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MAYA POTTERY PRODUCTION AT NAKUM, GUATEMALA, DURING THE PROTOCLASSIC PERIOD (100/50 BC – AD 300/350)*

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B. HERMES

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This study investigates the Protoclassic ceramic production at Nakum, Guatemala, using it as a proxy to explore the nature of the transition from the Preclassic to Classic period (100/50 BC – AD 300/350) in Central Maya lowlands. Petrographic analysis reveals that household specialisation existed in the local production of slipped serving and utilitarian wares at Nakum. The recovery of locally made polychrome vessels further indicates that Nakum might have participated in a new network of cultural interactions and trade, enabling the community to sustain stable growth at a time when many major Preclassic sites declined.

KEYWORDS: CERAMIC ANALYSIS, PETROGRAPHY, CRAFT ORGANISATION, GUATEMALA, MAYA ARCHAEOLOGY, PROTOCLASSIC PERIOD

INTRODUCTION

Although the Classic period is widely accepted as the apogee of Maya civilisation, we know very little about how it emerged, as the phase leading to the Classic period remains poorly understood in many ways. This phase is referred to as the Protoclassic period (ca. 100/50 BC – AD 300/350) in our study, subsuming the transition from the Late Preclassic to Early Classic period (Brady *et al*. 1998: 34–45; Callaghan 2013; Estrada-Belli 2011: 117–119; Kosakowsky 2001; Pring 2000; Walker *et al*. 2006; Źrałka *et al*. 2018: 236). In the Central Maya lowlands, some of the more noticeable and drastic changes that occurred during the Protoclassic period include the decline of El Mirador and other major Preclassic centres, the disruption of existing trade routes and exchange networks, and the emergence of new socio-political orders that paved the way to royal kingship—an element epitomising Classic Maya civilisation (Reese-Taylor and Walker 2002: 87–88). In terms of material culture, specifically ceramics, the Protoclassic period is marked by the introduction of distinctive vessel forms and modes (e.g. the mammiform tetrapods, basal-flanged bowls or “pot stands”); the replacement of waxy, dark red Preclassic slips by glossier, lighter orange slips to decorate serving vessels; and the appearance and spread of polychrome vessels throughout Maya lowlands (Brady *et al*. 1998; Reese-Taylor and

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Walker 2002: 99–105). However, very few sites yield strong evidence of Protoclassic occupation or the presence of ceramic and other cultural markers typical of this period (Callaghan 2013); thus, the pace, mechanism, and agency that underlaid these changes are still subjected to constant debate.

We seek to explore the nature of the Protoclassic period in Central Maya lowlands by investigating the manners in which pottery production was organised at that time, given that craft organisation is often used as a proxy to gain insight into broader issues relating to social relations, economic system, and political structure of past societies (see Costin 2005 for overview). Seventy-eight ceramic fragments, which comprise a variety of utilitarian and serving pottery, from the site of Nakum, Guatemala, are the focus of our study. This assemblage is particularly well-suited to address our objective, as Nakum is one of the few sites that yielded substantial amount of ceramic evidence securely dated to the Protoclassic period through stratigraphic excavations and radiocarbon dating (Źrałka *et al*. 2011, 2018). Using the type-variety classification system and thin-section petrography, we identify the presence of local potting groups, their technological traditions (principally the source and type of raw materials and the paste preparation method), and the variety of vessels they produced. Comparing the results with pottery production during the Preclassic and Classic period sheds further light on how the craft organisation, and by extension the socio-political context such craft was embedded in, might have evolved.

ARCHAEOLOGICAL BACKGROUND

Preclassic and classic pottery production in Maya lowlands

The extant understanding of pottery production during the Preclassic period (ca. 1,000 BC – AD 250) is rather patchy, but specialised household production is argued to have existed based on the study of utilitarian and slipped serving vessels dating to the Middle Preclassic period from Holtun (Callaghan *et al*. 2017), and the pottery that spanned over the course of the Preclassic period from Cahal Pech (Ebert *et al*. 2019). Neutron activation analysis (NAA) was used in both studies, revealing that these vessels were made and consumed within local context, and that the vessels with different function and decoration had different chemical composition and thus paste recipe. In addition to local production and consumption, some vessels were intended for inter-regional exchange with their production concentrated in a few centres. Examples of such vessels include the Mars Orange Ware (Callaghan *et al*. 2018) and Fine Red pottery (Neff *et al*. 1988; Kosakowsky *et al*. 2000) dating to the Middle and Late Preclassic period, respectively.

On the other hand, the study of pottery production during the Classic period, especially its later phase (ca. AD 500–800/850), has been a major focus in Maya archaeology. Perhaps one of the most distinctive features of this period was the presence of elite control in the production of polychrome vases with hieroglyphic text and courtly scene. Such control could have exercised via the direct participation of elites as artisans in the actual production that took place in workshops locating near or within the palace (Ball 1993; Reents-Budet 1994; Reents-Budet *et al*. 2000, 2012; Inomata 2001; Foias 2002; Sharer and Golden 2004; Halperin and Foias 2012; Helmke *et al*. 2017; Źrałka *et al*. 2020), or via commissioning skilled artisans to travel from primary to secondary political centres to paint the vases (Rice 2009a; Rice 2009b; Halperin and Bishop 2016). Otherwise, household specialisation seems to be a feature that continues to characterise pottery production during the Classic period, a point highlighted by various studies on different pottery classes in different regions of Maya lowlands using different analytical approaches (e.g. Fry 1979, 1980; Rands *et al*. 1982; Sunahara 2009; Halperin and Foias 2012; Howie 2012; Ting *et al*. 2015; Ting 2018). The production of the less elaborately decorated polychrome vases and other classes of serving vessels is said to have occurred at dispersed households and village communities, possibly alongside the manufacture of utilitarian pottery (Ball 1993). The potters who operated within the same region might have learnt and executed their craft through a constellation of practices, based on the results of a recent study of utilitarian pottery productions in the Belize River Valley (Jordan *et al*. 2020).

Whereas different aspects relating to Preclassic and Classic pottery production have been examined in varying extents, very little work has been done to bridge their developments over time, except the investigation on the materials from Holmul. Focusing on the orange slipped serving vessels, Callaghan (2008, 2013) proposed that their production and consumption were embedded in a ritual economy (Spielmann 2002; Well 2006) rather than a political economy. This argument was not only based on the projected function of these orange slipped vessels in ritual feasting but also on the observation that the raw materials and technologies used to produce the orange slipped vessels were largely unrestricted. A modified 'palace-school tradition' (Ball 1993) is further put forward to frame the production of the polychrome variants of the orange slipped vessels, in which the potters were not necessarily elites themselves, but the potters, possibly deriving from different socio-economic strata, were allowed to foster and circulate a shared belief system and worldview through participating in different stages of pottery making.

