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Ancient Recycling: Considerations of the Wasteful, Meaningful, and Practical from the Maya Site of Ucanal, Peten, Guatemala

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Abstract

Recycling practices among ancient societies are rarely systematically explored. When such practices are considered, they are often examined in dichotomous terms as either an elite artisanal capacity for producing meaning or as part of practical logics of rationality and efficiency in confronting scarcity. The study of groundstone tool, ceramic, and architectural recycling at the Maya site of Ucanal, Peten, Guatemala, challenges this false dichotomy in highlighting the varied ways meaning and value are produced. Diachronic and contextual analyses reveal that recycling practices of quotidian materials, such as groundstone and ceramics, did not increase during periods of crisis nor were they more common among modest households as compared to higher-status households. Likewise, evidence of substantial efforts to recycle elite and monumental building materials during the Terminal Classic period (*ca.* 830–950/1000 CE) did not coincide with a scarcity of labor or building materials. Such findings underscore the need to consider the role of abundance as it relates to recycling, a factor that also drives much contemporary recycling.

Keywords Recycling · Reuse · Spolia · Economics · Object biography · Inalienable · Ceramics · Groundstone · Architecture · Maya · Mesoamerica · Pre-Columbian · Terminal Classic

Introduction

Our contemporary world is in the midst of a recycling crisis. Since 2018, when China began to reduce its imports of plastic recyclables by 95%, many Western countries have been forced to rethink their recycling practices and, in some cases, have halted

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recycling in some cities (Katz 2019; Roston 2019; Semuels 2019). While recycling is a fundamental component of many late twentieth and early twenty-first century economies, it is rarely examined as a part of the practices of earlier societies. When recycling is mentioned, it is often considered in terms of rationalist, opportunistic behaviors stimulated by scarcity (Amick 2007; Rosell *et al.* 2015, p. 309; Stemp and Graham 2006; Vaquero *et al.* 2015). In some cases, such moments of scarcity are during periods of so-called collapse or decline (Amick 2015; Bailiff *et al.* 2010; Fleming 2012). In turn, when materiality, history, and cultural meanings are considered, they often focus on the recycling of unique, luxury objects or highly ornamental elements from monumental buildings (Brillant and Kinney 2011; Kovacevich 2013; Toussaint 2012). In these latter studies, the word "spolia" or "reuse" is employed to refer to such practices rather than the term "recycling," which often implicate energy flows and objective behavioral cycles (Schiffer 1972, 1995). These different perspectives, however, are not mutually exclusive and can be productively examined together when attempting to understand recycling practices during earlier time periods.

This paper examines ancient recycling in the Maya area with a specific focus on archaeological findings from recent excavations at the site of Ucanal in Peten, Guatemala. I use the term recycling here to refer to the reuse of an object (including buildings) or elements of an object through a change in the object's original form. It may or may not change the object's function. Although clearly related, recycling differs from object repair in that repair entails an effort to extend the use life of an object with the object maintaining its basic form. It also differs from lateral recycling (also known as reclamation) in which there is a change in the object's user or the social unit of use, but there is no significant change in the object's form (Schiffer 1972, pp. 158–159).

The site of Ucanal was occupied during the Classic (*ca.* 300–830 CE) to Postclassic period (*ca.* 830/1000–1521 CE) transition, a moment that is often considered to have been wrought by political crisis, environmental challenges, and the collapse of major Classic period dynasties. As such, it provides an opportunity to examine how recycling patterns may have changed during this moment in Maya history. In looking at the recycling of groundstone tools, ceramic vessels, and architectural building materials, it is clear that a range of motivations and contexts must be considered in assessing recycling practices. In particular, I find that a consideration of abundance as much as scarcity is needed for an understanding of ancient recycling. Furthermore, practical considerations could also be meaningful, spiritual, and discursive. In the case of some architecture programs at the site of Ucanal, I assert that the recycling of monumental building blocks was a means to promote a new political order that used the power of the old to create a new era in Maya history.

Rationalities, Sensibilities, and Historical Logics of Ancient Recycling

Previous archaeological studies of recycling have largely underscored rationalist logics involving arguments of scarcity or seemingly universal logics of practicality (Amick 2007, 2015; Greenhalph 1989; Rosell *et al.* 2015; Stemp and Graham 2006; Vaquero *et al.* 2015; Venditti *et al.* 2019). For example, Amick's (2015) study of stone tools revealed an increase in recycling practices from the Early to the Late Holocene at archaeological sites in the USA. At the Blackboard Mesa site, for example, he argued

that an increase in recycling was due to an increase in the depletion of obsidian resources over these two time periods. Obsidian recycling was identified by double patinas of finished tools, evidence of flake production from older cores and flakes, and obsidian hydration analysis on rehydrated flake scars.

Likewise, Fleming (2012) argued that after the fall of the Roman Empire in Britain during the fifth and sixth centuries, there was a significant decline in the production of iron objects due to diminished access to metal ores through trade and to the disappearance of skilled metalsmiths who could no longer count on the same market conditions. As a result, Fleming finds that there was a massive scavenging of iron building clampings, lead gutters, and pipes from abandoned Roman sites during this time. These materials were then melted down and recycled for new purposes. In turn, much of the early scholarship on Medieval, Byzantine, and Early Christian architectural recycling of non-ornamental materials, such as bricks or cut stone blocks, from Classical Roman buildings often underscored the convenience of reusing such materials and reflected the diminished capacity to reproduce the labor and skill of earlier Classic period times (Bailiff *et al.* 2010; Greenhalph 1989).

Similarly, in the Maya area, scholars have also noted examples of more humble peoples who "robbed" or reused cut stones from abandoned monumental and elite buildings of earlier eras (Child and Golden 2008, pp. 82–83; Hansen *et al.* 2008, pp. 43–44; Manahan 2004, 2008). Much of the rhetoric around these practices imply opportunistic behaviors by people, sometimes derogatorily labeled as "squatters," who lived among the ruins of a once glorious era of prosperity. The rationalist logics of recycling and their often cultural evolutionary undertones that link them to decay or decline, however, often ignore the culturally and socially meaningful ways in which people engage with the material world (*cf.* Cecil and Pugh 2018; Manahan 2008, p. 191). It also ignores the widespread practice of recycling building materials even when raw materials or labor were not necessarily scarce.

In contrast, studies on *spolia*, object biographies, and non-human agency have sought to probe the different meanings, motivations, and sensibilities surrounding recycling (Brillant and Kinney 2011; Chapman 2000; Fennetaux *et al.* 2015; Kalakoski and Huuhka 2018; Kinney 2006; Toussaint 2012). These studies explore the way history, visual anachronisms, social memory, esthetics, appropriation, and fragmentation of recycled objects produced new statements and experiences of cultural values, belonging, and ways of being. Much of this work has sought to underscore the semiotic, spiritual, and performative dimensions of recycling. For example, many early scholars of *spolia* have interpreted the recycling of building materials and sculptures as a symbolic display of violence and destruction of an earlier era or of a political enemy (Kinney 2006). Over time, the interpretation of spolia became more nuanced in considering different forms of appropriation, shifting meanings, and syncretic messages, such as the incorporation of carved Roman deities or emperors into later Christian crosses, pulpits, and other objects as a way to convert pagan images into Christian ones or what has been called *interpretatio christiana* (Kinney 2006, pp. 235–237).

