresponding with the two occupation phases of the site. The early phase sample consists of 292 artefacts and the late phase sample consists of 234 artefacts. The sample only includes flaked stone, almost exclusively related to the flake tool production. The sample comprises flint and cherts only. Due to time constraints, material from Doigs was only analysed for a limited number of attributes.

raw material	Long Island flint	white chert	other chert and flint	total
artefact category				
artefact type				
flaked stone				
flake	136	-	-	136
shatter	14	-	-	14
flake core	9	-	-	9
non-used water-worn pebbles				
non-modified water-worn pebble	1	-	-	1
other rock				
unidentified	-	40[a]	92[a]	132
total	160	40	92	292
%	54.8	13.7	31.5	100.0

Table F.17. Doigs, Antigua, Early Ceramic B occupation phase. Number of lithic artefacts by raw material by artefact type. [a] The artefact type for white chert and the other chert and flint group has not been determined.

raw material	Long Island flint	other chert	quartz	total
artefact category				
artefact type				
flaked stone				
flake	28	1	-	29
shatter	1	-	1	2
flake core	6	2	-	8
non-used water-worn pebbles				
non-modified water-worn pebble	1	-	-	1
total	36	3	1	40
%	90	8	3	100

Table F.18. Claremont, Antigua. Number of lithic artefacts by raw material by artefact type.

F.8.2 Claremont

The Claremont site is located within the confines of a broad alluvial valley that opens onto Carlisle Bay in Antigua. It is situated within a ploughed and furrowed pineapple field. The site lies approximately 2.4 km west of the Doigs site (Fuess, personal communication 2001). Martin Fuess conducted a surface reconnaissance and excavated a single 1 x 1 m test-unit there as part of his PhD dissertation work. “Based on diagnostic attributes of recovered ceramic materials a general Post-Saladoid/Late Ceramic Age chronological affiliation for the site was assigned” (Fuess, personal communication 2001). The test-unit revealed a cultural stratum 60 cm in thickness on average.

A small sample of 40 lithic artefacts was studied from the Claremont site (table F.18). This sample originated from the 1 x 1 m test-unit. This unit was excavated in arbitrary 10 cm levels using a 3.2 mm mesh-screen. It only includes flaked stone, almost exclusively related to the flake tool production. The sample comprises flint and chert. Due to time constraints, this material was only analysed for a limited number of attributes.

F.8.3 Coconut Hall

The site of Coconut Hall is situated on a peninsula-like point of low-lying limestone bedrock on the northeastern coast of Antigua and approximately 1.3 km northwest of the village of Seatons (Fuess, personal communication 2001). This segment of the point hosts one of the few natural surface scatters of flint on the main island of Antigua (see Chapter 2 and Appendix A). Fuess carried out archaeological fieldwork there as part of his PhD dissertation work (Fuess 1995, personal communication 2001). A preliminary surface reconnaissance showed that part of the site had been heavily disturbed by recent bulldozing activities related to a planned hotel construction. The undisturbed segment “may have been comprised of a series of smaller contemporaneous house clusters or shorter term intensive occupations through time” suggested by the identification of several concentrated midden areas (Fuess, personal communication 2001). Time constraints prevented the determination of the extent of the entire site. A single 1 x 1 m test-unit, however, was excavated within one of these midden clusters. Apart from a small number of historic artefacts, it entirely produced cultural remains related to a Post-Saladoid occupation. Two Strombus *gigas* shell samples supported this notion and yielded calibrated dates from cal AD 930 to 1180 (1370 ± 60 BP; Beta 81999) and cal AD 945 to 1190 (1350 ± 60 BP; Beta 93701), clearly positioning this site within the Late Ceramic A phase.

A sample of 229 lithic artefacts was studied from the Coconut Hall site (table F.19). This sample originated from the 1 x 1 m test-unit, which has been excavated in arbitrary 10 cm levels using a 3.2 mm mesh-screen. It only includes flaked stone, almost exclusively related to the flake tool production. The sample comprises flint and cherts. Due to time constraints, the material has only analysed for a limited number of attributes.

raw material	Long Island flint	Coconut Hall flint	other chert	burnt flint and chert	quartz	total
artefact category						
artefact type						
flaked stone						
flake	111	59	1	-	-	171
shatter	6	13	-	-	-	19
flake core	7	7	-	-	-	14
non-used water-worn pebbles						
non-modified water-worn pebble	1	-	-	-	1	2
other rock						
unidentified	-	-	-	23	-	23
total	125	79	1	23	1	229
%	54.6	34.5	0.4	10.0	0.4	100.0

Table F.19. Coconut Hall, Antigua. Number of lithic artefacts by raw material by artefact type.

F.8.4 Blackman's Point

The site of Blackman's Point is situated on the eastern edge of a broad, low-lying, level, limestone bedrock peninsula in north-central Antigua (Fuess, personal communication 2001). It lies immediately to the north of the major natural surface scatter of flint in the area (see Chapter 2 and Appendix A). After earlier work by Desmond Nicholson in the 1970s (Nicholson 1976), and later by Bruce Nodine in the late 1980s and early 1990s, Martin Fuess conducted excavation work there as part of his PhD-dissertation research. All three archaeological investigations demonstrated the unique character of the site in that it represents the only site known thus far from Antigua possessing stratified evidence for an Archaic Age occupation underlying a Late Ceramic Age cultural presence (Fuess, personal communication 2001). The site at least extends approximately 300 m southward along the eastern coast of the Blackman's Point peninsula and approximately 200 m inland.

Fuess' site survey work, which is of concern to this study, consisted of the excavation of three 1 x 1 m test-units to establish both the extent and depth of the cultural deposits. Test-unit 3 revealed the presence of both Archaic and Post-Saladoid occupations.

