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# Salt of the Maya: Evidence of Prehispanic Salt Production and Architectural Function at the Eleanor Betty Site, Paynes Creek National Park, Belize

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SALT OF THE MAYA:  
EVIDENCE OF PREHISPANIC SALT PRODUCTION AND ARCHITECTURAL FUNCTION  
AT THE ELEANOR BETTY SITE, PAYNES CREEK NATIONAL PARK, BELIZE

A Thesis

Submitted to the Graduate Faculty of the  
Louisiana State University and  
Agricultural and Mechanical College  
In partial fulfillment of the  
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Master of Arts

in

The Department of Geography and Anthropology

by  
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## **Abstract**

The Punta Ycacos Lagoon is home to many Classic Maya saltworks. Located in Paynes Creek National Park in southern Belize, these ancient sites may unlock answers to understanding Classic period trade along the southern coast of Belize. Archaeological investigations took place at one such site, the Eleanor Betty Site, in order to determine organization and architectural function. One transect was excavated along what is hypothesized to be the interior of a wooden structure. Using ethnographic, ethnohistoric data, in conjunction with archaeological fieldwork, the function of the structure within the salt-production site has been analyzed. The presence of preserved wooden posts, and an abundance of briquetage indicate this was a structure used in the salt production process at this site.

## **Introduction**

In the Toledo District of southern Belize is Paynes Creek National Park, which is home to the Punta Ycacos Lagoon system. Beneath the shallow waters of this lagoon lies evidence of Classic Maya (A. D. 300-900) salt workshops. Located in the western part of the Punta Ycacos Lagoon is the Eleanor Betty Site, which is the focus of my research. In this thesis I investigate the remains of wooden architecture and associated artifacts within the Eleanor Betty Site. Through excavation of a transect along a post-line hypothesized to be one wall of a structure, I seek to verify this as a site of salt production, determine if this line of posts is in fact remnants of a building, and if so, determine the architectural function of the structure within the Eleanor Betty Site.

The methods used in my research include archaeology, ethnographic, ethnohistoric, and architectural analysis. The use of ethnographic and ethnohistoric accounts is employed in order to gain better understanding of the roles of the people and architecture of craft production. How perishable architecture is and was used within production space in the Maya area is another aspect of ethnohistoric analysis. The study of ancient and modern perishable architecture gives insight into the labor process and types of natural resources used in construction. The combination of ethnohistoric and architectural analysis, in conjunction with archaeology, aids interpretation of the remnants of the salt production industry and the processes which took place at this site.

Using these research methods, the following discussion will address the study of Maya architecture, noting the characteristics of various modes of living. Such characteristics include distinguishing between elite and commoner areas, as well as residential and non-residential spaces. The study of households is considered in order to grasp the scope of domestic



production space within a household unit, and apply it to the current study of workshop production space, in regards to social and production organization. Natural resources are integral to the understanding of craft production, especially in geographic context. In many instances, craft production activities are conducted in close proximity to the natural resource. Naturally, the economic and trading spheres are important to consider in conjunction with proximity to natural resources. Since the Maya area encompassed vast and varied landscapes, the resources were likewise as varied as the physical landscapes. Salt is one resource which can only be exploited by limited means, and in certain geographic locations. It is produced by evaporating salt water, or burning palm ash. Prime locations for saline rich water are in northern Yucatán, and southern Belize. An overview of modern and ancient salt production, trade, and architecture follows. Last is a discussion of my research methods and interpretations of that research using correlations with other ancient and modern salt production sites.

## Maya Architecture

The study of structures has been a major field of inquiry in Mesoamerica since the Spanish conquest. Early Spanish explorers were impressed by Maya architecture, and their observations are still important today (Webster 1998). Hernan Cortés and Diego de Landa are certainly major figures whose writings describing their encounters with Maya architecture are irreplaceable documents. Landa's *Relación de las Cosas de Yucatán* is one of the primary sources for our initial investigations into Maya architecture and indeed the Maya culture. In his assessment of the Maya built environment, De Landa states:

If Yucatán were to gain a name and reputation from the multitude, the grandeur, and the beauty of its buildings, as other regions of the Indies have obtained by gold, silver, and riches, its glory would have spread like that of Peru and New Spain. For it is true that in its buildings and the multitude of them it is the most remarkable of all things which up to this day have been discovered in the Indies; for they are so many in number and so many are the parts of the country where they are found, and so well built are they of cut stone in their fashion, that it fills one with astonishment (Tozzer 1941: 170-171).

Of course most scholarly investigations on ancient Maya structures since Spanish contact have focused on monumental architecture, since those structures are the most visually apparent in the built environment (Webster 1998: 12). Monumental architecture can only reflect a fraction of ancient Maya life. More recent investigations of perishable structures and invisible architecture have given us more insight into the ancient peoples of Mesoamerica. Johnston (2004: 146) defines "invisible settlements [consist] of largely or completely buried settlement remains that leave no or very few surface traces". Archaeologists look for patterns in their research. Variation in soil consistency is a significant factor in archaeology. Patterns in soil may reflect past activity and structure placement. Materials and artifacts may form a pattern within an archaeological site, especially if they are analogous. Finding patterns in archaeological material aids interpretation of site function, as well as site layout. Such patterns in architectural form seem fairly straightforward. However, we must also look at the built environment and

landscape in order to deduce where and why structures were built (Webster 1998). The study of architecture encompasses many methodologies, but the overarching question is that of architectural function. In this study on structure function, I must distinguish the difference between residential versus non-residential structures, and elite versus commoner structures. Houses are characterized by their associated domestic middens in the archeological record, whereas non-residential structures have no midden or a midden with non-domestic refuse. Nonetheless, the investigation of invisible architecture is one possible methodological approach in household studies.

Johnson (2004) has investigated invisible architecture at Itzan, Peten, Guatemala. He describes how invisible settlements can be a significant research issue (Johnson 2004). This subject is a topic of debate among Mayanists. Many methodological challenges accompany the investigation of invisible settlements. Johnson (2004) states that examination of invisible architecture may aid in reinterpreting population density, size, and growth. Although there is evidence of ancient structures in the Maya area, difficulties remain in interpreting these structures.

Maya palaces and elite residences were built in specific locations. For instance, Demarest et al. (2003) describe the sacred geography of elite structures at Dos Pilas, in the Petexbatun region of Guatemala. Unlike other Classic Maya architecture, such as at Tikal, the structures at Dos Pilas are incorporated into the landscape. “Natural hills and terraces were enhanced by terrace walls so as to present them as artificial constructions” (Demarest et al. 2003). The Dos Pilas complex, although rapidly built, was carefully constructed in relation to natural features which related to Maya cosmology. This sacred geography was most likely what Maya rulers relied upon in legitimizing their power (Demarest et al. 2003).

Commoner residences in the Maya area are difficult to distinguish in the archaeological record, due to poor preservation. Unlike elite and public architecture, commoner architecture was perishable, constructed of wood poles, thatch, and sometimes mud or daub. In studying Maya houses and perishable structures, we may refer to Robert Wauchope's (1938) seminal ethnographic work on modern Maya houses, in which he concludes that modern Maya houses are still primarily constructed as they were in antiquity.

The differentiation between elite and commoner areas and structures is often telling from the type of architecture. Elites often lived in palaces which were linked both metaphorically and physically to public architecture, often built of stone. Commoner structures were typically constructed cheaply of perishable material. However, both elites and commoners engaged in craft production. The main evidence to differentiate between residential and non-residential areas or structures mostly lies in the presence or absence of domestic and industrial debitage or middens. The presence of a large amount of debitage is likely attributed to craft production, whereas the presence of largely domestic refuse in middens implies residential structures and compounds.

## **Houses and Households**

In many instances, rural individuals participate in part-time craft production, especially during times of agricultural inactivity. The most efficient production space would naturally be located in or near habitation. It is this notion which promotes investigation into household organization. The ways in which households organized themselves and their production spaces may give insight into the organization of larger, more intense production areas.

Ancient Maya commoners typically lived in a domestic group with kin relations or non-related individuals. Ashmore and Wilk (1988) identify four aspects of household social organization: the household, co-residential group, dwelling, and house. The household is a social unit of individuals that share activities. Co-residential groups are a social unit which seems similar to a household, but this group may or may not belong to a larger household. members of a co-residential group may not participate in the household activities. Examples of co-resident groups are stationary hunting camps, men's houses, menstrual tents for women, and priest's houses (Ochoa-Winemiller 2004). A dwelling is the physical structure or area of domestic activities. Finally, the house is a single or group of dwellings inhabited by a household.

The social organization of households is determined by a few factors. According to Yangisako (1979), the kind of domestic organization is determined by demographic, economic, and stratification factors. Demographic factors, such as age at marriage, life expectancy, and fertility levels affect the size and composition of domestic groups (Yangisako 1979). The size and composition of domestic groups thus affects the household economically.

In instances where the household is also the unit of production, the fluctuation among household size changes the ratio of consumers to workers (Sahlins 1972; Yanagisako 1979).

Production activities, in turn, are affected by the household labor power, which is “the most powerful determinant of the formation of extended family households” (Yanagisako 1979: 173). Division of labor is common worldwide. Often division of labor by gender and/or age is a direct correlate to the task at hand: “The physical demands and the urgency of the task may select for males in clearing, fencing, guiding a plow, or carrying the heaviest loads, but women often work more steadily and for longer hours to satisfy the daily needs of their households” (Netting 1974: 29). Netting is referring to an agrarian society, but his statement may hold true for domestic production units as well.

### **Household Production**

The concept of household is multi-faceted (Wilk et al. 1984). Culturally, the terms household and family often are used synonymously. Although anthropologists typically use the terms family and household loosely, they still recognize a distinction between the two terms (Yanagisako 1979: 162). However, a household is not only a domestic unit, but it also functions as a production units. Ancient and historic Maya typically lived in household units and participated in craft and workshop activities, such as salt production, lithic tool production, and pottery production. Studies of craft production are essential for understanding daily activities, economic organization, political economy, technology, exchange, and the role of craft goods in social relations (Aoyama 2007; Costin 2001).

Several factors contribute to the study of ancient Maya household production. First, we must distinguish between elite and commoner production space. In doing so, the type of workshop is determined as well. Elite craft production would have been attached to elite individuals or institutions rather than producing independently (Aoyama 2007; Costin 2001). Luxury items for the elite would have typically been produced by elite craftsmen attached to elite

compounds. Utilitarian goods would have been produced independently in a household workshop. Archaeologically, this determination is apparent in the setting, and elite versus domestic workshops should be obvious from the site context. Aoyama (2007) suggests several problems in identifying elite craft production. First, archaeological evidence of gendered craft production is limited, but recent gender studies have identified male and female production agents. Second, preservation is an ongoing issue when identifying craft production areas. Most perishable products in the Maya area do not survive due to the tropical climate. Therefore, any perishable goods produced, or perishable items used to produce goods do not show up in the archaeological record.

Within a production area, two main sources of information are the structure and material culture (Santley and Hirth 1993). By examining the structure, information about social and production organization, cultural functions, and the built environment, may be determined. The general layout of a built structure can indicate function. Material culture is also vital to interpreting household function. Material culture primarily includes analysis of domestic trash dumps, or middens. Middens offer information regarding what materials were used on a daily basis, and what materials may have been chosen over others at a site. Often within production areas, discarded material has been reused (Santley and Hirth 1993). Even though the investigation of structures and material culture are presented as separate sources of information, they are closely tied to one another.

### **Social Organization of Households**

Within these parameters, the type of household varies, depending on how production is socially organized (Yanagisako 1979). This inquiry leads us to consider the social stratification within households. Yanagisako (1979) stresses that peasants have been studied in a manner

which makes them seem like a uniform, if even faceless, aspect of past societies. Although there exists a definite wealth line demarking elites and commoners, each social stratum also had its own hierarchy of wealth as well. Peasants or commoners had differences in social status and wealth, as did lords and elites. These differences are not always apparent, and may often be overlooked “because they are so often obscured by kinship relationships which bind the landed to the landless and the land-rich to the land-poor” (Yanagisako 1979: 176). In order to comprehend the composition of ancient households, factors of demography, economy and social status must be invoked.



## **Craft Specialization and Production Space**

Several types of production space are used in the production of goods. Domestic craft production is, and has been, very common in the Maya area. Within settlements, individuals often produced ceramics for personal or household utilitarian uses only. Domestic craft production has its foundation in this sort of activity. These types of production spaces are a part of the household dwelling unit. Such domestic production would have produced ceramics, shell ornaments, stone tools, and sometimes salt.

Other types of production focus on a higher quantity of product. Quantitative production would require a higher intensity of output and, therefore, labor, as well as a larger space to work. The combination of a larger space and larger workforce was essential for certain trade goods such as ceramics, stone tools, and salt. Domestic and workshop craft production often overlap in product, for the scale of production depends on the economic factors at the time, as well as proximity to natural resources.

Another aspect of production is sociopolitical in nature. Differentiation between independent and attached production must be discussed here. Independent production is focused on production for a variety of consumers. Attached production is focused on production of goods primarily for elites. Production of goods within elite households is referred to as attached production (Hirth 2009). This form of production involves the development of institutions and practices that advance control over production (Costin 2001: 298).

Several methodologies may be used to interpret production spaces. Archaeologists use the term ceramic ecology to interpret context for areas of ceramic production. Ceramic ecology is a “facet of cultural ecology...which attempts to relate the raw materials and technologies that the local potter has available to the functions in his culture of the products he fashions” (Arnold

1991: 4). middle range research is also useful in archaeology. Essentially, this method of investigation seeks to compare modernity to the archaeological record in order to infer past activities. In conjunction with ceramic (or cultural) ecology, and middle range research, a look at spatial organization can provide much insight into an archaeological site. Arnold (1991) describes these methodologies in the context of domestic ceramic production, but the combination of ceramic ecology, middle-range research, and spatial organization would aid investigation into any production space.

### **Domestic Craft Production**

Domestic craft production was, and still is, a major enterprise among the populations of Mexico and Central America. Feinman and Nicholas (2011) note that most evidence for prehispanic production activities has been found in residential contexts. Products for use must be integrated into the economy, so these households must have been linked with exchange networks. Feinman and Nicholas (2011) surveyed two prehispanic production sites in the Valley of Oaxaca: Ejutla and El Palmillo. At both sites, craft production was carried out in domestic contexts. Ejutla produced ceramics and small shell ornaments, while El Palmillo produced stone tools. Ejutla is located in the highlands of the Ejutla Valley. This location raises the question of how and why this landlocked settlement procured and produced shell ornaments. Shell was a precious and symbolic commodity in Mesoamerica, and was used as currency during the late prehispanic era (Feinman and Nicholas 2011).

Archaeological excavations at Ejutla uncovered domestic areas and middens – indicating residential occupation. Also present were chipped stone tools made of chert and obsidian. These items were not produced as a trade good, but were used in the production of shell ornaments (Feinman and Nicholas 2011). Feinman and Nicholas (2011) suggest that the abundance of shell

at Ejutla would more than provide for local needs, and therefore indicates mass-production for long-distance trade. Also produced at Ejutla were utilitarian ceramics and mold-made figurines.

Excavations at El Palmillo, like at Ejutla, uncovered evidence of residential occupation: domestic refuse, human burials, and fire hearths (Feinman and Nicholas 2011). The craft activities at El Palmillo included primarily stone tool production. Local chert was used at the site to make bifaces, perforators, points, scrapers, and unifaces (Feinman and Nicholas 2011). The presence of spindle whorls and bone tools, such as awls and needles, possibly indicate cloth production, or at least a fiber industry. Evidence of domestic craft production is clear at Ejutla and El Palmillo. However, the scope of craft production varied between these sites. El Palmillo household production varied among individual households, while Ejutla production was more intense and homogenous.

