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ORIGINAL PAPER

Continuity and change in fine-ware production in the eastern Maya lowlands during the Classic to Postclassic transition (AD 800–1250)

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Abstract This study presents the results of an investigation into fine-ware production in the eastern Maya lowlands during the Classic to Postclassic transition (ca. AD 800–1250), a period characterised by the collapse of the Maya dynastic tradition. A selection of fine-ware ceramics—Ahk'utu' vases and Zakpah ceramics—from various sites across Belize was examined by thin-section petrography and SEM-EDS analyses. The resultant compositional and technological data reveal that fine-ware production exhibited varying degrees of continuity and change in potters' choices of raw materials and manufacturing technologies. The most significant change occurred in craft organisation. Fine-ware production shifted from the co-existence of two ceramic traditions, which guided potters regarding the raw materials used and technical practices followed in making Ahk'utu' vases during the earlier phase of transition (ca. AD 800–900/950), to the dominance of one broad tradition with greater liberty accorded producers in their execution of Zakpah fine-ware production during the later phase (ca. AD 950/1000–1200/1250). Such a shift is argued to have been stimulated by a change and increase in the demands for fine-ware ceramics during the later phase of the transition, corresponding to the emergence and proliferation of a new elite stratum in the Maya lowlands.

Keywords Ceramics · Manufacturing technology · Craft organisation · Thin-section petrography · SEM-EDS · Maya collapse

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Introduction

'Fine-ware', here, refers to ceramic vessels with more sophisticated surface finish and/or decoration as opposed to utilitarian ware. Fine-ware ceramics tend to have wider circulation, with their occurrence being mostly but not exclusively associated with elite contexts. The production of fine-ware ceramics has been the focus of interest in Maya archaeology because it is argued that their production was more susceptible to, and thus reflective of, the changes that occurred to the socio-political and economic context under which the production took place (McAnany 1993: 239; Rice 1987a; Rice and Forsyth 2004: 53). This is particularly true in the case of fine-ware production during the Late Classic period, with a profusion of research being conducted on the painted polychrome vessels (cf. Ball 1993; Foias and Bishop 1997, 2007; Halperin and Foias 2012; Inomata 2001; Reents-Budet 1994a; Reents-Budet et al. 2000; Rice 2009a). The recent decades have also witnessed an increase in the amount of research on fine-ware production in the periods that followed the Late Classic, notably with case studies on the Terminal Classic fine paste ceramics in the Usumacinta Valley in the western lowlands, the Postclassic slipped pottery in the Central Petén Lakes region in the southern lowlands (Cecil 2004, 2007, 2009; Cecil and Neff 2006; Rice 1986, 1987b) and the Late Postclassic pottery of the Yucatan Peninsula in the northern lowlands (Masson 2001; Rathje 1975; Rathje and Sabloff 1973; Sabloff and Rathje 1975). It is, therefore, surprising to note that there is a gap in our knowledge of fine-ware production during the Classic to Postclassic transition. The Classic to Postclassic transition refers to the period from AD 800 to AD 1250, subsuming the Terminal Classic and Early Postclassic periods when fundamental changes and restructuring are said to have occurred to the socio-political orders in the Maya lowlands, resulting in the disintegration of divine kingship

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and associated ideologies as well as material cultural representations. It is equally surprising to note that a gap exists in the present characterisation of fine-ware production, as reflected in the underrepresentation of data from the eastern lowlands, which have proven to be of crucial importance in rectifying our paradigms about the highly complex nature of the Classic to Postclassic transition (cf. Aimers 2007a: 342–346; Chase et al. 2008; Graham 2004; Graham and Pendergast 1989; Masson 2001; Pendergast 1981; Pyburn and Andres 2004). That being said, the technological study of the Classic to Postclassic pottery from the site of Lamanai (Howie 2012) and the stylistic and metric analyses of the Postclassic pottery from the site of Caye Coco (Mason and Rosenswig 2005) are among the exceptions, which based their discussion on fine-ware production in the eastern lowlands during the transition on evidence from a single site or localised area. Building on these previous efforts, this study seeks to investigate fine-ware production characteristic of the eastern lowlands during the Classic to Postclassic transition by examining the Ahk'utu' moulded-carved vases and Zakpah ceramics recovered from various sites in Belize. Production, here, is not only defined by the manufacturing process itself but also by how the production was organised. These aspects of production are reconstructed by using various analytical techniques, principally thin-section petrography and scanning electron microscopy energy dispersive spectrometry (SEM-EDS). The resultant data form the basis of exploring the compositional and technological variability that existed between and within the two vessel types. Both compositional and technological variability are useful in characterising the continuity and/or change that occurred to the craft organisation. More importantly, by placing the fine-ware production in the eastern lowlands to the better-known fine-ware production system of the Maya lowlands, it can infer to the nature of the Classic to Postclassic transition.

Background

Fine-ware production during the Late Classic period

Painted polychrome vessels epitomise the Late Classic fine-ware ceramics, and indeed the Late Classic material culture repertoire, and their production has been subjected to extensive research. One particular model that has been widely accepted and commonly used in framing the production of polychrome vessels during the Late Classic period is Ball's (1993) 'palace-school' and 'village-tradition' polychrome ceramic system. 'Palace-school' ceramics refer to specific polychrome vessels that were most likely used as presentation items, mortuary offerings, and reciprocal gifts among elites and political allies (Ball 1993: 258; Reents-Budet 1994b). Since these vessels functioned as status markers, their manufacture is argued to have been sponsored by elite patrons or initiated by elite patrons or even carried out by elites themselves (Ball 1993; Foias 2002; Reents-Budet et al. 1994; Reents-Budet et al. 2012; Sharer and Golden 2004: 30–31). The concept of elite artisans is supported by the identification of painters' signatures on some vessels, indicating that these painters might have been sons of nobility or connected with the royal family (Reents-Budet 1994c: 50–55; Inomata 2001). Judging from the specialised skills and time required to paint the polychromes with elaborate designs, it is further hypothesised that these vessels were made and decorated separately by potters and painters working in the same workshop (Reents-Budet et al. 1994: 219). Workshops were purportedly located at or near the palace, as evident in the ceramic wasters, paint pots, smoothers, polishers, and figurines and matching moulds recovered from the middens associated with the royal and elite residences at Buenavista del Cayo (Reents-Budet et al. 2000), as well as the recovery of pottery production tools and debris from the midden at the Central Acropolis of Motul de San José (Halperin and Foias 2012). Instrumental neutron activation analysis (INAA) of polychrome vessels revealed these 'palace-school' polychrome vessels were products of various workshops, with each workshop characterised by a high level of occupational specialisation and a high degree of elite administration (Halperin and Bishop 2016; Reents-Budet et al. 2000, 2012). In contrast, polychrome vessels of the 'village-tradition' are said to be the folk-order parallel to their 'palace-school' counterparts, referring to locally produced and locally circulated painted wares. Ball (1993) argued that the craft organisation of less elaborately decorated fine- or serving ware was not likely controlled by elites. The manufacture of these less elaborately decorated polychromes, alongside domestic utilitarian wares, appears to have taken place within a context of dispersed households, hamlets and village communities located outside major centres (Ball 1993: 265; Fry 1979, 1980; Halperin and Foias 2012: 167).

A more recent model was proposed by Rice (2009a), in which she attempted to explain the production of polychrome pottery in light of a calendar-based *may* model of geopolitical organisation (Rice 2004, 2009b). Notwithstanding a new production structure, Rice proposed that polychromes were commissioned by elites, who would have sent skilled artists from primary to secondary centres to paint the vessels. Even if, as has been argued, the *may* cycle was not a cycle of importance in the Classic times, the basic concept of particular seats of power/ritual affecting the production and circulation is a powerful one. Rice's proposed scenario also permits greater variability and flexibility in terms of the forms and decoration of pottery, as well as the uses and users of pottery within polities, while acknowledging that the production and distribution of polychromes were embedded in the cosmo-politico-ritual economy. These two models might have varied in their explanation of how the production of fine-ware ceramics was

organised during the Late Classic period, but the fundamental thrust of both models lies in the argument that the production of fine-ware ceramics, especially those of the highest calibre, was controlled by the elite class.

Fine-ware production during the Postclassic period

Unlike the Late Classic fine-ware ceramics, there is no specific model dedicated to examining fine-ware production in the Maya lowlands during the Postclassic period; in fact, what constitutes the Postclassic fine-ware repertoire is still poorly understood. Thus, the extant reconstruction of Postclassic ceramic production was largely drawn from Rathje's (1975) model, which was based on evidence recovered from the archaeological sites of Mayapan and Cozumel dating to the Late Postclassic period (AD 1250–1500), as well as on ethnographic documents of the early colonial period. Rathje (1975: 430–434) suggested that Late Postclassic pottery was the product of mass production, evident in their standardised and often simplified vessel forms, design and decoration techniques. This observation is supported by Masson (2001: 183) in her study of the Late Postclassic pottery, which she noted as displaying a general lack of diversity. In addition to the principle of mass production, Rathje (1975: 430) further proposed that division of labour was implemented to routinise tasks, resulting in less dependence on skilled artisans. Mass production and division of labour are argued to have been measures adopted by potters with the aim of increasing the overall efficiency and reducing the cost involved in production activities, which in turn contributed to the growth of commercialised exchange systems during the Late Postclassic period. Thus, it is generally assumed that the production of Late Postclassic pottery was controlled by market forces, and such an assumption is often applied to explain pottery production during the earlier phases of the Postclassic period.

