21 SPATIAL PATTERNING OF SALT PRODUCTION AND WOODEN BUILDINGS EVALUATED BY UNDERWATER EXCAVATIONS AT PAYNES CREEK SALT WORK 74

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Systematic flotation survey identified two rectangular wooden buildings and a post fence buried below the sea floor at Paynes Creek Salt Work, along with briquetage—the clay pots used to evaporate brine over fires to make salt. The site was ideal for investigating the spatial patterning of ancient activities inside and outside the buildings, as well as in the open yard defined by a line of palmetto palm posts. Transects were set out along an interior wall of each building and extending beyond the building at each end. Additional transects were placed perpendicular to the original transects. Techniques developed for excavating underwater are described, including use of submerged and weighted grid frames for excavations, use of long knives for cutting the mangrove peat matrix, use of plastic tapes for measuring depth of excavations in 10 cm levels below the sea floor, and use of a pulley system with Marine Transport Devices to transport excavated material to off-site screening stations. Screened material was sorted, typed, and recorded at the Lagoon Lab in shallow water nearby. Analysis of the artifacts reveals the yard was kept clean, whereas there was abundant evidence of salt production inside and immediately outside the wooden buildings.

Introduction

Historically and prehistorically states often controlled the production and distribution of desired resources. State control of salt production and/or distribution was carried out by control of the resource, the means of production (labor), and/or the means of distribution. In ancient China and during the Roman Empire salt production was, at times, controlled by the state (Adshead 1984; Flad 2011). The dynastic Maya surely had an interest in maintaining a regular supply of this basic biological necessity that was localized along the coast and at one inland salt works (Andrews 1983; Mackinnon and Kepecs 1989; McKillop 1995, 2005a, 2015; Valdez and Mock 1991; Woodfill et al. 2015). The depiction of a "salt person" painted on a Classic period building at Calakmul underscores the urban Maya interest in salt (Carrasco et al. 2009).

The dynastic Maya leaders of the Classic period may have controlled the production and/or distribution of salt by installing state representatives at salt works or by sending work parties to collect salt. In ancient China, a local representative of the state resided near salt works to collect a salt tax (Flad 2011). Archaeological evidence of a state representative overseeing salt production would include an overseer's residence near the salt works, as well as the presence of non-local goods. Sending work parties to collect salt would have been a seasonal endeavor during the non-agricultural

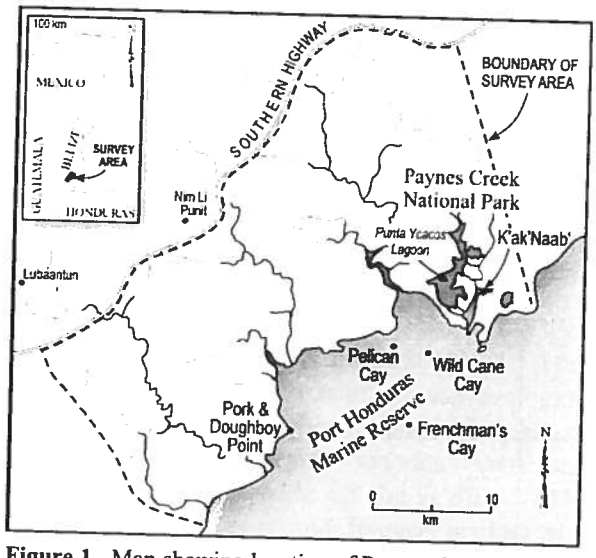

Figure 1. Map showing location of Paynes Creek National Park in southern Belize.

dry season. Alternatively, the inland dynastic leaders may have established alliances with the coastal Maya living near or at the salt works. Evidence would be an absence of an overseer's house, the presence of coastal subsistence goods, continuity in salt production facilities and traditions, and evidence of alliances, such as trade goods. Production may have been carried out by local workers year-round inside buildings to avoid rain.

