MAIZE AND STONE: A FUNCTIONAL ANALYSIS OF THE MANOS AND METATES OF SANTA RITA COROZAL, BELIZE

by

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ABSTRACT

The manos and metates of Santa Rita Corozal, Belize are analyzed to compare traditional maize-grinding types to the overall assemblage. A reciprocal, back-and-forth grinding motion is the most efficient way to process large amounts of maize. However, rotary movements are also associated with some ground stone implements. The number of flat and trough metates and two handed manos are compared to the rotary-motion basin and concave type metates and one-handed manos to determine predominance and distribution. Flat is the predominant type and, together with the trough type, these grinding stones make up the majority of metates at the site. Manos are highly fragmented, but the two-handed variety is more common among those fragments able to be identified. While this would at first glance support a fully maize dependent subsistence, the presence of two additional non-reciprocal motion metate types and the fact that the trough metates are clustered in one sector of the site suggest that, in addition to maize, significant processing of other foods also occurred in association with these grinding stones.

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INTRODUCTION

Stone tools for milling or grinding are found commonly in the archaeological record in the Americas. Comprising a hand-stone, or *mano,* and platform, or nether-stone, called a *metate,* they were, and in many places still are, essential household items for processing food and other substances. Because of their durability, they are often the only record of food-processing behaviors to survive. For this reason, they provide valuable information when looking at ancient societies and their subsistence practices.

In the Maya area, manos and metates are presumed to be used primarily for grinding maize kernels into more edible forms such as meal or flour. This assumption is based on the maize-dominated agriculture attributed to the Maya. From ethnographic data and experimental research, the forms of stone tools best suited for maize grinding are found throughout the Maya region. By looking at specific assemblages, the presence and predominance of these types of tools may indicate the level of maize-dependence or production of a particular community.

This thesis will study the manos and metates from the site of Santa Rita Corozal in northern Belize. The questions to be asked are: 1) does the mano and metate assemblage indicate a maize-based subsistence at Santa Rita Corozal; and 2) did processing occur as a primarily domestic, ritual, or specialized economic activity?

The tool forms traditionally associated with maize processing are two-handed manos and the trough and flat style metates. The frequency of these types will be compared to the total sample to see if they are predominant. Additionally, their context will be evaluated to identify which locations and structures they are associated with, such as household or ritual and to identify any patterns or clusters.

There are three basic styles of metates found at Santa Rita Corozal: flat, concave, and basin/trough. The flat styles appear to be the most numerous, which at first glance supports a maize-based subsistence picture. The mano data, however, may show something different, as there is a much greater degree of variation with approximately ten different cross-sectional shapes. This variety may mean that maize, while present, was not the only significant product being processed. Ground stone tools used as mortars and pestles can also be used to grind or pound other food items such as herbs, salt, roots, seeds, and meat-as well as non-food items like pigments and minerals. These alternate functions may be reflected by specific typology.

REVIEW OF THE LITERATURE

When looking for answers about subsistence practices among prehistoric civilizations, manos and metates are a potentially valuable source of information. Evaluating the form and function of these tools can help answer questions such as what kind of products they were processing, as well as methods and levels of production. Food grinding tools are found archaeologically in many regions of both the Old and New Worlds and have been the object of study from the earliest days of the field (Bennett 1898). The basic necessity of these tools is evident in their frequency in the archaeological record-and the fact that they are still used today in many cultures.

Some of the earliest simple grinding stones are found in South Africa dating to 49,000 B.P. (Kraybill 1977:495), and early basin-type stones from Negev, Israel date to the Upper Paleolithic (Kraybill 1977:501). In Southwest Asia, the earliest ground stone tools associated with food processing are also from the Upper Paleolithic and consist of small, portable hand-stones and grinding slabs from sites in the Levant (Wright 1994:249). Wright notes that the increases in size and diversity of these tools over time correlate with increased sedentism, intensified food production, and increased use of wild and domestic cereals as hunter-gathers transitioned to agriculture. Use-wear analysis on Natufian grinding tools show that an increase in flat working surfaces are specifically associated with processing cereals and legumes (Dubreuil 2004:1626).

As grinding technology advanced during the Bronze and Iron ages, basalt stone was widely traded and highly valued for its hard, textured surface, ideal for grain processing (Ebeling and

Rowan 2004:113). Similarly, in Australia, grindstones are found dating from the Pleistocene and continue to be used into modern times. Increasing diversity in grindstone types from their earliest forms is thought to be a result of increased dependence on wild grass seeds as food, resulting in specialized tools for processing these products (Smith 1988). However, Old World data may not be appropriate for the New World.

