



**HAL**  
open science

## Local production and long-distance procurement of beads and pendants with high mineralogical diversity in an early Saladoid settlement of Guadeloupe (French West Indies)

Alain Queffelec, Pierrick Fouéré, Céline Paris, Christian Stouvenot, Ludovic Bellot-Gurlet

### ► To cite this version:

Alain Queffelec, Pierrick Fouéré, Céline Paris, Christian Stouvenot, Ludovic Bellot-Gurlet. Local production and long-distance procurement of beads and pendants with high mineralogical diversity in an early Saladoid settlement of Guadeloupe (French West Indies). *Journal of Archaeological Science: Reports*, 2018, 21, pp.275-288. 10.1016/j.jasrep.2018.07.011 . hal-01850088v2

HAL Id: hal-01850088

<https://hal.science/hal-01850088v2>

Submitted on 11 Jun 2020

**HAL** is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.

# Local production and long-distance procurement of beads and pendants with high mineralogical diversity in an early Saladoid settlement of Guadeloupe (French West Indies)

Alain QUEFFELEC<sup>1</sup>, Pierrick FOUERE<sup>2,3</sup>, Céline PARIS<sup>4</sup>, Christian STOUVENOT<sup>5,6</sup>  
Ludovic BELLOT-GURLET<sup>4</sup>

1. CNRS UMR5199 PACEA, Université de Bordeaux, Ministère de la Culture, Bât B18  
Allée Geoffroy St Hilaire, 33615 Pessac Cedex, France

2. INRAP Grand-Sud-Ouest et Dom Tom, 140 avenue du Maréchal Leclerc, CS50036  
33323 Begles Cedex, France

3. CNRS UMR5608 TRACES, Université Toulouse Jean Jaurès, Ministère de la Culture, 5  
allée Antonio Machado, 31058 Toulouse cedex, France

4. Sorbonne Université, CNRS, UMR8233 MONARIS, 4 place Jussieu, 75252 Paris,  
France

5. DAC Guadeloupe, Ministère de la Culture, 28 rue Perrinon, 97100 Basse-Terre, France

6. CNRS UMR8096 ARCHAM, Université Panthéon-Sorbonne, Ministère de la Culture, 21  
Allée de l'Université, 92023 Nanterre cedex, France

Link to the published article: <https://doi.org/10.1016/j.jasrep.2018.07.011>

© <2018>. This manuscript version is made available under the CC-BY-NC-ND 4.0  
license <http://creativecommons.org/licenses/by-nc-nd/4.0/>

## Abstract

The preventive excavation of an archaeological site located at the Gare Maritime of Basse-Terre (Guadeloupe, French West Indies) revealed a series of stone artifacts including finished beads and pendants, as well as pieces representing several stages of the *chaîne opératoire*. This work is an integrated study of the mineralogy and typo-technology of these objects. The artifacts have been recovered from layers interpreted as midden deposits of an early Saladoid coastal settlement dated to 250 – 400 A.D. Non-invasive analyses by Raman spectroscopy have shown that the 50 artifacts belong to 13 different gemstones which are, in decreasing order of frequency: serpentine, amethyst, turquoise, sudoite, rock crystal, calcite, feldspar, diorite, jasper, aventurine, chlorite, paragonite and nephrite. All these materials' mineralogy, and in particular the great diversity of the so called "green rocks", could only be reliably determined through an analytical characterization. The diversity of

34 lithic materials used and abandoned in the Gare Maritime site dump is the largest known to  
35 date in the Caribbean archipelago. The presence of seven objects in turquoise is particularly  
36 noteworthy in view of its rarity in the other known sites in the region. The *chaîne opératoire*  
37 for each of these raw materials could be approached for the first time in the Caribbean area  
38 by emancipating ourselves from the “greenstone” category, which has been too often used  
39 in the past because of the lack of reliable mineralogical identification. These results make it  
40 possible to integrate the Gare Maritime site into the group of Saladoid sites which have  
41 delivered a large set of ornamental elements. On the one hand, the various shapes of  
42 artifacts fit the regional cultural pattern, both for beads and pendants shapes, the latter being  
43 mainly stylized frogs. On the other hand, the use of 13 semi-precious stones in the lapidary  
44 production is exceptional for the region and confirms the use at this period of many exotic  
45 raw materials. The provenance of these materials, although difficult to pinpoint properly due  
46 to the incomplete mapping of regional resources, documents a mixture of regional and even  
47 distant (continental) origins, thus strengthening the idea of a pan-Caribbean network for the  
48 exchange of raw materials for lapidary art.

49

## 50 **Keywords**

51 Caribbean archaeology; Beads technology; Raman spectroscopy; Stone beads; Lapidary  
52 art; Raw materials; Gemstones

53

## 54 **Highlights**

- 55 - An early saladoid archaeological site in Guadeloupe yielded 50 lapidary artifacts
- 56 - Thirteen different raw materials were identified through Raman spectroscopy
- 57 - The *chaînes opératoires* for each material has been documented
- 58 - Raman spectroscopy was mandatory to identify eight different *greenstone* gems
- 59 - The highlighted use of exotic gemstones fits the Saladoid pan-Caribbean network  
60 model

61

## 62 **1. INTRODUCTION**

63 The Saladoid series, also considered as the Saladoid phenomenon, is the first series of  
64 the Ceramic Age in the Antilles (Rouse, 1992). It develops inland and coastlands in South  
65 America, probably since 2500 BC (Berard, 2013; Rouse and Cruxent, 1963) and expands  
66 towards the Antilles from 500 BC until ca. 1000 AD, depending on the islands. These  
67 migrating groups replaces and probably acculturate mutually with the former preceramic  
68 occupants of the Antilles. Their subsistence is based on horticulture associated with hunting,

69 fishing and foraging, while their material production is based on highly decorated ceramic,  
70 a simple lithic industry and polished axes produced from rocks and shells. The coastal and  
71 maritime area of dispersion of this culture embraces the Northeastern coast of South  
72 America and the whole of the Antilles as far north as Puerto Rico (Berard, 2013; Bonnissent,  
73 2010; Hofman et al., 2007; Rouse, 1992).

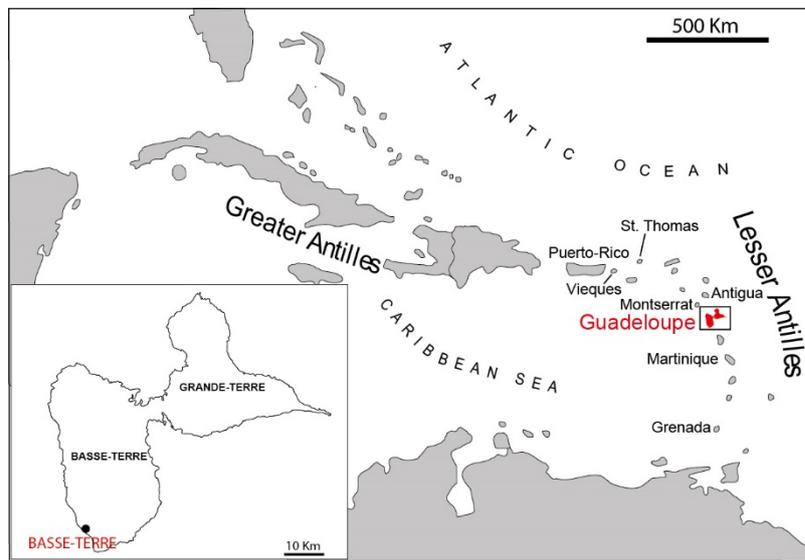
74 Several Saladoid archaeological sites have yielded mineral beads and pendants in the  
75 Lesser Antilles during the past decades (Bullen and Bullen, 1972; Cody, 1991; Crock and  
76 Bartone, 1998; Fewkes, 1903; Gent and de Mille, 2003; Harris, 1980; Havisser, 1991; Henocq  
77 et al., 1995; Mattioni, 1979; Murphy et al., 2000; Watters and Scaglione, 1994) and these  
78 special artifacts have been the basis of numerous hypothesis regarding diffusion networks  
79 and sociopolitical organization. Indeed, the diffusion of these artifacts made in "exotic"  
80 material among the West Indies during the Saladoid period (500 BC-1000 AD) has been  
81 one of the bases for the idea of a pan-Caribbean network (Cody, 1993; Hofman et al., 2007;  
82 Knippenberg, 2007; Rodriguez, 1993; Rodriguez Ramos, 2010; Watters, 1997). The  
83 lapidary production, estimated as highly valuable for several reasons such as rarity of  
84 suitable raw material, time and technological investment to produce them, has also been  
85 used for reflection on the "big man collectivities" vs. "complex tribe" models (Boomert, 1999;  
86 Righter, 2003).

87 Exotic provenance of most of the West Indian lapidary artifacts is frequently underlined,  
88 but with poor arguments on the exact provenance of their raw material which is generally  
89 related to an incomplete mineralogical description (Cody, 1993; Crock and Bartone, 1998;  
90 Righter, 2003; Roobol and Lee, 1976). The only mineralogical study being the one by  
91 Murphy *et al.* (2000) for three sites in Antigua. Stylistic observation and ethnographical  
92 observations have also entered the discussion, pointing to different geographical  
93 provenance (Boomert, 1987; Narganes Storde, 1995; Rodriguez Ramos, 2011) but with no  
94 formal evidence. Among the sites yielding mineral beads, some of them are also considered  
95 as lapidary sites dedicated to the transformation of one material, like Pearls (Grenada) for  
96 the amethyst (Cody, 1991), Trants (Montserrat) or sites from Antigua for the cornelian  
97 (Murphy et al., 2000; Watters and Scaglione, 1994). As Roobol & Lee (1976) already pointed  
98 out, precise greenstone attribution "could provide an estimate of inter-island trade or  
99 migration within the Greater Antilles", this statement obviously also stands for Lesser  
100 Antilles. Recent geological discoveries have renewed the knowledge on the geographical  
101 distribution of natural occurrences of some symbolically used minerals/rocks and especially  
102 jadeitite (Cárdenas-Párraga et al., 2010; García-Casco et al., 2009; Harlow et al., 2006;  
103 Rodriguez Ramos, 2011; Schertl et al., 2012). It offers the opportunity of some more precise  
104 artifact provenance definition.

105 In this context, the excavation of the Gare Maritime Saladoid site in Basse-Terre  
106 (Guadeloupe, French West Indies), during preventive archeological excavation, yielded a  
107 large collection of beads and pendants. It gives us the opportunity of an exhaustive  
108 mineralogical and technological study in order to document their *chaîne opératoire*. This  
109 knowledge, indeed, lacks for Guadeloupe, a large territory of the Leeward Islands, which  
110 had not previously yielded lapidary site and for which the beads and pendants are known  
111 only by the impressive discoveries at Morel (Durand and Petitjean Roget, 1991; Hamy,  
112 1884) or of recent excavations in Basse-Terre (Bonnissent and Romon, 2004; Etrich,  
113 2003a). The precise mineralogical identification of the Gare Maritime collection was reached  
114 thanks to a non-invasive analytical approach based on Raman spectroscopy. Applying an  
115 integrative technological study and an accurate mineralogical characterization to this new  
116 collection is thus of great interest to improve both our knowledge about the *chaîne opératoire*  
117 of beads and pendants and the diffusion of exotic minerals in the Lesser Antilles during the  
118 early Saladoid.

