

## Salt as a commodity or money in the Classic Maya economy

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### ABSTRACT

Marketplace trade was important for Late Classic (A.D. 600–900) Maya households to sell surplus products and obtain commodities from regional and long-distance trade. Elsewhere, urbanism was correlated with standardization of commodities, increased separation of producers and consumers, and the use of money for transactions. Cacao beans, woven cotton, and copper objects were used as money by the Yucatec Maya in the sixteenth century, with origins in Late Classic dynastic Maya tribute and taxation. Marketplace trade likely also featured some commodities as money, including cacao, woven cotton, and perhaps salt. Salt produced by boiling brine in pots over fires at the Paynes Creek Salt Works and in the Maya highlands is evaluated according to definitions of money.

There are contrasting views of the origins of money, including if it was used to facilitate exchange in marketplaces (Hirth, 2016) or for institutional or state needs for taxation or tribute (Graeber, 2014). By definition, money serves several functions, including a standard of value, a medium for exchange, a store of wealth, and a unit of accounting, although the same commodity need not serve all four functions (Jevons, 1875). Discussion of the origins and use of money in archaeology has been hampered by views of Karl Polanyi (1957) and other “substantivists.” They regarded all exchanges as “embedded” in social relations and that there was a qualitative difference between ancient and modern economies, with the latter including market forces of supply and demand. In contrast, “formalists” viewed no major qualitative differences between ancient and modern economies and that market forces of supply and demand were part of ancient economies. While accepting the social dimensions of economies, archaeologists have turned their focus to formalist approaches in evaluating ancient economies (Garraty, 2010; Hirth, 2016). Money, either as metal coins or commodities, was used in various ancient complex societies in the Near East, the Mediterranean, and China. This paper evaluates the use of commodities as money, specifically salt cakes, in the Classic (A.D. 300–900) Maya domestic economy, which included exchanges in marketplaces. Production at historic to modern salt works in the Maya highlands is compared with ancient sites at the Paynes Creek Salt Works in southern Belize to evaluate whether salt was produced in a form suitable for use as money at regional marketplaces during the Classic period (Fig. 1) (McKillop, 2002, 2005a, 2019).

At the time of European contact in the sixteenth century, the Maya in the Yucatan of Mexico used cacao beans, shells, and copper objects as

money. How far back in time were commodities used as money in the Maya area? The Classic Maya paid tribute to the state, exchanged goods in marketplaces, and traded with neighbors. Marketplaces—as locations where regular exchanges took place—as well as market exchanges in other settings, were common by the Late Classic (A.D. 600–900) (Dahlin, 2009; Freidel et al., 2016; Freidel and Shaw, 2000; Hutson, 2017: 143; King, 2015; Masson, 2020: 484–485; Masson and Freidel, 2012, 2013). The ways in which exchanges took place remains to be addressed.

### 1. The Classic Maya: Barter or use of money?

Were exchanges in Classic Maya marketplaces by barter or were commodities used as money in transactions, or both? Barter, where goods and services are directly exchanged, was evidently common among individuals and households in Mesoamerica (Berdan, 1975: 217). Some anthropologists believe that barter was common and that it was also the main way that goods and services were exchanged in marketplaces in ancient complex societies (Bohannan and Dalton, 1965).

Following Jevons (1875), barter works if both parties to the exchange have something the other wants. A successful strategy is to have multiple things available to barter for something you want. Value is established in bartering by having a fixed rate of exchange between commodities with negotiation over quality and size (Mayer, 2002) or by haggling (Hirth, 2016). Every exchange in barter consists of a specific number of units of one thing exchanged for a specific number of units of another thing. The units of measurement may be different, including a specific weight of one commodity and a specific length of another. The ratio between the two numbers becomes the value of each commodity.

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For example, if one kg of salt is bartered for two kg of honey, then the value of salt is twice that of honey. The value may fluctuate depending on the needs and wants of the people involved in the exchange. The ideal situation is to find two people who each have things the other wants. Jevons refers to this as a “double coincidence.” For example, on the coast of Bohol Island in the Philippines, standardized jars containing hardened salt were used to exchange for highland rice (Yankowski, 2010).

Although exchanges can be carried out by barter, money facilitates the exchange of multiple, different items. Use of commodities as money in exchanges simplifies purchases compared to bartering. For barter, each commodity needs a value for every other commodity. This problem is solved by using one commodity whose value is accepted for each other commodity. The chosen commodity becomes “the common denominator or common measure of value” in which to assess the value of every other

commodity (Jevons, 1875). A variety of commodities, including furs, dried codfish, cubes of raw tea, tobacco, corn, salt, and others, as well as coins and paper notes, have been used as money (Jevons, 1875).

Money performs functions that remedy issues with barter, including a standard of value, a medium for exchange, a store of wealth, and a unit of accounting. Separate commodities can be used for each of the four functions (Jevons, 1875). It is likely that salt cakes did not fulfill all of these functions if they were used as money. Hirth's (2016:250) statement about Aztec money may be useful for describing Maya money: “Modern money is a general-purpose currency that simultaneously serves as a medium of exchange, a unit of account, a standard for payment, and a means of storage... Money in the Aztec world was a special purpose commodity with agreed upon values that served as mediums of exchange...” The same thinking might apply to Maya salt cakes.



Fig. 1. Map of the Maya area with sites mentioned in the text. Map by Mary Lee Eggart.

## 2. Money and marketplace trade

Several commodities were used as money in the sixteenth century by the Aztec and Maya, according to Spanish reports, which are useful for interpreting the much earlier Classic Maya use of money. Historic records of the Tlatelolco marketplace at the Aztec capital of Tenochtitlan indicate money changers bought goods from producers, which made it easier for them to purchase other goods. Most of the Tlatelolco vendors were producer-vendors who sold food or goods from surplus household production. Barter was likely used alongside the use of cacao, cotton textiles called *quachli*, and metals that served as money (Hirth, 2016: 85–90; de Sahagún, 1959). One gold bar equaled two half bars or five tablets of gold, five tablets equaled 45 *quachli*, and one gourd of gold dust equaled 232 *quachli* (Gutierez, 2013: 157). Gold bars were cut into smaller amounts of standard sizes. Cacao beans were used to complete purchases using larger denominations of other commodities.

Although their economy was arguably as complex as that of the later Aztecs described in such detail by Sahagún and in the Tlapan and other tribute lists, there are limited economic records for the much earlier Classic period Maya. Both the institutional (palace) and domestic (household) economies of the Late Classic Maya may have used standardized commodities as money, as they did at the time of Spanish contact in the sixteenth century. Standard sizes and shapes of textiles, cacao, shells, copper bells and axes, and other commodities were used as money by the sixteenth century Maya in the Yucatan in marketplace trade, as reported by the Spaniards (Díaz del Castillo, 1956; Freidel et al., 2016; Kepcs, 2003; Masson and Freidel, 2012, 2013; Tozzer, 1941). In the Late Classic, sacks of cacao beans and piles of woven textiles were money used to pay tribute to the dynastic Maya to support the institutional economy and also were used in other exchanges among dynastic royal Maya such as marriages and military alliances (Baron, 2018a, 2018b; Freidel et al., 2016; McAnany, 2010; Tokovinine and Beliaev, 2013).

