Molding the ‘collapse’: Technological analysis of the Terminal Classic molded-carved vases from Altun Ha, Belize

Carmen Ting, Elizabeth Graham and Marcos Martínón-Torres
UCL Institute of Archaeology, London, United Kingdom, carmen.k.ting@gmail.com

Abstract - Technological analyses by visual examination, thin-section petrography, INAA and SEM-EDS of an assemblage of elite serving vessels from the site of Altun Ha, Belize, provide important data on technology and organization of production. According to the manner in which they were decorated, these vessels are referred to in the literature as ‘molded-carved’, but prior research has also shown that they share a distinctive iconographic program. Evidence so far indicates that they constitute a ceramic tradition that is reflective of social and political changes that characterized the Terminal Classic period in the Maya lowlands. The results of the technological analyses described here combined with prior research on contexts, iconography and glyphic texts suggest that alterations in political and social systems during the Terminal Classic stimulated changes not only in the type of elite pottery being produced but also in the manufacturing technology and concomitantly in the organization of production.

1. Introduction
Despite more than a century of excavations and research conducted in the Maya Lowlands, the nature of the Classic Maya collapse remains a source of speculation and debate (Aimers 2007; Rice et al. 2004). What Mayanists call the ‘Maya collapse’ is the end of the Classic period, or the Terminal Classic (A.D. 750-1050), in which drastic changes in the sociopolitical order took place in the Maya Lowlands. Among these changes were the disintegration of divine kingship and the discontinuation of cultural traits that had been widespread in the Southern Lowlands in Classic times. One of the more noticeable changes that takes place during the Terminal Classic period is the virtual disappearance in the archaeological record of polychrome vessels circulated by elites and their apparent replacement, at least in some areas, by vases decorated by molding and carving rather than by polychromatic painting (Aimers 2004, 80; Chase and Chase 2004, 343-345; Forsyth 2005, 11; Rice and Forsyth 2004; Smith 1955, 37-48; Willey et al. 1967, 311). The research described below comprises a technological analysis of the molded-carved assemblage from the site of Altun Ha, Belize. The aims are threefold: to distinguish the potential production groups; to reconstruct the manufacturing technology; and to characterize the organization of production. Based on these data, we are able not only to assess the impact of changes in the sociopolitical order but also to piece together the kinds of changes that occurred in the Maya Lowlands during the Terminal Classic period.

2. Classification
Molded-carved vessels, which occur in various forms and iconographic designs, were widely distributed in the Maya Lowlands during the Terminal Classic. All are considered part of what is known as the Pabellon System, a loose but useful category based on commonalities in decorative technique and molded-carved execution but not on details of design or pastes (Aimers 2009; Henderson and Agurcia 1987). At present, three types or traditions of molded-carved vases have been named in the literature, although the bases for the names are not the same in the three cases. In only one type, Ahk’utu’ Molded-carved (Helmke and Reents-Budet 2008), is the name based on a distinctive iconographic program and dedicatory glyphic phrases which indicate that the vases might be produced for a single patron (Helmke and Reents-Budet 2008, 41-43).

Pabellon Molded-carved and Sahcaba Molded carved — both originally described as ‘modeled-carved’ before the evidence accumulated for the use of molds — were established as ‘types’ in the assemblage from Uaxactun, a site in the central Peten region of Guatemala (Smith 1955, 34, 43-45, 95, 192, 194, 195; Smith and Gifford 1966, 160, 162). Pabellon Molded-carved as a type is characterized not only by a consistent set of iconographic imagery...
but also by a highly distinctive fine-orange paste (see Helmske and Reents-Budet 2008, 37 for references, e.g., Sabloff and Willey 1967; Smith 1958). The paste of Sahcaba as described in the literature is neither fine nor orange (Helmske and Reents-Budet 2008, 39) but its fabric is distinctive enough to have been included by Smith and Gifford (1966, 162) in the Teabo Ceramic Group as Puuc Red Ware; indeed Sahcaba was originally described by Smith as 'Carved Ferruginous Ware' (Smith 1955, Fig. 86), which suggests a paste dark red in color. Sahcaba has been identified at Caracol by Arlen Chase and Diane Chase, but apparently only on the basis of the absence of fine paste (Chase 1994, 173, 175, Figs. 13.11d and m; Chase and Chase 2001, Figs. 16b and 16m). Thus far, no distinguishing iconographic or glyphic characteristics have been defined as particular to Sahcaba at Caracol that are not shared by Ahk'utu (see Helmske and Reents-Budet 2008, 39). The Sahcaba example from Uaxactun, illustrated in Smith (1955, Fig. 86 i,m,o), has a scene that appears to depict interacting elite individuals in a style roughly comparable to that of Pabellon and Ahk'utu, but scene details and the style of execution are different.

