

22 ONE HUNDRED SALT WORKS! THE INFRASTRUCTURE OF THE ANCIENT MAYA SALT INDUSTRY

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Three models of the organization of the ancient Maya salt industry are evaluated with respect to salt production on the coast of Belize, including the "household production model," the "tribute model," and the "alliance model." Although the inland Maya at large urban cities clearly needed salt, did the salt come from salt works on the coast of Belize or was salt imported from the north coast of the Yucatan? The discussion is framed around the Paynes Creek salt works, where there is substantial evidence for infrastructure related to the production, storage, and distribution of salt. The Paynes Creek salt works have wooden structures used for indoor production of salt by boiling brine in pots over fires, and likely other wooden structures used to concentrate the salinity of the brine before boiling. The Paynes Creek salt works are described, including GIS analyses of the distribution of wooden posts at 100 underwater sites.

Introduction

During the height of the Late Classic Maya civilization (A.D. 600-900) there was a massive salt industry along the coast of Belize supplying inland cities, where salt was scarce. The workshops are marked by briquetage - broken pots and vessel supports from boiling brine over fires to produce salt. Preservation of wood in a peat bog below the sea floor in Paynes Creek National Park in southern Belize underscores the industrial scale of production and distribution, with wooden buildings and other equipment, as well as a full-sized canoe paddle (McKillop 2005a, 2006a, 2007a, b, 2008). Does the briquetage reported from other coastal Maya sites also represent industrial production, or was it household production or a cottage industry?

Was it only in southern Belize that a salt industry developed to supply inland areas where salt was scarce? In this paper, I examine the infrastructure of the Paynes Creek salt industry and its implications for understanding the ancient salt industry elsewhere along the coast of Belize.

A well-developed infrastructure was critical for a salt industry along the coast of

Belize to supply any significant portion of this bulk resource to meet the inland communities salt needs. In any industry, there is an infrastructure related to the production, storage, and distribution of the product, with the extent of the infrastructure related to the scale of production and the nature of the product. Household production, even a cottage industry, is carried out using existing facilities within the household. By way of contrast, industrial production, especially of a bulk resource such as salt, requires additional infrastructure to facilitate production, storage, and distribution. If salt from the coast of Belize supplied any significant portion of inland Maya salt needs, the infrastructure of coastal salt production must have been on an industrial scale. The unusual preservation of wood at the Paynes Creek salt works indicates there was more to salt making than the briquetage found at many coastal sites elsewhere. What insights do the Paynes Creek wooden structures provide on the infrastructure of the ancient Maya salt industry?

Wooden Structures and Industrial Equipment

Lacking direct evidence of wooden architecture from antiquity before the Paynes Creek finds, Maya archaeologists find analogies with the pole and thatch buildings of modern and historic Maya communities (Wauchope 1938; Ochoa-Winemiller 2004). Are there continuities from the Late Classic to modern times, despite significant changes in Maya culture? Are there architectural forms or details not represented in Maya buildings of the modern or historic past?

A study of modern Maya architectures and salt making provides analogy for interpreting the Paynes Creek wooden structures and for understanding the infrastructure of ancient Maya salt production. Various lines of evidence indicate perishable structures of pole and thatches were common in ancient times in the Maya area (Lohse and Valdez 2004). At Tikal, where stone temples, palaces, and elite residences dominate the ancient city, Haviland (1985) reminds us that wooden buildings were common, which were likely kitchens, storage buildings, houses, and workshops.

The mounded remains of ancient Maya buildings constructed of pole and thatch are common throughout the Maya area. Stone foundations or post molds provide limited information on wooden structures (McKillop 2006b). Pole and thatch buildings constructed on the ground surface have left no visible traces in the modern landscape (Somers and McKillop 2005). Some Late Classic Maya pots with painted scenes of court life of the dynastic Maya show architectural details framing the scenes, but they are limited to elite architecture. Excavation of ancient Maya buildings at Ceren revealed adobe walls with remains of wooden posts (Sheets 2002).