Excavations of the Paynes Creek Salt Works were carried out to address the context of salt production—household or separate workshop, the extent of production—seasonal or year round, and the identity of the salt

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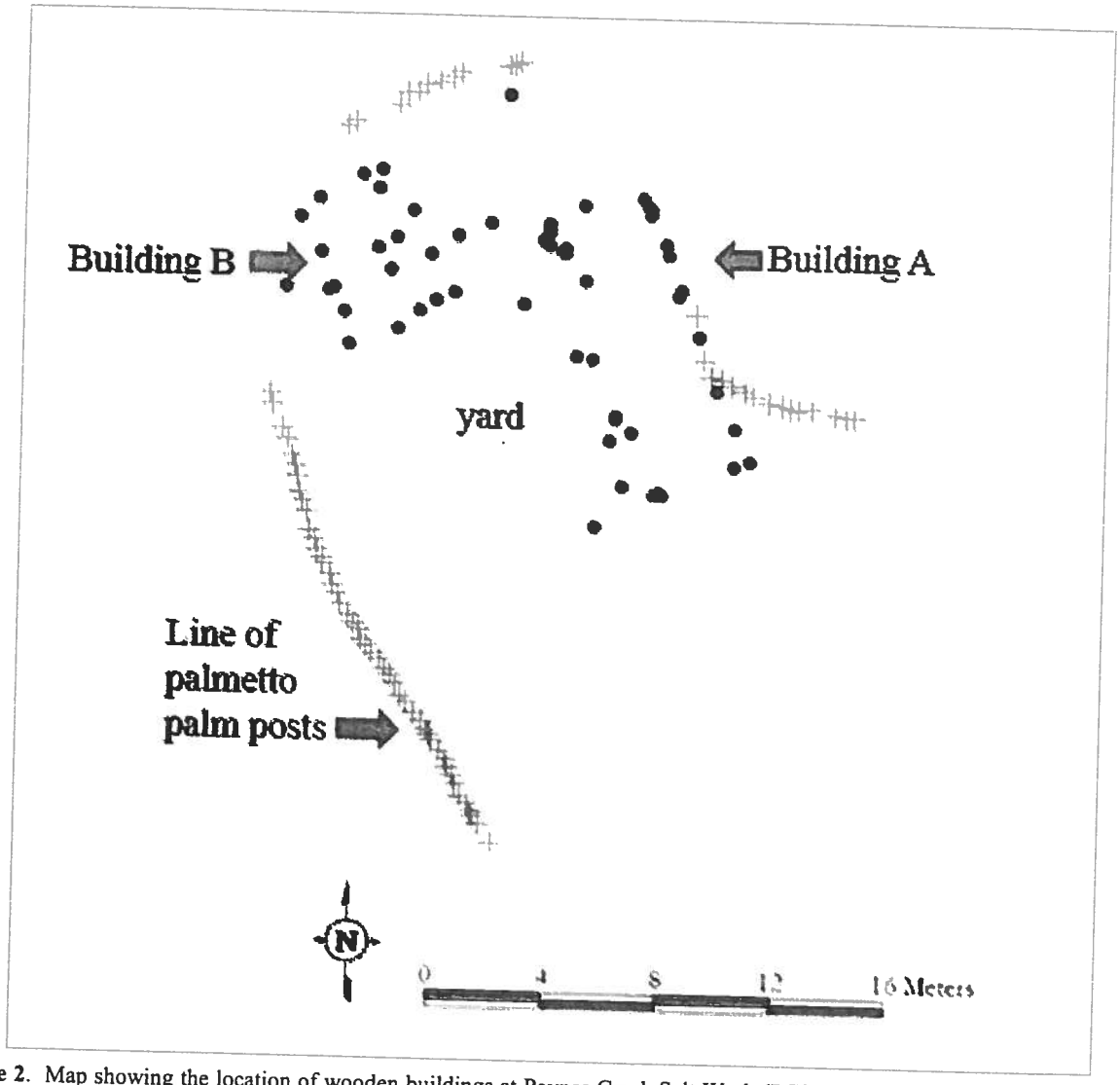

Figure 2. Map showing the location of wooden buildings at Paynes Creek Salt Work (PCSW) 74, with dots (solid wood posts) forming the outlines of structures and x's (palmetto palm posts) forming a line demarcating the boundary of the yard.

workers—either local entrepreneurs or seasonal visitors/families from inland cities. Previous research demonstrated mass-production of salt (from standardization of the salt pots, McKillop 2002) and large-scale production (indicated by the discovery of over 100 salt works). In this paper we discuss the results of excavations at Paynes Creek Salt Work 74, carried out in 2012 and 2013 (Figure 1).

Household or Factory Production

The domestic economy of household production includes activities within and around the domicile itself, as well as activities carried out by householders at other locations, such as farming, fishing, and hunting that are located near resources, some of which are seasonally exploited (see Nietschmann 1973). Salt makers often live in residences near salt works, either in the same community (Reina and Monaghen 1981) or nearby (Flad 2011; Parsons 2011). At the highland Maya community of Sacapulas, Guatemala, the salt makers' residences are located behind the salt work buildings, which were adjacent to the salt spring (Reina and Monaghen 1981). Flad (2011) suggests that the salt workers at Zhongba on the Yellow River in China lived nearby, but not at the salt works. Parsons (2001) notes that salt workers lived in Nexquipayac approximately 2 kilometers from

their salt works. Salt production can be year-round or seasonal. In west Mexico, inland settlers visited the coastal salt works seasonally and set up temporary camps nearby (Williams 1999, 2003).