We have assigned the sherds analysed in this research to the Ahk'utu Molded-carved type as defined by Helmske and Reents-Budet (2008). We base this assignment on the fact that where moulded-carved decoration is preserved on Altun Ha vessels, the iconographic program and/or the glypts can clearly be seen to fall within the Ahk'utu tradition (Graham et al. 1980, 164-165, Figs. 7, 8; Helmske and Reents-Budet 2008, Fig. 6). We emphasize nonetheless that this attribution is provisional, owing to the possibility that pastes of some of the sherds without decoration may turn out to connect them with a different tradition.

At one level, owing to the fact that courtly scenes continued to be represented on the molded-carved vase exteriors as they were on polychrome vases, these vases can be seen to be a continuation of the great Classic polychrome tradition. The molded-carved vases have been said, in fact, to take over “at least some of the functions of the polychromes during the Terminal Classic” (Forsyth 2005, 18). Nonetheless, although the vase form and the presence of courtly scenes are common features, the mode of execution changes from painting to the use of gouge-incision. The appearance of the molded-carved ceramic tradition therefore marks the beginning of a new era in the Maya Lowlands, and the period of transition remains little known.

3. Background
Previously known as 'imitation Pabellon' or described as 'modeled-carved' (Graham et al. 1980, 164-165; Graham 1987, 79), the molded-carved vases from Altun Ha display a characteristic cylindrical or barrel shape with either flat or concave bases supported by hollow tripod oven-shaped feet. Each tripod support is perforated and contains a ceramic rattler (Fig. 1a). The ceramic pastes are tempered with white inclusions that are visible to the naked eye. Vessel walls are covered with a thin layer of slip that ranges from dark red to light orange in color. Where the molded-carving design is in evidence, the exterior surfaces of the vases are decorated with three stacked horizontal moldings which frame the primary glyptic text and the iconographic scenes (Fig. 1b). Interpretation of the glyptic texts suggests that these vases were manufactured for an elite woman named Lady Olom, who lived during the first half of the ninth century in the eastern Peten region (Helmske and Reents-Budet 2008, 41-43). Interestingly, the distribution of these molded-carved vases is restricted to an area that stretches from the eastern Peten lowlands of Guatemala to the Caribbean coast of central Belize, where their presence is reported from 23 sites located along the Belize River and its tributaries. The site of Altun Ha and the Marco Gonzalez site on Ambergris Caye seem to be outliers, but their inclusion may reflect interaction between the inland sites and the coast.

Some archaeologists propose that the molded-carved vases were used in competitive feasting during the Terminal Classic period, a time of intensive jockeying among Maya elites for positions, power, and tribute rights (Helmske 2001; LeCount 1999; 2005; Pohl and Pohl 1994, 140). Feasting here not only refers to the sharing of an elaborately prepared meal but also includes acts of giving and receiving prestige goods, such as the molded-carved vases, which would have served to symbolize and maintain social ties (Clark and Blake 1994, 26-27; LeCount 2001). Within a local context, the liberal distribution of gifts served the purpose of binding leaders through indebtedness; on the regional level, gift exchange aided the building of alliances (Brumfiel 1994, 10). The molded-carved vases, therefore, functioned as both social and political currency. They served as symbols in validating hierarchies, consolidating support, and amassing tribute, but as a result they also encouraged the development of factionalism during the Terminal Classic period in the Maya Lowlands (Helmske 2001, 74-75).

