Finds in Belize document Late Classic Maya salt making and canoe transport

Heather McKillop*

Department of Geography and Anthropology, Louisiana State University, 227 Howe-Russell Geoscience Building, Baton Rouge, LA 70803-4105

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How did people in preindustrial ancient civilizations produce and distribute bulk items, such as salt, needed for everyday use by their large urban populations? This report focuses on the ancient Maya who obtained quantities of salt at cities in the interior of the Yucatan peninsula of Mexico, Belize, and Guatemala in an area where salt is scarce. I report the discovery of 41 Late Classic Maya saltworks (anno Domini 600–900) in Punta Ycacos Lagoon on the south coast of Belize, including one with the first-known ancient Maya canoe paddle. The discoveries add important empirical information for evaluating the extent of surplus salt production and river transport during the height of Late Classic civilization in the southern Maya lowlands. The discovery of the saltworks indicates that there was extensive production and distribution of goods and resources outside the cities in the interior of the Yucatan. The discovery of a wooden canoe paddle from one of the Punta Ycacos saltworks, Ka’k Naab’, ties the production of salt to its inland transport by rivers and documents the importance of canoe trade between the coast and the interior during the Late Classic. Archaeological discovery of multiple saltworks on the Belizean coast represents surplus production of salt destined largely for the inland Peten Maya during their Late Classic peak, underscoring the importance of non-state-controlled workshop production in preindustrial societies.

The discovery of 41 Late Classic (anno Domini 600–900) Maya saltworks in Punta Ycacos Lagoon on the south coast of Belize adds a new dimension to our understanding of economies in ancient civilizations. The research shows that there was extensive production outside urban areas and beyond the control of the dynastic royal Maya leaders in those cities. Entrepreneurs in southern Belize located saltworks near the natural resource, the sea. They produced a surplus for trade in response to the needs of urban consumers in the interior of the Yucatan peninsula where salt, a basic biological necessity, was scarce. Activities at the saltworks focused on the production of salt by workers who lived at nearby coastal settlements. Production was beyond the control of the Late Classic Maya state at cities in the interior of the Yucatan. Bulk inland transport of salt along rivers by canoe is supported by the discovery of a full-sized wooden canoe paddle at K’ak’Naab’, one of the Punta Ycacos saltworks. This type of production contrasts to the workshops attached to royal courts at Maya cities, where elite goods were produced for the dynastic Maya leaders and other elites (1). The saltworks also are distinct from the cottage industry style of household workshops at Colha, where stone tools were mass-produced for trade (2). Colha and the Punta Ycacos saltworks were located outside urban areas near natural resources used in workshop production and reveal the extent of non-state-controlled production in the ancient Maya and other civilizations.

Background

Saltworks previously discovered in Punta Ycacos Lagoon, a large salt water lagoon in Paynes Creek National Park, Belize, were marked by the presence of artifacts on the seafloor (3). The salt artifacts included the fragmentary remains of jars and bowls used to boil seawater to produce loose salt or salt cakes. One of the vessel supports was embedded at an angle in a clay base indicating the positioning of the vessel supports. Excavations at the Stingray Lagoon saltworks revealed a large fire hearth of charcoal, along with salt-making pots. Measurements of pottery indicated the salt pots were standardized in their dimensions, suggesting the mass production of salt. The previous study also shows variability among the four saltworks, suggesting that there were distinct work groups. However, with only four saltworks, the extent of production along the coast and its potential impact for supplying the Maya at the interior cities were undetermined.

Was there enough salt produced by the boiling method along the coast of Belize to satisfy the inland demand for this basic daily necessity during the Late Classic? The boiling method was a common method of making salt historically and ethnographically worldwide (4, 5). Salt was produced by the same method elsewhere along the Belize coast at Northern River Lagoon, Ambergris Cay, Kakalche, and Placencia (3, 6–9). The Belize coast was closer to the Late Classic area of Maya civilization in the southern Maya lowlands than the salt flats on the northern coast of the Yucatan, where salt was produced by solar evaporation (6, 10). If the Belize coast supplied salt for the Late Classic inland Maya, then there was bulk transport from the coast to the interior, arguably by boat from the coast along rivers to the interior of the Yucatan.