If the salt workers lived at the Paynes Creek Salt Works, either in separate houses (as at Sacapulas) or in the same building or plaza group, we would expect to find evidence of household activities such as those found in Maya residences at nearby Wild Cane Cay or at Chan in western Belize (see McKillop 2005b; Robin 2012). Material remains of household activities can include middens with plant and animal food remains, burials associated with houses, a variety of pottery vessel forms for household use in storage, cooking, and serving, as well as obsidian, chert, and ground stone tools. We would expect multi-crafting, including remains of salt production and domestic activities.

If evidence of residential activity is lacking, then we expect the salt workers lived farther away—either on the coast at Wild Cane Cay or another nearby coastal settlement (see McKillop 1996a), or inland such as at the likely salt consumer communities of Lubaantun and Nim Li Punit. Workers from the coast or inland communities may have visited the Paynes Creek Salt Works seasonally and set up temporary camps, as reported by Williams (1999, 2003) for west Mexico. Evidence in the archaeological record of coastal or inland settlement would include shared artifact assemblages, motifs, and temper in pottery. Activities at non-residential salt works may have been solely focused on salt production, or may have included related activities, such as cleaning and salting fish.

Excavations at Paynes Creek Salt Work (PCSW) 74

The organization of ancient Maya salt production was investigated through excavations at Paynes Creek Salt Work 74, a site with clearly demarcated wooden buildings and briquetage—the broken salt pots used to evaporate brine over fires (Figure 2). The site was discovered during systematic underwater survey in the western arm of Punta Ycacos Lagoon in 2006. Visible evidence consisted of briquetage and wooden posts protruding from the seafloor. PCSW 74 was located beside several other salt works that

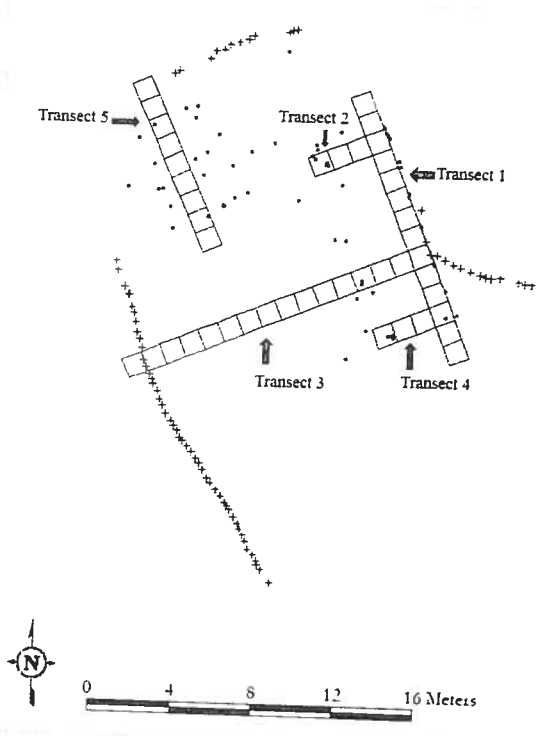

Figure 3. Map showing the location of transect excavations at PCSW 74.

formed a line along a relict shoreline (McKillop 2012; Sills and McKillop 2010). After discovery of Site 74, a team of archaeologists traversed the site in a boustrophedonic pattern, placing pin flags beside wooden posts and selecting artifacts visible on the seafloor. The location of each post and flagged artifact was mapped using a total station, with the data downloaded to a GIS. The outlines of two wooden buildings were well-defined by posts (Figure 2). Briquetage on the seafloor identified salt production was an activity at the site.

