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Chemical signatures of ancient activities at Chan b'i - A submerged Maya salt works, Belize

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ABSTRACT

Chemical analysis was undertaken at Chan b'i, an Early Classic (300–600 CE) ancient Maya submerged salt works to find activity areas not apparent from artifactual materials recovered from excavations. Chan b'i is one of 105 salt works located underwater in Paynes Creek National Park, Belize where wooden buildings are preserved due to mangrove peat matrix. The acidic peat (pH 6) preserved wood and other botanical remains, but is not conducive to the preservation of bone. Consequently, the artifactual record may be biased against the preservation of animal food remains and human burials, which are typically found at Maya settlements. In this study, we use inductively coupled plasma-mass spectroscopy (ICP-MS) to evaluate if there is evidence of other activities in addition to the salt production. The present study extends soil chemistry research to underwater archaeological sites. The results of chemical patterns indicate activity locations inside and outside of wooden architecture not shown by the artifactual remains.

1. Introduction

Chemical analysis of soil using inductively coupled plasma-mass spectroscopy (ICP-MS) can detect spatial variation in the concentrations of elements that allow the identification of activity areas at archaeological sites (Wells and Terry, 2007). This technique seemed ideally suited to identify if salt production was the only activity undertaken at the ancient Maya Paynes Creek Salt Works (Fig. 1) or if there were additional activities, including use as residences. Since the salt works were submerged by sea-level rise after they were abandoned (McKillop et al., 2010a, 2010b), the sites are underwater, making this a case study for the use of soil chemistry for inundated terrestrial sites (Sills et al., 2015). The Paynes Creek Salt Works were a Classic period (300–900 CE) industry for salt production carried out inside wooden buildings and then transported by canoe to inland Maya cities (McKillop, 1995, 2002, 2005a, 2007, 2009; McKillop et al., 2014; Robinson and McKillop, 2013, 2014; Sills and McKillop, 2010, 2013; Watson et al., 2013). The acidic sediment matrix of the submerged sites provided an excellent matrix for preservation of wooden buildings, but not for animal bone, shell, or human burials typically recovered from ancient Maya residences. Were bone and shell once part of the archaeological record at the Paynes Creek Salt Works, but decayed in the acidic sediment?

In this study, we used ICP-MS to find out whether additional activities occurred at the salt making sites that were not preserved in the artifactual record. Previous research (McKillop, 2005a, 2007, 2009; Sills and McKillop, 2010, 2013) indicates Maya workers came to the salt works from their homes that were located elsewhere. This interpretation is based on the abundance of briquetage found at the Paynes Creek Salt Works and the lack of domestic household goods such as fishing weights, spindle whorls, fish and animal bones, and limited amounts of obsidian and chert. The lack of domestic remains could be due to an issue with a lack of preservation. Chemical analysis of local sediments can help clarify our understanding of workshop production for the Classic Maya salt works.

In this study, we carried out chemical analyses of marine sediment from the Early Classic Chan b'i site (300–600 CE) to evaluate if there is evidence of residential settlement and/or indications of activities at the site in addition to salt production. Chan b'i has wooden posts demarcating the outlines of wooden buildings. Excavations revealed large quantities of briquetage—pottery used to evaporate brine over fires to make salt, indicating the site was used for salt production (Sills and McKillop, 2013). The lack of domestic household goods such as fishing weights, spindle whorls, fish and other animal bones, human burials, and limited amounts of obsidian and chert—all commonly found at Maya settlements—supported the interpretation that the workers lived elsewhere. Chemical analyses reported here indicate other activities were carried out at the site, in addition to salt production. The study expands use of chemical signatures as indicators of ancient activities to underwater sites. In addition, the findings of multi-crafting at