Protoclassic pottery in Nakum

Situated in the Yaxha-Nakum-Naranjo National Park, or the 'Triangle Park', in northeastern Guatemala, Nakum was an important Maya centre at the turn of the Preclassic and Classic periods (Fig. 1), as revealed by the recent investigations by the Jagiellonian University (Źrałka *et al*. 2011, 2018). Unlike most centres in the region, which were abandoned toward the end of the Preclassic period, Nakum experienced continuous occupation and growth. The Protoclassic period at Nakum dates to around 100/50 BC to AD 300/350, based on the radiocarbon samples collected from the excavations of Structures 14, 15, 99, and X, and the typological comparison with other sites that yielded substantial Protoclassic component (Hermes 2019; Źrałka *et al*. 2014, 2018; Supplementary Table S1). The excavation of these structures yielded almost 4,000 ceramic fragments, 11 complete vessels or ceramic discs, and two partially complete vessels, which were submitted to type-variety classification (refer to Supplementary Table S2 for the type-variety nomenclatures mentioned in the text, and Gifford 1976 for further explanation of how this classification works), allowing for the identification of a fully viable ceramic complex called Ajkok (Hermes 2019) that represents the Protoclassic period at Nakum. The Ajkok Ceramic Complex comprises eight ceramic classes, 24 groups, 85 types, and 105 varieties (Hermes 2019: 133–92), which can be divided into two facets (early and late), corresponding with Brady *et al*.' (1998) divisions of this ceramic phase into Protoclassic 1 and Protoclassic 2.

The early facet of Ajkok overlaps with the final part of the Preclassic period (Chicanel horizon). During this facet, we observe a continuation of the manufacture of vessel types and decorations typical of the Late Preclassic Chicanel horizon (termed Tzutz at Nakum) but with the addition of new vessel forms such as vessels with mammiform hollow supports. Although both slipped and unslipped ceramic groups characteristic of the Chicanel-Tzutz Complex continue, there is a slight increase in the frequency of materials with decoration imitating the Usulután-type designs (represented primarily by the Caramba and Escobal Groups). This early facet is also characterised by the apparition of pottery belonging to the Holmul Orange Class

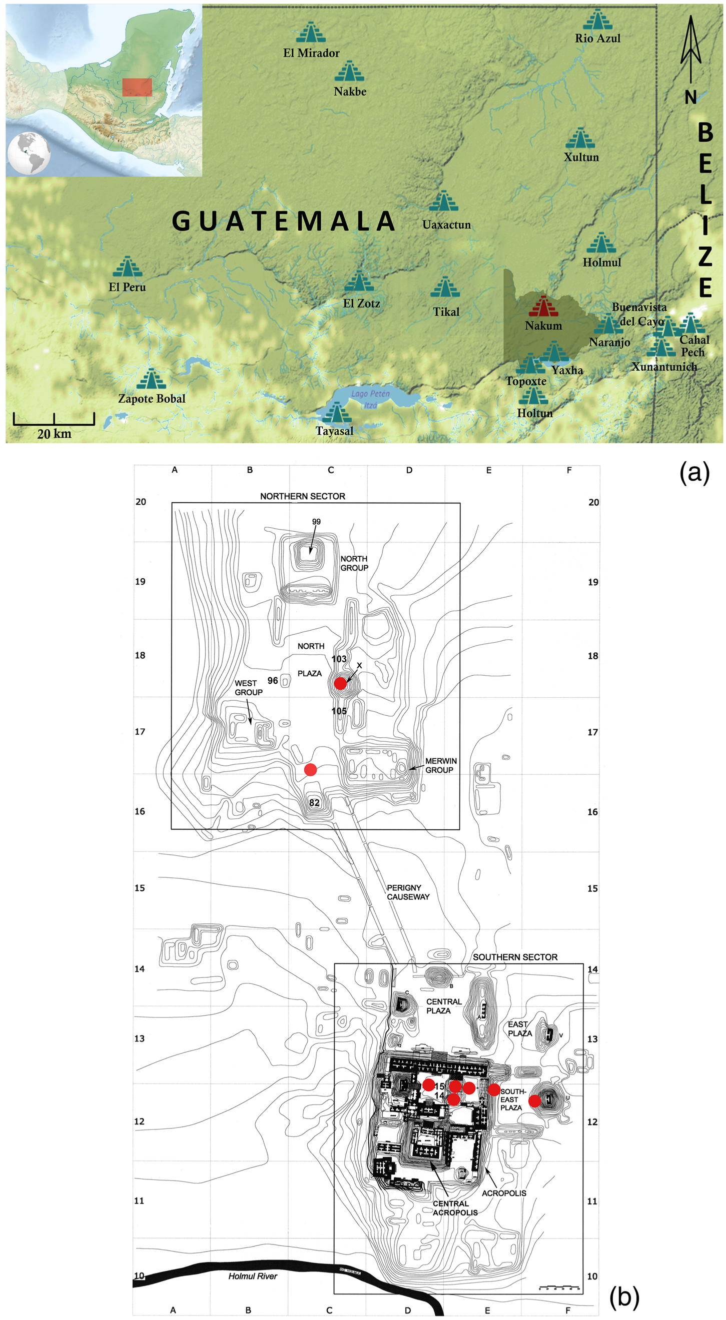

FIGURE 1 *Maps showing a part of Central Maya Lowlands where Nakum and other sites mentioned in the text are located, and the site plan of Nakum (a) Map of a part of Central Maya Lowlands showing the location of the Triangle Park and Nakum along with other sites mentioned in the text (map by Dorota Bojkowska, the Nakum Archaeological Project); (b) map of Nakum featuring major sectors and architectural complexes of the site along with the location of buildings where ceramic samples described in this article were recovered (note red dots that mark buildings from which samples come; map after Quintana and Wurster 2002 with corrections by the authors). [Colour figure can be viewed at wileyonlinelibrary.com]*

or Ware—which is a clear marker of Protoclassic in the Maya Lowlands (e.g. Brady 1987; Gifford 1976: 127–145)—characterised by the use of an orange base or background slip and new glossy finish of the vessel surface. This new ceramic class brings to Nakum bichrome (red-on-orange) and polychrome (red- and black-on-orange) decoration that usually embellishes such vessel forms as dishes, plates with sharp Z-angle, as well as vases with straight diverging walls and a rim thickened on the outside; all these vessels are tetrapods with hollow mammiformed supports. Within the Holmul Orange Class, we also identify the occurrence of polychrome decoration for the first time in the local ceramic repertoires of Nakum. The materials of the Holmul Orange Class (represented by the Aguacate Ceramic Group) constitute a reliable marker for the early facet of the Ajkok Complex, as evidenced by the Guacamallo Red-on-Orange and Ixcanrio Orange Polychrome.