Within the Tuxtlas region of Veracruz, Mexico, people in several modern communities practice ceramic production. These communities, which are nestled in the San Martín Massif, are San Isidro, Sehaulaco, Bascascaltepec, and Chuniapan de Abajo. In his ethnoarchaeological study of these craft-producing communities, Arnold (1991) examines the social aspects of craft production. In these communities, craft production is performed seasonally by peasant women. The men are agriculturalists. Although these communities are in close proximity, they do exhibit minor variability in production methods (Arnold 1991). All communities participate in seasonal production activities. Their scale and modes of production are not uniform, having certain “crucial differences” in production tools and techniques (Arnold 1991: 35). In regard to the final product, the ceramics, although produced in slightly differing methods, are all similar in manufacture and purpose.

Aoyama (2007) investigated lithic artifacts in craft production at Aguateca, Guatemala. He not only documents lithic production, but also the craft activities performed using lithics. The lithics used were obsidian and chert. Prismatic blades were produced from the obsidian, whereas chert was used to produce bifaces and bifacial points (Aoyama 2007). The obsidian blades were used for wood carving, meat processing, and possibly carving shell or bone (Aoyama 2007). The chert assemblages were used for meat or hide processing, bone and shell carving, stone working, wood carving, cutting grass, and digging (Aoyama 2007). Aguateca was home to household (commoner) as well as elite craft production. Aoyama (2007) notes that a significant number of Maya elites of both genders engaged in artistic and craft production, but not as a specialization.

Good (1995) has documented modern salt production in the Mexican state of Guerrero. This cottage industry is composed of kinship groups, who usually move to dry marshland during the dry season to practice their craft. Since salt workshops in Guerrero are typically seasonal occupations, and the rainy season floods the salt workshops, the production apparatus must be rebuilt every year. Good (1995) documents that the production units are built by the men. However, after the labor for constructing the salt-making equipment is complete, the male members of the family usually spend their days fishing, or they leave to seek wage labor elsewhere. Any men who remain are seen to be helping their female relatives – daughters, wives, mothers – in the salt-making process.

Traditionally in Mexico, salt is produced by evaporating salt-rich water or brine via sunlight in order to concentrate the salt crystals. This solar evaporation method of salt production is still practiced in Guerrero.



Figure 1: Solar drying pans at a multifamily saltworks at Chautengo, Guerrero, Mexico (Good 1995: Figure 6)

Household production and specialization has also been documented at Ceren (Sheets 2002). Households at this site have been interpreted as producing most of their own food, architecture, and implements (Sheets 2002). As well as a standard toolkit for stone, wood, and ceramics, householders have also been documented as engaging in at least one form of excess production (Sheets 2002). Such part-time production activities would have included groundstone tools, gourd, textile and fiber, and agricultural products (Sheets 2002).

### **Workshop Production**

Although domestic production was geared toward local consumption and a smaller quantity of goods output, workshops were used for mass-produced goods for local, as well as distant consumption. Goods such as stone tools, ceramics, and salt were items which were produced domestically as well as in workshops. One example of production for trade by workshops is Shafer and Hester's (1983) description of chert mining and tool production at Colha. Chert was an important natural resource for the Maya. Colha, Belize, is located in a "chert outcrop zone" (Shafer and Hester 1983: 519). The mining of chert at Colha is

demonstrated in the similarity between the worked chert and natural chert, the massive amounts of chert debitage, and the presence of tool failures and tests (Shafer and Hester 1983).

The most common evidence of a production area is debris or debitage and product failures (Costin 2001). Apparently the numerous workshops recognized at Colha suggest a successful venture. Shafer and Hester (1983) documented eighty-nine chert workshops at Colha and the vicinity, and dated the workshops from the Formative period (2000 B.C. to A.D. 250) to the Postclassic period (A.D. 900 to 1300). The difference between workshop and domestic craft activity is demonstrated by the high amount of material in the assemblages; the production at Colha certainly has surpassed local consumption (Shafer and Hester 1983).

Moholy-Nagy (1990) combined archaeological as well as ethnographic data in her investigation of lithic workshops. In her ethnographic investigations, Moholy-Nagy (1990:273) determined that in all cases, procurement and preliminary working of raw material was done at the quarry site, whereas the production of the finished product occurred at residential workshops. If workshops were located in close proximity, if not as an extension of a residence, debitage would most certainly have been disposed of in certain places, away from the residence. Since debitage is typically removed from its primary context, and found in secondary workshop contexts, Moholy-Nagy (1990) warns of the difficulties in distinguishing between workshops and workshop deposits. She states that the “insight gained from ethnoarchaeological and archaeological research permit us to distinguish between lithic workshops and workshop deposits, and between the production and discard stages of the use-life trajectory” (Moholy-Nagy 1990: 277).

Moholy-Nagy (1990) asserts that debitage does not remain in its primary context at workshops, but rather is moved to discard or dump areas. She noted that the term “workshop

deposit” is used interchangeably with “workshop” when the correct term should be “workshop dump” (Moholy-Nagy 1990: 268).

Moholy-Nagy (1990) identified six types of lithic deposits found in the archeological record. These include debitage mounds, unincorporated debitage concentrations, microdebitage incorporated into floors, debitage incorporated into construction fill, debitage included in special deposits, and random scatters (Moholy-Nagy 1990). A primary concern in this discussion is primary versus secondary context. Moholy-Nagy (1990) argues that in most cases, lithic debitage is found in secondary context. After all, craft workers would have preferred to keep their workspaces clean, in part to avoid any accidents from walking over sharp lithic debitage. In her discussion of the different types of lithic deposits, Moholy-Nagy (1990) suggests that the lithic debris on mounds often are in primary context (Moholy-Nagy 1990: 270). Debitage concentrations also are referred to as middens. They typically include domestic refuse as well as household craft refuse. Often, craft workers would remove all debitage from living areas. However, the Lacandon Indians of Chiapas did not remove debitage from houses soon to be abandoned. Moholy-Nagy (1990) asserts that microdebitage is usually in primary context, and microdebitage is therefore a good indicator of lithic workshops. However, she also states that it may be difficult to determine exactly what type of activity took place in areas where microdebitage is found in primary context (Moholy-Nagy 1990: 271).

The general practice of the ancient Maya was to re-use architecture. Often, when a structure was built over an earlier construction, the fill consisted of earth or middens. Lithic debitage was also used in special deposits such as caches and burials. Lithic debitage is often found in random scatters. Moholy-Nagy (1990) attributes this type of distribution to postdepositional factors.

Salt production is yet another mode of workshop craft production. Studies of ancient and modern salt production have been conducted in Mexico and Central America (Reina and Monaghan 1981; Andrews 1983; MacKinnon and Kepecs 1989; Good 1995; Williams 1999; Parsons 2001; Santley 2004; McKillop 1995, 2002, 2005, 2009). Salt is, and has been, an important commodity throughout history. Salt is a basic biological need, and has also been used in food preservation, textile dyeing, silver production, and rituals (Reina and Monaghan 1981; Andrews 1983; Williams 1999; Parsons 2001; McKillop 2002). The people of Sacapulas, in the highlands of Guatemala practice such workshop production of salt. Salt production here has been practiced and passed down over generations. Historical documents give us insight into the traditional method of salt production (evaporation by fire), which was still in use when Reina and Monaghan's (1981:15) study was conducted. Today, selling salt is often more profitable than wage-labor or agriculture (Reina and Monaghan 1981). Therefore, Sacapultecos need not travel far to market their product.



## **Natural Resources for Craft Production**

Natural resources in the Maya area are as vast and varied as the physical landscape. In order to produce trade goods, the Maya would have needed to exploit those natural resources available to them. The economy and trading spheres of the ancient Maya were integral to the social, political, and subsistence strategies of these prehispanic peoples. Andrews (1983) suggests that access to important natural resources and control of their trade was a major factor in state formation in the ancient world.

Control and trade of natural resources was important, since the Maya area covered vast and various landscapes. The Maya area encompassed modern day Mexico, Belize, Guatemala, Honduras, and El Salvador. This region, referred to as Mesoamerica, is divided into three main areas: the northern Maya lowlands, the southern Maya lowlands, and the southern Maya highlands (McKillop 2004a). The northern lowlands are the Yucatán Peninsula, which lies on a limestone shelf running from Yucatán to Belize. This karstic environment is home to the Puuc hills, and very few permanently flowing rivers (Coe 2005). The southern lowlands include Belize, the Peten district of Guatemala, and parts of Chiapas, Mexico. Contrasting with the karstic environment to the north, the southern lowlands are a more diverse area. This area is covered by tropical rainforest, and has more topographic relief such as limestone, sandstone, and granite rock formations. The southern lowlands are home to the Maya mountains, which are three granite batholiths in southern Belize. The southern highlands are located in southern Guatemala, Honduras, and El Salvador. This area includes volcanic mountains, from which obsidian was procured. This area was also good for agriculture due to the mineral-rich volcanic soils. Also from this area came volcanic basalt, which was imported in large blocks to the lowlands to make grinding stones for preparing corn. Each of these geographically diverse

landscapes has played its part in promoting trade in the ancient Maya economy. People in different regions were in need of certain natural resources and products that were not locally available. At the same time, these regions had products locally available which could be exploited. Such items would have included obsidian and basalt from the southern highlands and limestone, sandstone, and granite from the lowlands.

## **The Ancient Maya Economy**

Economic study is vital to our understanding of how the ancient Maya civilization developed, and how these ancient peoples lived on a daily basis. This includes trade of subsistence and exotic goods. If the ancient Maya had a centralized or decentralized economy is still debated. However, evidence of trade is obvious. Whether this trade was long-distance or local is not so clear. Local trade within regions was profitable and successful. Long-distance trade of exotic goods and staples has been documented as well. The extent to which local and long-distance trade extended is relatively known, as well as which items would or would not have been limited to near or far areas, although these exchange patterns are still being investigated. The general consensus is that exotic goods tended to be traded locally and long-distance, whereas subsistence goods were typically traded locally. Another consideration to keep in mind is that the development of trading spheres parallels or gives rise to major centers and complex societies (Rathje 1971; Freidel 1978, 1979; Voorhies 1982).

Following is a review of different models for the role of trade in Maya civilization. I consider several approaches to a centralized Mesoamerican economy, such as Rathje's (1971) cultural ecological model, Tourtellot and Sabloff's (1972) centralized economy theory, Voorhies' (1982) lowland to highland trade model, Polanyi's (1957) institutionalized economy theory, Berdan's (1978) centralized power theory, Dahlin's (2007) marketplace economy approach, and Halperin's (2001) view of the importance of household trade within market economies.

Several arguments for a decentralized Mesoamerican economy include Friedel's (1979) interaction sphere model, Renfrew's (1975) down-the-line model, Blanton's (1976) local

interaction sphere model, Blanton and Feinman's (1984) world system approach, and Hirth's (1978) gateway community theory.

### **Centralized Economy**

One viewpoint on the Maya lowlands is that this area was deficient in natural resources, and therefore dependent on trade with the highlands for subsistence goods. William Rathje (1971) was a supporter of this view. In his cultural ecological model, he describes trade as an economic way to distribute items from the highlands to the lowlands (Rathje 1971). According to this model, a complex society would have been formed in order to distribute the resources acquired through trade. Tourtellot and Sabloff (1972) also endorse a centralized economy in the Maya area. Subsistence, or useful items were traded locally and luxury, or functional goods were traded long distance.

Despite the argument for a centralized or decentralized ancient Maya economy, the fact remains that the general rules of trade and exchange are the same for local and long distance goods (Graham 1987). Graham (1987) notes that the Maya lowlands contained resources which could be exploited, such as granite for manos and metates, volcanic ash used in pottery, as well as chert, and clay. Barbara Voorhies (1982) also focuses on lowland trade. She supports the idea that the lowlands had perishable resources that were valued in the highlands. One such resource would have been salt. Salt making has been documented for many decades on the north coast of the Yucatán peninsula. Employed during prehispanic, as well as historic periods, the salt industry has been the focus of some studies on ancient Maya economy (Andrews 1983, 1979; Andrews and mock 2002; Good 1995; Gutman 1972; Hewitt, Marcus and Peterson 1987; MacKinnon and Kepecs 1989; McKillop 1995, 2004a, 2005a, 2005b, 2009; Parsons 1994, 2001;

Reina and Monaghan 1981; Santley 2004; Valdez and mock 1991; Valdez, et al. 1996; Williams 1999, 2008).

Karl Polanyi (1957) describes a substantive approach to investigate the way economies are embedded in society and culture. Polanyi suggests an institutionalized economy in Mesoamerica. In this model, the economy is an instituted process. Economic activity is embedded in the institutions, which move the material goods (Berdan 1978). Stability and coherence, which are the result of this institutionalized process, are achieved through three generalized patterns: reciprocity, redistribution, and (market) exchange (Berdan 1978). The movement of resources requires centralized power. In addition, this exchange system relied on ports of trade for foreign exchange. A major characteristic of this model is neutrality. By remaining neutral, ports of trade ensured safety for foreign traders, which promoted exchange in the said port of trade (Berdan 1978). Polanyi (1966:100) states that “unless the government was both capable and willing to defend its neutrality and to enforce law and impartial justice, foreign merchants had to avoid places occupied by military power”. Merchants reside in the port. Their activities are regulated. Locals in these markets provide a link between the foreign merchants and themselves; in other words, these ports of trade are closely linked with surrounding states (Berdan 1978).

The marketplace economy has also been investigated in the Maya area (Dahlin et al. 2007; Halperin et al. 2009). Dahlin (2007) uses soil analysis to determine the location of ancient Maya markets. Since market exchange goods were mostly perishable, markets or places of trade are difficult to identify in the archaeological record. Typically located in urban areas, marketplaces are not only an economic sphere, but also a social one. According to Dahlin (2007), geographic and locational models of economy may also serve political, administrative, or

ritual purposes. Halperin (2001) explores distribution patterns of Maya figurines. Using this example, she examines how households were an important factor in the exchange and interaction networks in the Motul de San Jose Region of Guatemala. Data from this study support evidence of Late Classic period Maya markets, or at least a form of centralized exchange.

### **Decentralized Economy**

Freidel (1979) proposes that complex societies formed through interaction spheres. These areas of interaction focused on trade and contact between sociocultural groups. This interaction fostered a beneficial relationship between these groups, which in turn fostered the development of an elite-controlled trading sphere. As an adaptive response to the influx of long-distance trade goods, elites in the core area of Petén began controlling distribution of said goods on the local level (Freidel 1979). This, then, led to competition among neighboring, or buffer areas for these goods, which fueled elite control of trade goods and the rise of more complex society, or culture areas. The culture area model contrasts with the interaction sphere model in that the latter postulates a connection between elite and local levels via an information network, which Renfrew (1975) has termed “down-the-line” long-distance networks (Freidel 1979).

In his review of the interaction sphere model in highland Mexico, Blanton (1976) states that the primary requisite for local interaction networks is a sedentary settlement. He further states that if these local interaction spheres are found in most non-Western societies, this fact in itself is not enough to spur the development of regional interaction spheres and complex society. Later, Blanton and Feinman (1984) suggest a world systems approach to interregional trade. In this model, the elite had control over luxury goods, movement of trade between the core and periphery areas stimulated the development of complex societies (Blanton and Feinman 1984).

Hirth (1978) suggests emergence of gateway communities in Formative Mesoamerica. As opposed to central places, which are centralized settlements at the center of an interaction sphere, gateway communities are located on the outskirts, or to one side, of the central point of interaction. These communities developed along trade and communication routes. People would have “operate[d] as commercial middlemen involving more ‘wholesale’ activities” (Hirth 1978).

