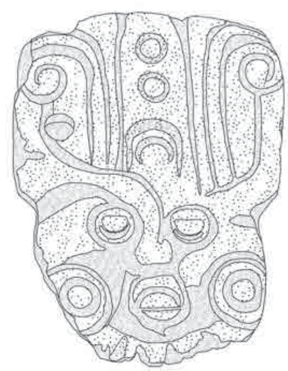
Investigations of the Belize River East Archaeology Project:
A Report of the 2014 and 2015 Field Seasons



Volume 2

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Investigations of the Belize River East Archaeology Project: A Report of the 2014 and 2015 Field Seasons

Volume 2

Edited by Eleanor Harrison-Buck

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Analytical Investigations

Chapter 1

Overview of BREA Analytical Investigations: 2014-2015

Eleanor Harrison-Buck

This is the second of a two-volume archaeological report that documents analytical studies that were undertaken by members of the Belize River East Archaeology (BREA) project between 2014-2015.

The BREA study area encompasses the watershed of the eastern Belize Valley, between Belmopan and Belize City, and represents an area measuring roughly 6,000 sq. km (**Figure 1.1**). In the last five years of fieldwork, the BREA team has devoted most of its time to documenting the archaeology in the middle Belize Watershed between Banana Bank and where the Belize River meets the confluence with Labouring Creek. Therefore, most of the analytical investigations included in the chapter contributions of Volume 2 are the analytical results of data collected from sites in this part of the river valley. The analytical studies presented in this volume were carried out by our staff, students, and specialists affiliated with the BREA project.

Background to the Research

Our investigations of the BREA study area, specifically in the middle reaches of the valley, have identified a dense occupation and a long history of settlement (**Figure 1.2**), extending from Formative to Colonial times, ca. 900 BC-AD 1900 (Brouwer Burg et al. 2014; Harrison-Buck, ed. 2011, 2013; Harrison-Buck, Murata, and Kaeding 2012; Harrison-Buck, Kaeding, and Murata 2013; Runggaldier et al. 2013). These sites range in size, from small house lots to larger centers with ballcourts and pyramidal architecture. The chapter contributions in this volume focus on material and paleoenvironmental studies from a number of different sites, primarily located in the middle Belize Valley, including Kaax Tsaabil, Saturday Creek, Hats Kaab, and Ma'xan (**Figures 1.1-1.2**). Below, I provide a brief overview of these analytical investigations that are presented herein.

Overview of Analytical Investigations

During the January 2014 season, BREA collected soil samples from different sites throughout the eastern Belize Watershed to address a number of different research questions, including issues related to ancient soil fertility and the possibility of identifying a biomarker for cacao in soils. Since 2012, Dr. Serita Frey, a soils specialist and professor in the School of Natural Resources and Environment at UNH, has led a BREA research project on the study of a cacao biomarker. Her team has developed a viable method for detecting the presence of theobromine in soils; however, its usefulness for identifying ancient sites for cacao cultivation is less clear and requires further analysis in the future (see **Knorr, Frey, and Buck, Chapter 2**).

Figure 1.1 Map of Belize showing BREA study area (map prepared by M. Brouwer Burg).

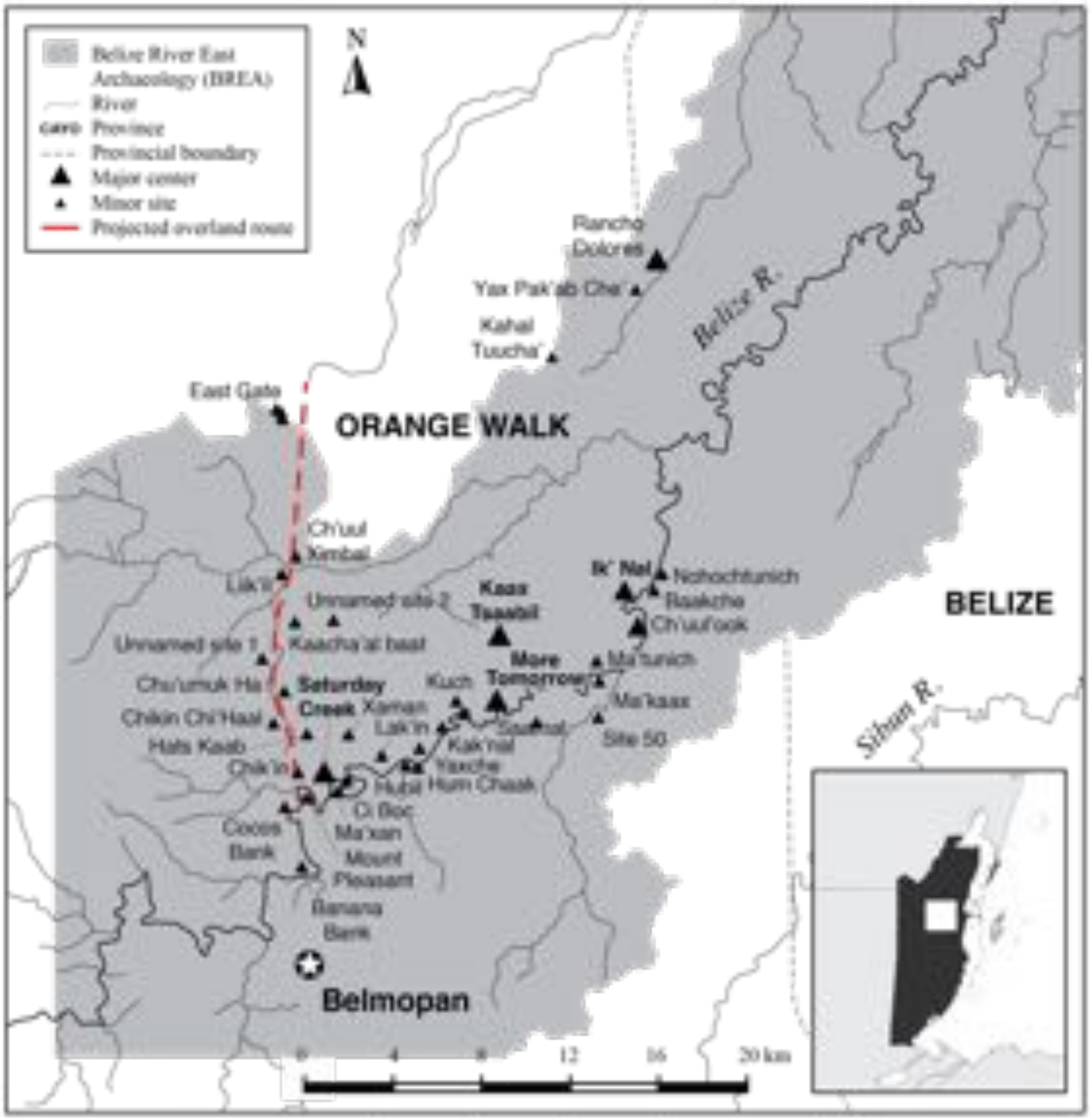

Figure 1.2 Western half of the BREA study area. Projected north-south overland route in dashed red line and our survey transects in solid yellow lines (map prepared by M. Brouwer Burg).

During the January and summer 2014 field seasons, other soil samples were collected primarily from locations in the middle reaches of the Belize Valley, but in this case collection targeted sources of clay (**Jones, Bryce, Prado-Fahnestock, Buck, and Harrison-Buck, Chapter 3**). The goal of this project is to identify clay sources that may have been used for ancient Maya ceramic production. This study aims to build on an ongoing geochemical study led by Bryce and Harrison-Buck examining BREA ceramics using Neodymium (Nd) isotopes, a geochemical tracer that has not been previously used for sourcing clays or ceramics in Mesoamerica. Combined, the results of these studies suggest that the signature of clay bodies within the watershed aligns with the local ceramic signature (types that most commonly appear in the assemblage), but does not align with the Nd signature of imports (rare types in the assemblage presumed to be non-local). The preliminary results are exciting as they suggest Nd isotopes offer a viable geoarchaeological tracer and accurate method for sourcing ceramics.

Another interdisciplinary study of the BREA project involves a long-term paleoenvironmental study. The project is aimed at testing a hypothesis proposed by Kitty Emery and Erin Thorton (2012, 2013) that suggests aquatic taxa from small water bodies, such as perennial wetlands, diminish in the Terminal Classic period at most sites when compared to the Late Classic period and can serve as a local index of drought directly associated with cultural contexts. Emery and Thorton (2012, 2013) relied on Neotropical animal ecology researchers to determine habitat preferences for the range of taxa identified in the zooarchaeological collections. In the summer of 2014, we conducted a similar study of the microenvironments and range of habitats found in and around the BREA wetlands (**Van Dam et al., Chapter 4**). Specimens of mollusks, fish and other water-dependent taxa were collected from around the Western Lagoon wetlands and a study of their local habitat preferences was carried out by our team of biologists.

Using this habitat study and comparative reference collection, our zooarchaeologist, Lori Phillips, will begin classifying all faunal remains recovered in wetland and settlement excavations by species and habitat preference during a summer lab season in 2015. We anticipate finding a heavy representation of locally acquired wetland-fidelic species from our excavations at sites like Jabonche that are located proximate to the perennial wetlands in the lower Belize Watershed (**Figure 1.1**). We aim to examine the ceramics from these contexts to refine our understanding of the relative chronology, enabling us to compare Late and Terminal Classic faunal assemblages from well-dated deposits. The long-term goal is to cross-examine Emery and Thorton's proposed model concerning pan-regional climate change in the Maya lowlands and its local impact on wetland use in this part of Belize. In this volume, Phillips (**Chapter 5**) focuses her attention on settlement in the middle Belize Valley and presents a preliminary study of the faunal material collected from seven ancient Maya sites where excavations have been previously conducted, including Ma'xan, Saturday Creek, Otley's Flat, Hum Chaak, Hats Kaab, Kaax Tsaabil, and Ik'nal (**Figures 1.1-1.3**). Notably, the heaviest density of faunal material was recovered from a rich midden deposit from Ma'xan where over half of the assemblage comprised fish and turtle (**Phillips, Chapter 5**).

Assisted by BREA staff members, a number of the undergraduate students participating on the BREA project as part of a University of New Hampshire archaeological field school carried out a series of analytical investigations of different artifact classes. In one study, the distributions of turtle bone and obsidian were examined in the context of circular shrine architecture (**Leslie Duff and Eleanor Harrison-Buck, Chapter 6**). Turtle carapaces are known to have been used as receptacles of blood offerings during Postclassic times and their high densities and direct association with obsidian bloodletting implements suggests that bloodletting activities may have occurred in the context of circular shrine buildings during Terminal Classic times.

During the summer 2014 field season we were fortunate to have Tawny Tibbits join the BREA team and as part of her dissertation research conduct chemical sourcing on a collection of our groundstone using portable x-ray fluorescence (pXRF). Here, she reports on her preliminary findings and discusses the BREA groundstone assemblage in terms of its sources of quarrying locales in Belize (**Tibbits, Chapter 7**). Based on these findings, a closer study of the groundstone distributions from the sites of Ik'nal and Hats Kaab in the BREA study area show that procurement sources changed over time (**Whelan and Tibbits, Chapter 8)**. Importantly, chemical sourcing of groundstone with pXRF when compared along side a visual study shows that visual inspection is not a reliable method for sourcing groundstone.

During 2014-2015, we carried out several excavations at Saturday Creek. Investigations in the North Plaza group (Operations 17-20) revealed a primarily Classic period (AD 200-800) occupation with a small amount of terminal debris dating to the Terminal Classic period (ca. AD 800-950). In contrast, our excavations in the Southwest Plaza group (Operations 23 and 24) revealed a later occupation beginning in the Terminal Classic and continuing through Late Postclassic times to the time of Spanish Contact. Operation 23 examined Structure 11, a small radial shrine structure (see Harrison-Buck and Flanagan, Volume 1). The associated ceramic material consisted mostly of smashed incense burners, including a Chen Mul Modeled censer, which suggests that the structure at least in its final phase served as a Late Postclassic shrine building. Here, we present a description and overview discussion of the different types of Postclassic censer ware that we recovered from this Postclassic shrine structure (**Linesman and Harrison-Buck, Chapter 9**).

During the summer of 2014, the western structure of Hats Kaab was investigated (Operation 22), specifically around the southeastern corner of the main western platform (see Brouwer Burg and Astrid Runggaldier, Volume 1). While no intact stone walls were found, intact floor surfaces constructed of re-deposited midden were identified. Within these contexts several discrete deposits of disarticulated human remains were identified along with associated grave goods, including a jade bead as well as ceramics that appear to date to the Late Preclassic (500 BC-AD 150). Osteological analysis of the Hats Kaab burials revealed that at least five individuals were represented and at least two were in primary contexts (**Wrobel, Chapter 10**). In addition to Hats Kaab, the osteological report includes an analysis of a single interment found at the nearby hilltop site of Kaax Tsaabil during the 2012 field season (see Murata et al. 2013). According to the osteological report the individual appears to be an older female who may represent a sacrificial victim, based on her body positioning and lack of a formal grave context.

Conclusions

This report offers a comprehensive look at the results of our year of field and lab work on the BREA project, carried out during the 2014-2015 field seasons. The results presented here exemplify our interdisciplinary team and the breadth of our research, which ranges from material cultural analyses to paleoenvironmental studies.

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Chapter 2

Soil Characteristics across a Settlement Intensity Gradient in the Maya Lowlands of Belize

Melissa Knorr, Serita D. Frey, and David G. Buck

Overview

The overall objectives of our soils research has been to conduct soil biogeochemical analyses to (1) examine how settlement intensity altered soil characteristics, (2) trace the local source(s) of clay for ceramic production, and (3) determine the locations of ancient cacao plantations. Soil samples were collected from three sites along a settlement intensity gradient, as well as from a suspected ancient cacao orchard and a chronological gradient of modern-day cacao plantations (**Figure 2.1**). The soils were analyzed for soil texture, pH, macro- and micronutrients, and a cacao biomarker (theobromine). The soil nutrient data were summarized in our 2013 report. Here we focus on our effort to develop a method to identify a cacao biomarker in soils (Obj. 3).

Research Approach

Soil samples were collected in 2014 along a chronological gradient of suspected to known current cacao cultivation with the goal of developing a method for assessing theobromine concentrations. Three soil cores were collected at one depth increment (~0-5 cm) from orchards ranging from 1-28 years of cultivation, as well as an abandoned orchard and lastly, a savanna area along a highway unlikely to have been cultivated for cacao. The abandoned orchard had been cleared of cacao in 2010 and was replanted with corn at the time of sampling. Samples were composited by location for a total of three replicate samples for each of the six sites (18 samples total). All samples were uniformally air-dried, sieved (2 mm) and analyzed for theobromine. To assess soil theobromine concentrations, soils disrupted by ultrasonication, filtered to remove precipitates, and pH adjusted (Henderson *et al*., 2007). Filtrates were then fraction purified with Supelclean LC-18 SPE cartridges, where theobromine was collected by extraction with chloroform. Extracts were then nitrogen-evaporated, reconstituted, and filtered through a 0.22 µm filter before injection onto a Shimadzu SCL-10A Liquid Chromotograph (HPLC) coupled with a Shimadzu SPD-M10A Mass Spectrophotometer (Srdjenovic et al., 2008).

Results

The cacao biomarker analysis indicated that this method is viable for detecting the presence of theobromine in soils; however, its usefulness for identifying ancient cacoa cultivation sites is less clear. Theobromine was detected in all current cacao orchards, ranging in age of production from 1, 4, 10 or 28 years. Amounts of the marker varied widely with no discernable trend in age of cultivation. Re-analysis of soil samples collected from the previously sampled modern-day cacao orchard in 2012 detected much lower amounts of theobromine (~20% of previously detected theobromine). This indicates that sample storage in air-tight containers may not be a viable storage option or that degradation of the marker can happen quickly upon soil disturbance. Soils from the non-cultivated savanna had the least amount of marker detection, while control samples from forested and agricultural U.S. sites gave inconsistent amounts, varying from 0-50% of theobromine detected in currently cultivated orchards.

Figure 2.1. **Example soil pit (top photo) and soil sampling area (bottom photo) at Saturday Creek (SC), the most intensively settled area sampled (photos by S. Frey).**

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Chapter 3

Neodymium Isotopes as a Geoarchaeological Tracer of Ancient Maya Clays in the Belize River Valley

Alan Jones, Julia Bryce, Florencia Prado-Fahnestock, David Buck, and Eleanor Harrison-Buck

Introduction

The neodymium isotopic ratios of clay bodies reflect the bedrock from which the clay minerals weathered. These same ratios are passed into materials manufactured from the clay, and can thus be used to infer a source deposit from which the material was produced. Similar applications using strontium isotopes in bone and tooth enamel have been used to trace migration and sedentism in human populations (Hodell 2004). Here we test the applicability of this technique by analyzing the $^{143}Nd/^{144}Nd$ of clays throughout the Belize River valley. Our objectives were to ground truth $^{143}Nd/^{144}Nd$ values and determine the overall range present within the study area as well as to begin building a database of neodymium isotopic values that archaeologists can use to determine the provenance of ceramics in the Maya region.

An alternative isotopic method to strontium for sourcing clays is necessitated by the geologic substrate of the Yucatan peninsula; a carbonate shelf composed primarily of marine limestone. Strontium is, compared to other trace elements, abundant in seawater, and its long oceanic residence time means that it is globally homogenous in the oceans (Capo et al. 1992). Because of its similar ionic radius, it also substitutes easily for calcium in the shells and tests of marine organisms. The strontium isotopic ratio of the carbonate sediments produced by these organisms can thus be seen to reflect the isotopic ratio of seawater at the time of their formation. The unique signature reflecting source lithology may thus be overprinted by the seawater signature in clay formed from the weathering of these limestones. Carbonate fragments were also frequently included as temper in the paste during ceramics production, further confounding efforts to use strontium as an isotopic tracer (Harrison-Buck et al. in revision).

Neodymium Isotope Systematics

Neodymium has five naturally occurring stable isotopes, listed here next to their natural abundances: ^{142}Nd (27.2%), ^{143}Nd (12.2%), ^{145}Nd (8.3%), ^{146}Nd (17.2%), and ^{148}Nd (5.7%). There are two radioisotopes of Nd: ^{144}Nd (23.8%) and ^{150}Nd (5.6%) with half-lives of 2.29×10^{15} and 7×10^{18} years respectively. Nd is joined to the isotope system of samarium (Sm) via the alpha decay of ^{147}Sm to ^{143}Nd. Because Nd and Sm are very close on the periodic table, and both are rare earth elements (REEs), they do not fractionate easily during crystal melting processes, and as a consequence deviations of the ratio of $^{143}Nd/^{144}Nd$ from the Chondritic Uniform Reservoir (CHUR) evolution line are very small in terrestrial rocks (DePaolo, 1976). For this reason, Nd isotope ratios are often reported in the format of epsilon notation, or ε_{Nd}—the deviation of the measured rock to the CHUR line, and we follow this format throughout this paper when reporting Nd ratios.

Materials and Methods

Clay sampling in Belize was conducted over the summer field seasons of 2013 and 2014. Collection took place throughout a wide swath of the Belize River valley and Maya lowlands, encompassing much of the Belize River East Archaeology project (BREA) study area, going as far west as the city of Benque Viejo near the Guatemalan border, and as far north as the city of Orange Walk (**Figure 3.1**). Sample locations were chosen based upon site accessibility (often along roadsides or river banks), local geology, and proximity to sites of particular archaeological interest. For samples collected from cut riverbanks or road cuts, 10-15cm of soil was removed from the exposed surface of the clay deposit using a steel hand trowel and approximately 200g of sample were collected with a clean trowel. Some samples were taken from the bottom sidewall of 1m deep test-holes in the same manner. Sites were geo-referenced using a Garmin handheld GPS unit. Samples were air dried in our field laboratory for approximately 48-60 hours before being bagged for export.

Following the methods of Sgualdo et al. (in press), the clay samples were prepared as follows for isotopic analysis. Samples were dried down at 60°C for 24 hours. Approximately 200mg of each sample was then digested in Nitric acid in Teflon vials (leachates intended for isotope analysis were stored in Nitric acid for approximately a year prior to column collection), which was evaporated under a laminar flow hood. A cut was made from these leachates to be run for rare earth element (REE) concentrations. Each sample was then dissolved in 3M Nitric acid and loaded onto an EIChroM Industries Sr spec 50-100 µm resin column, where the REEs were collected during the first two washing steps in 3M Nitric acid in Teflon vials prior to Sr collection. Strontium was collected in 5mL of 18 Ω H_2O in Teflon vials, while the rare earth washes were dried down under a laminar flow hood, brought up in 1N Hydrochloric acid (HCl), and loaded onto columns containing AG 50W-X8 200-400 mesh cation exchange resin and eluted with 1.5N HCl. REEs were collected in 8mL of 6N HCl in Teflon vials. To select for REEs and further concentrate Iron, the samples were again dried down, brought up in 2N nitric acid, and loaded into columns containing Eichrom TRU spec 100-150µm resin, and collected in 2mL of 0.05 N titrated HCl. Finally, to separate Samarium from Neodymium, the samples were dried down under a laminar flow hood, brought up in .25N nitric acid, and loaded onto columns containing Eichrom Ln resin. Collection was made in 4.5mL of 0.25N HCl.

Figure 3.1 Map of sampling locations for both the 2013 and 2014 field seasons.

Following these chromatography procedures, the samples were dried down under a laminar flow hood, diluted in 2% Nitric acid, and analyzed on a Nu Instruments Nu Plasma II ES Multicollector Inductively Coupled Plasma Mass Spectrometer (MC-ICP-MS) at the University of New Hampshire's plasma geochemistry laboratory. Nd solutions were run at 3 volts alongside repeated analyses of a JND-1 standard. The average standard $^{143}Nd/^{144}Nd$ of n=69 runs was 0.512137 with a standard mean error of ± 0.000003. Sample Nd measurements were bracketed using measured Standard ratios.

Results

The ε_{Nd} of the 13 measured samples ranged from -1.1 to 0.1, with $^{143}Nd/^{144}Nd$ significantly higher than the mean analytical error of .000005 (**Table 3.1**). This range is within the error of ε_{Nd} and thus the isotopic signature of clay bodies within the sampled area is statistically indistinguishable. Plotting ε_{Nd} against latitude indicates a possible latitudinal control on Nd, with Maya mountains in the south and depleted values toward the northern lowlands (**Figure 3.2**), although this correlation does not appear to be statistically significant across the sampled region.

Table 3.1 Isotope ratios of analyzed samples.

Samples	Latitude	Longitude	ε_{Nd}	$^{87}Sr/^{86}Sr$
2013 Clay 01	17.085	-89.127	-0.7	
2013 Clay 03	17.057	-89.142	-0.7	0.7494503
2013 Clay 11	16.971	-88.845	-1.0	
2013 Clay 12	17.169	-88.84		0.7800379
2013 Clay 17	17.307	-88.534	-1.0	0.7451269
2013 Clay 18	17.307	-88.533	-1.1	
2013 Clay 19	17.697	-88.84		0.7114090
2013 Clay 20	17.791	-88.537	-0.4	
2013 Clay 21	17.776	-88.572	-0.3	
2013 Clay 22	18.026	-88.562	0.1	
2013 Clay 23	17.995	-88.535	-0.2	
2013 Clay 26	17.321	-88.777	-0.7	
2013 Clay 29	17.329	-88.754	-0.3	0.7171805
2013 Clay 35	17.345	-88.792	-0.3	

Discussion

We find minimal variation in the Nd isotopic ratio in clays from the Belize River valley. This consistency suggests that these deposits carry a distinct signature that can be used to distinguish foreign and local clays within Maya ceramics in the region. Analysis of clay pottery by Harrison-Buck et al. (in revision) shows ε_{Nd} values between -1 and 1 for ceramics identified via stylistic analysis as local products, and values approximately between -2 and -6.5 for ceramics sherds identified as potential "imports" (**Figure 3.3**) The weak correlation between latitude and Nd may be explained by the younging of bedrock south to north, although more samples need to be analyzed before any determination of a trend can be made.