As for the later facet of the Ajkok Ceramic Complex, we notice a shift in preference for vessels with orange base slip of the Aguila Group, replacing the red slip ceramics typical of the Preclassic period. It seems that the Aguila Group slowly replaces the Aguacate Group ceramics of the Holmul Orange Class. In terms of vessel shapes, during the later facet of Ajkok, there was a continuation of tetrapod plates and dishes with hollow mammiform supports and an acute Z-angle, primarily in different types of the Aguila Group. By the end of Ajkok, the use of mammiform supports declined, which was completely replaced by plates and dishes with low annular support and acute Z-angle. In addition to these slipped serving wares, undecorated ceramics

FIGURE 2 *Selected Protoclassic ceramic samples from Nakum that were included in this study [Colour figure can be viewed at wileyonlinelibrary.com]*

classified as the Uaxactun Unslipped Ware, as well as three undetermined wares that seem to be exclusive to Nakum, are the utilitarian pottery that made up the Ajkok Complex.

MATERIALS AND METHODS

Seventy-eight samples were selected, representing the type, group, and ware designations that were identified in the Protoclassic assemblage from Nakum (Fig. 2; Table 1). These samples are made up of both slipped serving and utilitarian pottery, encompassing a variety of vessel forms. Noteworthy are the four samples designated as the Mars Orange Ware, which is typical of the Middle Preclassic ceramic repertoire, and the presence of these samples in the Protoclassic context most probably reflects mixed or reused materials. We decided to include these Mars Orange samples, nonetheless, as they may contribute to the current debate on the Middle Preclassic exchange networks (see Callaghan *et al*. 2018), paving the way for the developments seen in the Protoclassic period. Thin-section petrography is the principal analytical method used in our study, with a separate study that focuses on the surface treatment using other microscopic techniques and experiments being in progress. The samples were prepared in the laboratory of the Faculty of Geology, Geophysics and Environmental Protection of AGH, University of Science and Technology Kraków, and analysed using the LEICA DM EP Polarising Microscope at the UCL Wolfson Archaeological Sciences Laboratories. All samples were subjected to an initial examination to identify their mineralogical and textural characteristics (e.g. the overall and relative abundance, shape, and size of the inclusions, the alignment of the inclusions and voids, and the colour of the clay matrix and its optical activity). Variations in the mineralogy and texture serve to place the samples into different fabric groups and associated subgroup. The Whitbread's system (Whitbread 1995) was loosely adopted to describe the characteristics of the fabric groups, whereas the estimation of the inclusions' abundance was carried out with reference to the percentage charts developed by Matthews *et al*. (1991).

Petrographic analysis is useful in establishing the presence of local pottery production at Nakum, because the samples included in this study were not recovered from contexts with direct evidence of production, which are generally rare in Maya archaeology (see Halperin and Foias 2012; Jordan and Prufer 2017; Reents-Budet *et al*. 2000 for exceptions). The potential provenance of the samples was determined through a comparison of their mineralogy with local geological maps and surveys, which are elaborated below. Petrographic analysis was also used to identify how many manufacturing traditions existed— each represented by a fabric group and/or associated subgroup—allowing us to address issues relating to craft organisation. Whereas it is true that a focus on the fabric of the samples in our study does not allow a full reconstruction of all stages of production, it will nonetheless permit an insight into the sources and types of raw materials the potters used, and the ways the materials were processed into making the ceramic paste, as well as some preliminary observations relating to the forming technique and firing temperatures.

Geological setting of Nakum and surrounding regions

Northeastern Guatemala, where Nakum is located, is part of the Maya (sometimes called Yucatán) Block, which stretches southward to cover the rest of northern Guatemala up till the Motagua River in the central-eastern part of the country and extends to the north and east to cover Belize, Yucatán Peninsula, and Western Mexico. The dominant bedrock of the block is limestones of varying geologic ages, and the limestones that underlie northeastern Guatemala date

Table 1 *The description of the Protoclassic ceramics selected for our study, including type-variety designation, vessel form, and context of recovery*

Sample no.	*Type of structure*	*Archaeological context*	*Ware*	*Group*	*Type*	*Variety*	*Vessel form*
148	pyramidal temple	Str. 15, core	Paso Caballo Waxy	Sierra	Sierra Red	Sierra	undetermined
149	pyramidal temple	Str. 15, core	Paso Caballo Waxy	Sierra	Sierra Red	Sierra	undetermined
150	residential	residential platform, surface	Paso Caballo Waxy	Sierra	Sierra Red	Sierra	undetermined
151	ceremonial	Str. 14, core	Paso Caballo Waxy	Sierra	Sierra Red	Sierra	undetermined
152	residential structure, periphery	Str. 2, looters trench	Paso Caballo Waxy	Sierra	Sierra Red	Sierra	undetermined
153	ceremonial	Str. 14, core	Paso Caballo Waxy	Boxcay	Boxcay Brown	Boxcay	undetermined
154	ceremonial	Str. 14, core (platform on which canal stands)	Paso Caballo Waxy	Boxcay	Boxcay Brown	Boxcay	undetermined
155	pyramidal temple	Str. X, core (Protoclassic version of the building)	Paso Caballo Waxy	Polvero	Polvero Black	Polvero	undetermined
156	pyramidal temple	Str. X, core (Protoclassic version of the building)	Paso Caballo Waxy	Polvero	Polvero Black	Polvero	undetermined
157	ceremonial	Str. 14, on the floor of the Hidden Building	Paso Caballo Waxy	Flor	Flor Cream	Flor	dish with rim flange
158	n/a	n/a	Paso Caballo Waxy	Flor	Flor Cream	Flor	dish with rim flange
159	n/a	n/a	Holmul Orange	Aguacate	Ixcanrio Orange Polychrome	¿Ixcanrio?	plate or dish with Z-angle
160	n/a	courtyard, construction fill	Holmul Orange	Aguacate	Ixcanrio Orange Polychrome	¿Ixcanrio?	plate or dish with Z-angle
161	pyramidal temple	Strs. 14–15, core	Holmul Orange	Aguacate	Guacamallo Red-on-Orange	Guacamallo	undetermined
162	pyramidal temple	Str. X, core (Protoclassic version of the building)	Holmul Orange	Aguacate	Guacamallo Red-on-Orange	Guacamallo	undetermined

(*Continues*)

Table 1 (Continued)