In the New World, the native peoples of North America also used manos and metates perhaps as far back as the late Pleistocene (Ray 1940) and the pre-Paleoindian period in North America (Carter 1977:707). Grinding tools at sites in the American Southwest have been used to document social changes as maize became the economic cornerstone of societies like the Pueblo Indians and reliance on agriculture grew (Eddy 1979; Mauldin 1993). As these societies became sedentary and populations increased, larger grinding surfaces to process more grain faster were developed. Studies have looked at grinding efficiency and intensity based on tool morphology, surface area, and wear-use patterns (Adams 1993; Lancaster 1983; Morris 1990).

Direct experiments have been done to replicate specific techniques and calculate the hourly meal output from grinding maize with different styles of manos and metates (Wright 1993), analysis of micro wear patterns resulting from different forces (Dodd 1979), as well as the efficiency of grinding different types of seeds and kernels on different materials (Adams 1999). Maudlin (1993) and Hard et al. (1996) put forth arguments that grinding surface area on manos can be directly correlated to the degree of agriculture practiced by a population. Others, such as Schneider (1993), caution that subsistence patterns are specific to each region and are based on multiple environmental and social factors, adding that tools are generally multi-purpose and can be used for different tasks over their use-lifetime. Changes in the frequency of mano and metate forms over time may reflect changes in site use and occupation, as well as increased levels of domestic plant processing (Nelson and Lippmeier 1993; Schlanger 1991:463) or even social changes based on group or individual preferences (Adams 1993:341).

In Central Mexico, the manos and metates of the Teotihuacan Valley were analyzed by Biskowski (1997) in regards to early market formation. By doing spatial analysis, the location and frequencies of grinding tools were used to evaluate areas of production clusters, as well as areas where they are unexpectedly absent. Biskowski proposed that there were market areas where maize products, such as tortillas, could be purchased directly; therefore maize preparation was not an activity to be found in all residential areas. Conversely, at the site of Aguateca, Guatemala, manos, metates, and jars for food storage were found *in situ* within elite residential structures (Triadan 2000). This suggests that food preparation was done at the household level and was not centralized, at least at the time of abandonment when the city was under siege. However, this pattern could also have resulted from historical factors, such as the siege itself, and not be reflective of household patterns.

In the Maya region of Mesoamerica, early studies of manos and metates were mainly descriptive, focusing on measurements of the different styles encountered during excavation. Early analyses of grinding stones were undertaken by Stromsvik at Chichen Itza (1931) and Calakmul (1937). He described the metates as “simple and purely utilitarian” (Stromsvik 1931:143), and noted that there was little variation in type over time. This consistency makes chronology more difficult to determine than with other artifacts, such as ceramics, which are more subject to stylistic changes. At Chichen Itza, there were two styles of metates. The most abundant was a heavy, coarsely made trough type; the second was a more scarce, finely-made footed variety. Stromsvik (1931:152) noted that the footed style was very similar to the one currently used by the local Maya people. The functions of both were presumed to be maize grinding. Stromsvik attributed the difference in styles to the rise and fall of the city.   He believed that Chichen Itza's "prime" years produced the footed variety, while the coarser trough style metates were credited to the final years when the city was in decline (Stromsvik 1931:152).

At Calakmul, Stromsvik (1937) noted that there were trough metates like those found at Chichen Itza, and also a round, basin style that was used with a one-handed mano. Despite the fact that heavy trough metates at Calakmul predated those at Chichen Itza, he again attributed them to the final, declining years of "cultural degeneracy" (Stromsvik 1937:127) rather than to differences in function.

Rathje (1972) looked at manos and metates as indicators of increasing sedentary maize agriculture and for their critical role in exchange systems. Because maize-based subsistence requires hard stone for grinding tools, sharp stone for cutting and chopping, and salt as a dietary supplement, he hypothesized that trade networks to supply these commodities contributed the rise of complex society across the different regions of the Maya area. Puleston (1978) disagreed and pointed out that the predominance of limestone metates across the lowlands suggests that those made of imported rock were luxury items only. Volcanic materials, such as vesicular basalt from the Maya Mountains in southern Belize, were in demand for food processing tools-and stone sourcing from various sites shows that it moved northeast along the Yucatan Peninsula (Abramiuk and Meurer 2006:347). Rocks used as raw materials for ground stone tools could have been obtained not only from the original mountain sources, but also from rivers where they were carried downstream (Graham 1987:754).