Sixteenth century Spanish explorers to Central America disrupted ancient Maya canoe trade and travel that had endured for more than a millennium (Fig. 1). This travel included sea trade around the Yucatan (11–13) but also shorter-distance travel along inland waterways in Belize, Mexico, and Guatemala, supplying the Maya in the interior at large urban cities with marine resources (8, 14, 15). Settlement of offshore islands underscores ancient Maya familiarity with boats and sea travel. Boats were necessary for transportation to island sites located off the coasts of Belize and the Yucatan, including near-shore islands, such as Isla Cerritos, Wild Cane Cay, Moho Cay, and Frenchman’s Cay (14–17), islands located farther from the mainland, such as Ambergris Cay, and Cozumel (8, 13), sites >40 km offshore on the Belize barrier reef, such as Hunting Cay, and sites on atolls beyond the reef.

Although no full-size wooden canoes have been recovered from ancient Maya sites, there are artistic depictions of ancient Maya canoes, including fisher folk paddling canoes shown on a mural from Chichen Itza (18) and mythical figures paddling canoes that are incised on bones from a burial from Tikal (19). In addition, there are miniature models of boats from Altun Ha, Moho Cay, and from two saltworks in Punta Ycacos Lagoon (3, 15, 20). Together with the settlement of offshore islands, various canoe-related artifacts from the Maya region indicate that the ancient Maya traveled by canoe. However, this evidence does not
address the question of whether goods were transported by canoe to inland cities or over land by human porters.

Research Questions
With only four saltworks in Punta Ycacos Lagoon and other saltworks farther north along the coast of Belize, the extent of salt production on the coast of Belize was unknown, so that it was unclear whether or not they could have supplied enough salt for the interior cities at the height of Late Classic civilization. The organization of production was geared toward the mass production of salt (3), but the extent of production in terms of the number of saltworks was unknown. A systematic search of Punta Ycacos Lagoon was initiated in 2004 to locate additional saltworks and, thus, to evaluate the extent of salt production on the coast of Belize and the potential for surplus production for trade inland to supply the salt needs at Late Classic cities in the interior of the Yucatan. Still, the question of how bulk quantities of salt were transported from the coast to interior cities remained.

Methods of the 2004 Survey
The 2004 systematic underwater survey of Punta Ycacos Lagoon began in the eastern arm of the lagoon, where water is a maximum of 1 m in depth. Previous fieldwork on the south coast of Belize revealed inundated terrestrial sites on the coast, on offshore cays (islands), and in shallow coastal waters (3, 21). Late Classic Maya sites were inundated by a sea-level rise, leaving the modern landscape a typical mangrove ecosystem dominated by red mangroves (*Rhizophora mangle*). The actual rise in sea level is recorded by Holocene deposits of mangrove peat up to 9 m deep that accumulated as seas rose within the Belize barrier reef inshore lagoon (3, 22–24). Sediment coring below the floor of Punta Ycacos Lagoon in 2004 indicates mangrove peat extends to at least 4.3 m deep, the maximum extent of the coring instrument. The peat is overlain by 10–30 cm of loose silt.

The land-based archaeological technique of pedestrian survey was used to search for sites in the lagoon, with a team of four persons walking or snorkeling on flotation devices at arm’s length back and forth across the lagoon, looking for artifacts on the sea floor. Snorkeling improved visibility of the seafloor because the bottom silt was not disturbed. Sites were identified by the presence of pottery. The location of underwater sites was recorded with a global positioning system. A transit was set up in the lagoon at a datum marked by a 4-ft (1 ft = 0.3 m) length of 0.5-inch (1 in = 2.54 cm) polyvinyl chloride pipe to begin mapping the distribution of remains at discovered sites.

Results
New Sites. Forty-one new sites were found during the underwater survey in Punta Ycacos Lagoon, bringing the total number of underwater sites in the lagoon to 45, which were all engaged in some aspect of salt production. The sites were identified by concentrations of potsherds on the seafloor. Twenty-three of the sites were embedded in mangrove peat in the eastern arm of the lagoon. The remaining sites were in the loose silt overlying the peat elsewhere in the lagoon. The peat in the eastern arm of the lagoon provided a matrix for the preservation of wood, including wooden buildings, a paddle, and other wooden objects, along with the pottery.