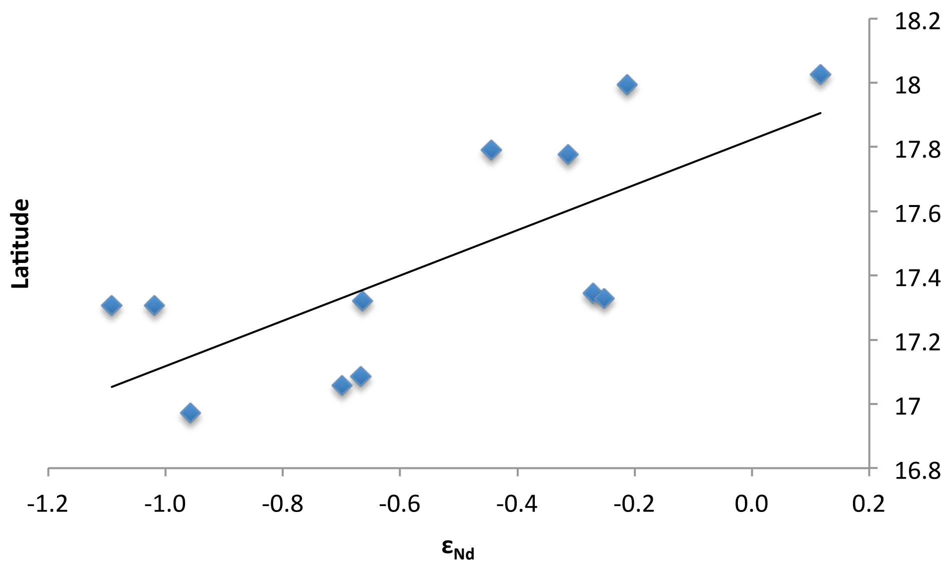

Figure 3.2 Measured ε_{Nd} plotted against latitude.

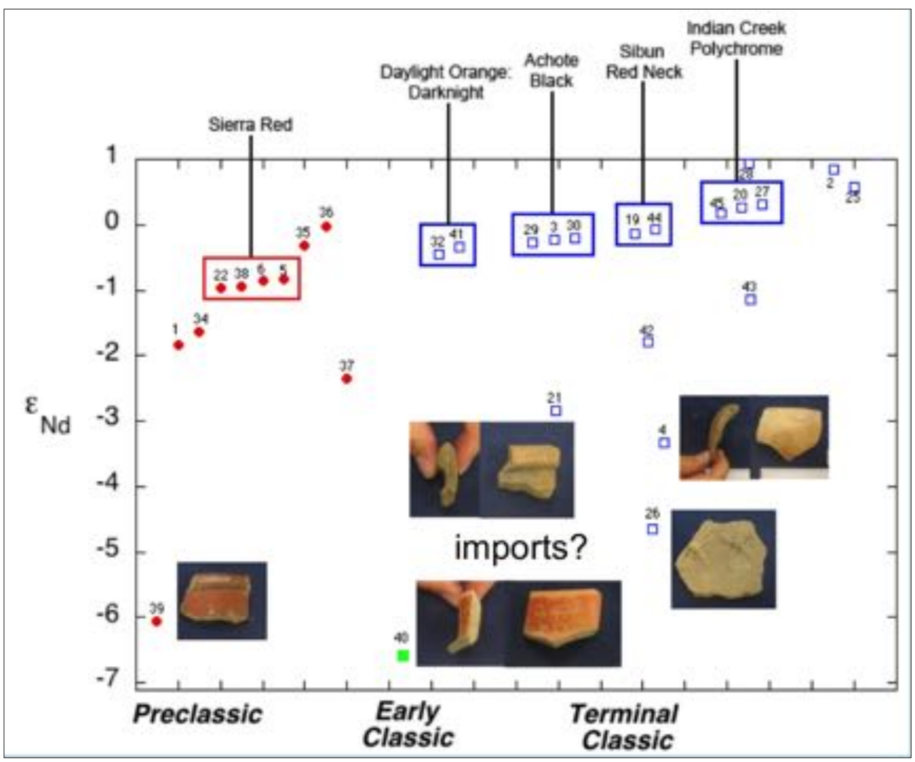

Figure 3.3 ε_{Nd} of ceramic artifact samples from Harrison-Buck et al. (n.d.). Labels are based on stylistic analysis.

Conclusions

Over the sampled area, ε_{Nd} remains within a relatively narrow range of signatures, possibly with weak enrichment of ε_{Nd} to the south. The range of measured values is consistent with the range of values found for ceramics produced within the Belize River valley, and confirms that suspected "imports" do not match the signature of clay bodies within the watershed. Further ground-truthing of regional clays affords a means of establishing a forensic tool for archaeologists studying ancient Maya ceramics.

Appendix 3.A: Sample Locations and Isotopic Data

Sample ID	Latitude (dec. deg.)	Longitude (dec. deg.)	$^{143}Nd/^{144}Nd$	$^{87}Sr/^{86}Sr$	$^{85}Rb/^{88}Sr$
BREA 2013 Clay 01	17.085	-89.127	0.512295999		
BREA 2013 Clay 02	17	-89.133			
BREA 2013 Clay 03	17.057	-89.142	0.51228015	0.7494503	0.348
BREA 2013 Clay 04	17.321	-88.79			
BREA 2013 Clay 05	17.285	-88.839			
BREA 2013 Clay 06	17.287	-88.838			
BREA 2013 Clay 07	17.329	-88.832			
BREA 2013 Clay 08	17.472	-88.349			
BREA 2013 Clay 09	17.54	-88.682			
BREA 2013 Clay 10	17.549	-88.616			
BREA 2013 Clay 11	17.151	-88.847	0.512147233		
BREA 2013 Clay 12	17.169	-88.84		0.7800379	0.984
BREA 2013 Clay 13	17.216	-88.852			
BREA 2013 Clay	17.216	-88.852			

14					
BREA 2013 Clay 15	17.33	-88.679			
BREA 2013 Clay 16	17.341	-88.716			
BREA 2013 Clay 17	17.307	-88.534	0.5121157	0.7451269	0.464
BREA 2013 Clay 18	17.307	-88.533	0.512078467		
BREA 2013 Clay 19	17.697	-88.457		0.711409	0.097
BREA 2013 Clay 20	17.791	-88.537	0.512410201		
BREA 2013 Clay 21	17.776	-88.572	0.512477308		
BREA 2013 Clay 22	18.026	-88.562	0.512697906		
BREA 2013 Clay 23	17.995	-88.535	0.512529034		
BREA 2013 Clay 24	17.291	-88.771			
BREA 2013 Clay 25	17.321	-88.777			
BREA 2013 Clay 26	17.321	-88.777	0.5122976		
BREA 2013 Clay 27	17.312	-88.766			
BREA 2013 Clay 28	17.864	-88.765			
BREA 2013 Clay 29	17.329	-88.754	0.512509046	0.7171805	0.00079
BREA 2013 Clay 30	17.328	-88.745			
BREA 2013 Clay 31	17.347	-88.715			
BREA 2013 Clay 32	17.349	-88.691			
BREA 2013 Clay 33	17.346	-88.793			
BREA 2013 Clay	17.344	-88.791			

34			
BREA 2013 Clay 35	17.345	-88.792	0.512499069
BREA 2013 Clay 36	17.38	-88.691	
BREA 2013 Clay 37	17.389	-88.642	
BREA 2013 Clay 38	17.39	-88.642	
BREA 2014 Clay 01	17.316	-88.728	
BREA 2014 Clay 02	17.324	-88.762	
BREA 2014 Clay 03	17.317	-88.756	
BREA 2014 Clay 04	17.263	-88.785	
BREA 2014 Clay 05	17.391	-88.641	
BREA 2014 Clay 06	17.4	-88.637	
BREA 2014 Clay 07	17.402	-88.635	
BREA 2014 Clay 08	17.397	-88.643	
BREA 2014 Clay 09	17.382	-88.657	
BREA 2014 Clay 10	17.332	-88.763	
BREA 2014 Clay 11	17.356	-88.784	
BREA 2014 Clay 12	17.357	-88.782	
BREA 2014 Clay 13	17.391	-88.782	
BREA 2014 Clay 14	17.302	-88.778	
BREA 2014 Clay 15	17.312	-88.789	
BREA 2014 Clay	17.345	-88.771	

16		
BREA 2014 Clay 17	17.353	-88.757
BREA 2014 Clay 18	17.383	-88.684
BREA 2014 Clay 19	17.37	-88.679
BREA 2014 Clay 20	17.381	-88.66
BREA 2014 Clay 21	17.352	-88.76
BREA 2014 Clay 22	17.323	-88.792
BREA 2014 Clay 23	17.304	-88.789
BREA 2014 Clay 24	17.297	-88.795
BREA 2014 Clay 25	17.317	-88.795
BREA 2014 Clay 26	17.323	-88.768
BREA 2014 Clay 27	17.306	-88.806
BREA 2014 Clay 28	17.314	-88.824
BREA 2014 Clay 29	17.297	-88.841
BREA 2014 Clay 31	17.293	-88.812
BREA 2014 Clay 32	17.265	-88.812
BREA 2014 Clay 33	17.289	-88.794
BREA 2014 Clay 34	17.32	-88.782
BREA 2014 Clay 35	17.35	-88.747
BREA 2014 Clay 36	17.337	-88.752
BREA 2014 Clay	17.137	-88.652

37		
BREA 2014 Clay 38	17.11	-88.659
BREA 2014 Clay 39	17.091	-88.658
BREA 2014 Clay 40	17.088	-88.614
BREA 2014 Clay 41	17.118	-88.655
BREA 2014 Clay 42	17.382	-88.783
BREA 2014 Clay 43	17.147	-89.053
BREA 2014 Clay 44	17.092	-89.067

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Chapter 4

A Study of Maya Landscapes and Faunal Capture in Belize: A Comparative Habitat and Zooarchaeological Study

Eric Van Dam, Judy Chupasko, David Buck, and Denver Thomas Cayetano

Introduction

Collaboration between biological scientists and archaeologists is essential in advancing our understanding of the records stored in the ancient remains of long-deceased flora and fauna. Preserved in hydric soil or clay, this organic evidence offers information about what animals were consumed and utilized in the past. Developing a comparative zooarchaeological collection is necessary to facilitate the identification of ancient fauna. A program involving animal capture not only provides a collection of contemporary fauna that can be used for comparison with the archaeological remains, this collection effort also allows researchers to identify the different types of environments these animals prefer and the local habitats with which they are generally associated. Our aim with the present project was to build on an existing comparative faunal collection to include more wetland fidelic taxa from Belize and to develop for these specimens a habitat fidelity index, using a template developed by Emery and Thorton (2012), which is discussed further below.

By tracking an animal's local habitat fidelity, its ancestral range of habitation within a geographic area can be outlined using the locations of multiple zoo-archaeological specimens of the same species that are found at different sites. If several species are used to act as representatives of their native habitats, this informs our reconstructions of past environments. For instance, a high density of water-dependent animals in the archaeological record at a site suggests that water bodies must have been present and were likely locally available in the past. Emery and Thorton (2013) have shown that fluctuations in the presence of small water-bodied fauna in ancient Maya contexts can serve as local proxies for past climate change, namely long-term drought that can cause stress on wetland and riverine species. They documented a drop in the quantity of small, water-dependent animals during the "collapse period" (ca. A.D. 800-900) when compared to the Late Classic period (ca. AD 600-800) at numerous sites across the Maya Lowlands, which they argue points to a reduction of smaller water bodies, like lagoons and wetlands, due to long-term drought. For their assessment, they relied on a comparative faunal collection and carried out a habitat fidelity study to be able to link the archaeological specimens with their associated habitats. However, they had to exclude certain species due to the limits of the existing archaeological collections under study. For instance, *Mollusca*—a key proxy for the existence of wetland environments—were not considered due to inconsistent collection methods.

In the present study, we aim to build on Emery and Thorton's existing comparative faunal collection to include more wetland fidelic taxa and to develop for these specimens a habitat fidelity index, using a template established in Emery and Thorton's (2012) study. Ultimately, our research aims to further cross-examine their hypothesis concerning the reduction of small water-bodied animals due to local drought conditions and its impact on human-wetland interactions in the BREA study area at the end of the Classic period.

Site Descriptions

During our fieldwork in Belize, there were two habitat types that were sampled by our field team: wetland (Crooked Tree area) and lowland broadleaf forest (Gallon Jug area). Each habitat is briefly described below. Both habitats simulated either habitat conditions offered by a functioning Maya agricultural center or one overgrown or affected by drought (Meerman n.d.). As noted above, the existence/nonexistence of wetland faunal remains was our focus in order to identify the types of small-water bodied animals that dwell in wetland habitats both now and during the Classic Maya period. However, the detection of forest-dwelling animals can also suggest an absence of wetlands, assuming that the organism died residing in its preferred habitat type. Therefore, we chose to sample these two habitat types in Belize. Our field sites of Crooked Tree and Gallon Jug are located in the northern part of Belize (**Figures 4.1** and **4.2**).

Crooked Tree Wetland Habitat Description

Crooked Tree served as our main reservoir of wetland habitat and associated fauna. Hugging Western Lagoon, the largest perennial wetland in Belize, the surrounding trails offered excellent wetland areas to from which to sample fauna. Such habitat was characterized by a multitude of aquatic plants. Wetland forests past the lagoon banks were comprised of trees such as bri bri (*Inga edulis*), paurotis palm (*Acoelorrhaphe wrightii*), pokenoboy (*Bactris* major), provision tree (*Pachira aquatica*), fig (*Ficus sp*.), mapola (*Luebea seemanii*), calabash (*crescentia cujete*), and bamboo (*Guadua sp.*). Other trees found in wetlands but not specifically in Crooked Tree include plants such as warree cohune (*Astrocaryum mexicanum*), black mangrove (*Avicennia nitida*), and red mangrove (*Rhizophora mangle*). Lagoon banks often are dominated by sedges like *Cladium jamaicense,* common spikerush *(Eleocharis palustris*), and southern cattail (*Typha domingensis*) while the forested wetland interior harbors greater varieties of herbaceous plants. Soil type is variable. Average rainfall is also variable (Biodiversity and Environmental Resource Data System of Belize n.d.a).

Figure 4.1 Map of the Crooked Tree sample site.

Figure 4.2 Map of the Gallon Jug sample site [Not shown: small Rio Bravo sample area].

Gallon Jug Habitat Description

The forests of Gallon Jug are several decades older than those found in Crooked Tree, and this is reflected in their ecological composition. Sampling done around the Chan Chich Lodge was all within old growth lowland broadleaf forest. Also called "high bush," this habitat has significantly older and taller trees with a very complex canopy system. Prominent flora in this habitat include the ceiba tree (*Ceiba pentandra*), mahogany (*Swietenia*), cohune palm (*Attalea cohune*), breadnut (*Brosimum alicastrum*), bullet tree (*Bucida buceras*), Panama rubber tree (*Castilla elastic*), American muskwood (*Guarea sp.*), Florida strangler fig (*Ficus* aurea), allspice (*Pimenta* dioica), and Brazilian firetree (*Schizolobium parahybum*). There is a wide diversity of low bush plants as well, with multitudes of epiphytic bromeliads growing on the higher individuals mentioned above. Forests can grow 25-30m tall on a limestone rich soil. Average rainfall is usually less than 2000mm per year (Biodiversity and Environmental Resource Data System of Belize n.d.b).

Methods

Before any animals are collected, they must be captured. While this is just a small step in the process of finding climatic influences on the Maya, it was far and away the majority of the fieldwork done for this project. Our team in charge of faunal specimen collection included: Dr. David Buck (Limnologist and Aquatic Ecologist at the Biodiversity Research Institute), Judy Chupasko (Collection Manager at Harvard's Museum of Comparative Zoology Mammalogy Department), Eric VanDam (Sophomore undergraduate at the University of New Hampshire, USA) and Denver Thomas Cayetano (Senior undergraduate at the University of Belize, Belmopan). For three weeks in Belize during the summer 2014 field season, we took up residence at the Bird's Eye View Lodge in the village of Crooked Tree and Chan Chich Lodge, whereupon satellite sample areas were established, as shown in **Figures 4.1** and **4.2**. Average daily routine involved early morning trap checks followed by faunal specimen euthanasia and processing with another late afternoon trap check. Evenings were spent setting up and attending mist nets in anticipation for the increased crepuscular activity of bats as well as continued animal processing and general record updating.

Results/Discussion/Conclusion

Overall, 124 individuals were caught from 36 different species (**Table 4.1**). More than half of our net yield was fish specimens, and yet our time spent collecting specimens in aquatic habitats spanned only 4 days. Bats required only a small amount of time for mist net setup followed by their eventual disentanglement from the nets, and yet bat specimens also make up a large part of the specimen index caught within those three weeks. In all, the activities necessary for the capture of other small mammals required most of the day, and yet only a handful of such specimens appear in our collection.

Table 4.1 Fidelity Index of Specimens caught between June 1st – June 23rd 2014 at all sample sites. Fidelity is measured out of 1, with 1 signifying that a species is always found in a specific habitat and 0 signifying that it is never found in a specific habitat.

Scientific Name	Common Name	Number of Individuals	Lowland Broadleaf Forest	Wetland (including lagoon habitats)	Riverine
Amphiliphos robertsoni	False firemouth (fish)	1	0	0	1
Artibeus jamaicensis	Jamaican fruit-eating bat	1	0	1	0
Artibeus phaeotis	Pygmy fruit-eating bat	5	1	0	0
Artibeus toltecus	Toltec fruit-eating bat	1	1	0	0
Astyanax aeneus	Bilum (fish)	6	0	0.66	0.33
Basiluscus vittatus	Basilisk lizard	1	0	1	0
Carolia brevicauda	Silky short-tailed bat	3	0.66	0.33	0
Cichlasoma urophthalmus	Crana (fish)	12	0	1	0
Decapoda sp.	Crab	1	0	0	1
Delphinonaias delphinulus	common dolphin mussel	2	0	1	0
Didelphis sp.	Opposum	1	0	1	0
Dorosoma petenense	Threadfin shad (fish)	5	0	1	0
Glossophaga sp.	long tongued bat	2	0.5	0.5	0
Glossophaga soriana	Common long-tongued bat	1	0	1	0
Ictalarus fuctatus	Blue catfish	2	0	1	0
Marmosa sp.	Mouse oppossum	2	0	1	0
Molossus molussus	Little mastiff bat	1	0	1	0
Myotis sp.	Myotis (bat)	3	0.33	0.66	0

Oreochromis niloticus	Tilapia	2	0	1	0
Oryzomys couesi	Rice Rat	1	0	1	0
Petenia splendida	Bay Snook (fish)	14	0	0.93	0.07
Philander oppossum	Gray Four Eyed Oppossum	3	0	1	0
Phyllostomid sp.	fruit-eating bat	8	1	0	0
Poecilia mexicana	Shortfin molly (fish)	2	0	1	0
Poecilid sp.	Tooth-carp (fish)	1	0	0	1
Pomacaea flagellata livescens	Apple snail	2	0	1	0
Pteronotus parnellii	Common mustached bat	2	1	0	0
Pterygoplichthys sp.	Armored catfish	1	0	0	1
Rhamdia laticuada	Filespin Chulin (fish)	5	0	0.6	0.4
Sturnira lilium	Little yellow-shouldered bat	2	1	0	0
Tamandua mexicana	Northern tamandua (anteater)	1	0	1	0
Thorichthys meeki	Firemouth cichlid (fish)	7	0	0.57	0.43
Thrachemys scripta	Slider	1	0	1	0
Trachops cirrhosus	Fringe-lipped bat	2	1	0	0
Vieja synspilum	Redhead cichlid (fish)	18	0	1	0
Xiphophorus helleri	Green swordtail (fish)	2	0	0	1

Each trapping round consisted of more than 100 live traps. Considering the 10 individual rounds that were completed, our success rate was 0.05%. While this is a typical outcome for small mammal trapping, especially in lowland forests and wetlands, we discovered there are other options that may boost the traps effectiveness, which should probably be used in the future. If time is allowed, preliminary and consistent baiting can draw a large mammal population to a concentrated area. Fruits such as dried bananas and mango matches the natural diet of tree and vine dwelling mammals such as opossums and mouse opossums while "sunflower seeds, peanut butter, oats, corn, bacon, banana, and dried or burnt coconut" are useful for catching mice and shrews that travel on ground level (Reid 2009). If a large enough food source is clustered for even a period as short as a week, animal activity is likely to exist there for more hours in the day as well (Reid 2009). Clustering traps in and around the periphery of such an area would be the logical next step. Instead of placing traps in an unbroken, unbiased pattern; bait piles could be centered amongst places of high characteristic mammal activity such as piles of woody debris, or within tangles of vines. Trap type would also differ according to seasonality and the intended capture species. For example, pitfalls would be the most appropriate trap for shrews, but in order to prevent drowning during the rainy season, live folding Sherman traps may be a suitable alternative (Animal Care and Use Committee 1998). Departing from a wide swath of territory and focusing more heavily on a few strategic, well-baited areas also demands less time for daily setup and maintenance. In exchange, more time could be spent sampling other zones or processing specimens that have already been caught.

Looking towards the future, we have a few additional goals in mind. We believe that future collection trips should continue to fill in the gaps of Emery and Thornton's existing fidelity index. Besides the differences in trapping protocols noted above, it would be helpful to conduct trapping in different locations and during different times of the year. We trapped only during the wet season. Trapping during the dry season might yield a different variety of organisms. Locals explained that turtles, for instance, were much more active during the dry season than the rainy season. In addition, we sampled solely in the north of Belize and in only two general locations (Crooked Tree and Gallon Jug). For ease of access, we also sampled on the edges of well-worn trails. There may be a greater yield of specimens if traps were set up farther away from human activity.

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Chapter 5

Faunal Analysis from Sites in the Middle Belize Valley: Methods and Preliminary Findings

Lori B. Phillips

Faunal analysis was conducted from seven sites in the BREA study area, including Ma'xan, Saturday Creek, Otley's Flat, Hum Chaak, Hats Kaab, Kaax Tsaabil, and Ik'nal (**Figures 1.1-1.3**). Preliminary faunal analysis was carried out in January of 2015 as part of a longer-term thesis project focused on ancient aquatic resource use. The purpose of this chapter is to outline the analytical methods utilized, report the preliminary findings, and discuss steps necessary for future analysis.

Methods

Before analysis can begin, faunal remains must be cleaned of sediment that may obscure identification. Light dry brushing with a toothbrush to remove attached sediment should be attempted first, while a damp toothbrush should only be used if the first technique is not successful. When using the damp toothbrush method the bone should never be submerged in water as the likelihood for bone breakage increases. These methods should only be used on structurally sound bone; if bone is too fragmented, deteriorated, or sediment is the only thing keeping it together, light dry brushing or keeping the attached sediment in place should be practiced. Once clean, damp bones should be left to dry on drying screens away from possible disturbances such as wind, animals, or accidental damage from humans. After drying, or dry brushing, bone should be cataloged in the artifact database and assigned an LCB number.