A sample of 395 lithic artefacts was studied from the Blackman's Point site (tables F.20-F.22). This sample originates from test-unit 3. This unit was excavated in arbitrary 10 cm levels using a 3.2 mm mesh-screen. The sample was divided into three sub-samples, corresponding with the two occupation phases and a mixed stratum at the site. The Archaic Age sample consists of 152 artefacts, the mixed sample of 31 artefacts and the Late Ceramic Age sample consists of 212 artefacts. The sample only includes flaked stone, almost exclusively related to the flake tool production. The sample only comprises flint and cherts. Due to time constraints the material has been only analysed for a limited number of attributes.

raw material	Long Island flint[a]	other chert	total
artefact category			
artefact type			
flaked stone			
flake	126	-	126
blade	9	-	9
shatter	7	-	7
flake/blade core	4	-	4
other rock			
unidentified	-	6[b]	6
total	146	6	152
%	96.1	3.9	100.0

Table F.20. Blackman's Point, Antigua, Preceramic Age occupation phase. Number of lithic artefacts by raw material by artefact type. [a] Long Island flint artefacts are all patinated; [b] The artefact type for other chert and flint group has not been determined.

raw material	Long Island flint	Blackman's Point flint	other chert	total
artefact category				
artefact type				
flaked stone				
flake	9	14	1	24
shatter	1	2	-	3
flake/blade core	2	2	-	4
total	12[a]	18	1	31
%	39	58	3	100

Table F.21. Blackman's Point, Antigua. Number of lithic artefacts from the mixed pre-Ceramic – Ceramic Age deposit by raw material by artefact type. [a] Long Island flint artefacts include Preceramic Age artefacts.

raw material	Long Island flint	Blackman's Point flint	other chert and flint	igneous rock	total
artefact category					
artefact type					
flaked stone					
flake	65	88	-	-	153
shatter	10	10	-	-	20
flake/blade core	5	4	-	-	9
other rock					
fragment unidentified core artefact	-	-	-	1	1
unidentified	-	-	29[a]	-	29
total	80	102	29	1	212
%	37.7	48.1	13.7	0.5	100.0

Table F.22. Blackman's Point, Antigua, Late Ceramic A occupation phase. Number of lithic artefacts by raw material by artefact type. [a] The artefact type for other chert and flint group has not been determined.

F.9 St. Eustatius

Three sites from St. Eustatius were included within this research. These are Golden Rock, Smoke Alley, and Godet (see figure 3.6).

F.9.1 Golden Rock

The Saladoid site of Golden Rock is situated in the centre of St. Eustatius on the "Cultuurvlakte" adjacent to the old air-strip. Threatened by destruction as a result of airstrip extension, Golden Rock was the subject of a large scale multi-year excavation research led by Aad Versteeg from Leiden University during the 1980s, following earlier work in the 1920s by Josselin de Jong, who attested to the significance of the site (Josseling de Jong 1947; Versteeg and Schinkel 1992). The multi-year archaeological research was aimed at investigating the intra-site structure. Large areas were opened to identify house plans and related midden areas. Results include the reconstruction of at least six house-floor plans, with associated small structures, in addition to a 25 by 16 m sized refuse area producing tons of shell remains, animal bone, coral, pottery, and stone artefacts. The main occupation of the site occurred between the 7th and the 9th century AD, placing it within the Early Ceramic B phase. Earlier activity, starting at AD 450, however, was also identified, i.e. hearths below the midden area, and must be interpreted as incipient, according to the excavators (Versteeg & Schinkel 1992, 229).

A sample of 3238 lithic artefacts was studied from Golden Rock (tables F.23 and F.24). It includes all lithic artefacts from the following 4 x 4 m test-units excavated within the midden area: 3, 4, 5, 6, 7, 8, 10, 11, 12, 13, 14, 15, 16, 21, 22, 24, 25 (Schinkel 1992, 181 fig.161; Versteeg 1992a, 12 fig. 12). In addition, only the flake tool technology associated artefacts from units 1, 2, 18, 19, and 20 were analysed.

All units were divided in 1 x 1 m squares, which were excavated in arbitrary 10 cm levels using 12 mm mesh-screens (Versteeg 1992b, 31-4). Residues from 2.8 mm mesh-screen, excavated within one sample-square of each 4 x 4 m unit, were not studied. The sample includes a wide variety of different raw materials. These comprise varieties of flint and chert, jasper, quartz, St. Martin greenstone, fine grained rock (possibly fine-grained igneous rock, tuffs, or mudstones), varieties of igneous rock and plutonic rock, varieties of metamorphic rock, pumice, tuff, limestone, calcite, beach-rock, calci-rudite, possibly sandstone, and red ochre.

Table F.23 (opposite page). Golden Rock, St. Eustatius. Number of lithic artefacts by raw material and artefact type (1st table).