Wooden Buildings. Wooden structures associated with salt production at 23 sites provide insight into the infrastructure for the production and distribution of salt in the Late Classic. Previous salt production in Punta Ycacos and elsewhere on the Belizean coast appeared to be an outdoor activity. Moreover, the ephemeral remains of potsherds hidden underwater in the modern landscape suggested that salt production was quite limited in extent, which was clearly not the case. The wooden buildings indicate that there was substantial infrastructure associated with salt production and a durable presence in the ancient world. The discovery of the Punta Ycacos wooden structures is a compelling reason to search for ancient sites in environmental conditions that preserve wood and other perishable materials, given that, before this discovery, no ancient wooden buildings had been found in the Maya area.

The wooden architecture at the Paynes Creek sites is defined by wooden posts, beams, and other construction wood. Several posts were excavated to verify their cultural nature and to take wood samples for radiocarbon dating and wood species identification. The excavated posts were straight and up to a meter in length back and forth across the lagoon, looking for artifacts on the sea floor. Snorkeling improved visibility of the seafloor because the bottom silt was not disturbed. Sites were identified by the presence of pottery. The location of underwater sites was recorded with a global positioning system. A transit was set up in the lagoon at a datum marked by a 4-ft (1 ft = 0.3 m) length of 0.5-inch (1 in = 2.54 cm) polyvinyl chloride pipe to begin mapping the distribution of remains at discovered sites.

The largest structure is at Chak Sak Ha Nal, where 112 wooden posts define the exterior walls of a rectangular wooden building measuring ~21 × 12 m. Inside the structure, there are 31 posts forming interior rooms and other construction wood, including beams and other horizontally placed wood whose arrangement remains to be mapped. Late Classic pottery sherds, including salt-making artifacts, are abundant inside the structure but not beyond, which indicates that the structure was used in some aspect of salt production, storage, or transportation. Other sites have walls demarcated by lines of posts, isolated posts, and other
construction wood, along with abundant salt-making artifacts. Detailed mapping of the wooden structure and associated pottery at Chak Sak Ha Nal and the other saltworks will elucidate the size, layout, and variability of the wooden structures and the patterning of artifacts used in salt production.

Salt-Making Artifacts. Pottery used in salt production dominates the ceramics, which resemble ceramics from the previous study (3). These ceramics include potsherds from bowls and jars used to boil seawater in pots over fires and solid clay cylinders used to support the pots over fires. Most of the clay cylinders were fragmentary, with two complete cylinders measuring 32 and 33 cm in length, respectively, indicating the height vessels were placed above a fire. Clearly, with 45 saltworks, an infrastructure including wooden structures, and the potential for discovery of additional saltworks in areas of the lagoon not yet surveyed, salt production was indeed extensive.

K’ak’ Naab’ Paddle. The recovery of a wooden canoe paddle from the K’ak’ Naab’ site ties the production of salt in Paynes Creek to its transportation by canoe. In the absence of any ancient Maya wooden canoes, the paddle represents previously uncharacterized primary evidence of prehistoric Maya boat travel and navigation. The K’ak’ Naab’ site has a wooden structure containing salt-making artifacts, with the paddle nearby. Potsherds extend over an area of ~10 × 15 m and are embedded in the mangrove peat. The paddle blade protruded from the mangrove peat into the overlying silt. The edge of the paddle blade in the silt was worm-eaten, but the remainder of the paddle was undamaged. Eight wooden posts found in the preliminary survey at K’ak’ Naab’ are similar in diameter (20–30 cm) and fresh in appearance, like posts at other sites in the lagoon.

Similar in shape to paddles shown in artistic depictions elsewhere in the Maya area (18, 19), the K’ak’ Naab’ paddle shows the actual size of paddles used by the Late Classic Maya: Carved from a single piece of wood, the paddle is 1.43 m long, with a round shaft that is 5 cm in diameter (Fig. 2). The grip is rounded and smooth, with flaking scars visible, such as could have been produced by a chert adze recovered from the site. The upper edge of the blade flares at a 90-degree angle to the shaft. The blade extends 8 cm from the shaft on one side, but only 2 cm on the other side. The blade of the paddle is rounded at the tip. A raised area on one side of the blade, 1.40 cm high, continues the shape of the shaft.

The paddle was carved from a species of *Manilkara*, probably *Manilkara sapote* in the family Sapotaceae. Although waterlogged, the wood is fresh in appearance, preserving the original light brown color of the wood. Sapotaceae wood also was identified from Late Classic midden deposits at the nearby island community of Wild Cane Cay (25). A wooden spear from Actun Polbihé cave, Belize, was made from *M. sapote* (26). Although *M. sapote* is better known for its sap that provided chicle for chewing gum, the wood is a durable hardwood. Deciduous hardwoods do not grow in the mangrove ecosystem surrounding the lagoon or on the adjacent pine savanna (27). However, they form the rainforest south of Punta Ycacos Lagoon, along Deep River.