Once an LCB number has been assigned, identification can begin. Identification includes recording taxonomy, element, side, age, sex, natural modifications, and cultural modifications. Taxonomic identification should be as specific as possible, ideally genus and species level, however this is not always possible due to preservation and fragmentation. As such, taxonomic identification in this report is broken into Large Mammals (deer, peccary, or tapir sized), Medium Mammals (dog or raccoon sized), Small Mammal (agouti, paca, or armadillo sized), and Micromammal (mouse or rat sized). When preservation permitted, identification of taxon was aided by Gilbert's *Mammalian Osteology* and Olsen's *An Osteology of Some Maya Mammals* (Gilbert 1990; Olsen 1982). Unfortunately bone identification guides for Mesoamerican avian, reptilian, and fish species were not available at the time of analysis, however personal communication with zooarchaeologist Dr. Erin Thornton made some finer identification possible. A total of 1019 faunal remains were analyzed and are reported in **Table 5.1**. The number of identified specimens (NISP) was recorded following Lyman's methods and percent NISP (%NISP) was calculated by dividing the NISP of each taxon by the total NISP of the site (Lyman 2008). NISP was utilized over the minimum number of individuals (MNI) due to the problems associated with determining turtle and fish MNI from fragmentary turtle carapace and isolated fish vertebrae, but the author is aware of the problems associated with this quantitative method of taxonomic abundance. A discussion of each site's results and an overall assessment of the results are discussed below.

Results

Table 5.1 summarizes the results of the fauna analyzed. The largest amount of fauna come from the site of Ma'xan, with a total of 446 remains analyzed. Of these remains fish and

Table 5.1 Preliminary Faunal Data by Site.

Site Name	Taxon	NISP	%NISP
Ma'xan	Bird	7	1.57
	Fish	115	25.78
	Large Mammal	27	6.05
	Medium Mammal	52	11.66
	Small Mammal	55	12.33
	Micromammal	17	3.81
	Turtle	101	22.65
	Unidentified	72	16.14
Total		446	
Kax Tsaabil	Bird	2	.98
	Fish	17	8.29
	Large Mammal	19	9.27
	Medium Mammal	39	19.02
	Small Mammal	23	11.22
	Micromammal	1	.49
	Turtle	78	38.05
	Unidentified	26	12.68
Total		205	
Ik' Nal	Bird	3	2.17
	Fish	8	5.80
	Large Mammal	31	22.46
	Medium Mammal	17	12.32
	Small Mammal	9	6.52
	Turtle	58	42.03
	Unidentified	12	8.70
Total		138	

Site Name	Taxon	NISP	%NISP
Saturday Creek	Fish	4	3.10
	Large Mammal	8	6.20
	Medium Mammal	6	4.65
	Small Mammal	6	4.65
	Micromammal	45	34.88
	Turtle	45	34.88
	Unidentified	15	11.63
Total		129	
Otley's Flat	Fish	1	1.82
	Large Mammal	5	9.09
	Medium Mammal	2	3.64
	Small Mammal	3	5.45
	Unidentified	44	80.00
Total		55	
Huum Chaak	Fish	2	8.33
	Large Mammal	6	25.00
	Medium Mammal	11	45.83
	Small Mammal	2	8.33
	Turtle	3	12.5
Total		24	
Hats Kaab	Large Mammal	2	9.09
	Medium Mammal	3	13.64
	Small Mammal	16	72.73
	Micromammal	1	4.55
Total		22	
NISP Total		1019	

turtle comprise almost half of the assemblage at a combined 48.43%. Pharyngeal grinders, dentaries, vertebrae, and pectoral girdle elements represent fish remains, whereas turtles are represented solely by carapace fragments. Identification of turtle species was not possible at the time however it is hypothesized many of the fish remains, particularly dentaries and pharyngeal grinders, are the remains of parrotfishes (Scaridae). This hypothesis will be fully tested in the future with the aid of a comparative collection. The next most abundant taxa include Medium and Small Mammals, 11.66% and 12.33% respectively. While representing less than 5% of the overall NISP, Ma'xan is one of three sites with bird remains and also one of two sites in which turkey (*Meleagris* spp.) was identified (**Figure 5.1**). These results indicate a high degree of aquatic over terrestrial animal use, which is likely the result of the site's proximity to rivers.

Figure 5. 1 Turkey Coracoid from Ma'xan (photo by L. Phillips).

Following Ma’xan, Kaax Tsaabil produced the second highest faunal count. Similarities to Ma’xan appear in the high amount of turtle remains (38.05%), presence of birds, and similar fish elements that may represent parrotfish (**Figure 5.2**). Kaax Tsaabil differs in the low representation of fish, less than 10% of the site’s total. Difference also exists with the second and third most abundant taxa, here being Medium and Small Mammals as opposed to Small Mammals. These differences could be the result of different animal procurement practices, preservation biases, or recovery methods biased towards larger mammal bones over fish.

The third largest assemblage is from Ik’nal with 138 analyzed specimens. This assemblage follows a pattern similar to Kaax Tsaabil in the high percentage of turtle remains followed by mammals, specifically Large and Medium Mammals. The majority of Large and Medium mammal remains were long bone shaft fragments and could not be identified to particular genus or family. As with Kaax Tsaabil, the low number fish remains may indicate different procurement strategies, preservation biases, or biased recovery methods, especially when taking the site’s location along a river into consideration.

Analysis of fauna from Saturday Creek resulted in the same high abundance of turtle remains, however Micromammals are significantly more abundant here compared to any of the other six sites. Besides Micromammals, presence of other mammal taxa are unusually low for the sample size. It should be noted that analysis of this assemblage was not finished in January, likely the reason for the unusual mammal NISPs, and will continue this summer.

Figure 5.2. Fish Dentary from Ik'nal. Possibly Parrotfish (photo by L. Phillips).

The last three sites (Otley's Flat, Huum Chaak, and Hats Kaab) have much smaller assemblage sizes. Poor preservation at Otley's Flat led to the majority of fauna classified as unidentifiable and those identified to a Mammal category were small long bone shaft fragments. Preservation at Huum Chaak and Hats Kaab was much better, with Huum Chaak showing mammalian abundance patterns similar to Ik'nal. Of note is the absence of aquatic taxa from Hats Kaab, possibly the result of animal procurement related to proximity to river resources or biases previously mentioned.

Discussion and Conclusion

Overall these results suggest the importance of aquatic resources at six of the seven sites, specifically the large number of turtle remains at each location. To better understand this apparent pattern, further analysis will be conducted with the aid of the Florida Museum of Natural History's faunal comparative collection. This will allow for more specific taxonomic identification and a finer grained analysis of which species may have been targeted. Additional data will be added this summer with the completion of faunal analysis from Saturday Creek and

Jabonche. Once faunal analysis is complete, exploration of patterns based on differing provenience should be conducted to illuminate potential differences between social status, ritual functions, domestic functions and subsistence.

This chapter aimed to describe the methods utilized during January's faunal analysis, the preliminary results, and future analyses that need to be conducted. Preliminary results have shown an interesting pattern in the utilization of taxa and will add to the growing literature on Maya animal use, specifically the potential importance of aquatic species to river communities.

Acknowledgements: I would like to thank the BREA team for allowing me to join the project and conduct analysis, as well as the warm welcome and inclusion into the team. This analysis would not have been possible without the help of my advisor, Erin Thornton, who answered emails and provided taxonomic identification through emails. Finally, thank you to Marieka for being a spectacular lab director, showing me the ropes of the BREA laboratory, and keeping me sane when analysis became overwhelming.

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Chapter 6

Examining Distributions of Turtle Bone and Obsidian associated with Shrine Structures

Leslie Duff and Eleanor Harrison-Buck

Introduction

Turtles for the Maya were multifaceted in use and meaning and were steeped in cosmological and ritual significance. This chapter examines the distribution of turtle shell along side obsidian at several Maya sites in Belize. Turtle shell and obsidian held both utilitarian and ritual significance for the Maya. Here, we present a careful study of their contexts in association with Terminal Classic circular shrine buildings at the site of Ik'nal in the BREA study area, as well as several sites in the Sibun River valley located to the south of the Belize River valley (**Figure 6.1**). We examine the distribution patterns of turtle shell and obsidian found in shrine contexts at these sites and suggest that the presence of these artifacts, particularly when found in combination, point to a ritual, rather than utilitarian use, possibly related to bloodletting activity.

In this chapter, circular shrines from three Maya sites in Belize are examined—Ik'nal (Str. 2), Obispo (Str. 479), and Oshon (Str. 402). Augustine Obispo and Samuel Oshon are located in the Sibun Valley just south of the BREA study area. These two sites are located on the Sibun River and are about 5km apart. Both have circular shrine buildings that were excavated by the second author between 2001-2003 as part of the Xibun Archaeological Research Project (XARP), directed by Patricia McAnany (Harrison-Buck 2003, 2004). The third site, Ik'nal, contains another circular shrine that was excavated in 2012 by the BREA Project, directed by Harrison-Buck (Harrison-Buck 2013). All three structures are coeval with one another, dating to the ninth century based on their associated ceramic assemblages (Harrison-Buck 2007, 2011, and 2013).

Distribution of Turtle Shell and Obsidian

Obispo Site

The circular shrine (Structure 479) at Augustine Obispo was divided into six 3-x-3 m squares, all of which were superimposed over a portion of the structure (**Figure 6.1**). The structure measured about 9 m in total diameter. Only four squares A, B, D, and E were excavated and revealed slightly less than half of the northwestern side of the circular structure.

Square B ended up being only half the size of the other excavated units due to a tree. Square A contained only a small portion of the structure and consisted mostly of the exterior plaza area. Square E exposed a large area of the interior room of the structure while Squares A, B, and D exposed the exterior portion. Squares A, B, and D also included portions of the surrounding plaza area to the north and west of the structure.

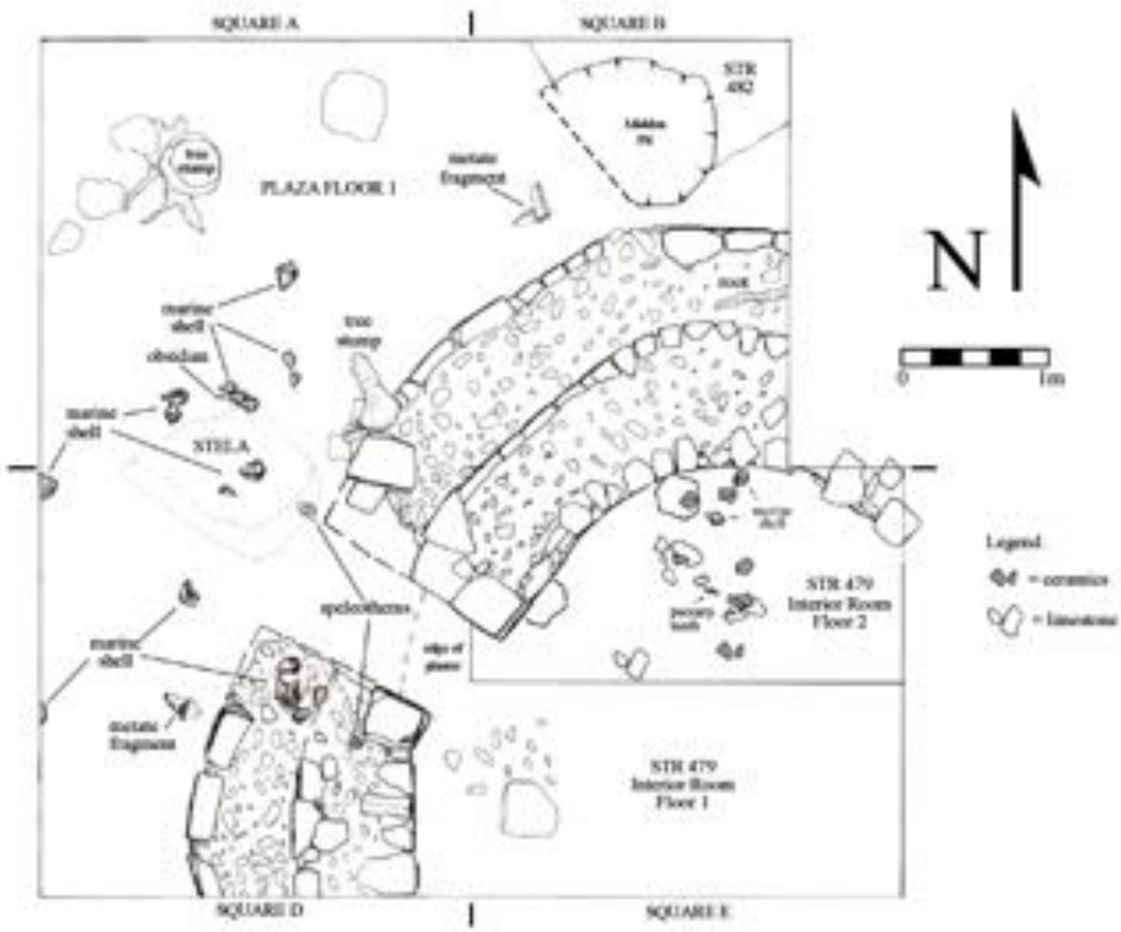

Figure 6.1 Plainview of Structure 479 at Obispo showing Squares A-E (drawn and digitized by E. Harrison-Buck)

The highest amount of turtle shell was found in square D (N=91 [**Figure 6.2**]). This square was situated over the exterior western portion of the structure and included the entryway of the structure. The majority of the shell appears to have been found in the vicinity of the structure's doorway around the plaza floor surface (Harrison-Buck 2004). The majority of obsidian was found in Square B (N=16), around the outside of the northern portion of the structure. Here, there is a midden pit where most of the obsidian was found (see **Figure 6.1**). Despite the small size of the square, there was still a high amount of turtle shell found in Square

B as well (N = 50). Though the majority of the turtle shell was found in a different layer, it was a midden-rich fill layer surrounding the midden deposit so it is possibly associated with the midden deposit.

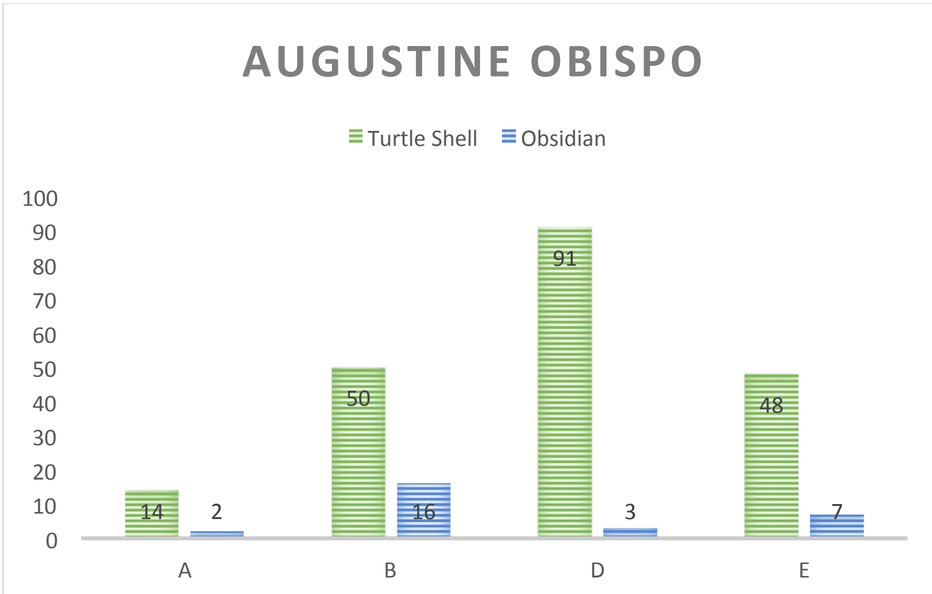

Figure 6.2 Total amounts of turtle shell and obsidian found at Obispo by square.

Oshon Site

The Samuel Oshon site is located within the lower reaches of the Sibun Valley within the Freetown district. As one of the largest sites within the lower and middle reaches of the Sibun Valley, the Oshon site is considered a main ceremonial center in this portion of the river valley and may have also functioned as a gateway community for the Sibun Valley due to its proximate position to the Caribbean Sea and the outlet of the Sibun River (Thomas 2005). The site was mapped during the 1999 field season and a total of thirty-seven structures were found. The site consists of two main plaza groups, Plaza A and Plaza B, located at the center of the site and several outlying groups comprised of one to five mounds.

The plazas are situated diagonally from each other, Plaza A being northwest from Plaza B and situated on slightly higher ground. Both plazas are about 200 meters north of the Sibun River. The circular structure (structure 402) is located in Plaza A along its western side and was partially excavated in 2001 (Harrison 2003). For the excavation a 5-x-5 m square unit was positioned cardinally only along the northeastern quarter of the structure and was divided evenly into four squares (A-D) measuring 2.5-x-2.5 m each (**Figure 6.3**).

The majority of turtle shell fragments were found in Square A (N=61 [**Figure 6.4**]). They were mostly found within the collapse and midden-rich fill that surrounded the exterior of the structure. Almost all of the turtle shell found in Square B (N=16) was found within the same layer, also around the exterior of the structure. There was an equal amount of obsidian found in Squares B and D (N=14). In both squares the majority of the obsidian was found in the same layer as the turtle shell previously described.

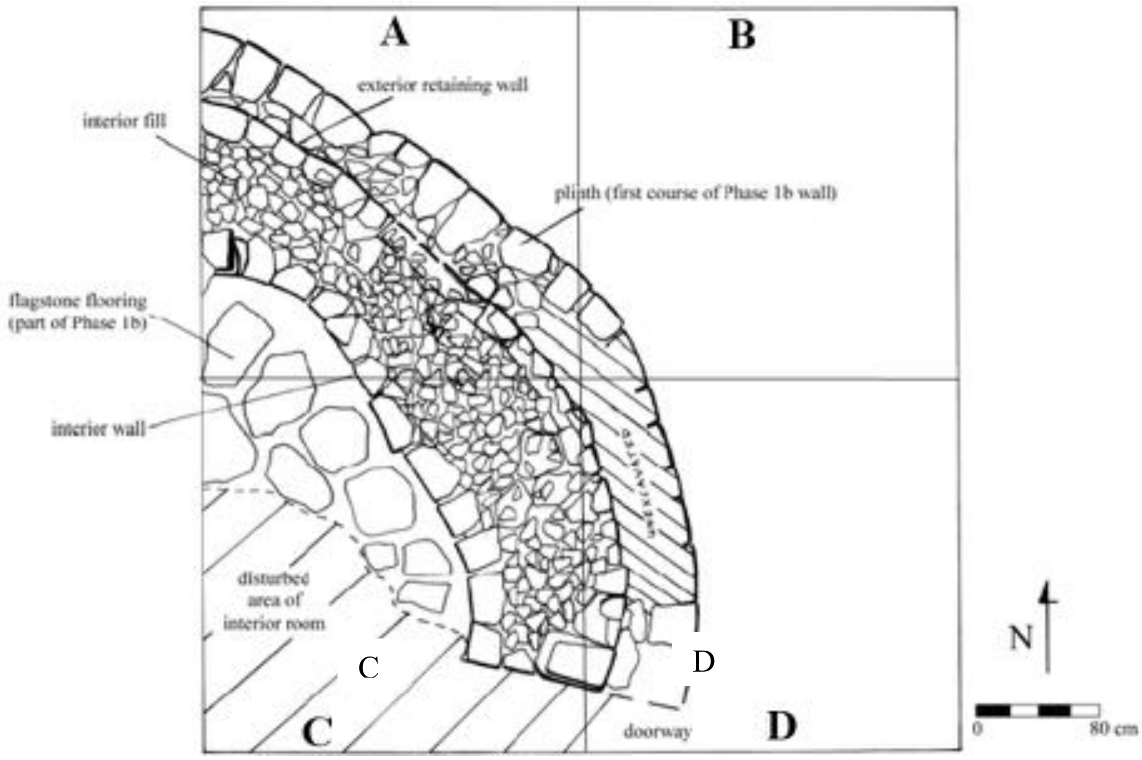

Figure 6.3 Plainview of structure 402 at Oshon (drawn and digitized by E. Harrison-Buck).

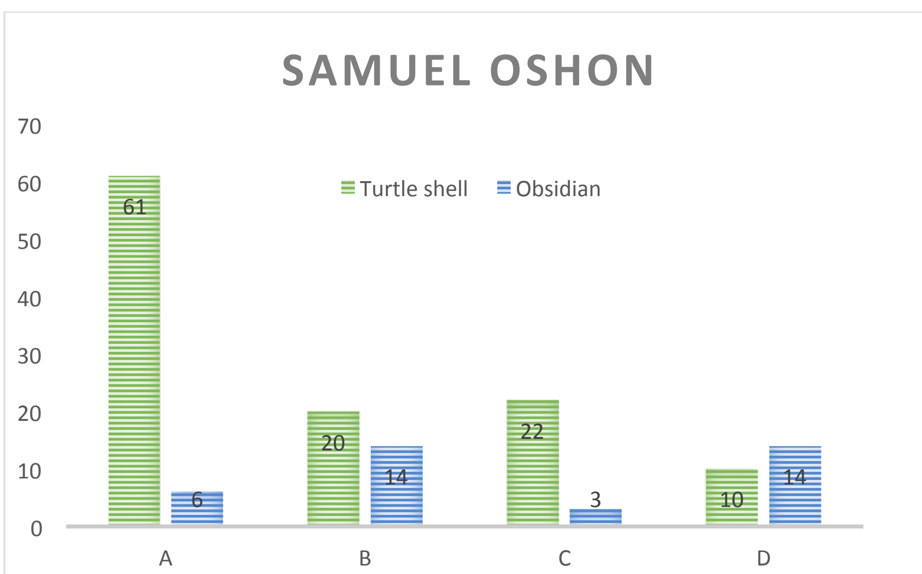

Figure 6.4 Total amounts of turtle shell and obsidian found per square at Oshon.

Ik'nal Site

The circular structure at Ik'nal (**Figures 6.5** and **6.6**) was excavated in the 2012 field season as part of the BREA project (Harrison-Buck 2013). The site of Ik'nal overlooks the Belize River and is only about 25-50m north of the river channel. The site core consists of a single plaza group with one main elite residential structure (Harrison-Buck 2013). To the east of the elite residence is the circular structure (Structure 2). The excavation unit was a 15-x-15 m area and encompassed the entire structure and some of the floor surface surrounding the basal platform on which the structure is situated. The excavation unit was divided into 25 squares (A-Y) each 3-x-3 m. Only Squares G, H, L, O, Q-T, and V-X were excavated (squares in red on **Figure 6.6**). Squares R and S encompass the interior part of the building, exposing about half of the interior room of the structure. All other excavated squares revealed the exterior walls of the building. Square Q exposed the doorway of the latest phase of the structure, which faced west towards the elite residential structure and the plaza area.