Modern ethnoarchaeological studies indicate that brine boiling was often combined with techniques for concentrating the brine prior to boiling (Williams 2003). Concentrating the salinity of brine had the obvious advantage of reducing the amount of wood fuel for the boiling process. Although brine from underground salt deposits in China were boiled without further concentration of the salinity, (Li and Falkenhausen 2006), brine from inland springs or from the sea was normally further concentrated in salinity before boiling. Solar evaporation in pans and leaching of salt-saturated soil are two common methods worldwide, including the Maya area. At the inland salt springs at Sacapulas, Guatemala, brine was poured through salt-saturated soil in wooden containers elevated over other containers to increase the salinity (Reina and Monaghan 1981). Old canoes were used in some areas, but on the west coast of Mexico Williams (2003) reports elevated wooden platforms with wooden funnels to capture the processed brine, which was then evaporated in salt pans with clay sides. Lines of posts demarcate the edges of salt pans at the large salt works on the north coast of the Yucatan (see Andrews 1983: Fig. 2.3).

The Paynes Creek Saltworks

Three underwater salt works and one other salt work in the adjacent mangroves were discovered and excavated in 1991 and 1994 in a large salt water lagoon system, Punta Ycacos Lagoon, in Paynes Creek National Park, on the coast of southern Belize (McKillop 1995, 2002). The presence of briquetage at the sites clinched their identification as salt works, using ethnographic analogy of modern and historic salt production (Reina and Monaghan 1981). That salt production took place is thus without question. The challenge now consists in evaluating the relative importance to the inland Maya, during the

Late Classic period, of salt produced on the coasts of Belize and Yucatan. I examined the organization of salt production to see whether salt was produced in bulk for trade or merely as part of household activities for home or local use. As will be seen below, the former alternative is highly likely. But even mass production at just four sites would hardly begin to satisfy the biological requirements of salt for the inland Maya. I therefore initiated a comprehensive survey aiming to investigate the scale of salt production in southern Belize, and to see whether additional salt works existed that might have helped meet the inland demand for salt during the Late Classic period.

A five-day survey in 2003 revealed eight new salt works, indicating that further survey was warranted. Thirty-three underwater sites were discovered in a 2004 pilot study, making a total of 45 salt works. Continued survey during 2005 to 2007 revealed additional salt works sites totaling 100. The number and density of salt works indicate that salt production was far more extensive than evident from the previous research (McKillop 2005a, 2005b, 2006a, 2007a, 2007b, 2008; Sills 2007; Somers 2007). Moreover, remains of wooden structures discovered in the course of the later surveys indicated that the infrastructure of coastal Maya salt production and distribution was far more sophisticated than originally imagined.

The Architecture of the Salt Industry

Lines of wooden posts were unexpectedly discovered during 2004 survey (McKillop 2005a). The posts were preserved in pristine condition, albeit waterlogged, due to their location in a peat bog below the sea floor. The peat is mangrove peat resulting from detritus trapped in red mangrove (*Rhizophora mangle*) roots. Mangroves grow taller to keep pace with the ongoing rise in sea levels

(McKillop 2002). Late Classic sites in Punta Ycacos Lagoon and the adjacent Port Honduras coastal region have been extensively inundated; radiocarbon dating indicates a sea level rise of at least one meter, and likely more, since the end of the Classic period (McKillop 2002).

The wooden posts were decayed and discolored black where they protruded above the peat into the silt that formed a loose film on the sea floor. One post at Site 15 was excavated in order to determine if it was a natural tree root or a post; it turned out to be a straight post with a sharpened base. Thereafter the underwater survey refocused on the search for the architecture defined by these posts. Three field seasons of survey and mapping have resulted in the discovery of 100 salt works. So far, we have identified wooden architecture at 72 of the sites. Wooden structures have been mapped at 46 sites, including some sites with more than one structure.

Patterns may be discerned in the distribution of sites and in the distribution of wooden posts within sites. Site boundaries were estimated by the spatial extent of artifacts on the seafloor, as well as the spatial extent of visible wooden posts. The distance between sites varied, but generally was marked by an absence of surface artifacts and wooden posts. Mangroves have obscured the spatial extent of some sites visible on the sea floor, such as Site 16, which abuts and clearly extends under mangroves. Part of Site 72 is hidden under a mangrove peat hummock, exposed above the water at extremely low tides (see Sills 2007). However, most of the sites are clearly demarcated and where mangroves have obscured parts of sites - either at the boundaries or within a site - it is usually evident (see Somers 2007). Excavations will further clarify exact boundaries. Furthermore, since we map and collect data at the level of the individual post and

artifact, we can vary the scale of analysis. For example, we can examine the distribution of all posts, to look at the entire salt industry in the lagoon system.