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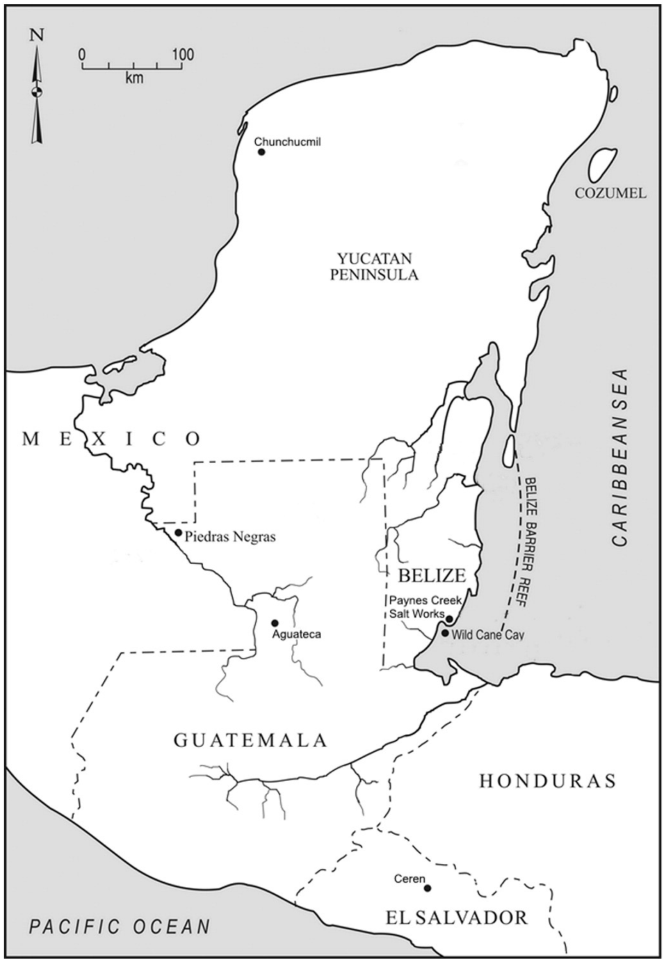

Fig. 1. Location map of southern Belize showing Paynes Creek National Park. Map from McKillop, 2006:30 modified by C Sills.

Chan b'i suggest that soil chemistry is a useful technique to identify "multi-crafting" (Hirth, 2009) in ancient workshops in the Maya area and beyond.

Chemical analysis of terrestrial soils in the Maya area has been successful in identifying activities not evident in the artifactual material. At the Maya sites of Aguateca (Guatemala) and Cerén (El Salvador), high values of phosphorus were interpreted as areas for food preparation, disposal, and consumption (Parnell et al., 2002; Terry et al., 2004). High values of phosphorus obtained from plaster floors in buildings from Chunchucmil, Mexico indicate that debris was swept to the corners and edges of buildings (Hutson and Terry, 2006). High values of phosphorus from the main plaza at El Coyote, Honduras (Wells, 2004) and from plaster surfaces at Actuncan, Belize (LeCount et al., 2016) were interpreted as areas for the preparation and consumption of food and beverages. Increased values of phosphorus coupled with zinc concentrations are interpreted as activities associated with marketplaces (Coronel et al., 2015). Heavy metals including copper, iron, mercury, manganese, lead, and zinc were associated with pigment production activities at Cerén (Parnell et al., 2002), painted urban houses at Piedras Negras, Guatemala (Wells et al., 2000), and midden deposits from craft production at El Coyote (Wells, 2004). These diverse applications of archaeological soil chemistry demonstrate the wide applicability of this method to different soil forming factors in contrasting geological environments throughout southern Mesoamerica.

