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Anthropogenic temper *versus* geological and pedological inclusions: grog temper as a possible chrono-cultural marker for the Late Ceramic Age in the pre-Columbian Lesser Antilles

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Abstract – In order to compare pre-Columbian cultural affiliations in the Lesser Antilles, we studied three ceramic series from Guadeloupe (F.W.I.) from well-dated Troumassoid sites between AD 1000 and 1300 (radiometric ages) attributed to the Late Ceramic Age (AD 1000–1500). The significance of the different types of inclusions in these ceramics is discussed through a petrographic study using optical and electron microscopy, that we subsequently compared with the local geological contexts. Two of the studied sites are located in the volcanic part of Guadeloupe (Basse-Terre), while the third one is situated in an area dominated by the sedimentary substratum of Grande-Terre and its silty cover. The petrographic analysis shows either the use of local heterogeneous materials: natural, geological or pedological aplastic inclusions (volcanic sands and cinders, ferruginous soils), and the addition of grog (anthropogenic temper). At each of the three sites studied, the presence of grog was demonstrated for several modal series. Comparison of the compositions of the pastes with the ceramic chrono-typology allow us to explore the proposition presented by Donahue *et al.* (1990), suggesting that the use of grog may infer a difference between Troumassoid and pre-Troumassoid assemblages. We also hypothesize a progressive diffusion of the use of grog temper into the Lesser Antilles, from the Guianas. This idea defies the commonly accepted idea that Troumassoid developed smoothly out of a locally present Saladoid ceramic series without external influence.

Keywords: Thin-section petrography / ceramics / grog temper / troumassoid series / Lesser Antilles

Résumé – Dégraissants anthropiques et inclusions géologiques ou pédologiques dans la céramique : la chamotte, possible marqueur chrono-culturel pour la période Céramique tardive précolombienne des Petites Antilles. Dans le but de comparer les filiations culturelles précolombiennes dans les Petites Antilles, nous avons étudié trois séries de céramiques de Guadeloupe (Antilles françaises), provenant d'occupations troumassoïdes bien datées entre AD 1000 et 1300 (âges radiométriques) ou de l'époque de la céramique tardive (AD 1000–1500). La signification des différents types d'inclusions dans ces céramiques est discutée grâce à leur étude en pétrographie en microscopie optique et électronique, puis mise en regard des contextes géologiques locaux. Deux des sites étudiés sont localisés dans la partie volcanique de l'île de Basse-Terre, tandis que le troisième se trouve dans une zone dominée par le substratum sédimentaire de Grande-Terre et de sa couverture limoneuse. Les caractérisations pétrographiques montrent l'usage de matériaux hétérogènes locaux : inclusions aplastiques naturelles d'origine géologique ou pédologique (sables et cendres volcaniques, sols ferrugineux) ; ou l'ajout de chamottes (dégraissant anthropique). Sur chacun des trois sites étudiés la présence de chamottes est ainsi démontrée pour plusieurs séries modales. La confrontation des compositions des pâtes avec le chrono-typologie céramique permet alors de conforter la proposition présentée par Donahue *et al.* (1990), qui place l'usage de la chamotte comme possible différence entre les assemblages troumassoïdes et pré-troumassoïdes. Nous émettons de plus l'hypothèse d'une diffusion progressive dans les Petites Antilles,

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à partir des Guyanes. Cette idée défie l'idée communément acceptée que les Troumassoïdes s'individualisent progressivement depuis les séries Saladoïdes sans influence externe.

Mots clés : Pétrographie / céramiques / dégraissants / chamottes / séries troumassoides / Petites Antilles

1 Introduction

The ceramic studies of pre-Columbian series have progressively developed for various areas of the Antilles, allowing a better understanding of the indigenous productions and exchanges in the Caribbean area before the arrival of Europeans (Hofman, 1993; Hofman *et al.*, 2007; Venter *et al.*, 2012). The technical links between the various chrono-cultural entities are always discussed. But ceramic assemblages also seem to be one of the best tools to identify the complex organization and succession of human communities in the Caribbean archipelago (for chrono-cultural nomenclatures see Petersen *et al.*, 2004, here summarized Fig. 1).

Petrographic characterizations of pre-Columbian ceramics in the Caribbean and of the surrounding continental areas are now quite common (see Donahue *et al.*, 1990; Fuess *et al.*, 1991; Conner and Smith, 2003; Catlin *et al.*, 2005; Fitzpatrick *et al.*, 2008; Pavia *et al.*, 2013). When combined with stylistic analysis they allow definition of not only the relative chronology of the various ceramic complexes, but also their movements and links over time and space. Each new study helps to fill the numerous gaps still existing (Ting et al., 2016, 2018).

Geochemical analyses of ceramics provide important results in areas dominated by volcanic geology and demonstrate that material supplies were systematically carried out in the immediate vicinity of the place of residence (Walter, 1991, 1992; Lawrence *et al.*, 2021). Here, we identify variability in temper through petrographic analyses to characterize the materials used in ceramic production and determine the presence or absence of grog temper. We then evaluate whether or not grog can be considered as a probable cultural marker, which may indicate changes between Saladoid and Troumassoid cultures (see Donahue *et al.*, 1990).

Grog is crushed pottery, added to clay matrix as a temper, mainly to limit the shrinkage during firing (Rye, 1981:116–117; Rice, 1987:75). Indeed, because grog is not revealed when using geochemical analyses and frequently confused with ferruginous fragments or pisoliths under stereomicroscopic, optical petrography remains the best method to highlight the presence of this temper (Whitbread, 1986).

Ceramic studies in the French Lesser Antilles, mainly performed with the naked eye, rarely mention the presence of grog temper. Microscopical analysis in this part of the Caribbean generally focuses on the composition of the clay by identifying and quantifying the different mineralogical elements, as done on Martinique for Saladoid ceramics (Gautier, 1974; Belhache *et al.*, 1991; Walter, 1991, 1992) or on Nevis island (Lawrence *et al.*, 2021). On Guadeloupe, grog as a temper in pre-Columbian ceramic series has only been macroscopically attested for few sites such as Capesterre-Belle-Eau, Basse-Terre (Toledo i Mur *et al.*, 2004:32), Toulourous or Marie-Galante (Colas *et al.*, 2002:23–24). Despite this apparent absence for the French West Indies, grog has been identified on southern Lesser Antilles islands such as Grenada (Goodwin, 1979: 309–312), Cariacou (Fitzpatrick *et al.*, 2008: 63), Trinidad (Harris *et al.*, 1972: 6–7; Venter *et al.*, 2012), and Barbados (Drewett and Hill Harris, 1991:182). Concerning the Northern Lesser Antilles, grog has been identified in pre-Columbian ceramic assemblages by Hoffman (1979:38) for the Mill Reef site on Antigua which was confirmed a decade later by Donahue *et al.* (1990) for the islands of Barbuda, Montserrat, Anguilla and Saint Martin. A decade later, under the impulse of James Petersen, grog was identified for Troumassoid ceramics from the Muddy Bay site at Antigua featured grog and sand (Murphy, 1999:234–235) and many post-Saladoid ceramics (N = 294) from Anguilla of which the LCA site of Sandy Hill was the most abundant in grog (Crock, 2000:228–229, Tab. 42). However, another series of analysis by the latter researcher does not mention the presence of grog at Anguilla and Salt River (Crock *et al.*, 2008). Macroscopic analysis on 65 sherds from Golden Rock (Saint Eustasius) also evidenced grog as a temper (Versteeg and Schinkel, 1992, Appendix 1:236). However, these observations have been challenged by Corinne Hofman (1993:195), who proposed that the red particles may not be grog but rather could be pisoliths or small lateritic nodules. In short, this debate can be avoided when microscopical analysis is applied, as recently done by Stienaers *et al.* (2020). Following this method, we initiate the study of three new ceramic assemblages from the Guadeloupe archipelago (Fig. 2).

2 Geological setting

The Guadeloupe archipelago is located in the northern part of the volcanic arc of the Lesser Antilles, where magmatic products are related to the subduction of the North American plate below the Caribbean plate (Bouysse *et al.*, 1990). The Guadeloupe archipelago is rather unique in the Lesser Antilles because the island shows both the recent active volcanic arc (Basse-Terre) and the old extinct arc (Grande-Terre) (Mattinson *et al.*, 1980; Corsini *et al.*, 2011), separated by a narrow strait or Salt River (Figs. 2 and 3). Grande-Terre features a long Pliocene-Pleistocene shallow-water carbonate platform with four sedimentary sequences separated by erosional unconformities linked to tectonic events (Munch *et al.*, 2013). The limestone is mainly coralline or rhodolithic, with various ages according to the sedimentary unit concerned. A large part of the western area of Grande-Terre is covered by clay fill-in and vertisols (Fig. 3). Basse-Terre is part of the active volcanic arc of the Lesser Antilles, with six interlocked volcanic complexes. Its bedrock is entirely volcanic whereas clay-filled and littoral sandy or clayey sediments may be found near the coast (Fig. 3). The Leeward or Capesterre volcanic part of Basse-Terre is part of the Southern Axial Chain with imbricated composite volcanics dating from 1.02–0.435 Ma (Lahitte *et al.*, 2012). More specifically, the local volcanic rocks mainly comprise andesitic lavas and tephras (Dumon *et al.*, 2009).

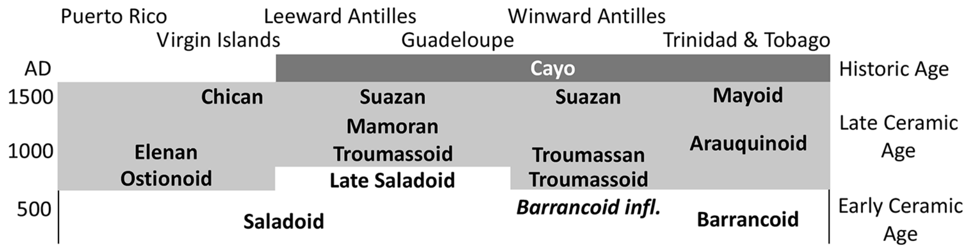

Fig. 1. Succession of human communities in the Caribbean archipelago (adapted from Petersen *et al.*, 2001).

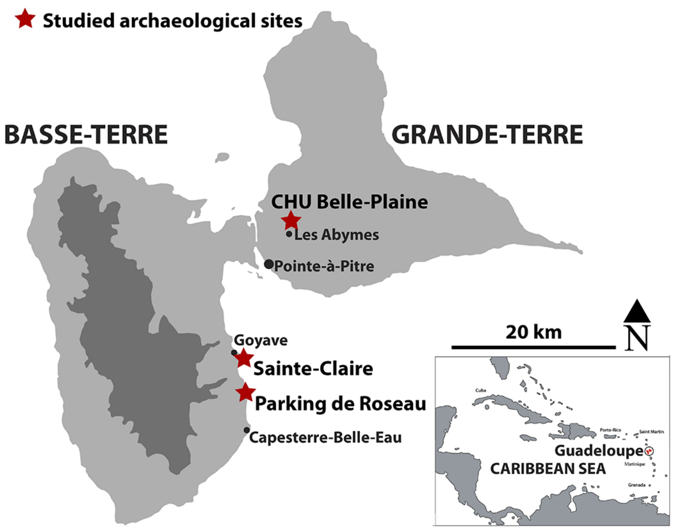

Fig. 2. Location of the studied sites.