Sample no.	Type of structure	Archaeological context	Ware	Group	Type	Variety	Vessel form
163	pyramidal temple	Str. 15, core	Holmul Orange	Aguacate	N/D Trichrome Red and Black-on-Orange	n/a	plate or dish with Z-angle
164	ceremonial	Str. 14, core	Holmul Orange	Aguacate	N/D Trichrome Red and Black-on-Orange	n/a	plate or dish with Z-angle
165	pyramidal temple	Str. 15, core	Peten Gloss	Águila	Águila Orange	Águila	dish with flared sides
166	ceremonial	Str. 14, on the floor of the Hidden Building	Peten Gloss	Águila	Águila Orange	Águila	dish with flared sides
167	ceremonial	Str. 14, core	Peten Gloss	Águila	Águila Orange	Águila	dish with flared sides
168	pyramidal temple	Str. 15, core	Peten Gloss	Águila	Águila Orange	Águila	dish with flared sides
169	ceremonial	construction fill	Peten Gloss	Águila	Águila Orange	Águila	dish with flared sides
170	n/a	Patio 1, construction fill	Peten Gloss	Águila	Águila Orange	Águila	dish with flared sides
171	n/a	n/a	Peten Gloss	Águila	Águila Orange	Rojo Mate	dish with flared sides
172	ceremonial	Str. 14, core	Peten Gloss	Águila	Águila Orange	Dos Hermanos	dish with flared sides
173	pyramidal temple	Str. U, core, reused material from earlier context	Peten Gloss	Águila	Águila Orange	Dos Hermanos	dish with flared sides
174	ceremonial	Str. 14, core	Peten Gloss	Águila	N/D Red-on-Orange Transitional	n/a	bowl with round sides
175	ceremonial	Str. 14, core	Peten Gloss	Águila	Sabaneta Black-on-Orange	Sabaneta	bowl with rounded Z-angle
176	ceremonial	Str. 14, core	Peten Gloss	Águila	Sabaneta Black-on-Orange	Sabaneta	bowl with rounded Z-angle
177	ceremonial	Str. 14, core	Peten Gloss	Águila	Sabaneta Black-on-Orange	Con Diseños	bowl with rounded Z-angle
178	ceremonial complex	Acropolis platform, core	Peten Gloss	Águila	Sabaneta Black-on-Orange	Con Diseños	bowl with rounded Z-angle
179	ceremonial	Str. 14, core	Peten Gloss	Águila	Sabaneta Black-on-Orange	Sis	bowl with rounded Z-angle
180	ceremonial	Str. 14, core	Peten Gloss	Águila	San Blas Red-on-Orange	San Blas	undetermined
181	pyramidal temple		Peten Gloss	Águila	San Blas Red-on-Orange	San Blas	undetermined

(Continues)

Table 1 *(Continued)*

Sample no.	*Type of structure*	*Archaeological context*	*Ware*	*Group*	*Type*	*Variety*	*Vessel form*
		Str. X, core (Protoclassic version of the building)					
182	ceremonial complex	Acropolis platform, core	Peten Gloss	Águila	Actuncan Orange Polychrome	Actuncan	dish with acute Z-angle
183		core of the patio	Peten Gloss	Águila	Actuncan Orange Polychrome	Actuncan	dish with acute Z-angle
184	ceremonial	Str. 14, core	Peten Gloss	Águila	Actuncan Orange Polychrome	Actuncan	dish with acute Z-angle
185	pyramidal temple	Str. X, core (Protoclassic version of the building)	Peten Gloss	Águila	N/D Trichrome Red and Black-on-Orange	Simple	dish with acute Z-angle
186	pyramidal temple	Str. X, core (Protoclassic version of the building)	Peten Gloss	Águila	N/D Trichrome Red and Black-on-Orange	Simple	dish with acute Z-angle
187	n/a	Patio 10, construction fill	Peten Gloss	Águila	N/D Trichrome Red and Black-on-Orange	Simple	dish with acute Z-angle
188	ceremonial	Str. 14, core	Peten Gloss	Águila	N/D Trichrome Red and Black-on-Orange	Simple	dish with acute Z-angle
189	ceremonial	Str. 14, core	Peten Gloss	Balanza	Balanza Black	Balanza	undetermined
190	ceremonial	Str. 14, core	Peten Gloss	Balanza	Balanza Black	Balanza	undetermined
191	ceremonial	Str. 14, core	Peten Gloss	Balanza	Balanza Black	Balanza	undetermined
192	ceremonial	Str. 14, core	Peten Gloss	Balanza	Balanza Black	Paixbono	undetermined
193	n/a	Str. 14, core	Peten Gloss	Balanza	Balanza Black	Paixbono	undetermined
194	ceremonial	Str. 14, core	Peten Gloss	Balanza	Lucha Incised	Lucha?	undetermined
195	ceremonial	Str. 14, core	Peten Gloss	Balanza	Lucha Incised	Lucha?	undetermined
196	ceremonial	Str. 14, core	Peten Gloss	Balanza	Lucha Incised	Lucha?	undetermined
197	ceremonial	Str. 14, core, on the floor of the Hidden Building	Peten Gloss	Balanza	Lucha Incised	Lucha?	undetermined
198	ceremonial	Str. 14, core	Peten Gloss	Fama	Caldero Buff Polychrome	n/a	dish with acute Z-angle
199	ceremonial	Str. 14, core	Peten Gloss	Fama	Caldero Buff Polychrome	n/a	dish with acute Z-angle
200	n/a	courtyard, construction fill	Peten Gloss	Fama	Caldero Buff Polychrome	n/a	dish with acute Z-angle
201	ceremonial	Str. 14, core	Peten Gloss	Pucté	Pucté Brown	Pucté	undetermined

(*Continues*)

Table 1 *(Continued)*

Sample no.	Type of structure	Archaeological context	Ware	Group	Type	Variety	Vessel form
202	n/a	area between Strs. 14 and 15	Peten Gloss	Pucté	Pucté Brown	Pucté	undetermined
203	n/a	area between Strs. 14 and 15, surface	Peten Gloss	Batellos	Batellos Black-on-Red	Batellos	dish with acute Z-angle
204	n/a	area between Strs. 14 and 15, surface	Peten Gloss	Batellos	Batellos Black-on-Red	Batellos	dish with acute Z-angle
205	ceremonial	Str. 14, on the floor of the Hidden Building	Peten Gloss	Batellos	Batellos Black-on-Red	Batellos	dish with acute Z-angle
206	ceremonial	Str. 14, interior of Red Building	Undetermined no.1	Kol	Kol Café Rojizo Estriado	n/a	globular bowl (olla)
208	n/a	area between Strs. 14 and 15, surface	Undetermined no.2	Leb´	Leb´ Negro Grueso	n/a	globular jar
209	pyramidal temple	Str. 15, core, reused material	Undetermined no.3	Leb´	Leb´ Negro Grueso	n/a	globular jar
210	pyramidal temple	Str. X, core	Mars Orange	Savana	Savana Orange	n/a	undetermined
211	pyramidal temple	Str. 15, layer of debris and collapse	Mars Orange	Savana	Savana Orange	n/a	undetermined
212	ceremonial	above the major chamber of the bedrock steam bath	Mars Orange	Savana	Reforma Incised	n/a	undetermined
213	pyramidal temple	Str. 15, core	Mars Orange	Savana	N/D Media Caña	n/a	globular jar or bowl
214	pyramidal temple	Str. 15, core	Uaxactún Unslipped	Paila	Paila Unslipped	Paila	globular jar or bowl
215	ceremonial	Str. 14, core	Uaxactún Unslipped	Paila	Paila Unslipped	Paila	globular jar or bowl
216	ceremonial	Str. 14, core	Uaxactún Unslipped	Paila	Paila Unslipped	Paila	globular jar or bowl
217	pyramidal temple	Str. X, core	Uaxactún Unslipped	Zapote	Zapote Striated	n/a	globular jar or bowl
218	residential structure, periphery	Str. 2, looters trench	Uaxactún Unslipped	Zapote	Zapote Striated	n/a	globular jar or bowl
219	ceremonial structure	Acropolis platform, core	Uaxactún Unslipped	Zapote	Zapote Striated	n/a	globular jar or bowl