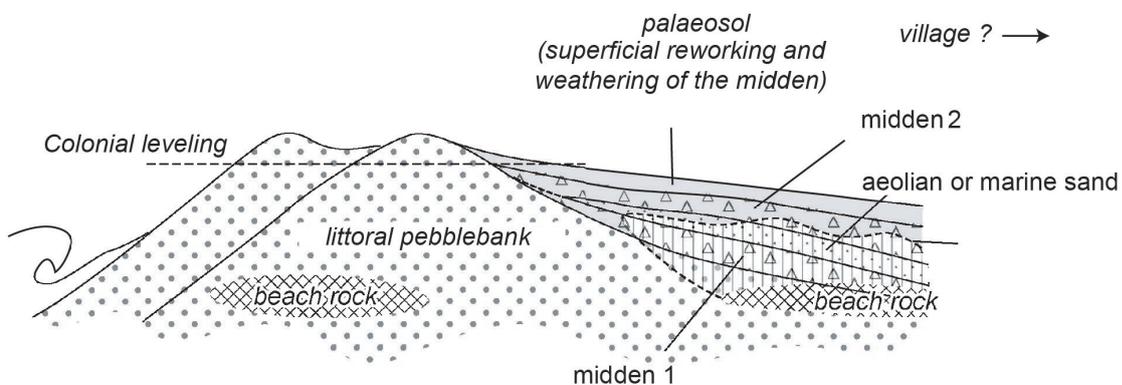
## 119 **2. ARCHAEOLOGICAL CONTEXT**

120 The archaeological site of Gare Maritime is located in the present-day commercial  
121 harbor of Basse-Terre city, the regional capital of Guadeloupe (Fig. 1). Nowadays it is ca.  
122 one hundred meters from the actual harbor dock, but during pre-Columbian times it was  
123 located just behind the littoral pebble bank and on a river bank (Fig. 2). Although its  
124 stratigraphy is separated into several units, the geoarchaeological, lithic and ceramic studies  
125 converge towards a rather long but single occupation of the site (Romon et al., 2013). The  
126 multiple layers are interpreted as a Huecan Saladoid (or Huecoid depending of the authors)  
127 midden separated in two main stratigraphic units by a very short event of sand deposition,  
128 possibly related to a violent storm. The excavation corresponds to a small part of the site,  
129 only represented by its coastal zone. The settlement area was presumably located further  
130 inland, and could be preserved under a modern square. The pre-Columbian occupation is  
131 well dated to 250-400 cal. A.D. with several radiocarbon dates related to the different  
132 stratigraphic units, only the very top layer being slightly more recent (Romon et al., 2013).  
133 This study concerns the 50 mineral artifacts which have been recovered during the manual  
134 excavation of 28 m<sup>2</sup> of the pre-Columbian layers.



135  
136  
137

Figure 1. Map of the regional and local position of the archaeological site of Gare Maritime, in Basse-Terre city. The islands hosting the archaeological sites mentioned in the text are also indicated.



138  
139  
140  
141  
142

Figure 2. Interpretative section of the Gare Maritime site representative of the Pre-columbian period (modified after Bertran P. in Romon, 2013).

### 143 3. MATERIALS AND METHODS

144 All the fifty mineral artifacts related to beads or pendants production recovered from  
145 the site have been studied in this work (Table 1, Fig. 3). They come from different layers  
146 and most of them have been recovered thanks to the systematic wet sieving with a 3 mm  
147 mesh of the full amount of sediment manually excavated during the archaeological  
148 operation.

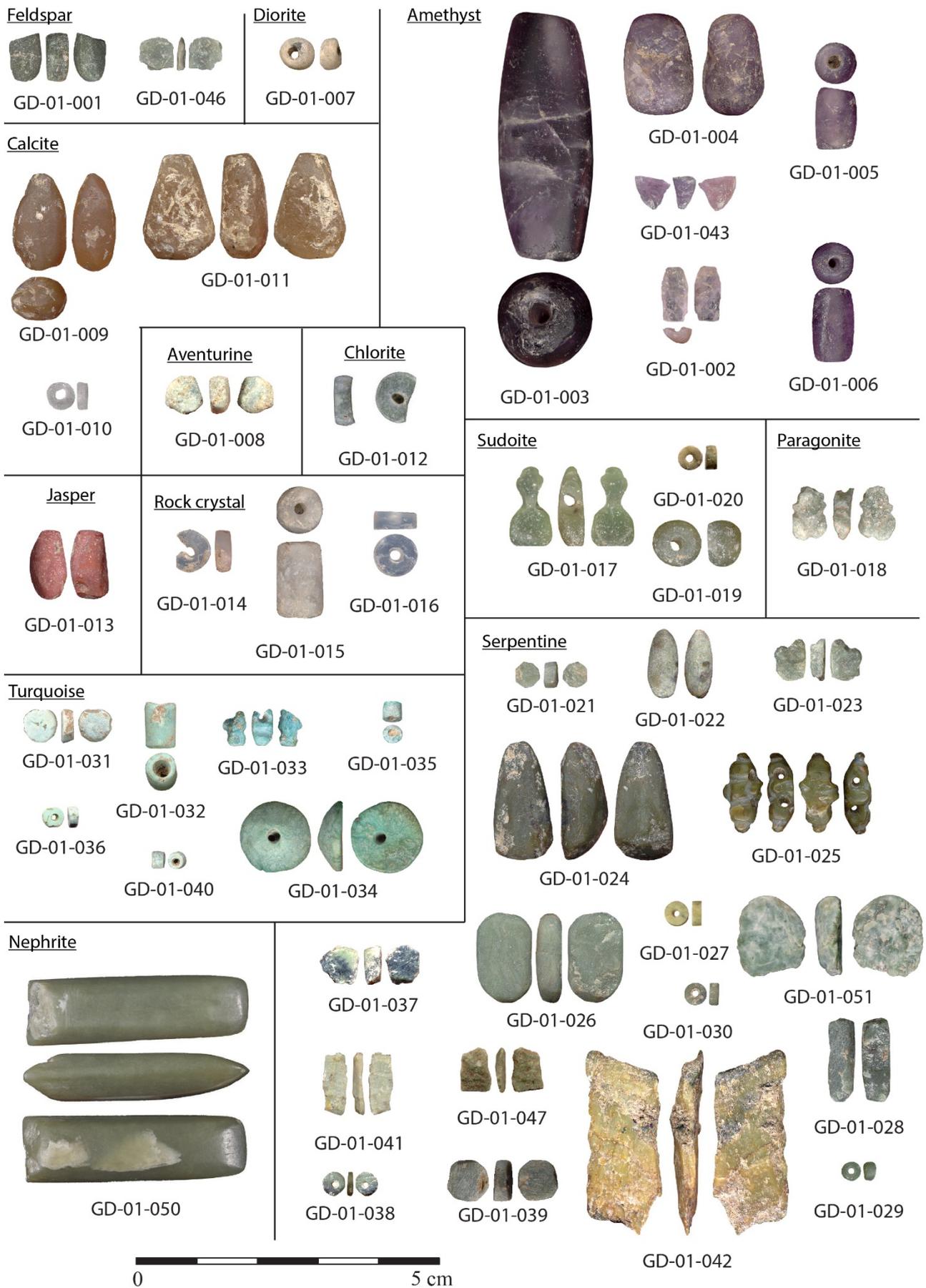
149

Artefact reference number	Bead length	Bead diameter	Perforation diameter	Weight	Perforation type	Final object	State	Gemological name	Identified minerals
	Pendant height	Pendant width	Pendant/blank thickness						
	(mm)	(mm)	(mm)		(g)				
GD-01-001	7,3	5,9	4,2	0,28	-	Tablet	Raw material	Feldspar	Albite + Paragonite
GD-01-002	9,1	4,2	1,8	0,12	Drilled from both ends	Long tubular bead	Finished / broken	Amethyst	Quartz
GD-01-003	41,7	16	2 - 3	15,96	Drilled from both ends	Long barrel bead	Finished	Amethyst	Quartz
GD-01-004	17	11,5	10,5	3,06	-	Tubular	Blank	Amethyst	Quartz
GD-01-005	10,4	7	2	0,78	Drilled from both ends	Long barrel bead	Finished	Amethyst	Quartz
GD-01-006	12,4	7	2	1	Drilled from both ends	Long tubular bead with convex ends	Finished	Amethyst	Quartz
GD-01-007	3,7	5,6	1,8	0,16	Drilled from both ends	Short barrel bead	Finished	Diorite	Anorthite + Diopside
GD-01-008	3	6	-	0,19	-	Polygonal	Blank	Aventurine	Quartz + Muscovite + Surfacic calcite
GD-01-009	16,3	9,2	7,5	1,52	-	Droplet bead/pendant?	Blank	Calcite	Calcite
GD-01-010	2	4,6	1,8	0,05	Double cone	Discoid tubular bead	Finished	Calcite	Calcite
GD-01-011	18	12	7	2,26	-	Droplet bead/pendant?	Blank	Calcite	Calcite
GD-01-012	3,2	8,3	-	0,29	Drilled from both ends	Discoid barrel bead	Finished / broken	Chlorite	Clinochlore
GD-01-013	11,7	5,9	5,7	0,51	-	Barrel	Blank	Cornelian	Quartz + Moganite + Hematite
GD-01-014	2,8	6,9	2	0,15	Chamfered	Discoid barrel bead	Finished / broken	Rock crystal	Quartz
GD-01-015	12,9	7,7	2	1,32	Drilled from both ends	Long tubular bead	Finished	Rock crystal	Quartz
GD-01-016	3	7,1	1,8	0,27	Chamfered	Discoid tubular bead	Finished	Rock crystal	Quartz
GD-01-017	13,9	7,2	4,2	0,48	Double cone + Plain	Pendant	Finished	Sudoite	Sudoite
GD-01-018	9	6	3,1	0,25	Drilled from both ends	Pendant	Finished / broken	Paragonite	Paragonite
GD-01-019	6,2	7,9	2	0,5	Drilled from both ends	Short barrel bead, wedge-shaped	Finished	Sudoite	Sudoite + Gypsum + Clinochlore
GD-01-020	2,1	4,2	1,5	0,06	Drilled from both ends	Short tubular bead	Finished	Sudoite	Sudoite + Gypsum + Clinochlore
GD-01-021	2,1	4	-	0,06	-	Polygonal	Blank	Serpentine	Antigorite

GD-01-022	11	4,3	-	0,33	-	Droplet bead/pendant?	Blank	Serpentine	Antigorite + Magnetite inclusions
GD-01-023	6,1	5,8	2,4	0,13	-	Polygonal	Blank	Serpentine	Antigorite + Microcharcoals
GD-01-024	19,9	9,7	6, 2	1,55	-	Droplet bead/pendant?	Blank	Serpentine	Antigorite
GD-01-025	13,4	6,5	4,5	0,39	Double cone	Pendant	Finished	Serpentine	Antigorite
GD-01-026	15	9,2	4,5	1	-	Oval	Blank	Serpentine	Antigorite + Hematite
GD-01-027	2	4	1	0,05	Drilled from both ends	Short tubular bead	Finished	Serpentine	Antigorite
GD-01-028	13,9	4,8	4	0,46	-	Tubular	Blank	Serpentine	Antigorite + Magnetite inclusions
GD-01-029	1,7	3,2	1	0,02	Drilled from both ends	Short tubular bead, wedge-shaped	Finished	Serpentine	Antigorite
GD-01-030	1,6	3,7	0,9	0,04	Drilled from both ends	Discoid tubular bead, wedge-shaped	Finished	Serpentine	Antigorite
GD-01-031	2,1	5,7	-	0,13	-	Discoid	Blank	Turquoise	Turquoise + Gypsum + Labradorite + Charcoal
GD-01-032	7,7	5,3	2,1	0,31	Drilled from both ends	Long tubular bead	Finished	Turquoise	Turquoise
GD-01-033	"6	"3,9	3,6	0,11	Double cone	Pendant	Finished / broken	Turquoise	Turquoise
GD-01-034	4,2	12	1,9	0,76	Drilled from both ends	Discoid plano-convex bead	Finished	Turquoise	Turquoise
GD-01-035	2,9	3,1	1,4	0,05	Drilled from both ends	Short tubular bead	Finished	Turquoise	Turquoise
GD-01-036	1,7	3,7	1	0,03	Drilled from both ends	Discoid tubular bead	Finished	Turquoise	Turquoise + Gypsum
GD-01-037	2,9	6,5	2,9	0,18	-	Polygonal	Blank	Serpentine	Antigorite + Clinocllore
GD-01-038	1,1	4,2	0,9	0,1	Drilled from both ends	Discoid	Blank	Serpentine	Antigorite
GD-01-039	2,9	7	-	0,22	-	Discoid	Blank	Serpentine	Antigorite
GD-01-040	2	2,8	1	0,02	Drilled from both ends	Short barrel bead	Finished	Turquoise	Turquoise + Magnetite inclusions
GD-01-041	10,4	4	1,4	0,08	-	Chip	Raw material	Serpentine	Antigorite + Charcoal + Surfacic iron/manganese oxide
GD-01-042	30	12	5	2,08	-	Chip	Raw material	Serpentine	Antigorite + Magnetite inclusions + Surfacic calcite
GD-01-043	5,7	5,1	3,7	0,09	-	Chip	Raw material	Amethyst	Quartz
GD-01-046	5,4	5,6	1,5	0,05	-	Chip	Raw material	Feldspar	Albite + Quartz + Titanite
GD-01-047	"7,5	"5	2	0,09	-	Chip	Raw material	Serpentine	Antigorite

GD-01-050	36,4	11,3	7,9	6,35	-	Pendant?	Finished / broken?	Nephrite	Actinolite
GD-01-051	4,3	11,4	-	0,74	-	Fragment	Finished / broken?	Serpentine	Antigorite
GD-01-056	-	-	-	0,1	-	Chip	Raw material	Amethyst	Quartz
GD-01-057	-	-	-	0,1	-	Chip	Raw material	Amethyst	Quartz
GD-01-058	-	-	-	0,1	-	Chip	Raw material	Amethyst	Quartz

Table 1. Summary of the typological measurements, technical facts and the mineralogical characterization of the studied lapidary artifacts.