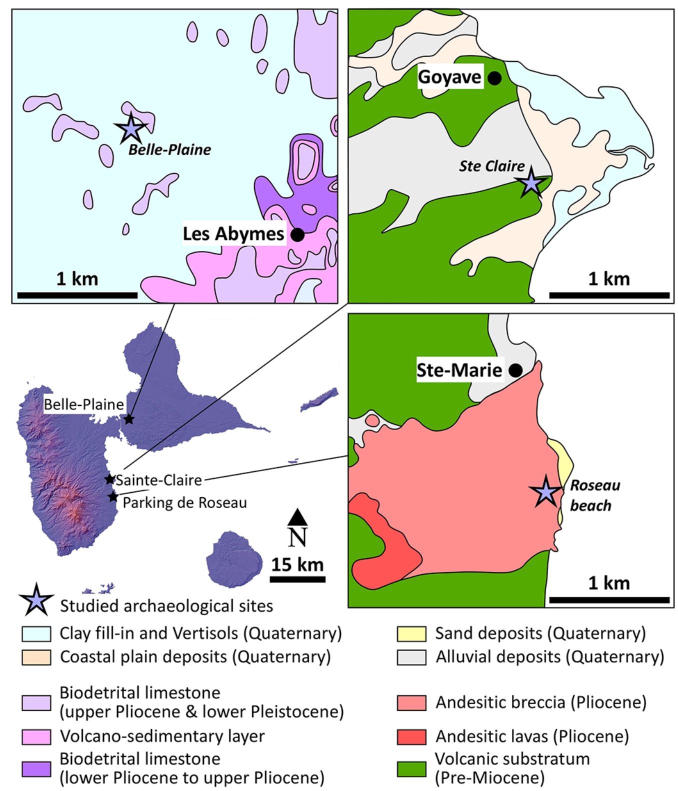

Fig. 3. Geological contexts of the studied sites.

3 Material and methods

3.1 Archaeological ceramic analysis

The focus aimed in this article is the recognition of the temper to highlight the main features of the various ceramic fabrics, a first step before the reconstruction of the stage of *chaîne opératoire* or identification of provenance areas in the Lesser Antilles islands, as described by Ting *et al.* (2016, 2018). For the study of the ceramic assemblages the modal or Rousean method has been applied. The objective of the modal method is to define modal units (morphological, morpho-decorative and decorative units) which reveal the diversity and the most significant morphological and decorative components of the ceramic collection (Balfet *et al.*, 1989:7–23; Rice, 1987:216, Fig. 7.4). This macroscopic approach allows an objective sampling for the microscopic analyses.

The principal elements of this classification of ceramic vessels and tools consist of the ratio between the orifice and the height of the vessels. In this way, we can distinguish five open forms: griddles, platters, bowls, cups, and goblets, as well as three restricted forms: pot, bottle, and restricted bowl. All these forms can be subdivided according to their dimensions. For example, orifice diameters serve when defining very large bowls or jars. Ceramic utensils mainly consist of lids, stoppers, tool sherds, spindle whorls, stools and tablets, statuettes, and other clay items frequently found during excavations. For Anglo-Saxon comparisons, see Anna Shepard's (1956:224–251) classification of vessel shapes which also evokes an aesthetic perception, in addition to taxonomic and functional ones. In general, whenever the vessel's height is unknown the descriptive method proposed by Prudence Rice with regard to vessel classification (Rice, 1987:217–219) is adopted.

The classification of vessel shapes is mainly based on the rim profile, which thus functions as a principal marker of the vessel shape. The vessel's orientation and diameter are determined using rim sherds (Hofman 1993:56). The rims larger than 5 cm, or constituent elements (CE) are isolated and macroscopically described: texture, temper, firing, surface finishing (technology), and decoration modes in order to establish a modal series (MS). Quantification of the ceramic assemblage is proposed not only by counting all fragments (rim, wall, base fragments) per excavation unit, but also

Table 1. General information about the excavated sites.

Site	m^2	Post holes	Pits	Hearths	Burials	Ceramics (kg)	CE
CHU Belle-Plaine	6350	126	34	10	2	38	100
Sainte-Claire	3500	78	28	0	0	38	86
Parking de Roseau	3575	143	32	0	0	69	385
	13 425	*347*	*94*	*10*	*2*	*145*	*571*

CE: number of constitutive elements in the ceramic assemblages.

regarding the presence of decorative elements such as modelling and slipping. Special attention is paid to: (a) the possible bias between the ceramics assemblages found in the archaeological layers or in the pits, (b) the features which may reveal multiple occupations or shifting activity areas, and (c) the spatial distribution of vessels shapes and their fragmentation.

3.2 Archaeometric ceramic petrography

Petrography is one of the best and quickest tools to identify the main components of ceramic temper (Quinn, 2009, 2013; Smith and Herbert, 2010). It provides geological background as well as textural characterization to reveal the presence and the variety of specific tempers such as grog, bones or plant inclusions that are sometimes impossible to identify with other geochemical techniques (Peacock, 1970; Whitbread, 1986).

As a preliminary study aimed to confirm and discuss the content or the lack of volcanic sand in certain ceramic sherds from Guadeloupe, 24 thin sections were prepared from samples collected from three different sites, in order to characterize the main paste observed during the ceramic analysis. The samples were prepared according to the standard procedures, largely described in Quinn (2013), but without slip-covering them, in order to allow further observations in SEM, cathodoluminescence or fluorescence microscopy. The observations were realized with optical polarized light microscopes Olympus BX-61, link to a QICAM Fast 1394 Digital Camera, from QImaging, and image analysis softwares Saisam and Areas from Microvision Instruments. To complete optical microscopy characterizations some observations of polished thins sections were realized with a SEM Tabletop Hitachi 1000, linked to an EDS system.

3.2.1 The Guadeloupean sites

The samples have been selected from systematically excavated contexts on three different sites on Guadeloupe, to wit CHU Belle-Plaine (Les Abymes), Sainte-Claire (Goyave), and Parking de Roseau (Capesterre-Belle-Eau) in 2013, 2014, and 2015 respectively. All excavations were led by one of the authors of the present work (Bel van den *et al.*, 2016, 2017, 2018) (Fig. 1). At all three sites, the topsoil was mechanically removed prior to excavation since this layer was in all cases highly disturbed by intensive ploughing for either bananas or sugar cane production. Below the topsoil, the sterile, yellow/orange colored volcanic subsoil appeared, revealing multiple features such as postholes, large circular pits, hearths, and burial pits. In total 1.3 hectares have been excavated yielding 347 post holes, 94 pits, 10 hearths, 2 burials, and 145 kilograms of ceramic material of which 571 rim, base, and griddle fragments (CE) are described in detail (Tab. 1).

All sites are considered habitation sites, used more or less intensively, as demonstrated by the density of post holes and pits per excavated surface. However, "classic" midden deposits have not been encountered within the excavation perimeter except for one area in the beach zone at Parking de Roseau. The most intriguing features at these sites are the large circular pits, which appear to be spatially organized, suggesting that an ensemble of pits may represent a particular activity area (Bel van den, 2017). CHU Belle-Plaine is considered to be a single component site whereas Sainte-Claire and Parking de Roseau also revealed some traces of earlier occupation and, in the case of Parking de Roseau, also a somewhat later occupation as witnessed by the ceramic studies and 30 radiocarbon dates. Each site provided 10 radiocarbon dates: all charcoal, except for one bone fragment of a mule dated to the Historic Times. The radiocarbon samples and the ceramic studies were performed on material excavated in the pits, proposing a more secure context for the results in contrast to material from midden areas. These datings were carried out within the framework of preventive archaeology at the three different excavations (Bel van den *et al.*, 2016, 2017, 2018).

The main occupation span for the sites ranges between AD 1000–1200 for CHU Belle-Plaine, AD 800–1250 for Sainte-Claire, and AD 1100–1300 for Parking de Roseau (Tab. 2); roughly at the beginning of the second millennium AD or the Late Ceramic Age in the Lesser Antilles. The ceramic studies revealed mainly Troumassoid ceramics without any Modified and/or Late (Cedrosan) Saladoid elements, except for Sainte-Claire, which revealed diagnostic elements for an earlier Late Saladoid occupation as highlighted by one radiocarbon date around AD 450. The Parking de Roseau site features one radiocarbon date around AD 900 (pit F 174) that does not fit the main occupation and earlier Saladoid ceramic elements have not been registered at all. Only CHU Belle-Plaine excavation appears to be solely Troumassoid stylistically, but it may also reveal some Suazan elements, what can also be the case for Parking de Roseau. In addition, the latter site also features a few later Cayo elements as confirmed by the presence of European objects, such as glass beads and Spanish earthenware, encountered primarily at the beach, situated at the foot of the site.

The results of the radiocarbon dating of all the three selected sites fall within a range of approximately 300 years, situated in between AD 1000–1300. This main timeframe is entirely ascribed to the Mamoran Troumassoid series of the LCA in the Lesser Antilles (reference to ceramic chronology

Table 2. Radiocarbon dates per site.

Sainte-Claire				
5	Post hole	835	30	POZ-75039
6.4	Pit	1145	35	POZ-75040
55.2	Pit	905	35	POZ-75041
56.1	Post hole	950	30	POZ-75042
62.1	Pit	825	30	POZ-75043
77	Post hole	1060	30	POZ-75044
112	Pit	1640	35	POZ-75045
174.1	Pit	1170	30	POZ-75046
207	Pit	985	30	POZ-75047
415	Post hole	1070	30	POZ-75049
Parking de Roseau				
156.3	Pit	720	30	POZ-84383
174.4	Pit	1170	30	POZ-84384
178.4	Pit	870	30	POZ-84387
197.6	Pit	805	30	POZ-84388
222.5	Pit	875	30	POZ-84389
337	Pit	735	30	POZ-84390
365	Pit	670	30	POZ-84391
412.4	Pit	805	30	POZ-84392
TR21-403	Pit	840	42	UBA-25514
TR19.2	Layer	254	25	UBA-25187

Archaeological features numbers in bold have been sampled for the petrographic analysis.

you are using) (Fig. 1). In Guadeloupe, being the pivot of the Lesser Antillean arch, these subseries are preceded by Late Saladoid and succeeded by the Suazan Troumassoid sub-series about AD 1300. The end of the latter series is believed to represent Contact-period Colonial Encounter and is replaced and/or merges with the historic Cayoid series which are attributed to the historic Callinago population of the 17th century. Vessel PR-81 (without grog) and PR-16 (with grog) possibly can be attributed to Cayoid series, despite the fact these CE's were found in a different context (burial).

4 Results

4.1 CHU Belle-Plaine (Les Abymes)

The ceramic series of this site is represented by 100 CE's (76 rims, 22 bases, and 6 griddles) and only four complete vessel shapes which can be associated to a small number of decoration modes. The morphological rim series are mainly represented by MS 6 and MS 8, to wit large open, or slightly restricted bowls with lips beveled towards the interior as well as converging rims (sometimes keeled or carinated) towards the interior. Scratchings are sometimes applied to the upper walls of the thinned lips. Large open bowls with inward thickened or folded lips (MS 3) can also be noted, having most often red slip applied to its interior. MS 2 represents the open simple shapes having a mean diameter of 30 cm and a rather thick vessel wall of 8 to 9 mm. The other series are clearly less abundant (MS 1, 4, 5, 7, and 9). Nevertheless, they represent distinct series when considering their morphology such as the concave-shaped rims (MS 4). The bases are either flat or concave-shaped of which the latter are the smallest and thickest suggesting a tronconical vessel shape with a “pointed” base. Griddles are generally small and only one third is footed. Less than 6% of the assemblage is decorated of which 60% is red slipped, 18% is scratched, 12% bears incisions, and 11% features modeling with only three anthropomorphic adornos.