Rectangular structures are evident in the distribution of wooden posts at some of the salt works, notably sites 74, 75, and 77 (Figure 1). Some sites have more than one rectangular structure, either abutting each other or located nearby, for example sites 74 and 77 respectively. The distribution of posts shows interior walls for some buildings, such as at Site 75. The structures vary in size.

Were modern patterns of wooden architecture replicated in the past, or were there ancient building types not represented by modern correlates? To investigate this, wooden post dimensions were divided into size brackets in order to discover patterns. Based on the diameter of the posts, we could discern a pattern of larger, load-bearing posts at the corners of structures with smaller posts in between, as shown in the Site 75 structure (Figure 2; McKillop 2007b, 2008); this parallels the construction principles of modern Maya houses (Wauchope 1938).

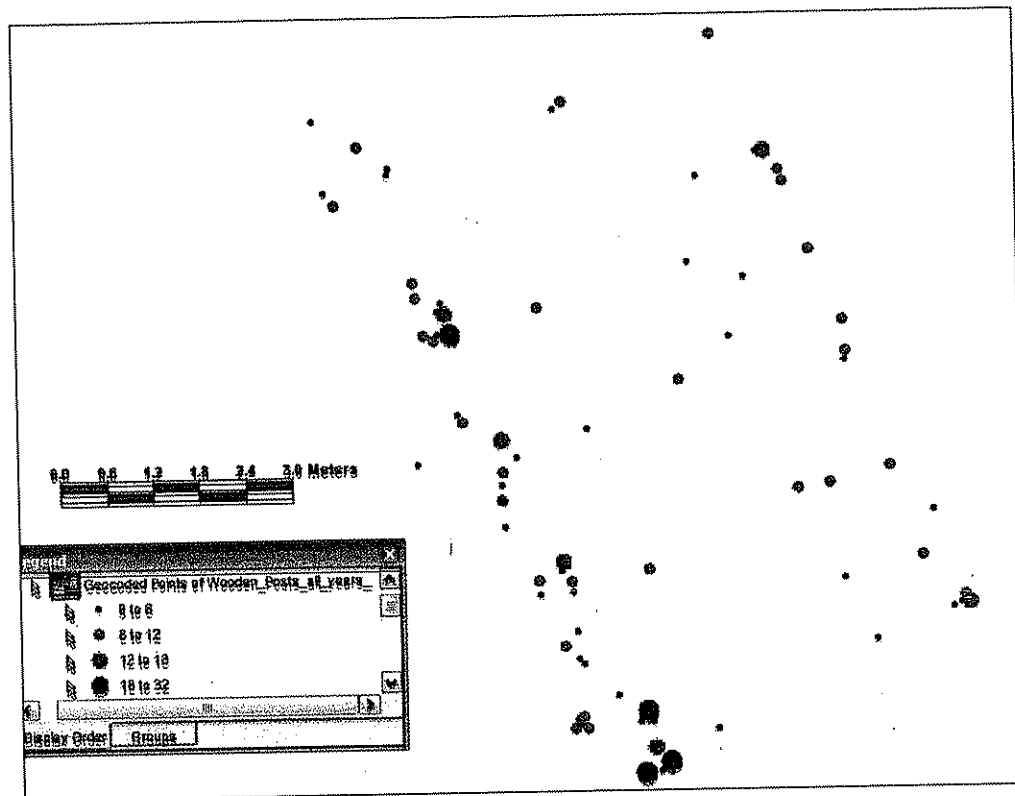


Figure 1. Posts at Site 75 divided by class intervals according to diameter show load bearing posts (12-18cm) at corners, similar to modern Maya houses in Wauchope's (1938) study.