### **Noncentralized Economy**

Another consideration is that the Maya economy was of a more “fluid nature involving both centralized and decentralized movement of items relative to the time and place” (Pemberton 2005). This type of noncentralized organization was evident in the function of independent craft specialists (McKillop 2002: 182). Attached craft specialists worked in cities and produced goods for the elite, whereas independent craft specialists lived in close proximity to natural resources and produced goods within their households (McKillop 2002). McKillop (2002:182) states that the “noncentralized organization of independent specialists reflects Classic Maya political economy”.

One such type of “uncentralized” trade was that of the southern coast of Belize (Pemberton 2005). In addition to subsistence items such as seafood and salt, the sea provided materials for ritual items such as stingray spines for bloodletting (McKillop 2007). Coastal trade routes have been regarded as merely a link between highland resources and lowland consumers (McKillop 2007; Rathje 1971). After the Classic period collapse, populations may have emigrated away from the inland cities that fell. Due to the influx of people, and the inevitable need for trade, the development of coastal trade in the Maya area has been seen as a Postclassic period development (McKillop 2007).

## **The Importance of Salt**

Salt is a highly desirable commodity. It is a biological necessity, as well as a key ingredient in food preservation, textile dyeing, silver production, and is used in ritual and for medicinal purposes. In addition to its physiological importance, salt is also a sociocultural and ideological object. In past societies, salt has been known to facilitate prestige and impersonal exchange in market economies (Parsons 2001).

Salt is a basic biological need. Salt regulates blood pressure and kidney functions, and a lack of it can cause muscle cramps, dehydration, and sometimes even death (Andrews 1983; McKillop 2002). Salt is naturally obtained from animal proteins and fats. In the tropical environment of the Maya area, animal protein was not part of the everyday diet, due to the shortage of domesticated animals (Williams 2008; Andrews 1983). The only domestic animals among the ancient Maya were the domesticated dog, Muscovy duck, and the stingless bee (McKillop 2004). Other sources of protein included white-tailed deer and peccary at inland sites, and fish, manatee, and sea turtle at coastal sites (McKillop 2004).

The body has a need to balance salt intake, in order to maintain equilibrium of bodily functions. Due to the hot and humid climate, salt intake in the Maya area would have been high. There is much debate about how much salt per day a Maya would have needed. Estimates for daily salt consumption range from 0.7 grams to 20 grams (Parsons 2001). A person who exerted more energy, such as a milpa farmer, would have required up to 30 grams of salt per day (MacKinnon and Kepecs 1989). The estimated salt requirement for the average Maya would have been 8 to 10 grams per day (Andrews 1983; Williams 2008; Parsons 2001).

Parsons (2001) notes that, historically, people consume far more salt than is required. The rise in consumption of artificial salt was due to not only an acquired taste for salt, but also



due to salt “consumed outside the human body” (Parsons 2001:5), through meat preservation, tanning hides, making soap, cloth-dyeing processes, and other economic activities. He suggests that the data for non-dietary and dietary uses for salt have been lumped together, thereby skewing the true calculation for average per-capita salt intake. Salt has also been used as a preservative for food and to tan animal skins. Food preservation played an important role in long-distance trade of foodstuffs, as well as for storing food for long periods of time. Salt has been documented as a preservative throughout prehistory in Mesoamerica. Valdez and mock (1991) suggest a link between salt-making and the preservation of seafood using salt at the site of New River Lagoon on the north coast of Belize. The presence of abundant salt-making artifacts, as well as abundant marine animal remains at the site, suggest to them that this was a site where salt processing and preservation would have surpassed local needs. However, seafood remains are not common at Classic period inland sites. Where seafood remains do occur is usually in elite contexts, which may suggest that seafood was a delicacy at inland sites (MacKinnon and Kepecs 1991; McKillop 1995, 2002; Valdez and mock 1991).

Textile dyeing was another economic activity which required salt. Saline solutions were often used as mordants by traditional cloth dyers around the world (Parsons 2001). Parsons (2001) notes that Stanfield’s (1971) description of preparing mordant ash and brine for cloth dyeing in West Africa may be useful in interpreting types of archaeological remains found around Lake Texcoco in the Valley of Mexico. Parsons further suggests that there may have been a direct link between salt makers and cloth dyers, since both activities necessitated the need to prepare brine. The salt-makers and textile dyers may have in some cases been the same people. Alternatively, salt-makers may have prepared brine for local dyers (Parsons 2001).

Salt has been used in producing silver. During the 16<sup>th</sup> century, Bartoleme Medina invented the de patio process to extract silver from the ore (Williams 1999:400). Instead of smelting, silver was extracted from the ore through chemical reaction between sodium and mercury. This new method of producing silver was cost-effective and less labor-intensive.

Ethnographic and ethnohistorical research has documented salt in ritual and medicinal use among the ancient Maya. Salt is considered to have sacred or spiritual attributes depending on the source. Several salt sources are considered sacred among the modern Maya, such as Sacapulas, San Mateo Ixtatán, and Salinas Atzam (Andrews 1983; Reina and Monaghan 1981). Certain color, taste, medicinal, and spiritual qualities are attributed to salts from these sources. Colonial Spanish chroniclers reported this sacred status of salt, and in many cases, indigenous religion and Catholicism were combined. Temple platforms, colonial and modern shrines, and wooden crosses are present at salt sources as statements of the sacred status of salt (Andrews 1983). A celebration is held every year at Sacapulas in honor of the spiritual alter-ego, or essence, that presides over the Salinas, or salt marshes (Reina and Monaghan 1981). The Catholic church at the Salinas Atzam in Chiapas has a shrine to the Virgin del Rosario, who is the patron saint that protects the sacred salts used by the local community (Andrews 1983). Salt use has been documented in curing ceremonies, birth and death ceremonies, as a glaucoma and epilepsy treatment, and to prevent conception, among other uses (Andrews 1983). MacKinnon and Kepecs (1989) suggest that pure white salt from the salt flats of the northern coast of Yucatán was preferred among the Maya for these purposes.

Salt has also been documented as a tribute item. The Triple Alliance of the Aztec empire received salt tribute from the Tehuacan area in southern Puebla, Mexico (Codice Chimalpopoca 1945:65, cited in Parsons 2001: 154). The *Codice mandocino* identifies a glyph for the

community of Iztacalco. Anaya has interpreted this glyph as depicting the apparatus for leaching salt from soil and boiling the brine (Paso y Troncoso 1886: 197, cited in Mendizabal 1946: 281, cited in Parsons 2001: 154).

## **Methods of Salt Production**

Salt is traditionally produced by solar evaporation, by heating in pots over fires, or sometimes a combination of both methods (Andrews 1983; Williams 1999). An additional source of salt production was palm ash. This method has been documented in the seventeenth century in the Petén region of Guatemala. The two species of palm documented specifically for salt production were *Sabal Mayarum* and *Cyrosophila agentia*. The plants were burned for the ashes, which were soaked in water, and then evaporated, leaving a salty residue (Andrews 1983). This method of salt production is noted as being very labor intensive for the small amount of salt produced (Andrews 1983). more widespread and well documented are the solar evaporation and evaporation by heating over fires. Both methods are still employed today in Mexico and Central America. The solar evaporation method allows natural evaporation via sunlight, of saline-rich brine in shallow pans. Evaporation by heat over fires results in salt cakes or loose salt crystals.

### **Solar Evaporation**

Solar evaporation was, and still is, used in the northern coast of Yucatán, where salt beds are abundant, and in western Mexico. The salt beds of Yucatán are located in the shallow coastal zone, which has high salinity content. Salt production was typically carried out in the dry season, in order to take advantage of the abundant dry and sunny weather. The solar evaporation method of salt production in prehistoric times would probably have involved raking or somehow gathering the salt from the mostly dry salt beds into sacks or vessels to carry back to the salt-production site. This salt water would have then been deposited into shallow evaporation pans to concentrate the salt. The tools used for modern salt production via solar evaporation include hoes, shovels, pick axes, and wheelbarrows. In prehistoric times, a fiber sack would have been used to carry soil, and ceramic vessels to carry the water to the evaporation pans. Archaeological

evidence of this process from prehispanic times has revealed itself in the form of large mounds of leached earth, broken ceramics, evaporation pans, and canals for moving water from salt springs or wells (Williams 1999).

### **Evaporation Over Fires**

Solar evaporation in the Yucatán was previously considered the only source of salt for the Maya in prehispanic times, and that it was traded over long-distances (MacKinnon and Kepecs 1989; Andrews 1983). More recent research has documented other salt sources in the lowlands, which employed evaporation over fire to produce and distribute salt. This method has been documented in southern Belize, Mexico, and northern Guatemala, including along the Belizean coast along inland lakes and springs (Williams 2008). This method of salt production has been well documented in the Maya lowlands. Graham (1994) reported ceramics thought to be associated with salt production at Watson's Island (McKillop 2002). The Watson's Island ceramics were similar to those from the modern salt-work of Sacapulas, Guatemala. Ceramics associated with the salt-making process were also identified at Placencia Lagoon, and Punta Ycacos Lagoon in southern Belize (MacKinnon and Kepecs 1989; McKillop 1995, 2002, 2005a). Tools of the fire evaporation method of salt production included ceramic pots for evaporating over fires; clay vessel supports (cylinders), sockets, and spacers; charcoal, and in some cases, remnants of architecture.

Traditionally, this method of salt production included pre-processing a brine solution. Making a brine solution included gathering salt-rich soil, then pouring brackish water over the soil. After the water filters through the soil, the resulting brine is collected in vessels, and evaporated over fires to produce salt (McKillop 2002; Williams 1999; Andrews 1983). Multiple ceramic brine-boiling vessels would have been placed over large fires, and were supported by

clay cylinders. These cylinders would have been fixed on the bottom of the vessels to allow them to be placed over the fire. Since multiple vessels were placed over the fire at the same time, clay disk-shaped spacers were placed in between vessels in order to space them evenly apart and allow for even heat distribution (Figure 3).

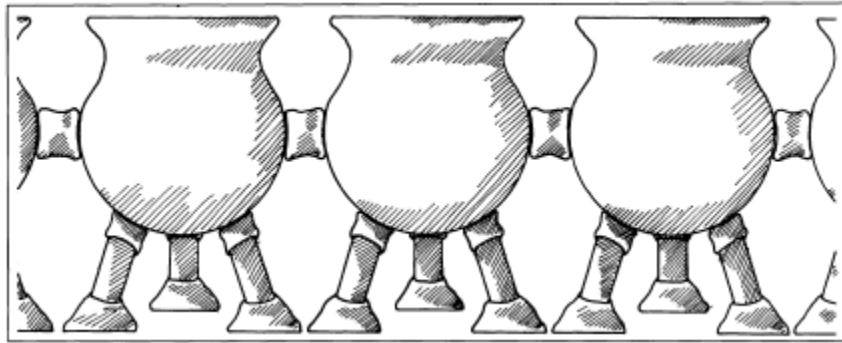


Figure 2: Configuration of fire evaporation apparatus (McKillop 1995)

## **Modern Salt Production**

### **Social Organization of Modern Salt Production**

Traditionally in Mesoamerica salt-making is considered a woman's occupation, in which technical knowledge is passed down through the females – mother to daughter or granddaughter. Good (1995) documents the organization of salt production in the Mexican state of Guerrero. This cottage industry is composed of kinship groups, who usually move to dry marshland during the dry season. Since salt workshops are typically seasonal occupations, and the rainy season floods the salt workshops, the production apparatus is rebuilt every year. Good (1995) documents that the production units are built by the men. However, after the labor for constructing the salt-making equipment is complete, the male members of the family usually spend their days fishing, or they leave to seek wage labor elsewhere. Any men who remain are seen to be helping their female relatives in the salt-making process.

The Sacapultecos of Sacapulas, Guatemala, include the labor of both men and women in producing salt (Reina and Monaghan 1981:17-18). Salt production there has been practiced and passed down since ancient times, and the identity of Sacapultecos lies in this fact. They identify with and take pride in being a group of ancient salt makers. Historical documents provide insight into the traditional method of salt production (evaporation by fire), which is still in use today (Reina and Monaghan 1981:15). Historically, Dominicans in the area uprooted peoples for labor and formed the village of Sacapulas. Each group retained its individual identity and a portion of land, but one group belonged to the owner of a salt workshop. This group of people became the salt-makers and hence, the most important group in the village (Reina and Monaghan 1981:15).

Unfortunately historic documents do not document much, if any, of the social organization of the salt-works of the sixteenth century in Sacapulas. However, the Sacapulteco life has been documented today, with attention to the social organization of salt production. Reina and Monaghan (1981) state that salt-making in Sacapulas has been a male-dominated craft, but today women are permitted to practice the craft. This change in social organization is in place due to factors of weather and ritual. Traditionally, the salt-works of Sacapulas were guarded by a male and female god, who protected and watched over the workshops. However, during a flood of the later 1940's and early 1950's, the female god was washed away. The Sacapultecos state that the female god left them for another place. The new place has salt, but the people do not possess the knowledge of salt production (Reina and Monaghan 1981:17). Due to the absence of the female god, the women of Sacapulas are permitted to practice the craft of salt production to make up for the lost salt taken away by the female god.

Three active salt-makers in Nexquipayac operate small workshops in the Valley of Mexico (Parsons 2001). Although operated by only one or two persons, these workshops are operated continually throughout the year on a part-time basis. All workshops are open-air, with the evaporation taking place under a roof (Parsons 2001). The workshops produce *sal blanca* and *sal negra*, which are made using traditional methods of evaporation over fire, although with a few modern substitutions. Salt is made by evaporating over an indoor stove, and is then collected and laid out to dry. The brine is poured into a flat, shallow metal pan on the indoor stove. After the water has evaporated, the salt-maker collects the crystalized salt and places it on a drying bed in a corner of the boiling hut (Parsons 2001).

Several forms of fuel are used for these stoves. The most popular fuel during the time of research was scrap rubber. Other types of fuel include local plants and animals such as maize



roots, and lakeshore grass, tree leaves, and animal manure (Parsons 2001). The *sal blanca* is distributed weekly by the saltmaker, either by personal delivery, in the local market, or from his house. *Sal negra* is primarily used for one purpose – preparing deep-fried pork – and is only prepared via special order, and delivered to the customer at the specified delivery date (Parsons 2001).

Tradition is at the heart of craft workshops in Mexico and Central America. The craftsmen and women who produce salt are usually descendants of indigenous groups that produced salt. Herein lies the true identity of craftspeople who produce salt. The long-standing tradition of making salt is what sets these people apart from others. They take pride in their occupation, and certainly in their product, which is usually highly prized in the particular region where the salt is produced.

### **Modern Salt Economy**

Today locally made salt in Mexico and Central America is typically not an expensive product. However, selling salt is often more profitable than wage-labor or agriculture (Reina and Monaghan 1981:29). With three salt production centers located in north-western Guatemala, Sacapulas salt is well-known in the area, and is preferred over commercial salt. Therefore, Sacapultecos do not need to travel far to market their product. In other instances, people have travelled to the saltworks in order to purchase salt. In the state of Guerrero, Mexico, a group of indigenous Indians, the Nahuas, travelled from the northern highlands to the southern coast to obtain salt to sell. This trip consisted of a caravan of mules or burros driven by individuals of kinship groups and *compadrazgo*, or friendship, networks (Good 1995). The salt from the southern coast was divided equally among those who were part of the caravan, and then sold in

their villages to earn a profit. This final profit was four to six times the original purchase price (Good 1995).