raw material	flint chert jasper	quartz	green-stone	calci-rudite	lime-stone	beach rock	calcite	meta-morphic rock	fine-grained rock	red ochre	uniden-tified rock
artefact category											
artefact type											
flaked stone											
flake	556	2	384	1	5	1	-	7	23	-	8
shatter	57	-	8	-	-	-	-	1	-	-	1
flake core	50	2	-	-	3	-	-	-	1	-	3
water-worn pebble with flake removal	-	1	-	-	1	-	-	-	-	-	-
complete axe preform	-	-	11	-	-	-	-	-	-	-	-
fragment axe preform	-	-	59	-	-	-	-	-	-	-	-
ground stone											
axe	-	-	3	-	-	-	-	-	-	-	-
fragment of axe	-	-	62	-	-	-	-	10	-	-	-
fragment of an axe/adze: edge flake	-	-	1	-	-	-	-	2	-	-	-
complete axe preform	-	-	-	-	-	-	-	1	-	-	-
zemi	-	-	-	4	4	-	-	-	-	-	1
fragment zemi	-	-	-	-	-	-	-	-	-	-	-
fragment bead	-	-	-	-	1	-	-	-	-	-	-
bead perform	-	1	-	-	-	-	-	1	-	-	-
pendant preform	-	-	-	-	1	-	-	-	-	-	-
used water-worn pebbles											
complete hammerstone	1	2	2	-	4	-	-	-	1	-	2
fragment hammerstone	1	-	8	-	-	-	-	3	-	-	1
complete anvil stone	-	-	-	-	-	-	-	-	-	-	-
fragment anvil stone	-	-	-	-	-	-	-	-	-	-	-
complete hammerstone anvil	-	-	-	-	-	-	-	-	-	-	-
fragment hammerstone anvil	-	-	-	-	-	-	-	-	-	-	1
complete active abrading stone	-	-	-	-	-	-	-	-	2	-	-
fragment active abrading stone	-	-	-	-	-	-	-	1	-	-	-
complete polishing stone	-	-	-	-	-	-	-	-	10	-	1
fragment polishing stone	-	-	1	-	-	-	-	1	6	-	-
complete possible polishing stone	-	-	-	-	-	-	-	-	20	-	2
fragment possible polishing stone	-	-	-	-	-	-	-	-	9	-	-
complete metate	-	-	-	-	-	2?	-	-	-	-	-
fragment metate	-	-	-	-	-	38	-	-	-	-	-
other type of abrading stone	-	-	-	-	-	-	-	-	-	-	-
ww pebble with narrow indentations	-	-	-	-	-	-	-	-	-	-	-
non-used water-worn pebbles											
non-modified water-worn pebble	2	-	2	-	14	-	-	1	8	-	6
fragment water-worn pebble	-	-	8	-	8	-	-	1	10	-	6
other used rock											
complete active abrading stone	-	-	-	-	-	-	-	-	-	-	-
fragment active abrading stone	-	-	-	-	-	-	-	-	-	-	3
fragment manos	-	-	-	-	-	-	-	-	-	-	-
complete metate	-	-	-	-	-	-	-	-	-	-	1
fragment metate	-	-	-	-	1	-	-	-	-	-	6
possible metate	-	-	-	-	-	-	-	-	-	-	-
complete passive grinding stone	-	-	-	-	-	-	-	-	-	-	-
other type of abrading stone	-	-	-	-	2	1	-	-	-	-	7
fragment whetstone	-	-	-	-	-	-	-	-	-	-	1
other rock											
natural rock	1	-	-	-	2	-	1	-	-	4	-
fragment natural rock	-	1	-	-	2	-	-	1	-	-	13
unidentified core artefact	1	-	12	-	1	-	-	-	-	-	1
fragment unidentified core artefact	1	-	49	-	6	10	-	1	3	-	16
unidentified	6	-	9	-	4	-	-	-	-	-	11
total	676	9	619	5	59	52	1	31	93	4	91
% of total (see other table)	20.9	0.3	19.1	0.2	1.8	1.6	0.0	1.0	2.9	0.1	2.8

raw material	pumice	igneous rock A	igneous rock B	igneous rock C	yellow igneous rock	igneous rock other	plutonic rock	tuff	possible sand-stone	total
artefact category										
artefact type										
flaked stone										
flake	-	19	5	20	-	5	-	-	-	1036
shatter	1	-	-	-	-	-	-	-	-	68
flake core	-	3	-	1	-	-	-	-	-	63
water-worn pebble with flake removal	-	-	3	-	-	10	-	-	-	15
complete axe preform	-	1	-	-	-	-	-	-	-	12
fragment axe preform	-	3	-	-	-	-	-	-	-	62
ground stone										
axe	-	-	-	-	-	-	-	-	-	3
fragment of axe	-	6	-	-	-	-	-	2	-	80
fragment of an axe/adze: edge flake	-	5	-	-	-	-	-	-	-	8
complete axe preform	-	-	-	-	-	-	-	-	-	1
zemi	1	-	-	-	-	1	-	-	-	11
fragment zemi	2	-	-	-	-	-	-	-	-	2
fragment bead	-	-	-	-	-	-	-	-	-	1
bead preform	-	-	-	1	-	-	-	-	-	3
pendant preform	-	-	-	-	-	-	-	-	-	1
used water-worn pebbles										
complete hammerstone	-	9	8	3	-	31	-	-	-	63
fragment hammerstone	-	1	5	2	-	10	-	-	-	31
complete anvil stone	-	-	-	-	-	2	-	-	-	2
fragment anvil stone	-	-	1	-	-	-	-	-	-	1
complete hammerstone anvil	-	-	-	1	-	2	-	-	-	3
fragment hammerstone anvil	-	-	-	-	-	-	-	-	-	1
complete active abrading stone	2	2	4	-	-	3	-	-	-	13
fragment active abrading stone	-	2	3	2	-	3	-	-	-	11
complete polishing stone	-	-	-	-	-	-	-	-	-	11
fragment polishing stone	-	1	-	-	-	-	-	-	-	9
complete possible polishing stone	-	5	4	-	-	4	-	-	-	35
fragment possible polishing stone	-	1	-	-	-	2	-	-	-	12
complete metate	-	-	-	-	-	-	-	-	-	2
fragment metate	-	-	3	-	-	-	-	-	-	41
other type of abrading stone	2	3	-	-	-	-	-	-	-	5
ww pebble with narrow indentations	-	-	-	-	-	1	-	-	-	1
non-used water-worn pebbles										
non-modified water-worn pebble	5	71	85	13	1	245	1	-	-	454
fragment water-worn pebble	5	7	24	2	-	31	-	-	-	102
other used rock										
complete active abrading stone	3	-	-	1	-	1	-	-	-	5
fragment active abrading stone	-	-	-	-	-	-	-	-	-	3
fragment manos	6	-	-	-	-	-	-	-	-	6
complete metate	-	-	1	1	-	-	-	-	-	3
fragment metate	-	6	147	19	21	2	-	2	-	204
possible metate	-	-	-	9	-	-	-	-	-	9
complete passive grinding stone	-	-	-	-	-	-	-	-	-	-
other type of abrading stone	-	-	5	29	-	17	-	3	3	67
fragment whetstone	-	-	-	-	-	-	-	-	-	1
other rock										
natural rock	12	1	1	4	-	1	-	4	-	31
fragment natural rock	9	20	1	16	-	18	-	3	-	84
unidentified core artefact	2	-	-	1	-	-	-	1	-	19
fragment unidentified core artefact	11	26	140	263	7	48	-	13	1	595
unidentified	5	2	2	1	2	1	-	3	2	48
total	66	194	442	389	31	438	1	31	6	3238
%	2.0	6.0	13.7	12.0	1.0	13.5	0.0	1.0	0.2	100.0