Macroscopic observations show that volcanic sand is the most popular temper (58%) followed by slightly sandy grog (25%), and vegetal matter (13%). Reduction is the most important (55%) mode of firing, followed by oxidized/reducing firings (O/R) (23%), and finally oxidized firing (22%). Four rims from the same circular pit F 186 and 1 base from pit F 200 were chosen for thin-sections (Fig. 3, CHU Belle-Plaine). Although these pits were not sampled for radiocarbon dating, the latter provided a homogenous time-frame for this site spanning only 200 years.

In the case of CHU Belle-Plaine, it has to be noted that the majority of the samples were taken from one pit (F 186) and this may constitute a bias when compared to the other sites. These samples, however, represent different vessel shapes from the same pit and may reflect the repertoire of the potter with one “grog batch” of prepared clay, which was discarded in a same place.

4.2 Sainte-Claire (Goyave)

The ceramic series of this site is represented by 88CE's (54 rims, 15 bases, and 19 griddles) containing only two complete vessel shapes. The morphological rim series are mainly represented by three open series, to wit MS II, MS IV, and,

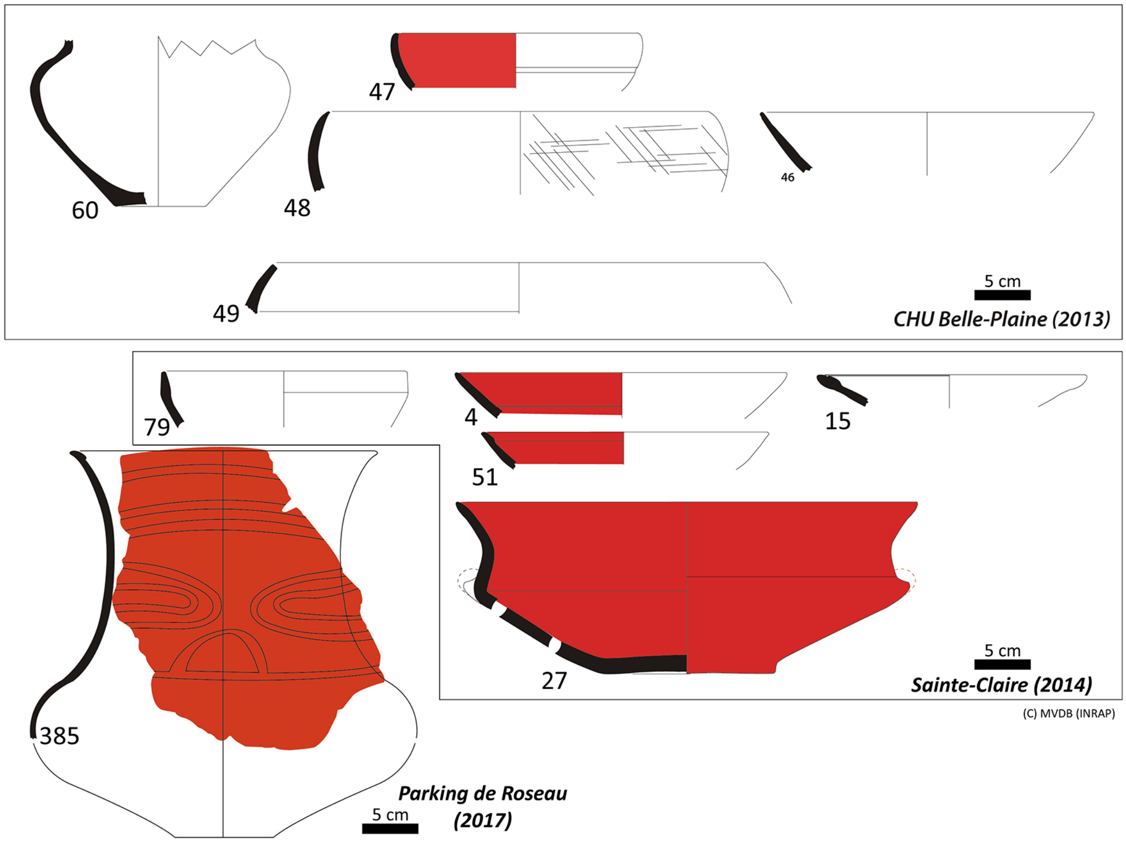

Fig. 4. Drawings of sampled vessels (Les Abymes, Goyave) and, from Parking de Roseau, reconstruction drawing of the Troumassoid vessel PR-385 (Capesterre-Belle-Eau).

to a lesser extend, MS III. The first concerns simple open large bowls. They can be carinated and feature scratching. The second one concern concave rims with unfinished or outward thickened lips (Fr., *ourlées*). This series comes generally with red slip. The last series exhibit convex rim profiles of large and small bowls of which the latter features a thickened lip folded towards the interior and red slip on both the interior and/or outside of the bowl.

The other series are clearly less common (MS I, V, and VI), but generally have large orifices (more than 40 cm) and bear some scratching. The bases are flat and, to a lesser extent, concave-shaped whereas the griddles are also flat with a triangular-shaped rim. Only two footed griddles have been recorded as well as one pot-stand (MS VII). Over 15% of the assemblage is decorated of which 87% features red slip, 8% incisions, 8% scratching, and finally some with modeling including numerous ribbon-handles (N = 11).

Macroscopic observations show that volcanic sand is the most popular temper (61%), followed by grog (37%). Firing is dominated by O/R (45%) and reduction (37%) environments, followed by oxidized firing (17%). It appears that reductive firing is associated to a grog temper. For thin-section analysis, three sherds were taken from large circular pits, except for F 5 which originated in a former post hole re-utilized as a waste pit. Circular pit F 62 was pierced by a large post hole which is part of a circular house plan. Pit F 55 (fill 2), pit F 62.1, and waste pit F 5 (fill 1) were dated between AD 1100 and 1250, suggesting a rather short timespan for the structure of about 150 years.

4.3 Parking de Roseau (Capesterre Belle-Eau)

The ceramic series of this site is represented by 385 CE's (268 rims, 101 bases, and 40 griddles) including 24 complete vessel shapes which can be associated to a small number of decoration modes. The rim series are dominated by unrestricted open vessels (MS 1-5) with rectilinear or convex rims having generally unmodified but also some thickened lips of which MS 1-3 also features carination and smooth inflection. These well-represented series also include MS 7 having concave rims. Among these vessels red slip, linear incisions, and some scratching can be observed. The majority have orifices c. 30 cm but 20 and 40 cm are also common suggesting 3 dominant vessel types for these series.

Closed vessel shapes are clearly less abundant (15%) and are represented by rectilinear (MS 8), convex (MS 9), and concave (MS 10) rims. All series feature some red slip and scratching, but MS 10 stands out having red slip and large incisions in combination with inward folded lips (Fig. 3, Parking de Roseau; Fig. 4). The other series are less common (MS 6 and MS 11-13) of which MS 11 represent finger pots and MS 12 trays (Fig. 5).

The majority of the bases are flat accompanied by only a few concave specimens among including a few highly concave

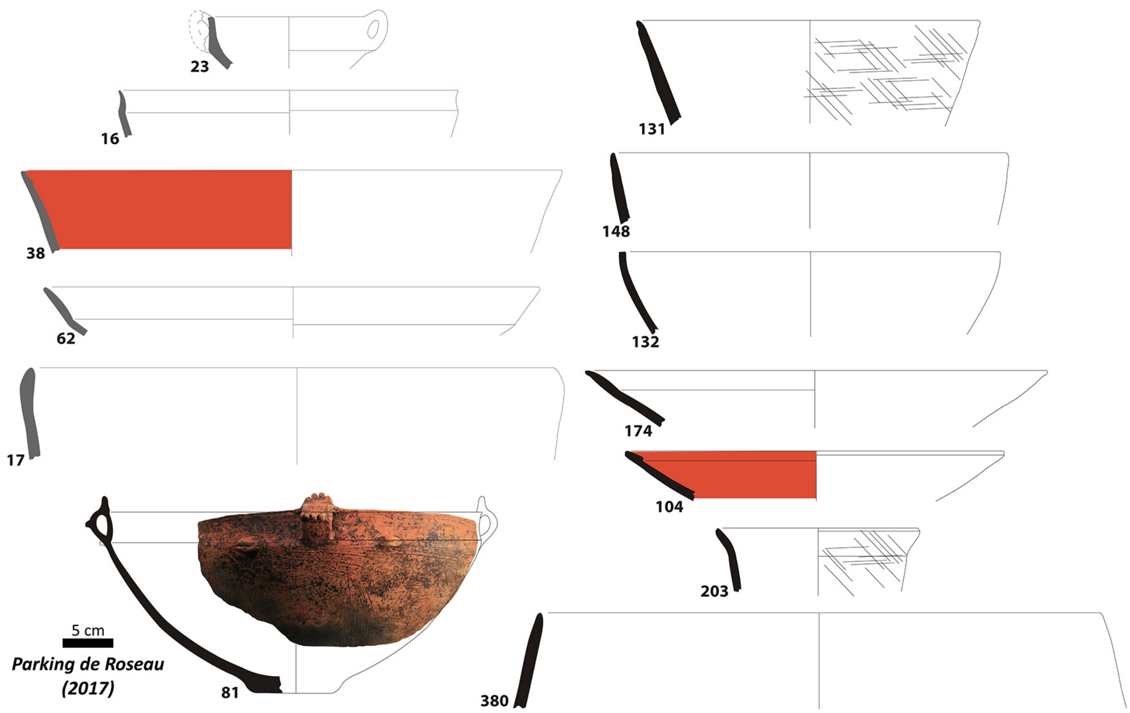

Fig. 5. Drawings of sampled vessels taken from Parking de Roseau (Capesterre-Belle-Eau). Note: light grey sections have been found in the beach zone, whereas black ones upon the higher plateau

ones, or concave-shaped of which the latter are the smallest and thickest suggesting a tronconical vessel shape with a "pointed" base. Griddles are generally small and only one third is footed. Only 5.6% of the assemblage is decorated of which 60% is red slipped, 18% is scratched, 12% bear incisions, and 11% features modeling including three anthropomorphic adornos.

Macroscopic observations show that grog is the most common (53%) temper followed by sand (44%). Reduction is the most common (63%) mode of firing, followed by oxidized (20%), and O/R firing (17%). All thin-section samples are from rims recovered from either the beach layers (N = 6) or the pits (N = 8). Four pits were dated: F 156 (fill 3), F 178 (fill 4), F 365, and F 412 (fill 4), suggesting the samples came from an occupation of roughly one century dated between AD 1175 and 1275 for the plateau (Fr., *morne*).

5 Petrographical analyses: natural *versus* anthropogenic tempers

To interpret the various aplastic inclusions observed in the studied thin sections, we characterized the components of the selected pastes from the three studies sites by shape and mineralogy using SEM (Fig. 6) and optical microscopy (Figs. 7–10). We also compare these results with some thin sections of samples from other archaeological excavations (*e.g.*, sherds with grog from Cayenne and sherds without any grog from Saint Martin) and other petrographic studies. Due to the slight differences between the clay pastes and the grog tempers observed under SEM imaging (Figs. 6A and 6D), we use optical microscopy and limit the use of SEM to the identification of volcanic mineral inclusions (Figs. 6B and 6C).