(Continues)

Table 1 (*Continued*)

Sample no.	*Type of structure*	*Archaeological context*	*Ware*	*Group*	*Type*	*Variety*	*Vessel form*
220	ceremonial	Str. 14, core	Uaxactún Unslipped	Quintal	Quintal Unslipped	Quintal	globular jar or bowl
221	ceremonial	Str. 14, core	Uaxactún Unslipped	Quintal	Quintal Unslipped	Quintal	globular jar or bowl
222	ceremonial	Str. 14, core	Uaxactún Unslipped	Quintal	Quintal Unslipped	Pasta Roja	globular jar or bowl
223	pyramidal temple	Str. 15, surface on top of the building	Uaxactún Unslipped	Triunfo	Triunfo Striated	Morfín	dish or bowl with rounded Z-angle
224	ceremonial	Str. 14, core	Uaxactún Unslipped	Triunfo	Triunfo Striated	Morfín	dish or bowl
225	ceremonial	construction fill that covers the bedrock steam bath	Uaxactún Unslipped	Triunfo	Triunfo Striated	Pasta Roja	dish with large diameter
226	ceremonial	Str. 14, reused context	Uaxactún Unslipped	Triunfo	Triunfo Striated	Pasta Roja	dish with large diameter

to Cretaceous (Dixon 1956; Donnelly *et al*. 1991). The region is further characterised by smaller exposures of Palaeozoic sedimentary rocks, red beds, and Late Cretaceous to early Teritary wackes. Outcrops of sandstones, conglomerates, and shales, which are derived from the Santa Rosa Group of the Maya Mountains in Belize (Bateson and Hall 1977), are also recorded. The southern part of Guatemala belongs to the Chortís Block, which encompasses all of El Salvador and Honduras, and most of Nicaragua. The Guatemalan Highlands is situated in this region and consists mainly of metamorphic and plutonic rocks, including granite, adamellite, quartzfeldspthic gneiss, two-mica schist, amphibolite, marble, and phyllite (Donnelly *et al*. 1991). Along the Pacific Coast in the western part of Southern Guatemala, an imposing chain of Quaternary volcanoes and alluvial sediments is present, with the volcanoes being the primary supplier of rhyolitic air-fall and ash-flow tuffs (Neff and Bove 1999). The two blocks are separated by the Motagua suture zone, which follows the course of the river with the same name, characterised by the presence of a dismembered ophiolitic assemblage of the El Tambor Group, with serpentinite being the dominant lithology (Donnelly *et al*. 1991; Ortega-Gutiérrez *et al*. 2010).

RESULTS

All but two samples were placed into two main fabric groups, namely the Calcite Group and Micaceous Group (Table 2). The characteristics of the fabric groups and two outliers are described below:

The calcite group

The majority of samples (n = 72) belong to the Calcite Group. These samples have the same basic mineralogical constituents, characterised by the presence of around 20 to 40% sparry calcite limestone and 5% to 10% iron-rich nodules, quartz and quartzite. The samples also share certain textural features, including a lack of preferred orientation (i.e., aligning to the margin of the thin section) of the inclusions and voids, and a high level of optical activity of the clay matrix. A thin layer of reddish brown or dark brown slip was identified in some samples. Yet, these samples are far from homogeneous in terms of their mineralogy and texture, which allow us to divide them into four subgroups (A to D) and two outliers.

The differences among Subgroup A, B and C mainly lie in the shape and grain size of inclusions, as well as their packing. The inclusions of Subgroup A (n = 32) are medium grained (0.08 to 0.40 mm and up to 3.60 mm for some quartzites, no clear mode size), and sub-angular to sub-rounded in shape (Fig. 3a). The inclusions in this subgroup are not closely packed together, with only a few inclusions overlapping with one another. Subgroup B (n = 18) stands out for its angular, coarse-grained inclusions (0.16 to 1.76 mm, mode size = 0.36 mm) (Fig. 3b). The border of these coarser grained inclusions often overlaps, resulting in a close- to single-spaced packing. Subgroup C (n = 15) is characterised by the presence of sub-rounded, fine-grained inclusions (0.08 to 0.80 mm, mode size = 0.16 mm) that are closely packed together (Fig. 3c).

Subgroup D (n = 5) and the two outliers can be differentiated from the previous subgroups for the presence of grog (crushed pottery fragments) and volcanic tuff, respectively. The grog accounts for around 20 to 30% of the fabric of Subgroup D (Fig. 3d). The grog has clear boundary, identifiable for the presence of fine-grained calcite, and in some cases slip, in a matrix that appears to be brown in plane polarised light (PPL) and dark brown in crossed

Table 2 *The distribution frequency of the samples in accordance to fabric groups*

			Calcite group					*Micaceous group*	*Outlier*	
Ware	*Type*	*Function*	*Subgroup A*	*Subgroup B*	*Subgroup C*	*Subgroup D*	*Outlier*	*-*	*Ash-tempered fabric*	*Tuff-tempered fabric*
Paso Caballo Waxy	Sierra Red	Serving	4	1						
	Boxcay Brown	Serving	1			1				
	Polvero Black	Serving	1			1				
	Flor Cream	Serving				2				
Holmul Orange	Ixcanrio Orange Polychrome	Serving			1	1				
	Guacamallo Red-on-Orange	Serving	2							
	N/D Trichrome Red and Black-on-Orange	Serving			2					
Peten Gloss	Aguila Orange	Serving	6	2	1					
	N/D Red-on-Orange Transitional	Serving								1
	Sabaneta Black-on-Orange	Serving	4		1					
	San Blas Red-on-Orange	Serving	1		1					
	Actuncan Orange Polychrome	Serving	2		1					
	N/D Trichrome Red and Black-on-Orange	Serving			3		1			
	Balanza Black	Serving	4		1					
	Lucha Incised	Serving	4							
	Caldero Buff Polychrome	Serving		1	1		1			
	Pucté Brown	Serving			1				1	
	Batellos Black-on-Red	Serving	1		2					
	Kol Brown		1							

(*Continues*)

Table 2 *(Continued)*

			Calcite group					*Micaceous group*	*Outlier*	
Ware	*Type*	*Function*	*Subgroup A*	*Subgroup B*	*Subgroup C*	*Subgroup D*	*Outlier*	-	*Ash-tempered fabric*	*Tuff-tempered fabric*
Undetermined no.1		Utilitarian (storage)								
Undetermined no.2	Leb' Black	Utilitarian (storage)	1	1						
Uaxactún Unslipped	Paila Unslipped	Utilitarian (storage)		3						
	Zapote Striated?	Utilitarian (storage)		3						
	Quintal Unslipped	Utilitarian (storage)		3						
	Triunfo Striated	Utilitarian (storage)		4						
Mars Orange	Savanna Orange							2		
	Reforma Incised?							1		
	N/D Media Caña							1		
Total			**32**	**18**	**15**	**5**	**2**	**4**	**1**	**1**