In the Maya area, the reuse of architectural elements from buildings of earlier time periods is not as commonly explored (Cecil and Pugh 2018; Halperin and Garrido 2019; Martin 2000). One prominent example is a series of hieroglyphic stone panels found out of their original reading order and placed, sometime during the Late Classic period (*ca.* 600–830 CE), on the steps of structure B-18 from the site of Naranjo (Fig. 1). Since the

glyphic texts refer to Naranjo's enemy, K'an II from Caracol, and his war victories over Naranjo among other dynastic events, the panels have been interpreted as Naranjo war trophies taken from Caracol. Thus, Naranjo's B-18 building erection served as a way to "rewrite" history in Naranjo's favor (Helmke and Awe 2016; Houston 1983; Martin 2000, 2017, p. 201). In addition, one of these panels from the same monumental program was found at the site of Ucanal, and two at the site of Xunantunich, further complicating the history of war trophies and power relations between Naranjo and Caracol (Graham 1980; Halperin and Garrido 2019; Helmke and Awe 2016).

Likewise, Mesoamerican scholars have underscored that the recycling of jade, a rare and highly valued stone, was not only common, but that recycled pieces had the potential to embody the sacred, to tap into genealogical ties to ancestors or deities, and to promote political ideologies and origins, whether fictional or real (Drucker *et al.*

Fig. 1 Map of the Maya area showing selected locations mentioned in the text

1959, pp. 26, 29, 157; Joyce 2003; Kovacevich 2013; Pillsbury *et al.* 2012, pp. 185–189; Taube 2004). While the best-known examples are of Late Preclassic (*ca.* 300 BCE–300 CE) and Classic Maya belt ornaments and pendants that were recycled from more ancient Olmec celts and jewelry, Late Classic (*ca.* 600–830 CE) and Terminal Classic (*ca.* 830–950/1000 CE) artisans also reworked younger Classic period jade ornaments into mosaic masks and pendants (Kovacevich and Callaghan 2018, p. Fig. 7.4; see also McVicker and Palka 2001; Proskouriakoff 1974, Fig. 8). For example, Palenque king K'inich Janaab Pakal's mosaic funerary mask from the end of the seventh century contained mosaic pieces recycled from earspools, beads, and a sculpted pendant in Classic period styles (Filloy Nadal 2016, pp. 41–44, 51). These recycled items were placed in areas of greater symbolic importance, such as under the eyes and mouth, and reinforced the power of jade to symbolize breath, life, links to ancestors, and other vital essences (Taube 2005).

Rather than view recycling through the lens of an either-or dichotomy between rationalist logics of practicality, efficiency, and convenience and cultural logics of meanings embedded in and created out of historically shifting circumstances, this paper seeks to bridge these perspectives. There is a long history of research that critique the binaries of idealism and materialism stemming from Marxism (Marx and Engels 1970; Marx 1973; Patterson 2009), histories of moral economies (Scott 1976; Thompson 1971), and various economic anthropological and sociological approaches (Hutson and Stanton 2007; Wheeler 2019; Wilk and Cliggett 2007). Economic activities are conducted by social actors who engage with the material world in meaningful ways and whose position in society, dispositions, traditions, and historical constraints and opportunities cannot be divorced from such material engagements of production, exchange, and consumption. In terms of recycling, however, the contrast between an elite artisanal capacity for symbolic acts with non-elite groups or a downtrodden society relegated to acts of practicality, rationality, and efficiency does little to bridge such divides. This false dichotomy is challenged with archaeological data from the Maya site of Ucanal.

Ucanal

The site of Ucanal is located in the Mopan River Valley in eastern Peten, Guatemala (Fig. 1). Excavations of the site began in the late 1990s with the Proyecto Atlas Arqueológico de Guatemala (1997–2000) directed by Juan Pedro Laporte (Corzo *et al.* 1998; Laporte 2004; Laporte and Mejía 2002; Mejía 2002). More recently, excavations by the Proyecto Arqueológico Ucanal or PAU (2014–2019), directed by Christina Halperin and Jose Luis Garrido, have systematically excavated different household contexts with a sampling of the smallest, medium-sized, and largest residential complexes, in addition to the site's ceremonial architecture (Halperin and Garrido 2014, 2016, 2018, 2019).

These investigations reveal that Ucanal's site core was at least 7.5 km^2 in size and was occupied from the Middle Preclassic to Postclassic periods. While its Middle Preclassic (*ca.* 700–300 BCE) occupation is relatively enigmatic and known primarily from deep excavations in the site core, its Late Preclassic occupation was more extensive with evidence of both residential settlement throughout the site and of the establishment of

the site's civic-ceremonial layout with the construction of its plaza spaces and large monumental buildings, including two E-groups (architectural complexes with a radial pyramid to the west and long-range structure to the east of a public plaza). Although settlement occupation during the Early Classic period (*ca.* 300–600 CE) was less pronounced than in the Late Preclassic period, excavations of an elaborately constructed stuccoed ceremonial building with a talud façade have been identified in the site's group J complex (Cruz Gómez and Garrido 2016), and, according to glyphic texts, the ruler of the site was named as subordinate to *Sihyaj Chan K'awiil* II (411–456 CE) from Tikal (Martin and Grube 2000, p. 34). It is during this time that the site is first known in relation to the political title and toponymic identifier that uses the term, *K'anwitznal*.

Similar to many other sites in the Southern Maya Lowlands, Ucanal expanded substantially during the Late Classic period. The majority of sampled groups since 2019 (84%, includes Atlas and PAU excavations) have been found to have Late Classic period construction phases, and many of its ceremonial buildings and spaces were expanded or refurbished during this time (Fig. 2). Although the *K'anwitznal* polity was politically subordinate to the larger site of Naranjo during the first half of the eighth century, it appears to have had substantial political influence in southeastern Peten (Carter 2016; Laporte 2004) and also had substantial economic and social ties to the Upper Belize Valley (Halperin *et al.* 2020b).

Although large polities, such as those centered at Tikal, Naranjo, Dos Pilas, and Copan, had already undergone or were in the midst of major political crises and settlement disruption during the Terminal Classic period (*ca.* 830–950/1000 CE), *K'anwitznal* rulers asserted their political independence during this time. At the site of Ucanal, 84% of architectural groups sampled since 2019 (not including excavated canals which also date to the Terminal Classic period) had one or more phases of Terminal Classic construction and 97% showed evidence of Terminal Classic occupation. In addition, many ceremonial buildings were either refurbished or newly built (Halperin *et al.* 2020b; Halperin and Garrido 2019; Laporte and Mejía 2002). As seen elsewhere in the Southern Maya Lowlands, less emphasis was placed on ostentatious displays of wealth and grandeur. Instead, elite and ceremonial architecture with vaulted ceilings and large, thick limestone masonry walls were often replaced with perishable wood buildings with thatch roofs that sat on large masonry foundations. Representations of elite individuals on stone monuments and other media portrayed leaders in simpler attire and accouterments, a pattern consistent across the Maya area (Halperin 2017; Halperin and Garrido 2019; Halperin and Martin 2020). In addition, new political-economic ties at the site were forged with western lowland sites, the Gulf Coast, and possibly also northern Yucatan (Halperin *et al.* 2020b).