In a second step, we try to define if these inclusions were "natural" or "anthropogenic" (temper). For some elements, where identification is not definitive, we add a third group, called "uncertain" (Tab. 3). In addition, we separate inclusions according to the various source-types observed: from the bedrock, from regolith and soils or from inclusions corresponding to plant residues.

-Inclusions from bedrock and regolith (Figs. 7 and 8): in all observed sherds, the pristine lithoclasts correspond to local bedrock as described by local geological maps and *in-situ* observations. Differentiation between bedrock fragments and weathered rock fragments coming from the regolith is sometimes difficult, especially when the lithoclasts are infrequent to very scarce. We choose to class as bedrock fragments the abundant unsorted fragments of pristine rock and to determine as regolith provenance the weathered lithoclasts and sorted sands (here mainly sands from volcanic contexts).

-Clays, ferruginous elements and grog temper (Figs. 8 and 9): the main key features used to recognize grog tempers from argillaceous concretions (clay lumps sometimes also called clay pellets) or ferruginous pisoliths are equivalent to those described by Whitbread (1986), Quinn (2009, 2013) or Smith and Herbert (2010) and take into account various criteria as shape and boundaries, colour, internal constituents, surroundings microcracks. In this study, the grog temper was quite easy to differentiate from clay lump with frequent angular shapes sometimes with a rectilinear face, microcrack bypassing the inclusion, differences of texture between the inclusion and the sherd. Ferruginous elements were also frequent, sometimes with laminated cortex and rounded shapes (ferruginous pisoliths) typical of tropical soils.

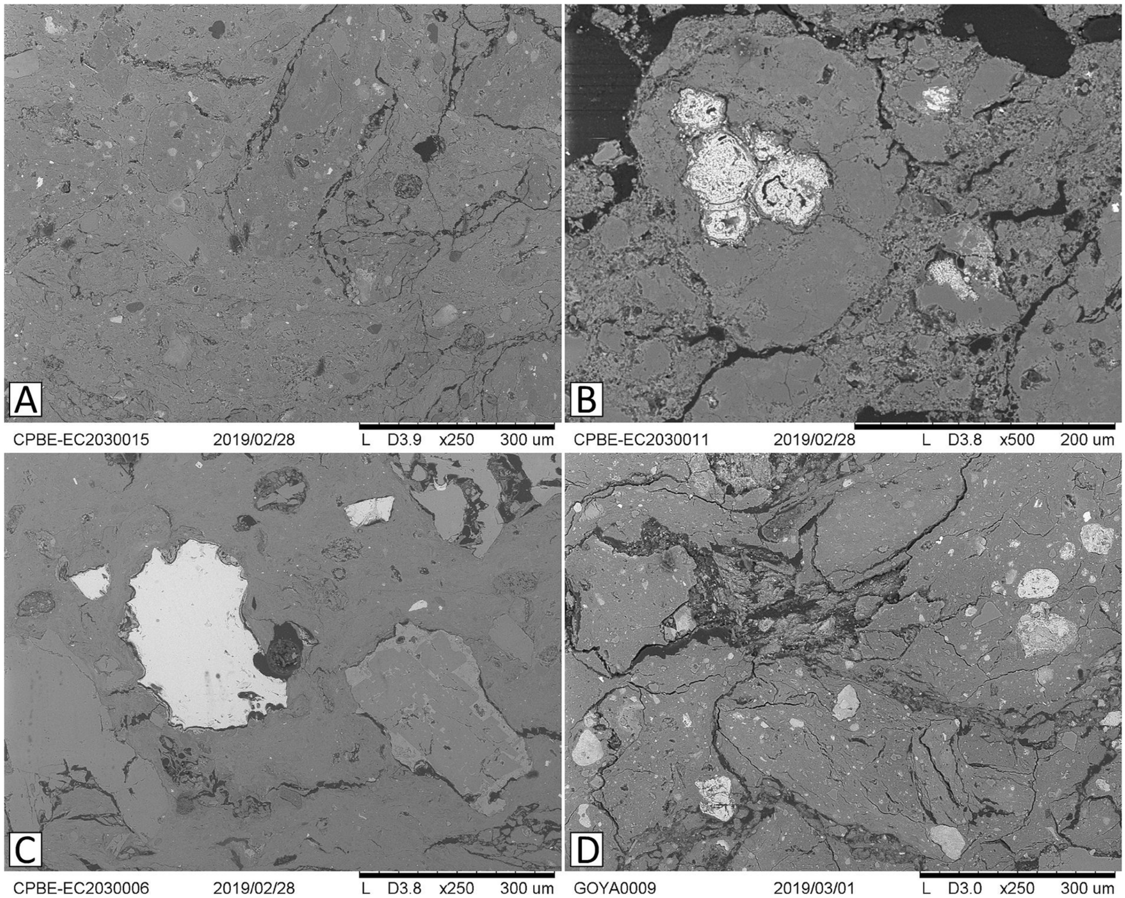

Fig. 6. SEM micrographs: A. Grog temper (Capesterre-Belle-Eau, PR-148). B. Volcanic cinders (Capesterre-Belle-Eau, PR-23). C. Volcanic sand (Capesterre-Belle-Eau, PR-203). D. Grog temper (Goyave, SC-27).

-Plant inclusions: various plant inclusions were observed (Fig. 8): scarce small fibrous or angular fragments, which probably correspond to occasional plant inclusions in the clay or in the soil used to create the pottery. Only a few sherds from French Guyana show numerous small plants inclusion, and these occur inside grog tempers. In these cases, the plant residues were interpreted as *caraipé*, plant cinder from the kwepi tree (of *Licania* genus), which is an “Amazonian” traditional tempering practice (Costa et al., 2004; Oliveira *et al.*, 2020) (Fig. 10).

6 Petrographic grouping

In total, 24 sherds from the Guadeloupe archipelago have been chosen for thin sectioning in order to determine by microscope the ingredients of the paste (Tab. 4).

For the *CHU Belle-Plaine* site (BP), the 5 sherds analyzed formed a unique group (BP1) for which grog is the main temper (Tab. 5). One sample however (BP-49) shows more vegetal elements and less grog temper, but the other petrographic features of this sample are very close to the others, leading us to consider that these differences may vary within the same group. Only a larger sample will show that a separation for this group is needed.

The clay matrix is very poor in loam and seems quite pure. The detrital inclusions are very scarce (less than 1%) and limited to two types of elements: very small grains (very fine sand and coarse silt) and middle to coarse grains. These elements are mainly angular quartz grains, but a few amphiboles and volcanic rock fragments are present too, only in very low amounts (1:3 per sample). Grog temper, from 50 μm to 2000 μm, is very abundant (more than 20 elements per sample) and the grog itself has frequently a different composition than the including sherd; having sometimes more small opaque material and/or sometimes more silt. Organic inclusions sometimes show preserved vegetal microstructures (plant remains), but numerous grains are only made of opaque black matter featuring micro-cracks and are hollow in the middle (carbonaceous residues). A few amber to brown-colored elements are probably phosphoric remains; they are mainly observed in the sherds containing less grog and more vegetal inclusions. Some ferruginous elements are present, but without typical pedological morphologies or discriminating features. They probably are pedological mixed clay/iron oxides elements. Interestingly, micro-cracks never showed up in the grog temper, but ran around it, whereas the vegetal and carbonaceous inclusions are frequently cracked. Macro-porosity is quite abundant, represented by shrinkage cracks, but also by small or larger rounded vacuoles; probably the result of totally altered organic elements.

For the *Sainte-Claire* site (SC), 5 sherds were petrographically analyzed. The samples formed two groups: SC1 and SC2

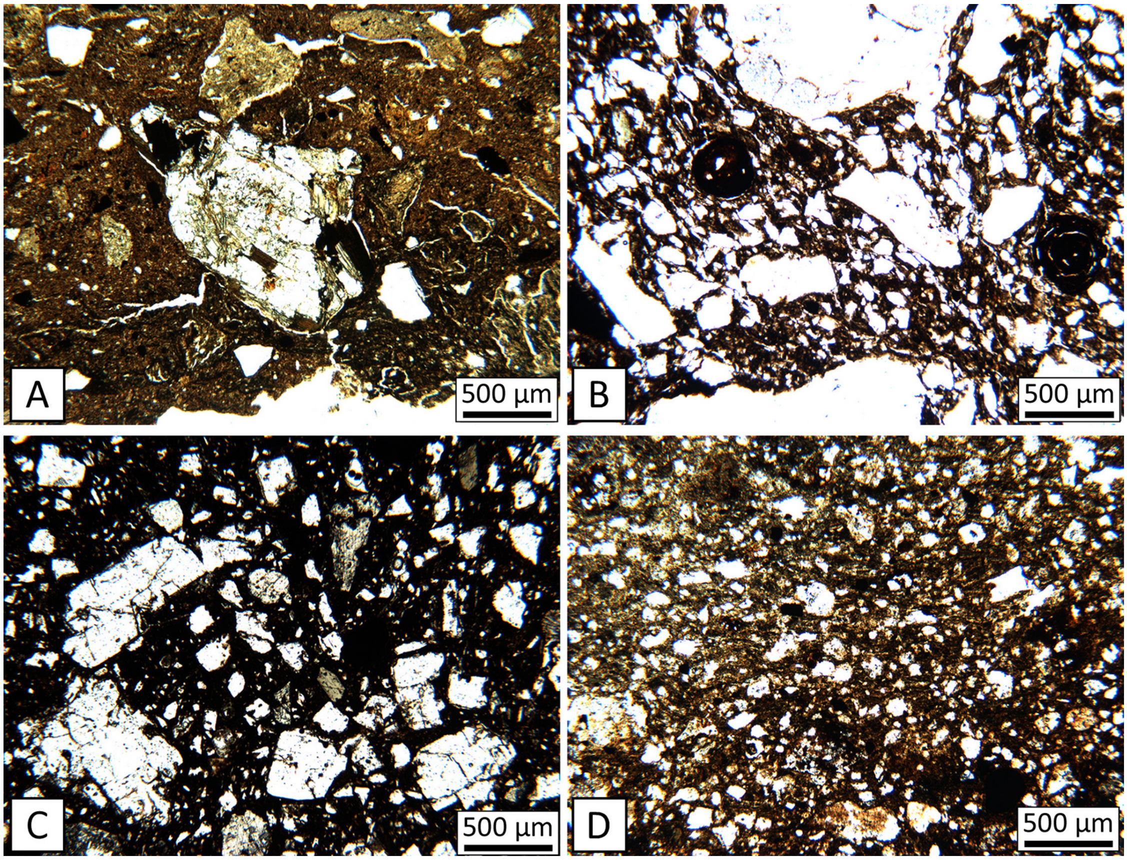

Fig. 7. Photomicrographs of thin sections showing minerals and lithoclasts from the discussed sites and comparatives ones (Plane-Polarized Light – PPL). A. Isolated weathered lithoclast (Cayenne, Perle-Noire, PN-212). B. Numerous pristine or poorly weathered lithoclasts (St-Martin, Grand Case, BK77-114). C. Volcanic sand (Capesterre-Belle-Eau, PR-5). D. Weathered small lithoclasts (Capesterre-Belle-Eau, PR-132).

(Tab. 5). In the main one (SC1, 4 samples), grog is the main temper and in the last sherd (SC-79, SC2 group) grog is absent, but numerous inclusions of sand and volcanic rock fragments are present (Fig. 11).