153  
154  
155  
156

Figure 3. Photographic documentation of the 47 main mineral artifacts related to lapidary production recovered from the Gare Maritime site. Three tiny amethyst chips are not represented. The classification by raw material types is achieved thanks to the Raman spectroscopy characterization (see table 1).

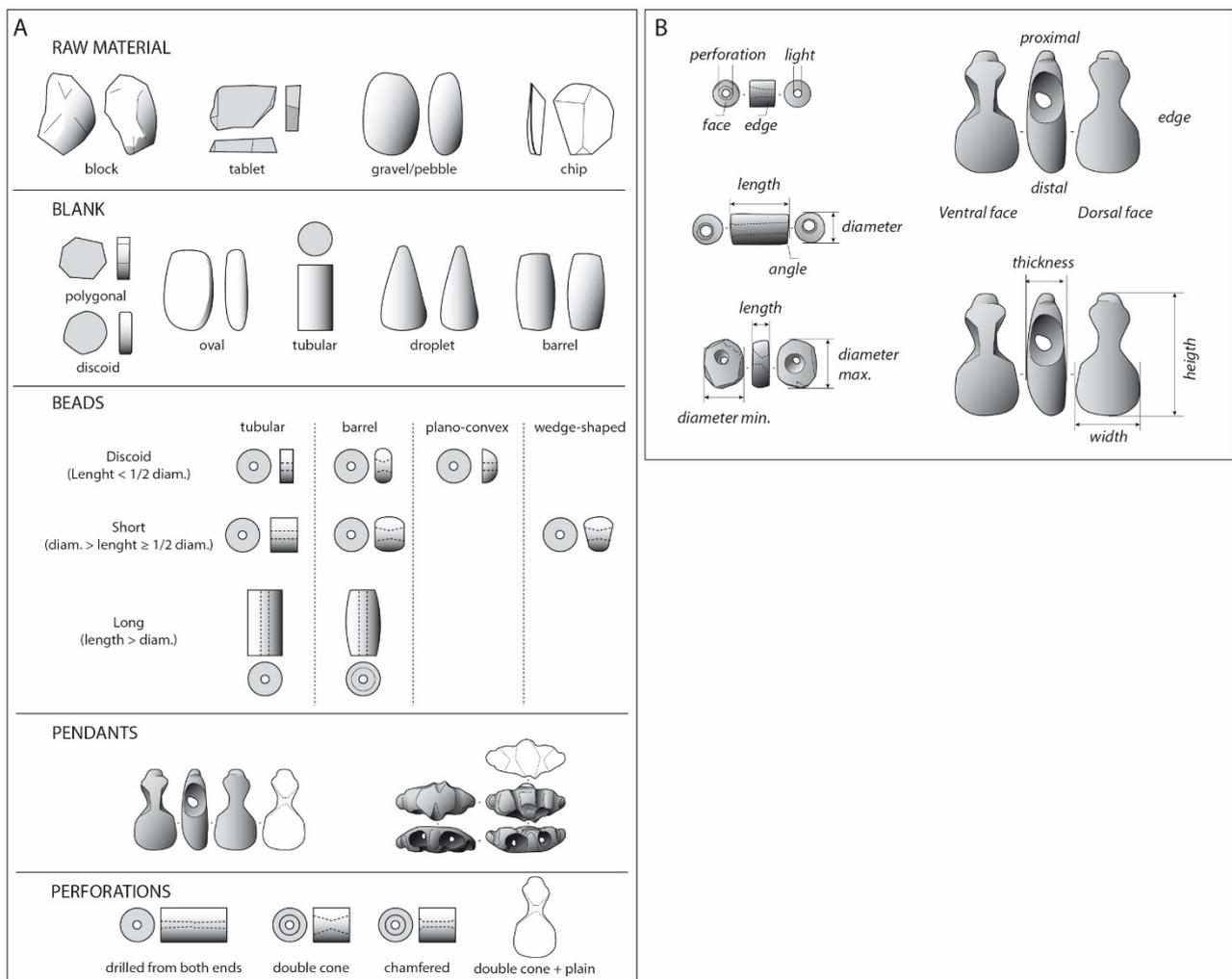
157 The artifacts were typologically classified according to the terminology exposed in Figure  
158 4a. Technological description and artifacts measurements were performed on the basis of  
159 the terminology and the characteristic dimensions presented in Figure 4b. Terminology is  
160 adapted from both Beck (1928) and Carter and Helmer (2015).

161 A first material classification was proposed via macroscopic observations, underlining  
162 a highly diverse raw material selection calling for a more detailed mineralogical  
163 determination. Especially 26 artifacts were classified as “*greenstones*”, a category related  
164 to an aspect rather than a rock type which can be linked to a specific geological source. It is  
165 therefore mandatory to analytically define the nature of raw materials in order to specify their  
166 geographic distribution and, when possible, their geographic origin.

167 Every object has been analyzed via Raman spectroscopy with a confocal Raman  
168 microspectrometer SENTERRA (Bruker Optics) equipped with 532 nm excitation line.  
169 Spectra were recorded between 100 and 1555  $\text{cm}^{-1}$  with a resolution of 3-5  $\text{cm}^{-1}$ . Some  
170 pieces were also analyzed with a confocal Raman microspectrometer HR800 (Horiba Jobin  
171 Yvon) using the 488 nm emission of a  $\text{Ar}^+$  Laser, a 600 lines/mm grating giving a spectral  
172 resolution of about 3  $\text{cm}^{-1}$ . For all measurements a 50x objective was used and spectra were  
173 collected on several locations for each artifact to explore the heterogeneity of the materials.  
174 All spectra were baseline corrected to subtract the fluorescence background.

175 Mineral identification was achieved mainly by comparison with the Ruff database  
176 (Lafuente et al., 2015) completed by some specific publications, and a strict mineralogical  
177 denomination was used according to the International Mineralogical Association list (Nickel  
178 and Nichols, 2009). Rock names for polymineralic artifacts and/or gemological appellations  
179 were also indicated to be consistent with names commonly used in archaeology.

180



181  
182

Figure 4. Terminology used for the beads and pendants typological description (A) and characterization (B).

183

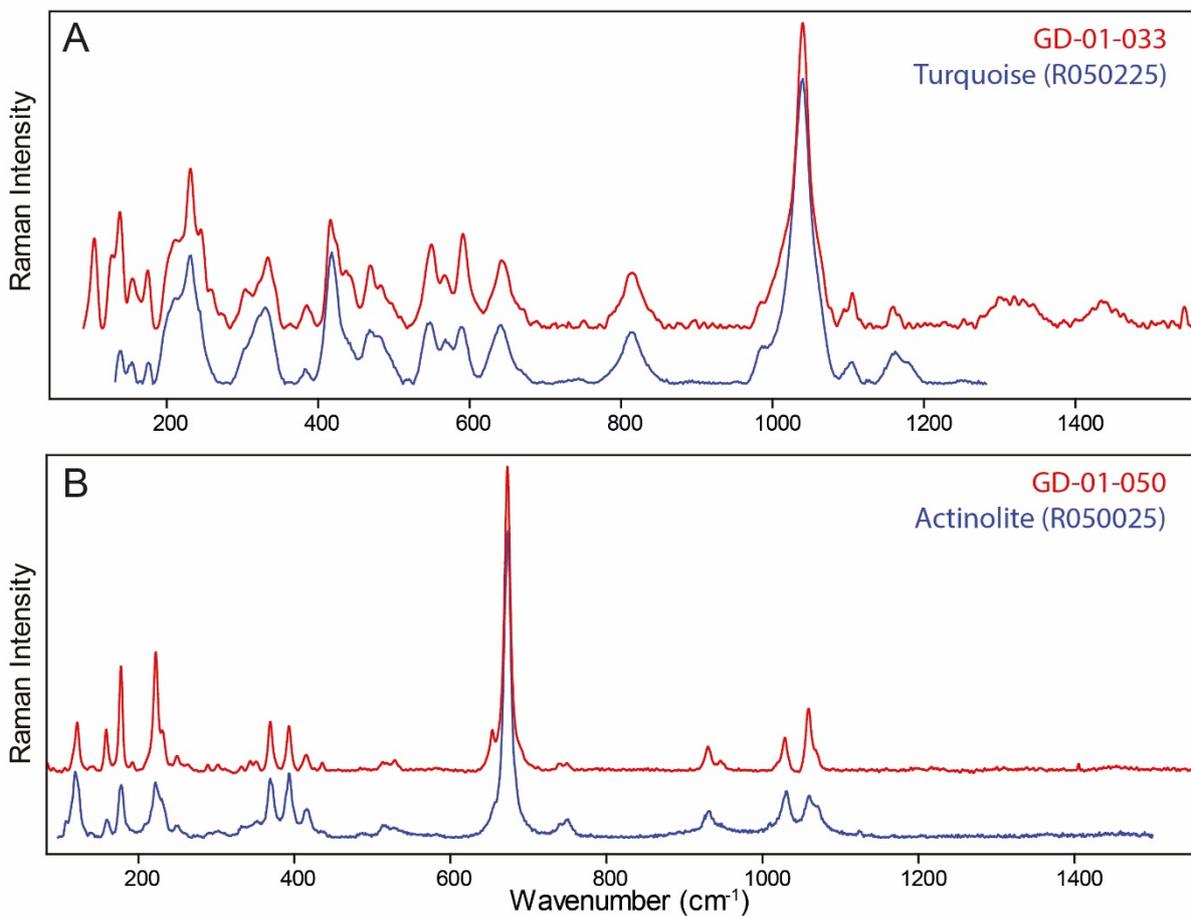
## 184 4. RESULTS

185 The mineralogical analysis of the Gare Maritime beads and pendants allowed us to  
186 confirm most of the macroscopic determination, and, as initially assumed, to refine the  
187 mineralogical composition of the *greenstones* (Table 1). Quartz and amethyst artifacts were  
188 obviously correctly determined macroscopically and thus confirmed by analysis, as well as  
189 calcite beads.