In contrast to the institutional economy that supported the Maya state, the domestic economy supported households. The household was involved in provisioning its members both from subsistence and crafting activities and from exchange with others within the community and in marketplaces in the region. Household specialization at the Cerén village in El Salvador allowed exchange with neighbors and in markets throughout the region (Sheets et al., 2015). At Caracol, marketplaces provided access to a wide variety of staple foods and luxury items from within the region, including serving vessels, as well as obsidian blades, jadeite beads, and other jadeite objects from outside the region (Chase et al., 2015).

Plazas at a variety of Classic Maya cities have been identified as the location of marketplaces on the basis of the presence of market stalls, localized activity patterns identified by micro-debitage or soil chemistry, artifact distributions, and in the case of the exterior of Chiik Nahb Structure 1 at Calakmul, painted images of vendors at a marketplace (Cap, 2015; Chase et al., 2015; Jones, 2015; Martin, 2012; Terry et al., 2015). In the Calakmul murals, vendors each show a commodity to a potential buyer, with glyphs indicating the commodity for sale (Carrasco et al., 2009; Martin, 2012). They include salt, maize, tamales, atole, tobacco, and other goods. In one scene, a seated salt vendor shows what has been interpreted as a salt cake that is wrapped in leaves to another person. That person holds a large spoon over a basket, presumably of loose, granular salt, “atz’aaam.” (Martin, 2012: Figure 19). This is the first documented glyph record of salt in the Maya area (Martin, 2012: 69). Other painted images on the exterior of the building depict human porters carrying large jars in a harness on their backs and with a tumpline to displace some of the weight (Martin, 2012: 22, Figures 25, 37). Simon Martin (2012: 80) interprets the building with painted scenes of everyday goods as a marketplace, with the building, Structure 1, as the focus of a religious-administrative compound. This view aligns with the Tlatelolco marketplace where there were producer-vendors, as well as retail-vendors, and where goods were acquired by barter and by use of

commodities as money, including cacao beans, standard lengths of cloth, shells, and other items. The Calakmul image of a salt vendor is visual evidence of salt cakes at a Late Classic Maya marketplace. The transaction supports use of salt in barter, as money, or both.

The possibility that salt served as money during the Classic period is investigated for the Paynes Creek Salt Works in southern Belize, where salt was produced by boiling brine over fires (Fig. 1) (McKillop, 2019). Salt had intrinsic value to the ancient Maya due to the restricted natural distribution of this basic biological necessity. It was a commodity that was traded extensively in the southern Maya lowlands, where the Classic period cities were concentrated. Previous models, based on evidence from a limited number of salt-producing sites, supported explanations for the production and circulation of salt based on elite demand for, or control, of long-distance trade (Andrews, 1983; MacKinnon and Kepcs, 1989). With new evidence that salt production was practiced in more places, like the Belizean examples from this paper, regional circulation is a more likely explanation (Fig. 1; McKillop, 2019).

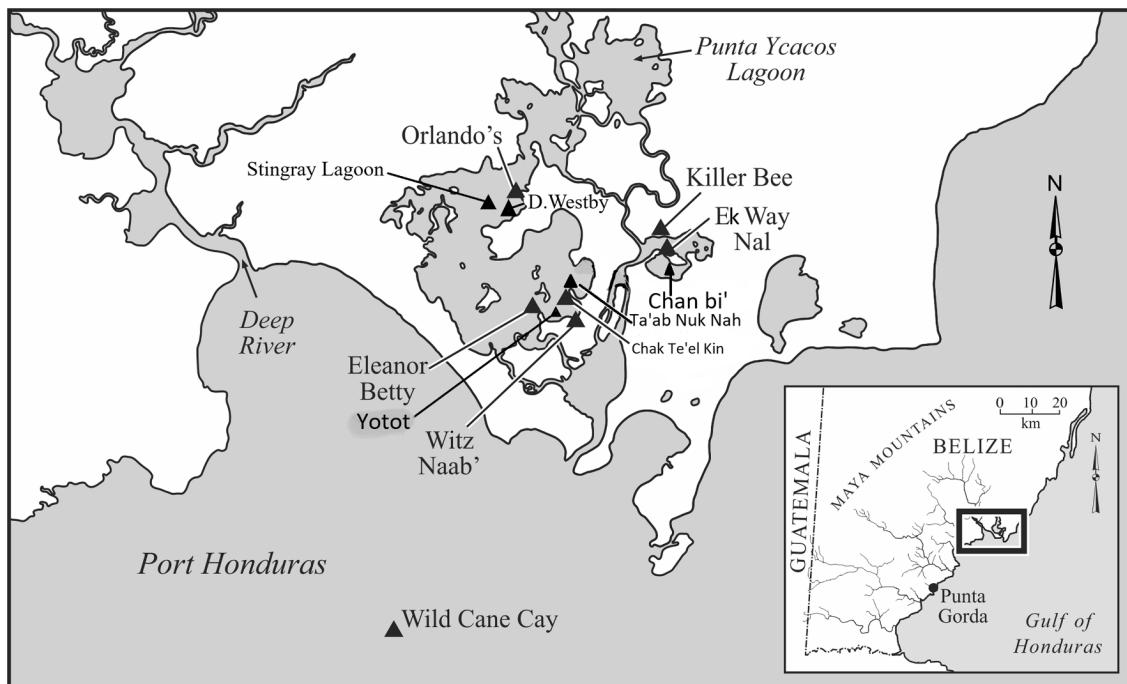
## 3. The Paynes Creek Salt Works

Salt making at the Paynes Creek Salt Works took place inside special purpose salt kitchens as part of surplus household production (McKillop, 2019). The salt was made in pole and thatch buildings constructed near the shores of Punta Ycacos Lagoon, a seasonally, hyper-saline coastal lagoon. A total of 4042 wooden architectural posts, beams, and wedges were mapped at 70 sites (McKillop, 2019). Each site consists of a cluster of wooden posts and associated artifacts embedded in the sea floor. The salt kitchens include rectangular buildings of various sizes (McKillop, 2019: Table 4.1). The Yotot site consists of two salt kitchens and a yard whose perimeter was defined by a line of palmetto palm posts (McKillop and Sills, 2016). The salt kitchens at the site had interior dimensions of 3.3 by 4.9 m and 3.5 by 9.9 m. Local wood was used from the mangroves and from the nearby deciduous rainforest (McKillop, 2019: Figures 5.2–5.3; Tables 5.2–5.3). Most of the sites were abandoned at the end of the Classic period when the inland consumers of the coastal salt abandoned their cities.