In the main group SC1, as in CHU Belle-Plaine site, a clear variability is observed, and sherds are not exactly equals, but altogether they form a quite homogeneous group. The clay matrix is slightly loamy and contains 2–3% to 5–7% of detrital inclusions, corresponding to a matrix of unsorted elements from dominant silt/loam (less than 63 µm) to few sand grains (max. around 1000 µm in length). The latter elements are mainly angular quartz grains, but two samples show pristine feldspars. Grog temper is very abundant (more than 20 elements per sample) having clear angles varying from 75 µm to 1000 or rarely 2000 µm in dimensions. The fabric of the grog fragments is made sometimes of only one or two types, but sometimes it seems more diversified. Organic inclusions are not abundant; elements showing preserved vegetal microstructures are scarce, except for one sherd where 10 elements were observed. We prefer to not consider a specific subgroup for this sample (SC-51), which is rich in organic inclusions, because all other petrographic features are identical to the main group of Sainte-Claire grog-tempered sherds. It may be necessary however to recognize here a subgroup if further study is carried out, showing more samples with abundant plant residues (and less grog temper?). Ferruginous elements are present, and small, rounded iron oxidized grains are quite numerous. In one sherd, where these elements are more numerous, three laminated ferruginous pisoliths (length over 2000 µm) are observed. The abundance of micro-cracks varies from one sherd to another, perhaps linked to burial processes. Rounded vacuoles seem to be rare to absent.

The sample SC-79 (which form the SC2 group), did not show any grog inclusions and is very different from the main group, with a clear sandy matrix from 20 to 30% of the observed areas, containing no grog or plant inclusions. The sand elements include mono-mineral crystals (quartz, feldspar, amphiboles, pyroxenes) and rounded volcanic lithoclasts. Two kinds of lithoclasts are observed: volcanic lavas fragments, with feldspar microliths and rare phenocrystals; volcanic cinders fragments, composed only by a fine crystallized mesostase and amorphous volcanic glass. These silico-detrital inclusions measure mainly around 125–250 µm (fine sand), but a few elements of 500 µm are observed too.

For the *Parking de Roseau (PR)* site, 14 sherds were petrographically analyzed (Tab. 5). According to the types and amount of non-plastic elements, we divided the samples in four groups: PR1 Ceramics with abundant grog temper, PR2 Ceramics with some to rare grog temper, PR3 Ceramics with volcanic cinders (without any grog) and PR4 Ceramics with volcanic sands (without any grog) (Fig. 12). The 14 samples are quite equally distributed between these four groups.

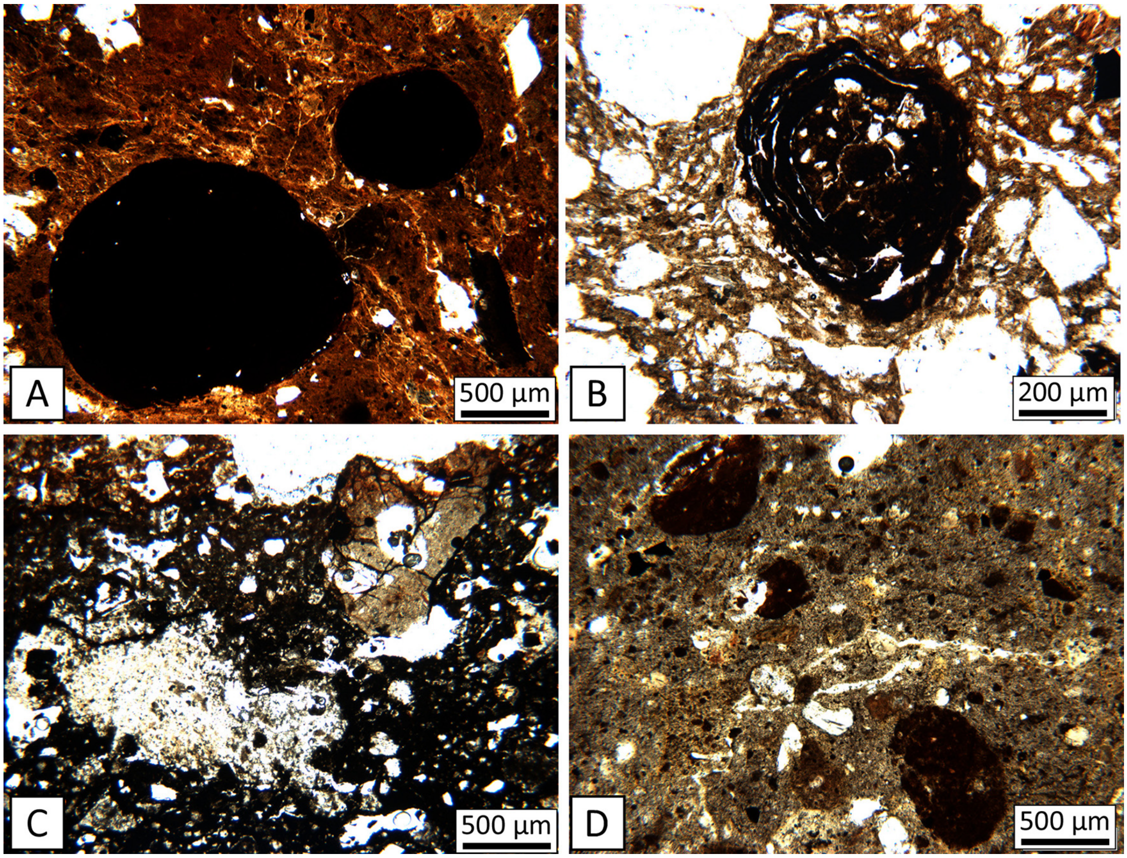

Fig. 8. Photomicrographs of thin sections showing ferruginous pisoliths or pellets and volcanic cinders (Plane-Polarized Light – PPL). A. Large ferruginous pisolith (Capesterre-Belle-Eau, PR-174). B. ferruginous pisolith with laminated cortex (St-Martin, Grand Case, BK77-114). C. volcanic cinders (Capesterre-Belle-Eau, PR-23). D. Argillaceous and ferruginous pellets (Capesterre-Belle-Eau, PR-131).

Table 3. Classification of tempers and aplastic inclusions: natural *versus* anthropogenic origins.

	Natural	Uncertain	Anthropogenic
Plant	Plant residues (roots)	Small charcoal inclusions	Plant cinders temper (Kwepi)
Soil	Ferruginous pisoliths Clay & Loam (silt)	Argillaceous concretions (clay lumps)	Grog temper
Regolith	Weathered rock fragments Clay & Loam (silt)	Weathered rock fragments Sorted sands	Sieved sands
Bedrock	Unsorted rock fragment Volcanic cinders	Very scarce rock fragments	Exogeneous crushed rocks

However, the groups 1 and 3 are quite homogeneous whereas the groups 2 and 4 are more heterogeneous and may include various sub-groups of ceramic fabrics.

In the first group (PR1, 3 samples: PR-62, PR-148, PR-174), grog is the main temper. The unsorted clay matrix contains very few silt and detrital inclusions, from silt to medium sand, representing less than 5% of the observed areas. The detrital grains are mainly angular quartz grains, but a few heavily altered feldspar and pyroxenes were observed too. Grog temper is dominant (or very abundant), with more than 20 elements per sample, sometimes with straight edges varying in size from 75 µm to 1000 or rarely 2000 µm. The fabric of the grog fragments is made of only one or two paste types, with a fine clay matrix, few inclusions or only few quartz grains and grog. Interestingly, grog fragments themselves also include grog. Sometimes it seems more diversified, because it contains various amount of loam and sand from one grog fragment to another. It must be noted here that we never observed grog made of ceramics fragments linked to groups PR3 and PR4. Organic inclusions are rare and correspond to carbonaceous elements without microstructural features; some of them are only partly preserved or preserved as vacuolar porosities. Ferruginous elements are present, showing themselves as small, rounded iron oxidized grains or laminated pisoliths.

In the second group (PR2, 4 samples: PR-16, PR-38, PR-104, PR-131), grog is also present, but in lesser quantities.

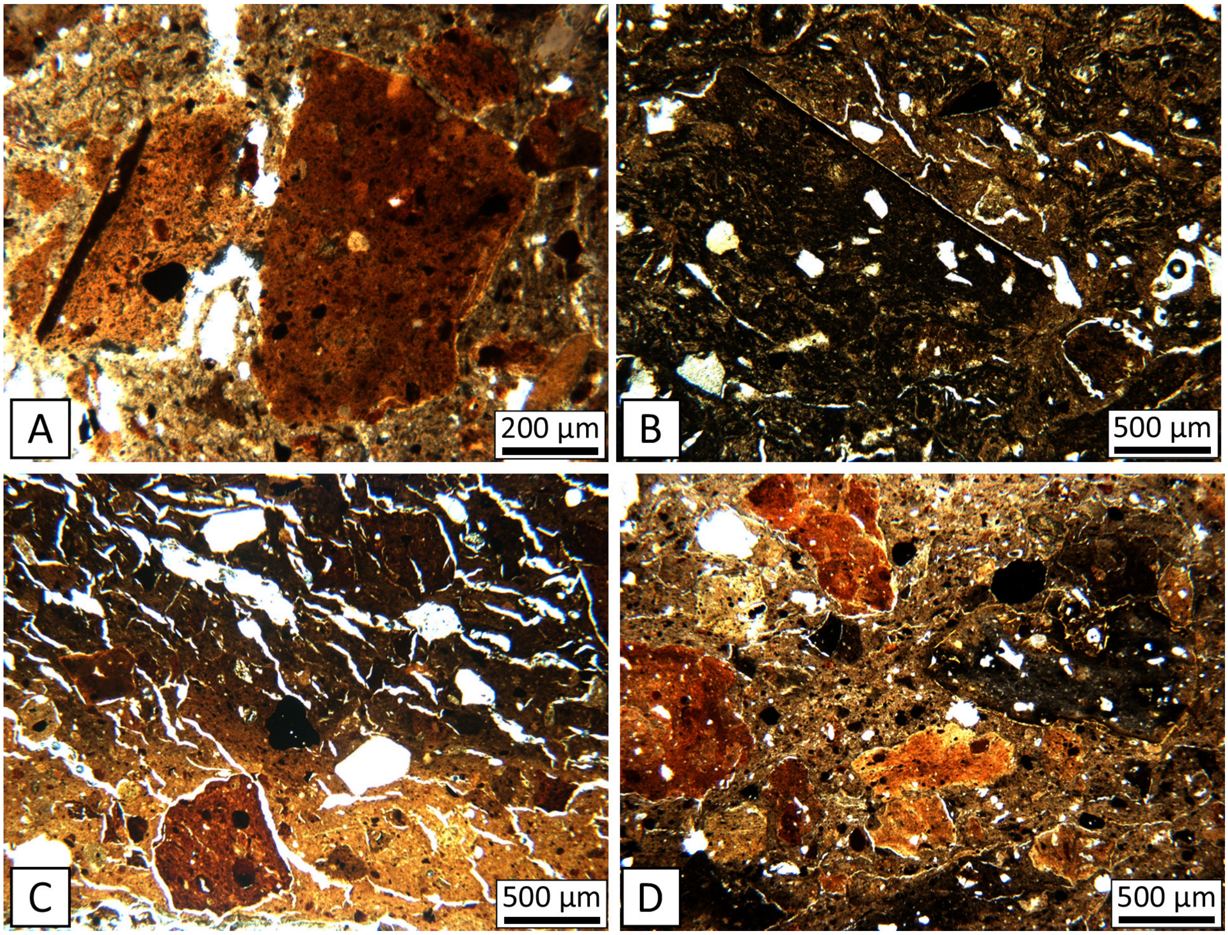

Fig. 9. Photomicrographs of thin sections showing grog tempers (Plane-Polarized Light – PPL). A. grog temper with angular shapes and dark slip (Capesterre-Belle-Eau, PR-148). B. large grog temper with dark engobe on a rectilinear surface (Cayenne, Perle-Noire, PN-216). C. Grog temper with difference of colour and bypassing microcracks (Les Abymes, BP-46). D. Grog temper with difference of colour and constituents (Goyave, SC-15).