Traditionally salt has been purchased for money, as well as for bartered items. Even today this barter system remains intact in some areas. Historic documents from Mexico provide information on such bartering systems. The *Relaciones Geograficas* documents that townspeople travelled to the nearby salt-making site of Araro in the Lake Cuitzeo region to trade fish for salt (Williams 1999:403). Salt making continues to be an important economic strategy. The general process has remained the same throughout Mexico and Central America from ancient to modern times (Good 1995:10). Technology has changed relatively little from ancient or historic times, especially since the production of salt is typically a cottage industry in Mexico and Central America. Although producing salt is a time-consuming process, price remains relatively low for the finished product, which is typically sold in the same region in which the salt is produced.

## **Evidence of Ancient Salt Production**

### **Organization and Trade of Ancient Salt Production**

Modern salt production in Central America is rooted in tradition. Previously salt production was thought to have occurred only in the northern Yucatán peninsula (MacKinnon and Kepecs 1989; Andrews 1983). As research on the ancient Maya centered on the importance of the lowlands, other salt sources were discovered and documented. The most prolific evidence for salt production via evaporation over fire is briquetage - the ceramic refuse from this method. After being fired, the clay vessels may have been broken in order to extract the final product.

Research at El Salado, Veracruz, Mexico, yields evidence to support Early Formative and Late Classic period salt production (Santley 2004). The El Salado saltworks contain landform modifications made for the salt-making process. Low dams were built across a salt stream so that the salt water could be collected in ceramic pans. The salt water was then boiled to produce salt crystals. As well as the land modifications, there are mounds of leached soil, as well ceramic sherds affiliated with the salt-making process or salt trade. The ceramics were originally thought to have been used in the salt-making process, but they have also been interpreted as packaging for the final salt product (Santley 2004). This latter interpretation is due to the fabric marked decorations on the vessels. Santley (2004:200) states that this explanation “makes sense when Texcoco Fabric marked occurs at non-salt-making sites”. Santley (2004) deduces that solar evaporation was the primary method of salt production during the Early Formative period at El Salado, whereas the method of evaporation over fire was the favored method of salt production during the Late Classic period. The reason for this change was most likely due to a rise in population, which in turn produced a need for a higher intensity of salt production (Santley 2004). Although intensity of production increased, the El Salado saltworks probably remained a

domestic production space. Santley (2004:219) notes that, even with a need for a larger output of the good, salt production at the household or small group level would have remained so, because an increase in labor does not always increase “efficiency of manufacture”.

Guzman mound in southern Guatemala is an ancient salt-making site at which salt was harvested by evaporating by heat. Evidence of this method lies in the mounds of leached earth, as well as artifactual evidence such as fine-and utilitarian-ware ceramics, charcoal, hearths, and daub (Nance 1992). The utilitarian ceramics were of a coarse paste with thick rims and a sizeable diameter; pottery which would have been durable and able to withstand several sessions of boiling the salt brine. Daub would have been a byproduct of firing several vessels at the same time, and charcoal is obvious evidence of firing. The faunal evidence points to at least a short-term occupation at this site.

Other salt production sites with evidence of mounded earth have been recorded by the Point Placencia Archaeological Project (MacKinnon and Kepecs 1989). A number of sites were discovered on the southern coast of Belize by the project, and have been dated to the Late and Terminal Classic periods (MacKinnon and Kepecs 1989). Evidence at these sites points to the evaporation by fire method of salt production. Artifacts found include cylinders, sockets, spacers, and mounds of leached earth. Absence of such features as house mounds and domestic refuse also point to a specialized production area.

At the lowland Maya site of Calakmul, Mexico, a ‘painted pyramid’ has been discovered which depicts ancient Maya commerce (Vargas, Lopez and martin 2009). These rare murals depict daily commoner trade and consumption of foodstuffs and trade goods. Accompanying text describes the scenes, notably referring to the vendors of items, such as “maize-gruel person,” “maize-bread person,” Salt-person,” “Tobacco person,” and Clay-vessel person” (Vargas, Lopez

and Martin 2009: 19248). This structure, located in the Chiik Nahb complex within Calakmul, serves as documentation of commoner life, and the role they played in Maya commerce. The murals “portray an ancient social mechanism that has left no other evidence of its existence” (Vargas, Lopez and martin 2009: 19248).



Figure 3: Southeast corner of the painted pyramid inside the Chiik Nahb complex, Calakmul, Mexico (Vargas, et al. 2009)



Figure 4: aj atz'aam “salt person” glyph on the painted pyramid inside the Chiik Nahb complex, Calakmul, Mexico (Vargas, et al. 2009)

## **Perishable Architecture**

### **Ancient Perishable Architecture**

Wooden architectural remains are rare in the Maya area, since the tropical climate is detrimental to organic material. This “invisible” landscape is a constant challenge to archaeologists. Wooden construction is documented as a regular component of Maya architecture, although little obvious evidence still exists (Wauchope 1938; Ochoa-Winemiller 2004; McKillop 2009).

Wooden architecture has been discussed at other Maya sites such as Tikal and Cerén (Haviland 1985; Sheets 2002). Haviland (1985) suggests wooden architecture was a component at Tikal. Wooden support beams have been found in monumental architecture at Tikal, Bonampak, and Palenque (Andrews 1977; Henderson 1997; Somers 2007). Corbelled vaults of temples such as those at Tikal exhibit vertical wooden support beams, although this feature is absent in later versions (Andrews 1977). However, the ancient site of Cerén in El Salvador provides us with a glimpse into the past. This small Maya village was rapidly buried by volcanic ash from the eruption of the Loma Caldera in A.D. 600 (Sheets 2002). Wooden architecture here is evidenced in the presence of charred wooden posts, wattle and daub walls, roofing poles, and grass roof thatch (Sheets 2002). Structures which were excavated at Cerén were built on fired earth platforms, with solid earth corner columns, wattle and daub walls, and roofing poles placed at 20 cm intervals (Sheets 2002).

Post holes and post molds are archaeological features which document perishable architecture. The holes dug in order to place wooden posts are post holes. As a wooden post decays, the organic material leaves a discoloration in the soil. These stains in the soil are post molds. Such features have been documented at the sites of San Juan, Chac Balam, and Ek Luum

on Ambergris Cay, Belize (Driver 1995; Guderjan 1995c; Guderjan and Brody-Foley 1995). The first structures were constructed during the Late Classic period at San Juan, and extend to the Terminal Classic period. The entire area of San Juan was artificially elevated on 2-5 meter marl platforms (Guderjan 1995c). Most structures were of perishable materials. However, structures 3 and 4 at San Juan are round, which is rare in the Maya lowlands, and typically associated with the Postclassic period (Guderjan 1995c). Chac Balam is a formal *plazuela* group, which is rare on Ambergris Cay (Driver 1995). The seven structures excavated all exhibited evidence of numerous construction episodes. Driver (1995) suggests the formal architecture at Chac Balam may be evidence of a structured hierarchy capable of organizing labor. Ek Luum is a much smaller site, mainly consisting of two mounds (Guderjan and Brody-Foley 1995). Mound 1 has evidence of “formal architecture in a minimal sense,” having several episodes of thinly plastered floors and a small amount of ritual-related ceramics. Mound 2 is interpreted as a residential area for a prominent individual at the site. Mound 2 also exhibits evidence of two rectangular structures, possibly contemporaneous with each other, with plastered floors, post molds, and domestic refuse (Guderjan and Brody-Foley 1995).

### **Modern Perishable Architecture**

Probably the most notable work on modern perishable architecture is Robert Wauchope’s 1938 *modern Maya Houses*. This ethnological work summarizes how the modern Maya in the Yucatán, Guatemala, and Belize construct their perishable architecture. Wauchope (1938) concludes that modern Maya houses are built in continuity with their ancient ancestors. Five basic house shapes are identified by Wauchope: apsidal, flattened end, rectangular, square, and round.

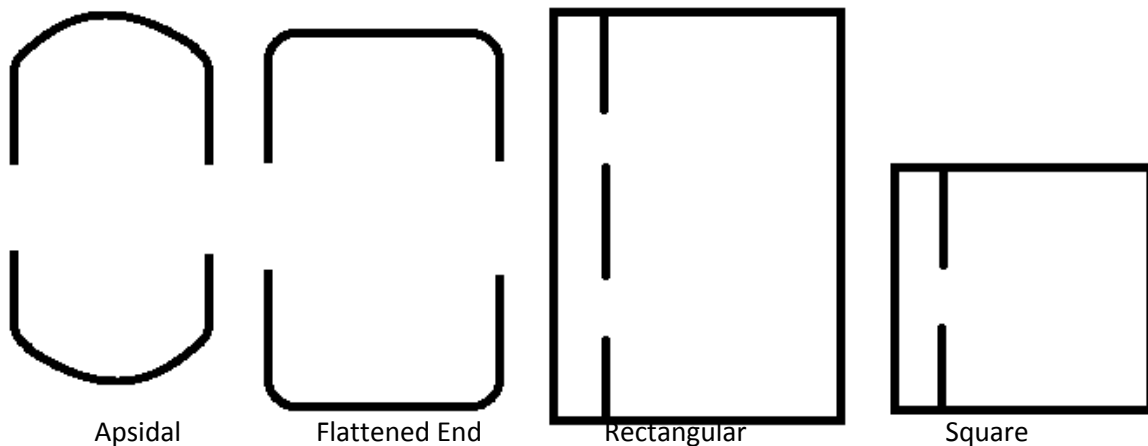


Figure 5: Basic house shapes, modeled after Wauchope (1938)

Apsidal houses are rectangular with rounded ends. Wauchope notes that the mainposts, which support the roof, always lie inside the line of the walls (Wauchope 1938). Apsidal houses are mainly encountered in the Yucatán, and is noted by Wauchope (1938) that they are absent in Guatemala. Apsidal plans have a *moi* and *kop u moi*, or roof purlins, which are used to secure roof supports via rope or vines (Wauchope 1938). Flattened end houses are rectilinear with rounded corners. Wauchope (1938) attributes this type of house plan to be the result of an attempt to build a rectangular structure around a framework typical of apsidal houses. Mainposts in flattened end houses are closer to the wall than in apsidal plans. Compared to apsidal and flattened-end houses, rectangular house plans have more mainposts which are smaller in diameter and lie inside the line of the walls (Wauchope 1938). Square houses have walls of equal length, with the mainposts in line with the walls (Wauchope 1938). Round houses are simply defined as having a circular plan and conical roof. Wauchope (1938) notes that he did not observe any round dwellings in his research area.

Mainposts for all house types range in diameter between 12 and 18 cm. Walls may be constructed of materials including cane, bamboo or rush, lashed together in either a horizontal or



vertical direction, and may or may not include wattle (Wauchope 1938). Walls are also constructed using rubble. Dry rubble masonry typically uses large limestone rocks laid without mortar. Rubble masonry requires the limestone to be broken and heated, with marl collected to use as mortar. Adobe brick construction is typical in Guatemala and Costa Rica, due to the frequency of earthquakes in the region (Wauchope 1938). A combination of these wall types and house shapes are documented in modern and ruined houses in the Maya area.

Moore and Gasco (1990) also document modern pole and thatch structures in Chiapas, Mexico. Citing Wilk (1983), Moore and Gasco (1990) note that the perishable structures encountered on the coast of Chiapas are typically serial dwellings which need constant maintenance to replace deteriorating building materials. Although these dwellings may have a short use-life, they have been noted to be occupied for at least five years, and upwards of ten in some cases (Moore and Gasco 1990).

## The Punta Ycacos Lagoon Saltworks

McKillop (2005a) has identified remnants of wooden architecture of ancient Maya salt-making sites in Punta Ycacos Lagoon in southern Belize, which date to the Classic period (A.D. 300-900). Due to the inundation of these sites, wooden posts have preserved. The existence of a large amount of salt-related materials and the lack of household debitage or middens around the structures indicates that these were areas of salt production (McKillop 2005a).



Figure 6: Map of the Maya area showing the location of Punta Ycacos Lagoon (McKillop 2004)

Paynes Creek National Park is a wetland habitat located in southern Belize. This habitat includes red, black, and white mangroves, and the Punta Ycacos Lagoon system. Within this lagoon system lie remnants of an ancient Maya extractive industry. Due to sea level rise during the Holocene, these remnants of ancient life have been preserved below the sea floor. The most remarkable, yet elusive, of these artifacts is wooden architecture. Although research had been ongoing since 1991, the discovery of wooden posts was not made until 2004 (McKillop 1995, 2009). What appeared to be a naturally occurring wood feature during 2004 survey turned out to be a modified wooden post with evidence of sharpening on the end (McKillop 2009). This unexpected discovery “led to the realization that Paynes Creek salt production was a massive industry with an extensive infrastructure” (McKillop 2009). Upon this discovery, previously surveyed sites were re-surveyed, and found to have wooden posts as well (McKillop 2009). As more posts were discovered and mapped, a pattern emerged in which the posts formed rectangular outlines of structures. The remnants of built structures, and evidence of ceramics historically used in salt production, point to the conclusion that salt production here likely took place within these structures, and was a highly organized, mass production industry (McKillop 2005a, 2009). Previous to finding wooden posts, the salt workshops were interpreted as small-scale, temporary production sites. However, with evidence of buildings, the scope of research changed significantly. The investment of time and labor to build such structures marks an enduring and intensive endeavor.

### **The Eleanor Betty Site**

The Eleanor Betty site is one presumed salt-production site in the Punta Ycacos Lagoon system which contains wooden architecture. Fieldwork was conducted at the Eleanor Betty site as part of the “Ancient Maya Wooden Architecture and the Salt Industry” project, directed by

Dr. Heather McKillop. Previous research in Paynes Creek has identified over 100 Classic Maya (A. D. 300-900) sites (McKillop 2009). Fieldwork conducted at the Eleanor Betty Site sought to determine the function of this site. Was it a site of salt production? What activities were taking place here?

The inundated Eleanor Betty Site lies in the western part of the lagoon system, near a modern-day mangrove shoreline, and is roughly 1 to 2 meter underwater. A linear survey was conducted upon arriving at the Eleanor Betty site in order to determine the general layout. In order to survey underwater, we lined up side by side to form a straight line in the water. Using our hands, we supported our bodies to float on the water and proceeded to hand-walk across the site in this line formation, feeling the sea floor with our hands to identify any features. Pin flags were used to mark the presence of wooden posts and notable artifacts, such as ceramic figurines. During this field season, three transects were excavated at the Eleanor Betty Site, all of which were placed at locations with a high density of artifacts in proximity to wooden posts. I set out to excavate a transect along a post line hypothesized to be a structure within the Eleanor Betty site, in order to determine its function.