4. Geological and archaeological settings of Altun Ha
Altun Ha yielded one of largest molded-carved assemblages, with approximately 200 sherds. The site is situated on the north-central coastal plain of Belize and was excavated from 1964 to 1970 (Fig. 2) (Pendergast 1979, 1982, 1990). Altun Ha is underlain by flinty siliceous Eocene and Miocene limestone, which serves as the parent material for clay loam and sandy loam in some areas (Pendergast 1979, 7; Wright et al. 1959, 77). The leaching and eluviation of limestone leaves the topsoil mottled black, yellow, and dull red color, with frequent flints.
In fact, the presence of limestone as underlying bedrock dominates the geology of Northern Belize which is described as a low-lying shelf, as opposed to the predominance of igneous (e.g. granite) and metamorphic rocks (e.g. gneiss, shales) as underlying bedrock in the mountainous southern region (Howie 2005, 120-135; King et al. 1992, 26).

As a small but important, and in fact staggeringly wealthy, urban centre in the central Maya Lowlands, Altun Ha had...
a long history of development. Early occupation dates to the Preclassic period, but the community reached its pinnacle during the Late Classic. Like many sites in the Southern Lowlands, Altun Ha experienced decline and eventually was to “descend into the dust” (Pendergast 1992, 71) toward the end of the 9th century. Yet the process of ‘collapse’ was unlikely to have been either sudden or massive, as is evident in the considerable quantity of Terminal Classic materials, including the molded-carved vases, retrieved through excavation. The majority of the molded-carved sherds were found in terminal occupation debris of the vaulted masonry (Structures C-6, C-10, E-7, E-14, E-44, E-51) and plazuela group residential structures (Structures J-1, K-32, K-34). The C- and E-Group structures are believed to have been residences of non-royal lineage elites whereas the J- and K-Group structures may have been the homes of extended families of the royal lineages.

5. Methods

A variety of archaeometric techniques, coupled with systematic sampling and statistical methods were employed to examine the molded-carved assemblage. Twenty-one molded-carved sherds were chosen for analyses employing a stratified sampling framework. The strata were created by visual examination based on variations in color, texture or ‘feel’, size and frequency of tempering materials, and the presence or absence of slip. Although the sherd abundances are not equal across these sampling strata, the selection procedure ensured a more balanced representation of paste variability within the assemblage (Drennan 1996, 237-41; Orton 2000, 26-30). Macroscopic examination of sherd color with reference to the Munsell color system was also useful in the preliminary assessment of firing conditions (Rice 2005, 343-345; Shepard 1976, 107-113). With the aid of a stereomicroscope, visual examination also helped to determine the decorative forming and surface finishing techniques.

Instrumental neutron activation analysis (INAA) was chosen because it allows the detection of a large number of elements, in particular trace elements, which are useful in discriminating production-related compositional groups with a high degree of precision and accuracy (Blackman and Bishop 2007, 321; Glascock 1992, 12; Pollard et al. 2007, 132; Speakman and Glascock 2007, 180). The samples were prepared according to the analytical protocols of the Smithsonian Institution (Blackman and Bishop 2007); samples were then activated by the 20MW research reactor housed at the National Institute of Standards and Technology (NIST) Centre for Neutron Research. 29 elements were detected: Na, K, Ca, Sc, Cr, Fe, Co, Zn, As, Br, Rb, Zr, Mo, Sb, Cs, Ba, La, Ce, Nd, Sm, Eu, Tb, Yb, Lu, Hf, Ta, Th, U and W. After experimentation with numerous bivariate plots to identify those elements with clearest grouping tendencies, 23 elements were selected and processed statistically using hierarchical cluster and principal component analysis (PCA) (Baxter 2003; Bishop and Neff 1989; Shennan 1997). These elements were those named above except for Co, Mo, Sb, Hf, U and W. An additional PCA was conducted on all minor and trace elements (excluding Na, K, Ca, and Fe) which are useful in discriminating the differences in the clay sources themselves.