There are only, around only 5 grog fragments by thin-section and quite no grog temper over 500 µm long. In this group 2, one sample (PR-38) shows some differences with the other grog sherds: the grog is very dark, with a lot of fragments less than 250 µm and no fragments over 500 µm long. In group 2, other aplastic inclusions are not well represented, however, less than 5% of the observed areas were seen under the microscope. These rare inclusions are clearly unsorted particle corresponding to isolated, weathered volcanic minerals such as quartz, few plagioclases and k-feldspar, very few altered pyroxens, and volcanic lithoclasts, plants or ferruginous elements. In these sherds, cracks are abundant to very abundant.

In the third group (PR3, 4 samples), grog is totally absent, and the clay is mixed with unsorted volcanic fragments made of isolated sub- to automorphous small feldspar crystals around 100 to 200 µm long (euhedral grains) and sub-rounded silicate rock fragments (anhedral grains) with very small feldspars crystals in a few to non-crystallized mesostase. These inclusions, measuring from 50 µm to 2000 µm, are interpreted as volcanic cinders. They represent 5 to 15% of the observed surfaces and sometimes even 25–30% in few limited areas. Others fragments of volcanic lavas – lithoclasts with phenocrystals or isolated minerals other than feldspars – are very rare or absent in this group 3. Ferruginous elements and plant remains are also rare to absent.

In the fourth group (PR4, 3 samples), grog is totally absent too and the volcanic sandy elements represent the main aplastic component (25 to 30% of the observed surfaces). Unlike the previous group, the inclusions do not correspond to cinders but to automorphic crystals. For two of the three samples, inclusions seem quite well sorted; length varies from 250 to 500 µm (medium-grained sand), with very few fine sands and loam/silts grains. In the last sherd, however, sand inclusions seem to be less sorted, and containing more weathered minerals. The proportion of the various microlithic and porphiric volcanic rocks vary a little from a sample to another, but because of the rather small number of studied sherds, we choose to put them all in a same group. The mineralogy of lavas observed is coherent with the petrography of the Madeleine-Soufrière volcano described by others (Lefevre and Cocusse, 1985), with feldspar (mainly plagioclases, few k-feldspar), olivine (largely altered in iddingsite) and pyroxene (probably augite). Feldspars are more abundant minerals, followed by pyroxenes. Plant fragments and ferruginous elements are rare.

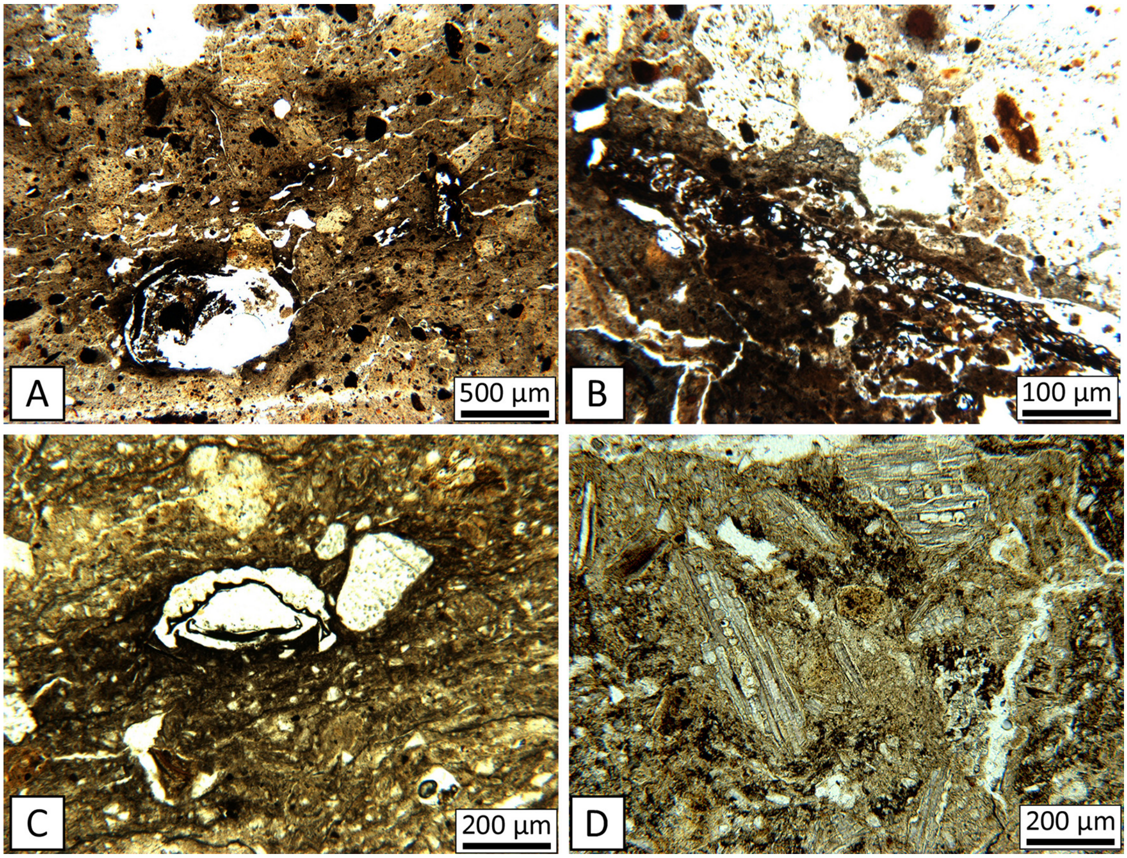

Fig. 10. Photomicrographs of thin sections showing plant residues (Plane-Polarized Light – PPL). A. carbonized plant inclusions (Goyave, SC-51). B. carbonized plant inclusions, probable moss (Goyave, SC-51). C. carbonized plant inclusions, probable seed (Cayenne, Perle-Noire, PN-217). D. *caraipé* temper (kwepi) inside grog temper (Cayenne, Perle-Noire, PN-215).

7 Inter-comparison of the three sites

The results of the thin-sections analysis show that ceramics from these three sites include various fabrics. The studied sherds reveal various quantities of grog (like in PR1 and PR2 groups) as well as sherds without grog of which the main aplastic inclusions are volcanic cinders (like in PR3 group) but mainly with volcanic sands (like in PR4 group). Plant inclusions are rare and most often observed at the same time as soil elements (ferruginous pisoliths) (Tab. 5). This ferruginous nodules and plant remains are believed to be extracted together with the raw clay, as well as the smallest quartz grains from the loam granulometry. Thus, the latter inclusions belong to the clay source and are not voluntarily added by the potter. The fact that these elements were still part of the fired vessel is merely due to a quick cleaning of the raw clay material without an intensive process of purification. However, when comparing the three sites, some identified elements may also reflect different clay and temper sources or supply strategies. The plant remains and pedological features seems to be linked to a fine matrix and to sourcing in or near coastal marshes whereas volcanic sands could be associated to the addition of lithic fragments form the regolith.

When comparing the ceramic repertoire and the presence of the main aplastics inclusions (Fig. 13), two-thirds of the forms are tempered with grog, whereas the last third part did not contain grog at all (volcanic cinders or volcanic sands). All red-slipped wares (N = 6) are grog-tempered, they correspond to small to medium open straight-walled (tronconic-shaped) bowls and one bell-shaped vessel with pierced notches on the careen. The non-grog tempered series only reveal modeled appendices materialized by an effigy vessel with small, decorated handles and another small bowl with handles.

In order to define potential links between the compositions of ceramics and cultural transitions or exchanges, it is important to identify the most significant vessel forms. A blatant but important vessel is the red-slipped bell-shaped vessel (SC-27) found at Sainte-Claire, which shows clear Saladoid attributes. It suggests an earlier occupation at this site, what is confirmed by the oldest radiocarbon date, found in a round pit (F 112) located at a few meters to the north of pit F 186 in which this vessel was found. Numerous outward thickened rims of SC-27, generally attributed to the Saladoid series (SC-MS IVc), were found in various pits of which F 174 was dated slightly prior to AD 1000. This date can be considered as the limit of the (Late) Saladoid series on Guadeloupe and the northern Lesser Antilles. It is noteworthy that this particular form has no outward thickened rim, common for (Late) Saladoid bell-shaped vessels, which might suggest a local or early Troumassoid adaptation to this vessel-type, as observed at the Anse à la Gourde site (Commune de

Table 4. General information on samples per site.

CE	Feature	Type	MS	Firing	Paste (Naked eye)
CHU Belle-Plaine					
46	186	Pit	2a	R	Sand + mica
47	186	Pit	6f	R	Plants + pisoliths
48	186	Pit	8	R	Sand
49	186	Pit	8	R	Plants + pisoliths
60	200	Pit	iia	R	Grog + some sand
Sainte-Claire					
4	13	Pit	iiia	R	Grog + some sand
15	**55**	Pit	iib	R	Grog + some sand
27	186	Pit	ivb	R	Grog + some sand
51	**62**	Pit	iiic	R	Grog + some sand
79	**5.1**	Post hole	ib	O/R	Sand + feldspar
Parking de Roseau					
5	S5s	Beach	5c	R	Sand + mica
16	S6	Beach	7b	O/R	Sand + pisoliths
17	S6	Beach	1b	O	Sand
23	S7s	Beach	1c	R	Plants + pisoliths
38	S1n	Beach	10b	R	Grog + some sand
62	S5n	Beach	2c	R	Plants + pisoliths
81	35	Pit	7b	R	Grog + some sand
104	220	Pit	3b	R	Grog + some sand
131	**412**	Pit	2a	O/R	Sand + feldspar
132	**412**	Pit	2d	R	Sand + feldspar
148	**156**	Pit	2a	R	Grog + some sand
174	**178**	Pit	3c	O/R	Sand + pisoliths
203	**178**	Pit	7e	R	Grog + some sand
380	**365**	Pit	8a	R	Grog + some sand

Archaeological Feature numbers in bold have been 14C dated.

Saint-François) (Pater and Teekens, 2004, Fig. 6.4). The fact this stylistically earlier vessel has a grog temper is indeed of first importance, because it establishes a link between the older Saladoid and later Troumassoid ceramics in the use of grog temper.

Another highly diagnostic element for the Mamoran Troumassoid sub-series is grooved incisions (Fr. *cannelures*), either wide linear parallel or complex curvilinear designs, and, in the case for the studied sites, often in combination with red slip and, more importantly, with folded lips towards the interior (BP-MS 3a; SC-MS Iva; PR-MS 10b: *cf.* Fig. 4). The vessel PR-38 represents such design as clearly identified in two dated pits (F 178 and F 222) at Parking de Roseau, both with a similar calibrated date of *c.* AD 1200. The petrographic analysis of this sample places it in the group 2 of the ceramics of this site, revealing small quantities of grog mixed with a loamy clay. The vessel BP-47, a small bowl with convex profile, may also be indicative because it features grooved linear incisions on the outside and red slipping on the inside, and clearly evoke Mamoran Troumassoid characteristics. The petrographic analysis of this sample revealed a heavy charge of grog in its paste.