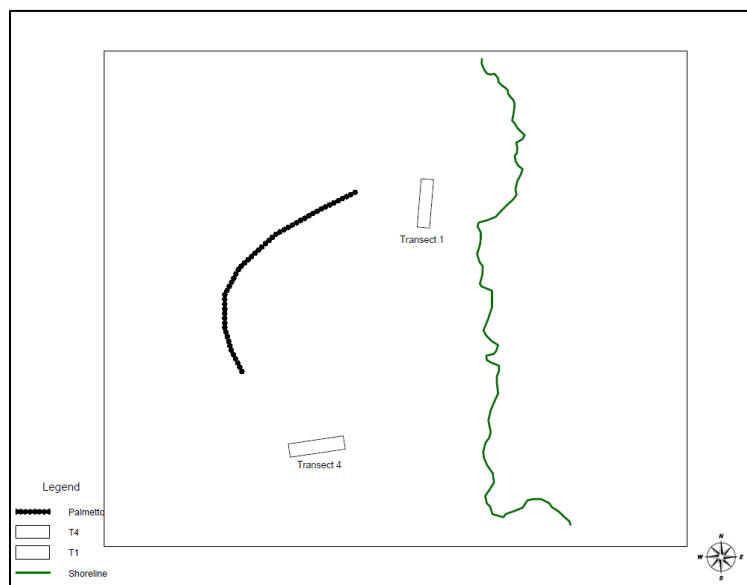


Figure 7: Sketch map of the Eleanor Betty site

## Transect 1

Underwater archaeology requires a slightly different thought process and methods to excavate. Because the Eleanor Betty site is a shallow one, excavation was a challenge. Archaeological sites that are in shallow underwater contexts prove to be the most difficult of underwater sites due to the difficulty of getting enough distance from the site without disturbing it (McKillop 2007). Since my objective was to determine the function of invisible architecture, a transect was plotted along a known post-line of a structure at the Eleanor Betty site. The structure was located in the northeastern quadrant of the site, and at the edge of the known site boundary. The transect (Transect 1) ran roughly north-northeast, following the wall of the structure. Starting one meter outside the northernmost known post, measurements were taken using a metric measuring tape in one meter increments, placing short 12-inch polyvinyl chloride (pvc) pipe segments into the sediment at each meter mark along the post-line, stopping one meter outside the last and southernmost known post in the post-line. Wire stake flags were then placed inside each pvc pipe segment, in order to see the transect above the water. The resulting transect was 0-7 meters long by 1 meter wide, running north-northwest.



Figure 8: Overview of Transect 1 at the Eleanor Betty Site. Facing north-northeast  
(Photo Courtesy of H. McKillop)

## **Materials and Methods**

Once Transect 1 was set up, excavations began. Excavation methods were to dig underwater in each 1x1 meter unit, 10 cm depth at a time. The depth in Transect 1 was dug to 20 cm total. The reason for stopping at this depth was due to the fact that artifact density was becoming more sparse, and also due to time restrictions. In order to dig underwater, some of the same methods used in terrestrial archeology were employed. A sharpened pointing trowel was used, as well as a plastic cup, and sometimes just my hands to scoop the sediment into a marine transport device (MTD). A rice sack was set inside the MTD, into which the sediment was placed. The MTD was then ferried via a makeshift pulley system to a screening station located outside the site boundary. The makeshift pulley system consisted of two long pvc pipe segments, roughly 1.5 meters in length, inserted into the sea floor, one at the screening station and one next to the transect. A long rope was then run to and around each pipe, so that the MTD could be tied to the rope and pulled to and from the excavation and screening station. As the sediment filled the rice sack in the MTD, the vessel was ferried to the screening station. The offsite screening location was set up in the lagoon itself to better facilitate water screening. Team members assisted in the excavation and screening of Transect 1. The screener would dump sediment from the rice sack into the screen while holding the screen in the water. This method often proved difficult and tedious (especially for one person), and was later aided with the addition of makeshift screen stands, which consisted of three long pvc pipe segments inserted into the sediment in a triangle pattern. Each unit was screened once using a ¼ inch mesh screen to separate any artifacts from the matrix. Artifacts were roughly sorted by category of ceramics, charcoal, shell, and botanicals, which were placed in Ziploc bags and labeled with site name, transect number, unit number, level, and a description of the contents.

## **Excavations: Level 1**

Excavation of Transect 1 began at the 0-1 m unit, reaching roughly 10 cm depth. This first level of excavation was to remove the topmost layer of sediment in order to expose the sea floor. The matrix for the entirety of level 1 of Transect 1 was silt, with a high density of mangrove roots running throughout. The presence of mangrove roots was a constant dilemma while excavating Transect 1, due to its close proximity (roughly 2-3 meters) to the mangrove shoreline. I excavated the first level using my hands to scoop up the sediment into a rice sack which was placed in a floating transport device. Once the rice sack was full, it was ferried offsite via a makeshift pulley system in order to be screened.

The matrix for unit 0-1 m at 0-10 cm level was comprised of coarse sand and silt with mangrove roots abundant throughout. A fairly dense artifact scatter was present in unit 0-1m, primarily consisting of potsherds and amorphous clay lumps (ACLs). Also present were several large cylinder fragments, an abundance of charcoal, and a few shells.

Unit 1-2 m contained coarse sandy silt matrix which was excavated by scooping it by hand into the rice sack. Mangrove roots remained constant throughout this unit. An artifact scatter was present in the form of ceramic sherds and a few cylinder fragments. Charcoal was in abundance here, while shell was sporadic.

Unit 2-3 m contained the same coarse sandy silt matrix present in the previous units. Excavations of the matrix by hand yielded an abundance of ceramics including a few large cylinder fragments and a few medium sized potsherds. Some shell and an abundance of charcoal were also present. Of note was a possible chert core and cortex, which was bagged separately.

The matrix for unit 3-4 m was the same coarse sandy silt present throughout level 1. Excavations were carried out by scooping the matrix by hand into the rice sack. Findings in this

unit were similar to those in the previous units. A ceramic artifact scatter was present in the form of potsherds, a few cylinder fragments, and an abundance of ACLs. Charcoal was found in abundance, with a few shells showing up throughout the unit.

Unit 4-5 m contained coarse sandy silt with mangrove roots running throughout. Excavations yielded similar artifact density as previous units of level 1. An abundance of ceramic sherds and ACLs, a few cylinder fragments, a few shells, and an abundance of charcoal were found.

The coarse sandy silt of unit 5-6 m of level 1 was excavated by hand and yielded an abundance of ceramic sherds, a few clay cylinder fragments, a good amount of ACLs and charcoal, and a few shells.

Unit 6-7 m displayed the same coarse sandy silt with mangrove roots in abundance throughout. Excavations were done by hand, and yielded similar artifacts as the previous unit. Ceramic sherds were abundant, with a few cylinder fragments noticeable, a good amount of ACLs, an abundance of charcoal, and a few shells.

All units of level 1 (0-10 cm) were analogous in matrix and artifacts. The entirety of level 1 was comprised of a coarse sandy silt matrix with mangrove roots continuing throughout. The close proximity to the mangrove shoreline is the reason for the abundance of mangrove roots present in the units. Ceramics seemed to mostly be briquetage, consisting mostly of clay cylinder fragments, many potsherds of Punta Ycacos Unslipped variation, and an abundance of amorphous clay lumps. Charcoal was in abundance throughout level 1. Shell was found throughout level 1, but in sparse numbers. The only lithic was found in unit 2-3 m, and was postulated as being a chert core and cortex.





Figure 9: Screening excavated material from Transect 1.  
(Photo courtesy of H. McKillop)

### **Excavations: Level 2**

Level 2 (10-20 cm) excavations began with unit 0-1 m. The matrix for this unit consisted mainly of coarse sand, with sandy mangrove peat showing up in the southwest corner. A large mangrove root was present in most of the north side of the unit, with the other areas comprised of a mangrove peat matrix mixed with sand. The central area of the unit was coarse sand. Excavation was performed using my hands to scoop out the sandy matrix, and a trowel to cut small chunks of the peat. A dense artifact scatter was present in unit 0-1 m, which consisting mainly of briquetage. ACLs ranging in size from 3-9 cm were numerous throughout the unit. Ceramic body sherds were prevalent. Charcoal showed up in a more dense concentration than in the previous level. The amount of shell remained constant.

The matrix for unit 1-2 m was comprised of a coarse sandy peat. Excavations were carried out using the same combination of hands and trowel mentioned for unit 0-1 m of level 2. ACLs remained very dense and numerous in this unit, as did charcoal. A hardwood post was discovered in the northwest wall of unit 1-2 m. A palmetto post was located right outside the

central wall of the unit. A very dense scatter of ceramics were present, including many vertical walled Punta Ycacos Unslipped potsherds.

Unit 2-3 m of level 2 consisted of a coarse sandy peat matrix, which was excavated using a combination of hands, trowel, and cup. I would excavate the more sandy areas using my hands and trowel to scoop into a plastic cup. In the areas with more peat, I would use my trowel to cut the peat in small chunks and deliver them by hand into the marine transport device. A dense artifact scatter was present here, including a good amount of briquetage. Vertical walled Punta Ycacos sherds, as well as ACL's were the most prevalent ceramics. Charcoal was found in dense quantity. Two hardwood posts were present just outside the northeast corner of the unit.

Unit 3-4 m exhibited a coarse sandy matrix with a mix of mangrove peat. Excavations were conducted using a combination of hands, trowel, and cup, as explained above. The artifact scatter in unit 3-4 m was located in the center of the unit, and was less dense than in the previous unit, although ACLs were still very numerous. Some small charcoal and a few large body sherds were present, as well as at least one Moho rim sherd, and two vertical walled Punta Ycacos Unslipped rims. The west and south walls of unit 3-4m contained a high density of sherds. The south half of the unit began exhibiting a shift from coarse sand to a peat matrix.

Unit 4-5 m was excavated using a combination of hands, trowel and cup. The matrix was comprised mostly of coarse sand with some mangrove peat. This unit displayed a higher artifact density than the previous unit. Lots of briquetage and ACLs were found, as well as a small amount of charcoal and very little shell. Some briquetage had evidence of burning on the outside.

Excavation in unit 5-6 m was performed using a combination of hands, trowel and cup. The matrix was comprised of a coarse sandy peat. Artifact density was consistent with unit 4-

5m. Dense scatters of ceramics included briquetage, including numerous ACL's of various sizes, rim and body sherds, and cylinder fragments. Little charcoal and shell were found.

Unit 6-7 m was of the same sandy peat matrix, which was excavated using a combination of hands, trowel and cup. Briquetage was found in slightly less dense quantity than the previous unit, but was still comprised of various potsherds, cylinder fragments, ACLs of varying sizes, and little charcoal or shell.

Excavations in level 2 (10-20 cm) demonstrated a higher artifact density than level 1 (0-10 cm). The types of artifacts were consistent throughout level 2. Briquetage was a main component of the artifact assemblage, as were ACLs. Of the ceramics which were not initially identified as briquetage, at least two Moho sherds were discovered. Charcoal was very dense starting in unit 1-2m, and gradually tapered off in the last two units.

Ceramic artifact density in Transect 1 demonstrates a definitive trend associated with salt production, due to the presence of such dense amounts of briquetage. Ceramic and charcoal density was certainly more in level 2 than in level 1. As excavations moved south along the post line, artifact density seemed to be sparse closer to 0m and 7 m units.

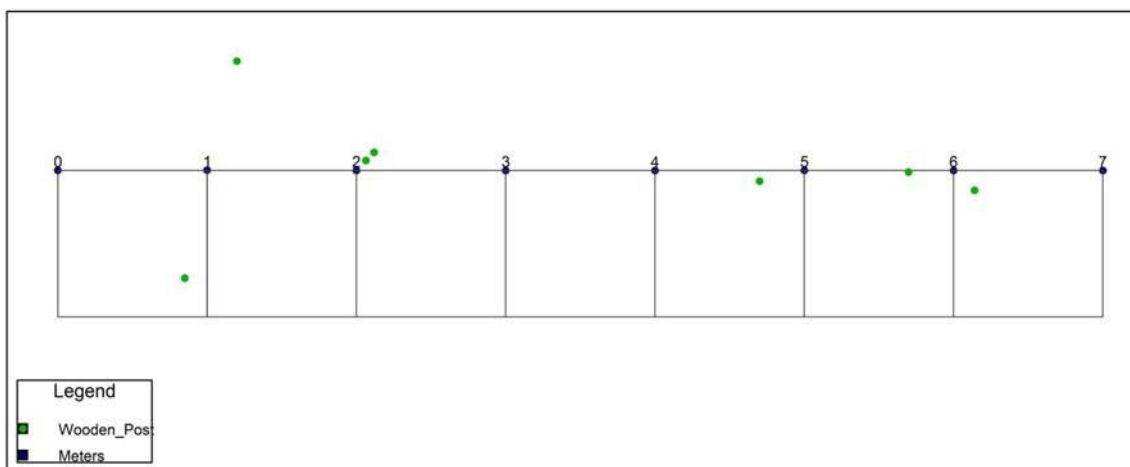


Figure 10: Plan drawing of Transect 1 showing location of wooden posts

## Artifact Analysis

Charcoal, shell, botanicals, and ceramics were the primary categories of artifacts discovered. Charcoal was found in abundance throughout Transect 1. The distribution varied among the units and depths. The charcoal was exported under permit in order to identify the wood species used in the firing process at the Eleanor Betty Site. Before exporting, the charcoal was taken back to the main laboratory in order to be processed. First it had to be dried. The drying process was done systematically by taking each unit and level, which were already bagged from screening, and arranging the charcoal in one layer across a plastic tray which was then placed in the sunlight to evaporate extra moisture. After the charcoal was dry, the weight in grams was taken for each unit and level.

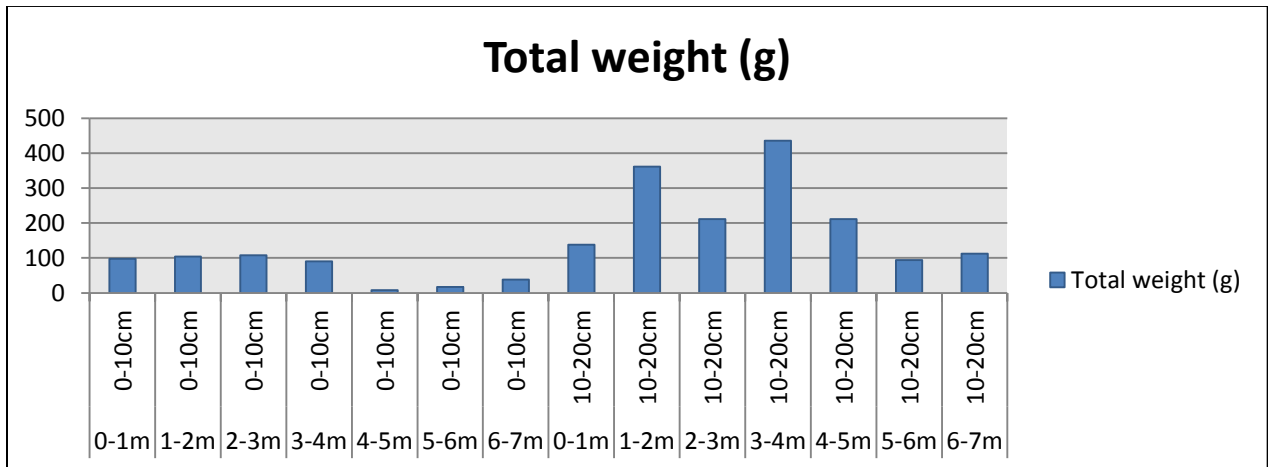


Figure 11: Weights in grams of charcoal per unit and level from Transect 1

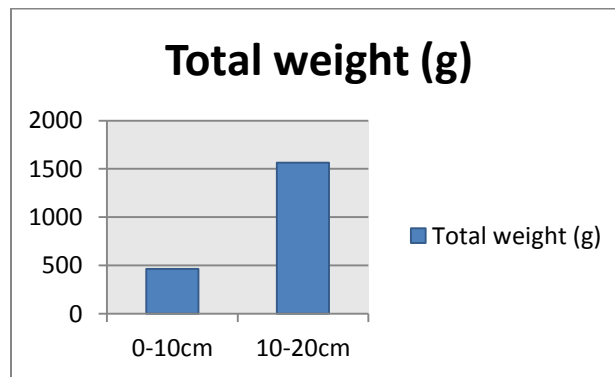


Figure 12: Total weight in grams of charcoal per level from Transect 1

Shell was not abundant throughout Transect 1. Shell was processed at the main laboratory. The shell, like the charcoal, needed to be dried. This process was the same as drying charcoal. The shell from each unit and level was turned out in one layer onto plastic trays, which were then placed in direct sunlight to evaporate the extra moisture. After the shell was dried, the weight was taken in grams for each unit and layer. The shell was not separated into different types, due to breakage. Generally the recognizable shells were mainly small bivalves and small mud conch (*Melongena melongena*) shells.