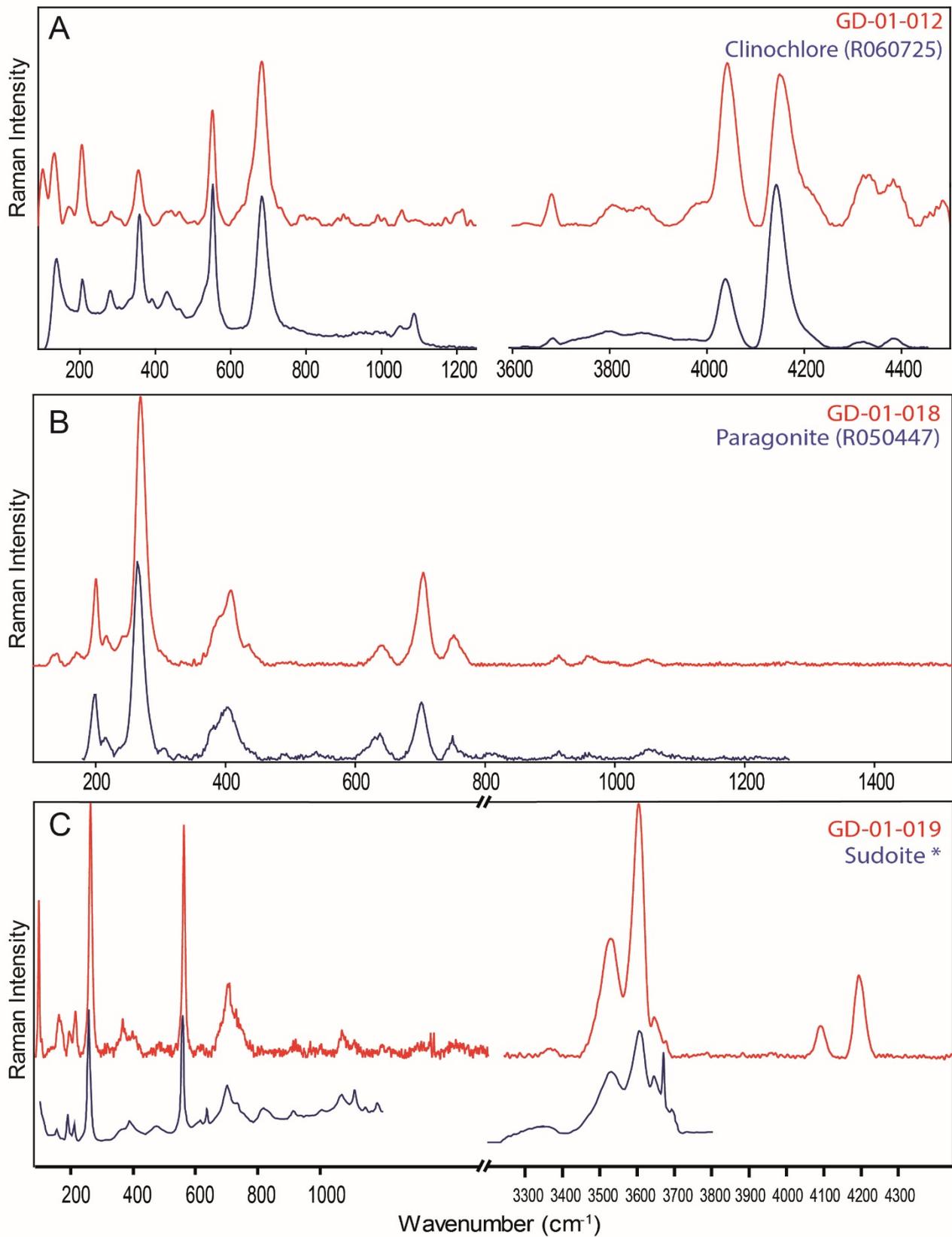
190 The major intake of Raman spectroscopy is clearly the mineralogical or petrographic  
191 attribution of the so called *greenstones* to eight different kinds of rocks or minerals (Table  
192 1). The remarkable amount of turquoise (7 artifacts) was confirmed (Fig. 5A), each of the  
193 light green-blue object having been correctly identified with the naked eye.

194 One blank (GD-01-008) was identified as the gem aventurine since it is green and  
195 composed of quartz and muscovite. Two greenish chips (GD-01-001 and GD-01-046) were  
196 identified as albite and albite + muscovite. A miniature celt shaped artifact is made of  
197 nephrite jade, the gemological/archaeological term for the rock composed primarily of the

198 amphibole actinolite (Fig. 5B). One broken discoid bead is made of clinocllore (Fig. 6A) and  
199 would be called chlorite as a gem. One frog-shaped pendant presenting clearly visible  
200 cleavage planes was identified as paragonite (Fig. 6B). Another frog-shaped pendant (GD-  
201 01-017), one sub-spherical (GD-01-019) and one discoid (GD-01-020) bead, were  
202 unexpectedly characterized as sudoite (Fig. 6C). Finally, seventeen of these *greenstones*  
203 were classified as serpentine rock, the main mineralogical component of which being  
204 antigorite (Fig. 7). Its straightforward identification by Raman spectroscopy is achieved by  
205 the presence of the specific band at 1045  $\text{cm}^{-1}$  and the shape and position of the O-H  
206 stretching bands at 3670 and 3697  $\text{cm}^{-1}$  (Groppo et al., 2006; Petriglieri et al., 2015; Rinaudo  
207 et al., 2003) observed in every serpentine artifact analyzed in this study.



208  
209 Figure 5. Representative Raman spectra of a turquoise artifact (GD-01-033) compared to a Ruff database  
210 turquoise reference (A) and of the celt-shaped pendant GD-01-050 compared with actinolite (B).



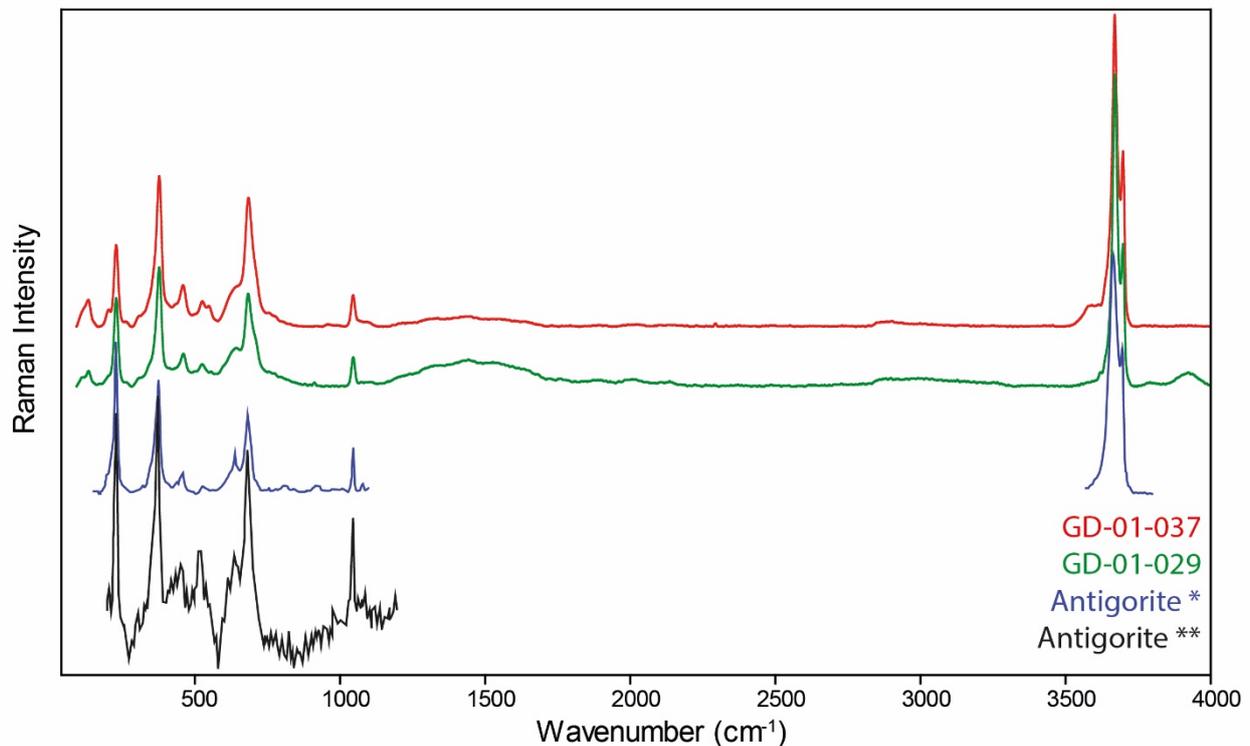
211

212

213

214

Figure 6. Spectroscopic identification for some of the greenstones. Raman spectra of the discoid bead GD-01-012 compared with clinocllore (A), the frog-shaped pendant GD-01-018 compared with Paragonite, (B) and the sub-spherical bead GD-01-019 compared with sudoite (C) (\* Reynard et al., 2015).

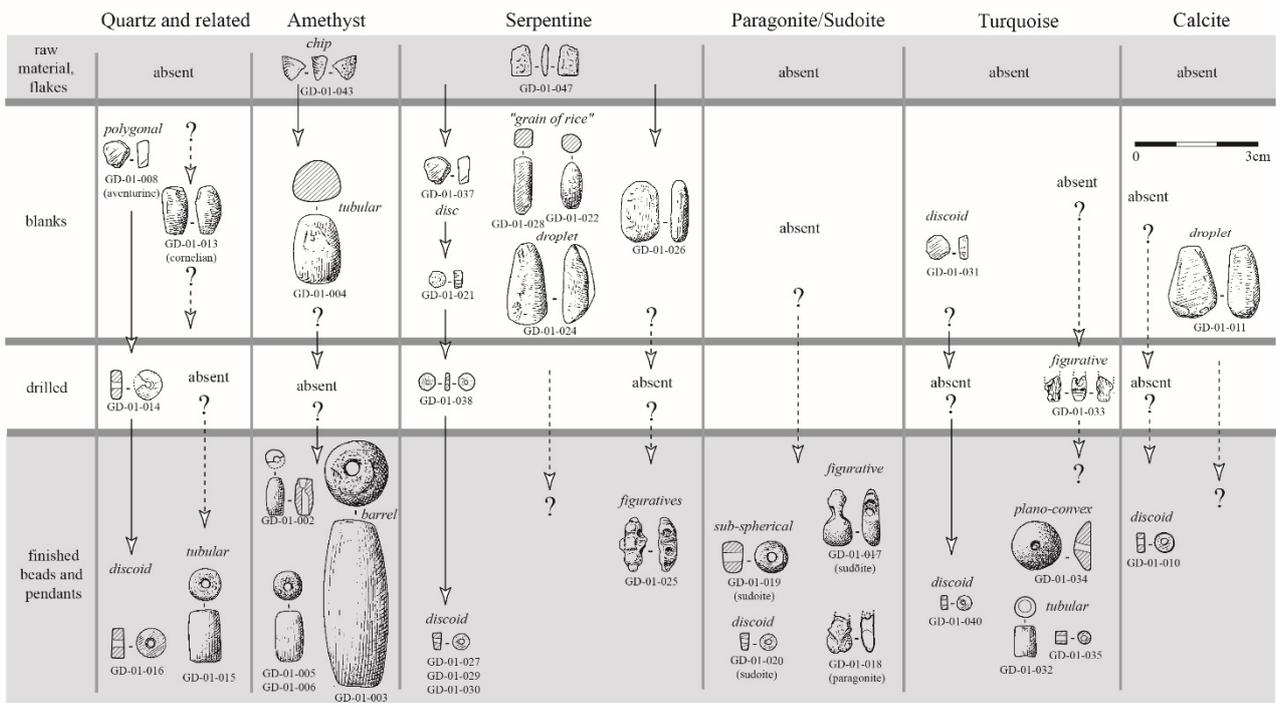


215

Figure 7. Raman spectra of two representative serpentine beads compared with antigorite spectra from literature (\* Petriglieri et al. 2015, \*\* Rinaudo et al. 2006).