The very common larger bowls (BP-MS 6f and 8; SC-MS IIIa; PR-MS 4a and 9a) are represented by convex or straight rims with thinned lips, often featuring some scratching, predominantly applied on the outside (BP-48, PR-131 and 148). At Parking de Roseau, ten specimens were found in dated pit F 178, one in dated pit F 174 and one in dated pit F 222 suggesting a calibrated date around AD 1200, which falls within the range of the CHU Belle-Plaine from where the analyzed fragment was taken. In south-eastern Martinique, these recipients were observed at the post-saladoid sites of À-Tout-Risque, Paquemar, and notably Macabou, dated AD 1000 (Allaire, 1977, Figs. 38–43).

Another interesting category is represented by small to medium sized bowls (SC-4, 15 and 51; PR-104 and 174) and large platters (PR-62) with rectilinear profiles. These vessels are marked by rectilinear incisions applied to the interior marking the (reflecting) rim or applied upon the thickened rim. Half of the samples have red slipping on the inside. Although not sampled for CHU Belle-Plaine, these vessels are certainly present at this site as represented by BP-MS 3 (N = 11) of which one element can be attributed to the above-mentioned folded lip vessels. Small to medium sized bowls are very popular at Parking de Roseau (PR-MS 2b-c and 3b-c), but far less popular at Sainte-Claire, what is probably due to the total ceramic sample size. Without doubt, they can be attributed to the Mamoran Troumassoid sub-series (Rouse and Morse,

Table 5. Results of the petrographic analysis per site.

CE	Grog	Sand (Qz + other min.)	Lithoclasts (volcanic lavas)	Lithoclasts (volcanic cinders)	Plant fragments + residues	Iron oxides elements	Group
CHU Belle-Plaine (BP)							
46	+++	+ (incl. 2 Amph)	+ (2 fragments)	–	++	++	**BP1**
47	+++	+	–	–	++	++	**BP1**
48	+++	+ (incl. 1 Amph)	+ (1 fragment)	–	++	++	**BP1**
49	++	+	–	–	+++	+	*BP1*
60	+++	+ (incl. 1 Amph)	–	–	+	+	**BP1**
Sainte-Claire (SC)							
4	++	+ (incl. Fk)	–	–	+	+	**SC1**
15	+++	++ (incl. Fk + Pl)	–	–	+	++	**SC1**
27	++	+ (incl. Fk)	–	–	+	+++ (incl. pisol)	**SC1**
51	+	+	–	–	+++	+	*SC1*
79	–	+++ (incl. Fk, Pl, Amph, Px)	++	+	–	+	**SC2**
Parking de Roseau (PR)							
5	–	+++ (incl. F + Px)	+ (1 fragment)	–	+	+	**PR4**
16	+	+	–	–	+	++	**PR2**
17	–	+	+	+++	–	+	**PR3**
23	–	+	+	+++	–	+	**PR3**
38	+	++	+	–	+	++	**PR2**
62	+++	+	–	–	++	+++ (incl. pisol)	**PR1**
81	–	+	+	+++	–	+	**PR3**
104	+	+	–	–	+	+	**PR2**
131	+	+ (incl. Fk + Px)	+	+	+	+	**PR2**
132	–	+	+	+++	–	+	**PR3**
148	+++	+	+ (1 fragment)	–	++	++	**PR1**
174	++	+	+ (1 fragment)	–	+	++	**PR1**
203	–	+++	+	–	–	+	**PR4**
380	–	+++	++	+	+	++	**PR4**

−: not identified; +: very few to few; ++: frequent to common; +++: dominant to very dominant.

1999:39–43). The petrographic analysis shows that these recipients are predominantly grog-tempered, except for SC 79, which is tempered with an abundant quantity of volcanic sand.

Small bowls with "banded" or flexed rims are rather popular at all sites (BP-MS 6c-e; SC-MS IIc et IIIb; PR-MS 1c and 2c-d) but our analyzed specimens (SC-79 and PR-23), although slightly different regarding their size, do not contain grog at all. These specimens were found at the beach zone of Roseau and may be attributed to later series such as Cayo. Interestingly, similar bowls (PR-5 and 132) with beveled lips (*biseautée*) do not contain grog either of which one was found at the beach and the other in the deeper feel of dated pit F 412 respectively.

Finally, restricted (large) vessels which are rather rare for these Troumassoid series (BP-MS 7a, 8; SC-MS V and VIa; PR-MS 8 and 9). In our petrographic analysis, they are represented by one grog-rich sample (BP-49) and one with volcanic sand temper (PR-380).

8 Discussion

Donahue *et al.* (1990:252) proposed two hypotheses concerning the presence of grog when considering Saladoid and post-Saladoid ceramic series: (a) grog either represents a local (Troumassoid) innovation or (b) it represents the influence of Barrancoid practices, coming from the South American mainland, mainly during the midst of the first millennium AD. The latter hypothesis was again elaborated by Petersen *et al.* (2001:251), which observed that the earlier Modeled-Incised Barrancoid ceramics which were largely open bowls with flanged rims and thicker, softer, unpainted slipped typical jars and bowls, with and without flanged rims. These vessels forms are mostly *caraipé* tempered (plant cinders from Lycania genus) but also include lesser amounts of crushed up rock and "grog" (sherd) temper.

The apparent dichotomy between the Saladoid and post-Saladoid series found some confirmation by additional microscopic analysis executed by Petersen which has been published in the dissertations by Crock (2000) and Murphy (1999). Other LCA sites, such as Salt River (Conner and Smith, 2001) and, to a lesser extent, Peter Bay (Conner and Smith, 2003:388) on the Virgin Islands as well as the Baie Orientale 2 site situated on Saint-Martin feature grog (Bonnissent, 1995, 2008:157).

The interesting proposition made by Donahue *et al.* (1990) is further explored in this paper by means of the three LCA sites excavated on Guadeloupe, focusing on the possibility of another wave of immigration from the mainland into the (Lesser) Antilles ending the long Saladoid ceramic tradition and introducing the Troumassoid which is, amongst others, materialized by the presence of grog as a temper. This hypothesis

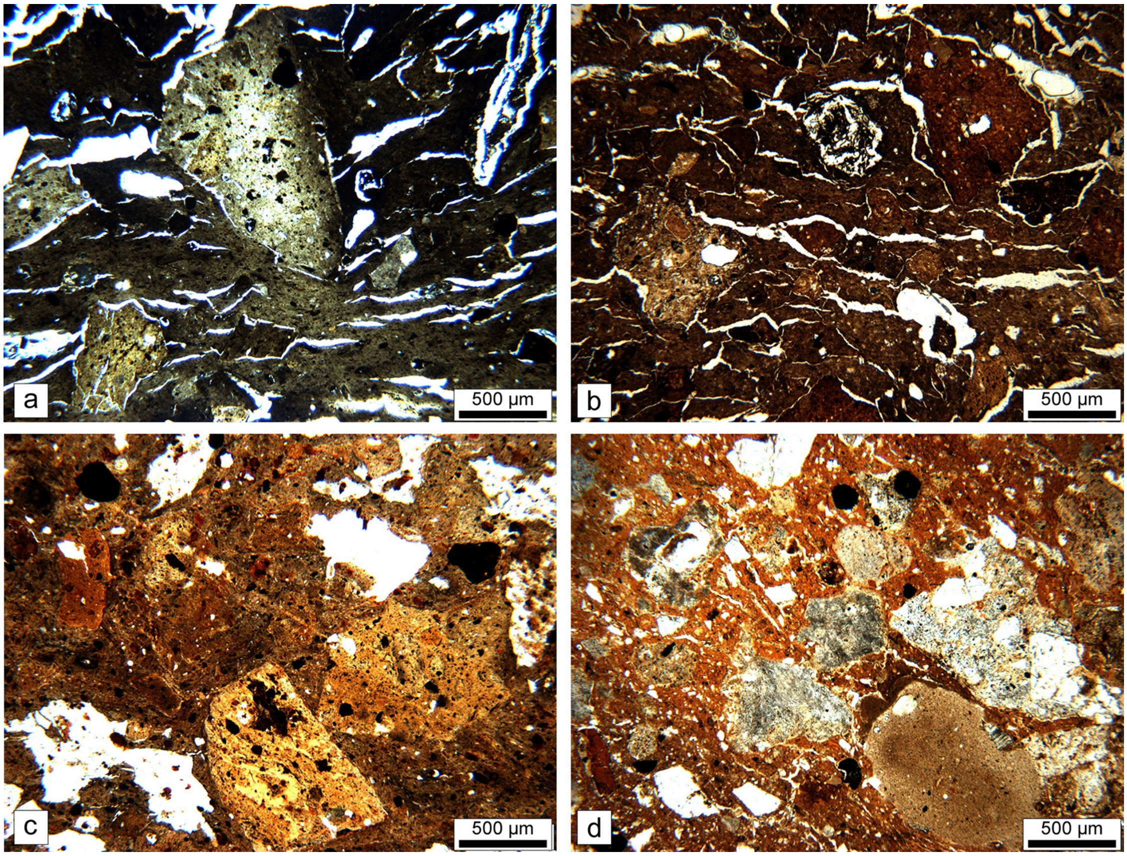

Fig. 11. Photomicrographs of thin sections taken from Belle-Plaine and Sainte-Claire (Plane-Polarized Light – PPL): Grog tempered sherds: (a) BP-47; (b) BP-47; (c) SC-27; (d) sandy matrix mainly with volcanic lithoclasts and isolated volcanic minerals SC-79.

is in contrast with other interpretations of this turning point in Caribbean archaeology in which the Troumassoid series represents a regional and fluid development out of the late Cedrosan Saladoid series under Barrancoid influences (Hofman *et al.*, 2007:252) or, at least, for the southern Lesser Antilles. During the second half of the first millennium AD important social modifications must have taken place which are materialized by diversification in the ceramic register as well as an increase in population evidenced by and increase of (Troumassoid) archaeological sites in the Lesser Antilles (Bright, 2011:163; Hofman, 2013). Through the analysis of paste, our perspective is less fluid and rather suggests a more chaotic period of development by means of the arrival of distinct groups from the mainland into the Lesser Antilles.

Our analysis of 24 samples, taken from three different, contemporary sites, shows that grog temper is present at all sites. Prior to this work, grog a temper was hardly known and/or neither well identified for pre-Columbian ceramic assemblages on Guadeloupe. Our petrographic analysis also showed that all samples contained small amount of quartz grains, and sometimes volcanic sands or cinders, pedological iron oxides particles in various quantities. Plant residues are also frequent, but never in dominant quantities. Therefore, it is difficult to tell whether this matter was intentionally added to the raw clay or if it was already present in the natural clay. However, the high quantities of organic matter in the Belle-Plaine samples may suggest it was added to the clay by potters at this site.

The near absence of lithoclasts for the samples from Sainte-Claire and Belle-Plaine is interesting, since both sites are located on volcanic soils, suggesting that clay was taken elsewhere, perhaps in coastal marshes or areas covered with thick clayey soils and in the case of Belle-Plaine the clay source should reveal amphiboles.

Grog as a temper is recorded for as one temper mode, probably used according various *chaînes opératoires*, alongside other practices that preferentially use either fine clays with little amount of aplastic inclusions or clays enriched with volcanic sands or cinders. Widely accepted among ceramics specialists, the grog presence is principally related to the fact that is resists better to thermal shocks (Rye, 1981:116–117; Rice, 1987:75). At Belle-Plaine, despite the fact that the majority was taken from one pit, it has been observed in various vessel shapes. The samples from Saint-Claire were taken from different pits providing different vessel shapes and also showing an assemblage dominated by grog as a temper. Parking de Roseau, pertaining to a larger sample, shows more variety in paste fabrics where grog and sand represent both half of the analyzed collection.