Transect excavations in 2012 and 2013 were placed at PCSW 74 to examine the material evidence of salt production and any other activities inside and outside buildings. Excavations focused on the interior and immediate exterior of each building and the yard. The yard was clearly defined as the space between the buildings and a line of palmetto palm posts (*Acoelorraphe wrightii*; Figure 2). The palmetto palm posts defined the boundary of the site as no artifacts are visible on the sea floor on the other side of the palmetto palm posts. One-meter wide transects were placed along an interior wall of each building and

extending two meters beyond in each direction (Figure 3). An additional transect was placed in the yard. Building A has interior dimensions of 10 X 3 m. A 14 m trench, Transect 1, was placed inside the building along the eastern wall. An additional three 1 X 1 m transects (Transects 2, 3, and 4) were placed perpendicular to Transect 1 inside the building along the north and south walls, respectively. A 15 m transect, Transect 3, was placed perpendicular to Transect 1 to extend across the yard and one meter beyond the line of palmetto palm posts. Transect 5 was placed along the west wall of the interior of building B. Transect 5 extended 2 m outside the building to the north and about 1.5 m outside the building on the south.

Each transect was set out using a 25 m plastic tape, with one person sighting along the tape from one end in order to maintain a straight line. Short lengths of 1" PVC pipe (about 30 cm in length) were placed at one m intervals. Before each PVC pipe was sunk into the sea floor, its location was written in black Sharpie along the side on the end to be sunk into the sea floor. The mangrove peat that forms the sea floor preserves the writing. The lines of PVC pipes demarcating transects formed the east wall of Transect 1, the north wall of transects 2, 3, and 4, and the west wall of transect 5. For excavations, a metal or a PVC plastic grid frame, each measuring one meter on the inside dimensions, was placed beside PVC meter markers and weighted with dive weights at opposing corners (Figure 4).

Excavations were carried out in 10 cm levels measured using plastic sewing tapes from the seafloor to a maximum depth of 60 cm. Stainless steel kitchen knives with 18" blades were used to cut the peat, along 6" pointing trowels. The peat was cut into sections and placed in small buckets with holes. When a bucket was full, the contents were dumped into 100 lb flour sacs placed inside small inflatable floats called MTDs (marine transport devices) along with a plastic bag with the provenience written with a black Sharpie (Figure 5). The plastic bag was then rolled up and placed inside another plastic bag. An MTD was tied to a length of PVC pipe beside the excavation unit. When a sack was full of excavated material, the MTD was untied from the PVC pipe and

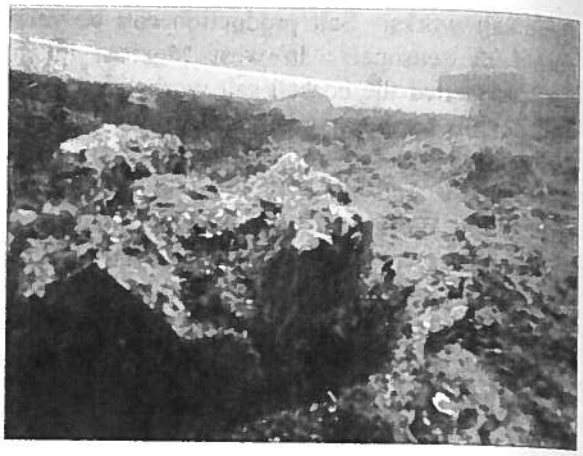

Figure 4. Underwater view inside excavation unit defined by metal grid frame held in place with dive weights. A wooden post protrudes from the sea floor.

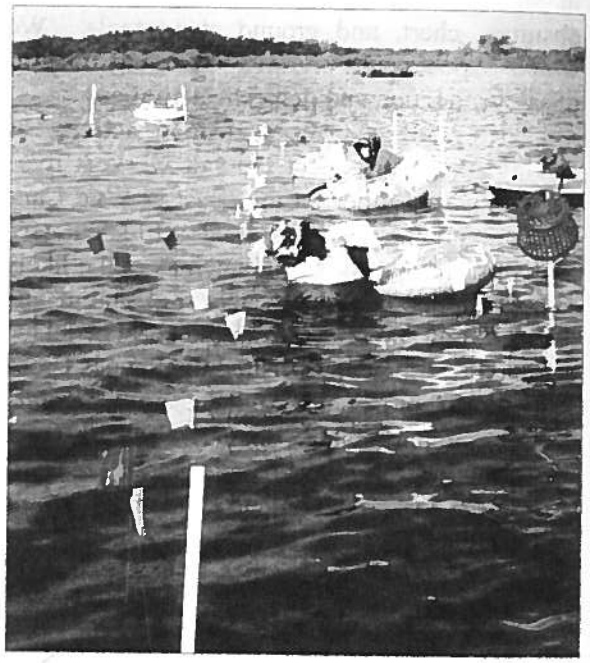

Figure 5. Transect 1 excavations showing Marine Transport Devices (MTDs) to hold sacks of excavated marine sediment.

attached to a line extending from the excavations to an off-site screening area in the water (Figure 6). The MTD line worked like a clothes line, consisting of a long line of rope tied around 4 long PVC pipes to move the MTDs to and from the site. The system allowed water screening off site, without the excavators trampling on the site or dragging heavy sacks of marine sediment across the site. In addition to excavated material, drinking water, sunscreen, snacks, empty sacks, and other supplies were moved to

Figure 6. Off-site screening area at PCSW 74.

excavators. The MTD line was moved as needed to be close to excavations. Excavators floated above the sea floor, either using RFDs (Research Flotation Devices) or floating in the buoyant salt water.