216 In Gare Maritime's site, relations between the raw material and typology can be  
 217 inferred from this quite large set of objects (Fig. 3 and 8, Table 1). The minerals represented  
 218 by few artifacts mostly show their use for different types of lapidary products. For example,  
 219 turquoise is used for discoid, tubular, plano-convex beads and small pendants. Serpentine  
 220 is used for beads and pendants, as well as sudoite and probably calcite if the droplet blanks  
 221 are meant to become pendants. The only consistency underlined in the corpus is the use of  
 222 quartz (as rock crystal or amethyst) only for beads and particularly tubular beads. This is in  
 223 opposition to the other two common materials, serpentine and turquoise, which have been  
 224 used for beads and pendants. The other rare materials (albite, anorthite, clinochlore,  
 225 carnelian, quartz + muscovite) are only used for beads, with the exception of nephrite which  
 226 is only used for a very specific artifact which could be a pendant. As regards to the color of  
 227 the material, the only connection with shape is the consistency in using the various green  
 228 materials to produce the frog pendants.

Although we have a truncated view of the production, linked to the partial excavation of the dump and the site, and a modest collection of 50 pieces, it is possible to estimate the ornaments that can result from an on-site processing and those that could be imported as finished or semi-finished products (Fig. 8).



229 Figure 8: *Chaîne opératoire* for the different minerals as represented in the Gare Maritime corpus. "Absent"  
 230 notices the absence of this step in the series discovered during the excavation. This excavation being partial,  
 231 questions remain about the actual absence of these products.

232 For rock crystal, there are no elements showing that the raw material was imported  
 233 unprocessed. For amethyst, three small chips show that the raw material has been cut onsite  
 234 although the corresponding preforms are missing. Only a partially polished cylindrical blank  
 235 has been discovered. Production based on amethyst seems to be limited to tubular and  
 236 barrel beads.

237 Serpentine is the most represented mineral, from raw material to finished products.  
 238 All the steps of shaping small discoid beads are represented. It is more difficult to interpret  
 239 the cylindrical preforms in terms of their becoming, as they could be used for tubular or  
 240 barrel-shaped beads, which are absent from the series, as well as for figurative pendants,  
 241 or to produce several discoid beads. The oval plate GD-01-026 could provide a good support  
 242 for a frog pendant for example. However, there are no intermediate processing steps for  
 243 these ornaments and it cannot be excluded that the artifact GD-01-025 has been imported  
 244 in finished form. No element of the sudoite artifacts production chain is present in the series,  
 245 only finished ornaments, beads and pendants, indicate that they were probably imported as  
 246 such.

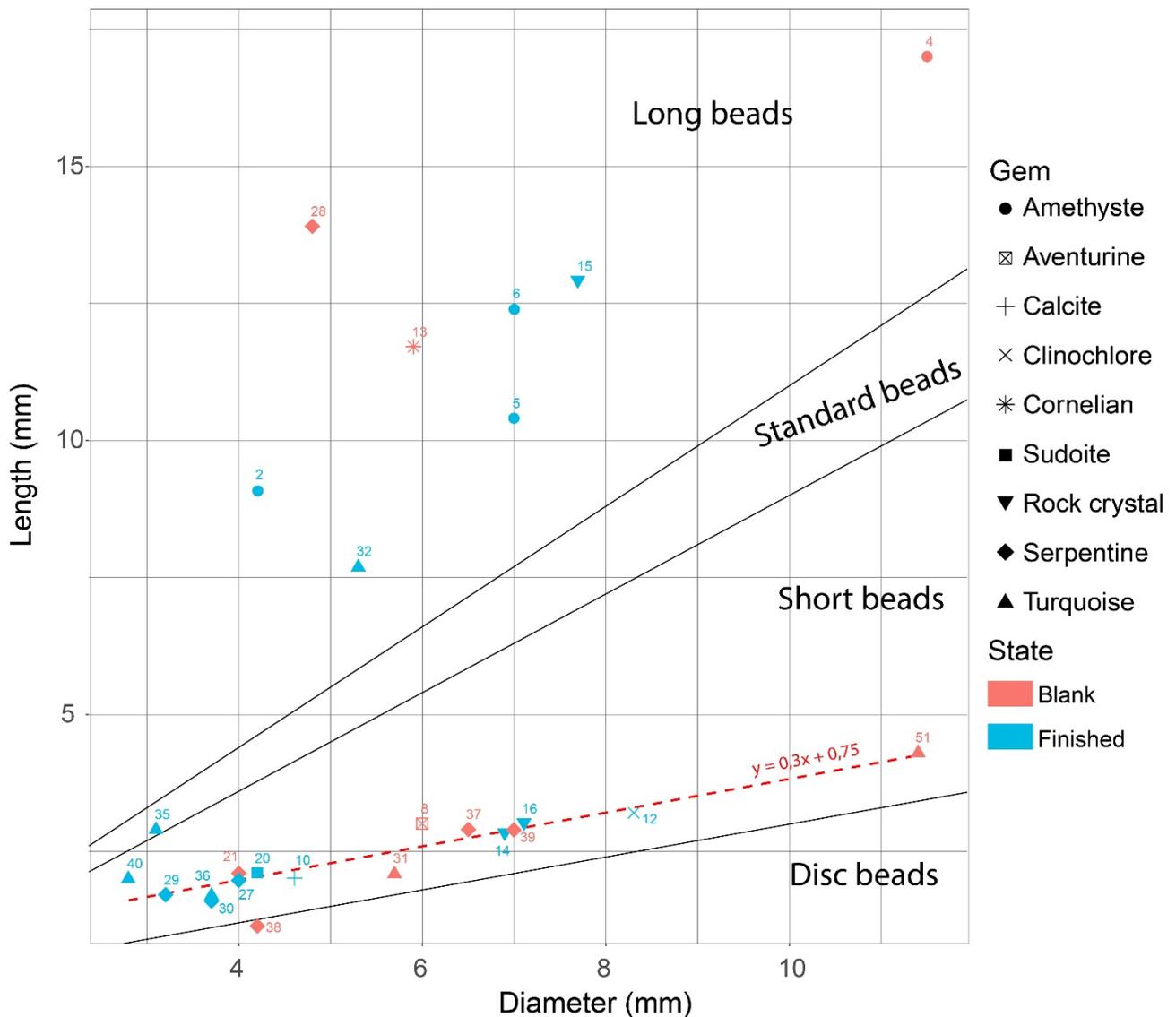
247 Although it has only seven pieces, the turquoise set offers quite an exceptional series  
 248 for the Lesser Antilles. It is absent in the form of raw material, but a discoid preform with  
 249 polished faces and still faceted edges shows that the first stages of these beads were made  
 250 at the site. The other pieces include finished shapes, with the exception of a fragment of a

251 pendeloque, which may have been broken during its manufacture.

252 Calcite ornament is curiously little represented, since this raw material may have a  
253 local origin (in Grande-Terre). Only two drop-shaped blanks, of which we do not know what  
254 type of ornament it was intended for, and a finished discoid bead, are formed in this material.

255 Blanks, unfinished objects, broken objects are present for aventurine, jasper,  
256 serpentine, turquoise and paragonite, suggesting that all these minerals have been worked,  
257 at least partially, on site. But most materials do not display the “raw material” and “reduction  
258 chips” stages. We could therefore hypothesize that preforms could have been the stage at  
259 which the Saladoids would have acquired most of these exotic minerals.

260 The details of each object's *chaîne opératoire* are difficult to infer from the Gare  
261 Maritime corpus, because most are finished and only document the last stages of the  
262 manufacturing process while some blanks do not seem to be connected to finished objects.  
263 The exception concerns discoid beads for which the full process can be studied by  
264 combining clues from the different gemstones. They are shaped from small chips (Fig. 8).  
265 Blanks are obtained by polishing both faces and edges to shape it from polygon into discoid,  
266 which diameter ranges between 5.5 and 6.5 mm. The blank is then given to its final thickness  
267 prior to perforation, as visible by the different sizes of blanks opposed to the homogeneous  
268 size of the finished objects (Fig. 9). A final polishing step, giving the luster, is probably the  
269 final step to make the finished bead after drilling. One can notice that the only bead falling  
270 in the “disc bead” category of Beck (1928) is a blank (Fig. 9). This bead is still not perfectly  
271 rounded and still not polished, as scratches are visible on its surface. The final steps would  
272 have probably made it smaller in diameter and would thus fall as a finished object into the  
273 “short bead” category. Only rock crystal beads and the chlorite artifact are bigger in size  
274 than those made from other material. Despite this bigger size of some artifacts, it is  
275 noteworthy that the proportions of the discoid tubular beads are very homogeneous, as  
276 showed by the regression line calculated on their dimensions (Fig. 9).

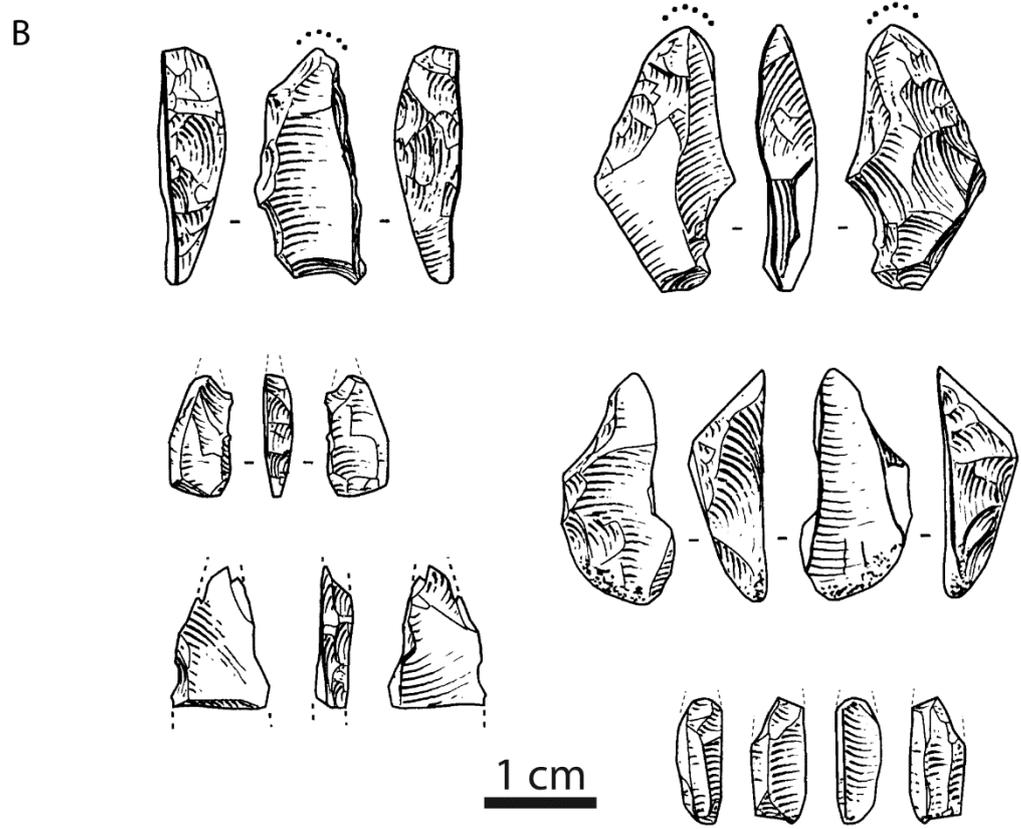


277  
 278 Figure 9: Dimension pattern for cylindrical and barrel beads from Gare Maritime. Limits between the different  
 279 types of beads are from Beck (1928). Only Bead GD-01-003 (excessively bigger than the others) is not  
 280 presented in this graph. The regression line is calculated on the basis of the discoid and short beads from  
 281 table 1.