The brine-boiling process at the Paynes Creek Salt Works produced briquetage, the term used worldwide to describe the broken salt-making pottery (vessels, oven furniture; Flad, 2011; Li and von Falkenhausen, 2006; Olivier, 2010). Briquetage found at the Paynes Creek Salt Works includes broken jars, bowls, and basins, along with solid clay cylinders used as vessel supports. At the top of each cylinder was a socket with a concave surface for a pot to rest. At the other end of the cylinder there was a glob of clay with a flattened base that rested in a fire (McKillop, 2002; McKillop and Sills, 2017). The Paynes Creek salt-making pottery, assigned to the Punta Ycacos type, was made in household workshops from clay and quartz-sand temper available in the Punta Ycacos Lagoon system (Fig. 2; McKillop, 2019). Local manufacture is underscored by the recovery of a wooden pottery paddle, made from local rosewood (*Dalbergia stevensonii*), that was found at the Chak Te’el Kin site (McKillop, 2019: Figure 6.5). The salt-making vessels are smooth on the interior and rough on the exterior, with thick rims and thin vessel bodies (McKillop, 2019: Figure 3.3). The thin vessel bodies would have transmitted heat well during brine boiling. The rough exteriors would have facilitated moving the pots, likely at the thick rim area. Ethnographic analogy suggests that the brine-boiling process resulted in loose salt or fire-hardened cakes that were transported in clay pots or as solid forms to consumers (Andrews, 1983; Reina and Monaghan, 1981).

## 4. Salt as Maya money

If salt was used as money by the Classic Maya, then it should have served one or more of the four functions of money as described by Jevons (1875), including a standard of value, a unit of accounting, a store of wealth, and a medium for exchange. As Hirth (2016: 250) noted, commodity money was perhaps most important as a medium of



**Fig. 2.** Map of Paynes Creek Salt Works showing underwater sites mentioned in the text. Insert shows location of map in southern Belize. Map by Mary Lee Eggart.

exchange among the Aztec, and will be the focus for evaluating Maya salt in this paper. Salt as a commodity used as money should have the following properties listed by Jevons (1875), including utility and value, portability, cognizability, divisibility, indestructability, stability of value, and homogeneity.

In terms of these properties, salt was a useful commodity as a biological necessity, flavor enhancer, and food preservative. Salt was portable. Salt was easy to recognize by sight and taste, so had cognizability. Salt blocks and loose salt can be divided, which supports divisibility. Stability of value is not known and cannot be assessed with the archaeological data in this paper. Salt is not indestructible, which is why it was probably better as a media of exchange than a store of wealth. Jevons (1875) separates homogeneity of material from homogeneity of units. Homogeneity of material cannot be assessed in this study, though it is probably fair to assume that the salt was pretty much all the same. However, homogeneity of units can be assessed—specifically whether salt cakes were of similar size and shape. A standard unit, or homogeneity in Jevon's terms, is a basic feature of money, so will be examined further for Maya salt production. As with the later Aztec economy (Hirth, 2016:250), the use of money in exchange may have been the most important characteristic.

## 5. Salt as a standard unit

Is there evidence that the Classic Maya made standard units of salt? Fire-hardened salt, as salt cakes, loaves, or other forms, were made through surplus household production by boiling brine from salt springs at communities in the Maya highlands of Guatemala and Mexico during historic times (Andrews, 1983; Reina and Monaghan, 1981). Some of these historic sites have continuity in salt production from prehistoric times. Andrews (1983: 84) found sherds from similar brine-boiling pots that were associated with Late Postclassic pottery (CE 1200–1500) in exposed, stratigraphic cuts at San Mateo Ixtatán. In addition, the stone foundations of the sheds over the wells are likely prehistoric (Andrews, 1983: 84). He found solid clay cylinder vessel supports at Sacapulas, where stone supports were used in historic times.

Of the many communities that carried out brine boiling to make salt from salt springs in the Maya highlands, there is detailed information for

four (Andrews, 1983; Reina and Monaghan, 1981). At San Mateo Ixtatán, women used jars to carry brine from four wells to their homes where they boiled the brine in small open vessels for 12–14 h (Andrews, 1983: Figure 4.9). The clay pots cracked and broke, leaving a solid salt cake that weighed about 22 kg (Table 1) (Andrews, 1983: Figure 4.10). The broken salt pots were discarded. The salt cakes were sold to wholesalers who broke them into smaller pieces for retail sale.

At Sacapulas, enriched brine was boiled over a fire in household-owned salt kitchens (Reina and Monaghan, 1981). Typically, 20 small, open bowls, made at home by the salt makers, were placed over a fire inside a family salt kitchen, which was located close to the salt spring and away from the home. Calabash gourds cut in half were used to dip brine from large pots stored in the salt kitchen. The bowls were refilled with brine until they were full of wet salt, which took a couple of hours. The wet salt was scooped into large storage jars. Some of the wet salt was returned to the brine-boiling bowls and heated further for about three hours until solid. These salt cakes were removed by breaking the bowls. The broken bowls were discarded inside and later moved to piles outside the salt kitchen. Two cakes placed together with their flat surfaces formed a “bolla” that weighed 10–20 kg (Andrews, 1983: 89). Wet salt stored in large jars in the salt kitchen was sometimes placed in a round wooden forms on a bed of sand on the hearth to produce round “casitas” that dried. Each casita weighed about 0.17 kg (Andrews, 1983: 90). The salt producers took the bolas and casitas to sell at regional markets. The weight range between 10 and 20 kg for salt cakes at Sacapulas reported by Andrews (1983) may reflect whether two salt cakes are put together to form a bolla (Table 1). Reina and Monaghan (1981) describe and illustrate uniformly sized open bowls made by molding clay over a form at Sacapulas, indicating the salt cakes are standardized in size and shape.

**Table 1**  
Standard units of salt produced at selected Maya communities.

Site	Unit Name	Unit Weight
Ixtapa	loaf	0.6 kg
San Mateo Ixtatán	pilon	22 kg
Sacapulas	bola	10/20 kg
Sacapulas	casitas	0.2 kg
Ek Way Nal	salt cake	2 kg

and do not range between 10 and 20 kg in weight.

At Ixtapa, brine was boiled over an adobe oven in large metal vats inside salt kitchens located near a salt spring. Formerly, large clay pots were used for brine boiling (Andrews, 1983: 59). As the salt congealed in the pots, it was removed and packed into cylindrical woven straw matting to create loaves (Andrews, 1983: Figure 3.6). Each loaf weighed 0.6 kg. Traders from a nearby village bought the salt loaves and sold them at markets in communities throughout the central Maya highlands.