Thin-section petrography was used to identify mineralogical constituents. This procedure helped in assigning sherds to fabric groups in the absence of access to information on raw material sources (Freestone 1991). Petrography is particularly useful in this case because the predominance of limestone as parent material in northern Belize, Yucatan and Peten homogeneous the chemical composition of disparate clay sources and thus increases the difficulty in discriminating among local sources (Howie 2005, 128-136). The application of thin-section petrography, therefore, serves to confirm and even refine the compositional groupings identified by INAA. The samples were studied by using Whitbread’s ceramic thin-section descriptive system (1995). Whitbread’s system allows the qualitative and semi-quantitative analyses, and its focus on the textural characteristics of the samples is useful in identifying manufacturing technology. For instance, the shape and orientation of voids are indicative of forming techniques whereas the optical states and color of the clay matrix are influenced by the general firing condition.

Scanning electron microscopy energy dispersive spectrometry (SEM-EDS) was chosen because this microanalytical technique allows the analysis of a specific spot or small area on the sample by directing the electron beam precisely on the area to be analyzed. High-resolution images can also be produced with the use of the secondary electron and backscattered electron detectors that are attached to the system. In this way, the SEM-EDS enables detection of the presence of a slip layer and the determination of slip composition. Firing temperature can also be estimated by focusing on the micromorphology (Maniatis and Tite 1981; Tite and Maniatis 1975; Tite et al. 1982; Wolf 2002). Analyses were conducted on polished cross sections using a Hitachi S-3400N SEM with an Oxford Instruments EDS, housed at the Wolfson Laboratories at the UCL Institute of Archaeology. Each sample was analyzed at a fixed working distance of 10 mm with the accelerating voltage set at 20kV. The process time of each analysis was set to 5 with deadtime ranging from 26% to 34%. Calibration with cobalt was conducted at the beginning and at regular intervals throughout the analysis of each sample. The results presented here are presented as stoichiometric oxides and have been normalized to 100% to account for sample porosity and small drifts in beam intensity.

6. Results

6.1. Compositional variability

Three chemically distinct groups were recognized and are shown in the plot of the first three principal components of the compositional data by INAA (Fig. 3; Table 1). These three groups can also be recognized by plotting the first, second and third components of the data of the minor and trace elements only on the bivariate plot, which suggests that the clay sources of these three groups are different. Group 1 is the core group which comprises the majority of the samples. These samples contain a significantly high bulk calcium (Ca) concentration that ranges from 11.6% to 22.1%. Such high Ca concentration is clearly caused by the addition of calcite as a tempering material, as the ceramic matrices themselves, analyzed by SEM-EDS, revealed relatively low CaO levels (Table 2). Thin-section petrography shows that polycrystalline calcite inclusions of medium- to fine-grained size predominate (Fig. 4a). Monocrystalline and polycrystalline quartz inclusions are common. Textural concentration features are also
common. In terms of the microstructure, planar voids, which display a preferred orientation parallel to the margin, are common in all samples. In terms of groundmass, all samples exhibit fine matrices with poorly sorted inclusions. The matrices are homogeneous throughout, varying from light yellowish brown to brown under PPL, and from dark brown to olive brown under XP, and are optically moderately active to inactive. Thin layers of slip, which appears to be red (2.5YR 5/8) in PPL and changes from dark brown (7.5YR 3/4) to reddish yellow (7.5YR 7/8) upon rotation in XP, can be identified in three samples.