We used "Scuba Notes," plastic waterproof notebooks with attached pencils, to record information on excavations. An underwater camera was used to film underwater and take digital images. A digital camera and digital video camera were used to take photos, with the camera equipment stored in dry bags in the PRS (Portable Research Station), anchored to the sea floor and moved along the transects.

The excavated marine sediment was screened using ¼ "mesh. The marine sediment consisted of firm mangrove peat containing briquetage, other artifacts, and plant remains. Screened material was placed in Ziploc bags. Labels were written using black Sharpie on small Ziploc sandwich bags that were folded and placed inside another sandwich bag to keep the label dry and intact. The labeled bag was placed inside each artifact bag. Flour sacks were used for excavations with abundant material.

Screened material was sorted, identified, and recorded at a Lagoon Lab set up nearby. The Lagoon Lab consisted of two plastic tables with folding metal legs under a tarp or tail-gating tent. For Transect 1 excavations in 2012, the Lagoon Lab was set up at a nearby point of land beside where we anchored the project boat. In 2013, the Lagoon Lab was set up in the shallow water at the Eleanor Betty Site. Bags were ferried from the site and stored in the mangroves. Excavating was faster than screening, even with two screens: Sacks of excavated material were stored on the seafloor inside excavated units and then transported to the lagoon lab for screening in deep water off site. Equipment for the Lagoon Lab transported and stored in waterproof bags included electronic balances for weighing material, cameras, calipers, notebooks, markers, and plastic bags. Screened material was rinsed in sea water and sorted into material classes.

Selected artifacts from the excavations were transported to the field station for 3D imaging using a NextEngine portable 3D scanner. The mangrove peat matrix and sea water that has remarkably preserved the artifacts and wooden architecture made the artifacts friable once removed from their protective environment. Three-dimensional imaging is used to create an additional scientific record of the recovered artifacts so they can be returned to deep-water caches for long-term conservation.

Artifacts from PCSW 74

Most of the excavated material was briquetage from the Punta Ycacos Unslipped type (McKillop 2002). Briquetage was sorted into rims, body sherds, solid clay cylinder vessel supports, bases (for vessel supports), sockets (for the top of vessel supports), amorphous clay lumps (ACLs), and other objects. The ACLs were unrecognizable fragments of sockets, spacers, and bases. Analysis of material from transect one indicates that amorphous clay lumps dominated in all units and depths, both inside and outside the building (Figure 7). Briquetage was common inside the building and immediately outside. Salt evaporation pots include round-sided bowls, jars, and vertical-wall basins of Punta Ycacos Unslipped type. All sherds have characteristic smooth interior and rough exterior. Water jars include Mangrove Unslipped jars with grooved, square lips, as well as Warrie Red jars, including one with an "S" unit-stamp on the vessel shoulder. In contrast, little pottery was recovered from Transect 3 excavations in the yard.

Abundant plant food remains were excavated at the eastern end of Transect 1, both inside and outside the building. Most of the plant food remains were endocarps of two