Many sites also have linear arrangements of posts made from palmetto palm (*Acoelorrhaphe wrightii*). Some of the lines of posts are up to 10 m away from the wooden architecture. In other instances, the lines of palmetto-palm posts abut the solid wooden posts. The site of Chac Sak Ha Nal

has a line of palmetto-palm posts forming a "U" shape around a structure formed by wooden posts. This "U"-shaped pattern is replicated at other sites. There are few artifacts inside these palmetto-palm post "walls." We do not yet know whether such lines of palmetto-palm posts were land-

retaining walls or household/workshop boundary fences. Another possibility is that some of them formed saltpans.

An earthen mound at the Killer Bee salt works in Paynes Creek National Park is interpreted as a slag heap remaining after brine had been leached through salt-saturated soil (McKillop 2002: 49, Fig. 2.25). At the other Late Classic-period salt works in the same area, any similar heaps would have been submerged below the sea (McKillop 2002: 49). Presumably there are remnants of such salinity enhancing devices, including saltpans and/or wooden containers for saturating brine at the Paynes Creek salt works and elsewhere along the coast of Belize where briquetage has been reported (McKillop 2002).

Ancient and Modern Maya Site Planning

The Paynes Creek settlement pattern departs from the well-known plaza groups that are characteristic of Maya architectural site planning. From stone temples and palaces arranged to form open plazas at the center of cities, to the mounded remains of more modest domestic architecture, the plaza grouping is known as the building block of ancient Maya site planning. However, the Paynes Creek wooden structures are arranged in linear patterns, with individual structures aligned in a NW to SE direction and not evidently arranged to form plaza groups. The buildings may have been aligned along a former shoreline, which will be determined by the use of bathymetry. Clearly, if the Paynes Creek wooden buildings were not aligned in plaza groups, we need to look for other settlement patterns at other ancient sites as well.

Although now under water, the sites are located on firm mangrove sediment that we assume was dry land at the time when the salt works were in operation. Loose silt covers the mangrove peat, creating an initial appearance of a uniform sea floor. The silt

masks the undulations of the surface of the mangrove peat below. In some non-site areas, the depth from the water surface to the top of the mangrove peat is quite deep, suggesting areas where there was salt water near the salt works that were located on land. Nearby salt water would have been necessary both for salt production and for transporting the salt and the salt workers.

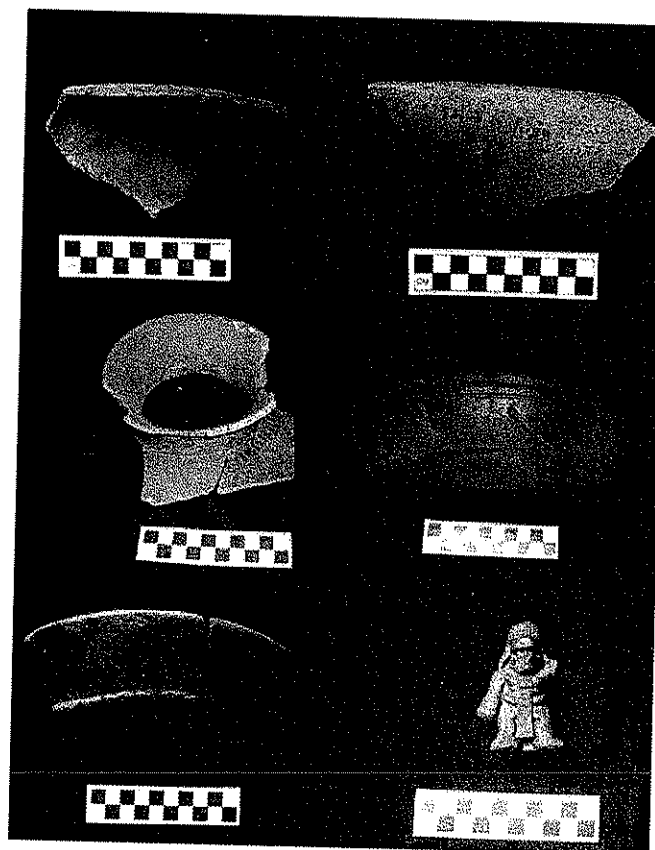


Figure 2. Ceramic fragments of Salt Production vessels.