raw material	flint chert jasper	greenstone	igneous rock	pumice	fine-grained rock	total
artefact category						
artefact type						
flaked stone						
flake	24	15	-	-	-	39
shatter	3	-	-	-	-	3
flake core	1	-	-	-	-	1
complete axe preform	-	1	-	-	-	1
fragment axe preform	-	1	-	-	-	1
used water-worn pebbles						
complete active abrading stone	-	-	1	-	-	1
complete possible polishing stone	-	-	-	-	1	1
non-used water-worn pebbles						
non-modified water-worn pebble	-	-	4	1	1	6
fragment water-worn pebble	-	-	1	-	-	1
other rock						
fragment unidentified core artefact	-	1	-	-	-	1
total	28	18	6	1	2	55
%	50	33	11	2	4	100

Table F.25. Smoke Alley, St. Eustatius. Number of lithic artefacts by raw material by artefact type.

F.9.2 Smoke Alley

During the different field-campaigns at the Golden Rock site, archaeological research was also undertaken at Smoke Alley, a Post-Saladoid site along the western leeward coast of the island and northwest of Oranjestad. Five 1 x 1 m test-units were dug to determine the extent of the midden deposit. This was followed by the excavation of a 225 m^2 large area using a mechanical shovel. This work revealed the presence of an approximately 10 by 10 m midden area, overlying two Amerindian house structures and two burials. Radiocarbon dating suggests that the occupation started during the later part of the Early Ceramic A and lasted well into the Late Ceramic A phase. The earlier occupation must have been short considering the low amount of material that is attributed to this phase. The predominant occupation was during the Late Ceramic A phase, around cal AD 1000 –1160 (Versteeg *et al.* 1996).

The sample studied from Smoke Alley only includes 55 lithic artefacts (table F.25). The material originated from five 1 x 1 m test-units, predominantly from the levels associated with the Late Ceramic A phase occupation. These units were excavated in 10 cm arbitrarily levels using 12 mm mesh screens (Versteeg *et al.* 1996). My wish to study diachronic patterns relating to the use of raw materials and production of stone tools on St. Eustatius formed the main purpose for the analysis of this small sample. Identified raw materials comprise, in order of decreasing frequency, flint, St. Martin greenstone, igneous rock, fine-grained rock, and pumice.

Table F.24 (opposite page). Golden Rock, St. Eustatius. Number of lithic artefacts by raw material and artefact type (2nd table).

raw material	flint chert jasper	quartz	greenstone	igneous rock	fine-grained rock	total
artefact category						
artefact type						
flaked stone						
flake	17	1	1	1	-	20
shatter	1	-	-	-	-	1
flake core	4	-	-	-	-	4
fragment axe preform	-	-	2	-	-	2
ground stone						
fragment of axe	-	-	1	-	-	1
used water-worn pebbles						
complete hammerstone	-	-	-	9	-	9
fragment hammerstone	-	-	-	1	-	1
complete hammerstone anvil	-	-	-	1	-	1
complete polishing stone	1	-	-	-	2	3
complete manos	-	-	-	1	-	1
non-used water-worn pebbles						
non-modified water-worn pebble	-	-	-	16	-	16
fragment water-worn pebble	-	-	-	6	-	6
other rock						
natural rock	1	-	-	-	-	1
fragment natural rock	-	-	-	1	-	1
fragment unidentified core artefact	-	-	2	-	-	2
total	24	1	6	36	2	69
%	35	1	9	52	2.9	100

Table F.26. Godet, St. Eustatius. Number of lithic artefacts by raw material by artefact type.

F.9.3 Godet

Very limited excavation work was performed at Godet, a Post-Saladoid site in close proximity to the Smoke Alley site along Statia's western coast (Van der Valk & Putker 1986). A single 2 x 4 m test-unit was excavated at Godet. Unfortunately, this site has not been radiocarbon dated. Based on ceramic features the main occupation at Godet site must be placed within the Late Ceramic A phase, around AD 800 to AD 1000. A small number of Saladoid ceramics suggest earlier activities occurred there as well.

The lithic sample from Godet only includes 69 artefacts (table F.26). The archaeological material originates from the single test-unit. The excavation methodology was similar to the Golden Rock excavations; arbitrary 10 cm levels were dug and dirt was sieved through 12 mm mesh-screens. The decision to study this small sample was based on the same grounds as the case of the Smoke Alley sample. Raw materials that were identified are, in order of decreasing frequency, igneous rock, flint, St. Martin greenstone, jasper, chert, and fine-grained rock.

		raw material	Long Island flint	other flint and chert	green-stone	igneous rock	red ochre	total
artefact category								
	artefact type							
flaked stone								
	flake		41	22	2	-	-	65
	shatter		5	6	-	-	-	11
	flake core		2	-	-	-	-	2
other rock								
	fragment natural rock		-	-	-	-	1	1
	unidentified core artefact		-	-	-	1	-	1
	unidentified		2	2	-	-	-	4
		total	50	30	2	1	1	84
		%	60	36	2	1	1	100

Table F.27. Kelbey's Ridge 1, Saba. Number of lithic artefacts by raw material by artefact type.

F.10 Saba

Lithic samples from three sites on Saba were studied. These include Kelbey's Ridge 1 and 2, and Spring Bay 3 (see figure 3.6).