Yet, this version of Postclassic pottery production is challenged by Cecil and colleagues based on their work on slipped pottery—as represented by Clemencia Cream Paste, Vitzil Orange-Red Paste and Snail-Inclusion Paste wares—from several sites in the Central Petén Lakes region, Guatemala, during the Postclassic period (AD 1000–1525) (Cecil 2004, 2007, 2009; Cecil and Neff 2006; Rice 1986, 1987b). By integrating stylistic, mineralogical and chemical analyses, Cecil and colleagues highlighted the following trends: First, the sources and types of raw materials and manufacturing technologies used are described to be highly diverse, as evident in the co-existence of various ceramic paste recipes, and slip recipes and application methods among the samples (Cecil 2004, 2007; Cecil and Neff 2006). Local clays from the lake region were used to make different ceramic paste recipes for the slipped pottery throughout the Postclassic period. Second, the organisation of slipped pottery production is said to have changed through time. The production was initially characterised by the use of similar recipes for ceramic paste and slip by different producers in the region during the Early Postclassic (AD 1000–1250). It then changed to the use of specific recipes for ceramic paste and slip in combination with specific decorative programmes by producers from specific communities in the region during the Late Postclassic (AD 1250–1525), and the end products varied in quality. Third, the observed changes, as argued by Cecil and colleagues (Cecil 2007; Cecil and Neff 2006; Rice and Rice 2009), were attributed to the migration of the Itza and Kowoj socio-political groups from the north to the Central Petén Lakes region around AD 1250. They hypothesised that the communities involved in the production of Early Postclassic slipped pottery were 'local' to the lake region, sharing similar technological knowledge and access to raw materials and thus contributing to the uniform recipes and manufacturing technologies. They further postulated that some of these local communities were continuous from the Late Classic times, with persistence of Late Classic production technologies such as the use of double slips in decorating the Snail-Inclusion Paste wares (Cecil 2007: 26; Cecil and Neff 2006: 1489). Following the arrival of the Itza and Kowoj during the Late Postclassic period, the association of specific recipes for ceramic paste and slip with specific decorative programmes is interpreted to reflect attempts by the Itza and Kowoj to establish socio-political boundaries. Establishing boundaries had the effect of stimulating competition by restricting access to raw materials.

Fine-ware production of the Classic to Postclassic transition

Prior to the research on slipped pottery from the Central Petén Lakes region as described above, the key study of fine-ware production is that of the Fine Orange and Fine Grey fine paste ceramics of the Terminal Classic period (AD 750–900) by Rands, Bishop and colleagues (Bishop 1994; Bishop and Rands 1982; Bishop et al. 1982; Rands et al. 1982). By pioneering the use of INAA in conjunction with petrographic and statistical analyses, they situated three discrete locations in the Usumacinta drainage as the production centres of fine paste ceramics. Their study has significant implications as the case was made that fine paste ceramics were produced locally from within the Maya lowlands, thus revoking the hypothesis that they were imported. Howie's (2012) research on the production of pottery from the site of Lamanai, Belize, during the Classic to Postclassic transition (AD 750–1050) is equally important, and particularly relevant, to this study. Based on the results derived from a combination of technological, mineralogical and chemical analyses, Howie was able to show that fine-ware production was characterised by the co-occurrence of multiple paste traditions, with each tradition being bound by a set of internally consistent technical practices during the early phase of transition (AD 750–900/950).

These multiple paste traditions, each of which followed internally consistent practices, were replaced (AD 900/950–1050) by the adoption of a more general, shared approach marked in contrast by a high level of internal variability in raw materials and technical practices. Such change in craft organisation is described to have co-occurred with a change in consumption patterns, which together point to significant changes in ritual and ceremonial practice. These important case studies serve as the point of reference for this study: Did the production of Ahk'utu' moulded-carved vases and Zakpah ceramics display changes that are similar to, or different from, the changes observed by Howie? How does the fine-ware production characteristic of the eastern lowlands compare with fine-ware production in other parts of the Maya lowlands during the Classic to Postclassic transition?

Ahk'utu' moulded-carved vases

Ahk'utu' vases belong to the moulded-carved tradition dating to ca. AD 800–900/950, or the Terminal Classic period (Aimers 2007b; Graham 1987; Graham et al. 1980; Helmke et al. 1998). The vases are cylindrical or barrel-shaped, supported by hollow, oven-shaped tripod feet, with each foot containing a ceramic rattler and a circular perforation (Fig. 1a, b). The vases measure between 17 and 36 cm in height. The exterior surface is covered by orange-red slip and is decorated with two panels framing scenes of human interaction; there is also a gouge-incised glyph band. The scenes depict courtly themes, which have been interpreted to mimic the decorative programme of the Late Classic polychrome vases (Reents-Budet 1994a). The main text of the glyphic band includes the label *ahk'utu'*, literally 'giving-implements', whereas the remaining glyphs record the name and titles of a member of elite called Lady Olom, who bore the exalted titles but without any clear indication of a royal title or pedigree (Helmke and Reents-Budet 2008: 41–43). Based on the decipherment, coupled with the contexts of recovery—Terminal Classic ritual debris, middens and/or caches associated with elite residential structures—it is suggested that the Ahk'utu' vases were used in gift-giving observances such as feasting and were produced for this purpose (Graham et al. 1980: 165; Helmke 2001: 51–52). Helmke (2001) further argued that the vases that recorded the name and titles of Lady Olom were initially produced for her, but their widespread circulation resulted in the emergence of copies, which continued to be produced and distributed via similar social processes but in different social networks. The Ahk'utu' vases have seem to have an identifiable sphere of distribution; their presence is reported at sites mostly located along the Belize River, but also in the Stann Creek District, and in central and northern Belize, as well as parts of adjoining eastern Petén.

Zakpah ceramics

Zakpah is the group designation (Aimers and Graham 2013), originally applied to Postclassic ceramics at Cerros (Walker 1990), now used to describe pottery recovered at Lamanai from contexts dating to ca. AD 950/1000–1200/1250 (Hanna et al. 2016), a phase known as 'Buk' (Graham 1987), which is equivalent to the Early Postclassic period in the broader Maya chronology (Graham 2004; Pendergast 1981, 1982). The Zakpah ceramics comprise a distinctive set of vessel forms, including chalices and pedestal-based jars (Graham 1987: 82; Howie 2012; Pendergast 1982). The chalices are composite silhouette dishes with outflared everted rims, supported by pedestal bases (Fig. 2a), whereas the pedestal-based jars (referred to as 'jars' hereafter) are composite silhouette jars with collared rims, also supported by pedestal bases, and in some

Fig. 1 Ahk'utu' moulded-carved vase: **a** the vessel profile and **b** a panel showing the iconographic design. Illustration by Christophe Helmke and photograph by Dorie Reents-Budet (Ting and Helmke 2013: figure 1)

Fig. 2 Zakpah ceramics: **a** chalice (John 2008: 220, figure 6.47) and **b** pedestal-based jar. Photograph of pedestal-based jar by Carmen Ting

vessels there are flanges at the junction between the jar and pedestal base (Fig. 2b). Zakpah ceramics are notable for their orange or orange-red, lustrous slips, and elaborate decoration of abstract reptilian or saurian, and geometric motifs by incision and gouge-incision (John 2008: 137–177). Whereas the Zakpah group's focus on incision and on reptilian and geometric motifs differs from the decorative painting styles and depictions of the Late Classic period, the motifs have their roots in Early and Late Classic Maya art, as revealed by the iconographic analysis of Zakpah ceramics by John (2008: 333–335). Thus, it is argued that the visual innovation and iconographic shifts that occurred in the Maya lowlands between the mid-tenth and early thirteenth centuries can be traced to lowland local histories rather than to singular 'invasions' from central Mexico. The function or purpose of Zakpah ceramics remains ambiguous, but Zakpah vessels played an important part in elite mortuary and offertory ceremonies, as indicated by the context of recovery and use-wear of such ceramics at Lamanai (Howie 2012; Howie et al. 2010). Their role in ritual is further supported by the complex imagery on the ceramics and large vessel size (diameter and height measures up to 63 and 56 cm, respectively)—all of which are said to have imparted a direct or immediate visual experience on viewer during ritual and ceremonial activities (Howie 2012). In addition to Lamanai, Zakpah ceramics were recovered in approximately a dozen sites across Belize (Ting 2013). Equivalents of Zakpah ceramics have yet to be identified beyond Belize, which suggests that they may be an exclusively Belize or eastern lowlands zone phenomenon and could be used as a marker to define the Early Postclassic period in the eastern lowlands (Masson and Rosenswig 2005: 379).