During the Postclassic period, occupation at Ucanal decreased dramatically. Only 32% of sampled architectural groups show evidence of Postclassic occupation. These groups include both continued use of the civic-ceremonial groups at the site core of the city, such as groups A, D, G, and K, and some residential groups in the site core. It is likely, however, that Postclassic settlement shifted to other zones of the site or to outlying areas not tested. Since Postclassic architecture relies less on large stone building foundations, it is more difficult to identify these settlements in the archaeological record (D. S. Rice 1986; D. S. Rice and Puleston 1981). Thus, how did recycling patterns change over the course of history at the site of Ucanal and how were these practices embraced by different social segments of the population? In

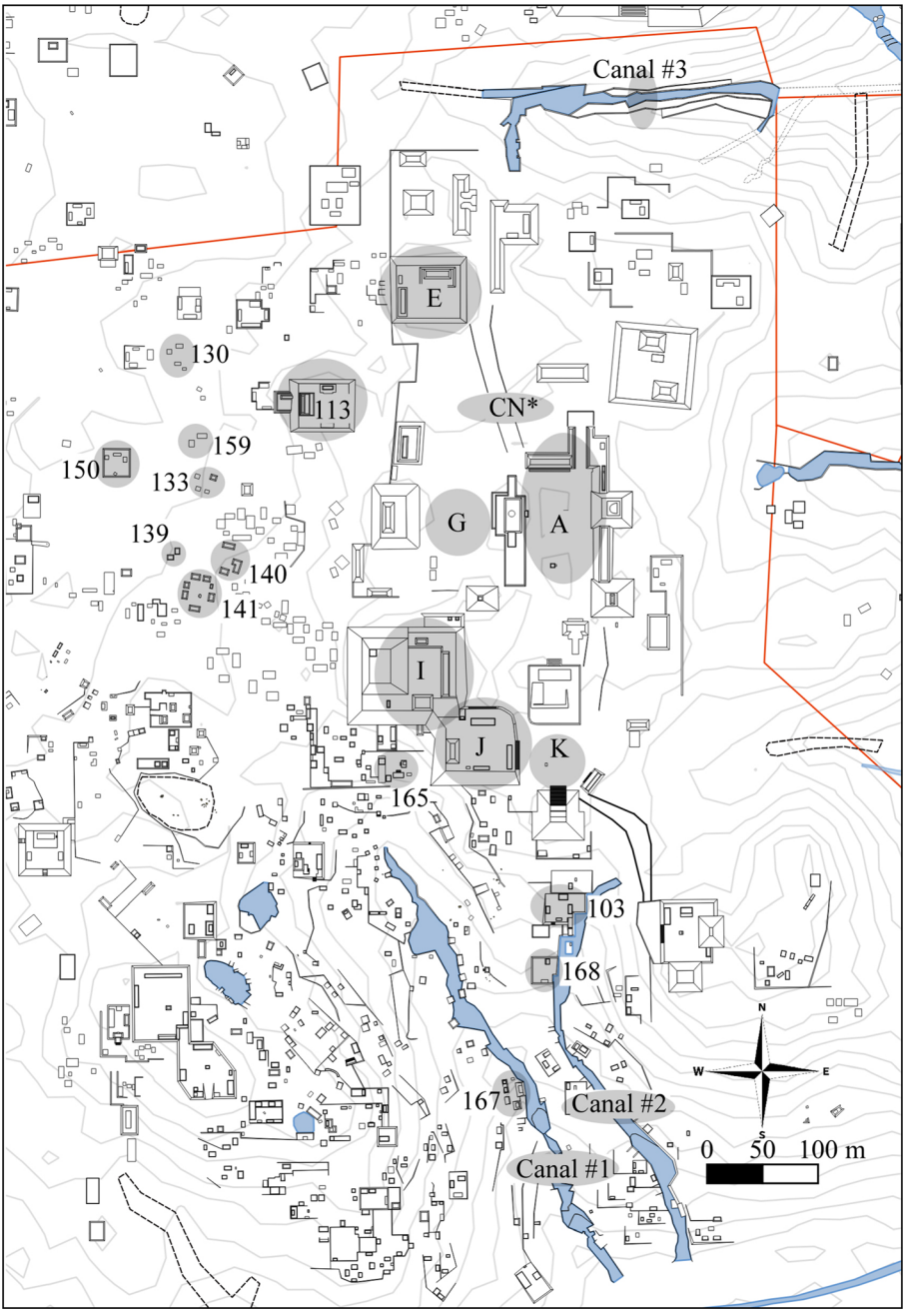


Fig. 2 Map of the central zone of Ucanal with PAU excavated architectural groups highlighted by labels and gray shading

particular, is there an increase in recycling practices during the Terminal Classic period, when many of the political-economic networks and alliances in the southern Maya lowlands were disrupted?

Recycling at the Site of Ucanal

The analysis of groundstone tools, ceramics, and architecture from the site of Ucanal was examined both in terms of temporal trends and social contexts of use. Social contexts of use were assessed by comparing data from different architectural groups (clusters of buildings around a central patio), which were ranked based on volumetric size. Rank 1 architectural groups are the largest and are associated with the highest elite residences and public ceremonial and administrative buildings. Rank 2 architectural groups comprise intermediate-sized residential buildings that may have been inhabited by higher-status commoner families or secondary elites or lower-status nobles. Rank 3 architectural groups, which comprise the majority of groups surveyed at the site, are the smallest residences and are likely to have been inhabited by commoner families (Halperin and LeMoine 2019).

Groundstone

Recycled groundstone artifacts consisted primarily of granite and quartzite *manos* (one- or two-handed tools used to grind corn and other items against a *metate* or grinding stone), which were truncated, through percussion and/or grinding, and turned into hammerstones and/or pestles (Fig. 3). A single metate was turned into a smaller mortar. Although the percentage of recycled groundstone artifacts was greatest for the Late Preclassic period and a very slight increase in recycling is noted between the Late Classic and Terminal Classic periods, sample sizes are low and as such, these distinctions are not statistically significant (Table 1c). Although one might anticipate commoner households to have more frequently engaged in recycling behaviors due to their more limited wealth and purchasing capabilities compared to higher-status households, these households had the lowest frequencies of recycled groundstone artifacts (Table 1a, b).

The low frequencies of recycled groundstone among the rank 3 commoner residences are even more surprising since the majority of groundstone tools from the site were imported, either as raw materials or, more likely, as manos and metates (de Chantal 2019; Halperin *et al.* 2020a). The closest quartzite and granite sources to the

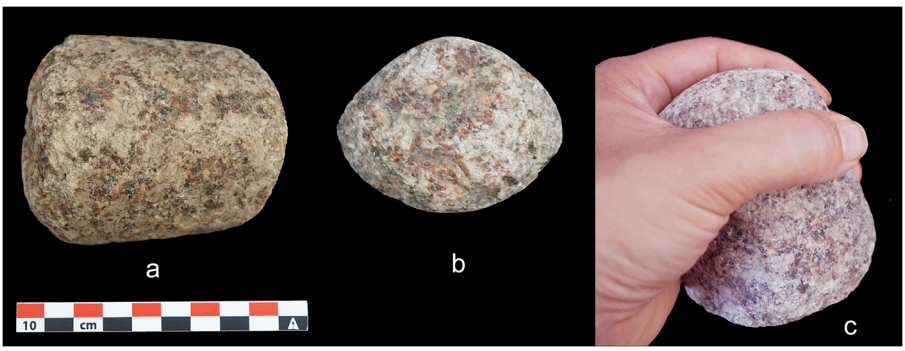


Fig. 3 Granite *mano* recycled into a hammerstone and/or mortar (PM214, UCA21B-8-2-2116, Group 103): **a** lateral side showing glossy use wear as a mano; **b** distal end showing evidence of percussion and smoothing; **c** placement in hand for scale (all photos by author)

Table 1 Recycled mano and metates from the site of Ucanal (PAU excavations 2016–2019)

	Recycled groundstone	Total groundstone	% recycled groundstone	95% confidence interval frequency	
				Lower	Upper
a. All time periods by architectural group rank					
Rank 1	5	75	6.67	1.45	13.66
Rank 2	3	27	11.11	2.29	32.47
Rank 3	2	49	4.08	0.49	14.74
b. Terminal Classic manos and metates by architectural group rank					
Rank 1	4	60	6.67	1.82	17.07
Rank 2	3	24	12.50	2.58	36.53
Rank 3	1	37	2.70	0.07	15.06
c. By time period*					
Late Preclassic	1	4	25.00	0.63	100.00
Late Classic	1	26	3.85	0.10	21.43
Terminal Classic	8	121	6.61	2.85	13.03

*Does not include 1 metate from a context with indetermined chronology

site came from outcrops along the northern and southern edges of the Maya Mountains in Belize (over 50 km away). The Guatemala Highlands are home to many groundstone source materials, including vesicular basalt and other extrusive igneous groundstone, although these sources are over 150 km from the site of Ucanal. Although the frequencies of vesicular basalt and other extrusive igneous groundstone tools from Highland Guatemala are low compared to other groundstone materials, their presence at the site increased during the Terminal Classic. Thus, it is also noteworthy that none of the vesicular basalt or other extrusive igneous groundstone was recycled into other types of objects since these items may have been considered more valuable.