Saltmakers at Salinas de los Nueve Cerros at the base of the Maya highlands also used brine boiling. Excavations revealed large ceramic brine storage pots up to 2 m in diameter that had been placed on clay ovens in the ground (Andrews, 1983: Figure 4.13; Dillon, 1977). Hard salt cakes, estimated to weigh 28.8 kg each, were formed in pottery molds in a flat round loaf shape or a cone (Woodfill, 2020: 174, 180). Woodfill et al. (2015) consider the salt works as a major producer for inland cities in the southern Maya lowlands and that the resident elite-controlled access to the salt springs and the distribution of salt within the community (Woodfill, 2020).

## 6. Identifying salt cakes in the archaeological record

Production of salt cakes for trade in the Maya highlands and elsewhere provide testable implications for identifying trade of salt cakes archaeologically. Possible use of this commodity as money will be addressed later. The first scenario is exemplified by Sacapulas, San Mateo Ixtatán and Salinas de los Nueve Cerros, where abundant discarded brine-boiling pots that were uniform in size indicate production of salt cakes of uniform size and discard of the pots inside or nearby the salt kitchens. In this case, broken brine-boiling pots are discarded outside, but the other briquetage, including a fire hearth or oven, remain indoors. Since the hardened salt was transported to marketplaces without pots, there would be no ceramic evidence of salt trade at marketplaces. However, salt cakes may have been individually wrapped in leaves as depicted for a salt vendor holding a salt cake on the painted building at Calakmul (Martin, 2012).

In the second scenario, there are no vessel sherds at the salt kitchens since the hardened salt cakes were transported in the pots in which they were baked, as on Bohol Island in the Philippines (Yankowski, 2010). In this case, only the non-vessel briquetage, including supports and oven furniture would be in the archaeological record. Hardened salt cakes may have been transported in pots from the coast to the Maya city of Aventura, where the pots were broken to remove the salt (Fig. 1) (Robin et al., 2019). This interpretation is supported by the excavation of thousands of tiny pottery sherds of Coconut Walk Unslipped pottery type that is associated with salt production, near the main plaza at Aventura. In the third scenario, where wet salt was removed from brine-boiling pots and placed into straw forms, as at Ixtapa and for the casitas made in wooden molds at Sacapulas, the size and number of the brine-boiling pots would not reflect the size and number of the units of hardened salt. At Sacapulas, two types of salt were made, including salt cakes hardened over a fire in bowls as well as loose, wet salt placed in forms and hardened over a fire.

The common recovery of salt pot sherds and oven furniture at the Paynes Creek Salt Works supports the first scenario that hardened salt cakes were removed from the brine-boiling vessels. Few brine-boiling jar fragments would have been found if the wet salt from the brine-boiling vessels was placed into forms made from perishable materials and hardened, or loose salt was produced. In any case, salt was not transported in clay pots as at Bohol or in the Aventura case study. Excavation of one of the salt kitchens at the Yotot site indicated that briquetage comprised 98% of ceramics by weight and there were few other artifacts (McKillop and Sills, 2016). The briquetage was concentrated inside the salt kitchens and immediately outside them and not dumped in the yard or outside the site. Were the size and shape of the salt-making pottery vessels at the Paynes Creek Salt Works standardized in form and size to make uniformly sized salt cakes?

## 7. Standardization of brine-boiling jars at the Paynes Creek Salt Works

The brine-boiling jars at the Paynes Creek Salt Works were used to evaluate whether the vessels were standardized for making homogeneous salt cakes. If salt cakes were used as money in market exchanges, it is necessary (but not sufficient) to demonstrate that salt cakes were produced in homogenous units. If salt was hardened in vessels before breaking them, the expectation is that highly variable vessel sizes would be inconsistent with the production of salt for use as money. The diameter of the vessel opening was used as a measure of standardization, since few rim sherds extended from rim to base to allow reconstruction of vessel wall shape, size, or volume. Vessel volume was calculated from a jar sherd from map location S on the sea floor at Ek Way Nal site. Since there was more than one item mapped at that location, the jar sherd was assigned S1. The rim had a complete wall profile from rim to base. The vessel volume was calculated from digitally rotating the rim profile to obtain a complete digital vessel, and then calculating the volume of the interior space, with the equivalent weight in salt, estimated at 2 kg (Fig. 3).

The sample of 449 sherds with measurable rim diameters derived from general sea floor collection at sites in 2003–2004, sherds that were individually mapped on the sea floor from 2005 to 2008, and excavated material from various years. One of the goals of the 2003–2004 survey was to recover measurable Punta Ycacos rims for standardization studies. After wooden architecture was discovered in 2004, the goal changed to locating and mapping distinctive pottery associated with the buildings. Excavations recovered all pottery, but there were fewer rims and distinctive sherds than from the sea floor survey, which covered larger areas. The changing goals contributed to the sample of pottery that was recovered. In particular, fewer Punta Ycacos rims were collected after 2004. Of the recovered rims, not all had measurable rims.

The sample in this study included 329 Punta Ycacos Unslipped jar rims and 120 Mangrove Unslipped jar rims. The Mangrove Unslipped jars were general purpose water jars that were not expected to be standardized. Comparison of all measurable Punta Ycacos and Mangrove Unslipped jar rims shows the coefficient of variation of 16.4 for the Punta Ycacos rims is less than the value of 25.3 for the Mangrove Unslipped rims (Table 2). However, many of the sites have small sample sizes, with fewer than four jar rims, including 16 sites for Punta Ycacos Unslipped and 22 sites for Mangrove Unslipped. These data were excluded from further calculations since the low numbers would not reveal variability that may have existed. Four sites, including Stingray



Fig. 3. Photo of 3D-printed salt-making vessel reconstructed digitally from S1 jar rim at Ek Way Nal to estimate vessel volume. Vessel was printed at 80% actual size. Photo by Heather McKillop of 3D printed vessel by Cher Foster and Rianna Bowen.

**Table 2**

Comparison of Punta Ycacos Unslipped and Mangrove Unslipped Jar rim diameters. (Measurements are in cm).

	Punta Ycacos Jar Rim Diameter	Mangrove Unslipped Jar Rim Diameter
Number	329	120
Mean	22.08	25.85
Maximum	40	52
Minimum	12	12
Standard Deviation	3.63	6.54
Co-efficient of Variation	16.44	25.30

Lagoon, Eleanor Betty, Chan B'i, and Site 11, have at least seven jar rims of both pottery types (Table 3). The coefficient of variation is less for Punta Ycacos Unslipped jar rims than for Mangrove Unslipped jar rims at each of the four sites. Six sites, including Ek Way Nal, Orlando's, David Westby Site, John Spang Site, Carpenter Site, and Site 13, have at least 10 measurable Punta Ycacos jar rims (Table 4). Two sites, including Sites 18 and 49, have at least 10 Mangrove Unslipped jar rims. Some of the individual sites have coefficient of variation for Punta Ycacos Unslipped jar rims much lower than the grouped site data, namely Chan B'i (7.7), Ek Way Nal (5.61), and Orlando's (5.1). The data indicate that there the salt production jars generally were more standardized than the Mangrove Unslipped water jars, but that there was variability in the homogeneity of the salt cakes produced from the Punta Ycacos Unslipped jars.