F.10.1 Kelbey's Ridge 1

Kelbey's Ridge 1 is the smaller and older settlement of two sites that are situated in a shallow depression, roughly triangular in shape and lying to the north of a pronounced outlet of the volcanic dome, called Kelbey's Ridge (Hoogland 1996, 37-38). Corinne Hofman and Menno Hoogland performed excavations at this locality during the late 1980s and early 1990s as part of their PhD dissertation research (Hofman 1993; Hoogland 1996) The site measures only 350 m² and is dated between cal AD 660-885, based on a single radiocarbon date. This date places Kelbey's Ridge 1 in the later part of the Early Ceramic B phase. The ceramics were classified to the Cedrosan Saladoid subseries, which makes this site one of the latest Saladoid sites in the region (Hofman 1993). Hoogland suggests that occupation must have been ephemeral considering its small size (Hoogland 1996, 122).

A lithic sample of 84 artefacts was studied from the Kelbey's Ridge 1 site (table F.27). This sample largely includes flake tool related material and some exceptional rare items. It originated from the test-units that are exclusively attributed to the Kelbey's Ridge 1 site. These include the following ones: 8, 10, 11, 13, 15, 16, 17, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, and 34 (Hoogland 1996, 120 fig. 6.2). They were excavated in arbitrary 10 cm levels using 4 mm mesh-screens. The raw materials identified include flint, chert, St. Martin greenstone, igneous rock, and red ochre.

F.10.2 Kelbey's Ridge 2

Kelbey's Ridge 2 belongs to one of the larger settlement sites on the island. It lies immediately to the southeast of the Kelbey's Ridge 1 site and measures 2000 m². The ceramics have been classified to the Chican Ostionoid subseries. The site is dated to the final two centuries of the Pre-Columbian Age, around AD 1300-1450, on the basis of 14 radiocarbon dates. This clearly positions Kelbey's Ridge 2 in the Late Ceramic B phase. Distinct refuse areas were not identified, but instead the excavations focussed on the identification of house-plans. The results suggest that a small village, consisting of four to five households occupied this area (Hoogland 1996).

A sample of 115 lithic artefacts was studied from Kelbey's Ridge 2 (table F.28). This sample only originated from systematically excavated and screened 1 x 1 m test-units attributed to the Kelbey's Ridge 2 occupation. These are the following ones: 1, 2, 3, 4, 5, 6, 7, 9, 12, 19, 20, 21, 22, and 23. (see Hoogland 1996, 118 fig.6.1). The excavation methodology in the field was similar to the one used at Kelbey's Ridge 1. The lithic material only includes flaked stone, which mainly can be related to flake tool production. Materials identified are flint, chert, and St. Martin greenstone.

raw material	Long Island flint	other flint and chert	green-stone	total
artefact category				
artefact type				
flaked stone				
flake	67	25	1	93
shatter	6	2	1	9
flake core	5	2	-	7
used water-worn pebbles				
active abrading stone	-	-	1	1
other rock				
unidentified	1	4	-	5
total	79	33	3	115
%	68.7	28.7	2.6	100.0

Table F.28. Kelbey's Ridge 2, Saba. Number of lithic artefacts by raw material by artefact type.

F.10.3 Spring Bay 3

Spring Bay 3 is a single component settlement site measuring 1000 m² in size. It is situated along one of the few accessible bays on Saba, only 100 m to the east of the larger Spring Bay 1 settlement. The material is ascribed to the Mamoran Troumassoid subseries. Although the actual radiocarbon dates show a range between AD 910 and 1395 (2 sigma), Hoogland suggested on the basis of a very characteristic pottery assemblage that this site must have been occupied during a single phase, which he positioned around the second half of the eleventh century AD, right in the middle of the Late Ceramic A phase (Hoogland 1996, 106-107).

A sample of 156 lithic artefacts was studied from the Spring Bay 3 site (table F.29). This sample originated from the test-units 31, 34, 36, and 37. These were excavated in arbitrary 10 cm levels using 4 mm mesh-screens. The sample only includes flaked stone, predominantly related to the flake tool production, in addition to some exceptional artefacts. The materials identified include flint, chert, quartz, St. Martin greenstone, and calci-rudite.

raw material	Long Island flint	other flint and chert	quartz	greenstone	calci-rudite	total
artefact category						
artefact type						
flaked stone						
flake	87	24	-	3	-	114
shatter	20	11	1	-	-	32
flake core	2	-	-	-	-	2
ground stone						
complete axe	-	-	-	1	-	1
zemi	-	-	-	-	1	1
used water-worn pebbles						
fragment active abrading stone	-	-	-	1	-	1
other rock						
unidentified	1	3	-	-	-	4
total	110	38	1	5	1	155
%	71.0	24.5	0.6	3.2	0.6	100.0

Table F.29. Spring Bay 3, Saba. Number of lithic artefacts by raw material by artefact type.

raw material	flint and chert	red chert jasper	dark green chert	white quartz	green-stone	igneous	plutonic	fine-grained rock	red ochre	uniden-tified	total
artefact category											
artefact type											
flaked stone											
flake	135	1	15	8	229	123	2	-	-	24	537
shatter	42	-	1	4	4	6	-	-	-	-	57
flake core	12	2	-	1	2	-	-	-	-	-	17
water-worn pebble with flake removal	-	-	-	-	-	2	-	-	-	-	2
ground stone											
axe	-	-	-	-	10	-	-	-	-	-	10
butt-end	-	-	-	-	13	-	-	-	-	-	13
axe preform	-	-	-	-	11	9	-	-	-	1	21
used water-worn pebbles											
hammerstone	-	-	-	-	-	4	2	2	-	-	8
hammerstone anvil	-	-	-	-	-	-	1	-	-	-	1
active abrading stone	-	-	-	-	-	8	3	1	-	1	13
polishing stone	-	-	-	-	-	5	-	6	-	2	13
possible polishing stone	-	-	-	-	-	4	-	14	-	9	27
possible manos/metate	-	-	-	-	-	1	-	-	-	-	1
other used rock											
active abrading stone	-	-	-	-	5	-	-	-	-	-	5
other abrading stone	-	-	-	-	-	1	-	-	-	-	1
pestle	-	-	-	-	1	-	-	-	-	-	1
non-used water-worn pebbles											
non-modified water-worn pebble	-	-	-	-	-	49	6	18	-	12	85
other rock											
natural rock	-	-	-	-	-	-	-	-	1	-	1
unidentified	7	-	-	-	88	1	-	-	-	-	96
total	196	3	16	13	363	213	14	41	1	49	909
%	21.6	0.3	1.8	1.4	39.9	23.4	1.5	4.5	0.1	5.4	100.0

Table F.30. Anse des Pères, St. Martin. Number of lithic artefacts by raw material by artefact type.