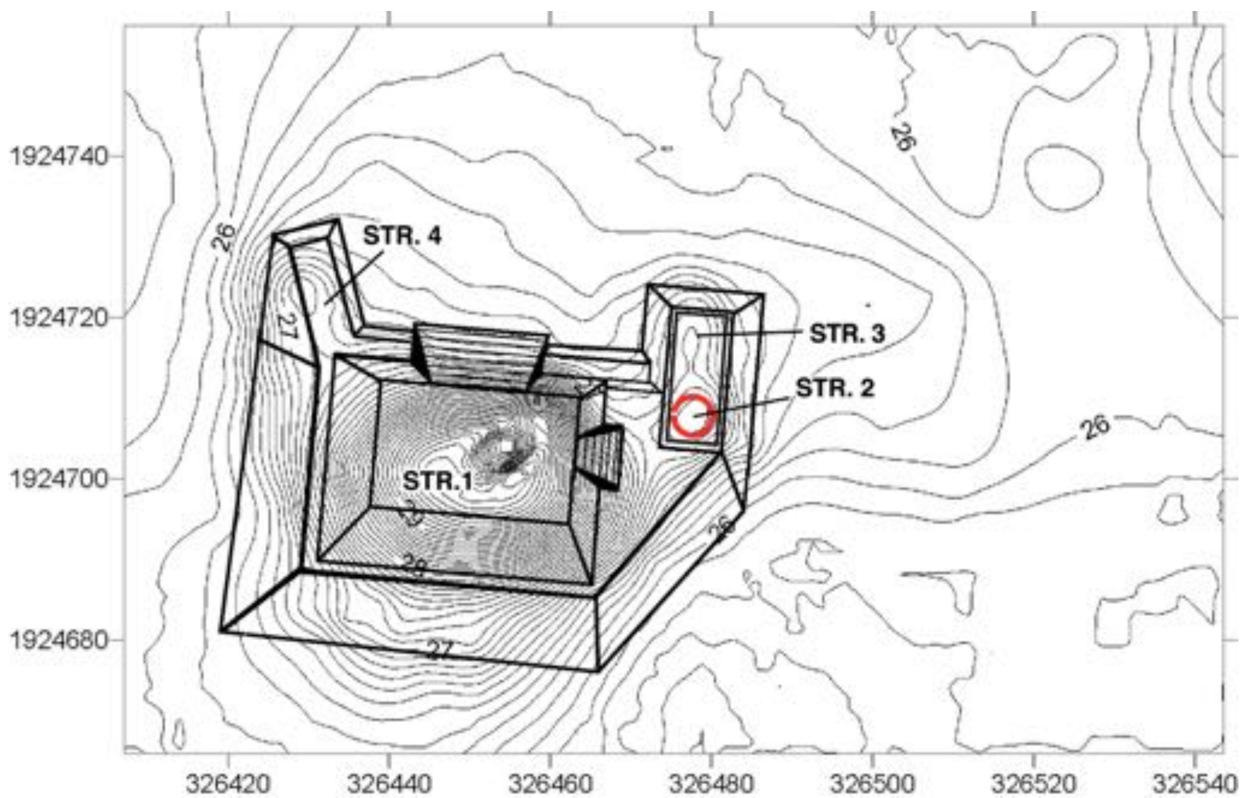

Figure 6.5 Rectified site map of Ik'nal showing location of circular structure (map prepared by S. Murata and A. Kaeding and adapted by E. Harrison-Buck).

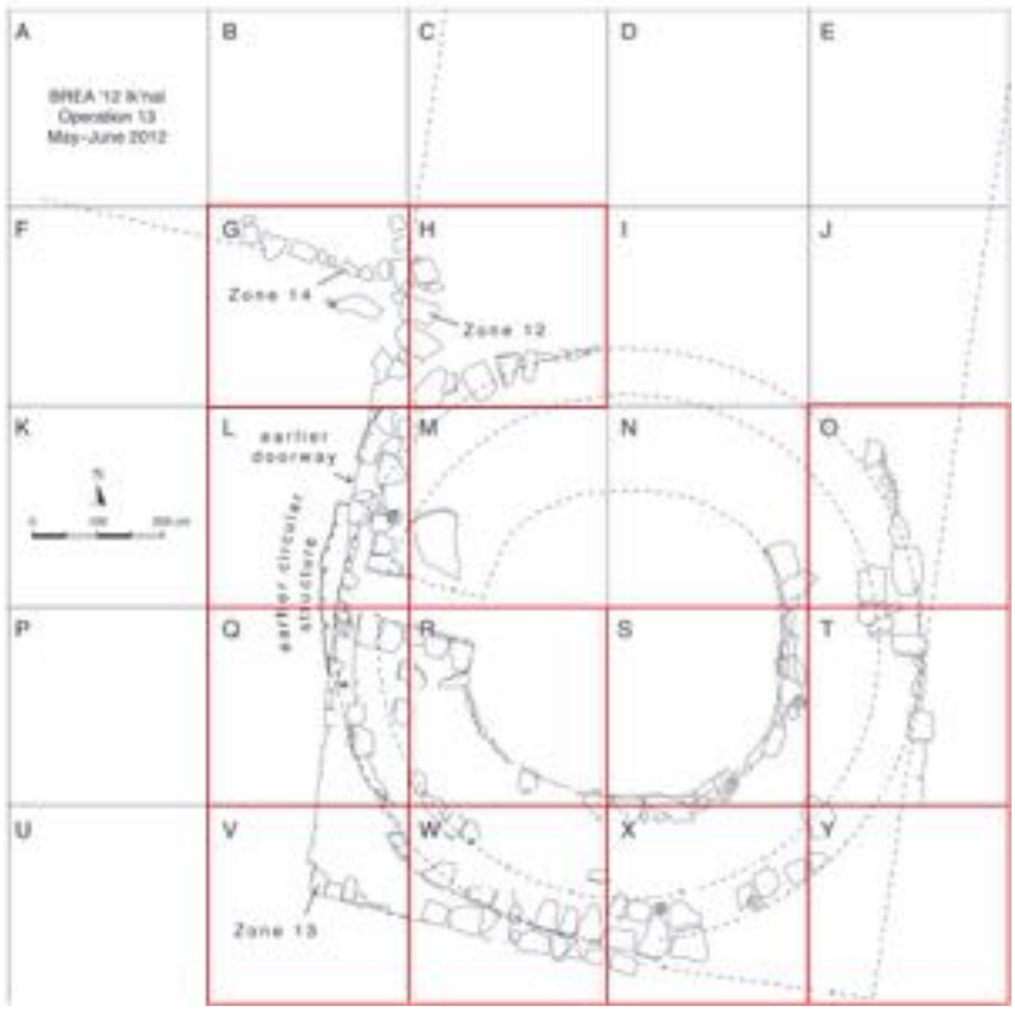

Figure 6.6 Planview of Structure 2 at Ik'nal showing Squares A-Y and those excavated in red (drawn by E. Harrison-Buck and digitized by M. Brouwer Burg).

A substantial amount of turtle shell was found in Square R (N=23), the western portion of the interior of the structure (**Figure 6.7**). This is the only square where no obsidian was found. Otherwise the obsidian was found throughout the unit, the most being located on the western half of the structure, particularly in Squares Q, V, and W around the front exterior of the building. Generally, the turtle shell was found along the western portion of the structure and the doorway. Very little turtle shell was found in the northern, southern, and eastern portions of the structure, with the exception of what was found in square T. Notably in the same square, a piece of green obsidian was found, which is likely from the Pachuca source in Central Mexico and is exceedingly rare in Belize (Harrison-Buck 2013).

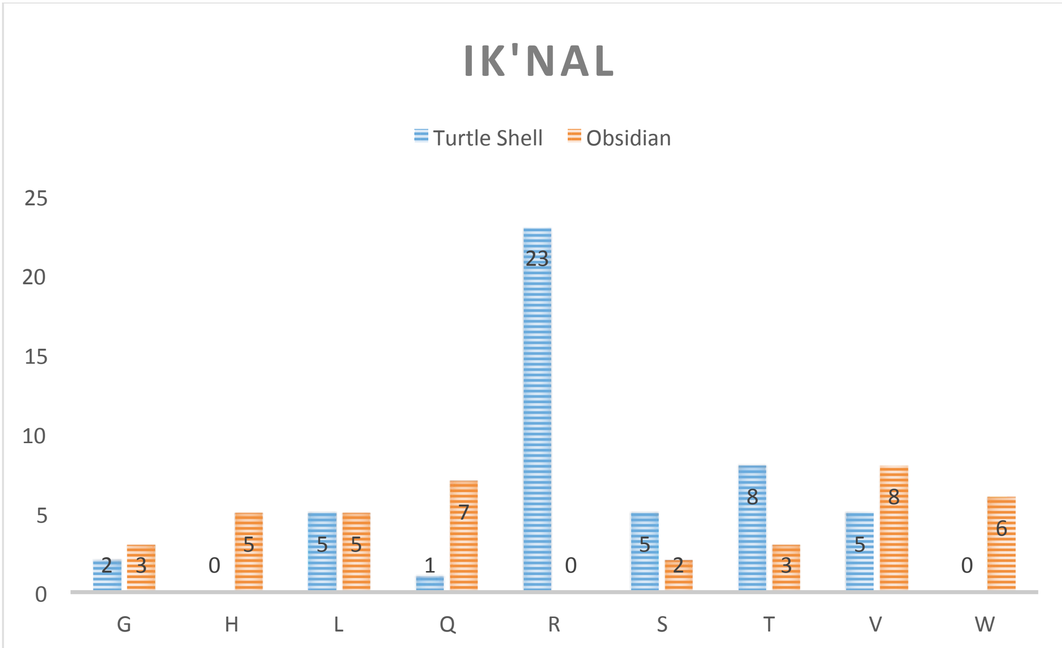

Figure 6.7 Total amounts of turtle shell and obsidian found by square at Ik'nal.

Discussion

Of the three structures, none were completely excavated, and different portions of the structure were revealed at each site. However, in all three cases the doorway of these buildings and a portion of the exterior plaza space in front of the entry way were exposed. In the cases of Ik'nal and Obispo the westernmost part of the structure was excavated and in each case the entirety of a western facing doorway was exposed. In both cases as well, the majority of turtle shell was found in or around the doorway. For the most part, obsidian was found within the same area around these buildings. At Oshon, only the northeast side of the structure and half of an eastern-facing doorway were exposed in the excavation of the circular structure **(Figure 6.3)**. The majority of turtle shell associated with this structure was found in Squares A and B in a midden-like terminal debris that surrounded the northeastern exterior of the building. At the Augustine Obispo structure the turtle shell was also found within a midden-like fill that was located along the northern exterior of the structure. Unlike Ik'nal and Obispo, the majority of the turtle shell that was found at Oshon was away from the doorway (Square D), although in this case the doorway faced east as opposed to west.

The structures discussed above in this report were chosen based on available data. As part of the XARP project a third circular structure was excavated at Pechtun Ha in the Sibun Valley, but very little of the structure's interior or surrounding plaza area were exposed (Harrison 1999). While both turtle bone and obsidian were noted at the site, there was limited finds from the excavation of the circular structure at Pechtun Ha, perhaps due to the limited horizontal exposure. However, another circular structure that was more fully exposed at the

BREA site of Hum Chaak also revealed little evidence of turtle bone and obsidian (Harrison-Buck 2011). The structure at Hum Chaak had been damaged by recent looting activities and was not as well preserved as the structures in the Sibun Valley. However, the lack of associated turtle bone and obsidian at the circular structures at both Pechtun Ha and Hum Chaak is curious and serves as a counter example to the patterned data presented above regarding high densities of both turtle shell and obsidian in the context of circular shrines. Even in the contexts discussed here, the density and distribution varies across a given structure. Yet, the sheer density of these two artifact classes found associated with circular shrines at Obispo, Oshon, and Ik'nal is significant when compared to other contexts and is no doubt meaningful in terms of the activities that may have taken place there in the past. Therefore, below we discuss the possible functional and cosmological significance that these materials in the context of shrines may have had in the past.

Turtles and the Maya

In ancient Mesoamerica turtles had multiple cosmological meanings, and multiple uses. Both terrestrial and marine turtles were often identified with water likely due to the common occurrence of turtles in aquatic habitats (Miller and Taube 1993). For the ancient Maya the turtle also was viewed as a circular or rounded earth (Taube 1988). There are a number of Late Classic altars carved in the form of turtles. For example, Altar 1 at Itzimte depicts Caban curls, an earth sign, on the shell of a turtle (Miller and Taube 1993).

One of the most common depictions of the turtle shell in Maya art can be seen in the resurrection scene of the Maize God (Miller and Taube 1993; Milbrath 1999; Stone and Zender 2011). The Maize God is often shown rising out of a cleft earth in the form of a turtle shell (Miller and Taube 1993). On one Late Classic vessel is the depiction of the emergence of the Maize god from the earth which appears as a turtle shell (Taube 1993). On either side of the shell is Chac brandishing lightning weapons, including the Mankin scepter, a burning, serpent-footed lightning axe (Taube 1993). In other scenes the Maize God is depicted emerging from the cell with the Hero Twins on either side (Miller and Taube 1993; Taube 1993; Milbrath 1999; Stone and Zender 2011). On one Late Classic polychrome vessel the Maize God carrying water and seeds, has been released from the turtle shell by the blow from Chac's lightening axe (Stone and Zender 2011). The Stingray Paddler God is with them, beating on a yellow turtle shell drum with a deer antler (Stone and Zender 2011).

Turtle shells were widely used as drums in ancient Mesoamerica (Miller and Taube 1993). The association of turtles and music can also be seen on page 24 of the Codex Borgia where a turtle is shown playing a drum while blowing a conch trumpet (Miller and Taube 1993:175). It is also possible that the use of turtle drums was in reference to thunder and storms (Miller and Taube 1993:175).

Just one of the Maya gods that turtles are associated with is God N, or Pauahtun. He commonly appears wearing a turtle carapace or sometimes a conch shell above his back. He is quadripartite in nature and had the responsibility of supporting the sky (Miller and Taube 1993; Milbrath 1999; Tozzer 1941). There is a Late Classic vessel depicting four Pauahtuns who appear with four Chacs, the god of rain and lightning (Miller and Taube 1993). Three of the Chacs are playing instruments, one of which is a turtle shell drum (Miller and Taube 1993) likely referencing thunder. God N is also considered to be the same as the four Bacabs identified by Landa, each associated with a different color, direction, and year bearer, one of which is identified as a turtle (Miller and Taube 1993; Milbrath 1999; Tozzer 1941; Paxton 2001; Thompson 1970)

There is also an association between turtles and God K, or K'awil. On page 46 of the *Dresden Codex* God K can be seen associated with turtle imagery (Rice 2012). He wears a turtle carapace as a pectoral and is also associated with the Maya turtle constellation (Paxton 2001; Rice 2012). God K is considered a storm god, or at least associated with storms, thunder and lightning similar to Chac (Miller and Taube 1993; Milbrath 1999; Paxton 2001; Rice 2012). Phonetic interpretations of the term *K'awil* suggests that it refers to flint, stone sculptures and stone axe heads associated with lightning (Milbrath 1999).

One of the manifestations of God K is as the Manikin scepter, which is often wielded by the rain god Chac where it represents lightening (Miller and Taube 1993). The Manikin scepter also acted as a symbol of rulership when held by a Maya king. God K is also the patron of royal bloodlines and dynasties, and of rulers as guarantors of cosmic sustenance through sacrifice and bloodletting (Rice 2012). Though K'awil is the more common translation of God K's name, his name has also been read as Tohil, based on linguistic connections with the word for obsidian (*tah* or *toh*) which suggests a connection with Tohil, the Quichė god of lighting and storms (Milbrath 1999). God K is also the embodiment of the k'atun, roughly 20 years by the Gregorian calendar (Milbrath 1999; Rice 2012). This is due to his association with and the embodiment of the planet Jupiter (Milbrath 1999; Rice 2012). During the Classic period the endings of k'atuns often related to recurrent positions of Jupiter and Saturn (Milbrath 1999; Rice 2012).

Turtles also have an association with k'atuns. At Mayapan, a stone turtle was found carved with 13 Ajaw faces on the edge of its circular carapace (Taube 1988) making the turtle a prehispanic katun wheel (Taube 1988; Miller and Taube 1993). There were also nine turtle-like figures drawn in the Dzibichen cave, each with its carapace shown as an ajaw glyph and believed to be connected to God K (Rice 2012). At the Usumacinta site of Piedras Negras, there is a massive cliff carving that bears a Late Classic representation of a tortoise shell emblazoned by an Ahau (Taube 1988). From either opening of the shell a deity head projects outward (Taube 1988). On one end it is God K, on the other God N (Taube 1988).

Stone turtles also served as a locus for penis perforation in Late Postclassic Yucatan (Miller and Taube 1993). An example can be seen in the Codex Madrid on page 19. It illustrates five gods engaged in bloodletting around a turtle altar (Miller and Taube 1993). It is likely that this rite was to fertilize the earth with blood during calendrical period-endings, such as the katun celebrations (Miller and Taube 1993). Another example of such iconography comes from figurines found at Structure 213 at Santa Rita. Four of the figurines found were of aged men engaged in penis perforation who are standing above turtles (Taube 1988). The Postclassic imagery are idealized portrayals of the bloodletting act being performed by gods on "larger than life" turtles. However, actual turtle shells, as well as carved stone turtles like those found at Mayapan that contain a receptacle on the back may have been used as catchments for blood offerings during the act of bloodletting (Taube 1988).

Concluding Thoughts

The carved stone turtles found at Mayapan that may have been used as receptacles for blood date to the Late Postclassic period. The turtle carapaces found at the Terminal Classic circular shrine structures in the Sibun and Belize Valleys may have served a similar purpose during this earlier time period. The evidence of turtle carapaces found along side high densities of obsidian in the context of circular shrines supports the claim that these artifacts are the remains of bloodletting activities. For the most part, obsidian was found either with or near the turtle shell and suggests that these items may have been used together in bloodletting activities that took place in and around these buildings, possibly in association with important calendrical rites associated with period endings, such as the k'atun. As discussed above, turtles were a cosmologically significant symbol for the Maya. They are not only associated with important period endings for the Maya, but also have strong associations with the earth and rain. These key elements are embodied in circular shrine architecture as animate wind shrines (see Harrison-Buck 2012). As such, these contexts are fitting for bloodletting rituals aligned to calendrical events that honor the movement of time and the seasons, which bring about the growth and renewal of life.

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Chapter 7

Provenance Analysis of Ground Stone Tools from the Middle Belize Valley

Tawny L.B. Tibbits

Introduction

During the field season of 2014 I used portable x-ray fluorescence (pXRF) on the ground stone tools excavated under the Belize River East Archaeology Program (BREA). The tools were of multiple raw materials (dacite, rhyolite), however the majority were granite. The focus of this research is to nondestructively source granite tools using pXRF. Therefore, tools that were not constructed of granite will not be discussed in depth. The tools were collected from several of the sites excavated and surveyed by the BREA team: Hats Kaab, Beaver Dam, Dueck East, Hum Chaak, Kaax Tsaabil, Ik'nal, and Ma'xan (see **Figures 1.1-1.3**).

Objectives

The primary objective of this project is to nondestructively develop geochemical fingerprints of each artifact in order to match it to a source outcrop in order to determine where specific sites were obtaining their granite ground stone tools from. This research employs a new method for using portable x-ray fluorescence (pXRF) in order to nondestructively develop geochemical fingerprints of granite artifacts, which will be used to source artifacts to known outcrops. This data will give us insight into potential exchange partners and how the Maya at the BREA sites were using these tools.

Geologic Background

The Maya Mountains are located in the central portion of Belize and are the only region with igneous outcrops. Belize has three distinct granitic zones within the Maya Mountains: Mountain Pine Ridge, Hummingbird Ridge, and Cockscomb Basin (**Figure 7.1**). These are granitoid rocks, generally two-mica granites with granodiorite, tonalite, and diorite also present in some areas. Each pluton is petrographically distinct, but not all variations of granitoids found in this region are able to be visually distinguished (Bateson and Hall 1977; Shipley 1978; Jackson et al. 1995). In order to determine specific rock types, geologists have traditionally used thin section analysis, a highly destructive and time consuming technique. Other methods for analyzing the geochemistry of granite are similarly hard on an artifact. Lab-based XRF generally requires either a pressed powder pellet where the granite has been crushed or the dissolution of the granite which is then fused into a glass disk for analysis. Electron microprobe is one of the most accurate methods for determining the geochemistry of a rock, however, in order to have a sample that is small enough to analyze, most researchers use thin sections.

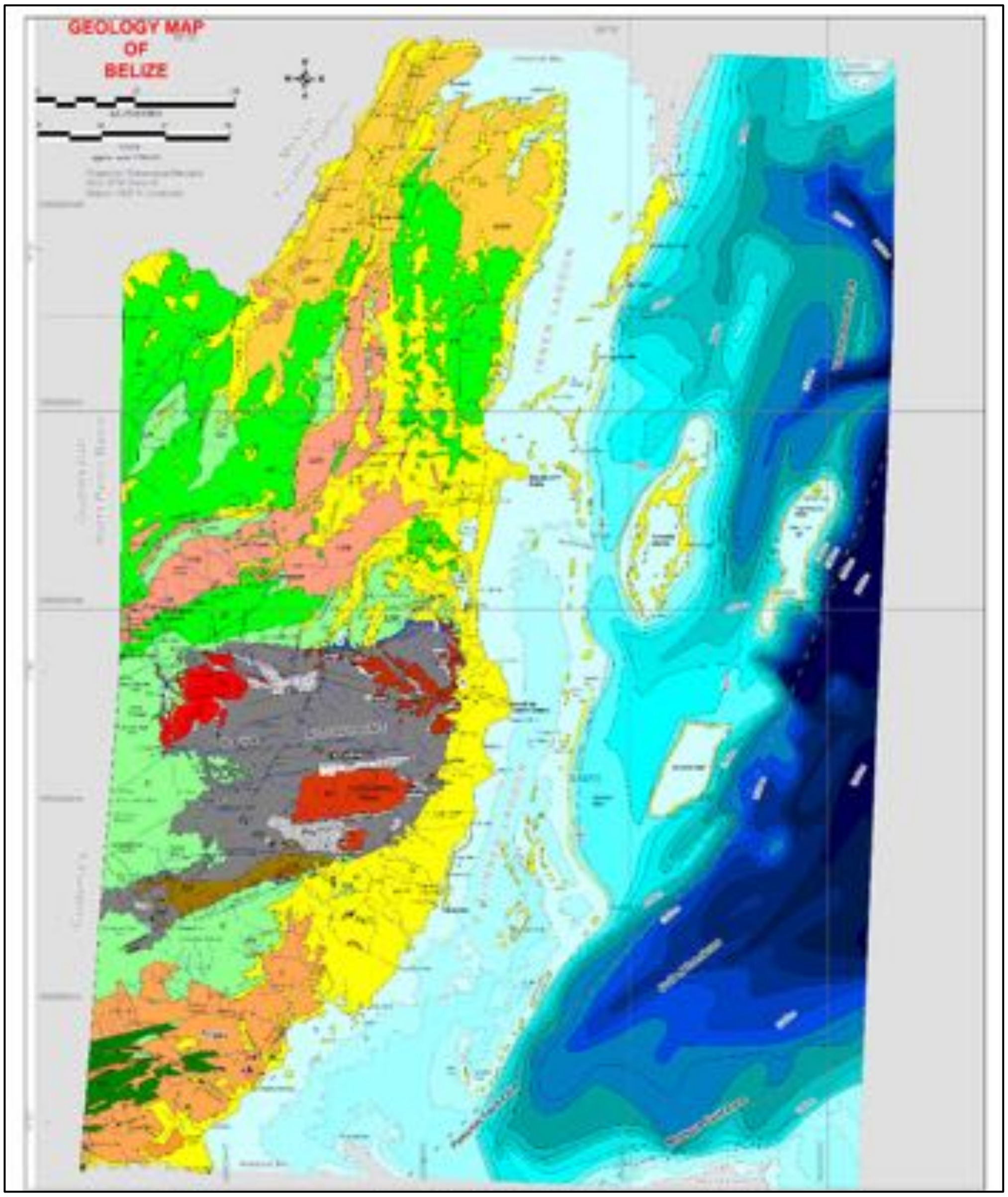

Figure 7.1 Geologic map of Belize. Red portions indicate granite outcrops. Gray is the metamorphic zone of the Maya Mountains.