Archaeological contexts

The Ahk'utu' vases and Zakpah ceramics included in this study were recovered from various sites across Belize. The vases came from eight sites: Altun Ha, Pook's Hill, Baking Pot, Marco Gonzalez, Cahal Pech, Mountain Cow, Zayden Creek and the Caves Branch sites (Sapodillas Rockshelter and Actun Lubul Ha) (Fig. 3). With the exception of Marco Gonzalez, archaeological evidence suggests that all sites experienced decline, abandonment of use and/or depopulation towards the end of the Classic period in the ninth century AD (Audet 2007; Graham and Pendergast 1989; Healy et al. 1998; Helmke 2006a, b; Morton 2010; Pendergast 1979; Wrobel and Shelton 2011). The Zakpah ceramics in this study were recovered from Marco Gonzalez (Fig. 3), which, along with Lamanai, produced the major extant assemblages of this pottery group (Graham et al. 2015; Graham and Pendergast 1989). Marco Gonzalez is the only site in this study that contains both types of fine-ware ceramics of the Classic to Postclassic transition, implying continuity in population and related activities. Smaller Zakpah ceramic assemblages from Caye Coco and Caracol are also included (Chase and Chase 2006; Masson 2002).

Methods

Macroscopic examination and sample selection

Macroscopic variation in fabric colour and composition, and presence or absence of slip and its colour constituted the basis of the strata from which a fraction of samples were selected, ensuring that the selected samples were representative of the compositional and technological variation that existed within and between assemblages. In total, 62 Ahk'utu' vases and 237 Zakpah ceramics were selected for further analyses (Table 1). This difference in the number of samples selected for the two vessel types was attributable to the overall small quantity of Ahk'utu' vases recovered despite the fact that their presence is reported from more sites. The high concentration of Zakpah ceramics recovered from Marco Gonzalez has been argued to reflect the site's function as a trading centre (Graham and Pendergast 1989). Macroscopic examination, in addition to

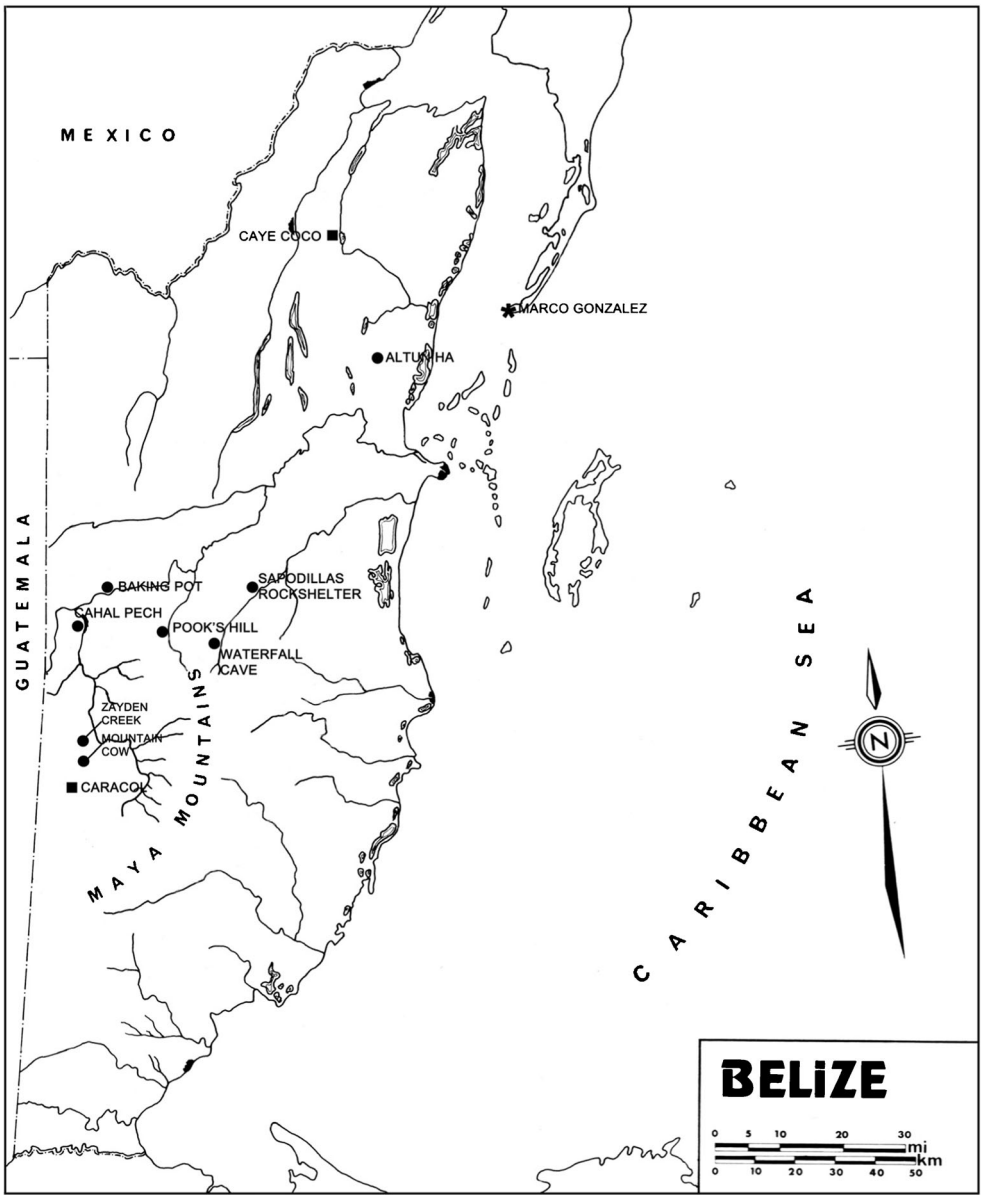

Fig. 3 Map of Belize showing the archaeological sites where the Ahk'utu' moulded-carved vases and Zakpah ceramics were recovered and included in this study. Legends: *circles* = Ahk'utu' moulded-carved vases; *squares* = Zakpah ceramics; *asterisk* = both Ahk'utu' and Zakpah ceramics

microscopic examination, was also useful in identifying certain aspects of manufacturing techniques, such as the mode and order of application of decorative methods, and preliminary assessment of firing condition.

Thin-section petrography and the geology of Belize

Thin-section petrography was used to characterise the mineralogical and textural composition of the ceramic samples (Freestone 1995). Mineralogical composition refers to the identification of aplastic component, i.e. temper and other inclusions in the clay component. Textural composition denotes the relative abundance, size, sorting and shape of aplastic inclusions and voids. Any variation in the mineralogical and textural composition was used to divide the samples into groups or subgroups, which are hypothesised to be representative of ceramic recipes that were unique to certain producers or production groups. Information on local and non-local geology has made possible the determination of the potential provenance of raw materials procured. Furthermore, petrographic data are also useful in revealing technological choices and practices (Quinn 2013; Whitbread 1995). For instance, the abundance and shape of aplastic inclusions can serve as evidence indicating whether the inclusions were added as temper or occurred naturally, whereas the size and sorting of aplastic inclusions is reflective of the paste preparation method. The thin sections were prepared and analysed using the polarising microscope at the UCL

Table 1 The Ahk'utu' and Zakpah samples included in this study

Vessel type	Site	Number of sherds sampled	Remarks
Ahk'utu'	Altun Ha	22	One of the largest Ahk'utu' assemblages
	Pook's Hill	20	One of the largest Ahk'utu' assemblages
	Baking Pot	8	
	Marco Gonzalez	5	
	Cahal Pech	2	
	Mountain Cow	2	
	Zayden Creek	1	
	Actun Lubul Ha	1	
	Sapodillas Rockshelter	1	
Zakpah (chalice and jar)	Marco Gonzalez	234	One of the largest Zakpah assemblages
	Caye Coco	2	More samples were recovered by surface collection and are not included in this study
	Caracol	1	

Institute of Archaeology Wolfson Archaeological Science Laboratories. A selected fraction of Zakpah samples was stained by a mixture of Alizarin Red S and potassium ferricyanide to distinguish the presence of dolomite from calcite.

Since the determination of the potential provenance of raw materials used in making the fine-ware ceramics entails building on knowledge of local geological conditions and sources of rocks and minerals, a brief summary of the geology of the study area is relevant in order to evaluate the strength of my conclusions. Belize is mostly underlain by limestones of different ages, with a general tendency of decreasing age from the southwest to the northeast (King et al. 1992; Wright et al. 1959). The limestones of the Cretaceous formations in the southwest are described as hard, with some limestones contributing to the development of the most striking karstic landscape of the country (King et al. 1992: 26; Wright et al. 1959: 24). The limestones of the Pleistocene–Holocene formations in the northeast are said to be deeply weathered, and display a marl-like characteristic, which is also known as sascab (Darch 1981; Darch and Furley 1983: 179). An exception to this vast low-lying limestone plain is the Maya Mountains, which occupy the southern part of the country. The geology of the Maya Mountains is characterised by the presence of Paleozoic metasediments and metamorphosed volcanic rocks with granite intrusions (Bateson and Hall 1977; Shipley and Graham 1987). Along the coast of mainland Belize is a carbonate shelf or coastal shelf, with varying geological composition depending on the geology of the adjacent coastal areas and other factors (High 1975). Of particular relevance to this study is Ambergris Caye, where Marco Gonzalez is situated. Located offshore along northeastern Belize, Ambergris Caye is underlain by Pleistocene limestones covered with Holocene skeletal carbonate sediments that are subjected to active processes of dolomitisation (Dunn and Mazzullo 1993: 121–122; Ebanks 1975: 234; Gregg et al. 1992: 143; Mazzullo and Reid 1988; Mazzullo et al. 1987, 1995: 341).