Considering the different vessel shapes, decoration modes and temper, as presented in Figure 8, in combination with the radiocarbon dates and cultural affiliation of this collection – the bell-shaped vessel (SC-27) must be attributed to the Late Saladoid series and not, as all the others, to the Troumassoid series –, we observe that all red slipped elements are tempered with grog. Indeed, Sainte-Claire is a multi-component site and

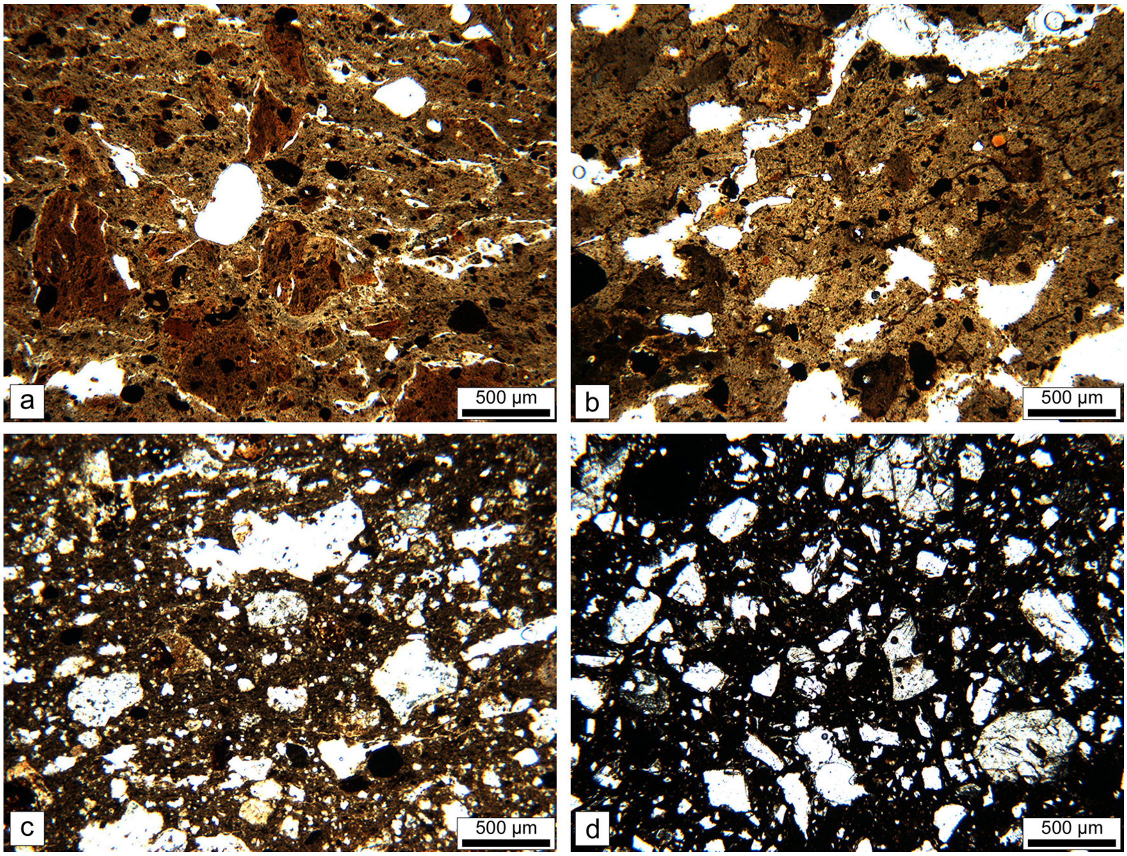

Fig. 12. Photomicrographs of thin sections taken from Parking de Roseau (Plane-Polarized Light – PPL); (a) group PR1: grog tempered sherd PR-62; (b) group PR2: matrix-rich sherd with very few temper (sparse grog fragments and few volcanic material) PR-104; (c) group PR3: sandy matrix with abundant volcanic cinders PR-81; (d) group PR4: sandy matrix with numerous volcanic lithoclasts and isolated volcanic minerals PR-05.

its earlier Saladoid occupation is attested for by many other Saladoid ceramic traits, notwithstanding that the majority of the ceramic assemblage as well as the radiocarbon dates adhere to the Troumassoid series.

The presence of grog in the "Barrancoid influenced" Cedrosan Saladoid subseries in the midst of the first millennium AD needs further attention here since it draws upon Terra firma influences. Despite the fact that Petersen *et al.*, (2001) pointed towards small amounts of grog for these series, Boomert (2000:119, 204) does not agree with this statement for the Barrancoid series for Venezuela. However, he does attribute grog to other assemblages such as the ones found at Los Cedros and Palo Seco on Trinidad (ibid.:132, 155). In fact, grog as a temper appears indeed to be rare in pre-Columbian Venezuelan sites as it only occurs at LCA sites in the Llanos and in two Ronquinan groups of the Middle Orinoco as defined by Howard in the 1940s (Gassón, 2002:257, 274; Roosevelt, 1980). But next to the mouth of the Orinoco River, grog is abundant among nearly all LCA ceramic complexes (AD 900–1500) along the coast of the Guianas from Guyana in the west to the Marajó Island (Brazil) in the east (Meggers and Evans, 1957; Evans and Meggers, 1960; Boomert, 1980; Roosevelt, 1991; Rostain, 1995; Schaan, 2004; Bel van den, 2015; Saldanha, 2016). The presence of grog has only been attested for by the naked eye and confirmed by microscopic analysis only for Cayenne Island (Bel van den *et al.*, 2014; Bel van den, 2015). Nevertheless, we think that the Guianas represent an important hearth for the origins of grog in the Lesser Antilles, passing through the mouth of the Orinoco or going directly to the islands as did the *Callinago* a few hundred years later in the 16th century (*cf.* Boomert, 1986).

If grog temper is considered an innovation coming from the mainland then, by consequence, previous ceramic series, *i.e.* Cedrosan Saladoid sub-series, are without grog. Since we have not personally analyzed such earlier assemblages (this should be future research) we can only rely on the literature, mainly represented by observations taken by the naked eye. Donahue *et al.* (1990:242, Tab. IV) showed that samples taken from Saladoid sites, such as Trants on Montserrat or Sufferer's on Barbuda, were indeed devoid of grog. It is said about Cedrosan Saladoid ceramics found on the inner arc of the Lesser Antilles that on the basis of low magnification microscope, temper constituents generally include "volcanic tuff, quartz, magnetite, feldspar, and hornblende/tourmaline, among others" (Petersen and Watters, 1995:134). For Guadeloupe, recent macroscopic data on Cedrosan and Barrancoid influenced Saladoid pastes has been provided by a small number of archaeological excavations at Bisdary (Gourbeyre, Basse-Terre) (Hildebrand in Romon *et al.*, 2006: 80 but relying on Chancerel in Etrich *et al.*, 2003:73–108) and at Grand Carbet (Capesterre-Belle-Eau, Basse-Terre) (Chancerel in Toledo i Mur *et al.*, 2004:32) for which grog was not attested for.

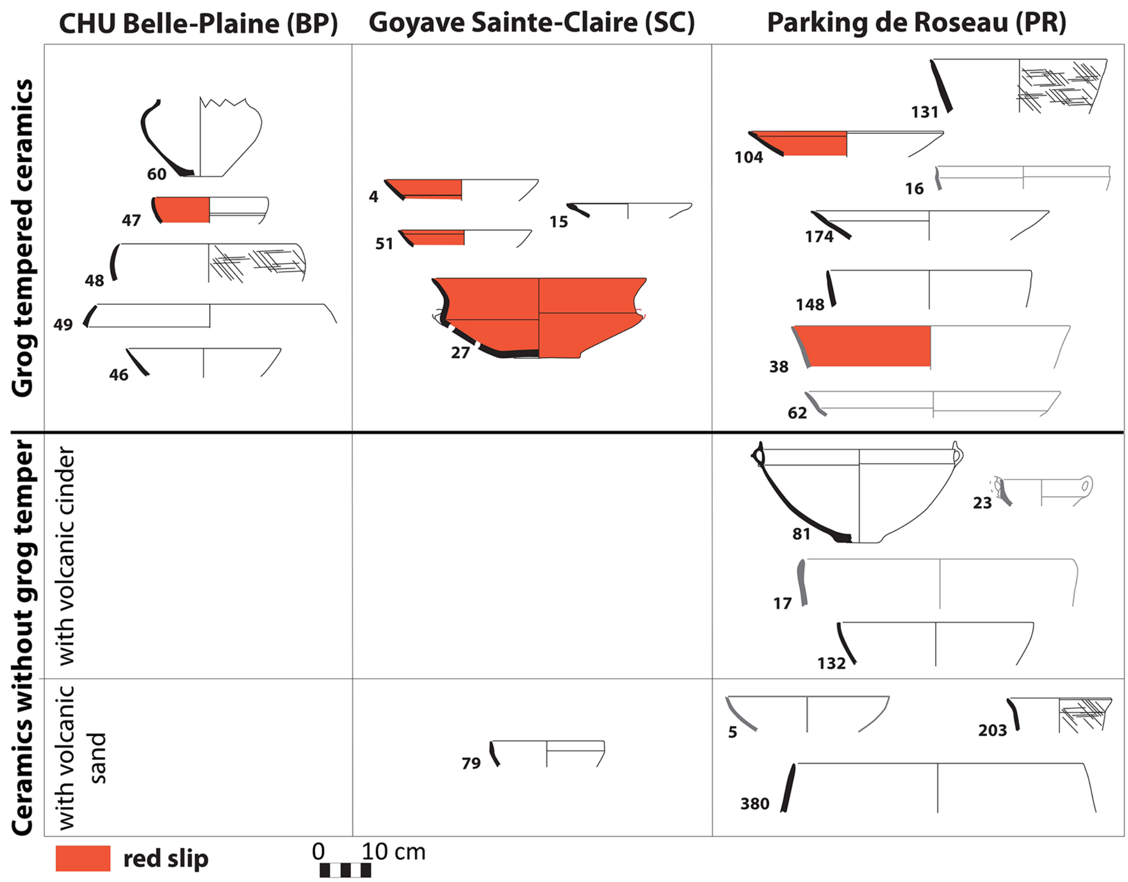

Fig. 13. Sub-divisions of vessels according to paste types.

9 Conclusion

The Guadeloupean test-case, explored in this study, showed the abundance of grog tempered ceramics for the Troumassoid series, and notably the Mamoran sub-series. And even if we underline that future microscopical analysis is needed for both Saladoid and Troumassoid sites on various islands in order to pin-point the inception data and place of arrival of grog tempered ceramics in the Lesser Antillean arch, we can confirm already part of the Donahue *et al.* (1990) hypothesis about the importance of grog as marker for important changes in the pre-Columbian ceramic production in the Lesser Antilles.

The Sainte-Claire site showed that (one) Late Saladoid bell-shaped vessels also contained grog, suggesting a possible pre-Troumassoid inception at Guadeloupe or perhaps an innovation signaling the end of the Saladoid era, just before AD 900. It is still difficult to specify if it is related to a true Troumassoid migration from the mainland around this latter date, or to a lingering Barrancoid influence among the Late Saladoid population of the Windward Islands. However, it appears once more evident that grog marks cultural changes in the first millennium AD; hence, now we may also add Guadeloupe to the list of Caribbean islands impacted by this change.

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