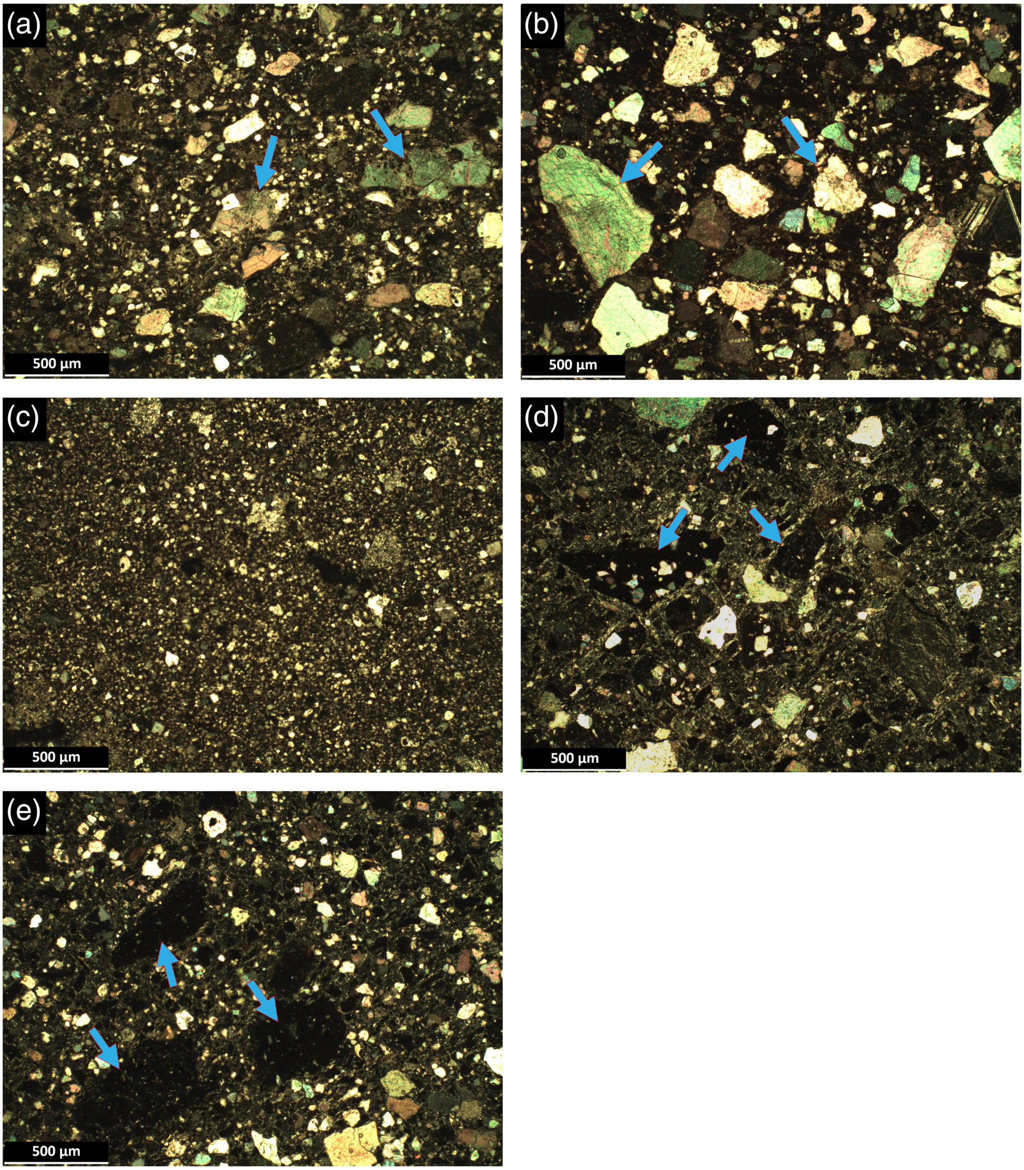

FIGURE 3 *Photomicrographs showing the fabrics of the Calcite Group Notes: Highlighting the presence of sparry calcite inclusions (indicated by the blue arrows) in (a) Subgroup A and (b) Subgroup B, (c) Subgroup C, (d) the grog (indicated by the blue arrows) in Subgroup D, and (e) the tuff (as indicated by the blue arrows) in the outlier. All photomicrographs were taken in XP at x50 magnification. [Colour figure can be viewed at wileyonlinelibrary.com]*

polarisation (XP). Another distinctive feature of this fabric is that the limestone and grog are coarse grained (0.08 to 0.8 mm, mode size = 0.4 mm) and very angular in shape. As for the two outliers, rounded and sub-rounded volcanic tuffs, which occur in a range of size (0.20 to 1.84 mm, no clear mode size), account for around 10 to 20% of the fabric (Fig. 3e).

The micaceous group

Four samples share this very fine-grained fabric, consisting of 30 to 40% muscovite and biotite, 10 to 20% volcanic ash, and 5% or less quartz, plagioclase feldspar, amphibole, iron-rich nodules, and sparry calcite limestone (Fig. 4a). All inclusions are less than 0.0625 mm in grain size, although some quartz, iron-rich nodules, and limestone measure up to 0.20 mm. The biotite and muscovite are elongated in shape, whereas other inclusions are sub-rounded to sub-angular. These inclusions are found to be present in an optically active matrix, which alters from reddish brown to dark reddish brown in XP. No preferred orientation is observed for the inclusions and voids. A thin layer of orange slip was identified in two samples.

The outliers

Two samples cannot be placed into the aforementioned fabric groups. One sample is dominated by the presence of volcanic ash, which accounts for 40% of the fabric (Fig. 4b). These volcanic ashes are very angular, measuring between 0.20 and 0.48 mm, with a mode size of 0.24 mm. Quartz grains are also present, but their occurrence is less than 5%. The other sample has volcanic tuff as its principal type of inclusion, accounting for 20 to 30% of the fabric (Fig. 4c). The characteristics of these tuffs are consistent with those identified in the two samples belonging