Scanning electron microscopy energy dispersive spectrometry (SEM-EDS)

SEM-EDS was used to characterise the elemental composition of the slip and associated ceramic body by focusing on a specific area of analysis of the sample. Any variation in composition between the two revealed whether or not clays from the same source but with refinement and/or addition of iron oxide were used for both slip and ceramic body (Freestone 1982). SEM can also produce high-resolution images at high magnification, allowing the examination of microstructure of the ceramic body, which was useful in estimating the temperatures at which the vessel was fired (Maniatis and Tite 1981; Tite and Maniatis 1975; Tite et al. 1982; Wolf 2002). The analyses were carried out using two different SEM suites—Hitachi SEM S-3400N and JEOL JXA 8600 Superprobe—at UCL Institute of Archaeology. Both instruments are fitted with Oxford Instruments INCA energy dispersive spectrometer analysis systems. They were set to 20.0 kV in voltage. The working distance was fixed at 10 mm, and the process time for each analysis was set to 5, with dead time ranging from 26 to 34%. By repeating the analyses of the same certified reference materials (BIR1 and BHVO2), the data produced by both instruments were accurate with the relative error for all elements below 10%, and the inter-instrument reproducibility was confirmed with the relative standard deviation of all elements below 8%. The elemental composition of the slip and ceramic body presented here represents an average of at least three analyses. All data were converted to oxides by stoichiometry and normalised to 100 wt.% to account for fluctuations in beam intensity and sample porosity.

Results

Ahk'utu' moulded-carved vases

Composition and potential provenance

Three fabric groups—Crystalline Calcite, Volcanic Ash and Mixed Carbonate—were identified (Table 2) (Ting 2015; Ting

Table 2 The distribution frequency of Ahk'utu' and Zakpah samples in accordance to the fabric groups and subgroups

Fabric group	Ahk'utu' vase	Zakpah chalice	Zakpah jar
Crystalline Calcite A	42		
Crystalline Calcite B	5	1	
Crystalline Calcite C		2	1
Volcanic Ash A	4		
Volcanic Ash B	4		
Volcanic Ash C	4		
Sascab A		61	20
Sascab B		48	27
Sascab and Quartz		12	8
Mixed Carbonate A	3	4	13
Mixed Carbonate B		30	10

et al. 2015: 18–21). The vast majority of samples belong to the Crystalline Calcite Group, with crystalline calcite serving as the principal type of inclusion. Two subgroups were further identified: Subgroup A contains calcite inclusions of varying grain sizes (ca. 0.08 to <3.2 mm with no clear mode grain size) and sorting (Fig. 4a), whereas the calcite inclusions of Subgroup B are generally more angular in shape and homogeneous in grain size (ca. 0.16–1.6 mm, mode grain size = 0.56 mm) suggesting that the calcite inclusions were likely added as temper for these vases (Fig. 4b). Subgroup B was further differentiated from Subgroup A by the presence of chert and chalcedony in a distinctively red clay matrix. Given the ubiquity of crystalline calcite in Belize and the common use of ceramic paste with crystalline calcite inclusions (Cecil 2007; Howie 2012; Jones 1986; Sunahara 2009), it is postulated that the vases of the Subgroup A were produced with resources extracted from sources local to the sites of recovery (Ting et al. 2015: 18–20). The only exception is represented by the vases recovered from Marco Gonzalez. There is a lack of raw materials required for pottery production on the island (or at least no adequate source has been located); therefore, the Ahk'utu' vases are assumed to have been imported from mainland Belize. On the other hand, the mineralogy of Subgroup B is consistent with the geology of Altun Ha and its surrounding area on the coastal plain east of the New River, which is underlain by limestones of Cayo and Doubloon Bank formations containing fragments of chert and chalcedony. Altun Ha is proposed as a likely source of production, at least based on the data.

Another major fabric group is the Volcanic Ash Group, which is distinguished by the addition of volcanic ash as temper. The samples were divided into three subgroups. Subgroups A and B contain biotite, plagioclase feldspar and quartz, but the inclusions of Subgroup A (ca. 0.16–0.56 mm, mode grain size = 0.24 mm) are coarser-grained than Subgroup B (ca. 0.16–0.24 mm, mode grain size = 0.16 mm) (Fig. 4c, d). Subgroup C contains only fine-grained quartz inclusions (ca. <0.16 mm) (Fig. 4e). The inclusions of the three subgroups exhibit a high degree of internal homogeneity in terms of grain size and sorting. The sources of volcanic ash is yet to be determined (Ford and Glicken 1987; Ford and Rose 1995), but the presence of quartz, feldspar and biotite inclusions in the samples of Subgroups A and B is consistent with the geology of the Maya Mountains area, which consists of granitic intrusions, thus pointing to the Maya Mountains area as the potential

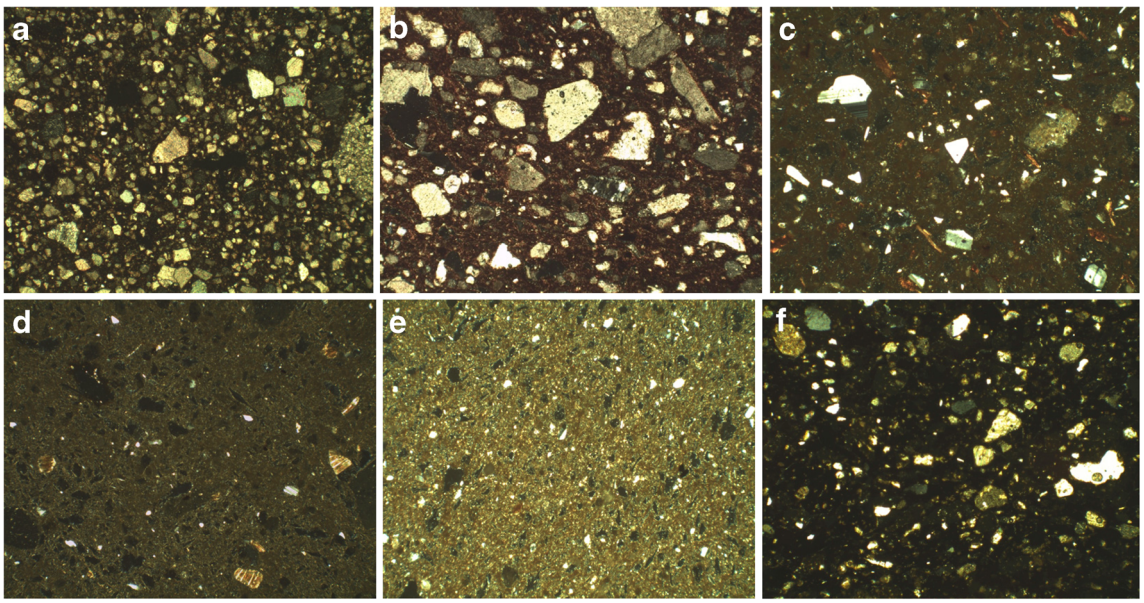

Fig. 4 Photomicrographs showing Ahk'utu' samples from **a** Crystalline Calcite Subgroup A, **b** Crystalline Calcite Subgroup B, **c** Volcanic Ash Subgroup A, **d** Volcanic Ash Subgroup B, **e** Volcanic Ash Subgroup C and **f** Mixed Carbonate Group. All photomicrographs were taken in XP at ×50 magnification. Field view = 3 mm

provenance of these vases (Ting et al. 2015). The fineness of Subgroup C has made it difficult to determine its origin. A few samples were placed into the Mixed Carbonate Group (Fig. 4f), which will be discussed below .

Slip application and composition

The presence of yellowish red (5YR 5/8) or reddish yellow (5YR 6/8) slip was recorded in 17 samples, including 13 from Crystalline Calcite Subgroup A, 3 from the Volcanic Ash Group and 1 from the Mixed Carbonate Group. Macroscopic observation revealed that the calcite vases were first slipped and then carved, whereas slip was applied after the execution of carving for the volcanic ash vases. Regardless of the order of slipping and carving, the analysis of the slip layer by SEM-EDS showed that there is no difference in slip composition between the calcite and volcanic ash vases. Yet, the slip composition is far from homogeneous, which might be attributable to the natural variation in clay sources or low level of standardisation in slip production as reflected in their high relative standard deviation value (Table 3). The compositional analysis further highlighted that there is no significant variation in elemental composition between the slips and associated clay body, although the slips stand out by virtue of a magnitude in their high FeO concentration. The FeO concentration of the slip ranges from 5.5 to 16.0% with a mean value of 9.5%, as opposed to 5.6% of the ceramic body (Ting et al. 2015: 21). This finding suggests that similar clay sources were used to make the ceramic paste and slip, but that iron oxide was added to the clays from which slips were made to enhance their redness (Papachristodoulou et al. 2010: 2152; Pérez-Arantegui and Castillo 2000).