Group 2 comprises only three samples, which contain bulk Ca concentrations comparable to those in Group 1, with an average of 17%. Group 2 is distinguished from Group 1 by its relatively higher bulk concentrations of Fe, Cr, La, Nd and Sm. Subtle variation between the two groups is also noticeable under thin-section petrography. In particular, although the mineralogy and groundmass of the samples of the two groups are largely similar, the size and frequency of inclusions vary (Fig. 4b). The polycrystalline calcite inclusions of the samples in Group 2 are much coarser-grained than those in the previous group. Textural concentration features are more frequent, which explains the higher Fe content because these concentrations are rich in Fe as shown in the SEM-EDS data.

Group 3 consists of only two samples. This group is completely different from the previous two groups in terms of chemical composition and mineralogical constituents. Bulk Ca concentrations are low and range from only 0.9% to 4.5%, but the samples have higher bulk Na and K concentrations. Thin-section petrography further confirms that these samples belong to an entirely different fabric group in which crystalline calcite is lacking. Instead, volcanic ash is the predominant type of inclusion, recognizable in thin section but also under the SEM due to their large and abundant round pores (Fig. 4c & d). Polycrystalline and monocrystalline quartz inclusions are common. Feldspar, biotite, muscovite and chert are present but very rare. Only a few textural concentration features are present. Planar voids are common. All samples exhibit very fine matrices with moderately to well-sorted inclusions. The matrices are homogenous throughout and appear light brown to brown under PPL to dark brown under XP, and are optically inactive. A thin layer of slip, which appear to be yellowish red (5YR 4/6) in PPL and brownish yellow (10YR 6/8) in XP, can be identified in one sample.

6.2. Technological variability

Macroscopically, the samples of Group 1 and Group 2 share similar physical attributes. The presence of a dark core in most samples indicates that the vessels were fired in an incomplete oxidizing atmosphere. The firing temperature of the samples is estimated to have been below 800°C, as evident in the presence of flaky structure of clay minerals in the secondary electron images on SEM (Fig. 5a) (Maniatis and Tite 1981; Tite and Maniatis 1975; Tite et al. 1982; Figure 3. Scatterplot based on the principal component analysis of the INAA data on the overall composition (excluding Co, Mo, Sb, Hf, U and W) of the Ahk’utu’ samples from Altun Ha. Circles represent Group 1 samples, diamonds represent Group 2 samples, and squares represent Group 3 samples.

Table 1. Average chemical composition by INAA for the three groups of Ahk’utu’ vases from Altun Ha.

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<td>47</td>
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Wolf 2002). In contrast, signs of incomplete oxidation are lacking in the samples of Group 3, which exhibit homogeneous colour throughout the cross section with no dark core; this suggests that the sherds are from vessels fired in a relatively complete oxidizing atmosphere. Again, the firing temperature of the samples cannot have been too high judging from the flaky structure of the clay minerals visible in the secondary electron images (Fig. 5b). The flaky structure of clay minerals seems to be contradicting with the observation of optical inactivity of the samples under Table 2. Average composition by SEM-EDS for the ceramic matrices of the three groups of Ahk’utu’ vases from Altun Ha. All figures are normalized to 100%.

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<th>P₂O₅</th>
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<td></td>
<td>Min.</td>
<td>0.4</td>
<td>0.7</td>
<td>20.5</td>
<td>52.7</td>
<td>0.2</td>
<td>0.5</td>
<td>2.6</td>
<td>1.0</td>
</tr>
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Figure 4. Photomicrographs of samples from a) Group 1; b) Group 2; and c) Group 3 under thin section petrography; and d) the presence of volcanic ash in a backscattered electron image in the SEM. All thin-section photomicrographs were taken at x40 in XP.
petrography. One possible explanation is that the firing atmosphere of the vessels from which these samples are derived may have reached a high enough temperature to initiate the process of vitrification, but the temperature at which they were fired at was not high enough to effect complete vitrification. It is also possible that the volcanic ash temper may act locally as a flux, promoting vitrification and then the overall hardness and homogeneity, but this hypothesis requires further investigation.