The communities analyzed in this project are located to the north of the Maya Mountains between the eastern portion of Mountain Pine Ridge and the western portion of Hummingbird Ridge. The bedrock located in the regions of habitation is exclusively sedimentary (Bateson and Hall 1977; Ward et al. 1985). There are waterways near Mountain Pine Ridge that flow to the Middle Belize Valley sites and were potentially used as modes of transport for these heavy tools. There are no direct waterways stemming from Hummingbird Ridge, however the Sibun River is a major outlet to the Gulf of Mexico. This route could easily have been used to move materials from Hummingbird Ridge up the coast of Belize and back inland through other riverways.

Artifact Assemblage

The metates were generally basin or slab, no footed metates were present in this assemblage at this time. There is one nearly complete trough or basin granite metate (**Figure 7.2**). Without the fourth edge it is difficult to say with certainty if the metate was basin or trough. Basin would have a lip at the broken edge while trough metates tend to have an open edge where a bowl would be placed to catch the materials being ground (Adams 1999).

Figure 7.2 Partial metate; with the missing edge it is difficult to determine if it was a trough or basin (photo by T. Tibbits).

Metates from these communities varied from approximately 2 cm to over 5 cm thick. Many show a curved dorsal surface and there is evidence of finely manufactured edges (**Figure 7.3**). This may indicate production by a skilled craftsperson. Of the metates, two fragments were constructed of a rhyolite with welded pumice inclusions of unknown origin for source material. The other non-granite metate is a fine-grained crystalline rock that is likely igneous and is of unknown origin for source material.

Figure 7.3 Curved dorsal surface and well-shaped edge (photo by T. Tibbits).

The manos ranged from circular, to oval, or to rounded square in cross sectional view (**Figure 7.4**). One whole mano has been recovered from excavations thus far. All were well-worn, indicating they had been used extensively prior to discard. There is evidence of worn distal ends which implies a use-life post-breakage. However, there are also manos that were broken and have edges that show no signs of use after breakage. Further work on the distribution of these tools may indicate if there are patterns in where reuse versus immediate discard occurred.

Figure 7.4 Various mano shapes in cross sectional view (photos by T. Tibbits).

In addition to manos and metates, this assemblage includes two hammerstones that are composed primarily of silica. They show evidence of being used to reshape and/or repeck grinding surfaces. One complete adze was excavated during previous seasons (**Figure 7.5**). These tools are not composed of granite and therefore will not be included in the following analyses.

Figure 7.5 Complete adze (photo by T. Tibbits).

Research Methods

In order to develop geochemical fingerprints for the artifacts, I used an Olympus Delta© family pXRF. The collection consists of 72 artifacts from the sites listed above. The collection consists of both manos and metates. The mechanics of pXRF are essentially the same as a laboratory-based XRF unit, an X-ray beam is shot and hits the object under analysis, and this excites the atoms at or near the surface. The excitement of the atoms releases a specific wavelength of energy that can be used to identify the element(s) present (Gill 1997). The Olympus internally corrects for background scatter and overlapping energy peaks in order to develop the elemental signature of the item, in this case, granite artifacts. This method is completely nondestructive and very quick, each analysis takes no longer than one minute.

Because granite is a coarse-grained rock and the beam diameter on the pXRF is 10mm, it is necessary to analyze multiple points per artifact. This study follows a rigorous protocol beginning with the analysis for internationally well-established standards, AC-E, GS-N (from SARM-CNRS, France), JA-1 (from the Geological Survey of Japan), BCR-2, and AGV-2 (from the USGS). By analyzing these samples prior to unknowns, a correction matrix can be developed in order to produce quantitative data. The second step of this method requires no fewer than five data points be taken per artifact. This is due to the large mineral crystals found in granite, by simply taking one data point it is very likely that an accurate representation of the geochemistry is being established. However, by taking five or more data points and averaging them together it is possible to develop an average signature of the artifact.

The BREA collections were generally comprised of coarse-grained granites with potassium feldspars that ranged from distinctly pink to lightly pinkish. Quartz and plagioclase crystals are easily distinguishable without the use of a hand lens. These proportions mean that the granites ranged from primarily white to primarily pink in color. The amount of micas ranged from approximately 2% to 10% of the overall composition. In general the most common mica was muscovite but biotite was also present. Hornblende was also found in several samples, though always in small grains and low percentages. Some of the artifacts had issues with weathering; the iron-bearing minerals in the tools had begun to alter and turned into a rusty-red color.

Interpretations and Conclusions

The following is a preliminary report on the interpretations and conclusions derived from this research. As the sites were distributed over a significant area it is important to analyze their location as well as the geochemical signatures for each site (**Figure 7.6**). First I will discuss a situation in which the elemental output for artifacts was problematic. Second, I will discuss how patterns emerge when looking at geochemical fingerprints of the artifacts. Finally, I will discuss possible source locations for each community that was analyzed based upon data collected in previous field seasons from outcrops within the Maya Mountains.

Prior to discussing the geochemistry of the artifacts in depth it is important to include that mercury (Hg) was found to be problematic in analyzing the BREA granite tools (**Figure 7.7**). Several artifacts had higher than expected levels of mercury present on their grinding surfaces. The cause of this is currently not understood. The samples that had higher levels of mercury came from Hats Kaab, an E group with unusually high amounts of manos and metates for a non-residential structure. In order to determine if the mercury was coming from soil contamination, possibly through the use of pesticides and fertilizers, pXRF readings were taken on and around the E group. There was no significant mercury in the soil. It is possible the mercury is leftover from past grinding activities; cinnabar (HgS) was sometimes used as a red dye by the Maya and would produce this peak in mercury readings.

The different sites included within the Middle Belize Valley surveys tend to have similar geochemical fingerprints. However there is some variation that indicates multiple outcrop sources. Two of three Beaver Dam granites have higher Sr/Y ratios than any other granites analyzed. Hum Chaak has a wide range of geochemical variation, ranging from low to moderately high levels of Rb/Sr. The majority of artifacts have Sr/Y and Rb/Sr ratios that are tightly clustered, indicating a shared source (**Figure 7.8**).

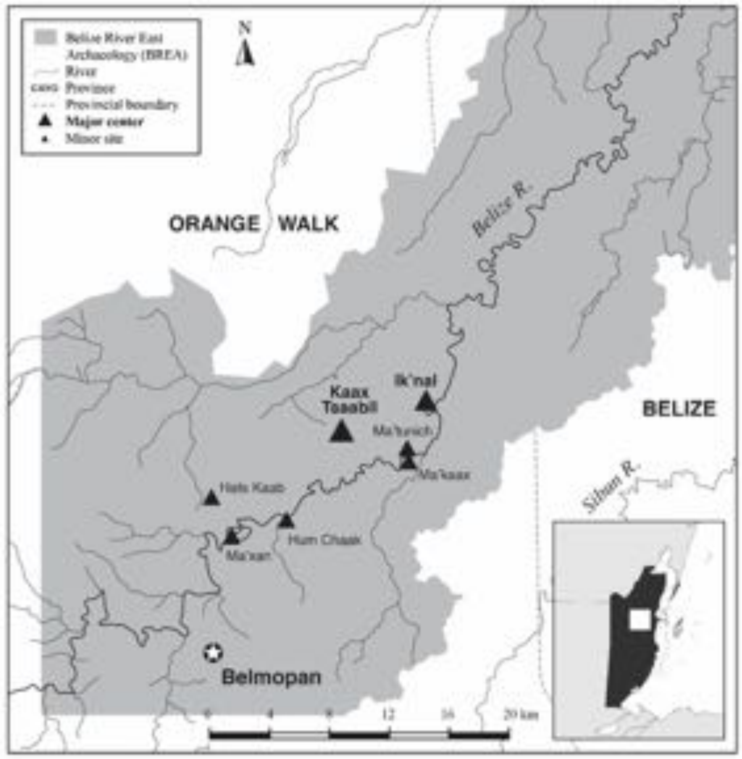

Figure 7.6 Distribution of sites with artifacts that were analyzed (map prepared by M. Brouwer Burg.

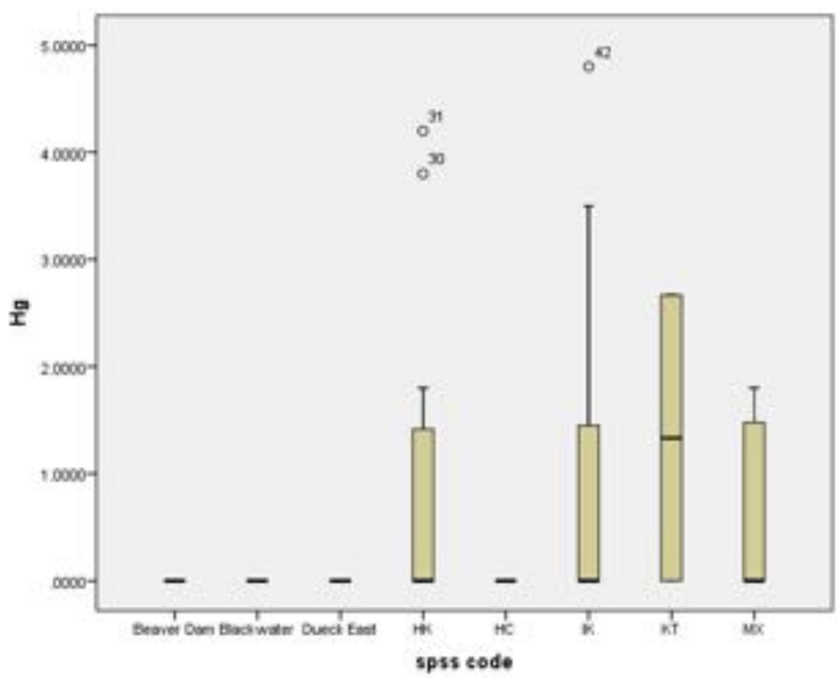

Figure 7.7 Hats Kaab, Ik’naal, Kaax Tsaabil, and Ma’xan had higher than normal readings of mercury present. The significance of this is currently unknown.

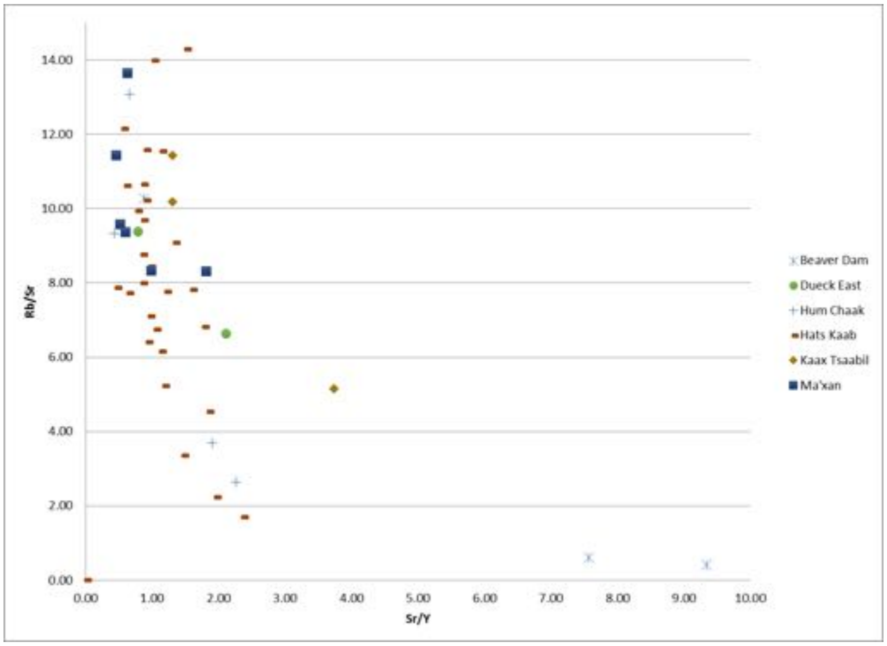

Figure 7.8 Rb/Sr and Sr/Y ratios showing artifact results. All Middle Belize Valley material except two artifacts from Beaver Dam generally cluster with low Sr/Y values.

When the artifacts are compared to the geochemical signatures of source granites, there are some very significant regions of overlap (**Figure 7.9**). The majority of material appears to be coming from Mountain Pine Ridge. There is also evidence that some of the tools were being made of granite that originated within Hummingbird Ridge. It does not appear that Cockscomb Basin was a source for these granites.

At the site of Pacbitun, just north of Mountain Pine Ridge, there is a granite ground stone tool workshop (Ward 2013). It is possible that the tools matching Mountain Pine Ridge granites at BREA were produced at Pacbitun, indicating a potential exchange partner. Furthermore, there are waterways that begin near Pacbitun and run through the Middle Belize Valley survey region (**Figure 7.6**). However further analysis directly comparing the geochemical signatures of Pacbitun tools to the artifacts in the BREA collections needs to be conducted.

Based on the current geochemical data it appears that Hats Kaab, Ik'naal, Ma'xan, Kaax Tsaabil, and Hum Chaak were using granite from Mountain Pine Ridge as their primary source for ground stone tools. These communities were importing granite tools from the south rather than using the locally available limestone. This may indicate a strong exchange connection with a production center that is using Mountain Pine Ridge granite. Additionally the presence of granite rather than any local materials may indicate that the exchange networks in the region were able to keep these communities well-stocked in granite tools so that when one broke it was not necessary to make expedient replacements from limestone.

Based on the geochemical data obtained via pXRF, the granite manos and metates from the Middle Belize Valley communities can be sourced to outcrops within the Mountain Pine

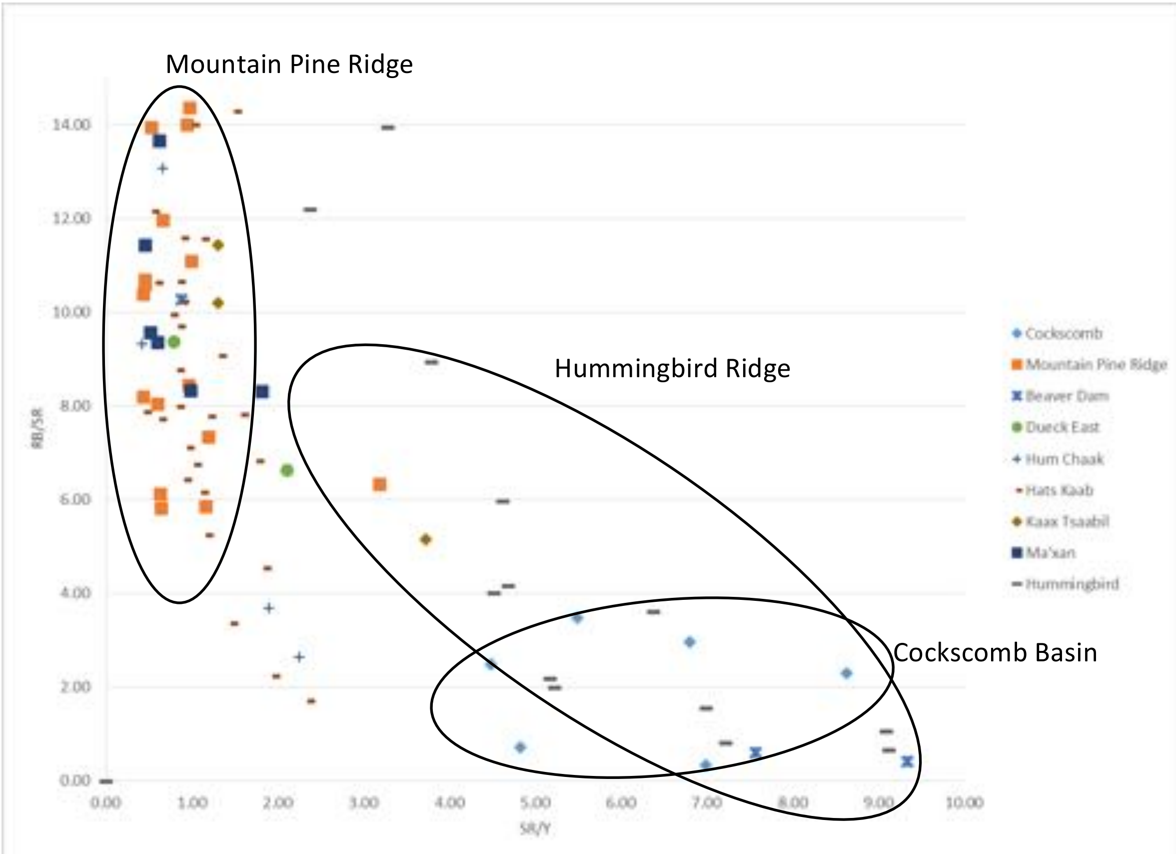

Figure 7.9 Rb/Sr and Sr/Y ratios for outcrops and artifacts. The majority of geochemical signatures found in artifacts from BREA sites can be sourced to Mountain Pine Ridge. However some also source to Hummingbird Ridge. While there is overlap between Hummingbird and Cockscomb, when individual points are analyzed their geochemistry more closely reflects that of Hummingbird.

Ridge and the Hummingbird Ridge plutons in the Maya Mountains. Some of the artifacts from BREA communities do not source directly to a pluton, however this is likely due to sampling rather than indicative of a source beyond Belize. In order to address this, future work needs to focus on sampling more of the variation within Mountain Pine Ridge. However, it is clear that based on the current dataset that the communities in the Middle Belize Valley are using multiple source locations to obtain their granite. Additionally, this implies an active choice by the Maya to use granite that has to be transported into the region over the locally available limestone.

Acknowledgements

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Chapter 8

Provenience Analysis of Groundstone Tools from Hats Kaab and Ik'nal

Cody Whelan and Tawny Tibbits

Introduction

Understanding provenience of artifacts is vital to modeling the movement of goods and resources in an archaeological context. In central Belize, considering origins of granite manos and metates, stone tools used for grinding and preparing food and other materials, can help trace trade patterns and transportation processes of igneous material across the Maya Lowlands. In the Belize River East Archaeology (BREA) study area (**Figure 1.2**), Hats Kaab and adjacent sites such as Ik'nal have yielded abundant mano and metate samples for provenience analysis and will be the focus of this study.

Objectives of the Research

The purpose of this analysis is to compile geochemical data of the mano and metate samples from Hats Kaab and Ik'nal to determine their provenience and carry out a comparative analysis between the two BREA project sites. Our aim is to determine if mano and metate material was sourced from geographically adjacent granitic sources or if trade was required to obtain the material observed at each site. Below we provide some background on the geology of Belize and present the methods and results of our study.

Geology of Belize

Belize consists of two primary geographically and geologically unique regions: The south-central Maya Lowlands and northern Maya Lowlands. Marine limestone dominates the northern Maya Lowlands, creating karst topography. While marine limestone and karst topography are present in the south-central Maya Lowlands, the dominating feature of this region is the granite-rich Maya Mountains. The Maya Mountains define central and southern Belize consisting of three chemically distinct granitic plutons: Hummingbird, Cockscomb, and Mountain Pine Ridge (**Figure 8.1**). The hummingbird pluton contains mostly potassium

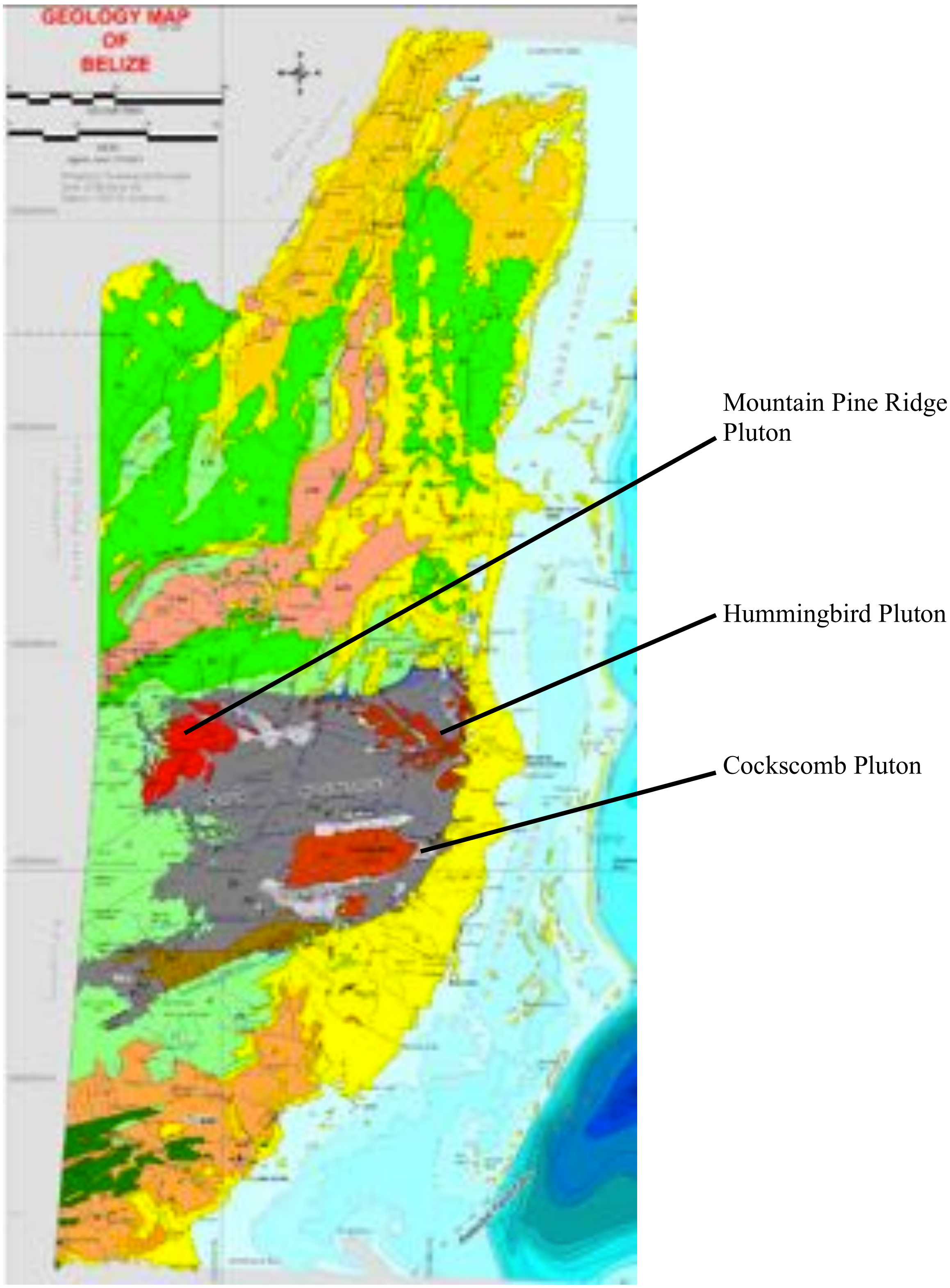

Figure 8.1: Geological map of Belize with major plutons labeled.

feldspar with few black minerals, giving it a pink color. Cockscomb is predominantly plagioclase feldspar with abundant black minerals giving it a grey "salt and pepper" appearance. Mountain Pine Ridge is the least homogenous of the three plutons and cannot be characterized by a single description as it contains both plagioclase and potassium feldspar with varying accessory minerals. Regional uplift and injection of the three plutons also caused contact metamorphism with the underlying bedrock (Tibbits 2012), resulting in schists and quartzites observed at the peripheral regions of the plutons.