F.11 St. Martin

F.11.1 Anse des Pères

Anse des Pères represents a late Saladoid habitation site situated along a cobble beach on the western coast of St. Martin between Marigot and Grande Case (see figure 3.5). A site survey, as part of Master's research work, showed that to the north of a small stream, called Ravine du Colombier, archaeological material was scattered over an area of approximately 15 000 m² including dense midden deposits (Knippenberg 1999b; Knippenberg *et al.* 1999). The pottery is exclusively attributed to the Cedrosan Saladoid subseries (Hamburg 1999) and ^{14}C samples produced calibrated dates between AD 750 and 950, making it the latest Saladoid site in the region and marking the end of the Early Ceramic B phase (Knippenberg 1999b). The site is interpreted as a habitation site, where people settled during a single continuous occupation, which may have lasted around 100 years.

Only a previously analysed lithic sample from the Anse des Pères site is included in the present research (Knippenberg 1999c). It includes 906 lithic artefacts, which originated from seven randomly chosen test-units within a dense midden area (table F.30). These units were excavated in 10 cm levels using 10 mm mesh-screens (Knippenberg 1999b, 87).

I studied this sample prior to beginning of my PhD research, and therefore, I used a different analysis procedure, which was described in my Master's thesis (Knippenberg 1995). In addition to this sample from the test-units, I analysed 300 artefacts from 127 systematically excavated shovel tests and 21 artefacts from haphazard surface collecting. These additional artefacts are not dealt with in the present quantitative analysis, but are mentioned in the case of rare artefact types. The materials identified include flint and chert varieties, St. Martin greenstone, jasper[2], quartz, igneous rock varieties, plutonic rock, sandstone, and red ochre. The flint and chert varieties include both true flints and (bedded) cherts.

F.12 Anguilla

Samples from three sites on the island of Anguilla were chosen for a detailed technological study. These are Sandy Ground, Barnes Bay, and Shoal Bay East (see figure 3.4). Along with the Sandy Hill and Forest North sites they formed the subject of a PhD dissertation written by John Crock, at the University of Pittsburgh (Crock 2000).

F.12.1 Sandy Ground

Sandy Ground is one of the largest and first settled sites on Anguilla, situated at Road Bay along its northern coast (Crock 2000). This bay is protected from eastern tropical storms and provides a relatively deep anchorage. These optimal characteristics probably formed one of the reasons that this site is one of the first settled on Anguilla. It is estimated to cover an area of at least 75 000 m². Radiocarbon samples have provided calibrated dates that fall within 95% range from AD 610 till AD 1390, corresponding with the later part of the Early Ceramic B and the following Late Ceramic A phases. Crock considers the occupation to be continuous. Furthermore, he characterizes the ceramics as early Post-Saladoid, to some degree resembling the Mill Reef style. Typical late Saladoid or late Post-Saladoid ceramics were not found within the test-excavations, but are known in small quantities from the earlier survey work performed by the Anguilla Archaeological and Historical Society (AAHS) (Crock 2000, 59-94; see Crock & Petersen 1999).

A sample of 789 lithic artefacts was analysed for Sandy Ground (table F.31). This sample originated from a single 1 x 3 m test-unit (N482 E281). It was excavated in arbitrarily 10 cm levels within natural stratigraphy using 3.2 mm (1/8 inch) and 6.4 mm (1/4 inch) mesh-screens. This large unit was subdivided into three 1 x 1 m squares, of which only in the two western squares a 0.5 x 0.5 m quadrant was reserved for fine screening (3.2 mm) (for description of all artefact categories, see Crock 2000, 68-91). Both mesh-size residues were studied. The materials identified include flint, St. Martin greenstone, quartz, calcite, limestone, calci-rudite, igneous rock, and fine-grained rock.

[2] In the 1995 and 1999 reports, this material is called red stone.

raw material	flint chert	quartz	greenstone	igneous	calci-rudite	limestone	calcite	uniden-tified	total
artefact category									
artefact type									
flaked stone									
flake	246	1	152	8	126	22	-	1	556
shatter	48	1	6	-	26	1	1	-	83
flake core	17	-	1	-	1	1	-	-	20
complete axe preform	-	-	4	-	-	-	-	-	4
fragment axe preform	-	-	7	1	-	-	-	-	8
ground stone									
fragment of axe	-	-	10	-	-	-	-	-	10
fragment axe preform	-	-	1	-	-	-	-	-	1
zemi	-	-	-	-	1	1	-	-	2
fragment zemi	-	-	-	-	-	1	-	-	1
fragment bead	-	-	-	-	-	-	1	-	1
bead preform	-	-	-	-	-	-	2	1	3
used water-worn pebbles									
complete hammerstone	-	-	-	1	-	1	-	-	2
complete active abrading stone	1	-	-	1	-	-	-	-	2
complete possible polishing stone	-	-	-	1	-	-	-	-	1
non-used water-worn pebbles									
non-modified water-worn pebble	-	-	1	2	-	2	-	1	6
fragment water-worn pebble	-	-	-	1	-	1	-	-	2
other used rock									
fragment metate	-	-	-	4	-	-	-	-	4
other rock									
fragment natural rock	-	-	-	-	1	-	65	-	66
unidentified core artefact	-	-	2	-	-	-	-	-	2
fragment unidentified core artefact	-	-	7	-	-	-	-	-	7
unidentified	8	-	1	-	-	-	-	-	9
total	320	2	192	19	155	30	69	3	790
%	40.5	0.3	24.3	2.4	19.6	3.8	8.7	0.4	100.0