Firing atmosphere and temperature

Macroscopic examination of paste colour revealed that the calcite vases were fired in a wide range of redox atmospheres as reflected in the presence of dark firing core of varying thickness, whereas the volcanic ash vases were fired in an atmosphere that succeeded in achieving complete oxidation, resulting in their homogeneous bright paste colour throughout. The SEM analysis of the microstructure showed there is a lack of vitrification of the clay matrix of the calcite vases, suggesting that they were fired at temperatures lower than 750°C (Fig. 5a) (Maniatis and Tite 1981). In contrast, the volcanic ash-tempered vases seem to have been fired at higher temperatures but still below 800°C, as evident in the development of tiny isolated patches of glassy surface, especially at the interface between volcanic ash temper and clay matrix (Fig. 5b, c) (Ting et al. 2015: 23).

Zakpah ceramics

Composition and potential provenance

Four fabric groups—Sascab, Quartz and Sascab, Mixed Carbonate and Crystalline Calcite—were recognised, and there is no distinction between the fabrics used to make chalices and jars (Table 2). The Sascab Group is the dominant fabric, with micritic calcite, or sascab, serving as the principal type of inclusion. The identification of micritic calcite with coralline structure and skeletal carbonate sand in the samples of Subgroup B serves to differentiate Subgroup B from Subgroup A, but in both cases, the inclusions display a wide range of grain sizes (ca. 0.16–3.2 mm with no clear mode grain size) and sorting (Fig. 6a, b). The presence of micritic calcite in the Sascab Group suggests northern Belize as the origin, and particularly the northeastern coast for Subgroup B. Despite the coralline structure of the micritic calcite, and the presence of skeletal carbonate sand in the samples of Subgroup B, a northeastern coast provenance is postulated for the vessels of Subgroup B rather than a local provenance at Ambergris Cay, where Marco Gonzalez is situated. This is because the suitability of the weakly developed carbonate mud on the Caye as raw material for pottery manufacture is highly questionable (King et al. 1992: 188–189). Also, given

Table 3 The maximum, minimum, mean, standard deviation (st. dev.) and relative standard deviation (rsd) of normalised SEM-EDS data (wt.%) of the slip and ceramic body of 17 Ahk'utu' moulded-carved vases

Area of analysis		MgO	Al_2O_3	SiO_2	K_2O	CaO	TiO_2	FeO
Slip (n = 17)	Maximum value	2.8	35.3	59.1	3.1	4.2	1.4	16.0
	Min value	0.4	20.7	51.3	0.3	1.9	0.6	5.5
	Mean	1.6	29.0	54.3	1.0	2.9	1.1	9.5
	st. dev.	0.9	3.3	2.9	0.7	0.8	0.3	2.8
	rsd (%)	58	12	5	72	29	26	29
Ceramic body (n = 17)	Maximum value	1.4	36.1	70.5	3.8	6.4	1.5	7.5
	Minimum value	0.3	16.8	51.2	0.5	1.4	0.5	4
	Mean	0.8	29.2	57.2	2.0	3.3	1.0	5.6
	st. dev.	0.4	5.7	5.6	0.7	1.3	0.3	1.0
	rsd (%)	47	19	10	37	38	28	18

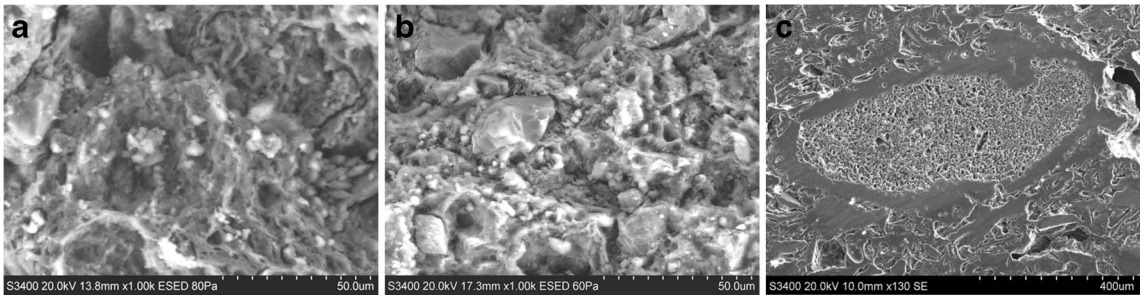

Fig. 5 Secondary electron (SE) images of **a** calcite sample showing the flaky structure of clay minerals; **b** volcanic ash sample showing the development of small bloating pores; **c** volcanic ash sample showing the development glassy phase at the interface of volcanic ash and clay matrix

the heavy fossiliferous nature of the sediments on the Caye, the few occurrences of micritic calcite with coralline structure and skeletal carbonate sand in the ceramic samples point to a non-local provenance. Further evidence to support a non-local source is the absence of dolomite in the samples, as shown by staining the samples by a mixture of Alizarin Red S and potassium ferricyanide. As noted above, active dolomitisation of carbonate sediments is characteristic of Ambergris Caye; therefore, dolomite would be expected to be present in the samples if the vessels were made with local raw materials.

Micritic calcite was also found in the Quartz and Sascab Group, although quartz is the principal type of inclusion in these samples (Fig. 6c). The quartz and micritic calcite inclusions are homogeneous in grain size (ca. 0.16–1.52 mm, mode grain size = 0.64 mm) and sorting. The mineralogy and texture of the Quartz and Sascab Group are consistent with Howie's

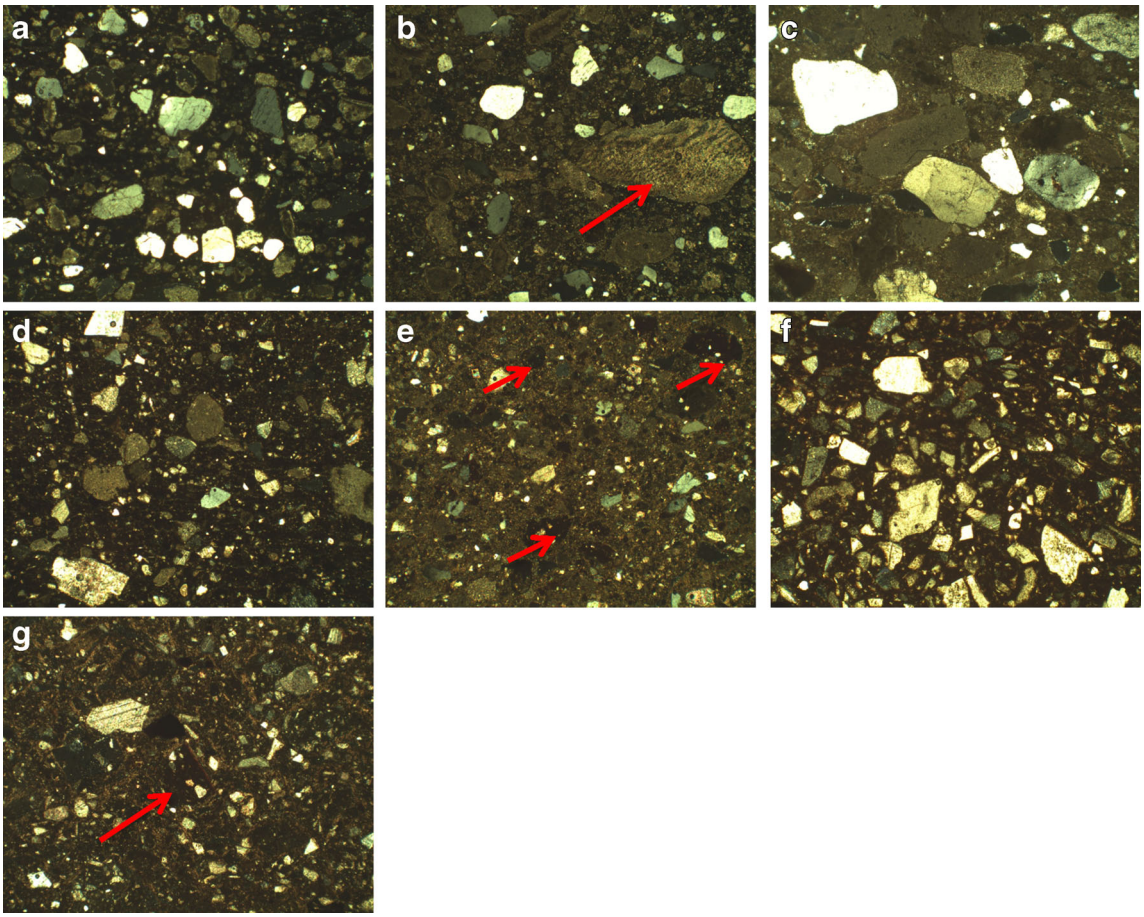

Fig. 6 Photomicrograph showing Zakpah samples from **a** Sascab Subgroup A, **b** Sascab Subgroup B with micritic calcite inclusion displaying coralline structure (indicated by *red arrow*), **c** Sascab and Quartz Group, **d** Mixed Carbonate Subgroup A, **e** Mixed Carbonate Subgroup B with grog temper (indicated by *red arrows*), **f** Crystalline Calcite Subgroup A and **g** Crystalline Calcite Subgroup B with grog temper (indicated by *red arrow*). All taken in XP at ×50 magnification. Field view = 3 mm

(2012) Sascab-Quartz A Group, which is described to be local to the archaeological site of Lamanai, implying that these vessels originated from Lamanai.