It is important to note the chemical distinction between potassium feldspar and plagioclase feldspar, as identifying and sourcing granites is dependent on their distinct chemical compositions. Potassium feldspar ($KAlSi_3O_8$) contains K^+ whereas plagioclase feldspar ($CaAl_2Si_2O_8$) contains Ca^{2+}; the granites in Belize are compositionally unique in their abundance of potassium and plagioclase feldspar, providing a distinct signature for each pluton. By determining the abundance of the K^+ and Ca^{2+} in each sample, it is possible to identify the source of each sample.

Methodology

To understand spatial distribution of the samples among the BREA project area, visual identification of mano and metate grain size, composition, and accessory mineral count is recorded into an excel file with associated lab collection bag (LCB) number and operation-zone-square number. Normalization of data is required to compare mano-metate compositions between sites due to varying sample sizes. Visual identification includes noting abundance of quartz, composition of feldspar (potassium or plagioclase), appearance of muscovite and/or biotite (mica), quantity of black accessory minerals (pyroxene, amphibole, etc.), and average grain size. It should be noted however, that visual identification of composition is unreliable due to weathering, and other meteoric zone processes of the samples. It is therefore necessary to determine composition using portable X-ray Fluorescence, which provides sourcing based on elemental composition rather than visual cues.

Composition of each sample is collected using the portable XRF instrument, which measures bulk percent abundance of heavy elements for each artifact. Portable X-Ray Fluorescence (pXRF) is a non-destructive, cost effective, and easy to use chemical analysis tool, making it ideal for archaeological applications. Though some precision is forfeit to other geochemical techniques, XRF can provide accurate measurements when analyzing bulk composition of material. XRF works on the fundamental principle that atoms emit x-ray photons when bombarded with high-energy, low-wavelength x-rays. The emitted photons can be quantified to determine the percent abundance of each element in the sample (Guthrie, 2012). XRF Data was collected and post-processed by Tawny Tibbits. Graphing element abundance allows visual representation of variation in composition among mano and metate samples.

Mano and Metate samples were collected during the BREA 2012 field season from sites Hats Kaab (Preclassic) and Ik'nal (Terminal Classic). During the 2014 field season, Mano and Metate samples were grouped by site, tool type, and composition (**Figure 8.2** and **8.3**). Each mano and metate sample was classified by visual identification and by geochemical results from pXRF. For both Hats Kaab and Ik'nal, the number of mano and metate samples for each composition (Cockscomb, Mountain Pine Ridge, Hummingbird) as determined by visual identification, were added and divided by total number of samples at that site to normalize the data for comparison with other locations.

Results

Mano and metate samples identified visually show plagioclase feldspar rich granites as the predominant material used for production of manos and metates for all sites. The one exception is the Ik'nal manos, which are predominately potassium feldspar granites (**Figure 8.4**). The results of the chemical data gathered from XRF analysis of the BREA samples contradicts the visual analysis, reinforcing the notion that visual identification of composition is not a reliable method of sourcing ground stone. In contrast to the visual analysis, chemical data reveal a greater bulk abundance of potassium in most samples over calcium, suggesting a greater volume of potassium feldspar (**Figures 8.5-8.7**). **Figure 8.8** illustrates the abundance of each source pluton at Ik'nal and Hats Kaab. For Ik'nal, the chemical results suggest a distinction between the sources used for mano or metate groundstone tools. Ik'nal mano samples are distributed evenly amongst the three sources, while metates from Ik'nal are sourced primarily to the Hummingbird outcrop. For Hats Kaab, Mountain Pine Ridge (MPR) is the dominant source of both mano and metate samples. Hats Kaab Mano and Metates were sourced from Mountain Pine Ridge, whereas mano and metates from Ik'nal were sourced from Mountain Pine Ridge, Hummingbird, and Cockscomb plutons.

Discussion

Generalized composition distribution determined from visual identification of mano and metate samples shows a preference to plagioclase feldspar granites as shown in **Figure 8.4**. In contrast, the chemical data from the pXRF illustrates the majority of samples have an abundance of potassium, suggesting the feldspar in most of the mano and metate samples are predominantly potassium feldspar (**Figures 8.5, 8.6, 8.7**). The discrepancy in the visual and chemical data would suggest different sources for the same samples, which clearly is not the case. The color differences noted in the visual analysis of the granites is likely due to physical and chemical weathering processes, which alters stone color and makes it appear as though it contains minerals not present. This process was considered when classifying samples with a reddish-pink coating;

LCB	Op	Zone	Square	Artifact type	Shorthand desciption	Description
BREA 2012 IK - Preclassic (1300 BC - AD 200)						
3258	13	2	W	Metate	mica w/plag	Fine-grained micaceous plagioclase feldspar grainte
3248	13	2	O	Mano	mica w/plag	Medium grained micaceous plagioclase feldspar granite
3240	13	6	S	Mano	plag	Medium-coarse grained plagioclase feldspar granite; abundant black minerals
3230	13	2	T	Metate	mica w/plag	Medium-coarse grained micaceous plagiclase felspar granite; moderate # of black minerals
3157	13	2	L	Mano	k-spar	Medium-Coarse grained K-spar granite;Moderate distribution of black mionerals
3289	13	2	X	Metate	k-spar	Medium grained k-spar; abundant black minerals
3289	13	2	X	Mano	basalt	Fine grained black basalt
3092	13	4	Q	Metate	plag	Medium grained plagiocase granite with few black minerals
3092	13	4	Q	Metate	plag	Medium grained plagiocase granite with few black minerals
3277	13	8	S	Mano	k-spar	Coarse grained k-spar granite with few black minerals
3106	13	2	Q	Mano	k-spar	Coarse grained k-spar granite with few black minerals
3206	13	1	W	Mano	plag	Coarse grained plagioclase feldspar granite. Moderate count of black minerals
3041	13	3	Q	Mano	k-spar	Medium grained k-spar; few black minerals
BREA 2012 HK - Terminal Classic (800 - 950 AD)						
3593	7	10	D	Mano	plag	Medium grained plagiocase granite with moderate black minerals
3514	7	1	C	Metate	plag	Medium grained plagiocase granite with moderate black minerals
3514	7	1	C	Mano	plag	Fine-medium grained quartz rich plagioclase feldspar granite with few black minerals
3514	7	1	C	Mano	plag	Fine grained quartz rich plagioclase granite
3521	7	1	D	Metate	plag	Coarse grained plagioclase feldspar granite with few black minerals
3656	9	1	B	Mano	plag	Coarse grained plagioclase feldspar granite. Moderate count of black minerals
3644	7	1	B	Mano	plag	Coarse grained plagioclase feldspar granite. Moderate count of black minerals

Figure 8.2 Description of mano and metate data by site, LCB, Op, Zone, and square. Includes visual identification description.

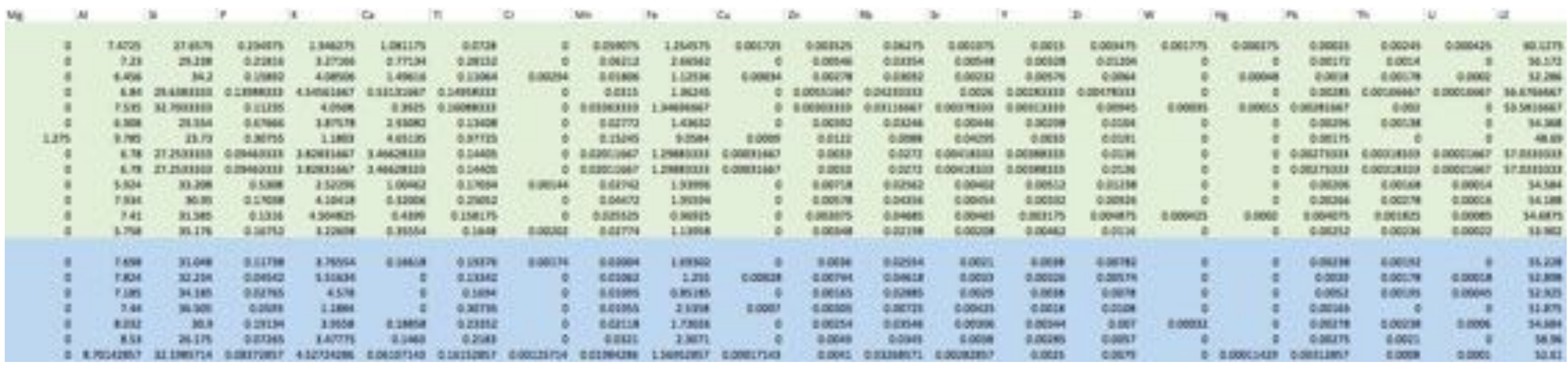

Figure 8.3 pXRF geochemistry data for each sample by site and LCB. Column extended across from Figure 8.2.

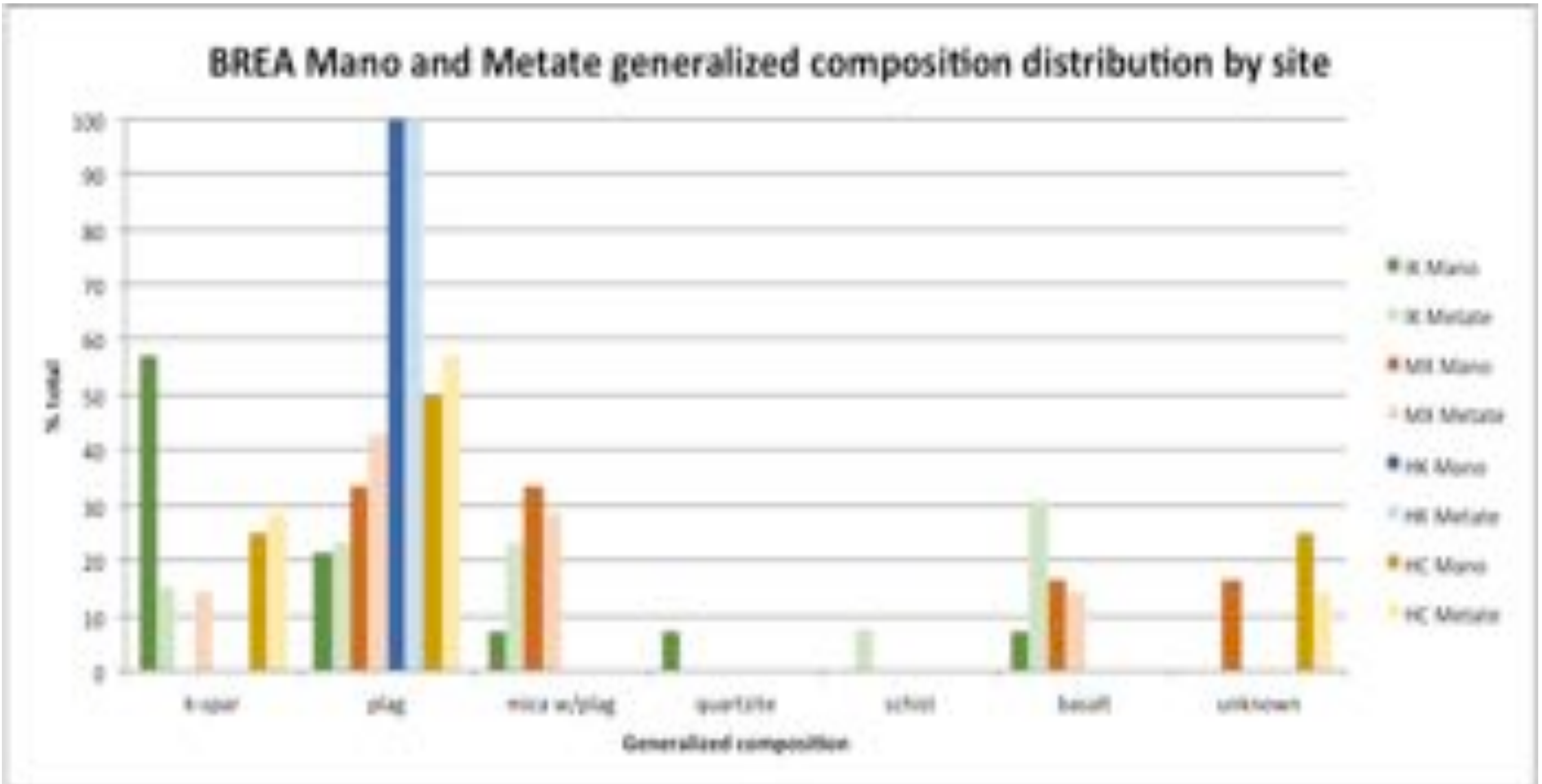

Figure 8.4 Site distribution of composition of manos and metates from IK, HC, HK, and MX – BREA 2011 and 2012 field seasons.

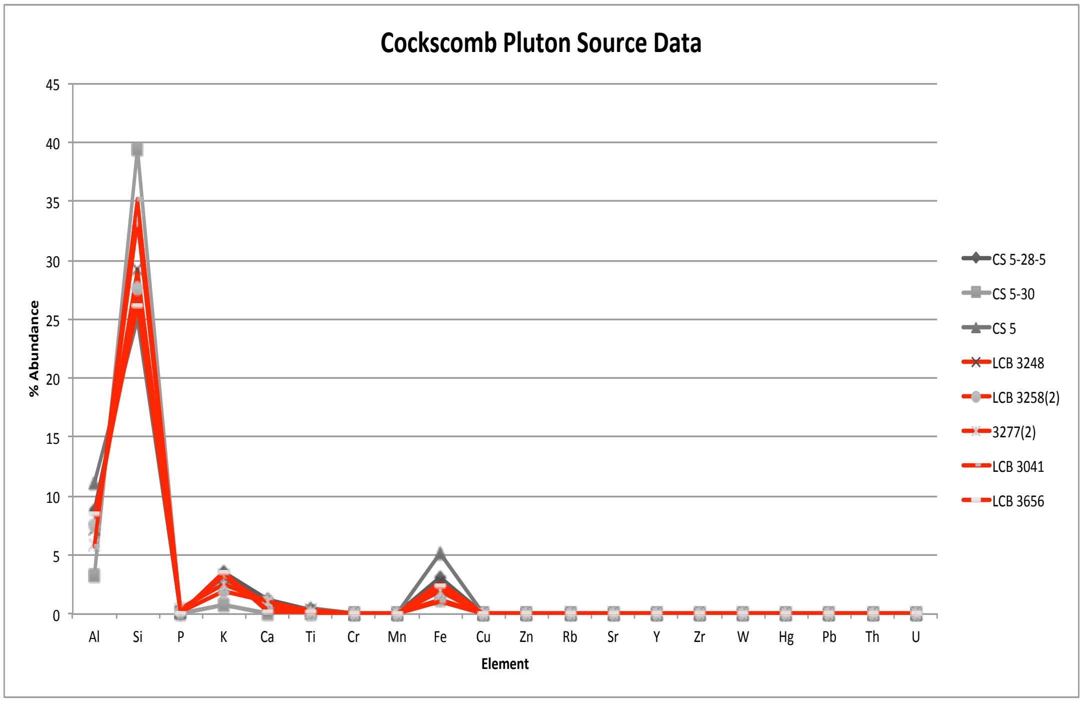

Figure 8.5 Percent abundance of each element in samples from IK and HK (colored) overprinted on the source percent abundance from Cockscomb (Greyscale).

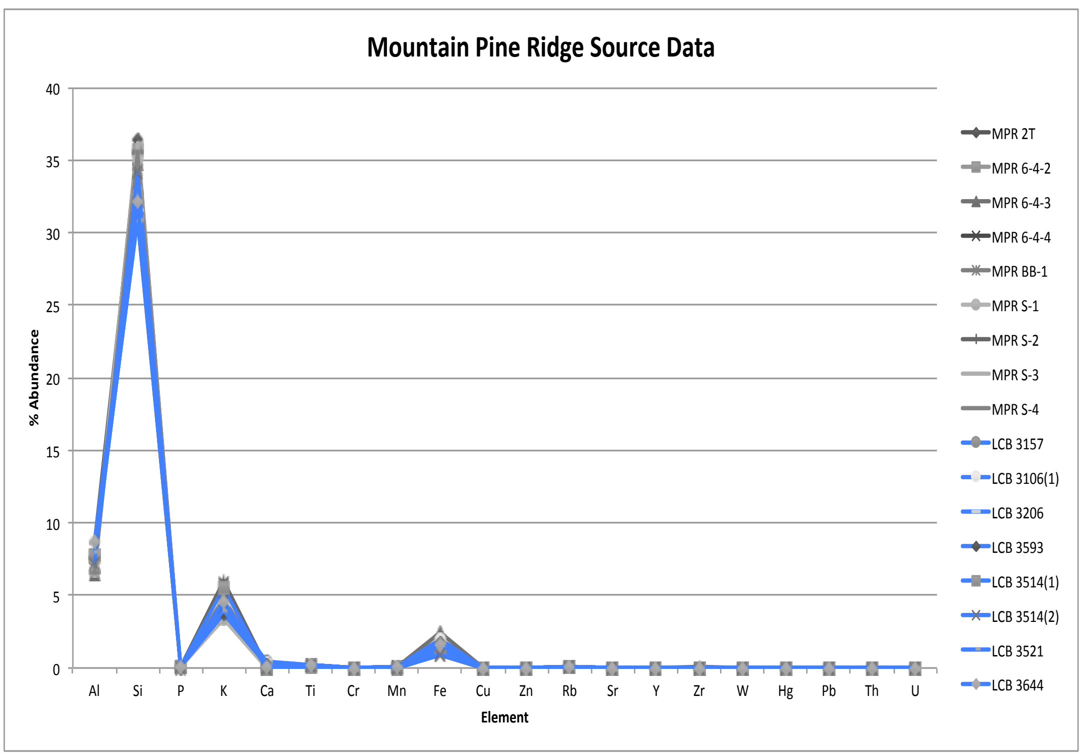

Figure 8.6 Percent abundance of each element in samples from IK and HK (colored) overprinted on the source percent abundance from Mountain Pine Ridge (Greyscale).

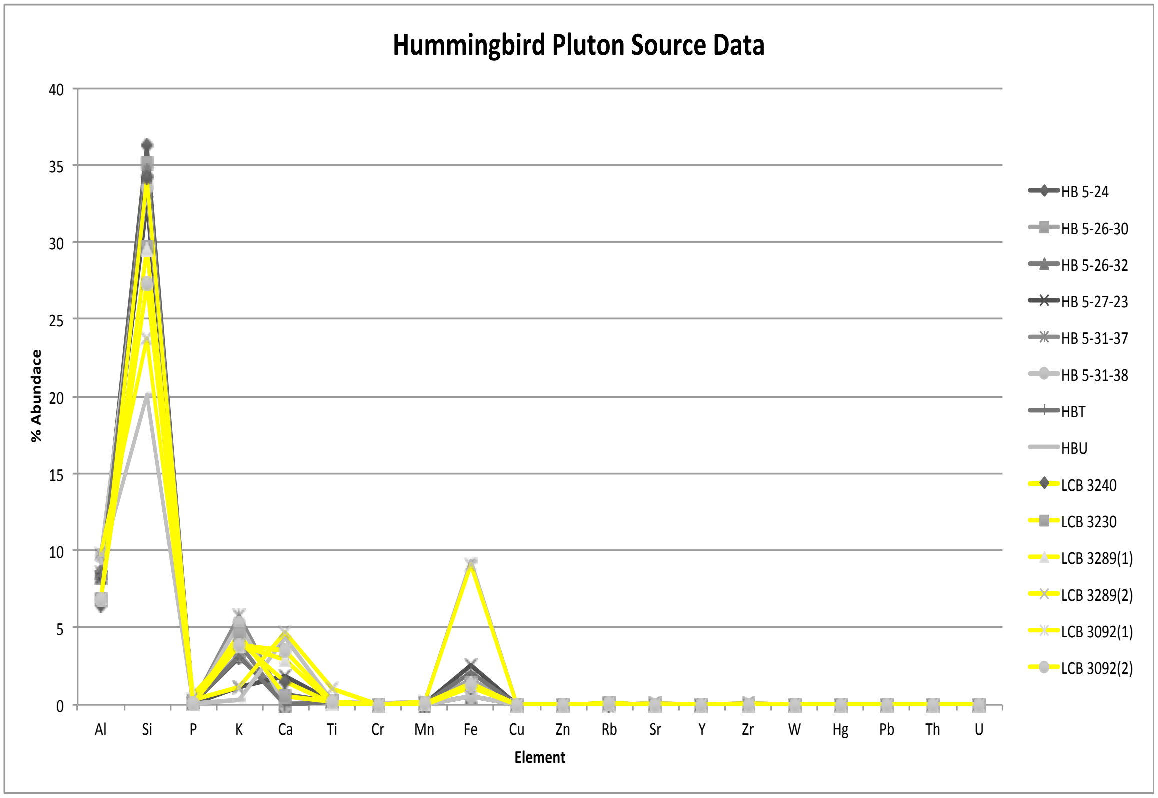

Figure 8.7 Percent abundance of each element in samples from IK and HK (colored) overprinted on the source percent abundance from Hummingbird (Greyscale).

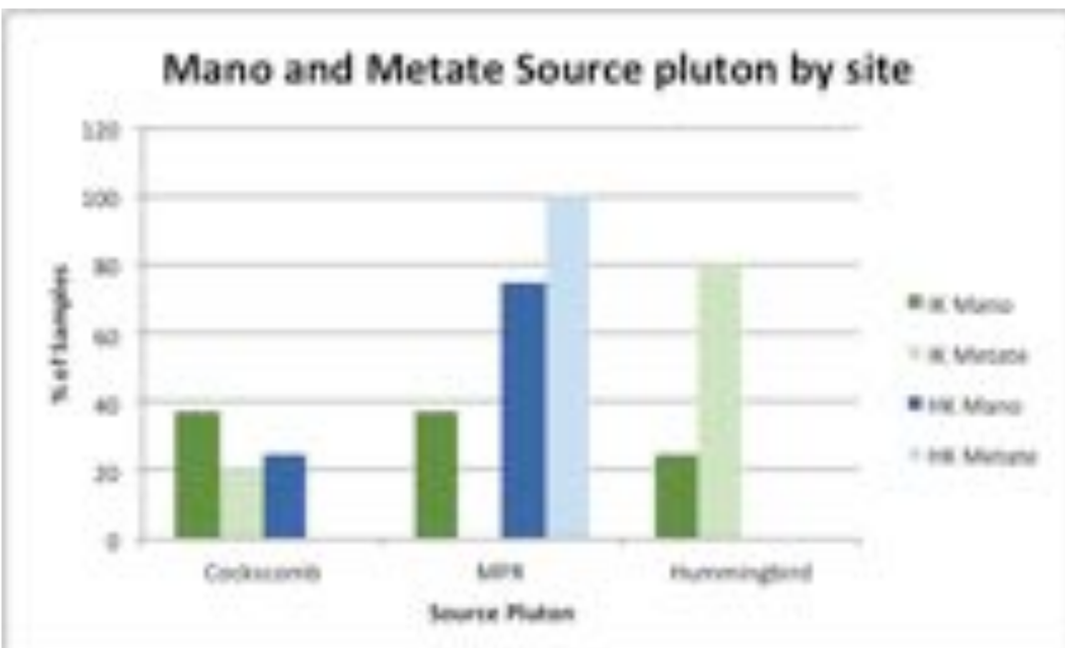

Figure 8.8 Normalized (to percent of total samples) distribution of manos and metates by site and source pluton.

several samples with this description had a small fresh break, allowing identification of plagioclase feldspar. Groundstone samples without a fresh break, but similar weathering patterns (i.e. reddish-pink coating) might be presumed to comprise similar compositions. This assumption could lead to incorrect identification of weathered material and reveals the weaknesses of visual sourcing, which continues to be heavily relied on in archaeological analyses of groundstone. Though multiple samples appear visually similar in terms of feldspar content and quartz abundance, chemical signatures reveal variation in visually similar samples. The chemical study strongly suggests that visual sourcing of groundstone material is an unreliable way to determine shared provenience and should be avoided as it obscures the data results more than it clarifies.