Although, based on the appearance of the larger and better preserved sherds, we believe that the exterior surfaces of all molded-carved vases were once slipped, a slip layer was preserved on only three samples from Group 1 and one from Group 3. The slips on the samples from Group 1 were applied before carving as evident in the absence of slip in the troughs under the stereomicroscope, whereas the slip on the sample from Group 3 was applied to the surface after carving, as shown in the presence of slip remnants in both the ridges and troughs of the carving lines. In all cases, slip could be easily detected as a homogeneous layer, with partially vitrified microstructure, attached to the surface of the sherd in the backscattered electron images on the SEM (Fig 5c & d). The slip layers do not exceed 20μm in thickness. No apparent variations in brightness can be distinguished between the slip layers and the rest of the matrices in the backscattered electron images, a fact which suggests that both slip and vessel body were made of clay of similar composition. SEM-EDS analyses of the slips and their associated matrices confirm that only slight variations in composition exist between the two, although a general trend of higher iron oxide (FeO) and relatively lower potassium oxide (K2O) can be observed in the slip layers of three out of four samples; such variation may be caused by the removal of impurities from the clay during preparation of the slip.

7. Discussion

7.1. Discrimination of potential production groups

The rationale behind the physiochemical analyses of ceramic materials is that potters’ recipes for combination of clay and non-plastic tempers are unique to these production groups (Harry 2005; Reents-Budet et al. 1994; Reents-Budet et al. 2000, 101; Rice 2009, 128). Therefore, based on the results, we propose that the three distinct compositional groups potentially represent three production groups, each of which produced molded-carved vases according to its own ceramic recipe. Group 1 vases were tempered with a mixture of medium- and fine-grained calcite; Group 2 vases were tempered with coarse-grained calcite; and Group 3 vases were tempered with volcanic
uneven access to air suggest that the molded-carved vases were fired in a non-kiln, open firing structure. Non-kiln open firing method does not involve the construction of permanent firing structure, thus making the identification of the pottery production location or workshop in the Maya areas more difficult (Rice 1997; Rye 1981, 96-98).

7.3. Characterisation of the organisation of production

In the absence of archaeological evidence of production or firing locales, the organization of production of the molded-carved vases from Altun Ha can be assessed on the basis of indirect evidence as proposed by Costin (1991). Costin’s parameters include standardization, skill and efficiency.

Standardization refers to “the relative degree of homogeneity or reduction in variability in the characteristics of the pottery” (Rice 1991, 268), and is measured on the basis of the compositional and technological variability in this study. Judging from the distance of coefficient between samples on the dendrogram of INAA data by agglomerative hierarchical analysis (Fig. 6), Group 3 is obviously separated from the other two groups whereas the difference between Group 1 and 2, noticeable in the chemistry but also in the petrographic structure, is sufficient enough to suggest the involvement of different production groups. The small size of Groups 2 and 3 makes it difficult to make any reliable assessment of the internal fabric standardization. For Group 3 in particular (the ash-tempered ware), there is a significant chemical difference between the two samples, perhaps suggesting that they represent different subfabrics. However, it should be noted that SEM-EDS of one of these sherds showed unusually high P2O5 contents (around 10%); given that this oxide is easily subject to post-depositional alteration, the divergent chemistries between these two sherds may just reflect different degrees of contamination.

It is worth highlighting that, in spite of the technical differences noted between the three groups (in temper, order of slipping/carving, and firing regime), they all broadly conform to the same technology in manufacturing; thus resulting in similar style of the end-products. These similarities indicate that some technological information may have been shared by all producers, but more importantly, they also suggest that all potting groups aimed to manufacture pottery that would be recognized by consumers over a broad area on the basis of color, shape, and pictorial representation. Consumer demands can therefore be seen to have influenced what could be said to be the ‘type’ of the vessel. The co-existence of three production groups reflects, however, localized community traditions of resource use and manufacture.