There is no set threshold for a coefficient of variation that marks "standardized" or "standardized enough to be used as money." This is a relative comparison. This study compared coefficients of variation for rim diameters for Punta Ycacos Unslipped jars (used for brine boiling) and Mangrove Unslipped water jars. The coefficient of variation for brine boiling jars ranged was 16.44 which is less than the coefficient of variation of 25.30 for all sites. For the four sites with at least 10 rim sherds from both types, the coefficient of variation ranged from 7.77 to 24.59, which overlaps with the range of 18.61 to 28.86 for the water jars. Including sites with only one of the pottery types, the range of 5.1 to 12.14 for brine boiling jars overlaps with the range of 7.27 to 14.97 for the water jars. Further evidence will be needed to determine whether the same relationship exists for vessel volume. With some exceptions at particular sites, there is a pattern of brine boiling jars as more standardized than water jars. This pattern is consistent with the expectations one would have for brine-boiling jars if they were used to produce cakes of salt used as money, but it is not sufficient information to prove that use. Standard units of salt could be counted and inventoried for exchange as a commodity and perhaps also used as money in marketplace trade.

## 8. Regional marketplace trade of Maya salt cakes

In the Maya highlands, salt cakes were traded regionally, sometimes by the salt producers, and at other times by traders who bought the salt at the salt works. Traders bought the salt from the producers at San Mateo Ixtatán and traded it in markets in the region in the Maya highlands (Andrews, 1983: 87). The salt producers from Sacapulas

transported their salt to various marketplaces within their region. Traders bought salt from the Ixtapa salt producers and sold it in marketplaces.

Hirth (2016: Figures 4.4–4.5) plotted the locations of salt works and consumer communities in highland Mexico from the *Relaciones Geográficas*. He found that highland salt was traded 50–150 km from a salt work, but that merchants from large salt-producing towns often traveled 175–325 km. Some service areas overlapped, indicating competition among salt producers or the need for multiple suppliers to meet demands, or different uses of salt from various sources. Hirth and Pillsbury (2013: 16) provide contrasting ideas for the Maya area: "Salt, for example, was not widely traded with Yucatan, but individuals traveled from towns to the coast to process what they needed." Masson (2020: 485–487) notes they ignore the substantial evidence for salt production and trade in the Maya area (Andrews, 1983; Kepcs, 2003; McKillop, 2002, 2005a).

The Maya highland salt works provide a model of coastal Maya regional trade with inland communities to supply them with salt, likely in the form of fire-hardened salt cakes as in the highlands. Using other trade goods as proxies provides a framework for including salt to coastal-inland trade in southern Belize. The contemporary Late and Terminal Classic inland cities of Lubaantun and Nim Li Punit are 67 and 47 km distant by water, along the coast and up rivers from the salt works. The coastal Maya were adept mariners, with a canoe and paddles recovered from the Paynes Creek Salt Works (McKillop, 2017). The salt works have Lubaantun-style ocarinas and unit-stamped pottery made at inland sites (McKillop, 2002). Other resources, such as marine fish, sea shells, and stingray spines also likely figured in coastal-inland trade. For example, Lubaantun has the same marine fish species recovered from excavations at the coastal trading port of Wild Cane Cay, located within a km of the salt works (Hammond, 1975; McKillop, 2005b; McKillop and Aoyama, 2018). Although no fish bones were preserved in the acidic mangrove peat matrix of the salt works, use-wear analysis indicated that most of the chert stone tools were used to cut fish or meat or to scale fish or scrape hides, so evidently some of the Paynes Creek salt was likely used to salt fish for local use and/or trade (McKillop and Aoyama, 2018).

The evidence for regional trade shows barter, or trade in complementary resources between inland and coastal populations. As a standard unit of hardened salt, the cakes may have been used in marketplaces for use in accounting and as money, perhaps along with local cacao beans. The Village Farm site, located on the coast between the Rio Grande and Golden Stream, is located on a modern cacao farm, in one of the best cacao-growing zones in the Maya area (Baron, 2018a, 2018b) (Fig. 1). The site also has Lubaantun-style ocarinas and unit-stamped pottery, making it contemporary with the Paynes Creek Salt Works (McKillop, 2002, 2019). The Rio Grande provides canoe access to Lubaantun, whereas Golden Stream approaches the inland city of Nim Li Punit. The Maya at each of these communities needed salt that was not part of institutional exchange for status goods, including such highly crafted items as a jadeite plaque with incised decoration and hieroglyphs from a tomb at Nim Li Punit (Prager and Braswell, 2016).

Elsewhere along the coast of Belize a similar technology of salt production using brine-boiling was used (Fig. 1). Was there standardization of production and of the product—hardened units of salt—at the

**Table 3**

Inter-site comparison of jar rim diameters. (Measurements are in cm).

Site Name	Site #	Pottery Type	Number	Mean	SD	Median	Range	CV
Stingray Lagoon	56	Punta Ycacos	99	22.3	3.7	22	14–38	16.6
Stingray Lagoon	56	Mangrove	41	24.2	6.3	24	14–44	26.2
Eleanor Betty	67	Punta Ycacos	14	23.7	5.83	22	16–40	24.59
Eleanor Betty	67	Mangrove	21	29.5	7.9	28	21–52	26.76
Chan B'i	24	Punta Ycacos	10	21.5	1.7	2.2	19–25	7.77
Chan B'i	24	Mangrove	8	25.6	4.77	26	18–34	18.61
–	11	Punta Ycacos	7	20.7	2.63	21	16–23	12.70
–	11	Mangrove	7	24.1	6.96	25	13–37	28.86

**Table 4**

Sites with 10 or more Punta Ycacos or Mangrove jar rim diameters. (Measurements are in cm).