Ceramics

Ceramic recycling consisted of ceramic vessels that were converted to other types of objects (Fig. 4). These vessels were likely recycled from already broken vessels and modified by smoothing, grinding, chipping, and/or perforating to create new objects. The most common recycled ceramic artifacts from Ucanal were circular discs of different sizes (Fig. 4a, b). Some of the larger discs may have served as lids to constricted neck water jars. Some smaller discs were perforated in the middle and may have been used as spindle whorls for spinning cotton, maguey, and other fibers (Fig. 4e, f) (Halperin 2008, pp. 115–117; Hendon 1992, p. 10; H. Moholy-Nagy 2003, p. 76; Parsons and Parsons 1990, pp. 314, Fig. 39; Willey *et al.* 1965, pp. 402–405). Other discs were perforated at their edges and may have been repurposed into pendants or other adornments (Fig. 4i) (Rossi *et al.* 2015, p. Fig. 7). Some of the small, square, hexagonal, and other small-sized reworked sherds (*e.g.*, roughly worked discs with

perforations that do not pierce the entire width of the sherd, see Fig. 4c) may have been used as gaming pieces among other possible uses (Trudel-Lopez 2020; P. M. Rice 2018). Other semi-circular forms or irregular shaped reworked sherds have greater evidence of wear on one or more edges, indicating that they may have been refashioned to function as polishers and smoothers (Fig. 4g, i) (Halperin and Foias 2010; López Varela *et al.* 2001). Ash-tempered ceramic polishers, which were common during the Classic period, may have worked especially well as smoothers or polishers since the volcanic glass within the ceramic paste was both extremely fine (microscopic) and sharp and, as such, was similar to fine sandpaper (Fig. 4g). Although evidence of crushing ceramics to use as temper for making new ceramics or for stucco and mortar production has occasionally been identified for other sites in the Maya area (Cecil and Pugh 2018; Gillot 2014; Howie 2012), it was not examined here (although see discussion below).

Comparisons of the frequencies of recycled ceramic vessels (expressed as ratios of recycled ceramic artifacts per 1000 sherds) over time reveal that there was no significant rise in recycling practices over the course of the Classic to Postclassic period transition (Fig. 5, Table 2). In fact, the frequencies of recycled ceramics remain relatively similar throughout all time periods with the exception of the Early Classic period when sample sizes were lower and confidence intervals further apart. In addition, ceramic recycling frequencies were not higher among the small architectural groups as one might expect if scarcity arguments are to be invoked (Table 3). In fact, during the Terminal Classic period, recycling frequencies were slightly higher among the elite-associated rank 1 architectural groups as compared to rank 2 architectural groups and lowest among rank 3 architectural groups. This tendency for elites to engage in recycling practices is further identified among architectural materials, as detailed below.

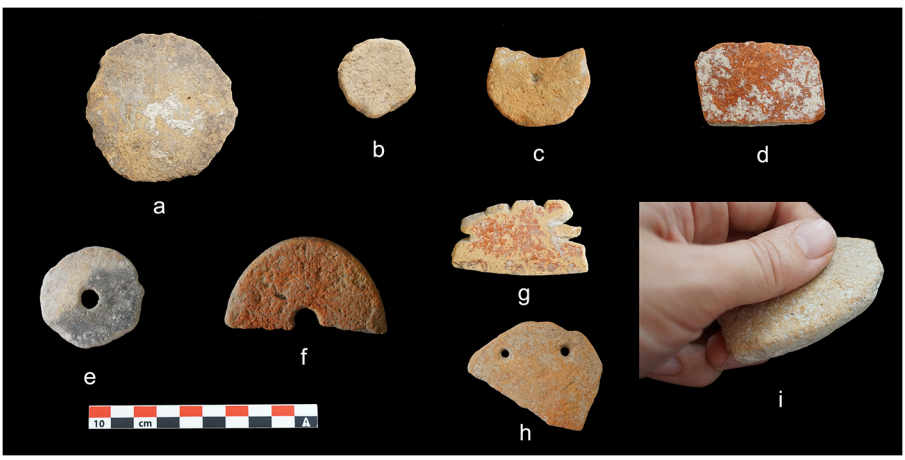


Fig. 4 Ceramic artifacts recycled from ceramic vessels: **a** disc (UCA18D-5-1-1845); **b** disc (UCA15B-4-2-1913); **c** disc with a perforated center that does not penetrate entire sherd (UCA2C-8-2-2234); **d** rectangle (UCA18D-2-6-1747); **e** centrally perforated sherd disc, possible spindle whorl (UCA5A-19-1-232; **f** centrally perforated sherd disc, possible spindle whorl (UCA16B-3-4-1668); **g** possible bone tool polisher, found with extensive bone tool production debris (UCA1B-27-8-2431); **h** pendant (UCA17A-15-1757); **i** possible polisher (UCA15A-2-4-1907) (all photos by author)

Architecture

The more limited horizontal excavations at the site of Ucanal to fully expose the architecture of earlier time periods as well as the difficulty of identifying recycled from non-recycled limestone blocks make temporal comparisons of architectural recycling difficult. Nonetheless, two cases of limestone block recycling during the Terminal Classic period stand out as massive efforts to incorporate earlier construction materials into new buildings: one of the ballcourts at the site (ballcourt #1) and an elite architectural complex (group J). Ballcourt #1 is situated in one of the site's most sacred and centrally located precincts, plaza A (Figs. 2 and 6). It was newly constructed during the early part of the Terminal Classic period (*Hal*perin *et al.* 2020a; Laporte and Mejía 2002), alongside other ceremonial buildings in the plaza A complex. The ballcourt is among the largest known ballcourts in the Southern Maya Lowlands at 40 × 26 m (not including the northern enclosure space, which would extend it to 54.5 × 26 m) (Taladoire 2015, p. Fig. 2).