Non-wood botanicals were not very common. Coyol and cohune nuts were the primary botanicals found in excavation. Coyol, or *Acrocomia mexicana*, had a large range of economic uses (McKillop 1994, 1996; McNeil 2010). The coyol palm tree is indigenous to the Maya area, and is found in abundance. The nut was edible, and the leaves of the Coyol palm were used for thatched roofs. Cohune palms (*Orbigyna cohune*) are also native to the Maya area (McKillop 1994, 1996). The palm leaves are also used for thatched roofs and building materials, the cohune nut can be eaten raw, and is sometimes used to produce oil, while the hearts can be processed into wine (Morehart and Butler 2010). In addition, these trees regenerate quickly, provide shade, timber, fuel, protect from erosion (Goldstein and Hageman 2010). In fact, Furley (1975) states that the Maya tended to spare these trees due to the reasons listed above. Also, the trunks were very hard and durable to the extent that fire from milpa agriculture does not kill the tree (Ewel 1976).



Figure 13: Washing pottery at the Eleanor Betty Site field lab  
(Photo courtesy of H. McKillop)

## Ceramics

Artifacts were processed in the field lab for convenience and due to time restrictions. Ceramics were separated into type, following the Maya type-variety system, and then drawn and measured by Dr. McKillop, with photos by Cory Sills. I weighed artifacts by material class and provenience and assisted with sorting. Ceramics included fired clay lumps, or amorphous clay lumps (ACLs), vessel sherds, cylinders, sockets, and spacers. At Stingray Lagoon, another Punta Ycacos saltwork, ACLs were mixed with charcoal, evidently the remains of fires (McKillop 2002).

There are four ceramic types: Punta Ycacos Unslipped, Mangrove Unslipped, Warrie Red, and Moho Red (McKillop 2002). Punta Ycacos Unslipped ceramics are very coarse and sand tempered. Punta Ycacos Unslipped jars generally have two shapes: “jars with in-curved sides and out-curved neck and jars with in-curved sides and vertical neck, both of which had

direct or exterior folded rims and round lips” (McKillop 2002). The ceramic jars used to boil brine, as well as some bowls, are generally of this type (McKillop 2002). Most Punta Ycacos Unslipped sherds were of thick neck walls. These vessels had thick, outwardly-curved necks with the body of the vessel becoming slightly thinner. Pottery such as this was generally poorly-fired and hence displayed black spots from the poor workmanship. Although brine boiling jars were poorly-fired, they were the most-used vessels at the Punta Ycacos salt-making sites. As well as the jars, brine boiling apparatus were also Punta Ycacos Unslipped. Such artifacts included cylinders, sockets, and spacers.

Mangrove Unslipped pottery was found in slightly less abundance than Punta Ycacos Unslipped. Mangrove Unslipped is less coarse than Punta Ycacos Unslipped, and it is tempered with calcite, and therefore very porous. Mangrove Unslipped pottery includes jars and bowls similar in form to Punta Ycacos Unslipped jars and bowls (McKillop 2002). Mangrove Unslipped pottery was most likely used for storing saline-rich brine before boiling,

Another type of water jar found within the Punta Ycacos Lagoon saltworks is Warrie Red. This pottery has a red slip, and has a fine paste. The slip was mostly discolored to a red-brown or gray color due to their underwater provenance. Stamped decoration has been found on such vessel types within Punta Ycacos Lagoon (McKillop 2002). Warrie Red water jars and bowls made up this type of ceramic assemblage, and were similar in form to Mangrove Unslipped and Punta Ycacos Unslipped. However, Warrie Red vessel thickness was less than the former two ceramic types (McKillop 2002).

Moho Red ceramics are composed of a fine paste and also have a red slip. These sherds were hard, and chalky to the touch. Moho Red was the fineware at these salt workshops, so the forms were bowls and dishes of relatively thin walls (McKillop 2002). Such fineware would

have been tripod bowls or dishes, and were probably traded in the Port Honduras region (McKillop 2002). The presence of these vessels, as well as figurine whistles, and candeleros, or incense burners, possibly indicates that rituals took place at the salt workshops (McKillop 2002). Such rituals have been documented at the salt workshops in Sacapulas (Reina and Monaghan 1981).

All but the Moho Red vessel forms have been identified as jars and bowls, which were used in the salt production process. We know that the jars were used to store brine to be poured into the boiling pots. This leads to the question of what the bowls were used for. The salt-makers at Sacapulas boil water in shallow pans or bowl-like apparatus.

#### **Transect 4 Comparisons**

During the summer of 2011, a total of three transects were excavated at the Eleanor Betty Site. Each was laid out in a previously identified location of dense artifacts scatter in conjunction with wooden posts. I will compare Transects 1 and 4 in order to aid the interpretation of the site as a whole. Transect 4 was excavated by Taylor Aucoin as part of his research for an undergraduate honors thesis at Louisiana State University, with help from the team. Transect 4 was set up in the southern portion of the site, running west to east. In level 1 (0-10 cm) of Transect 4, the artifact scatter was dense and consisted of large amounts of briquetage, with a fair amount of charcoal. However, as excavations progressed from west to east, the amount of ceramics dropped off, while the amount of charcoal increased. Level 2 (10-20 cm) was similar to level 1 (0-10 cm). The first two units of Transect 4 were similar to level 1, but with slightly less dense material. In unit 2-3m the ceramic material increased, as did the



charcoal. Moving toward the last units of Transect 4, the ceramics decreased, while the charcoal significantly increased, as described for level 1.

Aucoin (2012) notes that artifact density is higher along what he has interpreted as the interior wall of a structure. Since Transect 4 seemed to run through a structure, findings were more varied here than in Transect 1. Farther into the structure transected by Transect 4, ceramics decreased while charcoal increased. Inside the structure, two hardwood posts were discovered, as well as a shell midden. The additional findings of a few fineware sherds, chert and obsidian flakes, and botanicals such as coyol and cohune nuts, seems to point to a function of food production.

Drawing comparison between Transect 1 and Transect 4, these two areas had differing functions within the Eleanor Betty Site. Transect 1 contained mostly briquetage and charcoal. Transect 4 revealed an unexpected oyster shell midden, as well as a high density of charcoal. The findings and interpretation of Transect 4 as a possible site of food preparation area within a structure may be evidence of ancient Maya habitation at the Punta Ycacos lagoon saltworks. Taken together, Transect 1 and Transect 4 provide prolific evidence of a salt industry.

## Discussion

Evidence of wooden architecture related to salt-making activities is conclusive at the Eleanor Betty site. Like the other sites which have been investigated in the Punta Ycacos Lagoon system, the Eleanor Betty Site contains (in at least one area) ceramic types which have been documented as primary paraphernalia used in the fire evaporation method of salt production. Ceramics associated with salt production, also known as briquetage, were abundant inside the structure from Transect 1 and throughout the site. These recurring types of ceramics included Punta Ycacos Unslipped, Mangrove Unslipped, Warrie Red, and Moho Red. Punta Ycacos Unslipped ceramics were the most abundant. These ceramics were used primarily for the evaporation process, and included themselves as brine-boiling jars, cylinders, spacers, sockets, and amorphous clay lumps (McKillop 2002). Mangrove Unslipped ceramics were less numerous than Punta Ycacos wares, and were most likely used for storing brine (McKillop 2002). The Warrie Red vessels had a finer paste than Punta Ycacos and Mangrove Unslipped wares. Warrie Red jars and bowls were of a finer craftsmanship, and were possibly utilized for storing brine and also probably used in salt rituals. Moho Red vessels were primarily fine paste bowls used most likely in salt rituals as well (McKillop 2002).

Most of the ceramics associated with Transect 1 were Punta Ycacos Unslipped and Mangrove Unslipped, with a few Warrie Red and Moho Red in each unit. Artifact density followed a pattern of being sparse outside the boundaries of the structure wall, and more dense inside. This observation was constant for each unit and level of Transect 1. The consistent association of briquetage with wooden architecture in Transect 1 implies a close relationship between the two. Since the ceramics included mostly Punta Ycacos Unslipped and Mangrove Unslipped sherds, the structure may be interpreted as being a shelter in which to store brine and

salt. One other hypothesis is that this structure was used in the evaporation process. An abundance of charcoal and broken briquetage may attest to this idea, and there is ethnographic evidence for this interpretation. In the modern-day saltworks at Sacapulas, Guatemala, the Sacapultecos heat brine to produce crystallized salt (Reina and Monaghan 1981). The salt is then either poured into large storage vessels, or they remain in the bowls for further heating, which produces a solid salt cake. This process is conducted inside wooden structures, which serve also as a storage facility for salt, firewood, and whole and broken ceramic vessels used in the salt-making process (Reina and Monaghan 1981).

One major aspect of rural life that is absent from the Eleanor Betty site, as well as the other Punta Ycacos saltworks, is evidence of domestic occupation. The sparse botanical artifacts recovered from Transect 1 reveal no conclusive evidence besides the fact that the ancient Maya at these sites did in fact use coyol and cohune palms. Since the nuts can be consumed raw, they could have merely provided a snack during the workday. Also, the leaves from both palms are known to have been used as thatching material. Likewise, chipped stone such as chert and obsidian were found in sparse quantities throughout the site. Chipped stone has such varied uses, however, that it is present at almost all prehistoric sites.

Looking at the El Salado saltworks, Santley (2004) noted that not all ceramics found in the archaeological record at the site were used in salt production. Fabric-marked pottery found at the site has been interpreted as packaging for the final salt product. However, Santley notes that this explanation “makes sense when Texcoco Fabric marked [pottery] occurs at non-salt-making sites” (Santley 2004: 200). However, this explanation does not account for the large amount of ceramics at the site (Santley 2004).

## **Artifacts of Salt Production**

Here I compare other artifact assemblages from salt-making sites with the assemblage from Eleanor Betty. MacKinnon and Kepecs (1989:525) note that it is logical for salt-making objects to be associated with coastal lagoons, since lagoon salinity increased in the dry season, as the shallow water evaporates, and is not replenished by rain. Also, cylinders have been a debated topic. When MacKinnon and Kepecs (1989) presented their findings, the apparatus for boiling brine using cylinders, sockets, and spacers was a newly discovered technology in Mesoamerica. MacKinnon and Kepecs (1989) note that Placencia cylinders are generally poorly made. Although cylinders were found, it was unclear how long one cylinder would have been, due to the erosion on both ends. It was therefore undetermined how far above fires the boiling pots would have sat. MacKinnon and Kepecs (1989) suggest one reason for cylinder breakage would have been due to knocking them against a hard surface in order to remove the partially fired sockets (this is most likely what the daub is in Guzman mound). Riehm (1961) has documented cylinders in prehistoric salt production contexts in Belgium and France that had tapered points which would have been wedged into the ground (MacKinnon and Kepecs 1989). This feature seems efficient, although no evidence of tapered cylinders exists in the Maya area. Also, the cylinders in Placencia Lagoon are suggested to have been re-used, since they exhibit no dark centers (MacKinnon and Kepecs 1989). On the other hand, sockets and spacers were most likely not completely fired, and therefore are rarely preserved wholly in the archeological record (MacKinnon and Kepecs 1989).

According to MacKinnon and Kepecs (1989), Andrews (1983: 63, 111) notes that mounds of leached earth left over from evaporation by fire would not survive long enough to be found in prehispanic contexts. However, the Placencia Lagoon mounds have been interpreted as

prehispanic salt-making middens, since they contain salt-making refuse and leached earth (MacKinnon and Kepecs 1989: 530). No evidence suggests habitation here: no stone foundations or rubble filling; artifacts are only found in the mounds and nowhere else; no burials or ritual context; minimal evidence of food procurement and preparation, although the workers probably camped at the sites but did not permanently occupy it (MacKinnon and Kepecs 1989: 530). However, two inland sites in Placencia Lagoon have been linked to the regional center of Ch'acben K'ax (MacKinnon and Kepecs 1989). In contrast to the other Placencia Lagoon sites, these two inland sites experienced long-term habitation, evidenced in the presence of house mounds, public architecture, and domestic artifacts. MacKinnon and Kepecs (1989) conclude that residents of these inland sites commuted to the saltworks to produce salt.

Another dynamic to the Placencia Lagoon salt is socioeconomic. In Mesoamerica, salt made from leached earth is sometimes seen as impure and less desirable (MacKinnon and Kepecs 1989). Because of this, MacKinnon and Kepecs (1989) suggest that the Placencia Lagoon saltworks were most likely catering to commoner populations rather than elite. This idea goes back to the fact that, depending on where the salt source is, different minerals affect the quality and taste (Andrews 1983; Reina and Monaghan 1981). Because Yucatán salt was 'pure', and did not accumulate extra minerals through a leaching process, it was often favored by the elite not only quality, but also for taste. Andrews (1983: 22) notes that the salt beds in northern Yucatán have been the largest producers of salt in mesoamerica (MacKinnon and Kepecs 1989).

In his ethnographic study of saltmakers at Nexquipayac, Parsons (2001) notes that, since soil and water are heavy, ancient and historic workshops near Nexquipayac were located in close proximity to Lake Texcoco and Lake Xaltocan-Zumpango (Parsons 2001). He states that in order to minimize transport cost, most prehispanic salt workshops would have been located

“right at the best soil sources” (Parsons 2001:139). He also postulates that, although the workshops were seasonal, soil collection could have taken place during the wet season and stored at the workshops (Parsons 2001: 139). Parsons (2001) also notes that the modern workshops were open-air, with only the boiling and drying of salt taking place indoors. This indoor area is relatively small, containing a fuel-burning stove and a small flat area to dry salt. Although this structure is constructed of bricks, some correlation may be drawn between it and Transect 1 at the Eleanor Betty Site. The dense deposits of salt-making ceramics, along with associated charcoal may point to this structure as a brine boiling hut.

In her research at the David Westby Site, Melissa Braud (1996) concluded that this was a site undoubtedly devoted to salt production. Based on a comparison with the nearby island trading port of Wild Cane Cay, the evidence was conclusive that habitation and trade did not occur at the David Westby Site. However, nearby Wild Cane Cay has been interpreted as a trading port based on locale, evidence of obsidian, and varied ceramics. The location of Wild Cane Cay was an important one, located at the mouth of the Deep River (McKillop 2005b). Although lithics are a very common commodity, obsidian was one of the most abundant exotic trade good on Wild Cane Cay (McKillop 1989). Ceramics were found to span from the Early Classic through the Postclassic periods on the island, supporting the idea that Wild Cane Cay was inhabited during this time (McKillop 1989). The ceramics here also resemble those from other southern Lowland sites including Lubaantun, Seibal, and Altar de Sacrificios. Such diagnostic ceramics included unit-stamped Tinaja Red vessel fragments, and figurine whistles (McKillop 1995, 2005b). Contrasting the David Westby Site with Wild Cane Cay provides a clear dichotomy between the function of these two sites.

In her research of the John Spang Site in Punta Ycacos Lagoon, Sills (2007) concluded that this was also a site of a focused salt industry. Evidence of briquetage from the fire evaporation method of salt production, in combination with evidence of preserved wooden posts, confirmed the function of this site. Using comparative methods to Wauchope's 1938 work *Modern Maya Houses*, Sills discovered similarities between these ancient structures and modern ones. Rectangular shapes were revealed in research at the John Spang sites, but structure size varied.