Site Name	Site #	Pottery Type	Number	Mean	SD	Median	Range	CV
Ek Way Nal	60	Punta Ycacos	20	22.3	1.25	22	20–24	5.61
Orlando's Site	58	Punta Ycacos	22	21.7	1.1	22	18–24	5.1
David Westby Site	57	Punta Ycacos	11	18.9	3.1	20	14–24	16.8
John Spang Site	72	Punta Ycacos	10	21.9	4.77	22.5	15–32	21.8
Carpenter Site	61	Punta Ycacos	15	21	2.55	21	16–25	12.14
–	13	Punta Ycacos	15	22.7	2.93	24	16–25	12.90
–	18	Mangrove	10	26.7	7.27	27	15–38	7.27
–	49	Mangrove	12	25.9	3.88	25	22–34	14.97

height of Late Classic civilization in the southern lowlands? The briquetage at the Placencia Salt Works has a similar inventory of bowls and jars of Punta Ycacos Unslipped, as well as solid clay cylinder vessel supports with sockets and spacers, and spacers to that at the Paynes Creek Salt Works (Sills, 2016; MacKinnon and Kepcs, 1989). Excavations on the northern point of Moho Cay, a coastal trading port in the mouth of the Belize River, revealed a settlement with pottery styles similar to the upper Belize valley and northern Belize (McKillop, 2004). Most of the site had eroded, leaving intact burials in a shallow offshore area, where thousands of solid clay cylinder vessel supports for salt pots were found, supporting an interpretation of a separate area of salt kitchens from the community. At Northern River Lagoon, a coastal village in northern Belize, there was similar brine-boiling technology (Masson and Mock, 2004), as well as evidence that salted fish were transported inland (Masson, 2004). Similar briquetage at other sites on the coast of Belize provides a future line of research to investigate the standardization of their salt pots in form and size, as necessary but not sufficient evidence for use of hardened salt as commodity money.

## 9. Conclusions

“The kitchen is a bank with money for us, Rosa joked. So when we need money at any time during the year we come to the kitchen and make money, salt” (Reina and Monaghan, 1981: 21). Rosa’s statement at Sacapulas, where people store salty soil in their salt kitchens during the rainy season to make salt when needed, underscores the value of salt in the historic Maya domestic economy. Study of the production of salt cakes historically and prehistorically in the Maya area indicates there is a murky line between barter and use of commodities as money. In the above quote, Rosa the saltmaker knows the value of salt in the marketplace. Perhaps the dichotomization of barter and money, or commodity and money, becomes less important. If Jevon’s seven properties of money, especially homogeneity, are the same for a commodity that is bartered and for a commodity used as money, how are they distinguished at a production site, such as the Paynes Creek Salt Works?

The transition to urbanism in ancient civilizations in the Near East and China witnessed increased standardization of some commodities, which were easy to count, and also were used as money (Bevan, 2016; Hamilton and Lai, 1989). Producers, traders, and consumers counted standardized commodities rather than weighing and measuring them (Bevan, 2016). Production of quantities of uniformly sized salt cakes fits this scenario.

Maya salt cakes may have fulfilled the function of “medium of exchange” in Jevon’s (1875) definition of money. Salt cakes as a commodity used as money should include the following listed by Jevons (1875), namely utility and value, portability, cognizability, divisibility, indestructability, stability of value, and homogeneity. In terms of “utility,” salt is a basic biological necessity and is also useful for preserving food. Salt was valued in the Maya area because of its restricted distribution. Salt cakes, or loose salt in sacks or pots as depicted in the Calakmul paintings of traders (Martin, 2012) are portable. Salt cakes are not as portable as cacao beans, although salt cakes could have been easily transported in canoes along the coast and up rivers in southern Belize. In terms of cognizability, salt is identifiable by sight and taste. In

terms of divisibility, the units of hardened salt can be counted, are durable, and divisible. At the Ixtapa salt works, Andrews (1983: 60) found that “the saltmakers themselves have only a vague notion of how much they produce. They tend to think of production in terms of the number of bemequenes (salt loaves) produced, rather than in terms of kilograms or tons.” Hardened salt may have been cut into smaller units for trade, as at San Mateo Ixtatán (Andrews, 1983). Loose salt may have been transported in large ceramic pots carried on the back (Martin, 2012) or in woven sacks from the Yucatan salt works, a method suggested for Salinas de los Nueve Cerros (Freidel, 2020). Salt is not indestructible, but it can be stored for years if kept dry, so salt cakes have a sense of being indestructible. Stability of value is not a trait that can be evaluated in the archaeological record of the salt works. The most important trait, homogeneity, is discussed as standard units of salt, either as salt cakes or other shapes of hardened salt or as loose salt. Using salt cakes as money would have facilitated marketplace exchanges, as was the case historically at the Aztec marketplace of Tlatelolco for other commodities. Produced as homogeneous units, salt may have been used as money in exchanges. In the Paynes Creek Salt Works study, the coefficient of variation was used as a relative measure of standardization to compare brine boiling and water jars. Due to a virtual lack of rims with much of the vessel wall need to reconstruct volume, rim diameters were compared. The brine boiling jars were more standardized than the water jars in the sample of 449 rims. For sites with at least seven rims of each type, the same result was found. When comparing sites with at least 10 brine boiling jars or 10 water jars, water jars from sites 18 and 49 has coefficient of variation within the range of brine boiling jar rims at other sites, underscoring comparisons need to be site specific.

This discussion of standard units of hardened salt as possibly used as money at Late Classic Maya marketplaces underscores that the origins of Maya money may have originated in the domestic economy, while acknowledging the parallel or even earlier use of cacao and cloth for tribute and taxation in the institutional, state economy (Baron, 2018a, 2018b). Surplus production of salt was part of the domestic economy and governed by households. It was not part of institutional exchange for status goods. The need for money in the domestic economy derives from the role of surplus household production for exchange locally and at regional markets to obtain goods and resources. Households were not self-sufficient. They were integrated into local, regional, and long-distance exchange networks through marketplaces. Use of money would have facilitated exchanges, perhaps with a money changer as in the Aztec marketplace at Tlatelolco. The Classic Maya at the Paynes Creek Salt Works supplied salt to inland communities, perhaps using hardened units of this scarce commodity as money. They traded with other producer-vendors, and they may have used salt cakes and cacao beans, to obtain a variety of basic and nonlocal goods for household use. As a valuable commodity in a standard size that could be counted, divided, and stored, salt cakes would have been valued as a standard quantity of other commodities. As commodities that everyone valued because they needed it, the average Maya family may have had a salt cake in reserve for future purchases by barter or by perhaps using it as money.

The focus of salt production and trade was within regions and so variation between regions in the size of salt cakes is a reasonable

interpretation for trading commodities and also for use of salt cakes as money in intra-regional trade. Standard units of hardened salt, as cakes, loaves, or fractions thereof, varied among regions in the Maya highlands historically. Regional trade is evident between the coast and inland sites in southern Belize during the Late Classic where ocarinas and unit-stamped vessels that were made at inland sites were found on the coast and marine resources were found at inland sites.

Use of money facilitates exchanges that are characteristic of ancient complex societies. Graeber (2014) argues that money developed from agreed-upon values of various commodities to meet institutional needs of the state. Hirth (2016) underscores that commodities used as money by the Aztecs were important to the functioning of the domestic economy for exchange of surplus household production in the marketplace and elsewhere. Graeber denies that barter existed, whereas Hirth and others regard barter as common, even co-existing with the use of money in Aztec marketplace exchanges. Documentation of surplus production during the Late Classic in the Maya lowlands provides a venue for discussing the mechanisms of exchange in the domestic economy, which may have seen one or more valued commodities, such as salt cakes, used as money to facilitate transactions in the marketplace and elsewhere.