Infrastructure of Paynes Creek Salt Industry

At Paynes Creek, salt was produced in rectangular wooden buildings, where brine was boiled in pots over fires to produce loose salt or salt cakes, leaving behind the broken bowls jars, cylindrical clay vessel supports, and water jars. Several activities took place at the salt works: Salt boiling vessels were made using local clays and quartzite sand temper that was

commonly available. Brine was boiled to produce salt. Salt production took place inside wooden structures, providing protection from rain, which is common even during the dry season. Mapping individual pottery sherds at the *K'ak' Naab'* salt works indicated waste was moved outdoors, presumably to keep the workshop clean of debris (McKillop 2007a). Buildings also were used to store equipment and supplies, such as firewood and water jars for storing brine and salt pots for boiling, as at Sacapulas. Some structures were likely warehouses where salt was stored before it was transported elsewhere. A full-size wooden canoe paddle found at the *K'ak' Naab'* salt works provides evidence for water transport (McKillop 2005a, 2007b). Some of the salt works hosted periodic salt rituals, as evidenced by pottery ocarinas and serving vessels (McKillop 2002). They were not locally produced, in contrast to the salt boiling vessels.

Infrastructure of the Ancient Salt Industry along the Coast of Belize

If we take the Paynes Creek salt industry and extend the model to other places on the coast of Belize where salt production has been reported, Belize may have been a major supplier of salt for the inland Maya during the height of the Late Classic civilization. Missing at the other Belize salt works are the wooden structures, including buildings for salt production as well as saltpans, brine concentration apparatuses, and docks. Without this infrastructure, the industry has the tendency to be regarded as a form of salt making, which was part of the household production, and marginal to the political economy of the Late Classic Maya. Moreover, there are no reports of mass-production of salt from studies of standardization of the briquetage for other sites on the coast.

The widespread occurrence of briquetage along the coast of Belize demonstrates that salt production involving brine boiling was a viable technique (Andrews and Mock 2002; Braud 1996; Graham 1994; MacKinnon and Kepecs 1989; McKillop 1995, 2002, 2007a, 2007b, 2008; Sills 2007; Somers 2007). That most salt works with briquetage date to the Late Classic indicates the salt works expanded or arose in response to the increased demand for salt to meet basic dietary requirements of the larger population at inland cities (McKillop 2002, 2005a). Salt works are documented in coastal lagoons at Placencia (MacKinnon and Kepecs 1989), at Watson's Island and elsewhere at Colson Point in central Belize (Graham 1994), at Northern River, Lagoon Midwinter's and Salt Creek Lagoon north of Belize City (Andrews and Mock 2002), on Ambergris Cay (Graham and Pendergast 1989), and at Moho Cay (McKillop 2004).

The Paynes Creek salt works differ from other briquetage-yielding sites along the coast of Belize. The other sites are described as settlements where salt production was one of many activities, perhaps carried out as a cottage industry. After the abandonment of the Paynes Creek salt works, salt was then locally produced as part of the household economy during the Postclassic at the trading port of Wild Cane Cay and at nearby Frenchman's Cay (McKillop 2002:112). Comparison of the two kinds of sites shows variation in the organization of production. The Late Classic Paynes Creek salt works are clearly an industry, whereas elsewhere production was for household needs, as at Wild Cane Cay and Frenchman's Cay in the Postclassic; even if the household-produced salt was traded elsewhere, that trade was organized at the household level.

Brine boiling styles differed along the coast of Belize, as indicated by the

existence of at least two types of briquetage. The use of open bowls, jars with restricted orifice, or straight-walled basins supported by solid clay cylinders, together with sockets, spacers and bases, is common to southern Belize, including Paynes Creek and Placencia. The rims of the vessels are thick (as are the necks of jars) for holding or carrying, but the vessel bodies are thin, suitable for conducting heat. Further north, along the Belize coast, solid clay cylinders have been reported from Moho Cay and from coastal lagoons to the north, but not from Colson Point or Ambergris Cay. Solid clay cylinders are common at Moho Cay, including one from a burial (McKillop 2002: Fig. 3.52). From Colson Point to Northern River Lagoon, including Ambergris Cay, the containers reported are thin-walled open platters and designated as Coconut Walk Unslipped.