The Mixed Carbonate Group is characterised by the presence of various types of carbonate inclusions, including crystalline and micritic calcite, and shell fragments. Two subgroups were identified, with the addition of grog temper in Subgroup B distinguishing its samples from those of Subgroup A (Fig. 6d, e). The inclusions are angular, displaying homogeneous grain size (ca. 0.16–1.44 mm, mode grain size = 0.4 mm) and sorting. Lamanai was the potential provenance of the Mixed Carbonate Group, judging from its similarity with Howie's (2012) Grog-Mixed Carbonate Group, which is described as local to Lamanai. Noteworthy is that the Mixed Carbonate Group also characterises a small quantity of Ahk'utu' samples, suggesting that these vases were made at Lamanai.

Crystalline calcite inclusions are the principal type of inclusions for a few samples, with their mineralogical and textural characteristics similar to Crystalline Calcite Subgroup B (Fig. 6f). A further subgroup, Subgroup C, is identified owing to the addition of grog temper (Fig. 6g). Although Altun Ha potters are suggested as having produced the Ahk'utu' vases of Crystalline Calcite Subgroup B, it is not certain whether potters based at Altun Ha were involved in producing Zakpah ceramics, owing to the decline of the centre towards the end of the ninth century AD. That being said, the raw materials from the coastal plain east of New River might have been continued to be used, but by communities other than Altun Ha, in making Zakpah ceramics. Alternatively, the red and brown clay containing chert fragments around Corozal town, east of Progresso Lagoon and Hill Bank-Gallon Jug area, might have been procured to make Zakpah ceramics.

Slip colour and composition

The presence of slip was recorded in 87 chalices and 45 jars comprising samples from all fabric groups, but the slips exhibit different hues of orange, ranging from 'orange' (yellowish red 5YR 5/8) to 'red' (red 2.5YR 4/6) and 'brown' (strong brown 7.5YR 5/6). In spite of the macroscopic variation in slip colour, the chalices and jars are consistent in the order of slipping and carving, in which the vessels were slipped before the execution of incision and gouge-incision. The analysis of slip layers by SEM-EDS showed that there is no distinction in the composition of slip between chalices and jars. The compositional data further demonstrated that there is no significant difference in composition of the 'orange' and 'red' slips, suggesting that variation in colour was caused by duration and condition of firing (Table 4). That being said, the composition of the 'orange' and 'red' slips is far from homogeneous, as expressed in the high relative standard deviations of all elements, reflecting natural variation in raw materials or low degree of standardisation in slip production. On the other hand, the 'brown' slips stand out from the other two slip colours for their higher CaO concentration. It is the higher CaO concentration that contributed to the brown colour of the slips, as calcite grains inhibited the growth of iron oxides (Freestone 1982: 104; Maniatis et al. 1983: 780–781; Nodari et al. 2007: 4666). Interestingly, the 'brown' slips are mostly associated with the vessels of the Mixed Carbonate Group, implying that producers might not be as effective in removing the carbonate particles during slip preparation, or perhaps different clay sources and recipes for slip were used. Nonetheless, in all cases, slips of all colours have markedly lower CaO and higher FeO concentrations than their associated body clay. This finding indicates that non-calcareous clays were deliberately chosen to produce slips whereas calcareous clays were chosen in making the ceramic pastes.

Firing atmosphere and temperature

The chalices and jars appear to have been fired in varying redox atmospheres, judging from the visual examination of their paste colour. No particular correlation was noted among firing atmosphere, fabric group and vessel type. The vast majority of vessels—judging from the thickness of the dark firing core—were fired in atmospheres that range from incomplete oxidation to reduction followed by a brief period of oxidation. An exception are the vessels of the Crystalline Calcite Group, which were likely fired in a complete oxidising atmosphere, as evident in the homogeneous paste colour. Lack of vitrification of the clay matrices, however, indicates that the chalices and jars of all fabric groups were fired at temperatures lower than 750°C (Fig. 7).

Discussion

The choice of raw materials

There is little overlap in the raw materials used to produce Ahk'utu' vases and Zakpah ceramics (Table 1). This is highlighted by the identification of the dominance of crystalline calcite ceramic paste recipes for Ahk'utu' vases as opposed to the widespread use of micritic calcite ceramic paste recipes for Zakpah ceramics and the discontinuity in the use of volcanic ash temper. Such shift in preference for the raw materials used in fine-ware production might be related to the events that occurred in eastern lowlands during the Classic to Postclassic transition. The decline of communities in the southern part of eastern lowlands during the early phase of the transition might have contributed to the drastic decrease in the use of crystalline calcite ceramic paste recipes, as the petrographic and provenance studies confirmed that the Ahk'utu' vases with

Table 4 The maximum, minimum, mean, standard deviation (st. dev.) and relative standard deviation (rsd) of normalised SEM-EDS data (wt.%) of the 'red', 'orange' and 'brown' slips and their associated ceramic body of 95 Zakpah chalices and jars

Slip colour	Area of analysis		MgO	Al_2O_3	SiO_2	K_2O	CaO	TiO_2	FeO
Orange (n = 59)	Slip	Maximum value	5.3	32.7	57.2	4.5	8.1	3.4	20.5
		Minimum value	1.3	19.5	43.5	0.7	1.2	0.5	6.4
		Mean	2.3	27.8	51.8	2.0	4.0	1.2	11.0
		st. dev.	0.9	2.7	3.2	0.8	1.6	0.4	2.7
		rsd (%)	38	10	6	40	40	35	25
	Ceramic body	Maximum value	4.8	28.2	60.5	2.8	22.4	1.6	7.2
		Min value	1.0	20.2	45.5	0.6	5.1	0.6	4.2
		Mean	2.1	24.1	53.6	1.4	12.4	1.0	5.5
		st. dev.	0.7	1.6	3.1	0.4	3.4	0.2	0.7
		rsd (%)	35	7	6	27	27	21	12
Red (n = 26)	Slip	Maximum value	5.4	35.7	56.7	6.5	9.2	1.9	19.5
		Minimum value	1.1	20.6	42.0	0.9	1.9	0.6	6.0
		Mean	2.4	28.3	51.1	2.1	4.1	1.3	11.7
		st. dev.	1.2	3.6	4.0	1.3	1.6	0.3	3.2
		rsd (%)	52	13	8	59	40	23	28
	Ceramic body	Maximum value	4.2	28.9	56.6	2.7	18.4	1.7	8.7
		Minimum value	1.3	20.9	46.5	0.9	3.8	0.6	4.1
		Mean	2.2	24.5	53.8	1.6	11.4	1.0	5.7
		st. dev.	0.7	2.0	2.3	0.4	3.6	0.2	1.0
		rsd (%)	31	8	4	25	31	25	17
Brown (n = 10)	Slip	Maximum value	4.9	29.1	61.4	5.7	14.7	2.3	17.1
		Minimum value	1.3	18.6	44.1	0.9	2.7	0.7	0.8
		Mean	2.2	23.4	51.7	3.0	7.0	1.3	11.5
		st. dev.	1.1	3.9	5.0	1.8	4.2	0.5	2.9
		rsd (%)	49	17	10	58	60	40	25
	Ceramic body	Maximum value	2.3	25.2	57.5	2.7	18.4	1.2	5.9
		Minimum value	1.1	21.7	46.5	0.8	9.4	0.7	3.9
		Mean	1.6	23.7	54.6	1.2	13.1	0.9	5.0
		st. dev.	0.4	1.0	3.5	0.6	3.0	0.1	0.6
		rsd (%)	26	4	6	48	23	15	12

crystalline calcite inclusions were largely produced at the site of recovery using local resources. It was also the decline of these communities that might have led to the breakdown of existing elite networks, which in turn disrupted the movement of raw materials including volcanic ash (Graham 1994; Jones 1986; Simmons and Brem 1979), resulting in the disappearance of volcanic ash-tempered tradition. The subsequent rise of communities along the coastal and riverine locations in the northern part of eastern lowlands during the later phase of the transition might have attributed to the widespread use of micritic calcite ceramic paste recipes in making Zakpah ceramics, as the petrographic and provenances studies have established the connection between the two.