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## References

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

Baron, Joanne, 2018a. Ancient monetization: The case of Classic Maya textiles. *J. Anthropol. Archaeol.* 49, 100–113.

Baron, Joanne, 2018b. Making money in Mesoamerica: Current production and procurement in the Classic Maya financial system. *Econ. Anthropol.* 5, 210–223.

Berdan, Frances F., 1975. Trade, Tribute, and Market in the Aztec Empire. PhD dissertation. Department of Anthropology, University of Texas, Austin.

Bevan, Andrew, 2016. Making and marking relationships: Bronze age branding and Mediterranean commodities. In: Bevan, Andrew, Wengrow, David (Eds.), *Cultures of Community Branding*. Routledge, New York, pp. 35–86.

Bonhannan, Paul, Dalton, George (Eds.), 1965. Markets in Africa. Northwestern University, African Studies 9, Evanston, IL.

Cap, Bernadette, 2015. *How I Know It When I See It: Marketplace Identification at the Classic Maya Site of Buenavista del Cayo, Belize*. In: King, Eleanor (Ed.), *The Ancient Maya Marketplace: The Archaeology of Transient Space*. University of Arizona Press, Tucson, pp. 111–137.

Carrasco, Ramón Vargas, Vázquez López, Verónica A., Martin, Simon, 2009. Daily life of the Ancient Maya recorded on murals at Calakmul. Mexico. *Proc. Natl. Acad. Sci.* 106, 19245–19249.

Chase, Arlen F., Chase, Diane Z., Terry, Richard E., Horlacher, Jacob M., Chase, Adrian S. Z., 2015. Markets among the Ancient Maya: The Case of Caracol, Belize. In: King, Eleanor (Ed.), *The Ancient Maya Marketplace: The Archaeology of Transient Space*. University of Arizona Press, Tucson, pp. 226–250.

Dahlin, Bruce, 2009. Ahead of its time? The remarkable Early Classic Maya economy of Chunchucmil. *J. Soc. Archaeol.* 9, 341–367.

Díaz del Castillo, Bernal, 1956. *The True History of the Conquest of Mexico*. Farrar, Straus and Cudahy, New York.

Dillon, Brian, 1977. *Salinas de los Nueve Cerros, Alta Verapaz, Guatemala*. Ballena Press Studies in Mesoamerican Art, Archaeology and Ethnohistory 2. Ballena Press, Socorro, NM.

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.

Freidel, David A., 2020. Nuts, bolts, and bridges: Some reflections. In: Masson, Marilyn A., Freidel, David A., Demarest, Arthur A. (Eds.), *The Real Business of Ancient Maya Economies*. University Press of Florida, Gainesville, pp. 3–13.

Freidel, David A., Masson, Marilyn A., Rich, Michelle, 2016. Imagining a Complex Maya Political Economy: Counting Token and Currencies in Image, Text, and the Archaeological Record. *Cambridge Archaeol. J.* 27, 29–54.

Freidel, David A., Shaw, Justine, 2000. The lowland Maya civilization: Historical consciousness and environment. In: McIntosh, Roderick J., Tainter, Joseph A.,

McIntosh, Susan K. (Eds.), *The Way the Wind Blows: Climate, History, and Human Action*. Columbia University Press, New York, pp. 271–300.

Garraty, Christopher P., 2010. Investigating market exchange in ancient societies: A theoretical view. In: Garraty, Christopher P., Stark, Barbara L. (Eds.), *Archaeological Approaches to Market Exchange in Ancient Societies*. University Press of Colorado, Boulder, pp. 3–32.

Graeber, David, 2014. *Debt: the first 5,000 years*. Melville House, New York.

Gutiérrez, Gerardo, 2013. Negotiating Aztec tributary demands in the tribute record of Tlapa. In: Hirth, Kenneth, Pillsbury, Joanna (Eds.), *Merchants, Markets, and Exchange in the Precolumbian World*. Dumbarton Oaks Research Library and Collection, Washington, DC, pp. 141–167.

Hamilton, Gary, Lai, Chikong, 1989. Consumerism without capitalism: consumption and brand names in late Imperial China. In: Rutz, Henry, Orlove, Benjamin (Eds.), *The Social Economy of Consumption*. University Press of America, Lanham, MD, pp. 253–280.

Hammond, Norman, 1975. *Lubaantun: A Classic Maya Realm*. Monographs of the Peabody Museum of Archaeology and Ethnology 2. Harvard University Press, Cambridge, MA.

Hirth, Kenneth G., 2016. *The Aztec Economic World: Merchants and Markets in Mesoamerica*. Cambridge University Press, New York.

Hirth, Kenneth G., Pillsbury, Joanne, 2013. Merchants, Markets, and Exchange in the Pre-Columbian World. In: Hirth, Kenneth G., Pillsbury, Joanne (Eds.), *Merchants, Markets, and Exchange in the Pre-Columbian Worlds*. Dumbarton Oaks, Washington, D.C., pp. 1–22.

Hutson, Scott, 2017. *Ancient Maya Commerce: Multidisciplinary Research at Chunchucmil*. University Press of Colorado, Boulder.

Jevons, William Stanley, 1875. *Money and the Mechanisms of Exchange*. Appleton and Company, New York.

Jones, Christopher, 2015. The Marketplace at Tikal. In: King, Eleanor M. (Ed.), *The Ancient Maya Marketplace*. University of Arizona Press, Tucson, pp. 67–89.

Kepcs, Susan, 2003. Chickinchel. In: Smith, Michael E., Berdan, Francis F. (Eds.), *The Postclassic Mesoamerican World*. University of Utah Press, Salt Lake City, pp. 259–268.

King, Eleanor (Ed.), 2015. *The Ancient Maya Marketplace: The Archaeology of Transient Space*. University of Arizona Press, Tucson.

Li, Shuicheng, von Falkenhausen, Lothar (Eds.), 2006. *Ancient Salt Production and Landscape Archaeology in the Upper Yangzi Basin: Preliminary Studies*. Salt Archaeology in China, vol. 1. Science Publishers, Beijing.

MacKinnon, J., Jefferson, Kepcs, Susan M., 1989. *Prehispanic Saltmaking in Belize: New Evidence*. *Am. Antiquity* 53, 522–533.

Martin, Simon, 2012. *Hieroglyphs from the Painted Pyramid: The epigraphy of Chiik Nahn structure Sub 1–4, Calakmul, Mexico*. In: Golden, Charles, Houston, Stephen, Skidmore, Joel (Eds.), *Maya Archaeology 2: Precolumbian Mesoweb Press*, San Francisco, CA, pp. 60–81.