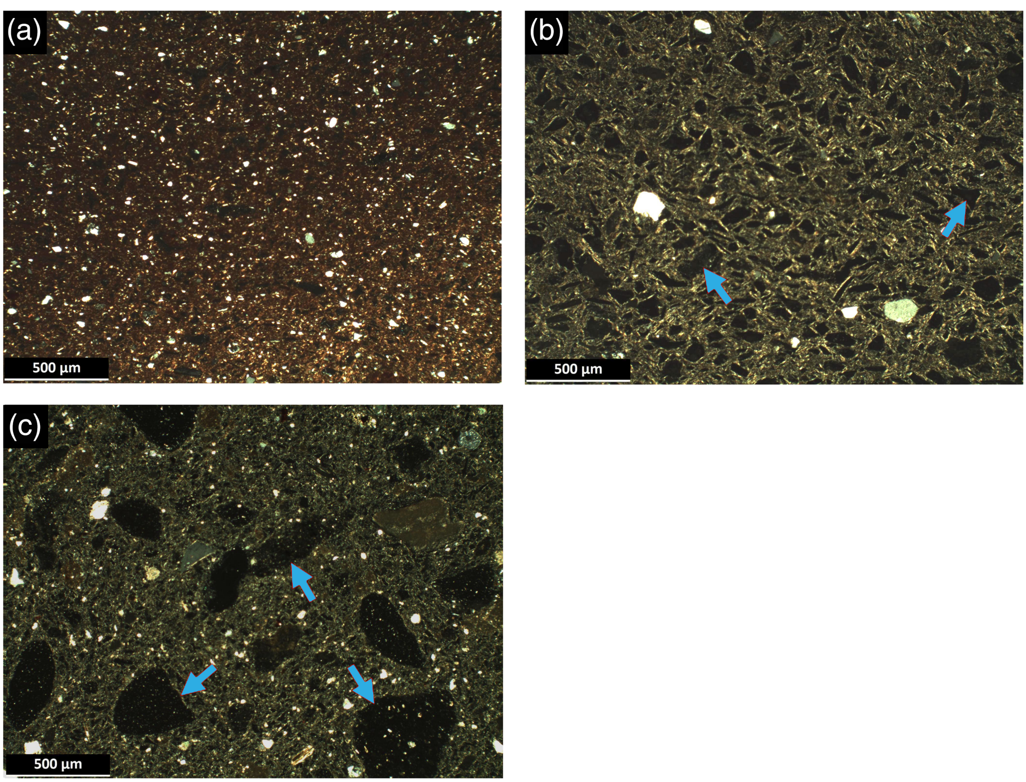

FIGURE 4 *Photomicrographs showing the fabric Notes: (a) the Micaceous Group, (b) the outlier with volcanic ash inclusions that are isotropic (as indicated by the blue arrows), and (c) the outlier with volcanic tuff (as indicated by the blue arrows). All photomicrographs were taken in XP at x50 magnification. [Colour figure can be viewed at wileyonlinelibrary.com]*

to the Calcite Group: rounded to sub-rounded in shape and a range of size (0.20 to 1 mm, no clear mode size). The rest of this fabric is made up of 5% or less fine-grained (0.08 to 0.20 mm) sparry calcite limestone, quartz, and biotite. In both samples, the inclusions and voids do not display any preferred orientation, and the matrix is optically active.

DISCUSSION

Determination of the potential provenance

The predominance of sparry calcite limestone in all samples of the Calcite Group is consistent with the geology of Nakum and more generally northeastern Guatemala, which is underlain by limestone (Donnelly *et al*. 1991). Limestone quarries are described to have located near almost every major site in the region (Callaghan 2008: 565). The grog temper found in Subgroup D could have acquired easily from any old broken pots. Thus, all subgroups associated with the Calcite Group are likely representative of local production in Nakum. It is difficult to determine whether or not the two outliers of the Calcite Group were produced locally at Nakum. Whereas the presence of sparry calcite limestone in these samples points to local production, the sources of volcanic tuff are yet to be established. Volcanic tuff and ash are not native to northeastern Guatemala, but they are found in abundance in the Guatemalan Highlands, with sporadic deposits in Belize (Simmons and Brem 1979). It is hypothesised that these Highlands tuff and ash were made available to the lowlands communities by serving as protective material for obsidians for exchange over long distance, although this argument was used to explain the widespread use of volcanic ash-tempered fabrics during the Late Classic period (West 2002). Alternatively, it is suggested that ash was deposited into the lowlands through regular ashfalls from the Guatemalan Highlands (Ford and Rose 1995; Ford *et al*. 2017).

The mineralogy of the Micaceous Group is consistent with the geology of the Guatemalan Highlands, where two-mica schist, amphibolite, granite, and volcanic ash deposits are common. This fabric also displays striking similarity to those that were used to produce the Middle Preclassic slipped serving vessels designated as Mars Orange Ware from Holtun (Callaghan *et al*. 2018: 826, Fig. 3), with the Maya Mountains being postulated as its origin in this case. Muscovite granite is one of the main igneous rocks common to the Maya Mountains, and the degradation of the silicates results in extensive clay mineral deposition (Wright *et al*. 1959; Graham 1994), whereas the volcanic ash might have derived from the welded tuff of the Bladen Volcanic Series located along the southern edge of the Maya Mountains (Bateson 1972; Bateson and Hall 1977; Shipley and Graham 1987). Concurrently, the Micaceous Group in our study is exclusively associated with the Mars Orange Ware, making Central Belize a feasible origin of production for these vessels. Whereas it is impossible to decide whether the Micaceous Group was originated from the Guatemalan Highlands or Central Belize without further petrographic and chemical analyses of the raw materials extracted from these regions, it is certain that these vessels were not produced at Nakum. The potential provenance of the two outliers with volcanic ash and tuff is undetermined due to the lack of any inclusions that are indicative of their link to the deposits in a specific region.

Characterisation of the production groups and their traditions

Focusing on the production at Nakum, we argue that the variations seen in the fabrics of the Calcite Group represent the co-existence of different manufacturing traditions, each with distinctive way of sorting the sparry calcite limestone temper and preparing the ceramic paste, even though the same local sources of raw materials were procured. This argument is further supported by the correlation that exists between the Calcite Group variants and ware designation; and between the fabrics and vessels' function in some cases. Calcite Subgroup B displays a strong association with the vessels classified as Uaxactun Unslipped Ware and the two undetermined wares that are exclusive to Nakum. These vessels are of utilitarian nature, comprising medium and large pitchers, bowls, and bowls that were mainly used to store water and in some instance food. The use of grog in Calcite Subgroup D has clearly marked a different way of preparing the ceramic paste, and this fabric is tied to the serving vessels belonging to the Paso Caballo Waxy Ware, which is dated to the earlier phase of the Protoclassic period. It was also during this phase that we record in a small number of samples the presence of fine-grained fabric characteristic of Calcite Subgroup C, which continued to be in use but in greater frequency throughout the rest of the Protoclassic period. This fine-grained fabric tends to correlate with the serving vessels with trichrome and polychrome decoration.

Some broad technological traditions were shared by the potters using different ceramic pastes. Notably, hand-forming techniques were used in shaping the vessels, as shown in the absence of preferred orientation of the inclusions and voids (Thér 2016). For the serving wares, slips were applied directly onto an unburnished surface, which is consistent with the results of the petrographic analysis of some Naj Tunich Ixcanrio Ornage polychrome vessels (Brady *et al*. 1998: 28). Both slipped serving and utilitarian vessels were fired at low temperatures, possibly below 750 °C, reflected in the high optical activity of the clay matrix and the lack of disintegration of the limestone inclusions (Fabbri *et al*. 2014).