On the other hand, an interesting observation regarding the use of raw materials in fine-ware production is the use of grog temper in the production of Zakpah ceramics during the later phase of the transition, as evident in the identification of samples of Mixed Carbonate Subgroup B (n = 40) and Crystalline Calcite Subgroup C (n = 3). The use of grog temper was recorded in Preclassic pottery, but its application seems to have waned throughout the Classic period (Jones 1986: 20); the identification of grog temper in Zakpah ceramics might represent the revival of certain aspects of pottery production of previous times (Howie 2012), even though analyses on other types of fine-ware ceramics and domestic pottery are warranted to verify this hypothesis.

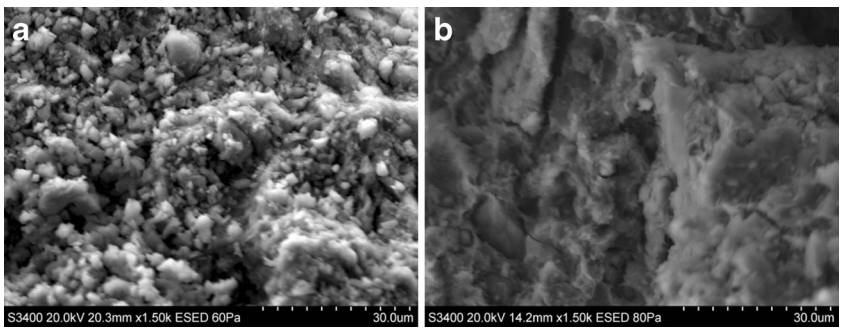

Fig. 7 Secondary electron (SE) images showing the lack of vitrification of the clay matrix of samples from **a** Sascab Subgroup A and **b** Crystalline Calcite Subgroup A

Manufacturing technologies

The manufacturing technologies—including paste preparation, surface finish and firing methods—vary between Ahk'utu' vases and Zakpah ceramics (Figs. 8 and 9), as well as within each vessel type. Variation in paste preparation between Ahk'utu' vases and Zakpah ceramics is not only limited to the type of raw materials used as discussed above but also the size of inclusions. The inclusions in the ceramic pastes of Ahk'utu' vases are generally finer-grained than those of Zakpah ceramics. The finer-grained inclusions might have facilitated the execution of more delicate iconographic designs found on Ahk'utu' vases, whereas the use of coarser-grained inclusions might be required to support the forming of Zakpah ceramics, which are significantly larger in size than Ahk'utu' vases. Yet, the inclusions of all ceramic pastes for each vessel type are by no means homogeneous in grain sizes and sorting, especially so in the case of the crystalline calcite ceramic pastes for Ahk'utu' vases, and the micritic calcite ones for Zakpah ceramics, reflecting low level of standardisation in paste preparation in both cases.

Turning to surface finish, Ahk'utu' vases and Zakpah ceramics share similar modes of decoration, i.e. slipping, incision and gouge-incision. Non-calcareous clays were carefully chosen to prepare the slips of their respective desired colour, but the composition is far from being homogeneous in both cases. However, variation still exists in the actual execution of decoration between and within these two vessel types. The order of slipping and carving is different between the calcite and volcanic ash Ahk'utu' vases, and incision and gouge-incision were only applied to enhance the designs that were already imprinted inside the moulds or applied to the vases by stamps. On the other hand, the order of slipping and carving seems to be consistent across all fabric groups for the Zakpah ceramics, with incision and gouge-incision being used to execute the designs from scratch.

In terms of firing, both Ahk'utu' vases and Zakpah ceramics were fired in a wide range of redox atmospheres. The majority of Ahk'utu' vases, especially the crystalline calcite ones, were fired in incomplete oxidising atmosphere, with the volcanic ash vases fired in complete oxidation. This contrasts sharply with the Zakpah ceramics, which were mostly fired in reducing atmosphere, followed by a brief period of oxidation. A possible explanation for the shift to reducing atmosphere is to prevent spalling owing to the use of calcareous clays in preparing the ceramic pastes of Zakpah ceramics, as demonstrated by the SEM-EDS analysis. Nonetheless, with the exception of the volcanic ash vases which were likely fired at slightly higher temperatures, all Ahk'utu' vases and Zakpah ceramics were fired at temperatures below 750°C. Varying redox atmospheres, coupled with low temperatures, points to the use of open firing methods for both vessel types.