Masson, Marilyn A., 2004. Fauna Exploitation from the Preclassic to the Postclassic Periods at Four Maya Settlements in Northern Belize. In: Emery, Kitty F. (Ed.), *Maya Zooarchaeology: New Directions in Method and Theory*. The Cotsen Institute of Archaeology Press, University of California, Los Angeles, pp. 97–124.

Masson, Marilyn A., 2020. Conclusion: The ties that bind. In: Masson, Marilyn A., Freidel, David A., Demarest, Arthur A. (Eds.), *The Real Business of Ancient Maya Economies*. University Press of Florida, Gainesville, pp. 464–487.

Masson, Marilyn A., Freidel, David A., 2012. An Argument for Classic Maya era Maya Market exchange. *J. Anthropol. Archaeol.* 31, 455–484.

Masson, Marilyn A., Freidel, David A., 2013. Wide Open Spaces: A Long View of the Importance of Maya Market Exchange. In: Hirth, Kenneth G., Pillsbury, Joanne (Eds.), *Merchants, Markets, and Exchange in the Pre-Columbian Worlds*, Dumbarton Oaks, Washington, D.C., pp. 201–228.

Masson, Marilyn A., Mock, Shirley B., 2004. Ceramics and Settlement Patterns at Terminal Classic Period Lagoon Sites in Northeastern Belize. In: Demarest, Arthur A., Rice, Prudence M., Rice, Don S. (Eds.), *The Terminal Classic in the Maya Lowlands: Collapse, Transition, and Transformation*. University Press of Colorado, Boulder, pp. 367–401.

Mayer, Enrique, 2002. *The Articulated Peasant: Household Economies in the Andes*. Westview Press, Boulder CO.

McAnany, Patricia A., 2010. *Ancestral Maya Economies in Archaeological Perspective*. Cambridge University Press, Cambridge, UK.

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

McKillop, Heather, 2004. The Classic Maya Trading Port of Moho Cay. In: Garber, James F. (Ed.), *The Ancient Maya of the Belize Valley*. University Press of Florida, Gainesville, pp. 257–272.

McKillop, Heather, 2005a. Finds in Belize document Late Classic Maya Salt Making and Canoe Transport. *Proc. Natl. Acad. Sci.* 102, 5630–5634.

McKillop, Heather, 2005b. In Search of Maya Sea Traders. Texas A & M University Press, College Station.

McKillop, Heather, 2017. Early Maya Navigation and Maritime Connections in Mesoamerica. In: Balard, Michel (Ed.), *The Sea in History: The Medieval World*. Boydell and Brewer, Bognor Regis, UK, pp. 701–715.

McKillop, Heather, 2019. *Maya Salt Works*. University Press of Florida, Gainesville.

McKillop, Heather, Aoyama, Kazuo, 2018. Salt and marine products in the Classic Maya economy from use-wear study of stone tools. In: *Proc. Natl. Acad. Sci.*, pp. 10948–10952.

McKillop, Heather, Sills, E. Cory, 2016. "Spatial patterning of salt production and wooden architecture evaluated by underwater excavations at Paynes Creek Salt Work 74. *Res. Rep. Belizean Archaeol.* 13, 229–237.

McKillop, Heather, Sills, E. Cory, 2017. The Paynes Creek Salt Works, Belize: A model for ancient Maya salt production. In: Mathews, Jennifer P., Guderjan, Thomas H. (Eds.), *The Value of Things: Prehistoric to Contemporary Commodities in the Maya Region*. University of Arizona Press, Tucson, pp. 67–86.

Olivier, Laurent, 2010. The 'briquetage de la Seille' (Mosele, France): An Iron-Age Proto-Industrial salt-extraction center. In: Li, Shuicheng, von Falkenhausen, Lothar (Eds.), *Salt Archaeology in China, Volume 2: Global Comparative Perspectives*. Science Publishers, Beijing, pp. 239–259.

Polanyi, Karl, 1957. The economy as instituted process. In: Polanyi, K., Arensberg, C.M., Pearson, H.W. (Eds.), *Trade and Market in the Early Empires: Economies in History and Theory*. The Free Press, Glencoe, IL, pp. 243–270.

Prager, Christian M., Braswell, Geoffrey, 2016. Maya Politics and Ritual: An Important New Hieroglyphic text on a Carved Jade from Belize. *Ancient Mesoamerica* 27, 267–278.

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

Robin, Cynthia, Grauer, Kacey, Nissen, Zachary, Kosakowsky, Laura, Fitzgerald, Kat, 2019. Aventura in northern Belize context: Challenging traditional narratives of ancient Maya civilization through the results of the 2017 Field Season. *Res. Rep. Belizean Archaeol.* 16, 27–236.

de Sahagún, Bernardino, 1959. Florentine Codex: General History of the Things of New Spain, vol. 9. The Merchants. Translated by Arthur J.O. Anderson and Charles E. Dibble. University of Utah Press, Salt Lake City.

Sheets, Payson, Dixon, Christine, Lenz, David, Egan, Rachel, Halmbacher, Alexandria, Slotten, Venicia, Herrera, Rocio, Lamb, Celine, 2015. The Sociopolitical Economy of an Ancient Maya Village: Cerén and Its Sacbe. *Latin Am. Antiquity* 26, 341–361.

Sills, E. Cory, 2016. Re-evaluating the ancient Maya salt works at Placencia Lagoon, Belize. *Mexicon* 38 (3), 69–74.

Terry, Richard E., Bair, Daniel A., Coronel, Eric G., 2015. Soil Chemistry in the Search for Ancient Maya Marketplaces. In: King, Eleanor M. (Ed.), *The Ancient Maya Marketplace*. University of Arizona Press, Tucson, pp. 138–167.

Tokovinine, Alexandre, Beliaev, Dmitri, 2013. People of the road: Traders and travelers in ancient Maya words and images. In: Hirth, Kenneth, Pillsbury, Joanna (Eds.), *Merchants, Markets, and Exchange in the Precolumbian World. Dumbarton Oaks Research Library and Collection*, Washington, DC, pp. 169–200.

Tozzer, Alfred M. (translator), 1941. Landa's *Relaciones de las Cosas de Yucatan*. Papers of the Peabody Museum of Archaeology and Ethnology 18, Harvard University, Cambridge, MA.

Woodfill, Brent K.S., 2020. Large-scale production of basic commodities at Salinas de los Nueve Cerros, Guatemala: Implications for ancient Maya political economy. In: Masson, Marilyn A., Freidel, David A., Demarest, Arthur A. (Eds.), *The Real Business of Ancient Maya Economies*. University Press of Florida, Gainesville, pp. 172–183.

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

Yankowski, Andrea, 2010. Traditional technologies and ancient commodities: An Ethnoarchaeological study of salt manufacturing and pottery production in Bohol, Central Philippines. In: Li, Shuicheng, von Falkenhausen, Lothar (Eds.), *Salt Archaeology in China, volume 2: Global Comparative Perspectives*. Science Publishers, Beijing, China, pp. 160–181.