Excavations within the fill of the western side of ballcourt #1 (structure A-2) indicate that the building was not only constructed as a single construction episode, but that its construction fill was comprised almost entirely of recycled large cut stone blocks (Figs. 7 and 8). These blocks were uniformly sized at approximately 0.50 × 0.20 × 0.15 m. It is extremely unusual to find such large quantities of cut stone blocks within construction fill since the efforts to quarry blocks, shape the blocks, and carry the heavy blocks were

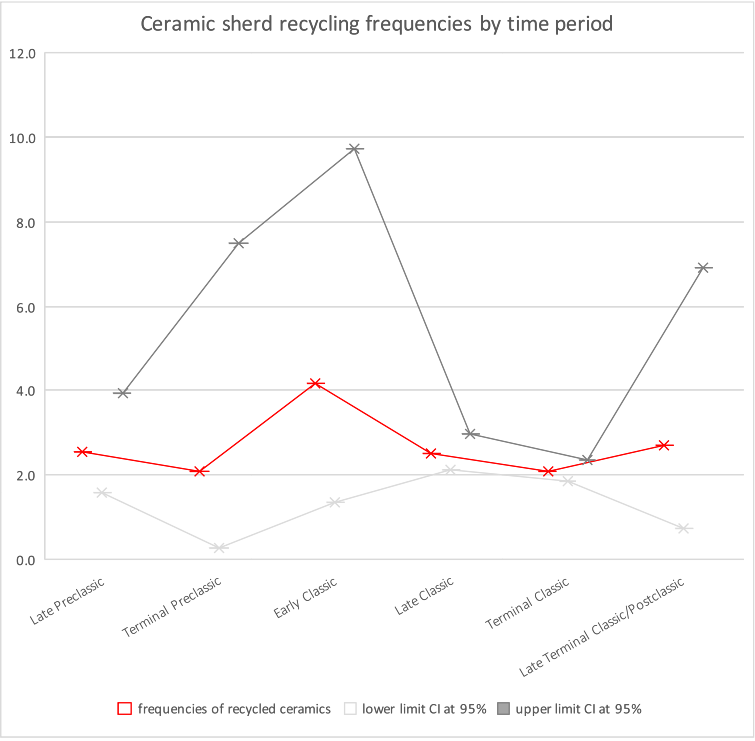


Fig. 5 Ceramic sherd recycling frequencies by time period with 95% confidence interval limits (see Table 2)

Table 2 Recycled ceramic artifacts from the site of Ucanal (PAU excavations 2016–2019) by time period

Time period	Recycled ceramics	Total ceramics	Frequency of recycled ceramics
Late Preclassic	20	7830	2.55
Terminal Preclassic	2	967	2.07
Early Classic	5	1200	4.17
Late Classic	138	54,931	2.51
Terminal Classic	285	137,267	2.08
Late Terminal Classic/Postclassic	4	1481	2.70
Total	466	203,676	

Does not include 12 samples from indeterminate or mixed contexts

much greater than the effort to quarry and transport small and medium-sized limestone cobbles and rocks.

In addition to the construction fill, however, the exterior block retaining walls appear to have been constructed of recycled materials as well (Fig. 7b). They were the same standardized size as the blocks found in the fill, perhaps indicating that they came from the same original architectural program, although it is not known which one. In addition, three of the lower wall blocks had small perforated holes indicating their use and placement in other contexts prior to their use as part of the ballcourt. One of the holes may have been a perforation for a round wooden crossbeam, while another from the ballcourt's northern wall enclosure contained a hook shape and may have been from a door jamb where other such holes often served as cord holders. Excavations of the northern enclosure wall, however, indicate that it was built slightly later in the Terminal Classic than the two parallel ballcourt structures (A-2 and A-3) (Halperin *et al.* 2020a). Nonetheless, since both the structures and wall enclosure would have been covered in stucco, these holes were likely not visible after their construction. If both of the

Table 3 Recycled ceramic artifacts from the site of Ucanal (PAU excavations 2016–2019) by architectural group rank

	Recycled ceramics	Total ceramics	% recycled ceramics
Late Preclassic			
Rank 1	7	5604	1.25
Rank 2	9	1006	8.95
Rank 3	1	2121	0.47
Late Classic			
Rank 1	44	27,680	1.59
Rank 2	16	8828	1.81
Rank 3	33	18,424	1.79
Terminal Classic			
Rank 1	161	62,832	2.56
Rank 2	71	38,384	1.85
Rank 3	38	36,024	1.05

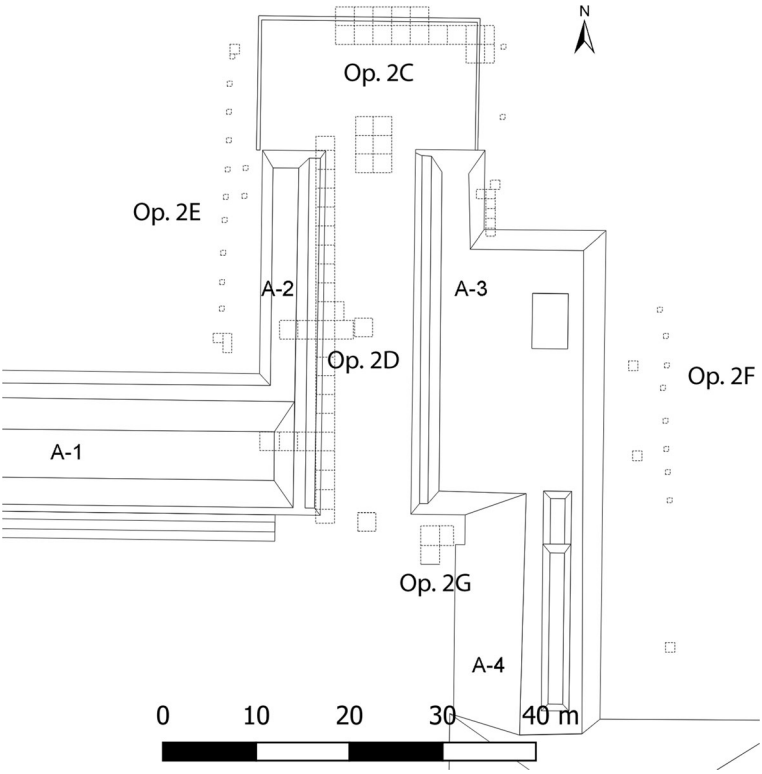


Fig. 6 Plan of Ucanal Ballcourt #1 excavations by the PAU in 2019 with locations of excavation units

structures were filled with recycled blocks, it would represent 910.8 m^3 of construction material.

The other massive effort to incorporate recycled materials was in the Terminal Classic renovations of group J (Fig. 9). Initial constructions of this architectural complex date at least to the Late Preclassic period, and as mentioned earlier, it possessed an Early Classic construction phase that included an elaborate building with a stuccoed talud façade located on the western side of the complex (structure J-6). During the Late Classic period, evidence of residential occupation and bone tool production was found in excavations along the northern side of the complex (Halperin *et al.* 2019; Perea and Dubois Francoeur 2020). During the Terminal Classic period, however, the entire complex was refurbished with a massive new platform (representing a volume of approx. 4480 m^3) that stood approx. 1 m above the earlier Late Classic period constructions. The platform fill contained large recycled blocks and vault stones. Unlike the ballcourt whose fill was almost entirely of recycled blocks, the Terminal Classic group J platform fill was a mix of typical medium- and small-sized limestone cobbles and rocks (mostly in the lower levels of the fill) and recycled blocks and vault stones in an approximately 70 to 30% ratio. Nonetheless, vertical excavations of both the northern (Op. 1D and 1B) and southern sides (Op. 1E) of the complex indicate that the recycled block materials extended throughout the large *ca.* 76 × 74-m platform.