282 The specific equipment used for the manufacturing of beads is difficult to identify.  
 283 Gare Maritime site delivered several pebbles used as hammers and some stone polishers  
 284 which were able to participate in the manufacture of ornaments. Three polishers with groove,  
 285 made of volcanic rock, were likely used for calibrating small discoid or tubular beads,  
 286 polished in a row on a link or on the unit (Fig. 10a). At Gare Maritime site, six drills made of  
 287 flint have been discovered (Fig. 10b). They could have been used to start a first hole, but  
 288 another technique was necessary to drill small diameter holes, sometimes several  
 289 centimeters long, in very hard materials. Hence these flint tools were probably more suitable  
 290 for soft materials such as shell; also knowing that more than over a thousand shell beads  
 291 have been recovered during the excavation (Romon et al., 2013)



10 cm



292  
293  
294

Figure 10. Tools that can be part of the beads production *chaîne opératoire* at Gare Maritime site. A – Polishers with groove, made of volcanic rock. B – Flint drills.

## 295 5. DISCUSSION

296 Gare Maritime site has proved to be one of the richest excavated West Indian site for  
297 beads and pendants and especially one which displays a great diversity of raw materials.  
298 Indeed, 50 artifacts from 13 different raw materials have been recovered during the manual  
299 excavation of 28 m<sup>2</sup> of pre-Columbian layers. One has to keep in mind that it is not a surface  
300 collection and even if it seems limited, it is one of the largest excavations of this kind of  
301 production place. It could be argued, however, that this is probably a limited production case,  
302 reduced to the needs of the local population only and not surplus production for export as  
303 has been shown at Golden Grove (Mones 2007).

304 With regard to the occupation of the site, neither geological observations, nor the  
305 complete study of the archaeological material, nor radiometric dating has allowed chrono-  
306 cultural differentiation between the different layers. The analysis of the set of beads and  
307 pendants itself does not support any stratigraphic differentiation either. Mineralogical  
308 species, shapes, states of production, are dispersed homogeneously through the  
309 archaeological levels of the midden. The full amount of symbolic items has therefore to be  
310 considered as a single set.

311

### 312 *5.1 Raw materials, their distribution and their potential origin*

313 The accurate mineralogical determination by Raman spectroscopy applied to the  
314 complete set of artifacts allowed, on the one hand, to confirm part of the macroscopic  
315 observation and, on the other hand, to precisely define the mineralogy of *greenstones*. The  
316 kinds of minerals used for the production of symbolic items at Gare Maritime are in adequacy  
317 with those mentioned for the other lapidary sites of the Lesser Antilles for this period. Indeed,  
318 use of rock crystal, amethyst, carnelian, diorite, serpentine and nephrite, is already known  
319 from the major lapidary sites like: Tecla, Sorcé, Tutu, Royall, Elliot, PA-15, Trants, Vivé and  
320 Golden Grove (tabl. 2). Regarding the raw material represented, the specificity of Gare  
321 Maritime lies in the more common use of turquoise, here for the production of seven artifacts  
322 while only one is known in Royall (Murphy et al., 2000), two in Pearls (Cody, 1991), one in  
323 Manzanilla (Trinidad) (Nieweg and Dorst, 2001), and a relatively small amount in Sorcé and  
324 Tecla (Narganes Storde, 1995) and Prosperity (St. Croix, USVI) (Hardy, 2010). If the high  
325 concentration of a mineral can be seen as a specialization of the site like it is supposed for:  
326 Pearls (for amethyst), Trants (for cornelian) and Golden Grove (for diorite) (Cody, 1991;  
327 Crock and Bartone, 1998; Mones, 2007); Gare Maritime could be interpreted as a turquoise  
328 specialized site. However, over-interpretation should be avoided as seven artifacts among  
329 50, dispersed in several cubic meters of a midden, make it difficult to attribute a turquoise'

330 workshop status to the site.

331           The diversity and the exogenous origin of the materials used for the lapidary  
332 production of Gare Maritime raise the question of their provenance, with diversified  
333 inferences according to each material. Diorite can be supposed to come from Tobago, where  
334 it is well known both geologically and archaeologically (Mones, 2007; Snoke, 2001). The  
335 kind of very big and dark amethyst recovered (especially GD-01-003) is geologically rare  
336 and its origin is unknown despite some allusions to amethyst present in Martinique. Indeed,  
337 contrary to Cody (1993) and Hofman et al. (2007), we cannot confirm the presence in  
338 Martinique of amethyst crystals large enough to make the numerous beads found in the  
339 saladoid sites around the West Indies when reading the literature cited for this statement in  
340 these two papers, which are respectively Pinchon (1967) and Westercamp and Tazieff  
341 (1980). The first one wrote: "*Amethyst, when it is constituted by big crystals deeply colored,*  
342 *is appreciated by stone cutters; [...] unfortunately, this is not the case of our Martinican*  
343 *source which is simply a geological curiosity*" (proposed translation from French). The  
344 second citation, which is the booklet of the geological map of Martinique, only mention  
345 amethyst in the list of hydrothermal minerals present on the island, and not at all as dark  
346 purple crystals of 4 to 5 centimeters of length.. The distinctive hue of the bead GD-01-003  
347 makes it certainly special and it should be noted that this very dark purple color was also  
348 mentioned at the Pearls site among lighter colors (Cody, 1991), and that this specific color  
349 and this size of minerals does exist in Brazil (Epstein, 1988).

350           Concerning nephrite, the case is even more complex, since literature is contradictory.  
351 Cody (1993), based on old citations that we could not find for reading, mentions Mount  
352 Roraima and other localities in Brazil. Despite this, no recent work can confirm this: Harlow  
353 et al. (2006) and O'Donoghue (2006) stand for a complete lack of evidence of nephrite in  
354 Mesoamerica and South America, while Meirelles & Costa (2012) seem to locate nephrite  
355 in Brazil as a common fact.

356           Finally, turquoise items provenance is still difficult to establish. The only well  
357 documented sources of this mineral are the numerous mines located in the South West of  
358 the USA that provided the green mineral for Mesoamerican and North American pre-  
359 Hispanic people (Harbottle and Weigand, 1992). Other sources are known in South America  
360 (Evans, 1913; Evans and Southward, 1914; López et al., 2018) and could have been related  
361 to the presence of turquoise in the North of the continent and further in the West Indies. One  
362 last hypothesis for the origin of the turquoise artifacts recovered in the West Indies could be  
363 the existence of such a mineral source in the Greater Antilles. The jadeite example recently  
364 proved the possibility of discovering unknown sources of archaeologically valuable minerals

365 in this region (Cárdenas-Párraga et al., 2010; García-Casco et al., 2009; Harlow et al., 2006;  
366 Rodriguez Ramos, 2011; Schertl et al., 2012). Recent works based on isotope  
367 measurements to discriminate geological sources (Hull et al., 2014; Othmane et al., 2015;  
368 Thibodeau et al., 2015) in North America may in the future be applied to West Indian  
369 archaeological turquoise to trace their origin.

370 Since most materials are coming from outside Guadeloupe and even outside Lesser  
371 Antilles, this raises the question of a single origin or multiple origins, even quite distant, for  
372 these products. Amethyst of the size and color of the bead GD-01-003 or even the quite  
373 large amount of large beads made of this gem points towards a Brazilian origin. Other  
374 minerals could also come from this region. Several minerals are products of low grade  
375 metamorphism, such as antigorite, sudoite, paragonite and chlorite. This type of  
376 metamorphism is found in the Greater Antilles as a product of the subduction activity in the  
377 region, but a detailed regional inventory of the availability of these lithic resources for  
378 prehistoric man is still to be carried out to propose provenances. Since most of the gems  
379 have their origin outside Guadeloupe and we can assume that their origin is not unique, the  
380 assumption of a large diffusion system involving South America and the Antilles is the most  
381 logical for us.

## 382 *5.2 Typo-technologies, manufacturing and regional connections*

383 Comparisons can also be made with other sites in the Lesser Antilles regarding the  
384 shapes of Gare Maritime's beads and pendants. Indeed, cylindrical, discoid, barrel-shaped  
385 and spherical beads are known from most of the archaeological sites previously listed. At  
386 Gare Maritime the diversity of shapes is the greatest for the quartz and amethyst artifacts  
387 with the complete range of shapes found in the Lesser Antilles, despite the very high  
388 hardness of these materials. Some cylindrical or barrel beads (GD-01-003, GD-01-005, GD-  
389 01-006 and GD-01-015) made of amethyst are nearly identical to those found in the burials  
390 of Morel in Guadeloupe (Durand and Petitjean Roget, 1991), and Vivé in Martinique  
391 (Mattioni, 1979); or in other contexts like in the Guadeloupean sites of: 24 rue Schoelcher  
392 (Etrich, 2003a), Allée Dumanoir (Etrich, 2003b, 2002), Anse Ste Marguerite (unpublished);  
393 the West Indian sites of: Pearls (Cody, 1991), Elliot (Murphy et al., 2000) and other parts of  
394 the Morel site (Delpuech, 1995; Hambourg, 1999) or the continental site of Midden  
395 Ramdutt's field in Guyana (Roth, 1944).

396  
397 Regarding the manufacturing, it is difficult to imagine how Amerindian people  
398 managed to drill such long beads of amethyst with their technology, an issue that has been  
399 already raised before. The only answer that one can find is in old texts about the Amazonian

400 bead makers, like Vincent Roth (Roth, 1944) that cannot recall if Wallace or Bates told him  
401 that drilling a bead "took the spare time of three generation", and specify the technique used:  
402 "with nothing harder than the mid-rib of leaf of the ite palm". It is noteworthy that Walter  
403 Edmund Roth, his father, wrote, in 1924, quoting Wallace (1889), that it took two lives and  
404 not three. We thus have probably only one primary source writing about quartz bead makers  
405 in the Amazonian Basin that is Wallace (Wallace, 1889) who wrote: « *I now saw several of the*  
406 *men with their most peculiar and valued ornament a cylindrical, opaque, white stone, looking like*  
407 *marble, but which is really quartz imperfectly crystallized. These stones are from four to eight inches*  
408 *long, and about an inch in diameter. They are ground round, and flat at the ends, a work of great*  
409 *labour, and are each pierced with a hole at one end, through which a string is inserted, to suspend*  
410 *it round the neck. It appears almost incredible that they should make this hole in so hard a substance*  
411 *without any iron instrument for the purpose. What they are said to use is the pointed flexible leaf-*  
412 *shoot of the large wild plantain, triturating with fine sand and a little water; and I have no doubt it is,*  
413 *as it is said to be, a labour of years. Yet it must take a much longer time to pierce that which the*  
414 *Tushaiia wears as the symbol of his authority, for it is generally of the largest size, and is worn*  
415 *transversely across the breast, for which purpose the hole is bored lengthways from one end to the*  
416 *other, an operation which I was informed sometimes occupies two lives.*». Some very rare drills or  
417 fragments of drills, related to hard stone drilling, have been mentioned in a few sites, as it is  
418 the case (but unfortunately without any representation of them) in Pearls as a "drill bit [made  
419 of] hard stone" (Cody, 1991) or in PA-15 with "small trapezoidal chert flakes [that] may be  
420 drill bits" (Gent and de Mille, 2003). Cody (1991) and Crock & Bartone (1998) also note the  
421 presence of partially drilled quartz beads, the latter mentioning that the bottom of the hole  
422 presents a remnant cone, leading them to think that a hollow drill must have been used.  
423 Regarding the Gare Maritime's artifacts that could be related to manufacturing tools (fig. 10),  
424 as previously discussed, they are mainly represented by polishers and the flint drills  
425 identified cannot be at the origin of fine and long bead's holes. The lack of precise  
426 information for the drills of Pearls and PA-15 unfortunately prevent us to think they are  
427 different from the ones from Gare Maritime. The documentation of drilling technologies will  
428 need further studies, regarding for example use wear studies of artifacts and putative tools,  
429 or complementary investigation based on experimental archaeology.

430 The plano-convex bead made in turquoise (GD-01-034) is only similar (typology and  
431 raw material), to our knowledge, to the *adornos plano-convexo* found in Sorcé (Narganes  
432 Storde, 1995) among a thousand beads and pendants recovered during its excavation. In  
433 this site, this specific type of artifacts always exhibits a greenish color even if they are made  
434 of diverse materials. They are there interpreted as eyes of disappeared wooden or cotton  
435 sculptures. It could also be similar in shape to the turquoise bead of Royall's site (Murphy et

436 al. 2010 fig. 10).