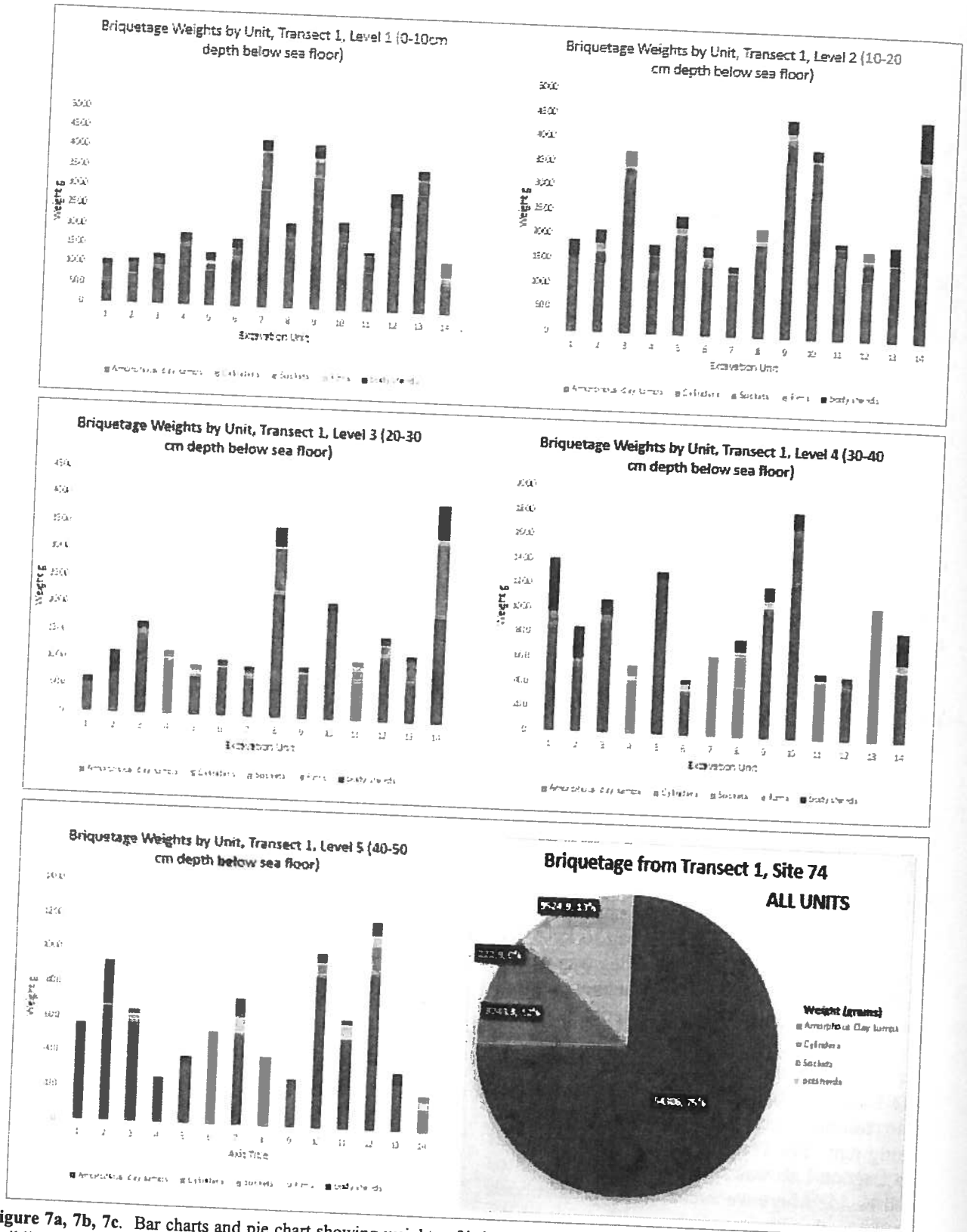

Figure 7a, 7b, 7c. Bar charts and pie chart showing weights of briquetage by unit and depth in Transect Excavation 1 through Building A at Paynes Creek Salt Work 74.

common native palm fruits, cohune (*Attalea cohune* or *Orbignya cohune*) and coyol (*Acrocomia mexicana*). Endocarps from both palm fruits were commonly recovered from the sea floor at most of the underwater sites. The native palms do not grow in salty water, but are common on high, dry ground in southern Belize. They have been recovered from Classic and Postclassic period midden deposits at nearby Wild Cane Cay, as well as other nearby coastal- and island sites, notably Pelican Cay, Frenchman's Cay and Pork and Doughboy Point (McKillop 1994, 1996b). Although smaller than coconuts, the native palm fruits grow in large clusters, so may have been a significant wild food source. As suggested for Wild Cane Cay, these and other tree crops may have provided a significant food source in areas of limited land (McKillop 1994). Other tree crop remains recovered from PCSW 74 include mamey apple (*Mammea americana*) and nance or craboo (*Byrsonima crassifolia*). The trees do not grow in salty water. The palm fruits, nance, and mamey apple may have formed part of meals, collected from trees that grew at the salt works or harvested elsewhere and brought to work. The lack of floor boards for the buildings meant they were constructed directly on dry ground. The sediment matrix of the site consists of mangrove peat which is deposited under conditions of sea-level rise, similar to salt works in the eastern arm of the lagoon (McKillop, Sills, and Harrison 2010).