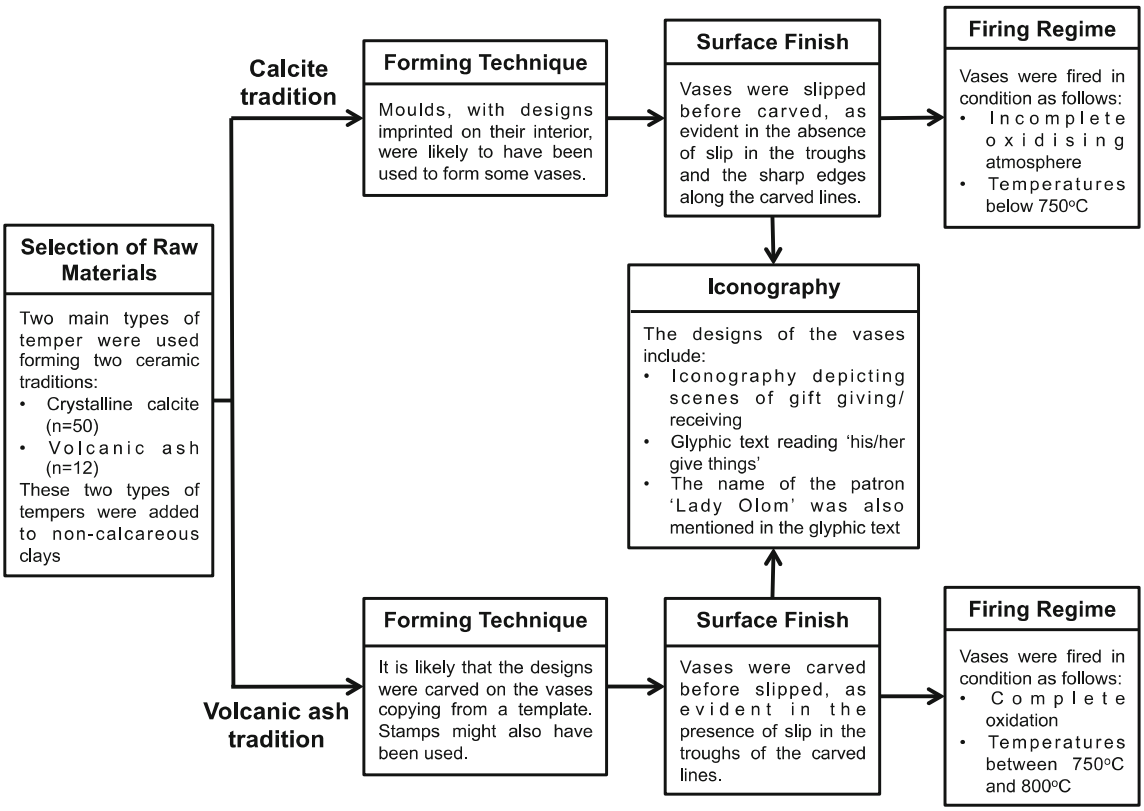

Fig. 8 The chaîne opératoire of the Ahk'utu' moulded-carved vases

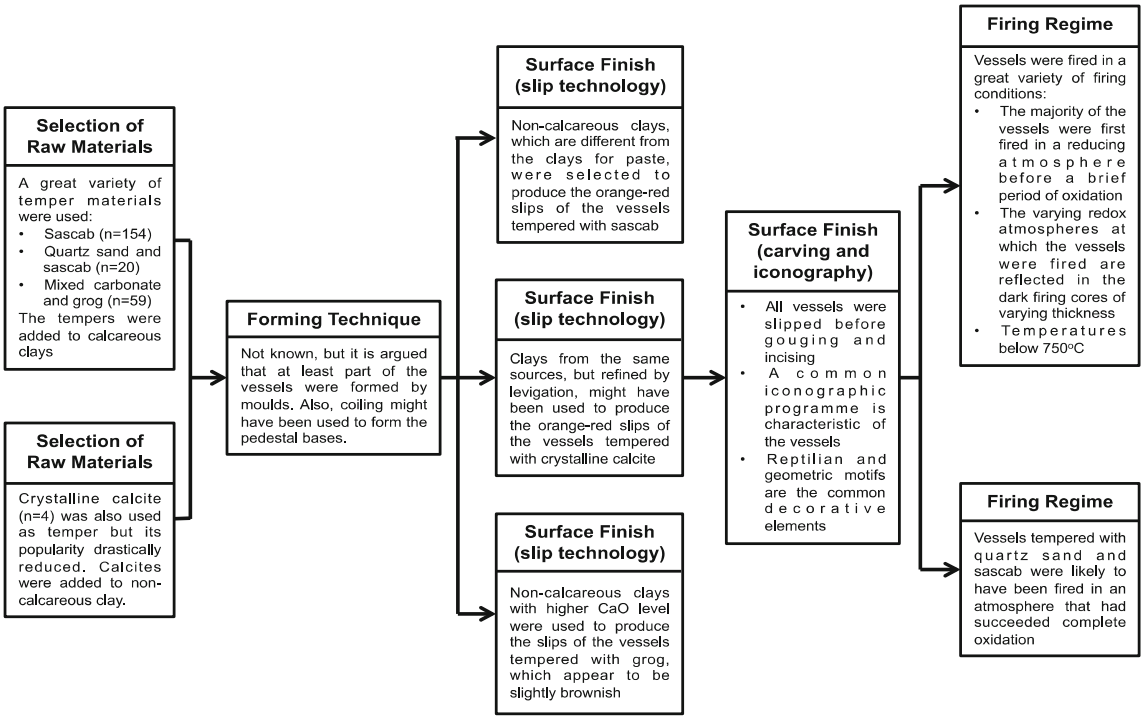

Fig. 9 The chaîne opératoire of the Zakpah ceramics

Craft organisation

Based on the compositional and technological data, it is evident that multiple production groups were involved in the production of both Ahk'utu' vases and Zakpah ceramics, but these production groups appear to have organised in two distinct ways. The production of Ahk'utu' vases was bound by two ceramic traditions—the calcite and volcanic ash traditions—which served to guide their associated producers in the choice of raw materials, forming, surface finish (i.e. the order of slipping and carving) and firing methods. This finding corresponds with Shepard's (1964) observation regarding the co-occurrence of the calcite and volcanic ash transitions in making ceramics in the Maya lowlands. Yet, rather than being a rigid system, these ceramic traditions were flexible enough to have permitted the co-existence of various ceramic recipes, in which similar raw materials were used but with different paste preparation methods, as exemplified in the identification of three ceramic paste recipes (Crystalline Calcite Subgroups A and B, Mixed Carbonate Group) for the calcite vases and three (Volcanic Ash Subgroups A, B and C) for the volcanic ash vases. In contrast, the production of Zakpah ceramics can be considered as one broad tradition, with great flexibility in the selection of raw materials and technical practices in producing vessels with similar morphologies and iconography. This broad tradition was materialised in a multiplicity of localised production groups, each with considerable liberty at the execution of the manufacturing processes. The concentration of these localised production groups in northern Belize, as indicated by the provenance studies, suggests the development of some sort of regional specialisation. Such change in the organisation of fine-ware production is consistent with the patterns highlighted by Howie (2012) in her study of pottery production at Lamanai during the transition.

The production of Ahk'utu' moulded-carved vases and Zakpah ceramics in the eastern lowlands and its relations to fine-ware production in the Maya lowlands during the transition

By comparing the results of this study with other better-known examples of fine-ware production—as represented by the Terminal Classic fine paste ceramics and the Postclassic slipped pottery—it has become apparent that fine-ware production in the Maya lowlands during the Classic to Postclassic transition is characterised by the co-existence of multiple regional production spheres. Each production sphere is made up of multiple localised production groups, each characterised by the use of raw materials that were likely procured from local sources and exhibited varying degrees of standardisation and specialisation. Yet, in spite of the use of local raw materials and multiple ceramic recipes, the producers within each production sphere seem to have shared the idea of what the end products should look like in terms of vessel form, colour and iconographic representations. In other words, the demands of consumers, i.e. the elites, influenced the style of fine-ware being produced.

Perhaps the most important feature that characterises fine-ware production during the Classic to Postclassic transition, as demonstrated particularly by the results of this study and the analyses of the Postclassic slipped pottery in the Central Petén Lakes region, is that its organisation was far from static and that it changed through time. In case of the Ahk'utu' moulded-carved vases and Zakpah ceramics, the change in craft organisation was accompanied by the change in vessel form and iconographic representation. Further the argument aforementioned, such change in the style of fine-ware ceramics is attributed to, and thus reflective of, a change in the composition and demands of the elites (Graham 2006: 114, 119; Graham and Helmke 2009). Indeed, hieroglyphic evidence recorded the emergence and proliferation of a new elite stratum that was considered as 'secondary' or 'lesser' to the Late Classic royal elites during the early phase of the transition. These 'non-royal' elites might have appropriated and amassed enough wealth and resources through constant shifting and transfer of tribute rights (Graham 2011: 38; 2012: 427–428), which was invigorated by the occurrence of frequent warfare during the end of the Late Classic and later periods (cf. Demarest 1996; Inomata 2003, 2004; Stuart 1993: 348–349). These new elites, with a change in their demands, instigated a change in their style of fine-ware, but there is no evidence indicating that elites had structurally intervened with the production process; thus, the elites are said to have 'controlled without controlling' (Graham 2012). The actual process of production was still largely placed in the hands of producers, and the change in craft organisation can, therefore, be interpreted as the producers' response to the change in elites' demands (Graham 2006: 121). Although this study argues for the lowering of social pyramid as the main factor leading to a change in craft organisation, this argument does not necessarily contradict with what Cecil and colleagues had hypothesised regarding the changes in the production of Postclassic slipped pottery in the Central Petén Lakes region, which appear to have occurred at later time at the turn of the Early and Late Postclassic period. In fact, by comparing the two case studies, what seems to have happened was that there was greater flexibility in how the fine-ware production and associated socio-political structures could be maintained in the Maya lowlands during the Classic to Postclassic transition.

The production of Ahk'utu' moulded-carved vases and Zakpah ceramics and its relation to Late Classic and Late Postclassic fine-ware production

The production of Ahk'utu' moulded-carved vases and Zakpah ceramics differed from the production of the Late Classic elaborately decorated polychrome vessels. There is no evidence showing that fine-ware production was attached to the palace compound or elite residences, or that the elites were directly involved in the production activities during the transition, even though the Ahk'utu' moulded-carved vases are argued to have been initially produced under the patronage of Lady Olom in the ninth century AD (Helmke and Reents-Budet 2008). The production of fine-ware ceramics during the transition, however, appears to have shared some features with the so-called village-tradition of the less elaborately decorated polychrome vessels of the Late Classic period (Ball 1993: 259), which are both characterised by the involvement of multiple local production groups. If we accept that some of the elaborately decorated polychromes were produced by elite artisans and then note that these vessels and their associated craft organisation ceased to exist towards the end of the Classic period in the ninth century AD, these observations would have indicated that the consumers of these elaborately decorated polychromes, i.e. the royal elites, had experienced a demise in power.

The production of the Ahk'utu' vases and Zakpah ceramics also differed from the pottery production characteristic of the Late Postclassic period (Rathje 1975). The manufacturing technologies of Ahk'utu' moulded-carved vases and Zakpah ceramics are far from standardised, with their composition and technical practices such as surface finish and firing methods displaying a high degree of internal heterogeneity. Also, there is no evidence indicating that fine-ware production during the transition was marked by craft or occupational specialisation. Although the production of Zakpah ceramics involved some sort of regional specialisation, such specialisation is characterised by multiple production groups using a great variety of raw materials derived largely from northern Belize rather than a concentration of production activities at a particular site (Rathje 1975). Furthermore, the same paste recipe was used to produce both chalices and jars, indicating a lack of product specialisation. All evidence suggests that such rules as standardisation, specialisation, simplification and routinisation did not apply to the production of Ahk'utu' moulded-carved vases and Zakpah ceramics; and if we accept the Late Postclassic pottery as products of mass production, such transformation in craft organisation might have occurred during the later facet of the Postclassic period.

Conclusion

The results of the compositional and technological analyses on the Ahk'utu' moulded-carved vases and Zakpah ceramics have highlighted that continuity and change are two interrelated forces in shaping the fine-ware production in the eastern lowlands during the Classic to Postclassic transition. There appears to have been a significant change in terms of the types of raw materials, including tempers and clays for paste and slip, used in the production of the Ahk'utu' moulded-carved vases and Zakpah ceramics, but one criterion of raw materials remained largely constant over time, which was the emphasis

on the procurement of local resources (Arnold 1980; Arnold et al. 1991). In this way, the changing preference for raw materials might simply be a reflection of changes in production locations (i.e. the materials locally available are different), suggesting that different communities were involved in the production and even exchange of the Ahk'utu' moulded-carved vases and Zakpah ceramics. Also, there seems to have been little consistency in manufacturing technologies such as in forming and firing methods between the two types of fine-ware ceramics, but their respective technical practices generally reflected a low degree of standardisation. Perhaps the most obvious difference between the two types of fine-ware ceramics lies in their craft organisation. Whereas the involvement of multiple production groups is noted in both cases, the production groups of the Ahk'utu' moulded-carved vases were bound by a set of procedures that were specific to their ceramic traditions. This contrasts with the Zakpah production groups, which shared ideas on what Zakpah ceramics should look like but executed these ideas with greater liberty and flexibility. Taken together, fine-ware production neither completely changed nor remained constant through time; but when changes occurred, they represented a gradual process of modification.

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