437 All the pendants found in Gare Maritime are frog-shaped pendants of small size (the  
438 so called "segmented frog" (Cody, 1993)), all made in green colored material. For two of  
439 them (GD-01-017 and GD-01-018), as for the amethyst beads, the shape is very close to a  
440 frog pendant found in another vicinity site (Cathédrale de Basse-Terre (Bonnissent and  
441 Romon, 2004)) and the mineralogy is identical (Queffelec et al. unpublished data). But  
442 similar objects have also been found in other islands of the Lesser Antilles, Greater Antilles  
443 and even Costa Rica (Cody, 1993; Rodriguez Ramos, 2010).

444 Beyond the variety of shapes and materials excavated from the Gare Maritime site that  
445 fits perfectly in the diversity of the lapidary sites or adornments-rich sites of the Lesser  
446 Antilles, the Gare Maritime stone artifacts also enter in the range of the Early Ceramic Age  
447 "shiny personal ornaments" period as Rodriguez-Ramos calls it (Rodriguez Ramos, 2011).  
448 This tradition, connected to a north-south West Indian trade route with materials and ideas  
449 coming from South America, or even, depending on the authors, a Pan-Caribbean network  
450 involving also Mesoamerica, is said to disappear to be replaced by productions on more  
451 local materials (Knippenberg, 2007; Rodriguez Ramos, 2010, 2007). The dating of the Gare  
452 Maritime site (250 – 400 cal. AD), indeed, corresponds to the model of a lapidary crafting  
453 using exotic materials during the first five centuries of our era by adding a new point on the  
454 map and on the timeline. Indeed, Gare Maritime presents a large diversity of materials  
455 coming from outside the Guadeloupe Island (jasper, diorite, serpentine and sudoite) and  
456 even some other from outside the Lesser Antilles (amethyst, nephrite, turquoise) with  
457 perhaps for the latter a South American origin.

458

Island	Contexte	Amethyst			Rock crystal			Cornelian			Chalcedony			Serpentine			Nephrite			Calcite			Turquoise			Diorite			Other
		R/C	B	F	R/C	B	F	R/C	B	F	R/C	B	F	R/C	B	F	R/C	B	F	R/C	B	F	R/C	B	F	R/C	B	F	
Puerto Rico	Excavations			X	X		X			X			X		X		X		X			X		X		X		aventurine, marble, malachite	
Vieques	Excavations			X	X		X			X			X		X		X		X			X		X		X		aventurine, marble, malachite	
St. Thomas	Excavation (midden)			X			X								greenstone		greenstone				X							green chert	
Antigua	Excavations + surface				X	X	X	X	X	X	X	X			X				X	X	X			X			X	jasper, limestone, tuff, barite	
Antigua	Excavations + surface	X			X		X	X		X	X				X			X	X	X						X	limestone, tuff, barite		
Antigua	Excavations					X	X							X	X		X	X		X	X				X	X			
Montserrat	Excavations + surface			X	X		X	X	X						greenstone		greenstone										X	feldspar	
Guadeloupe	Excavation (midden)	X	X	X			X						X	X	X			X		X	X		X	X		X	jasper, aventurine, feldspar, chlorite, sudoite, paragonite		
Martinique	Excavation (burial)			X				X							greenstone		greenstone												
Grenada	Excavations	X	X	X	X	X	X					X	X											X					
Tobago	Excavations																								X	X	X		

459 Table 2. Presence / absence of the most common minerals found in the lapidary sites identified in the Lesser Antilles or the bead-rich sites of the region. R/C: Raw  
460 material / reduction Chip; B: bead or pendant Blank; F: Finished bead or pendant. Sites are listed from north to south (see fig. 1).

461

## 462 **CONCLUSION**

463 The site of Gare Maritime (250 – 400 cal. AD) yielded a collection of 50 lapidary artifacts  
464 ranging from the raw material to the finished object. Beyond illustrating the development of  
465 the lapidary art in the Caribbean basin, the presence of a wide variety of exogenous raw  
466 materials testifies to long-distance diffusions networks. Such a collection, recently  
467 excavated, for this specific prehistoric period in Guadeloupe offers primary documentation  
468 for studying the entire *chaîne opératoire* of these valuable goods.

469 Raman spectroscopy was mandatory in non-invasively identifying the precise  
470 mineralogical composition of all these objects, especially the 33 so-called *greenstones*. For  
471 this color class, eight different kinds of rocks or minerals have been identified, which are:  
472 aventurine, chlorite, feldspar, nephrite, paragonite, serpentine, sudoite and turquoise.  
473 Beyond that, five other kinds of rocks or minerals (amethyst, calcite, jasper, rock crystal and  
474 diorite) were identified in the collection.

475 Due to the lack of accurate and reliable geological resource documentation about the  
476 lithic resources in the West Indies, for the moment it is not possible to attribute a precise  
477 geographical provenance for the identified raw materials. Moreover for some of the mineral  
478 identified, as amethyst, nephrite and turquoise, a more distant source on the continent  
479 (Mesoamerica or South-America) must be investigated. At this stage, the results obtained  
480 contribute to define the distribution areas of raw materials and specific typologies that  
481 already contribute to the debate of cultural diffusions.

482 The *chaînes opératoires* for the different materials have been approached, despite  
483 some raw materials poorly represented in the studied collection. Some materials are  
484 processed on site (amethyst, aventurine, jasper, feldspar, calcite, serpentine and turquoise),  
485 while others (chlorite, diorite, nephrite, paragonite, rock crystal and sudoite) seems to be  
486 brought on site already finished. Pendants are made only of green materials, while very hard  
487 material such as rock crystal and amethyst are used only for bead production.

488 Style and material analysis allow to confirm the extension of a homogeneous production  
489 with some objects found very similar to nearby and remote archaeological sites. The main  
490 minerals, also, are represented in most of the studied sites in the area. The geographical  
491 and chronological position of the Gare Maritime site fit the model of a lapidary production of  
492 beads and pendants in exotic minerals during the end of the Saladoid period.

493 Further accumulation of data and the methodology implemented in this work applied to  
494 future archaeological collections will provide an advanced description of the *chaîne*  
495 *opératoire* for these prestigious artifacts.

496 **ACKNOWLEDGMENTS**

497 We are grateful to Thomas Romon (INRAP, UMR5199 PACEA) who directed the  
498 excavation of the Gare Maritime archaeological site, and to Eddy Foy (NIMBE, LAPA-  
499 IRAMAT) for his help during the mineralogical validation via X Ray Diffraction analysis of  
500 some artifacts. This study was conducted in the frame of the Programme Collectif de  
501 Recherche “Parures amérindiennes en matériaux lithiques dans les Antilles Françaises :  
502 minéralogie, sources géologiques et fabrication” funded by the Regional Service of  
503 Archaeology of Guadeloupe and the Guadeloupe Regional Council. This research was also  
504 partially supported by the LabEx LaScArBx research program (ANR-10-LABX-52).

505

506 **BIBLIOGRAPHY**

- 507 Beck, H.C., 1928. Classification and Nomenclature of Beads and Pendants.  
508 <https://doi.org/10.1017/S0261340900013345>
- 509 Berard, B., 2013. The Saladoid, in: *The Oxford Handbook of Caribbean Archaeology*. W.  
510 Keegan, C. Hofman & R. Rodriguez Ramos, pp. 184–197.
- 511 Bonnissent, D., 2010. Archéologie précolombienne de l’île de Saint-Martin, Petites Antilles.  
512 Des campements des nomades des mers aux villages des agriculteurs-potiers  
513 (3300 BC-1600AD). Editions Universitaires Europeennes.
- 514 Bonnissent, D., Romon, T., 2004. Fouilles de la Cathédrale de Basse-Terre (Rapport Final  
515 d’Opération No. SRA 2002-13). INRAP Guadeloupe, Basse-Terre Guadeloupe.
- 516 Boomert, A., 1999. Saladoid sociopolitical organization, in: *Proceedings of the 18th*  
517 *International Congress for Caribbean Archaeology*. Grenada, pp. 55–77.
- 518 Boomert, A., 1987. Gifts of the Amazons: Green stone pendants and beads as items of  
519 ceremonial exchange in Amazonia and the Caribbean. *Antropologica* 33–54.
- 520 Bullen, R.P., Bullen, A.K., 1972. Archaeological investigations on St. Vincent and the  
521 Grenadines, West Indies, American studies (Springfield, Vt.). Bryant Foundation,  
522 Orlando. Fla.
- 523 Cárdenas-Párraga, J., García-Casco, A., Nunez-Cambra, K., Rodríguez-Vega, A., Blanco-  
524 Quintero, I.F., Harlow, G.E., Lázaro, C., 2010. Jadeitite jade occurrence from the  
525 Sierra del Convento mélange (eastern Cuba). *Bol Soc Geol Mex* 62, 199–205.
- 526 Carter, B., Helmer, M., 2015. Elite Dress and Regional Identity: Chimú-Inka Perforated  
527 Ornaments from Samanco, Nepeña Valley, Coastal Peru. *BEADS J. Soc. Bead*  
528 *Res.* 27, 46–74.
- 529 Cody, A., 1993. Distribution of exotic stone artifacts through the Lesser Antilles : their  
530 implications for prehistoric interaction and exchange, in: *Proceedings of the 14th*  
531 *International Congress for Caribbean Archaeology*. A. Cummins and P. King,  
532 Barbados, pp. 204–226.
- 533 Cody, A., 1991. From the site of Pearls, Grenada : exotic lithics and radiocarbon dates, in:  
534 *Proceedings of the 13th International Congress for Caribbean Archaeology*. E.N.  
535 Ayubi and J.B. Haviser, Curaçao, pp. 589–604.
- 536 Crock, J.G., Bartone, R.N., 1998. Archaeology of Trants, Montserrat. Part 4. Flaked stone  
537 and stone bead industries. *Ann. Carnegie Mus. PITTSBURGH* 67, 197–224.
- 538 Delpuech, A., 1995. Le Moule. Morel, in: *Bilan Scientifique Régional de Guadeloupe*.  
539 DRAC Guadeloupe, Basse-Terre, Guadeloupe.
- 540 Durand, J.-F., Petitjean Roget, H., 1991. A propos d’un collier funéraire à Morel,