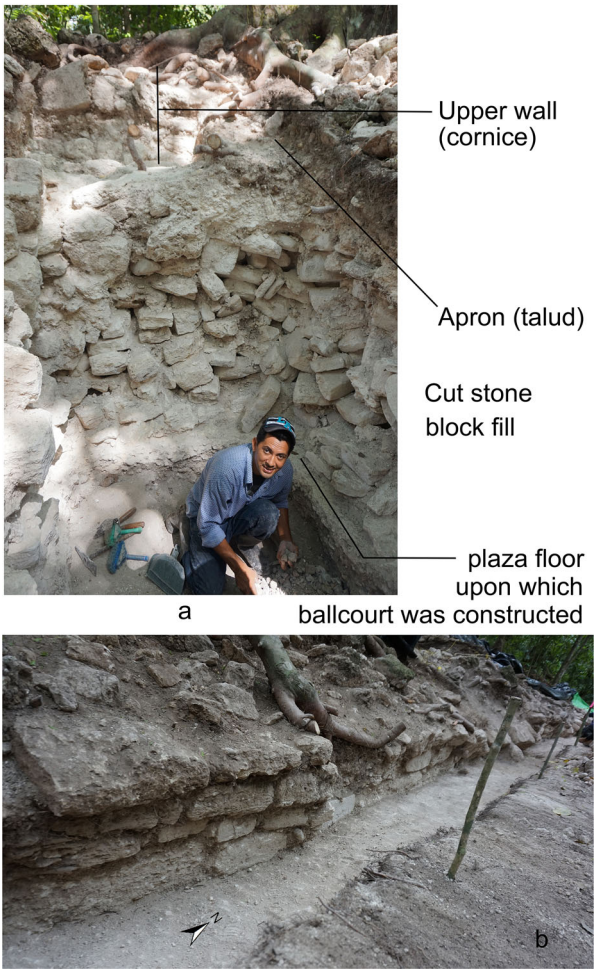
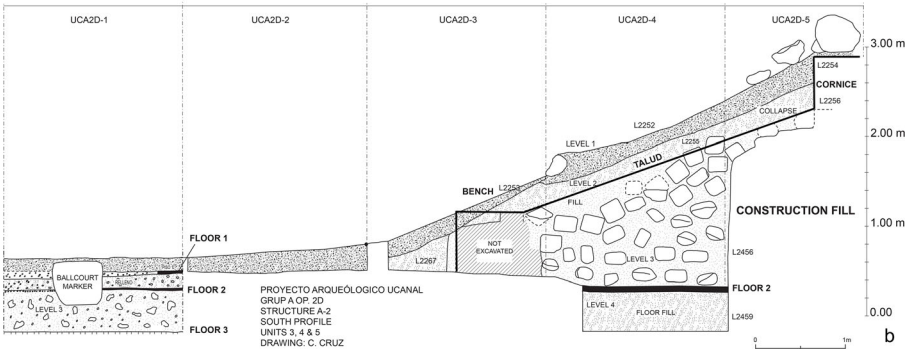


Fig. 7 Ucanal ballcourt #1 **a** excavations of interior construction fill of ballcourt structure A-2 comprising almost entirely of cut block stones and **b** cut block stone blocks along structure A-2 ballcourt bench (Op. 2D) (photos by author)

Smaller residential buildings belonging to both commoner and more well-to-do families also may have incorporated recycled building materials, although on a much smaller scale than seen in the Ucanal ballcourt #1 and the elite residential/administrative group J. Such practices can be inferred, in part, by the use of many different size cut facing stones, although the ability to identify differences between newer and older cut stones can never be made with any certainty. The incorporation of recycled blocks is more apparent when some blocks are decorated or of raw materials distinct from the other building materials. In the case of the Ucanal residential group 167, a rank 3 residential group, two sculpted blocks were incorporated into the northwestern facing wall of a Terminal Classic "C"-shaped platform (Fig. 10) (Cano Estrada 2019). The style of the blocks, uniformly shaped and sculpted with a denticulated pattern on one side, were different enough from the surrounding building

a



b

Fig. 8 Ucanal ballcourt #1 **a** construction fill comprised almost entirely of large cut stone blocks (photo by author) and **b** drawing of a cross-section of structural A-2, south profile showing the eastern profile of structure A-2 and excavated areas (drawing by C. Cruz)

materials of less standardized and undecorated cut stone slabs and rock cobbles to indicate that the two blocks were not sculpted specifically for this residence. Rather, they likely had been recycled from an elite or public residential building elsewhere at the site.

Discussion

The evidence of recycling among different materials from the site of Ucanal raises three principal issues that deserve exploration. Firstly, the practical, rationalist logics of recycling were not necessarily devoid of meaning and of the engagement with material histories and memories. Some of the most utilitarian items, in fact, may have been inalienable possessions, items that are strongly tied symbolically to their original owner, that grow in value with age, and possess a power to define who people are in a historical sense (see also Mills 2004; Weiner 1985, 1992). As such, in addition to the

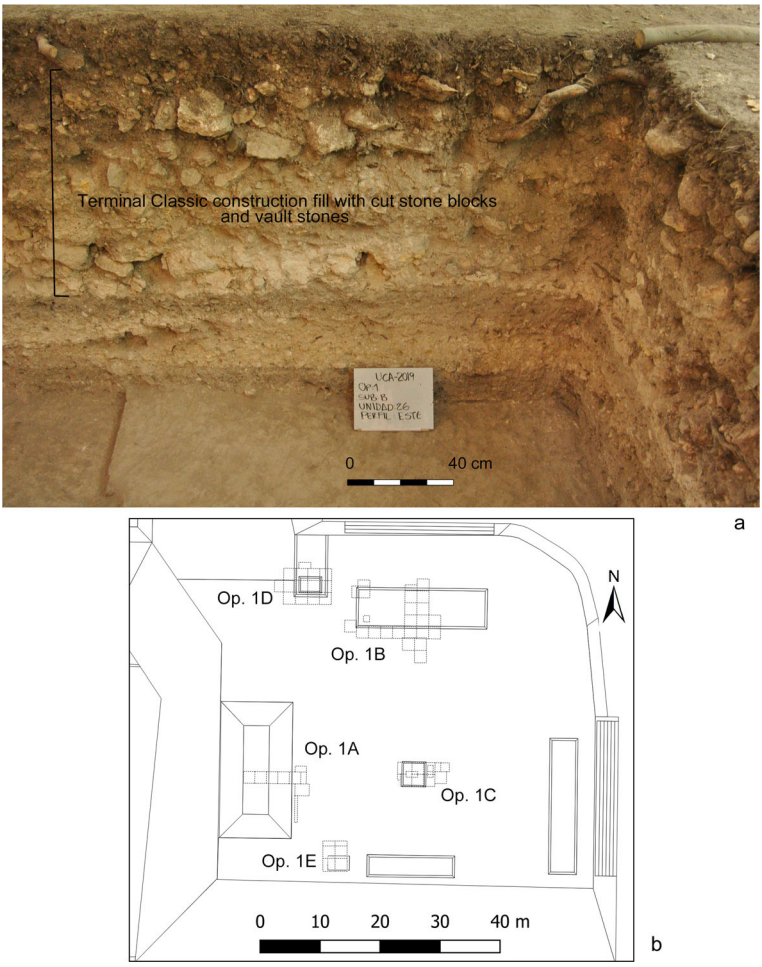


Fig. 9 Ucanal group J: **a** east profile of the southeastern corner of Op. 1B excavations showing Terminal Classic construction fill level comprising limestone blocks and vault stones; **b** plan map of excavations

practical ways in which ancient peoples turned wasted or broken items into objects, the practices of recycling may have been part and parcel of the continuity of family histories and memories. For example, despite the likelihood that manos and metates were obtained in ancient markets or through traveling vendors, these groundstone tools were some of the most important objects within a Maya household. Ethnographic Maya data indicate that manos and metates are often family heirlooms, passed down multiple generations, mostly from mother to daughter (Searcy 2011, pp. 73–74, Figure 4.5). The meaningful ties that bound a woman to her mano and metate were reinforced on a daily basis as the grinding of corn among Mesoamerican women has been estimated to comprise from 3 to 5 h a day, and thus, grinding stones served as an intimate extension of her physical body and were responsible for nourishing family members and guests (Foster 1979; Searcy 2011; Vogt 1970). Ethnographic research among the Q'eqchi',