Salt and the Political-Economy of the Late Classic Maya

There was a strong inland demand for salt from the coast to meet the basic daily biological needs of the inhabitants of the urban areas. There are several models that could explain how they were supplied with salt. In the "*household production model*," coastal salt production was limited to household or cottage industry, with limited distribution, underscoring the need for long-distance import from the northern Yucatan salt flats (Andrews 1983), or implying that inland salt sources were adequate (eg. Dillon 1977). A second model, the "*tribute model*," parallels the Aztec or Inca strategy of using military force or imposing on local rulers to incorporate the coastal Maya salt works into a regional state and then exact tribute. In a third model, the "*alliance model*," the inland dynastic Maya may have created trading and other alliances, sanctified by rituals and

feasts, in order to maintain a regular supply by trade in salt.

The Paynes Creek salt works were not part of the "*household production model*," since they appear not to have been directly associated with residences or communities, and because the scale of production exceeded household demand. The salt workers presumably lived year-round at the contemporary coastal settlements nearby. There is no evidence of the "*tribute model*" at the Paynes Creek salt works. They were not part of the royal court workshops supplying goods for the dynastic Maya, because of the considerable distance. There is no evidence of dynastic Maya direct control of production (like the Inca used with Inca style warehouses throughout their empire, for example). The "*alliance model*" best fits the Paynes Creek salt works, with independent, local producers engaged in a negotiated trade relationship with the inland dynastic Maya. Because of the distance and the special skills needed for salt production and canoe navigation, the dynastic Maya at their inland urban centers may have found it more cost effective to negotiate trade and perhaps marriage alliances with the coastal salt producers than to manage the production and distribution of salt directly. Moreover, the Late Classic Maya polities of southern Belize, closest to the salt works, were decentralized, putting the coastal Maya in an advantageous position both economically and politically.

But why would the coastal elite have wanted to satisfy the inland salt demand by establishing trade alliances with the dynastic leaders of the inland cities? The main trading port of Wild Cane Cay was located some seven kilometers from the Paynes Creek salt works, at the mouth of the Deep River and the northern end of the relatively sheltered waters of Port Honduras (McKillop 1996, 2005c). This location was at the nexus of the riverine and coastal

trading routes. In the "alliance model," as part of the political hierarchy of feasting, the coastal Maya, perhaps centered at the trading port of Wild Cane Cay, were incorporated into the ritual ideology and political structure of the Maya dynasties that drove their understanding of the Maya world, the gods, and people's place in the world. The coastal Maya received goods such as ocarinas, serving vessels, and other trade pottery that were markers of status. The stylistic similarities between Paynes Creek ceramics, especially figurine whistles and "unit-stamped" pottery, tie the coast to inland cities in southern Belize and adjacent Guatemala, as far as Seibal, Altar de Sacrificios, and the Petexbatun region (McKillop 2002), further supporting the "alliance model." Without preserved wood demonstrating a significant infrastructure of the salt industry at Paynes Creek or quantification of the briquetage to evaluate mass-production, other sites with briquetage elsewhere along the coast of Belize appear to be household production or cottage industry, without great impact on the inland salt needs. Is this interpretation really valid, or can we begin to see the entire coast of Belize supplying massive quantities of salt to meet inland needs?

Acknowledgements Fieldwork since 2004 was carried out with permits from the Belize Institute of Archaeology and with the financial support of a Faculty Research Grant from Louisiana State University (2004), as well as grants from FAMSI (Foundation for the Advancement for Mesoamerican Studies, 2005), the National Science Foundation (2005-2008), and the National Geographic Society (2006-2007). I am grateful to many individuals at the Institute of Archaeology in Belize for permits and assistance. Fieldwork was accomplished with the assistance of LSU graduate students Bretton Somers, Cory

Sills, Amanda Evans, Kevin Pemberton, Zoe Morris, and Michael Mirobelli, as well as Mark Robinson and John Young. I appreciate the assistance of LSU undergraduates Amanda Pitcock, in charge of wood conservation, and Victoria Harrington, in charge of data management in the Coastal Landscapes and Cultures Research Group lab. Fieldwork was facilitated by the friendship and hospitality of John Spang and Tanya Russ, and by the goodwill of many people in Belize, particularly in Punta Gorda town. I note in particular, the friendship and help of the late Emory King Sr., who encouraged and facilitated my research in Belize from my arrival in June 1979 until his death in August 2007.

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