Table F.31. Sandy Ground, Anguilla. Number of lithic artefacts by raw material by artefact type.

raw material	flint chert	greenstone	igneous rock	fine-grained rock	calci-rudite	limestone	calcite	unidentified rock	total
artefact category									
artefact type									
flaked stone									
flake	316	88	11	1	73	31	1	4	525
shatter	80	1	1	-	11	1	21	-	115
flake core	18	-	-	-	-	1	-	-	19
water-worn pebble with flake removal	-	-	-	-	-	1	-	-	1
complete axe preform	-	1	-	-	-	-	-	-	1
fragment axe preform	-	9	-	-	-	-	-	-	9
zemi preform	-	-	-	-	1	-	-	-	1
ground stone									
fragment of axe	-	3	1	-	-	-	-	-	4
fragment zemi	-	-	-	-	1	-	-	-	1
bead preform	-	-	-	-	-	-	4	-	4
used water-worn pebbles									
complete hammerstone	-	1	-	-	-	2	-	-	3
fragment hammerstone	-	-	1	-	-	-	-	-	1
fragment metate	-	-	-	-	-	1	-	-	1
non-used water-worn pebbles									
non-modified water-worn pebble	-	3	4	-	-	6	-	-	13
fragment water-worn pebble	-	-	-	-	-	1	-	-	1
other used rock									
fragment manos	-	-	-	-	-	-	-	1	1
fragment metate	-	-	8	-	-	-	-	-	8
other rock									
natural rock	-	-	-	-	-	-	5	1	6
fragment natural rock	-	-	-	-	-	1	119	2	122
fragment unidentified core artefact	-	4	1	-	-	-	-	-	5
unidentified	7	-	-	1	-	-	1	-	9
total	421	110	27	2	86	45	151	8	850
%	49.5	12.9	3.2	0.2	10.1	5.3	17.8	0.9	100.0

Table F.32. Barnes Bay, Anguila. Number of lithic artefacts by raw material by artefact type.

F.12.2 Barnes Bay

The settlement site of Barnes Bay is located on the western portion of Anguilla's northern coast, just inland between Barnes Bay and Mead's Bay. Threatened by destruction as a result of the expansion of the Cocoloba/Metaresort hotel, archaeological fieldwork was undertaken there in 1996. The size dimensions are not reported for this site. The calibrated radio-carbon dates suggest occupation between AD 775 and AD 1320, placing this site within the Late Ceramic A phase. The ceramics are largely attributed to the early Post-Saladoid style, possessing many similarities with the Mill Reef style from Antigua (Crock 2000, 124-160).

A sample of 850 lithic artefacts was analysed from Barnes Bay, including both residue samples from 6.4 (1/4 inch) and 3.2 mm (1/8 inch) mesh screens (table F.32). This sample originated from two 2 x 2 m test units: N401E418 and N402E423. Within each test unit, two one metre squares were chosen for analysis. These are the squares N400E417 and N401E418 from the former unit, and N401E422 and N402E423 from the latter. All squares were systematically excavated in arbitrarily 10 cm levels within natural stratigraphy. During the excavation of N400E417 and N401E422, only 6.4 mm mesh screens were used, whereas within the other two units, a 0.5 x 0.5 m sample square was reserved for fine mesh screening

raw material	flint chert	greenstone	igneous rock	meta-morphic rock	limestone	calcite	red ochre	uniden-tified rock	total
artefact category									
artefact type									
flaked stone									
flake	20	195	1	-	6	4	-	-	226
shatter	10	3	-	-	-	-	-	1	14
flake core	-	-	-	-	-	1	-	-	1
fragment axe preform	-	7	-	-	-	-	-	-	7
ground stone									
fragment of axe	-	1	-	-	-	-	-	-	1
bead preform	-	-	-	1	-	-	-	-	1
non-used water-worn pebbles									
fragment water-worn pebble	-	-	1	-	-	-	-	-	1
other rock									
natural rock	-	-	-	-	-	2	-	-	2
fragment natural rock	-	-	-	-	-	41	1	-	42
fragment unidentified core artefact	-	-	-	-	1	-	-	-	1
unidentified	1	-	-	-	-	-	-	-	1
total	31	206	2	1	7	48	1	1	297
%	10.4	69.4	0.7	0.3	2.4	16.2	0.3	0.3	100.0

Table F.33. Shoal Bay East, Anguilla. Number of lithic artefacts by raw material by artefact type.

(Crock 2000, 128). The materials include flint, chert, St. Martin greenstone, calci-rudite, calcite, limestone, igneous rock, and unidentified fine-grained rock.

F.12.3 Shoal Bay East

The large settlement site of Shoal Bay East is situated along Anguilla's northeastern coast, to the west of Island Harbour. Along with Rendezvous Bay, Sandy Ground, and Sandy Hill, it represents one of the earliest sites on the island. Test-excavations in sandy near-beach environments revealed clearly separated occupation levels, covering an extensive period of Amerindian prehistory. The oldest date was obtained from a small test-unit situated more inland. It gave a calibrated age between AD 655 and AD 850 (95% confidence level) (Crock 2000). From one test-unit excavated within the near beach environment, several charcoal samples and one kaolin pipe fragment provided dates that covered a period from AD 1000 till AD 1800. Main Amerindian occupation on this site is dated between AD 1000 and AD 1400. The ceramics from the excavations exclusively display Post-Saladoid traits. Only rare finds within the AAHS collection can be considered Saladoid, and support the early date from the test-pit, which did not yield any diagnostic finds, however (Crock 2000).

A sample of 297 lithic artefacts was analysed from Shoal Bay East (table F.33). This sample was obtained during the excavation of a single 2 x 1 m test unit, N558E467. This unit was excavated in arbitrary 10 cm levels within natural stratigraphy, using a 6.4 mm (¼ inch) mesh screen. Only from certain levels (corresponding to dense artefact deposits) 0.5 x 0.5 m sample squares were sieved through a 3.2 mm (1/8 inch) screen. The analysed sample comprises 297 artefacts. Identified materials include flint, chert, St. Martin greenstone, calcite, limestone, igneous rock, metamorphic rock, and red ochre.