Turning to the other two parameters to characterize the organization of production, skill and efficiency, these are influenced by the political, economic and social conditions under which production is organized, and remain even harder to access archaeologically (Costin 1991; Costin and Hagstrom 1995, 622-623). It is generally assumed that the levels of skill and efficiency are positively correlated with degree of craft specialization, with the exception of objects that have significant social or political value in which case extra energy, time and resources are required in their production. Although archaeological evidence suggests that the molded-carved vases had significant social and
political value, they were efficiently produced as evidenced by the use of molds. The use of molds in the manufacture of the Ahk'utu' vases has the advantage of producing standardized products (at least in terms of their physical appearance) efficiently; reducing the level of skills required; and thus reducing the risk and cost involved (Arnold 1999). The apparent discrepancy between the value of goods and the costs involved in their production can perhaps be explained by political developments in the Maya Lowlands during the Terminal Classic. We believe that competing elites required the efficient production of molded-carved vases as political and social currency to build alliances and legitimize their precarious positions during the relative political instability and reorganization characteristic of Terminal Classic times.

Based on the above information, and with reference to the eight-part typology of craft specialization created by Costin (1991), we propose that the production of the molded-carved vases from Altun Ha was organised as dispersed corvée, which entailed the involvement of part-time labor producing for elite or government institutions within a household or community setting.

8. Conclusion
The results of this study in conjunction with earlier research on molded-carved vases, cited above, suggest that these vases were circulated among elites who were responding to changes in the sociopolitical order during the Terminal Classic period (Graham 1985, 227-228). Change was clearly occurring both in the kinds of elite pottery being produced and in methods of manufacture. Like in the Classic period, consumer demand could be satisfied regionally or inter-regionally depending on the type or style of vase desired, a fact that suggests continued lowland integration at the elite level (Chase and Chase 2005, 88). Unlike the Classic period, however, the Terminal Classic saw the disappearance of polychrome vases and their replacement by the molded-carved vases.

As in the Classic period, there was a wide range of groups producing pottery in the Terminal Classic throughout the lowlands (Rice 1987, 79-80), but the case of the Ahk'utu' vases as reflected in the Altun Ha samples demonstrates greater variety in local production. One possible explanation is that elites throughout the Southern Lowlands continued to share a value structure but there existed greater flexibility and fluidity in the way that the material that reinforced this structure could be produced. With regard to social hierarchy, this situation may reflect a lower pyramid in which more individuals had access to means of accumulating status and wealth than had existed in Classic times. Helmke and Reents-Budet (2008, 47) suggest that molded-carved special service wares were not associated with the highest royal segment of Maya society. They propose that what we may be seeing is a restructuring of social negotiations from paramount royalty during the Late Classic to lesser nobles during Terminal Classic times (Helmke and Reents-Budet 2008, 47; see also Graham 1985, 228). With regard to the distribution zone of Ahk'utu' vases in particular, they suggest that this reflects the spatial extent of a particular Terminal Classic social network. We concur but add that the social network may have had an economic basis, in which case it may also map out tribute relationships.

Although further analyses of a greater number of vessels are essential, our results nonetheless show clearly the distinctive contribution that can be made from technological studies. From a study of style, iconography and epigraphy, Helmke and Reents-Budet (2008) were able to distinguish the limits of an area encompassing the eastern Peten and parts of Belize in which the vessels with the Ahk'utu' scene and reference to a particular patron occurred. This commonality might at first suggest the existence of a single production source. The Altun Ha technological evidence alone, however, indicates that the efforts of different production groups were marshalled to produce such vessels, which in turn suggests that the relationship between consumers (elites) and producers was different from the Classic period when polychromes were circulated and producers are believed to have been attached to elite households. We might even ask if molds were traded to stimulate production over a wide area in response to elite demands. As analysis proceeds, we hope to have answers to such questions, and to shed more light on the dynamics of the changing relationships of the period of ‘collapse’ and the Classic to Postclassic transition.

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