Beyond the Maya area, soil chemistry has been used to detect evidence of human settlement through high concentrations of phosphates from the deposition of organic waste (Lippi, 1988). Organic refuse deposits show higher phosphate values than areas where these activities do not occur (Middleton and Price, 1996; Terry et al., 2004). Chemical analysis can also indicate activity areas not seen on the surface, such as refuse from meals, ash from fires, and human waste (Fulton et al., 2013; Holliday and Gartner 2007; Hutson and Terry, 2006; Lippi, 1988; Middleton and Price, 1996; Middleton, 2004; Terry et al., 2000, 2004; Wells and Moreno Cortés, 2010). Chemical analyses of soil sampled in a modern Maya market where vendors sold food and crafts resulted in high concentrations of phosphorus and zinc in the soil (Dahlin et al., 2007).

Ancient Mesoamericans frequently kept the floors of their homes and workshops clean by sweeping or removing debris to disposal areas. Archaeological sites that experienced rapid abandonment, such as at Aguateca and Cerén, are the exception (Aoyama, 2007; Emery and Aoyama, 2007; Inomata, 2001; Parnell et al., 2002; Sheets, 2002). Defining activity areas that were kept clean can be difficult due to the low amounts of artifacts. However, earthen or plastered floors inside of buildings can hold chemical signatures over long periods of time allowing chemical analysis to aid with interpretation of activity areas (Wells, 2010).

1.1. Salt production activities

Salt commonly is made from salty water using two methods: solar evaporation and by heating in pots over fires, the latter producing briquetage. Solar evaporation uses warm air and the sun to evaporate water in shallow holding pans until only salt remains. This type of production was common on the north coast of the Yucatan in ancient and modern times (Andrews, 1983; Andrews and Mock, 2002). The Paynes Creek salt makers evaporated brine by heating it in pots over fires to make salt. This method dominated salt production for the ancient Maya in southern Belize (MacKinnon and Kepecs, 1989; McKillop, 1995, 2002) and at inland locations such as the modern day salt works of Sacapulas, Guatemala (Reina and Monaghan, 1981). Both methods are documented in Mesoamerica, for modern and historic salt production as well as in the archaeological record, exhibiting variability regarding site layout and composition (Andrews, 1983; Dillon et al., 1998; McKillop, 2002; Nance, 1992; Parsons, 2001; Reina and Monaghan, 1981; Williams, 1999, 2004; Woodfill et al., 2015).

Ethnographic and archaeological analogs are used to elucidate the structure of activity areas at the Paynes Creek Salt Works. In order to enrich the salt content of brine, salty water was leached through salt-saturated soil, which is documented ethnographically at Sacapulas (Andrews, 1983; Reina and Monaghan, 1981), Costa Chica, Mexico (Good, 1995), and at Nexquipayac, Mexico (Parsons, 2001). The salty soil is placed into a filtering apparatus where water is repeatedly poured over the soil. The brine percolates through the soil to collect in a container below. Woven mats, sand, and grasses are variously used to filter the salty water without the soil. The salt-enriched brine is then evaporated in pots over fires. The leached soil is removed and placed into heaps, forming mounds (Andrews, 1983; Good, 1995; MacKinnon and Kepecs, 1989; McKillop, 2002; Williams, 1999, 2004).

At modern day salt works, brine, wood fuel, storage jars, and tables and chairs are stored in salt production buildings near the source of salt water or soil away from the residential sector of the community (Parsons, 2001; Reina and Monaghan, 1981; Williams, 1999, 2004). The Paynes Creek Salt Works have been interpreted as similar to the modern ethnographic examples (McKillop, 1995, 2002, 2005a, 2007; Sills and McKillop, 2010, 2013). The Paynes Creek salt workers produced salt inside wooden buildings but did not reside in the salt making structures. Instead, they traveled to the salt works for production.

However, the archaeological record from the Paynes Creek Salt Works, including Chan b'i, may be biased against the preservation of remains from meals and other indicators of additional activities taking place at the salt works. Additional activities as seen at the modern salt works could be discovered through chemical testing not readily apparent from the excavated artifacts. According to Parsons (2001), the salt makers of Nexquipayac have locations to leach the soil, dispose of the leached soil, store brine, as well as processing facilities including