Likewise, Somers (2007) found conclusive evidence of a high-intensity salt production industry in the Punta Ycacos Lagoon system. Somers (2007) found similar evidence at all eight sites studied, which confirmed a function primarily of salt production, and little evidence of habitation. Such evidence follows suit with other research findings in the Punta Ycacos Lagoon, such as briquetage associated with salt production, and wooden architecture. However, he reports that the sites studied did not conform to any standardization in layout or design (Somers 2007). He goes on to state that this non-standardization in architecture may speak to the opportunistic exploitation of the wood and the high-saline lagoon water present in and around these sites.

McKillop, in her extensive work in the Punta Ycacos Lagoon and surrounding areas, has brought to light the importance of trade along the southern coast of Belize (McKillop 1995, 1996, 2002, 2004b, 2005a, 2005b, 2007a). The documentation of trading ports along the Belizean coast, such as Moho Cay and Wild Cane Cay, is an integral part of our understanding of the Maya trading spheres. Moho Cay lies at the juncture of the Belize River and coastal Caribbean transportation routes (McKillop 2004b: 271). The use of this cay has been documented from the Late Preclassic through the Postclassic. Such long-running use suggests

habitation, and the location suggests possible use as a trading port. Evidence to support this idea lies in the presence of non-local goods such as obsidian, jade, and basalt (McKillop 2004b). Moho Cay also most likely participated in intra-lowland trade as well. Evidence of both local and non-local goods points to the notion that Moho Cay participated in local and long-distance trade (McKillop 2004b). Nearby Wild Cane Cay has also been interpreted as a trading port spanning from the Classic to Postclassic periods (McKillop 1996). The high density and varied sources of obsidian, and the presence of a variety of other exotic items are likely evidence of a trading role here (McKillop 1996). Like Moho Cay, Wild Cane Cay is also geographically situated in a trade-friendly locale, and McKillop (1996) notes that the island also has a natural harbor.

The main focus of this study is architectural function. This leads to the question of whether the posts in Transect 1 are in fact the remains of a structure. All but one of the posts discovered in and around Transect 1 are hardwood, and are generally placed in a linear form running roughly north-south. The transect began and ended 1 meter outside the location of wooden posts. I expected to run into other posts on the western side of the northernmost and southernmost units, which would follow the general rectangular outline of a wooden structure. However, only one smaller post was found in the southwest corner of unit 0-1 m. This could be evidence of a rectangular structure, especially since there is another larger post just outside the northeastern boundary of unit 1-2 m. However, the two largest posts are located in units 5-6m and 6-7m. Looking at the configuration of the posts, several structural layouts can be hypothesized. Considering the posts generally make an L-shaped pattern, and assuming the posts are all contemporaneous, this could likely be the corner of a rectangular structure. The presence of smaller wooden posts in the middle of Transect 1 may indicate the remains of a wall.



However, the general layout of these posts is not readily apparent. The presence of the medium-sized post in the southwest corner of unit 0-1 m may be a good indicator of a perpendicular wall to the main post line in Transect 1.

Previous investigation at sites such as Tikal (Haviland 1985), Cerén (Sheets 2002), Ambergris Cay (Guderjan 1995c), and Cuello (Sharer and Traxler 2006) have documented perishable structures built atop earthen platforms which were often coated with lime plaster (Sharer and Traxler 2006). However, these types of platforms were generally for residential structures. Unlike these documented perishable structures at sites such as Tikal, Cerén, and Ambergris Cay, the possible structure in Transect 1 at the Eleanor Betty Site has no evidence of being built atop any kind of platform.

In comparison to modern Maya architecture studied by Wauchope (1938), the layout of the possible structure of Transect 1 could be a promising example of a rectangular structure. However, the measurements of mainposts for Wauchope's (1938) rectangular house plan does not correlate with the measurements on any presumed mainposts of the current structure of Transect 1. There is a gap in the postline configuration in Transect 1, between units 2-3 m and 4-5 m. This gap runs north to south, spanning roughly 2.75 meters along the eastern edge of Transect 1. This could be an opening for a door, since most Maya houses are documented as having doors in the middle of walls (Wauchope 1938).

The configuration of wooden posts in Transect 1 seems to be generally in an L-shape. This would definitely fit into a plan for a rectangular structure, which seems to be the prevalent shape in the Punta Ycacos Lagoon sites. The assumption that the configuration of posts in Transect 1 is a structure is a logical conclusion. Smaller posts which have been found within structures at the Punta Ycacos sites may indicate room divisions or permanent furniture

(McKillop 2005a). However, the placement of the smaller posts in Transect 1 does not make a telling distinction of either room dividers or permanent furniture. However, the irregular placement of the posts leaves much to interpretation.

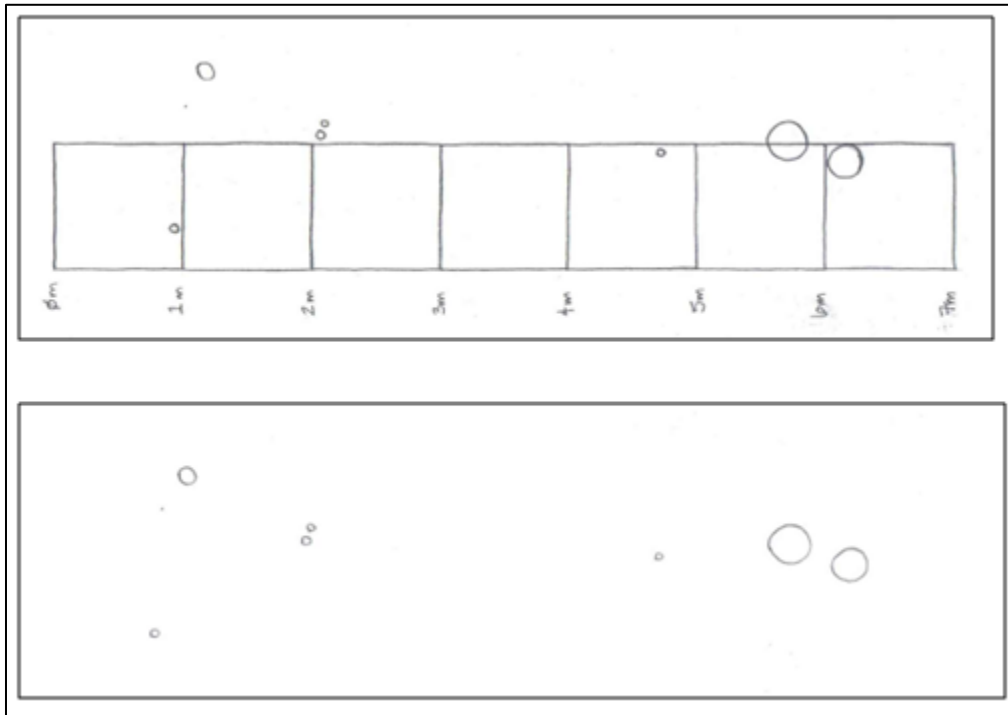


Figure 14: Schematic drawing of Transect 1 showing wooden posts by size and location

## Summary and Conclusions

Salt was an important factor in the ancient Maya political and subsistence economies. Salt production, trade, and consumption were a vital part of everyday life for the Maya. Uses for salt have been documented as a biological necessity, as a preservative, as part of the textile industry, for silver production, and in ritual and medicine. Due to the various purposes salt is used for, this natural resource has been highly prized throughout history. Indeed, salt has been attributed to migration, wars, and settlement patterns in Mexico and Central America (Williams 1999:400; Gilmore 1955:1013).

The production of salt, however, must take place at certain areas close to sea water or salt springs. Therefore, the idea of long-distance trade would explain some of the fineware artifacts found at ancient salt-production sites in the Punta Ycacos lagoon system in southern Belize. Hence, the salt economy of the ancient Maya was conducive to furthering the development of the Mesoamerican state. William Rathje (1971) suggested that the need for goods such as salt, basalt, and obsidian, and the transportation needed to move these items led to the development of the Maya lowlands. However, other models have proven otherwise. More recent research has noted that subsistence items within the Classic Maya economy were produced locally, whereas long-distance trade focused on elite goods (McKillop 2002; Tourtellot and Sabloff 1972). Nevertheless, the Classic Maya economy relied upon more locally produced subsistence goods such as salt, rather than procuring them from long-distance trade routes. The time and transportation costs would have outweighed the cost of the product itself in some cases. Therefore, locally produced goods would have been the norm, rather than procurement of long-distance trade goods. Although the Maya did rely on long-distance trade for certain goods, a logical conclusion is that, if possible, they would have obtained other goods and resources by a

more cost-effective and quicker means. To understand the social aspects and economy of a region, the study of natural resources, such as salt, is useful.

As well as social and political aspects, investigation of the physical remains of production must be addressed. Architectural remains can tell a story, which can be interpreted and retold. The interpretation of architectural remains seeks to eventually determine function. In order to do this, archaeologists must evaluate whether this was an elite or commoner structure, and if it was residential or non-residential. Elite structures were often associated with public architecture, which was usually constructed of stone and other nonperishable materials. If located in an urban area, ancient Maya commoners would have most likely lived on the outskirts of the city in pole and thatch structures. Because perishable structures do not typically survive in the archaeological record, the refuse left behind is a telling factor of class in a residential area. Elites and commoners usually had differentiated diets in different regions. A look at household refuse of faunal material may lead to class interpretation in residential areas. Evaluating between residential and non-residential space may also be interpreted through the identification of middens. Production areas, even if located near a residence, display little or no domestic refuse such as floral or faunal remains, and an abundance of homogenous refuse.

The scope of the research for this thesis was to determine architectural function using a combination of archaeological, ethnographic, ethnohistoric, and architectural analyses. Ethnographic and ethnohistoric data are irreplaceable research methodologies, and are quite often used in conjunction with archaeology. Comparing ethnohistoric accounts of Maya houses and salt production sites has provided much insight into the ancient Maya salt industry. Traditional methods of salt production and architectural construction have remained fairly constant in Mexico and Central America. Modern substitutions for materials and methods are

inevitable, but tradition is deeply rooted not only in the social, but also in economic aspects of these rural communities.

The wooden posts in Transect 1 at the Eleanor Betty Site do not form a clear outline of a structure shape. However, taken in context with previous research into ancient and modern perishable architecture, as well as the scope of research within the Paynes Creek National Park, the wooden posts may indeed be interpreted as a rectangular structure. I am convinced that this structure was used in the salt-making process at the site, but the function of the structure is still open to interpretation. Assuming that this is one structure, it could be interpreted as being used either for storing saline-rich brine and the finished product of loose salt or salt cakes, or it was used to fire clay vessels for evaporating the brine solution. The configuration of posts could be more than one structure, although it is difficult to determine from the one transect. The abundance of charcoal and broken briquetage found in Transect 1 is prolific evidence for the latter hypothesis. However, these two hypotheses can be combined into one as well. The saltmaker at Nexquipayac use the same structure to fire vessels for evaporation, as well as for storing and drying the finished product (Parsons 2001). The Maya at the Eleanor Betty Site could have similarly used the same building to fire, dry, and store salt. This would make for an efficient process between firing, drying, and storing of the salt.

Mass-production of salt at the Eleanor Betty site seems conclusive, especially when taken in context with the other Punta Ycacos Lagoon saltworks, as well as historic and modern ethnographic and ethnohistoric accounts. The presence of abundant specialized ceramics, remnants of wooden architecture, and the absence of domestic refuse are telling attributes to the presence of a dedicated production space. Although many aspects of this ancient industry have been uncovered, just as many aspects still remain elusive. For instance, we still lack knowledge

regarding the people who produced salt in the Punta Ycacos Lagoon system. Ongoing research must continue in order to further our understanding of the once-great empire of the ancient Maya, as well as the people who supplemented the production of goods and the trade economy of the ancient Maya.

## References Cited

Adshead, Samuel A. M.

1992. Salt and Civilization. St. Martin's Press: New York.

Anawalt, Patricia R.

1981. *Indian Clothing Before Cortes: Mesoamerican Costumes from the Codices*. University of Oklahoma Press: Norman.

Andrews, Anthony P.

1977. *Maya Cities: Placemaking and Urbanization*. University of Oklahoma Press: Norman.

1983. Maya Salt Production and Trade. University of Arizona Press: Tucson.

Andrews, Anthony P. and Shirley B. Mock

2002. New Perspectives on Salt Trade. *Ancient Maya Political Economies*. Edited by Marilyn A. Masson and David A. Freidel, pp. 307-334. Alta Mira Press: Walnut Creek.

Arnold, Philip J.

1991. Domestic Ceramic Production and Spatial Organization: A Mexican Case Study in Ethnoarchaeology. Cambridge University Press: Cambridge.

Berdan, Frances Frei.

1978. Ports of Trade in Mesoamerica: A Reappraisal. In *Cultural Continuity in Mesoamerica*. Edited by David L. Browman, 179-198. Mouton Publishers : Paris.

Blanton, Richard

1976. Anthropological Studies of Cities. *Annual Review of Anthropology* 5:249-264.

Blanton, Richard and Gary Feinman

1984. The Mesoamerican World System. *American Anthropologist* 86: 673-682.

Braud, Melissa R.

1996. Evidence for Salt Production at the Inundated David Westby Site South Coastal Belize. Masters Thesis, Department of Geography and Anthropology, Louisiana State University, Baton Rouge, Louisiana.

Browman, David L.

1978. Cultural Continuity in Mesoamerica. Mouton Publishers: Paris.

Chapman, Anne C.

1957. Port of Trade Enclaves in Aztec and Maya Civilizations. In *Trade and Market in the Early Empires*. Edited by Karl Polanyi, Conrad M. Arensberg, and Harry W. Pearson, pp. 114-153. The Free Press: New York.

Coe, Michael D.

2005. The Maya. Seventh Edition. Thames and Hudson Ltd: New York.

Costin, Cathy Lynne

1991. Craft Specialization: Issues in Defining, Documenting, and Explaining the Organization of Production. *Archaeological Method and Theory* 3:1-56.

Cowgill, George L.

2004. Origins and Development of Urbanism: Archaeological Perspectives. *Annual Review of Anthropology* 33:525-549.

1993. Comments on Andrew Sluyter. *Ancient Mesoamerica* 4:201-203.

Dahlin, Bruce, Christopher T. Jensen, Richard E. Terry, and David R. Wright

2007. In Search of an Ancient Maya Market. *Latin American Antiquity* 18: 363-384.

De Landa, Diego.

1941. *Relacion de las Cosas de Yucatán*. Translated by A. M. Tozzer. Papers of the Peabody Museum of American Archaeology and Ethnology, vol. 18. Harvard university: Cambridge, Mass.

De Leon, Jason P.

2009. Rethinking the Organization of Aztec Salt Production: A Domestic Perspective. *Archaeological Papers of the American Anthropological Association* 19:45-57.

Demarest, Arthur, Kim Morgan, Claudia Wolley and Hector Escobedo

2003. The Political Acquisition of Sacred Geography: The Murcielagos Complex at Dos Pilas. In Maya Palaces and Elite Residences: An Interdisciplinary Approach. Edited by Jessica Joyce Christie, 120-153. University of Texas Press: Austin.

Dillon, Brian, Kevin Pope, and Michael Love

1998. An Ancient Extractive Industry: Maya Saltmaking at Salinas de las Nueve Cerros, Guatemala. *Journal of New World Archaeology* 7(2-3): 37-107.



Driver, W. David

1995. Chac Balam: Excavations and Architecture of a Formal Plaza Group. *Maya Maritime Trade, Settlement, and Populations on Ambergris Caye, Belize*. Edited by Thomas H. Guderjan and James F. Garber, pp. 43-65. Maya Research Program: San Antonio.