- 541 Guadeloupe : les Huecoïdes sont-ils un mythe ?, in: Proceedings of the 12th  
542 congress of the IACA. Martinique, pp. 53–72.
- 543 Epstein, D.S., 1988. Amethyst mining in Brazil. *Gems Gemol.* 24, 214–228.
- 544 Etrich, C., 2003a. 24, rue Schoelcher (rapport de diagnostic archéologique No. 2003-27–  
545 0004). DRAC Guadeloupe, Basse-Terre Guadeloupe.
- 546 Etrich, C., 2003b. Le site de l'Allée Dumanoir (rapport de fouille archéologique No. 2003-  
547 27– 0004). DRAC Guadeloupe, Basse-Terre Guadeloupe.
- 548 Etrich, C., 2002. Capsterre-Belle-Eau. Allée Dumanoir, in: Bilan Scientifique Régional de  
549 Guadeloupe. DRAC Guadeloupe, Basse-Terre, Guadeloupe, pp. 24–28.
- 550 Evans, O.H., 1913. A Note on the Occurrence of Turquoise in Northern Chile. *Man* 13,  
551 158–159.
- 552 Evans, O.H., Southward, J., 1914. A Further Note on the Occurrence of Turquoise at Indio  
553 Muerto, Northern Chile. *Man* 14, 37–39.
- 554 Fewkes, J.W., 1903. Precolumbian West Indian Amulets. *Am. Anthropol.* 5, 679–691.
- 555 García-Casco, A., Vega, A.R., Párraga, J.C., Iturralde-Vinent, M.A., Lázaro, C., Quintero,  
556 I.B., Agramonte, Y.R., Kröner, A., Cambra, K.N., Millán, G., Torres-Roldán, R.L.,  
557 Carrasquilla, S., 2009. A new jadeite jade locality (Sierra del Convento, Cuba): first  
558 report and some petrological and archeological implications. *Contrib. Mineral.*  
559 *Petrol.* 158, 1–16. <https://doi.org/10.1007/s00410-008-0367-0>
- 560 Gent, B., de Mille, C.N., 2003. Preliminary Investigations At PA-15, A Saladoid Site On  
561 Antigua, in: Proceedings of the 20th International Congress for Caribbean  
562 Archaeology. C. Tavares Maria and M. A. Garcia Arevalo, Santo Domingo,  
563 Republica Dominicana, pp. 181–188.
- 564 Groppo, C., Rinaudo, C., Cairo, S., Gastaldi, D., Compagnoni, R., 2006. Micro-Raman  
565 spectroscopy for a quick and reliable identification of serpentine minerals from  
566 ultramafics. *Eur. J. Mineral.* 18, 319–329.
- 567 Hambourg, T., 1999. Le Moule. Morel, in: Bilan Scientifique Régional de Guadeloupe.  
568 Basse-Terre, Guadeloupe, pp. 26–28.
- 569 Hamy, E.-T., 1884. Un anthropolithe de la Guadeloupe. *Rev. Ethnogr.* 516–520.
- 570 Harbottle, G., Weigand, P.C., 1992. Turquoise in pre-columbian America. *Sci. Am.* 266,  
571 78–85.
- 572 Hardy, M., 2010. It's a Small World? Settlement and Interaction on St. Croix, Virgin  
573 Islands, in: The Canvas of Space : Method and Theory of Spatial Investigations in  
574 the 21st Century. Presented at the Annual meeting of Society for American  
575 Archaeology, St Louis.
- 576 Harlow, G.E., Murphy, A.R., Hozjan, D.J., de Mille, C.N., Levinson, A.A., 2006. Pre-  
577 Columbian jadeite axes from Antigua, West Indies: Description and possible  
578 sources. *Can. Mineral.* 44, 305–321.
- 579 Harris, P., 1980. Excavation report : Lovers Retreat, period IV, Tobago, in: Proceedings of  
580 the 8th International Congress for the Study of the Pre-Columbian Cultures of the  
581 Lesser Antilles. Suzanne M. Lewenstein, Arizona State University, pp. 524–552.
- 582 Haviser, J.B., 1991. Preliminary results from test excavations at the Hope Estate site (SM-  
583 026), St. Martin, in: Proceedings of the 13th International Congress for Caribbean  
584 Archaeology. E.N. Ayubi & J.B. Haviser, Curaçao, pp. 647–666.
- 585 Henocq, C., Bonnissent, D., Boulfroy, V., Chauvières, F.-X., Lenoble, A., Stouvenot, C.,  
586 Richier, A., Weydert, N., 1995. Hope Estate - Saint-Martin. Rapport de fouilles  
587 programmées 1995 (No. SRA 44). AAHE (Association Archéologique Hope Estate),  
588 SRA DRAC Guadeloupe.
- 589 Hofman, C.L., Bright, A.J., Boomert, A., Knippenberg, S., 2007. Island Rhythms: The Web  
590 of Social Relationships and Interaction Networks in the Lesser Antillean Archipelago  
591 between 400 B.C. and A.D. 1492. *Lat. Am. Antiq.* 18, 243.  
592 <https://doi.org/10.2307/25478180>

- 593 Hull, S., Fayek, M., Mathien, F.J., Roberts, H., 2014. Turquoise Trade of the Ancestral  
594 Puebloan: Chaco and Beyond. *J. Archaeol. Sci.*  
595 <https://doi.org/10.1016/j.jas.2014.02.016>
- 596 Knippenberg, S., 2007. Stone artefact production and exchange among the Lesser  
597 Antilles. Amsterdam University Press.
- 598 Lafuente, B., Downs, R.T., Yang, H., Stone, N., 2015. The power of databases: the  
599 RRUFF project, in: *Highlights in Mineralogical Crystallography*. T. Armbruster & R.  
600 M. Danisi, Berlin, pp. 1–30.
- 601 López, G.E.J., Coloca, F.I., Rosenbusch, M., Solá, P., 2018. Mining, macro-regional  
602 interaction and ritual practices in the South-central Andes: The first evidence for  
603 turquoise exploitation from the Late Prehispanic and Inca periods in North-western  
604 Argentina (Cueva Inca Viejo, Puna de Salta). *J. Archaeol. Sci. Rep.* 17, 81–92.  
605 <https://doi.org/10.1016/j.jasrep.2017.09.036>
- 606 Mattioni, M.D., 1979. *Salvage Excavations at the Vivé Site, Martinique: Final Report*.  
607 Department of Anthropology, University of Manitoba.
- 608 Meirelles, A.C.R., Costa, M.L. da, 2012. Mineralogy and chemistry of the green stone  
609 artifacts (muiraquitãs) of the museums of the Brazilian State of Pará. *Rem Rev.*  
610 *Esc. Minas* 65, 59–64.
- 611 Mones, M., 2007. Amerindian lithics of Tobago: a preliminary report, in: *Proceedings of the*  
612 *21st International Congress for Caribbean Archaeology*. B. A. Reid, Trinidad et  
613 Tobago, pp. 757–766.
- 614 Murphy, A.R., Hozjan, D.J., de Mille, C.N., Levinson, A.A., 2000. Pre-Columbian gems and  
615 ornamental materials from Antigua, West Indies. *Gems Gemol.* 36, 234–245.
- 616 Narganes Storde, Y.M., 1995. La lapidaria de Sorce, Vieques y Tecla, Guayanilla, Puerto  
617 Rico, in: *Proceedings of the 16th International Congress for Caribbean*  
618 *Archaeology*. Richard, Basse-Terre, pp. 17–26.
- 619 Nickel, E.H., Nichols, M.C., 2009. *The New IMA List of Minerals – A Work in Progress –*  
620 *Updated: September 2015*. IMA.
- 621 Nieweg, D.C., Dorst, M.C., 2001. The Manzanilla 1 (SAN-1) site, Trinidad, in: *Proceedings*  
622 *of the 19th International Congress for Caribbean Archaeology*. Alofs & Dijkhoff,  
623 Aruba, pp. 173–185.
- 624 O'Donoghue, M., 2006. *Gems*, 6th edition. ed. Oxford; Burlington, MA.
- 625 Othmane, G., Hull, S., Fayek, M., Rouxel, O., Lahd Geagea, M., Kyser, T.K., 2015.  
626 Hydrogen and copper isotope analysis of turquoise by SIMS: calibration and matrix  
627 effects. *Chem. Geol.* 395, 41–49. <https://doi.org/10.1016/j.chemgeo.2014.11.024>
- 628 Petriglieri, J.R., Salvioli-Mariani, E., Mantovani, L., Tribaudino, M., Lottici, P.P., Laporte-  
629 Magoni, C., Bersani, D., 2015. Micro-Raman mapping of the polymorphs of  
630 serpentine. *J. Raman Spectrosc.* 46, 953–958. <https://doi.org/10.1002/jrs.4695>
- 631 Pinchon, R., 1967. *Quelques aspects de la nature aux Antilles*. Ozanne, Fort-de-France.
- 632 Reynard, B., Bezacier, L., Caracas, R., 2015. Serpentine, talc, chlorites, and their high-  
633 pressure phase transitions: a Raman spectroscopic study. *Phys. Chem. Miner.* 42,  
634 641–649. <https://doi.org/10.1007/s00269-015-0750-0>
- 635 Righter, E., 2003. Saladoid Midden And Burial Distributions At The Tutu Site, St. Thomas,  
636 USVI: The Missing Link, in: *Proceedings of the 20th International Congress for*  
637 *Caribbean Archaeology*. C. Tavaréz Maria and M. A. García Arevalo, Santo  
638 Domingo, República Dominicana, pp. 24–30.
- 639 Rinaudo, C., Gastaldi, D., Belluso, E., 2003. Characterization of chrysotile, antigorite and  
640 lizardite by FT-Raman spectroscopy. *Can. Mineral.* 41, 883–890.
- 641 Rodríguez, M., 1993. Early trade networks in the Caribbean, in: *Proceedings of the 14th*  
642 *International Congress for Caribbean Archaeology*. A. Cummins and P. King,  
643 Barbados, pp. 306–314.
- 644 Rodríguez Ramos, R., 2011. The circulation of jadeitite across the Caribbeanscape, in:

645 Hofman, C., van Duijvenbode, A. (Eds.), *Communities in Contact. Essays in*  
646 *Archaeology, Ethnohistory & Ethnography of the Amerindian Circum-Caribbean.*  
647 *Sidestones Press, Leiden, pp. 117–136.*

648 Rodriguez Ramos, R., 2010. *What is the Caribbean? An archaeological perspective.* J.  
649 *Caribb. Archaeol. Special Publication #3.*

650 Rodriguez Ramos, R., 2007. *Puerto Rican precolonial history etched in stone.* University of  
651 *Florida.*

652 Romon, T., Bertran, P., Fouéré, P., Hildebrand, M., Serrand, N., 2013. *Le site de la gare*  
653 *maritime de Basse-Terre (Guadeloupe), in: Martinique, terre amérindienne: Une*  
654 *approche pluridisciplinaire.* Bérard, Benoît, Leiden.

655 Roobol, M.J., Lee, J.W., 1976. *Petrography and source of some Arawak artifacts from*  
656 *Jamaica, in: Proceedings of the 6th congress of the IACA. Guadeloupe, pp. 304–*  
657 *313.*

658 Roth, V., 1944. *A stone-age bead factory on the Mahaica river.* *Timehri* 26, 42–48.

659 Rouse, I., 1992. *The Tainos : rise and decline of the people who greeted Columbus.* Yale  
660 *University Press, New Haven; London.*

661 Rouse, I., Cruxent, J.M., 1963. *Venezuelan archaeology.* New Haven: Yale University  
662 *Press.*

663 Schertl, H.-P., Maresch, W.V., Stanek, K.P., Hertwig, A., Krebs, M., Baese, R., Sergeev,  
664 *S.S., 2012. New occurrences of jadeitite, jadeite quartzite and jadeite-lawsonite*  
665 *quartzite in the Dominican Republic, Hispaniola: petrological and geochronological*  
666 *overview.* *Eur. J. Mineral.* 24, 199–216. [https://doi.org/10.1127/0935-](https://doi.org/10.1127/0935-1221/2012/0024-2201)  
667 [1221/2012/0024-2201](https://doi.org/10.1127/0935-1221/2012/0024-2201)

668 Snoke, A.W., 2001. *Petrologic and Structural History of Tobago, West Indies: A Fragment*  
669 *of the Accreted Mesozoic Oceanic Arc of the Southern Caribbean.* Geological  
670 *Society of America.*

671 Thibodeau, A.M., Killick, D.J., Hedquist, S.L., Chesley, J.T., Ruiz, J., 2015. *Isotopic*  
672 *evidence for the provenance of turquoise in the southwestern United States.* *Geol.*  
673 *Soc. Am. Bull.* 127, 1617–1631.

674 Wallace, A.R., 1889. *A narrative of travels on the Amazon and Rio Negro, with an account*  
675 *of the native tribes, and observations on the climate, geology, and natural hitory of*  
676 *the Amazon valley, 2nd ed.* Ward, Lock & Co, London, New-York and Melbourne.

677 Watters, D.R., 1997. *Maritime trade in the prehistoric eastern Caribbean, in: The*  
678 *Indigenous People of the Caribbean.* Gainesville, pp. 88–99.

679 Watters, D.R., Scaglione, R., 1994. *Beads and pendants from Trants, Montserrat:*  
680 *Implications for the prehistoric lapidary industry of the Caribbean.* Carnegie  
681 *Museum of Natural History.*

682 Westercamp, D., Tazieff, H., 1980. *Martinique, Guadeloupe, Saint-Martin, La Désirade,*  
683 *Guides géologiques régionaux.* Masson, Paris.

684