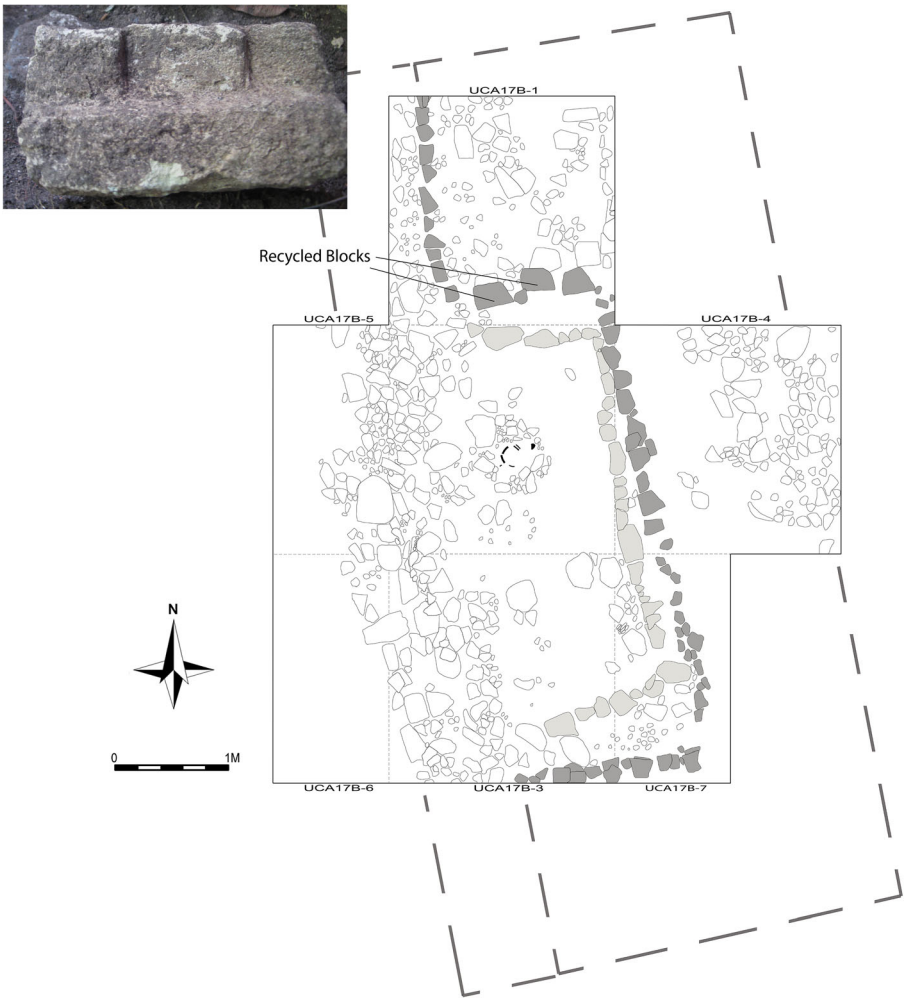


Fig. 10 Plan map of Structure 167-2 (final) from Ucanal Group 167 showing the location of recycled sculpted stone blocks and photo of one of the recycled blocks (map and photo by M. Cano Estrada)

K'iche', and Poqomam Maya indicates that while groundstone tools are often thrown out when broken, there are some cases in which broken fragments are turned into other types of tools, such as truncated manos used to grind coffee rather than corn or as a support for a table (Searcy 2011, pp. 98–100). Today, such tools may take on new meanings as they are used less frequently, but continue to represent family histories, as is the case of a heavy vesicular basalt mano and metate maternally passed down the generations and brought all the way from western Mexico to Riverside, California, where it now sits prominently on display in a family kitchen, even if it is rarely used for grinding anything (Irene De Anda, personal communication 2010, 2019). Thus, the recycling of manos into hammerstones or mortars in the past also had the potential to extend the life and memory of family members, and perhaps most particularly those related to the maternal line, even if its form and use was modified over time.

In turn, while the incorporation of recycled architectural blocks into new buildings were often acts of efficiency and expediency, they also may have been socially and culturally meaningful. The two sculpted blocks from Ucanal's commoner residence, group 167, may have imbued vitality into the building in the same way that more formal burials, caches, and heirloom objects deposited in building foundations had the potential to breathe life into a house and protect its inhabitants (Hendon 2010; Joyce and Gillespie 2000; Stross 1998). For example, De Lucia (2017, pp. 176–178) has suggested that the careful burial of a single cut stone block with plaster surface buried in an Early Postclassic adobe house from Xaltocan, Mexico, was part of an act of house dedication, providing the seed for household growth and becoming. The specific genealogical histories of a recycled stone block and the building(s) it once belonged to may not have been known—what Riegl (1982) refers to as "age value" as opposed to "historical value." Rather, the knowledge that it was from another time, an era of ancestors, may have also rendered it powerful (Hamann 2002). Similarly, Cecil and Pugh (2018) have found evidence of the incorporation of crushed Late Classic ceramics (grog) into Late Postclassic effigy censer pastes and have argued that the recycled ceramics vitalized the censers with the spiritual soul necessary for them to work properly (see also Brown 2000; McAnany and Brown 2016).

In turn, the sheer quantity of recycled materials from certain contexts, such as Ucanal's ballcourt #1, and a Terminal Classic construction phase of the group J platform reveal acts in which entire buildings, whether standing or in partial ruin, may have been rendered invisible through the acts of recycling. As in previous arguments of spolia, the intention of the acts are difficult to identify with any certainty as the same recycled elements may have been part of destructive, violent acts, following the medieval Latin meaning of the term of "things taken by force," or a form of appropriation in which the materials of an earlier era are incorporated into the new to create fictive continuities between past and present (Brillant and Kinney 2011; Kinney 2006). In Mesoamerican worldviews, destruction and construction were often two sides to the same coin, with both the breaking of objects and the making of sacrifices, such as the giving of life or blood, as part of generative processes of creation (Hamann 2008; Mock 1998; Monaghan 1995; Newman 2018).

During the Terminal Classic period, however, there appears to be a pattern of incorporating elite and public monumental Late Classic building materials into civic-ceremonial and elite Terminal Classic building foundations, as seen at the sites of Actuncan, Lamanai, Minanha, among other sites (Bey III *et al.* 1997, p. 250; E. Graham 2004; Iannone 2005; Mixter 2019). For example, at the site of Actuncan, the Late Classic vaulted masonry residence of the site's ruler (structure 19a) was dismantled and its vault and cut facing stones were incorporated into the construction fill of Terminal Classic elite building foundations (Mixter 2019). The Ucanal examples, as well as those from Actuncan, Lamanai, and Minanha, were highly coordinated and too large in scale to be the work of a few families of modest means. The emphasis in these cases, however, was not so much to visually showcase earlier construction materials as a semiotic message to be memorialized in visual terms, as seen with the hieroglyphic stone panels thought to have originated from Caracol, as mentioned earlier. Rather, great effort was taken to recycle building materials for construction fill, effectively rendering invisible earlier buildings whose histories were likely well known. As such, the importance of these recycling practices was not just a practical way of dealing with

the abundance of the past but was centered on their performative roles, whereby the very acts of building were practices of political revisionism.

The burial of materials recycled from masonry buildings with vaulted stone roofs from Ucanal group J and its replacement with wooden buildings on stone foundations underscores a broader trend in the Maya area during the Terminal Classic period in which ostentatious displays of grandeur and finery were deemphasized not just in architecture but in decorated ceramics and elite adornment practices (Adams 1971; Halperin 2017; Just 2007). While these practices may have been tied to the collapse of some palace economies and dynastic support for certain elite-sponsored artisans and master masons, the continuation of political institutions, urban infrastructure projects, and a thriving population at Ucanal suggests that these shifts were as much a conscious choice for change in the esthetics of political and social expression as an unraveling of a political-economic system.