Figures 8.5, **8.6**, and **8.7** display the chemical data of each sample overprinted on the source data from the corresponding pluton, allowing a complete view of the provenience of each sample by LCB number. **Figure 8.8** is derived from results of **Figures 8.5**, **8.6**, and **8.7**, and illustrates an abundance of material sourced from Mountain Pine Ridge found at Hats Kaab whereas groundstone from Ik'nal is more evenly distributed across the three plutons, with the majority of groundstone sourced from Hummingbird pluton, several from Cockscomb pluton, and few from Mountain Pine Ridge pluton. This distributional pattern might suggest isolation of Hats Kaab from other locations, or that trade occurred only with sites that had direct access to material from the Mountain Pine Ridge granite source. Considering proximity of Hats Kaab to Mountain Pine Ridge, it is possible all material was collected directly from the source, but it is just far enough that it would likely take more than a day to walk there, requiring some overnighting and suggesting the need for intersite exchanges with another site closer to Mountain Pine Ridge granite (Brouwer Burg et al. 2015). Ik'nal, on the other hand, appears to have been more actively involved in trade with farther reaching sites, as is inferred by the even distribution of groundstone material from several different sources. For groundstone material from Cockscomb or Hummingbird pluton to be available, trade with distant sites would be necessary (refer to **Figure 8.1**). It is important to note the difference in time period during which each site was present. Hats Kaab primarily dates to the Preclassic period (500 BC-AD 200), whereas Ik'nal was active during Terminal Classic times (ca. AD 800-950). The temporal separation may explain the differences in the granite sources, perhaps indicating a shift in trading patterns over time based on the representative mano and matate material from each site. Further investigation in the future may clarify the diachronic changes in resource procurement and whether the spatial distribution patterns also vary within and between sites throughout the Belize Valley for any given time period.

Conclusions

The results of this study emphasize the critical need for chemical sourcing in groundstone studies. The lack of correspondence in the results of the visual identification and chemical analyses suggest that attempting to visually source groundstone material is not a viable approach. Provenience data of groundstone tools from Hats Kaab and Ik'nal presented here provide insight into the trade relations with other sites, specifically for granitic material used for mano and metate production. The groundstone material from Ik'nal that could be firmly sourced came primarily from Cockscomb and Hummingbird with only a small percentage from Mountain Pine Ridge. In marked contrast, Hats Kaab yielded a much higher frequency of groundstone material from Mountain Pine Ridge, and a general lack of material from Hummingbird and Cockscomb. This suggests Hats Kaab was likely engaged in trading for mano and metate material with sites in close proximity to the Mountain Pine Ridge source, such as Pacbitun, where Tibbits has observed groundstone production at or near such sites (see Tibbits, this volume). Like Hats Kaab, Pacbitun has a strong Preclassic component, however, Ik'nal appears to date primarily to the Terminal Classic and has not revealed a Preclassic component thus far (Harrison-Buck, personal communication December 2014). The presence of different granite sources at these two sites—Hats Kaab and Ik'nal—indicate that the sources of groundstone changed over time and by the Terminal Classic, trade relations were primarily geared toward sites associated with the Cockscomb and Hummingbird areas to the south. Future comparisons of sourced groundstone from sites that are proximate to these granite plutons, such as Pacbitun in the Mountain Pine Ridge, may offer further insights into the interaction and trade with sites in the middle Belize Valley.

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Chapter 9

A Study of the Censers associated with a Postclassic Shrine (Structure 11) at Saturday Creek

Holly Linseman and Eleanor Harrison-Buck

Censers in the Maya world were used in burning a variety of aromatic resins and gums. They constituted important, symbolic roles in the ritual life of the Maya. These rituals involved the calendar, historical cycling, cosmological beliefs, and ceremonies incorporating fire as a renewing force in cyclical transformations (Rice 1999: 45). Some scholars even suggest that pieces of paper with droplets of blood sacrifice could have been burned within them (Rice 1999: 45). While there is evidence of censer usage spanning the known archaeological record of the Maya, here we focus specifically on an assemblage of Postclassic Maya censers that were discovered at Operation 23 associated with Structure 11, a small, square shrine structure located in the Southern Plaza of the Saturday Creek site core (for further discussion see Harrison-Buck and Flanagan, Volume 1). The censer types vary with a few different types of paste, applique use, and striations. They also contain either effigy or non-effigy attributes. The styles seen at Operation 23 indicate connection with certain cities in the northern Maya lowlands, including Mayapan from where the styles are thought to originate.

During the Postclassic. Maya cities in Northern Yucatan, such as Chichen Itza and Mayapan rose to prominence, while for the most part many cities witnessed a population decrease, particularly in the southern Maya lowlands. In the middle parts of Belize River Valley, where the BREA project has been focused, the archaeological record points to some disruption and decline of sites at the end of the Late Classic period, but also presents evidence of continued occupation in many places during the Postclassic period, including Saturday Creek. The presence of Postclassic censers in the Southern Plaza at Saturday Creek that are similar to those found in the north reflect some degree of interaction between this area of the Maya world and the northern lowlands.

Methods

The artifact samples analyzed herein are a subsample from the artifact assemblage collected during the excavation of Operation 23 in the summer of 2014. Only sherds of censers containing clear diagnostic features were considered in the present study—body fragments with no diagnostic features were not included in the sample. In this analysis, we rely on Smith's (1971) study of censers from Mayapan comparing his list of different design elements from effigy and non-effigy censers to those found in the assemblage of Operation 23. The Postclassic non-effigy censers from Mayapan contain a wide range of appliqued design elements, including circle, circle-and-dot, thumb-impressed fillet, and braided elements. All of these appliqued elements were found in the Saturday Creek assemblage. The most common non-effigy type from Mayapan is referred to as the Cehac-Hunacti, which appears to be well-represented in the Saturday Creek assemblage. In addition, there is evidence of non-effigy ladle-handled censers in the Saturday Creek assemblage that resemble Smith's (1971:Fig. 62 g-i) Navula Unslipped "frying pan" censer with a hollow tubular handle. Finally, the assemblage also contains types that appear similar to Smith's (1971:Figs. 70-73) effigy censers, namely the Chen Mul Modeled type, which include arms, legs, feet, hands, and facial elements, as well as a range of appliqued elements that are part of the censer headdresses and adornos, including spikes, twists, braids, feathers, and other elements. The following presents these findings from Saturday Creek in more detail.

Results

A total of 159 sherds were identified as censer fragments and analyzed in this study. Of these, 148 were identified as non-effigy types and 11 were identified as effigy types in the Saturday Creek assemblage. **Figure 9.1** compares the effigy versus non-effigy fragments and each grouping shows the total weight of the artifacts classified into those two categories. Although this subsample only represents the diagnostic pieces in the assemblage, the results suggest that the vast majority of the censers (N=79%) deposited in Operation 23 were non-effigy types and that a relatively small proportion (N=21%) were effigy forms. Because of their modeled features, these types are readily identifiable in the assemblage. However, it is possible that the total amount of effigy types in the assemblage represents a slight underestimation as some of the small appliqued pieces, such as the braided element, placed under the non-effigy category are also occasionally found on effigy censers.

Figure 9.2 shows the density and spatial distribution of all the effigy and non-effigy censers found in each of the individual squares of Operation 23 (Squares A-J). By far the vast majority of the censers were recovered from the plaza areas around the exterior of Structure 11, rather than on the surface of the shrine structure or its stairs. **Figures 9.3** and **9.4** show this relative distribution of the effigy and non-effigy censers in Operation 23 in a pie chart format.

Below we describe the different types and various appliqued elements found in the assemblage that were designated as non-effigy and effigy types. We provide the total numbers found and also designate their Field Collection Bag (FCB) numbers, providing a more detailed contextual reference for the reader, which links the individual ceramic fragments to their archaeological provenience to facilitate further research on the assemblage in the future.

Non-effigy Ceners. A total of three fragments of "the braid" were found in Operation 23 (FCB 5507, 5501, and 5545). This is an ornamental twist formed by two strands of clay wrapped and twisted around each other. As noted above, this element is found on a range of censer types and it is possible one or more represent fragments of an effigy censer and were misidentified.

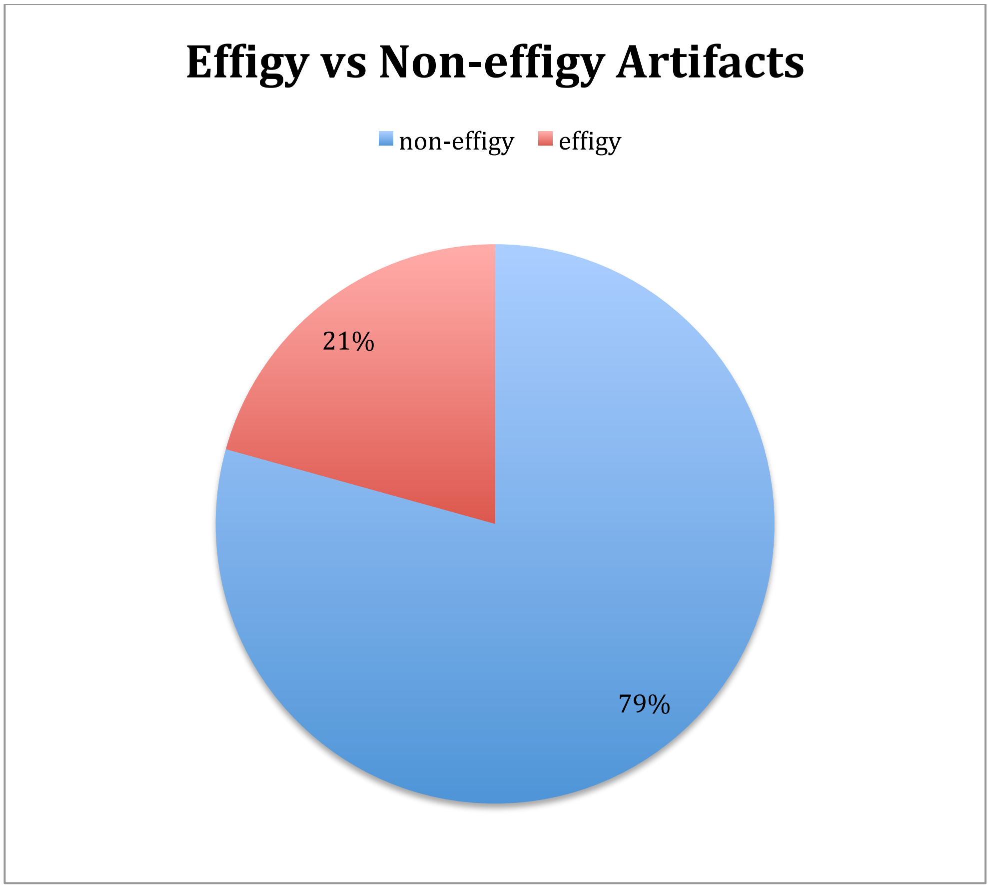

Figure 9.1. Effigy verses non-effigy artifacts, by weight, found from Op. 23 at Saturday Creek (prepared by Holly Linseman).

Multiple numbers of sherds are found with “the circle” applique on them, their pastes either gray or cinnamon, characteristic of the Cehac-Hunacti type (FCB 5502, 5516, 5529, 5517). Several isolated applique dots fallen off of vessels were found in the assemblage. Similar to the former, the “circle-and-dot” applique was found on three sherds (5519, 5559) and it is also possible a few of the dot appliques are simply missing the other circle applique, having fallen off prior to excavation. These sherds all have a gray paste. Another design found on non-effigy types like Cehac-Hunacti Composite is the “spike” (Smith 1971:31b), which is found on several sherds from Operation 23. Lastly, one of the most common attributes found on the sherds in Operation 23 that indicate censer usage is the thumb impressed fillets that resemble a “pie crust” decoration. The impressed fillet is a common element found on non-effigy types, such as Cehac-Hunacti Composite type and Thul Appliqued jar (Smith 19712:Fig. 62a-f).

Other diagnostic attributes of non-effigy censers found in Operation 23 are hollow tubular handles opening into a bowl characteristic of Navula Unslipped types (FCB 5511, 5501, 5502, 5517, 5519). There were also a number of pedestal feet identified in the Operation 23 assemblage that may be parts of non-effigy censers or possibly belong to grater bowls (FCB 5519, 5553, 5539, 5533), both of which date to the Postclassic period at Mayapan and elsewhere.

Figure 9.2 Planview of Op. 23 with Individual Squares Shaded Based on Relative Density of Censer Wares (map by E. Harrison-Buck, digitized by M. Brouwer Burg).

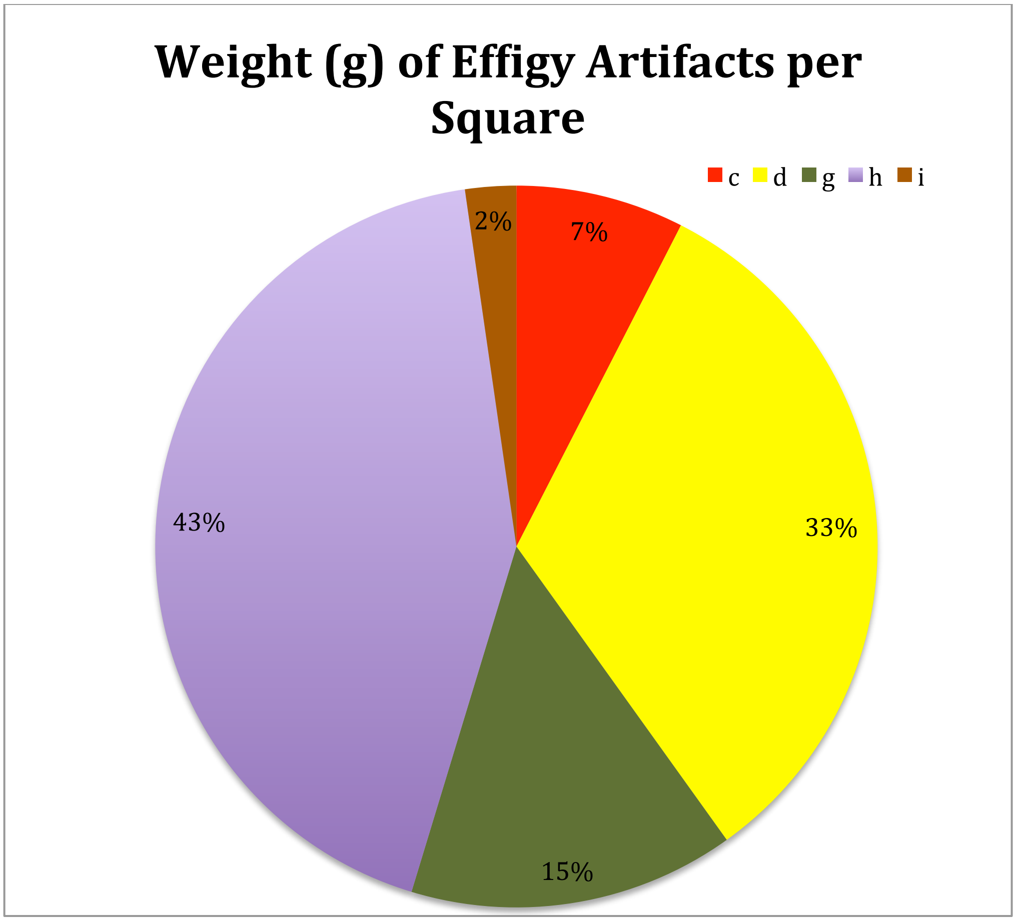

Figure 9.3. Weight of effigy artifacts per square from Op. 23 at Saturday Creek (prepared by Holly Linseman)

Effigy Censers. Clear evidence of effigy censers were found in Operation 23, all in a fragmentary state. The effigy fragments contain faces, legs (FCB 5533), knees (FCB 5505), and feet (FCB 5516 and 5539) characteristic of the Chen Mul Modeled types found at Mayapan (Smith 1971:Fig. 70). Because of their fragmentary state, it is entirely possible some sherds classified as non-effigy types are actually part of the effigy censers. Further analysis and attempts at reconstruction may resolve some of the classification issues. One partially reconstructable effigy face was recovered from Operation 23 that aligns with Smith's description of the "Old God" Itzamnaaj:

> …blue face, red mouth toothless except for a single molar in each corner and surrounded by an orange area, sunken eyes with prom eyebrows and orange eyelids, prominent cheekbones, markedly Hebraic nose with a round projection over the bridge; elaborate bonnet-style headdress with funnel like crown and feathers; vertical side flanges; an unidentified conical object, originally covered with rows of triangular spikes, is held in upturned hands; pouches hang from either arm. (Smith 1971: 50)

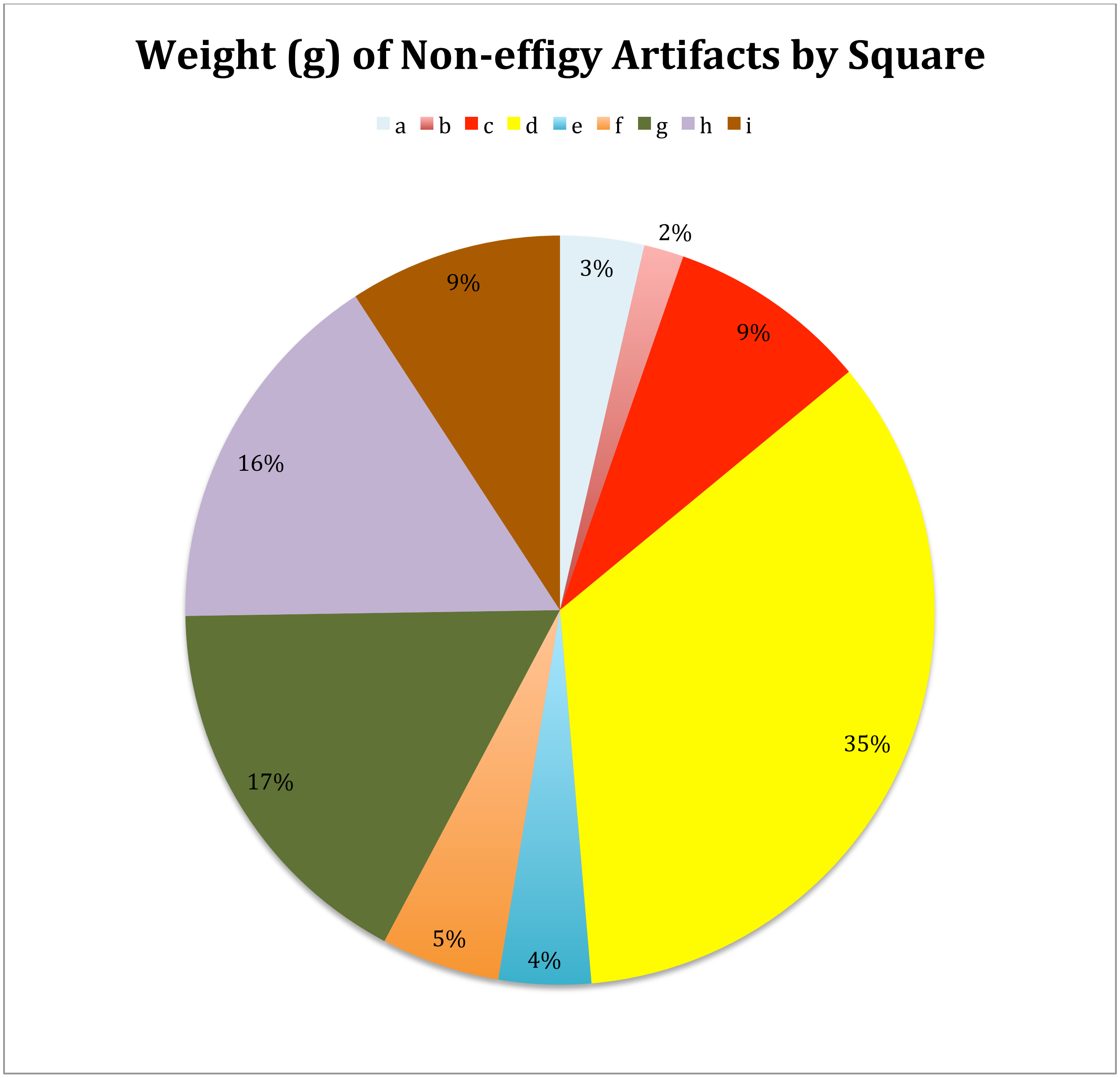

Figure 9.4 Weight of non-effigy censors per square from Op. 23 at Saturday Creek (prepared by Holly Linseman)

Although only the face and earspool, and a bit of the headdress were recovered in the Operation 23 sample, it resembles the Chen Mul Modeled type identified as Itzamnaaj, at Mayapan produced during the Late Postclassic, beginning ca. A.D. 1200 (**Figure 9.5**). However, the Saturday Creek example diverges slightly, containing eyes with punched out pupils, rather than the typical Mayapan painted eyes (Milbrath, Aimers, Lope, Floan 2008: 112).

Another example of a humanoid censer found at Saturday Creek that has two fangs protruding from its face resembles Chac, the rain god, who is often featured with such fangs on censers at Mayapan (**Figure 9.6** [cf. Smith 1971:Fig. 30x, z-bb]). However, most of the

Figure 9.5. Itzamnaaj effigy censer from Op. 23 at Saturday Creek (photos by M. Brouwer Burg)

Figure 9.6. Chac effigy censer from Op. 23 at Saturday Creek (photos by M. Brouwer Burg)

Mayapan examples show Chac attached to the front of a censer jar or serving as the receptacle; in this case, the Chac figure appears to serve as a handle to a ladle censer (FCB 5506), showing how elements of the Mayapan censers were copied but given their own regional artistic style.

Discussion

Both the forms and styles of the effigy and non-effigy censers from Saturday Creek bear a strong resemblance to the Postclassic censers from Mayapan, particularly the Cehac-Hunacti Composite, Navula Unslipped, and Chen Mul Modeled types. However, the slight variations in styles suggests that most of the effigy and non-effigy censer were probably locally produced, rather than imported from Mayapan. Although not procured through long-distance exchange with Mayapan, the sharing of ideas suggests a strong interaction between the northern and southern Lowalnds during the Late Postclassic period. The existence of the Chen Mul Modeled type this far south suggests Mayapan held a strong influence across a broad area of the Maya Lowlands during the Postclassic time period and possibly held some degree of regional control in this area. Alternatively, it is possible that the censer styles spread from the Peten Lakes region to the west in Guatemala where a faction of the Itza were living during the Late Postclassic; this group is typically associated with the Chen Mul Modeled censer tradition at Mayapan. Either way, the evidence suggest a shift in the regional interaction spheres during the Late Postclassic with continued occupation in this part of the middle Belize Valley during a period often associated with population depletion and withdrawal from city centers in the southern Maya Lowlands. The appearance of the Chen Mul Model of effigy censers show the interconnected nature of the Maya world even at this time, and perhaps indicates an inland route of trade and/or pilgrimage. The local production of foreign-style censerware in Belize also points to a renewed specialization of ceramic making and lends further support to the idea that the Maya living in and around Saturday Creek were still actively engaged socially, politically, and economically during this late period.