Radiocarbon dating and analysis of associated ceramics date Belize salt production and canoe travel to the height of Late Classic Maya civilization, when the demand for salt was greatest in the interior cities of the Peten. A radiocarbon date of 1,300 ± 40 B.P. (sample no. Beta-192705, Beta Analytic, Miami) from a sample of the grip end of the paddle concurs with the age of the associated ceramics from K’ak’ Naab’. The radiocarbon age of the paddle, corrected by 13C/12C, with a 2 sigma calibration is calculated at anno Domini (A.D.) 680–880. A radiocarbon date of 1300 ± 60 B.P. (sample no. Beta-192704, Beta Analytic, Miami) from a wooden post at the nearby Sak Nuk Naj saltworks corroborates the Late Classic age. The radiocarbon age of the post, corrected by 13C/12C, with a 2 sigma calibration is calculated at A.D. 670–960. Both dates are within the range of the calibrated radiocarbon date of A.D. 670–870 (2 sigma; sample no. Beta-69869, Beta Analytic, Miami) from the Stingray Lagoon site (Fig. 1), which is located in the larger western arm of the lagoon (3). The radiocarbon dates fit with the Late Classic age of the ceramics. No earlier or later ancient Maya sites or...
and distribution of salt, made by boiling seawater in pots over fires. Wooden buildings were used in the production, storage, and trade in antiquity. The Late Classic Maya at inland cities also imported goods and resources from more distant areas, notably cacao, conch, fishes, manatee, and sea turtle, all found at inland cities (3, 14). Cacao is grown extensively today on the mainland coast, and trade in antiquity. The Late Classic Maya at inland cities in the interior of Belize to cities in the interior of Belize and the adjacent Peten of Guatemala, notably Lubaantun, Pusilha, Seibal, and Altar de Sacrificios (3). In addition to salt, other resources produced on the Belize coast include a variety of marine resources in demand by the inland dynastic Maya, including stingray spines used in ritual bloodletting, conch shells used as horns (principally queen conch, Strombus gigas, and Turbinella angulata), and seafood (fishes, manatee, and sea turtle), all found at inland cities (3, 14, 20, 21). Cacao is grown extensively today on the mainland coast, with a cacao bean from Frenchman’s Cay indicating its local use and trade in antiquity. The Late Classic Maya at inland cities also imported goods and resources from more distant areas, notably obsidian, a common import to the Late Classic trading port of Wild Cane Cay off the coast of Punta Ycacos Lagoon (21).

Examples from Art and Ethnohistory. The K’ak’ Naab’ paddle corroborates the shape of paddles shown in ancient Maya art, which is different from modern Maya and other paddles. Artistic depictions show paddles and their use in canoes, with most images showing sacred activities, such as the ancient Maya Paddler Gods’ role in delivering the maize god from the primordial sea at the moment of the creation of the world. Pictorial depictions incised on bones from Late Classic Burial 116 in Temple 1 at Tikal (19) show the Stingray Paddler god and the Jaguar Paddler god paddling a canoe (Fig. 3). Like the K’ak’ Naab’ paddle, their paddles have a straight handle without an expanded grip. The blades are straight along the upper side, rounded at the sides and at the tip. The scene indicates that Classic Maya held paddles by the shaft, with one hand near the top and the other hand above the blade. Other artistic depictions of canoeists paddling are known from Piedras Negras, recording a Yaxchilan emissary’s trip downstream to attend a ruler’s accession to the throne (28). Similar paddles are depicted in a scene on a painted mural dated to the Postclassic at Chichen Itza (18).

The virtual identity of the artistic depictions of paddles with the shape of the K’ak’ Naab’ paddle suggests that artistic representations of canoes in the same images show the accurate shape of canoes used by the ancient Maya. Miniature models of boats, similar in shape to the pictorial depictions, have been recovered from several Classic Maya sites, including canoes carved from manatee rib bone from Altun Ha and Moho Cay (15, 20), and examples in clay from Orlando’s Jewfish and Stingray Lagoon, previously investigated saltworks in the western arm of Punta Ycacos Lagoon (3).