Secondly, the broader patterns of recycling at the site of Ucanal are not clearly associated with historical periods of presumed scarcity or with households that possessed the least amount of labor and resources. There is no evidence for significant increases in the recycling of ceramics or groundstone during the Classic to Postclassic transition. Furthermore, during the Terminal Classic period, evidence for recycled ceramics is more common in the context of the largest architectural groups rather than the smallest groups that were likely occupied by more modest families. In addition, recycled groundstone was systematically more common in larger residential contexts than in smaller ones, and the most substantial evidence of architectural recycling at the site was of elite and civic-ceremonial buildings.

Thirdly, these patterns point to the need to also consider abundance in ancient recycling practices. Like the concept of scarcity, abundance is not an absolute condition but situationally and historically relative. For example, while newly sedentary Natufian populations in the Levant consumed very little compared to later periods of urban development, Hardy-Smith and Edwards (2004) argue that the increases in productive and consumptive behaviors in the 12th millennium with the earliest sedentary villages were out of step with habitual refuse practices of discarding items around living spaces and resulted in a "garbage crisis," in which people lived among greater and greater amounts of trash until new discard practices were more habituated. In turn, Smith (2012) has underscored the fact that ancient cities relative to their hinterland zones were not only loci for accelerated production but also accelerated consumption where inhabitants possessed both greater quantities and diversities of goods. Although she does not mention recycling practices, the possession of more and more material items in urban contexts creates a series of material opportunities and challenges that are ripe for creative ways to recycle.

Despite the emphasis on Roman spolia that was curated, rediscovered, appropriated, and showcased during the late antiquity periods onward, Classical Romans themselves were prolific recyclers, reworking a range of materials from portrait statues to bronze objects (Ng and Swetnam-Burland 2018). Most notably, the large-scale production of Roman ceramics also created a tremendous quantity of materials that was reused and recycled on a massive scale: ceramics were reused as packaging containers and recycled into grinding palettes, strainers, funnels, lamp covers, incense burners, gaming pieces, weights, drain elements, planters, polishers, and raw materials in concrete construction,

rubblework, mortar and wall plaster, pottery temper, and as flavoring agents and salves (Peña 2007).

For the pre-Columbian Maya as well, it is clear that an abundance of material possessions was also met with diverse ways to recycle the large quantities of broken, discarded, or unwanted items. For example, recent excavations at the site of Uxul in Mexico reveal that one of the city's large water reservoirs, Aguada Oriental at 100 × 100 m in size, was lined completely with thousands of broken pottery vessels (Grube *et al.* 2012, pp. 37–44). The construction of the Aguada appears to have been during the beginning of the Late Classic period, at the height of the city's occupation and a time of political stability (*ibid*). Likewise, the high frequencies of ceramic and groundstone recycling among elite and middle-status households at the site of Ucanal may reflect the sheer abundance of material possessions these households generated in relation to the smaller, commoner households.

In general, elite households in the Maya area are known to have consumed more and thus generated more trash than small, commoner households (Andrieu 2009; Halperin and Foias 2016; Straight 2017, p. 98). For example, at many Classic period sites, commoner households tended to discard their trash at the outskirts of their household compounds and within kitchen gardens, while elite and non-elite residents living in the site core had less available space for trash disposal and tended to accumulate trash deposits for eventual deposition in the construction fill of public and elite architecture (Foias *et al.* 2012; Halperin and Foias 2016; Hattula Moholy-Nagy 1997, 2020, p. 4; Robin 2002). The density of some of these construction fill trash deposits is extraordinary. Construction fill from above Late Classic Tomb 116 below Temple I at Tikal yielded over 380,000 pieces of broken obsidian and 157,000 pieces of chert debitage, trash that may have also been of symbolic importance (Hattula Moholy-Nagy 1997, pp. 305–306). A platform area just north of the Motul de San José palace (Op. 2A-3, -5, 40, -41, -42) possessed over 20,798 ceramic sherds weighing 573,193 g, the bulk of which appeared to have been a direct deposit of domestic and elite artisan trash since no fill stones were mixed with the fine soil (Halperin and Foias 2016; Halperin 2012).

Regardless of whether Classic Maya peoples were running out of space or not for garbage deposition, material objects—whether broken, discarded, or even complete—were relatively plentiful in urban centers with bustling economies. During the Terminal Classic period, Ucanal continued to actively engage in on-site production in ceramics (Halperin 2019), chert and obsidian (Cotom and López López 2019; Hruby 2019), and textiles among other likely crafts, and even widened its economic networks from Late Classic times (Halperin *et al.* 2020b). Although many of the typical material symbols of elite power had changed, such as more modest ornamentation and dress in the depictions of elites, a diminution in the production and consumption of polychrome vessels, and the replacement of perishable superstructure buildings over buildings with masonry walls and roofs, the city of Ucanal continued to be loci of productivity. One possibility is that abundance, in addition to scarcity, has the potential to create opportunities for recycling. As such, more varied understandings of the conditions, contexts, motivations, and meanings of recycling are needed.

A renewed look at ancient recycling as possibly linked to abundance raises some parallels with contemporary issues on recycling. A recycling crisis mentioned at the beginning of the paper is only partially due to the fact that China, Indonesia, and other Asian countries halted the importation of garbage from the USA, Canada, and Europe.

The heart of the problem, however, is the high rates of consumption and the high rates of waste generation among these Western nations (R. Wilk 2016).[1] Western *per capita* rates of waste production tower over those of poorer countries, underscoring the global inequalities in environmental resource depletion and contributions to climate change. Many environmentalists point to recycling not as the primary strategy for environmental sustainability but as the final resort behind reducing consumption, selective consumption, waste minimization, and repair in that order (Connelly *et al.* 2012, p. 76). Although contemporary consumption and waste practices are on a scale unparalleled in human history and are clearly different from those of the ancient Maya, ancient recycling practices may have also been a part of relative surges in consumption and in the generation of waste, practices in which different social groups participate in on unequal terms. Further studies, however, are needed to systematically examine ancient recycling practices from the perspective of both class distinctions and long-term trends over time.

Conclusion

The common conception that some lower-status social groups or certain types of societies (ancient as opposed to modern; developing as opposed to developed nations, *etc.*) recycle as acts of necessity and practicality while more privileged groups do so as semiotic acts of meaning creates a false dichotomy. Such a false dichotomy deprives, on the one hand, some groups of their agency, creativity, and history-making capacities. On the other hand, it ignores an aspect of recycling that needs to be further underscored: that some privileged groups and certain types of societies, such as urban ones, contribute disproportionately to the problem of waste since they tend to consume more. Abundance, in addition to scarcity, also creates the conditions for recycling practices. The practical acts of dealing with an abundance of waste were not necessarily devoid of meaning, and the meaningful acts of repurposing objects and buildings may have simultaneously been economizing acts of practicality.

For the Pre-Columbian Maya from the site of Ucanal, Guatemala, an examination of groundstone tools and ceramic vessels reveals that recycling did not increase over the course of the Classic to Postclassic period transition, a period often associated with environmental challenges, political crises, and shifting political-economic networks in the Southern Maya Lowlands. The recycling of these quotidian items was likely part of practical acts of maximizing available materials and minimizing effort but also had the potential to record personal histories and create new forms of value. Evidence of substantial recycling of architectural materials at the site also existed during the Terminal Classic period. These recycling practices were not driven by a scarcity of labor or materials. Rather, they were performative acts that buried the signs of political power of earlier eras to remake them anew.

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[1] See also http://www.atlas.d-waste.com/

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Compliance with Ethical Standards

Conflict of Interest The author declares no conflict of interest.

Code Availability (Software Application or Custom Code) NA

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