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Chapter 10

Analysis of the Human Skeletal Remains from Burial Features at Kaax Tsaabil and Haats Kab

Gabriel D. Wrobel

Introduction

Excavations conducted by the BREA project during the 2013 and 2014 field seasons recovered several burial features—one from Kaax Tsaabil and two from Hats Kaab (for site locations see **Figures 1.1** and **1.2**). Following excavation, *in situ* documentation, and the removal of the burial features by members of the BREA project, I performed a standard forensic analysis of the recovered bones intended to provide basic osteological descriptions related to aspects of biological identity and reconstructions of mortuary pathways. The results of the analyses presented below includes estimates of age and sex, as well as an assessment of the absence or presence (and descriptions when present) of pathologies, cultural modifications, and evidence of peri- and post-mortem trauma.

Kaax Tsaabil Burial 1

Burial 1 is a primary, articulated burial that was excavated from a central plaza group at the hilltop site of Kaax Tsaabil (**Figure 10.1**). The burial was found in Operation 14, a 2 x 14 m trench that was placed roughly on the centerline of Structure 5, encompassing a small portion of the structure's summit and front (southern) side where excavations exposed a staircase running down into the plaza area. The burial feature was found toward the summit of the mound in Zone 16 of Squares B and H in Op. 14 (see Harrison-Buck et al. 2013 and Murata et al. 2013 for further details of the excavation). A preliminary analysis of the skeleton was performed at the end of the 2013 field season in Belize, and since then the bones have been stored by the Central Belize Archaeological Survey project. Following the upcoming 2015 field season, I will seek permission from the Institute of Archaeology to export the bones to the Michigan State University Bioarchaeology Laboratory, where they can be further analyzed.

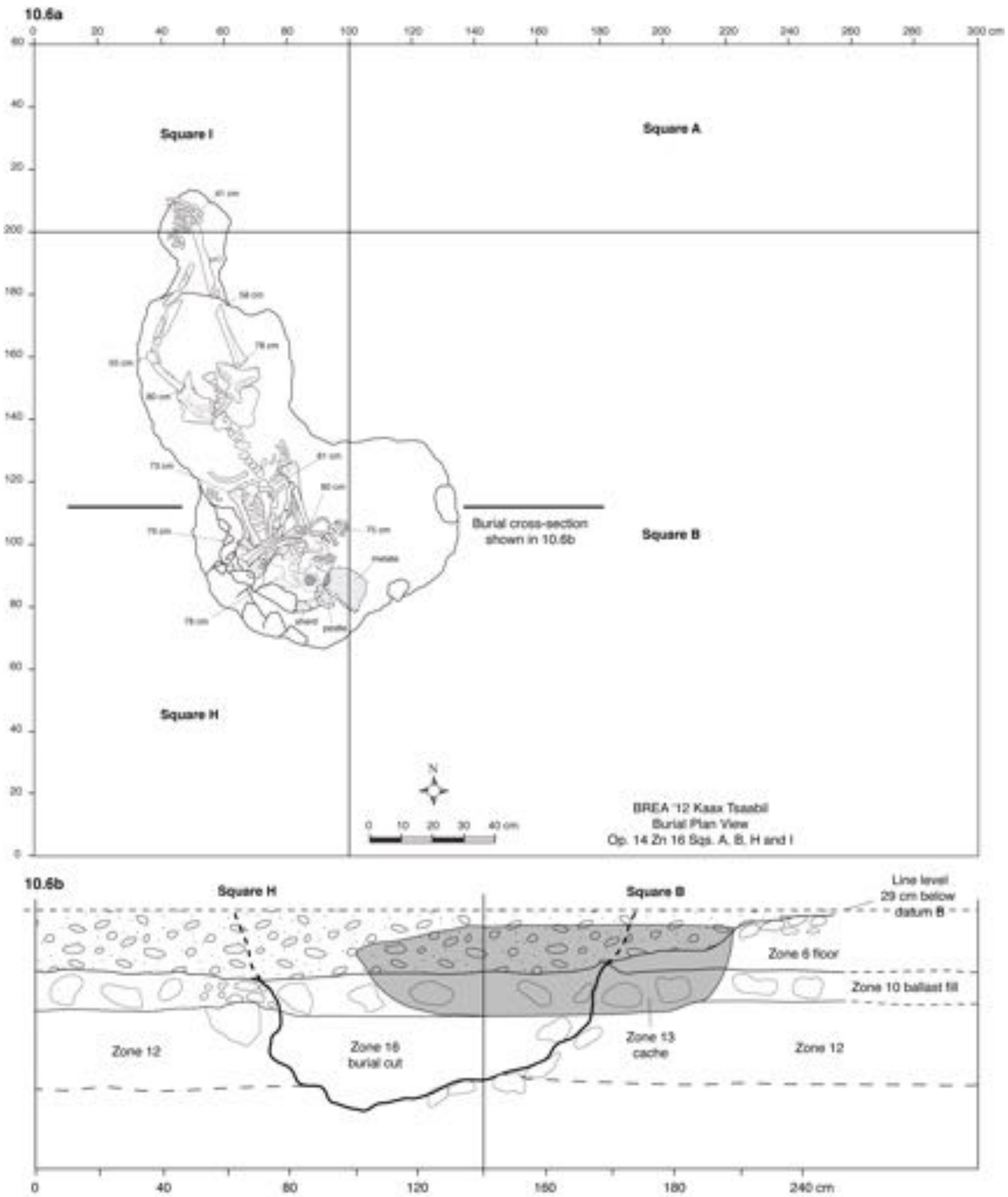

Figure 10.1. Kaax Tsaabil interment (Zone 16, Squares H and B) a) Planview and b) Profile (digitized by M. Brouwer Burg).

Age

"Middle-age" (~30-50). Age assessment is based solely on the moderate dental attrition. Because the front teeth show relatively little attrition in comparison to the posterior teeth, it is likely that that the individual is on the younger end of this range. Other features standardly used for adult age assessment, such as the pubic symphysis and cranial sutures, were not visible in the fragmentary remains. It is possible that reconstruction of some of these elements in the lab will aid in generating a broader set of age-related data.

Sex

Likely female. The individual shows a mix of masculine and feminine morphological features. Masculine features include the nuchal line, the mastoid process, and several robust muscle attachments, especially on the humerus. Feminine features include the open angle of gonion, the small brow ridges and sharp orbital margins, and the overall small body size. In addition, the olecranon fossae of the humeri display bilateral fenestrations (i.e., holes), which are more common among females in several non-Maya groups (though admittedly there is no such study among Maya groups). The shape of the chin is intermediate.

The pelvis was poorly preserved, so sex determination was ultimately based on robusticity measurements using a discriminant function analysis method derived from the Colonial Tipu collection (Wrobel et al. 2002). The measurements are listed in **Table 10.1**, and strongly suggest that the individual is a female, despite the rugose muscle attachments. Large muscles of the arm are common among Maya females and may be at least in part be the result of activities like grinding corn with a mano and metate. Measurements of the tibia were not available because it was particularly fragmented and an infection had disfigured the remaining surfaces.

Table 10.1. Long bone robusticity measurements used in the discriminant function analysis.

		Left	Right
Ulna			
	Minimum circumference	-	30
Radius			
	Minimum circumference	33	35
	Tuberosity diameter	13.6	14.9
Humerus			
	Least circumference of shaft	53	53
	Maximum head diameter	-	
	Deltoid tuberosity diameter	20.6	20.8
Femur			
	A-p diameter of midshaft	24.5	29.2
	Circumference of midshaft	77	76
	Maximum head diameter	>/= 39.6	(39.5)*
	Subtrochanteric a-p diameter	27.5	23.45
	Maximum a-p diameter of femoral shaft	-	26.3

*estimated

Cultural modifications

The broken cranium does not appear to be modified. However, the upper anterior teeth are filed (**Figure 10.2**). The central incisors have been shaped somewhat differently, with the right displaying Romero's (1970) B5 pattern and the left the B4 pattern. It is unknown if this asymmetry was intentional or was the result of accident. The lateral incisors and canines all display the same C3 pattern. All of these patterns, as well as the specific combination of them, are quite common in the central Belize area during the Late-Terminal Classic period, and have been documented, for instance, in the caves of the Roaring River Valley (see Wrobel et al. 2014).

Figure 10.2. The filed upper anterior teeth of Kaax Tsaabil Burial 1.

Pathologies

The dentition shows significant pathologies, including large caries on the 2nd right lower molar and the right lower canine (**Figure 10.3**). In addition to being quite painful, these large caries would have made this individual susceptible to systemic infection, which could have led to her death. Many of the teeth have light calculus deposits and the individual displays moderate recession of the alveolar bone on both the mandible and maxilla, which is the result of periodontal disease.

The cranial vault displays very minor pinprick lesions consistent with porotic hyperostosis, indicating metabolic disease, likely anemia. There is a small "button osteoma" on the frontal bone, which is an overgrowth of normal bone that forms in the periosteum and has no clinical significance.

The individual shows evidence of a rather severe infection in the form of mild ostitis on the left tibia and fibula, and more pronounced porosity and swelling on the right tibia (**Figure 10.4**) and fibula. The bilateral nature of the infection suggests a systemic, rather than a localized, infection.

Figure 10.3. Small calculus deposits on teeth and a large caries on right mandibular second molar.

Figure 10.4. Right tibia showing inflammation.

Other notable features of the skeleton

The individual displays natural agenesis of the left 3rd molars of both the mandible and the maxilla, and the right 3rd molar of the maxilla. In addition, the left lateral incisor is pegged (though filed nonetheless). By itself, agenesis is not particularly noteworthy. However, it is an epigenetic trait, which can be used at a population level to determine the genetic relatedness of different groups. For instance, a high frequency of molar agenesis was noted among skeletons deposited in Je'reftheel, a small cave in the Roaring Creek Works (Wrobel et al. 2014). Because several dental studies of Classic period Maya skeletal populations have found relatively low frequencies of agenesis, we argued that the individuals within Je'reftheel may have been closely related because they shared a rare genetic anomaly. Alternatively, if high frequencies of agenesis are found among skeletons recovered in central Belize, where we currently have no large reference samples, this trait may instead indicate a regional genetic difference between central and northern Belize populations. These competing hypotheses will require a great number of individuals to test.

Finally, the unusual burial position and the central plaza location could suggest that the individual was an offering, rather than a burial. Murata et al. (2013:140) describe the body position:

> The arms were raised up near and to either side of the skull. Perhaps most interestingly, though the individual was extended and supine, it did not lie on a flat surface. Rather the skull, torso, and pelvis were largely on the same level, but the legs extended upward bending. At the very simplest level of analysis, this suggests that this individual was interred in a pit that was essentially too small. Admittedly, the 'cut' of the burial pit was not all together clear and the position of the burial leaves open the possibility that there was no formal burial pit, but rather, this represents an individual who died on the surface of a stepped platform and that perhaps his or her legs are propped up on a step that lies underneath, again at a roughly 40 degree angle at the knees.

Furthermore, while a few broken artifacts were found in close association with the body, including a large metate fragment, their haphazard, fragmentary, and random nature may suggest these were simply included as fill rather than as grave goods. However, a ceramic cache containing a series of inverted vessels found approximately 20 cm above the body has been tentatively interpreted as representing a termination event, of which the burial may have been included. Specifically, though the burial was placed in close association with ceremonial architecture in the elite zone of the site, the burial context does not appear reverential. Careful analysis of the bone surfaces found no indicators of perimortem trauma, though certainly this absence of evidence does not rule out a nonfunerary interpretation.

Hats Kaab Burial 1

Excavations at the site of Hats Kaab during the 2014 field season revealed a complex burial feature containing articulated and disarticulated bones. Brouwer Burg and Runggaldier provide a detailed description of the burial context and excavation (see Volume 1 of this report). The bones were exported to the Michigan State University Bioarchaeology Laboratory, where they were analyzed and are currently being curated. Bones were left in block and wrapped in aluminum foil with directional information written on the foil. In this way, the orientation of the bones in many cases could be determined as they were unwrapped and excavated in the lab. **Figure 10.5** shows the general location of the bones within the feature. Below, I provide a description and identification of elements, and when possible provide interpretation of their depositional history.

Layer 1

Layer 1 appears to comprise a partial primary burial in the form of a pair of articulated legs, as well as scattered bone fragments and teeth from a minimum of two other individuals (**Table 10.2**). Preservation was very poor and several of the packets containing the blocks of bone and soil had dried and crumbled during transport, mixing the bone fragments and making directional information difficult to assess. The general spatial relationship between the bones suggests this is the lower half of a primary, extended burial in association with scattered bone fragments. This was generally confirmed during the inventory. Bones 1 and 2 are both femurs, while Bones 9 and 10 each contain a tibia and fibula. In both cases, the femurs were too fragmentary to side, but was oriented anterior side up, suggesting a supine body position. Each tibia was reconstructed as much as possible, allowing them to be sided. This confirmed the assumed supine position of the body (i.e., the left leg was on the left side).

Other bones in Layer 1 appear to be scattered and are not articulated. The possible exception to this is “Bone 4”, which includes six teeth that are all heavily worn. Five of the teeth represent the lower right mandibular arcade, including both premolars and all three molars. The first molar is missing half of the crown as the result of a mega-caries. Two small fragments of a mandible were also present. The other tooth found in this area is a lateral upper right incisor. It is too worn to assess for modification, but polishing and a small depression along the center anterior surface may indicate that the individual originally had an inlay, but there is no way to confirm this. The teeth were

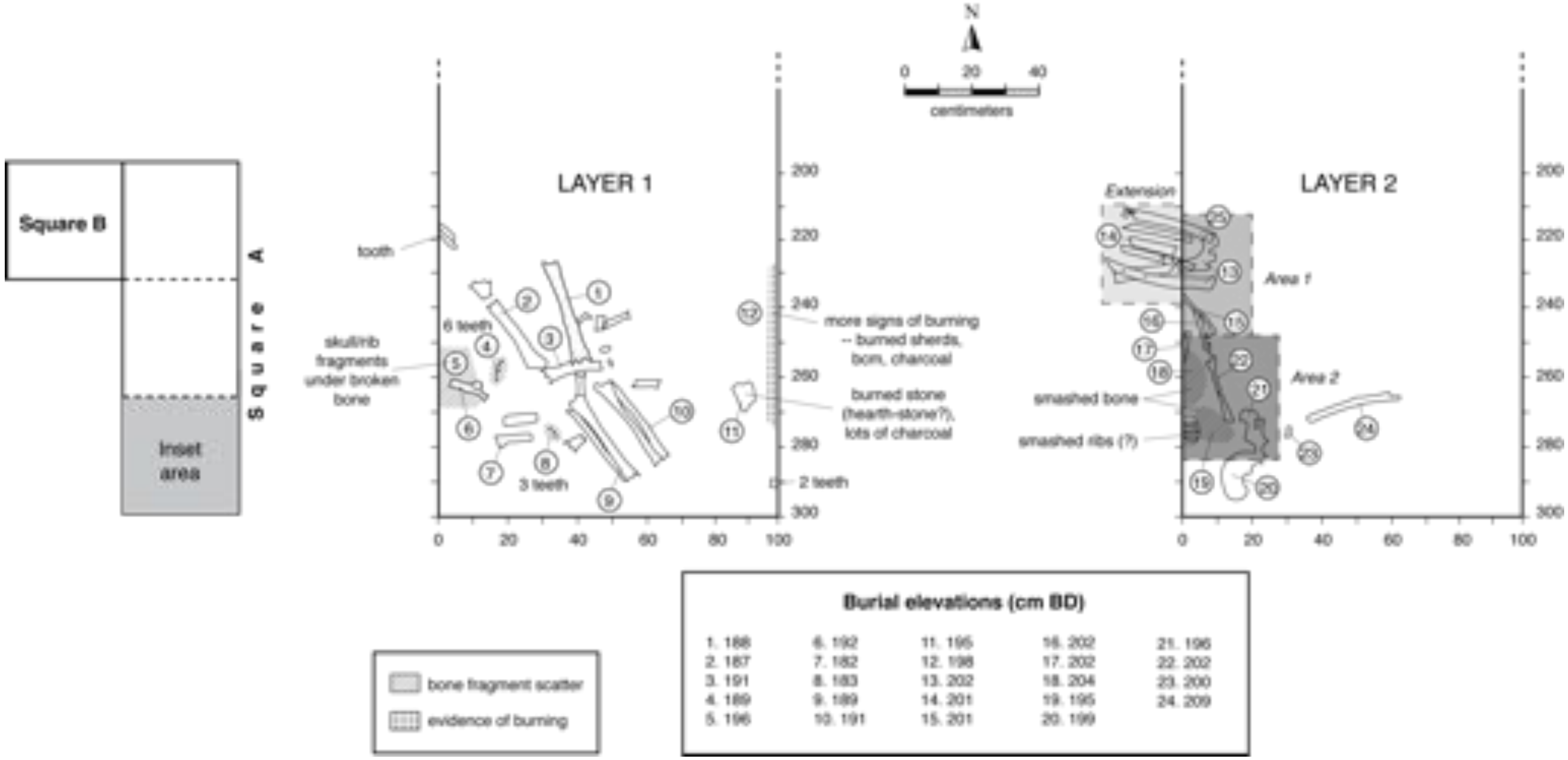

Figure 10.5. Plan view of Hats Kaab burial at southern end of the trench, as uncovered in two superimposed layers, with elevations (drawn by Runggaldier and Brouwer Burg and digitized by M. Brouwer Burg).

collected together with highly fragmentary bone, which I assume corresponds to Bones 5 and 6 on the map. These included fragments of the first and second cervical vertebrae, another unknown cervical vertebrae (perhaps C3?), and two small occipital fragments. The presence of cranial and cervical vertebrae together could indicate a primary burial, though if so, seemingly disturbed.

Table 10.2. List of identified bones in Layer 1, labeled in Figure 10.5.

Number	Element	Side	Area present
1	Femur	Left (?)	Shaft
2	Femur	Right (?)	Shaft
3	Possble radius and /or ulna	Unknown	Unknown
4	Teeth – Very worn	Right (all)	rI^2, rP_1, rP_2, rM_1(?), rM_2, rM_3
5, 6	Cranium, vertebrae, mandible	N/A	Occipital, C1, C2 (and C3?)
7a	Humerus	Right	Proximal half
7b	Humerus	Left	distal third of shaft
8	Teeth	Right (all)	rC^1, rP^1, rP^2
9	Tibia / Fibula	Right	shaft
10	Tibia / Fibula	Left	shaft
Tooth in NW corner	Tooth	right	rI^1
Teeth in SE corner	Teeth	Left and likely left	lI_1 and an upper (left?) premolar
Between Bones 8 and 9	Longbone fragments	unknown	unknown
Slightly east of Bone 1	Radius	left	Proximal end

Other teeth in Layer 1 include Bone 8, which includes an upper right canine and premolars that are all likely from same individual based on consistently mild to moderate attrition. The canine is not modified. Two teeth found in the southeast corner of the excavation include a lower central incisor with moderate wear, and an upper premolar (likely a left) with heavy wear. Based on the differences in attrition, it is possible they belong to two different individuals. Finally, there was a single isolated upper right central incisor with heavy wear found in the northwest corner of the excavation. Thus, there are a minimum of two dentitions within Layer 1—at least one that displays mild-moderate wear (Bone 8 and the lower incisor in the southwest corner), and at least one that displays heavy wear (Bone 4, the upper premolar in the southwest corner, and the upper central incisor in the northwest corner).

Bone 7 consists of two humerus fragments. The piece lying slightly north (7a) is the proximal half of a right shaft, while the other piece (7b) is the distal third of a left shaft. Based on general size and robusticity, these likely belong to the same individual. The clean, straight breaks around midshaft suggest they were broken intentionally and long after death. Other scattered bones in the area were highly fragmented and include fragments of a proximal left radius to the east of Bone 1 and an unlabeled bone found between Bones 8 and 9, which may be fragments of the right leg (tibia or femur). It is not clear whether these scattered bones represent a single individual and whether they belong to either of the dentitions.

Layer 2

Layer 2 appears to comprise a separate and earlier primary burial of a middle adult female lying supine with legs flexed to the left (west) and head pointing to the southeast (**Table 10.3**).

Sex

The generally gracile features of the skull and longbones strongly suggest the individual is female.

Age

An age in the middle adult range (30 – 45) is suggested by heavy attrition on the molars, paired with moderate attrition on the other teeth.

Body position

A skull (Bones 20 and 21) found in the southwest corner of the excavation contained a complete mandible, and a nearly complete dentition that is missing only the mandibular third molars. Fragments of the cranium appear somewhat scattered, though it is likely this occurred following the collapse of the cranium under of the weight of the soil. The cranium is partially reconstructable and shows no evidence of modification. While dental attrition is heavy on the molars, the other teeth display only moderate attrition. This and the lack of antemortem tooth loss suggest an age in the middle adult range (30 – 45 years). The teeth are not modified and show some pathologies, including calculus build-up, several cervical caries, a megacaries that obliterated the upper right second molar crown, and evidence of periodontal disease in the form of alveolar resorption. Also found in association with the skull were fragments of a right scapula, a head of humerus, and a second cervical vertebrae.

Bones 15, 16, and 22 comprise an articulated right arm. Bone 22 is a very fragmentary humerus, which was collected in two parts. The northern fragments are of the distal end, while the southern fragments (closer to the cranium) are of the proximal end. Bone 15 is a right radius with the distal end pointing north and the proximal end pointing towards the humerus. Similarly, Bone 16 is the right ulna, with distal end also pointing north. The smashed bones found next to the arm (including Bone 18) are mostly small fragments of the vertebrae and ribs, while many of the bones found in the western extension were from the hand. The left arm was partially exposed in the west side of the unit. Bone 17 is the distal shaft of the left radius, and its position suggests the left arm was partially flexed and rested on the individual's stomach.

The bones of the leg are tightly clustered, originally suggesting a bone bundle. However, upon closer inspection, it appears the individual's legs were loosely flexed at the hip (~ 80 degrees) and completely flexed at the knees. The tight flexion likely suggests that the body was at least partially wrapped. The paired femurs (Bone 13) lie together with proximal ends pointed east. The right tibia and fibula (Bone 25) lie slightly north of the left leg (Bone 14), and all are oriented with distal ends pointing east.

Other scattered bones were found in the area. Most were highly fragmented and some may belong to the primary burial, though clearly many do not. For instance, near the cranium were four femoral fragments, three of which form the majority of a robust left femur shaft that was placed posterior side up with distal end pointing east. Another small fragment, Bone 24, could not be sided but belongs to a different femur. Additionally, a deciduous left maxillary second molar.

Table 10.3. List of identified bones in Layer 1, labeled in Figure 10.5.

Number	Element	Side	Area present
20, 21	Skull	N/A	Partial cranium, mandible, dentition
18	Ribs and vertebrae	N/A	fragments
22	Humerus	right??	Shaft
15	Radius	Right	Shaft
16	Ulna	Right	Shaft
17	Radius	Left	Distal shaft
25	Tibia/fibula	right	Shafts
14	Tibia/fibula	left	Shafts
24	Femur	Left	Shaft
23	Femur	Unknown	Shaft fragment

Other notable features of the skeletons

Neither cranium showed evidence of porotic hyperostosis or any evidence of trauma.

The "stacked" nature of the primary burials suggests reuse of the area for burial, and thus future expansions of the excavation would almost certainly reveal more burials. The placement of bone fragments within the graves is quite common and has two possible explanations. The first is that the intrusive graves disturbed earlier burials and some of the fragments were unintentionally mixed with the backfill. However, in the case of the larger bones found in close contact with the primary burials (Bones 3, 7, and 24), it is likely their placement is intentional and thus could indicate practices related to ancestor veneration.

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