Implications. The association of the wood structures with abundant salt-making debris is evidence for some kind of storage facility or production infrastructure. Pottery at the site indicates that salt was produced by boiling seawater in pots over fires, as indicated by the abundant broken salt-making pottery vessels inside the structures.

The discovery of the K’ak’ Naab’ paddle ties the production of salt to its transport in canoes. The paddle is new evidence about the size and technology of Late Classic Maya canoe paddles and the first primary evidence of water-borne navigation of the ancient Maya, corroborated by artistic depictions (18, 19, 28).

Radiocarbon dates and ceramics link the paddle and Late Classic salt-making sites together in time, which helps make the case that bulked surplus was produced for transport. The abundance of salt-making artifacts and the lack of domestic refuse, burials, and food remains, in contrast to their common recovery at settlements on the coast, indicates that the saltworks were places where salt was produced for use elsewhere. The extent of Late Classic coastal salt production occurred when there was the greatest demand for salt at inland cities. The coastal saltworks were abandoned at the same time as the collapse of the Late Classic civilization in the southern Maya lowlands and the abandonment of the inland cities. Settlement continued on the coast, where salt making was associated with part of household production at Wild Cane Cay and Frenchman’s Cay, island trading ports near Punta Ycacos Lagoon.

Several lines of evidence link this surplus salt and the Peten interior. The presence of unit-stamped pottery (with impressed decorations on vessel shoulders) and clay figurine whistles from inland sites at the Paynes Creek saltworks reinforces the significance of the coastal–inland trade of salt and other commodities at the height of the Classic Maya civilization. The distribution of unit-stamped pottery extends from the south coast of Belize to cities in the interior of Belize and the adjacent Peten of Guatemala, notably Lubaantun, Pusilha, Seibal, and Altar de Sacrificios (3). In addition to salt, other resources produced on the Belize coast include a variety of marine resources in demand by the inland dynastic Maya, including stingray spines used in ritual bloodletting, conch shells used as horns (principally queen conch, Strombus gigas, and Turbinella angulata), and seafood (fishes, manatee, and sea turtle), all found at inland cities (3, 14, 20, 21).

Fig. 3. Classic Maya paddles depicted on incised bone from Burial 116 in Temple 1 from Tikal. (Courtesy of Mary Lee Eggart.)
The discovery of 41 saltworks and an ancient wooden canoe paddle demonstrate there was extensive, non-state-controlled salt production and the means of transport by canoe to inland Maya cities. In general, the subsistence economy of the Late Classic Maya was more complex than previously considered and included mass production of goods outside urban areas and beyond state control. This finding is important because it furthers our understanding of premodern, indigenous systems of production and exchange, in particular the extent of political control of the economy. The Punta Yacacos research indicates that salt production on the coast of Belize was extensive, dated to the height of Maya civilization when inland demand for salt was at its greatest, and that the production and canoe transportation of salt were locally controlled by the coastal Maya instead of the geographically distant Maya state at cities in the interior. In addition to the Paynes Creek saltworks, salt production is documented elsewhere along the coast of Belize (Fig. 1), suggesting that the Belize coast provided a closer source of salt than that produced on the north coast of the Yucatan. The discovery of the canoe paddle from K’ak’ Naab documents that the transportation of salt was by water, a viable option for moving bulky resources up nearby rivers to supply the large populations of the Late Classic cities in the interior of the southern Maya lowlands.

Conclusions

Work on inundated coastal archaeological sites pays off by adding to what we know about ancient production and exchange, especially in a period so far removed from European accounts. The discovery of 41 new saltworks brings the total to 45 saltworks in Punta Yacacos, with only part of the lagoon investigated so far. This research adds commensurately to our knowledge of the extent of salt produced along the Belizean coast during the Late Classic, when demand at interior cities was greatest. The 2004 discovery of salt production associated with wooden buildings provides new information on the infrastructure of salt production. At least some aspect of the boiling and storage of pots or salt took place indoors, as is known ethnographically at the highland Maya community of Sacapulas, where brine from a salt spring is boiled in wooden buildings and the equipment and fuel are stored indoors (5, 29). The association of salt production artifacts with wooden buildings and a canoe paddle broaden our knowledge of ancient production and trade and underscore the information about ancient cultures worldwide that can be recovered from peat bogs and other unusual environmental settings that preserve wood from the distant past.

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