Paynes Creek Salt Work 74 dates to the Late to Terminal Classic based on type-variety analysis of ceramics and a radiocarbon date on a blade fragment from a wooden canoe paddle (Beta #350510: Cal AD 660 to 730 and Cal AD 740 to 770). The age is corroborated by the presence of Belize Red sherds (locally referred to as Moho Red) in small numbers in the excavations as well as Mangrove Unslipped jar rim sherds that have grooved lips typical of the Terminal Classic. A clay boat model (Punta Ycacos Unslipped type) resembles boat models from PCSW 57 (Orlando's Site), as well as other boat models from Moho Cay and Altun Ha carved from manatee rib bones, and painted and incised depictions of canoes elsewhere (McKillop, Sills, and Cellucci 2014).

Discussion

Transect excavations at PCSW 74 reveal that activities at the site were focused on salt production indicated by the abundance of briquetage, along with water jars used to store brine and salt. Water jars included Mangrove Unslipped and Warrie Red types. Unit-stamping with an "S" decoration on the vessel shoulder on a Warrie Red sherd also supports a Late to Terminal Classic age for the site. The lack of diversity of vessel forms, and lack of spindle whorls and fishing weights typical of Wild Cane Cay or other coastal Maya communities suggests that neither building was used as a residence. Instead, the buildings were used for producing salt by evaporating salty water in pots over fires. Indoor production means salt making could have occurred year round instead of seasonally.

A lack of diversity of pottery shapes and abundance of briquetage also was found from excavations at other Paynes Creek Salt Works, notably Chan b'i, Atz'aam Na (Sills and McKillop 2013), Stingray Lagoon, David Westby, and Orlando's (McKillop 2002). Chemical analyses of marine sediment associated with buildings at Chan b'i suggests a focus on a single activity (Sills, McKillop and Wells 2015). However, any bones from burials or animal bones in midden deposits would not have been preserved in the acidic mangrove peat that preserved the wooden building posts. Excavations at the nearby above sea level earthen mounds at Killer Bee and Witz Naab indicate they were slag heaps from enriching the salt content of brine before the evaporation process, since the matrix is was mostly composed of briquetage and soil (Watson et al. 2013). There was no indication the earthen mounds contained residences for salt workers or for a local representative of an inland city as in ancient China (Flad 2011). Instead, the archaeological evidence from PCSW 74 such as the lack of ceramic diversity, along with local forms of pottery, and evidence of botanicals from nearby woodland areas supports an interpretation that the inland cities formed alliances with the coastal Maya who lived near the salt works. This interpretation contrasts with the idea that an overseer from the state controlled the production and/or distribution of salt in the ancient Maya economy.

Figure 8. Survey at Paynes Creek Salt Work 74, showing large size of pottery sherds.

Conclusions

Excavating underwater has the benefit of wonderful preservation not commonly seen at terrestrial inland sites in the Maya area with the exception of dry caves. Although difficult, underwater excavations at PCSW 74 yielded excellent preservation of wooden posts that demarcate the outlines of wooden buildings, plant food remains, a portion of a wooden canoe paddle blade, and a small ceramic canoe. The lack of trampling by animals or people after the salt work was abandoned and the subsequent sea-level rise, meant that the sherds were large, with many measurable rims and reconstructable vessels (Figure 8; McKillop and Sills 2013).

The methodological techniques that were developed at PCSW 74 will continue to preserve these underwater sites from trampling by excavators. The use of long knives for cutting the mangrove peat matrix insures that artifacts will not be ripped apart. The MTDs allowed the excavators to transport heavy bags of sediment across a site without dragging on the sea floor In addition, water screening excavated material at off-site screening stations shields the site from possible contamination. All of these techniques will guide the PCSW future excavations.

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References

Adshead, S.A.M.
1992 *Salt and Civilization.* St. Martin's Press, New York.

Andrews, Anthony P.
1983 *Maya Salt Production and Trade.* University of Arizona Press, Tucson.

Carrasco, Ramón Vargas, Verónica A. Vázquez López, and Simon Martin
2009 Daily Life of The Ancient Maya Recorded on Murals at Calakmul, Mexico. *Proceedings for the National Academy of Sciences* 106:19245–19249.

Flad, Rowan K.
2011 *Salt Production and Social Hierarchy in Ancient China: An Archaeological Investigation of Specialization in China's Three Gorges.* Cambridge University Press, New York.

Mackinnon, J. Jefferson, and Susan M. Kepecs
1989 Prehispanic Saltmaking in Belize: New Evidence. *American Antiquity* 53:522–533.