F.13 Vieques

F.13.1 Sorcé

The Sorcé site actually forms part of the multi-component settlement called La Hueca/Sorcé, where Luis Chanlatte Baik and Yvonne Narganes Storde, from the University of Rio Piedras have performed excavations over the last 30 years. Sorcé is situated around 150 m from the south coast near Puerto Real in the middle of the island of Vieques and extends over an area of approximately 60 000 m² (see figure 3.3). The long-term excavation project has mapped 20 mounded areas where high concentrations of archaeological material were found, interpreted as refuse dumps belonging to Amerindian settlements. In all 20 areas, systematic test-unit excavations were performed to collect samples of material remains to place the site in the regional cultural chronology. Based upon the presence of two different ceramic styles, the excavators distinguished two components within the site area: (1) The La Hueca component, which corresponds to the deposits yielding La Hueca style ceramics, basically situated in the western part of the site area; and (2) the Sorcé component, which corresponds to the deposits yielding Cedrosan Saladoid ceramics, more or less limited to the eastern area (Chanlatte Baik 1984; Narganes Storde 1991).

From the excavated mounds I chose the YTA-2 one (Narganes Storde 1991), belonging to the Sorcé component of the site, for my sample. The reasons for selecting this deposit were its relatively high artefact content and its small temporal variation based on radiocarbon dates. The calibrated dates fall between AD 135 and 620, placing it within the Early Ceramic A phase. In total, seventeen 2 x 2 m test units were chosen haphazardly from the 1980 field season, including the five units from which radiocarbon dates were obtained. All excavations were conducted according to the same procedure. Test units were excavated in arbitrarily layers of 20 cm each and dirt was dry sieved through a 6.4 mm (¼ inch) mesh screen.

The total number of artefacts studied comprises 1018 lithic specimens (table F.34). This does not represent the entire lithic sample from these units, as artefacts associated with the lapidary industry were analysed earlier by Yvonne Narganes Storde (1995) and therefore, left out of the present study. Despite possible temporal variation within the YTA-2 refuse area, this sample has been treated as one entity with no temporal distinctions being made. This lumping is justified by the small raw material variation between units and levels in this site area.

Materials include a number of flint and chert varieties, different types of igneous rocks, quartz, jasper, St. Martin greenstone, limestone, sandstone, silicified rock, plutonic rock, metamorphic rock, red ochre, fine grained sedimentary rock, and different varieties of semi-precious stone.

raw material	flint chert	quartz	green-stone	other green rock	pumice	lime-stone	sand-stone	igneous rock	plutonic rock	meta-mor-phic rock	semi-precious stone	fine-grained rock	red ochre	uniden-tified rock	total
artefact category															
artefact type															
flaked stone															
flake	197	108	-	19	1	-	-	14	-	4	-	6	-	4	353
shatter	32	30	-	-	-	-	-	1	-	1	-	-	-	2	66
flake core	31	75	-	-	-	-	-	-	-	-	-	-	-	-	106
water-worn pebble with flake scar	-	-	-	-	-	-	-	2	-	-	-	1	-	1	4
flaked piece	-	-	-	-	-	-	-	1	-	-	-	1	-	-	2
ground stone															
axe	-	-	-	-	-	-	-	2	-	1	-	-	-	-	3
fragment of axe	-	-	9	3	-	-	-	21	-	3	-	8	-	-	44
adze	-	-	-	-	-	-	-	1	-	-	-	-	-	-	1
fragment of an adze	-	-	1	-	-	-	-	17	-	-	-	-	-	-	18
fragment of an axe/adze: edge flake	-	-	-	-	-	-	-	-	-	1	-	2	-	-	3
complete axe preform	-	-	-	-	-	-	-	13	-	2	-	1	-	-	16
fragment axe preform	-	-	-	-	-	-	-	-	-	3	-	7	-	-	10
adze preform	-	-	-	-	-	-	-	1	-	-	-	-	-	-	1
used water-worn pebbles															
complete hammerstone	2	2	-	-	-	-	-	1	1	-	-	-	-	1	7
fragment hammerstone	-	1	-	-	-	-	1	3	-	-	-	1	-	2	8
complete hammerstone anvil	-	-	-	-	-	1	-	-	-	-	-	-	-	-	1
fragment hammerstone anvil	-	-	-	-	-	-	-	1	-	-	-	-	-	-	1
fragment anvil	-	-	-	-	-	-	-	1	-	-	-	-	-	-	1
active abrading stone	-	-	-	-	-	-	-	1	-	-	-	-	-	2	3
polishing stone	2	-	-	7	-	-	-	26	-	-	-	2	-	4	41
non-used water-worn pebbles															
non-modified water-worn pebble	3	24	-	16	1	4	-	47	3	-	-	6	1	5	110
fragment water-worn pebble	-	1	-	1	-	-	-	25	-	2	-	9	1	6	45
other used rock															
complete active abrading stone	-	-	-	-	2	-	-	-	-	-	-	-	-	-	2
fragment active abrading stone	-	-	-	-	-	-	2	-	-	-	-	-	-	-	2
other rock															
natural rock	3	7	-	-	-	-	4	15	1	1	1	2	10	11	55
fragment natural rock	1	6	-	-	1	-	2	38	-	3	-	5	-	15	71
unidentified core artefact	-	-	-	-	1	-	-	-	-	-	-	-	-	-	1
fragment unidentified core artefact	-	-	-	-	-	-	-	2	-	-	-	-	-	-	2
unidentified	10	5	-	-	-	1	-	2	-	3	-	6	-	11	38
total	281	259	10	46	6	6	9	235	5	27	1	57	12	64	1018
%	27.6	25.4	1.0	4.5	0.6	0.6	0.9	23.1	0.5	2.7	0.1	5.6	1.2	6.3	100.0

Table F.34. Sorcé, Vieques. Number of lithic artefacts by raw material by artefact type.

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