These observations seem to have shared certain features of Hirth's (2009) definition of household specialisation, which is measured by the household's capacity to minimise and/or diversify risks and to increase productivity through the creation of punctuated work schedules involving a mix of different activities, including pottery production. The potters, who were involved in the production of utilitarian vessels, realised that the sparry calcite limestone inclusions needed to be coarser grained (Calcite Subgroup B) and of greater abundance to increase the toughness and strength of these storage vessels (Feather 1989; Tite *et al*. 2001). Once the potters worked out an effective paste recipe, the same recipe remained to be in use throughout the course of the Protoclassic period and possibly beyond, which can be seen as attempts made by potters to minimise risks. On the other hand, the production of serving vessels seem to be more susceptible to changes in technology. Although the fabric of Subgroup A was used to produce serving vessels throughout the entire Protoclassic period, the coarse-grained, grog-tempered fabric (Calcite Subgroup D) seems to have faded out in favour for the fine-grained sparry calcite limestone-tempered one (Calcite Subgroup C). The latter trend, coupled with the correlation we observe between Subgroup C and the vessels with trichrome and polychrome decoration, leads to the speculation that this fabric was among some of the early attempts by the potters to create a fine-grained ceramic paste, a feature that is common to the Classic period polychrome vessels. All these can be considered as potters' effort to increase their production of goods with both social and economic value.

Reconstruction of the Protoclassic pottery production

Our characterisations of pottery production, especially the serving vessels, at Nakum during the Protoclassic period correspond with how similar craft was organised in the neighbouring Holmul region, where a ritual mode of production was proposed to frame the production of the orange slipped serving wares (Callaghan 2008, 2013). Whereas it is tempting to apply similar model to understand how pottery production at Nakum was organised, we are cautious of the fact that production behaviours and manufacturing decisions are also affected by material and functional constraints, and that in many cases production for ritual activities could not be easily teased out from practical economy. In this sense, the ritual mode of production does not seem to have explained why some manufacturing traditions (Calcite Subgroup A and C) persisted in their way of preparing the ceramic paste when they were making pottery that was clearly intended for ritual activities deriving from different sets of ideologies (Reese-Taylor and Walker 2002) or why the same types of raw materials, and the same paste preparation method in some cases, were used to make serving vessels and their utilitarian counterparts (see Spielmann 2002 for the extraction of raw materials from locations with social and symbolic significances in a ritual mode of production). Equally, there is no evidence indicating that the production of serving vessels at Nakum was controlled by the ruling elites. Thus, the development of an elite-controlled craft system to frame the production of polychrome vases with courtly scene and hieroglyphic text probably occurred later into the Classic period.

On the other hand, our data reveal that there was significant overlap in the craft organisation of local production of utilitarian and serving pottery, marked by the co-existence of multiple manufacturing traditions (and possibly multiple potting groups), the use of local raw materials, and the presence of household specialisation. These features are hardly unique to the Protoclassic production at Nakum; in fact, these descriptions have been repeatedly brought forth by the research on Preclassic and Classic pottery (see the brief overview in archaeological background above). Although we acknowledge that there are major temporal and geographical gaps among these studies, a combination of these observations has urged us to rethink the possibility that perhaps with the exception of a few pottery classes (e.g. polychrome vessels of the highest quality), pottery production in Maya lowlands had always been a plastic system, with the power to make decisions regarding the actual production process and craft organisation being firmly placed in the hands of the potters (Graham 2002, 2012; Ting *et al*. 2015; Ting 2018; Callaghan and Kovacevich 2020). These decisions, as we propose, were often made based on the ability of the potters to increase productivity and diversify risks, supported by a specialised craft structure, which together had allowed the potters to respond to the changing demands as a result of the changing socio-political circumstances.

Implications on the Protoclassic developments at Nakum

By combining these petrographic observations with the ceramic typologies and architectural data that pertain to the so-called Protoclassic, it has become evident that Nakum experienced significant, stable growth during this period, which was otherwise marked by the decline of many Preclassic Maya centres, including the large kingdom of El Mirador. Whereas the causes leading to the decline of these Preclassic centres and the disruption of associated trade networks are still subjected to much debate, it has been suggested that prolonged droughts and intensified warfare were among some of the key factors (Ebert *et al*. 2017; Estrada-Belli 2011: 65, 119–120; Hansen 2016: 412). At Nakum, a large proportion of Protoclassic polychrome vessels were usually found in association with the ceremonial structures or contexts; and many of these vessels were decorated with abstract motives, which were also found in other sites that displayed strong Protoclassic 'components' in their ceramic assemblage. Judging from their similarity, it is highly probable that the Maya centres that consumed these Protoclassic polychrome vessels (and even involved in their production as seen in the case of Nakum) were participating in the same network(s) of cultural and trade interactions, with the shared vessel forms and decorations conveying important symbolic, religious, and social ideologies. The identification of some imported Middle Preclassic Mars Orange Ware suggests that Nakum, despite being classified as a secondary Maya centre, had a long tradition of being involved in important regional exchange systems. Based on these findings, we postulate that participation in this new network —which was materialised in the presence of Protoclassic polychrome vessels among other things—might have played a crucial role in enabling Nakum to weather the transition from the Preclassic to Classic period.

CONCLUSION

Our study contributes to the current debate that evolves around the nature of the Protoclassic period and the ways in which these developments might have led to the making of Classic Maya civilisation. We provide new insights into the Protoclassic Maya pottery production, which is poorly understood owing to the difficulties in identifying the materials of this period in most sites. The petrographic analysis on the Protoclassic ceramic assemblage from Nakum reveals that the local community was involved in the production of both slipped serving and utilitarian vessels. Clays from local sources were procured, as evident in the limestone-rich fabrics that characterise most samples, but the raw materials were prepared in different ways for the utilitarian and slipped serving vessels. The paste recipe for the utilitarian vessels seem to have been consistent through time, marked by the use of coarse-grained calcite as temper. The paste recipes for the serving wares exhibit changes, with grog being only used as temper in the early phase of the Protoclassic production, during which a super fine-grained calcite paste was also introduced to make the polychrome vessels. The recovery of these polychrome vessels at Nakum suggests that the local community was engaged in a new network of trade and cultural exchange, which might have enabled Nakum sustained a stable growth at a time when many major Preclassic Maya centres declined. Building on these findings, our next step is to expand the scope to include the Protoclassic polychrome vessels found in other sites to explore the nature of this network and the role this network played in the transition from the Preclassic to Classic periods. Another focus is to investigate the technological links between these Protoclassic polychrome vessels and their Classic counterparts using a combination of scientific analyses and replication experiment of the slips and paints.

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PEER REVIEW

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SUPPORTING INFORMATION

Additional supporting information may be found online in the Supporting Information section at the end of the article.

Table S1. List of radiocarbon dates associated with Ajkok ceramic complex from Nakum

Table S2. The definition of selected nomenclatures used in the type-variety system