McKillop, Heather
1994 Ancient Maya Tree-Cropping: A Viable Subsistence Adaptation for the Island Maya. *Ancient Mesoamerica* 5:129–140.

1995 Underwater Archaeology, Salt Production, and Coastal Maya Trade at Stingray Lagoon, Belize. *Latin American Antiquity* 6:214–228.

1996a Ancient Maya Trading Ports and the Integration of Long-Distance and Regional Economies: Wild Cane Cay in South-Coastal Belize. *Ancient Mesoamerica* 7:49–62. 1996b Prehistoric Maya Use of Native Palms: Archaeobotanical and Ethnobotanical Evidence. In *The Managed Mosaic: Ancient Maya Agriculture and Resource*

Use, edited by Scott L. Fedick, pp. 278–294. University of Utah Press, Salt Lake City.

2002 *Salt: White Gold of the Ancient Maya*. University Press of Florida, Gainesville.

2005a *In Search of Maya Sea Traders*. Texas A & M University Press College Station.

2005b Finds in Belize Document Late Classic Maya Salt Making and Canoe Transport. *Proceedings of the National Academy of Sciences* 102:5630–5634.

2012 Constructing and Using a GIS for Fieldwork: The Underwater Maya Project. *Research Reports in Belizean Archaeology* 9:267–278.

2015 Evaluating Ancient Maya Salt Production and the Domestic Economy: The Paynes Creek Salt Works and Beyond. *Research Reports in Belizean Archaeology* 12:97–106.

McKillop, H., and E. Cory Sills
2013 Sustainable Archaeological Tourism of the Maya Paynes Creek project Using 3D Technology. *Anthropology News May/June: 12–13.*

McKillop, Heather, E. Cory Sills, and Jessica Harrison
2010 A Late Holocene Record of Caribbean Sea-Level Rise: the K'ak' Naab' Underwater Site Sediment Record, Belize. *ACUA Underwater Archaeology Proceedings* 2010:200–207.

McKillop, Heather, Elizabeth C. Sills, and Vincent Cellucci
2014 The Ancient Maya Canoe Paddle and the Canoe from Paynes Creek National Park, Belize. *Research Reports in Belizean Archaeology* 11:297–306.

Nietschmann, Bernard
1973 *Between Land and Water*. Seminar Press, New York.

Parsons, Jeffrey R.
2001 *The Last Saltmakers of Nexquipayac, Mexico: An Archaeological Ethnography*. Anthropological Paper 92, Museum of Anthropology. University of Michigan., Ann Arbor.

Reina, Ruben E., and John Monaghan
1981 The Ways of the Maya: Salt Production in Sacapulas, Guatemala. *Expedition* 23:13–33.

Robin, Cynthia
2012 *Chan: An Ancient Maya Farming Community*. University Press of Florida, Gainesville.

Sills, E. Cory, and Heather McKillop
2010 The Architecture of Salt Production at the John Spang Site, Paynes Creek National Park, Belize. *Research Reports in Belizean Archaeology* 7:253–258.

2013 Underwater Excavations of Classic Period Salt Works, Paynes Creek National Park, Belize. *Research Reports in Belizean Archaeology* 10:281–288.

Sills, E. Cory, Heather McKillop, and E. Christian Wells
2015 Chemical Analysis of Marine Sediment from Chan b'i, Paynes Creek Salt Works, Belize. *Research Reports in Belizean Archaeology* 12:261–270.

Valdez, Jr. Fred, and Shirley Mock
1991 Additional Considerations for Prehispanic Saltmaking in Belize. *Latin American Antiquity* 56:520–525.

Watson, Rachel, Heather McKillop, and E. Cory Sills
2013 Brine Enriching Slag Heaps or Mounded Remains of Salt Makers Homes? Earthen Mounds in the Mangroves at the Paynes Creek Salt Works. *Research Reports in Belizean Archaeology* 10:297–304.

Williams, Eduardo
1999 The Ethnoarchaeology of Salt Production at Lake Cuitzeo, Michoacan, Mexico. *Latin American Antiquity* 10:400–414.

2003 *La Sal de La Tierra*. Zamora, Michoacan: El Colegio de Michoacan.

Woodfill, Brent K.S., Brian Dervin Dillon, Marc Wolf, Carlos Avendaño, and Ronald Canter
2015 Salinas de Los Nueve Cerros, Guatemala: A Major Economic Center in the Southern Maya Lowlands. *Latin American Antiquity 26*:162–179.

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