Dull, Robert A., John R. Southon, and Payson Sheets

2001. Volcanism, Ecology and Culture: A Reassessment of the Volcan Ilopango TBJ Eruption in the Southern Maya Realm. *American Antiquity* 12: 25-44.

Ewel, John J.

1976. Litter Fall and Leaf Decomposition in a Tropical Forest Succession in Eastern Guatemala. *Journal of Ecology* 64: 293-308.

Feinman, Gary M. and Linda M. Nichols

2011. Domestic Craft Production and the Classic period Economy of Oaxaca. In *Producción Artesanal y Especializada en Mesoamérica: Áreas de Actividad y Procesos Productivos*, Edited by Linda R. Manzanilla and Kenneth G. Hirth, pp. 29-58. Instituto Nacional de Antropología e Historia, Universidad Nacional Autónoma de México: Ciudad de México.

Freidel, David A.

1978. Maritime Adaptation and the Rise of Maya Civilization: The View from Cerros, Belize. In *Prehistoric Coastal Adaptations: The Economy and Ecology of Maritime Middle America*. Edited by Barbara L. Stark and Barbara Voorhies. Pp. 239-265. Academic Press, Inc.: New York.

1979. Culture Areas and Interaction Spheres: Contrasting Approaches to the Emergence of Civilization in the Maya Lowlands. *American Antiquity* 44:36-54.

Furley, Peter A.

1975. The Significance of the Cohune Palm, *orbignya cohune* (Mart.) Dhlgren, on the Nature and in the Development of the Soil Profile. *Biotropica* 7: 32-36.

Gilmore, Harlan W.

1955 Cultural Diffusion Via Salt. *American Anthropologist* 57:1011-1015.

Goldstein, David J. and Jon B. Hageman

2010. Power Plants: Paleobotanical Evidence of Rural Feasting in Late Classic Belize. In *Pre-Columbian Foodways: Interdisciplinary Approaches to Food, Culture, and Markets in Ancient Mesoamerica*. Edited by John E. Staller and Michael. D. Carrasco, pp. 421-440. Springer: New York.

Good, Catharine

1995 Salt Production and Commerce in Guerrero, Mexico: An Ethnographic Contribution to Historical Reconstruction. *Ancient Mesoamerica* 6:1-14.

Graham, Elizabeth

1994. The Highlands of the Lowlands: Environment and Archaeology in the Stann Creek District, Belize, Central America. Prehistory Press: Madison.

1987. Resource Diversity in Belize and its Implications for Models of Lowland Trade. *American Antiquity* 52:753-767.

Guderjan, Thomas H.

1995a. The Setting and Maya Maritime Trade. *Maya Maritime Trade, Settlement, and Populations on Ambergris Caye, Belize*. Edited by Thomas H. Guderjan and James F. Garber, pp. 1-8. Maya Research Program: San Antonio.

1995b. Settlement Patterns and Survey Data. *Maya Maritime Trade, Settlement, and Populations on Ambergris Caye, Belize*. Edited by Thomas H. Guderjan and James F. Garber, pp. 9-30. Maya Research Program: San Antonio.

1995c. Excavations and Architecture at San Juan. In *Maya Maritime Trade, Settlement, and Populations on Ambergris Caye, Belize*. Edited by Thomas H. Guderjan and James F. Garber, pp. 31-42. Maya Research Program: San Antonio.

Guderjan, Thomas H. and Lisa L. Brody-Foley

1995. Excavations and Architecture at Ek Luum. *Maya Maritime Trade, Settlement, and Populations on Ambergris Caye, Belize*. Edited by Thomas H. Guderjan and James F. Garber, pp. 66-72. Maya Research Program: San Antonio.

Gutman, T.

1972 Review of the Importance of Salt in Historical Literature with Special Reference to West Mexico. *Katunob* 8(6):40-49.

Hallock, Ashley L.

2009. Paleoenvironmental Investigations Near Hattieville, Central Belize: Implications for Ancient Maya Salt Production. Masters Thesis Washington State University.

Halperin, Christina T., Ronald L. Bishop, Ellen Spensley, and M. James Blackman

2009. Late Classic (A.D. 600-900) Maya Market Exchange: Analysis of Figurines from the Motul de San Jose Region, Guatemala. *Journal of Field Archaeology* 34: 457-480.

Haviland, William A.

1985. *Excavations in Small Residential Groups of Tikal, Groups 4F-1 and 4F-2*. Tikal Report No. 19. University Museum, University of Pennsylvania: Philadelphia.

Hayden, Brian and Aubrey Cannon

1983. Where the Garbage Goes: Refuse Disposal in the Maya Highlands. *Journal of Anthropological Archaeology* 2: 117-163.

Henderson, John S.

1997. *The World of the Ancient Maya*. Cornell University Press: Ithaca, NY.

Hester, Thomas R. and Harry J. Shafter

1992. Lithic Workshops Revisited: Comments of Moholy-Nagy. *American Antiquity* 3:243-248.

Hewitt, William P., Marcus C. Winder and David A. Peterson

1987 Salt Production at Hierve El Agua, Oaxaca. *American Antiquity* 52:799-816.

Hirth, Kenneth G.

1978. Interregional Trade and the Formation of Prehistoric Gateway Communities. *American Antiquity* 43:35-45.

Johnston, Kevin J.

2004. The "Invisible" Maya: Minimally Mounded Residential Settlement at Itzan, Peten, Guatemala. *Latin American Antiquity* 15:145-175.

Kaunitz, M.

1956 Causes and Consequences of Salt Consumption. *Nature* 178:1141-44.

Leventhal, Richard M.

1990. Southern Belize: An Ancient Maya Region. *Vision and Revision in Maya Studies*. Edited by Flora S. Clandy and Peter D. Harrison, pp. 125-142. University of New Mexico Press: Albuquerque.

McKillop, Heather

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

1996. Ancient Maya Trading Ports and the Integration of Long-Distance and Regional Economies: Wild Cane Cay in South Coastal Belize. *Ancient Mesoamerica* 7: 49-62.

- 2002 *Salt: White Gold of the Ancient Maya*. University Press of Florida: Gainesville.
- 2004a *The Ancient Maya: New Perspectives*. New York: Norton Publishers.
- 2004b The Classic Maya Trading Port of Moho Cay. In *The Ancient Maya of the Belize Valley: Half a Century of Archaeological Research*. Edited by James F. Garber, pp. 257-272. University Press of Florida: Gainesville.
- 2005a Finds in Belize Document Late Classic Maya Salt Making and Canoe Transport. *Proceedings of the National Academy of Sciences of the United States of America* 12: 5630-5634.
- 2005b In Search of Maya Sea Traders. Texas A&M University Press, College Station.
- 2007a Ancient Mariners on the Belizean Coast: Stingrays, Seafood, and Salt. *Belizean Studies* 29(2):14-28.
- 2007b. GIS of the Maya Canoe Paddle Site, K'ak' Naab'. FAMSI Research Reports.  
<http://www.famsi.org/reports/05032/index.html>
- 2009 Mapping Ancient Maya Wooden Architecture on the Sea Floor. *ACUA Underwater Archaeology Proceedings* 2009:277-286.
- MacKinnon, J. Jefferson and Susan M. Kepecs  
1989 Prehispanic Saltmaking in Belize: New Evidence. *American Antiquity* 53:522-533.
- McNeil, Cameron L., David A. Burney, and Lida Pigott Burney  
2009. Evidence Disputing Deforestation as the Cause for the Collapse of the Ancient Maya Polity of Copan, Honduras. *Proceedings of the National Academy of Sciences* 107: 1017-1022.
- Moore, Jerry D. and Janine L. Gasco  
1990. Perishable Structures and Serial Dwellings from Coastal Chiapas: Implications for the Archaeology of Households. *Ancient Mesoamerica* 1: 205-212.
- Morehart, Christopher T. and Noah Butler  
2010. Ritual Exchange and the Fourth Obligation: Ancient Maya Food Offering and the Flexible Materiality of Ritual. *Journal of the Royal Anthropological Institute* 16: 588-608.

Murata, Satoru

2011. Maya Salters, Maya Potters: The Archaeology of Multicrafting on Non-Residential Mounds at Wits Cah Ak' al, Belize. Ph.D. dissertation, Graduate School of Arts and Sciences, Boston University, Boston, Massachusetts.

Nance, C. Roger

1992. Guzman Mound: A Late Preclassic Salt Works on the South Coast of Guatemala. *Ancient Mesoamerica* 3: 27-46.

Parsons, Jeffrey R.

1994 Late Postclassic Salt Production and Consumption in the Basin of Mexico. In *Economies and Politics in the Aztec Realm*. Edited by M.G. Hodge and M.E. Smith, pp. 257-290. Studies on Culture and Society, Vol. 6, Institute for Mesoamerican Studies, State University of New York, Albany.

2001. The Last Saltmakers of Nexquipayac, Mexico: An Archaeological Ethnography.

University of Michigan Museum of Anthropology: Ann Arbor.

Polanyi, Karl

1957. The Economy as Instituted Process. In *Trade and Market in the Early Empires*. Edited by Karl Polanyi, Conrad M. Arensberg, and Harry W. Pearson, pp. 243-270. The Free Press: New York.

1963. Ports and Trade in Early Societies. *Journal of Economic History* 23: 30-45.

1966. Dahomey and the Slave Trade: An Analysis of an Archaic Economy. University of Washington Press: Seattle.

Rathje, William

1971 The Origin and Development of Lowland Classic Maya Civilization. *American Antiquity* 36: 275-285.

Reina, Ruben E. and John Monaghan

1981 The Ways of the Maya: Salt Production in Sacapulas, Guatemala. *Expedition* 23(3):13-33.

Renfrew, Colin

1975. Trade as Action at a Distance: Questions of Integration and Communication. *Ancient Civilization and Trade*. Edited by J.A. Sabloff and C.C. Lamberg-Karlovsky, pp. 3-59. University of New Mexico Press: Albuquerque.

Santley, Robert S.

2004 Prehistoric Salt Production at El Salado, Veracruz, Mexico. *American Antiquity* 15:199-221.

Santone, Lenore

1997. Transport Costs, Consumer Demand, and Patterns of Intra-regional Exchange: A Perspective on Commodity Production and Distribution from Northern Belize. *Latin American Antiquity* 8: 79-88.

Sharer, Robert J. and Loa P. Traxler

2006. The Ancient Maya. Sixth Edition. Stanford University Press: Stanford.

Shaw, Leslie C.

2012. The Elusive Maya Marketplace: An Archaeological Consideration of the Evidence. *Journal of Archaeological Research* 20:117-155.

Sheets, Payson

2002. *Before the Volcano Erupted: The Ancient Ceren Village in Central America*. University of Texas Press: Austin.

Sills, Elizabeth C.

2007 The Architecture of Ancient Maya Saltmaking; Distribution and Analysis of Preserved Wooden Posts at the John Spang Site in Paynes Creek National Park, Belize. Masters Thesis, Department of Geography and Anthropology, Louisiana State University, Baton Rouge, Louisiana.

Sluyter, Andrew

1993. Long-Distance Staple Transport in Western Mesoamerica: Insights Through Quantitative Modeling. *Ancient Mesoamerica* 4:193-199.

Somers, Bretton M.

2007 Spatial Analysis of the Preserved Wooden Architectural Remains of Eight Late Classic Maya Salt Works in Punta Ycacos Lagoon, Toledo District, Belize. Ph.D. Dissertation, Department of Geography and Anthropology, Louisiana State University, Baton Rouge, Louisiana.

Sullivan, Alan P.

2008. Ethnoarchaeological and Archaeological Perspectives on Ceramic Vessels and Annual Accumulation Rates of Sherds. *American Antiquity* 73:121-135.

Tourtellot, Gair and Jeremy A. Sabloff

1972. Exchange Systems Among the Ancient Maya. *American Antiquity* 37:126-135.

Valdez, F. and Shirley P. Mock.

1991. Additional Considerations for Prehispanic Saltpanning in Belize. *American Antiquity* 56:520-525.

Valdez, Francisco, Catherine Liot, Rosario Acosta, and Jean Pierre Emphoux

1996. The Sayula Basin: Lifeways and Salt Flats of Central Jalisco. *Ancient Mesoamerica* 7:171-186.

Varién, Mark D. and Barbara J. Mills

1997. Accumulations Research: Problems and Prospects for Estimating Site Occupation Span. *Journal of Archaeological Method and Theory* 4: 141-191.

Varién, Mark D. and James M. Potter

1997. Unpacking the Discard Equation: Simulating the Accumulation of Artifacts in the Archaeological Record. *American Antiquity* 62:194-213.

Voorhies, Barbara

1982. An Ecological Model of the Early Maya of the Central Lowlands. *Maya Subsistence: Studies in Memory of Dennis E. Puleston*. Edited by Kent V. Flannery, pp. 65-95. Academic Press, Inc: New York.

Wauchope, Robert

1934. House Mounds of Uaxactun, Guatemala. *Carnegie Institution of Washington Publication* 436, *Contribution No. 7*: Washington, D.C.

1938. Modern Maya Houses: A Study of their Archaeological Significance. *Carnegie Institution of Washington Publication* 502: Washington, D.C.

Webster, David

1994. Classic Maya Architecture: Implications and Comparisons. In *Function and Meaning in Classic Maya Architecture*. Edited by Stephen D. Houston, pp. 5-47. Dumbarton Oaks, Washington D.C.

Williams, Eduardo

1999 The Ethnoarchaeology of Salt Production at Lake Cuitzeo, Michoacán, Mexico. *Latin American Antiquity* 10(4):400-414.

2008. Salt Production and Trade in Ancient Mesoamerica. *Precolumbian Foodways. Interdisciplinary Approaches to Food, Culture and Markets in Ancient Mesoamerica.* Edited by John Staller and Michael Carasco, pp. 175-190. New York: Springer



## Vita

Tamara Spann was born in Mobile, Alabama in April 1982 as the second of twin daughters to Lynda and Jimmie Spann. She grew up in Monroeville, Alabama and attended Alabama Southern Community College on an art scholarship after graduating from Monroe County High School in 2000. After attaining an Associate in Arts degree in 2002, she moved to Montgomery, Alabama to attend Auburn University at Montgomery in pursuit of a degree in Secondary Education. Tamara was always intrigued by history and archaeology, and after taking an Introduction to Archaeology class, she was hooked. She briefly studied Sociology, and finally decided to pursue a degree in History. In the summer of 2004 she attended the Auburn University Montgomery Field School at Fort Toulouse, Alabama, directed by Dr. Craig T. Sheldon, Jr. After learning various skills, she was put in charge of mapping the archaeological site, and quickly fell in love with archaeology and mapping. Following her newfound skills, she began taking Geographic Information Systems (GIS) classes at Auburn Montgomery under the direction of Dr. Terance L. Winemiller. In December of 2006, she graduated from Auburn University at Montgomery with a Bachelor of Arts in History. After graduation, Tamara continued to work full time in the furniture retail industry. In 2008, she learned that her alma mater had a newly founded certificate program in GIS, and in July of 2010 she attained a Certificate in GIS from Auburn University at Montgomery. During this time, she gained an appreciation of the ancient Maya culture, and, motivated by Dr. Winemiller, she applied to his alma mater, Louisiana State University. In August 2010 she began graduate studies in Anthropology at Louisiana State University under the direction of Dr. Heather McKillop. In the summer of 2011 she participated in Dr. McKillop's ongoing project, "Ancient Maya Wooden Architecture and the Salt Industry". During her time at Louisiana State University, Tamara was fortunate enough to gain temporary employment at the Louisiana Division of Archaeology. She

is currently still employed by the Louisiana Division of Archaeology, and is also employed as a GIS Technician at Owen and White, Inc., Consulting Engineers.