Sydrys and Andresen (1976) also looked beyond simple description when they evaluated ground stone tools from sites in northern Belize. Metates from the Corozal District of Belize were classified by type of stone and the possible geologic sources. They were compared to those from other lowland sites in the Peten in Guatemala and the northern Yucatan Peninsula. By looking at metates made of local sedimentary stone, such as limestone, versus non-local stone, such as basalt, they hoped to reveal the distribution and availability of trade goods. Specifically, they focused on metamorphic and igneous intrusive stone, such as granite and quartzite from the Maya mountains in western Belize, and igneous extrusives such as basalt from the southern Guatemala volcanic highlands.

A similar study by Peeples (2003) looked at manos from the site of Colha, Belize, analyzing not only form and dimension but raw material and geologic sources as well. Catalogues of ground stone tools at Dzibilchaltun and Rio Bec (Rovner and Lewenstein 1997), as well as Cerros, Belize (Garber, 1989), have also documented form and composition. At Caye Coco, Belize, Delu (2007) analyzed an assemblage of manos and metates, looking at commerce systems based on raw material and distribution. She evaluated not only form and function, but discard and re-use patterns, to look at ritual function and social status.

Anderson (1997) analyzed another set of metates from Chichen Itza and confirmed some of Stromsvik's earlier findings. The coarser, utilitarian trough metates were predominant in the assemblage. His conclusions as to the differences in style, however, were different. He proposed that the heavy trough styles were likely an adaptation to the local environment. The relative softness of the local limestone meant that thinner styles would wear out much more quickly than the heavier trough type. Therefore, a simple, more easily produced, metate with a thicker platform would be a practical solution (Anderson 1997:190). At the time of Anderson's study, he noted that stone metates were no longer favored by the local Maya, who instead were using metal grinding implements because the newer technology avoids getting grit in the meal that occurs when grinding maize on the soft local limestone (Anderson 1997:191). A diet of food containing stone grit can cause wearing-away of the teeth, which is visible in the archaeological record in dental analysis (Saul and Saul 1997:46). In fact, Gann (1918:71) noted this effect in both the modern Maya of his time, as well as in skeletal remains recovered during his excavations in northern Belize.

At the site of Chunchucmil in northwestern Yucatan, Watanabe (2000) found heavily used trough and basin metates (larger than those at Chichen Itza) and also an unusual quern style with a spillway or overflow channel set into the rim. Noticeably absent from the assemblage were the flat, legged style metates found commonly at other sites in the Yucatan (Watanabe 2000:16). Also nearly absent were manos. Watanabe noted only three possible mano fragments found in his study (Watanabe 2000:43). He theorized that the differences in the assemblage at Chunchucmil were related to the product being processed. Rather than maize, it may have been achiote seeds, which are commonly used as a condiment and colorant, and grows well in the arid thin soils of the region (Watanabe 2000:97).

Ethnographic research documents modern Maya use of manos and metates from material selection and manufacture (Hayden 1987a) to morphology and function within the context of the culture (Horsfall 1987; Searcy 2005). Observed preferences in tool form and function during food preparation can illuminate use constraints that may not be obvious from style analysis alone. Some early ethnographic accounts (Gann 1918:21; Gann and Thompson 1931:185) describe maize grinding metates as flat to slightly concave stones used with an elongated mano shaped like a rolling pin. As mentioned previously, Stromsvik (1931:144) noted that the Maya at Chichen Itza were using flat 3-legged metates for maize grinding with long slender manos that tapered at the ends. Maize was ground after being soaked in a solution of lime-water overnight (a process called *nixtamalization*), similar to the process noted by Friar Diego de Landa (1994:56) in his *Relacion de las Cosas de Yucatan* (written ca. 1566).

The preparation and consumption of maize by modern rural Maya in particular can shed light on specific techniques and nutritional requirements. Examples include the necessity for alkali processing (Katz et al. 1974; Serna-Saldivar et al. 1987; Krause et al. 1992) and for consuming "green" or unripened corn (Brenton 2003) to avoid niacin-deficiency and increase the bio-availability of amino acids such as Lysine and Tryptophan. These data may be applicable to behaviors in the past.

Ethnographic data can also reveal factors that affect the use-life of grinding tools of various materials, as well as what substances they are used to process over their use-lifetimes (Hayden

1987b). Hayden notes, for example, that manos and metates originally used for grinding maize may later be used to grind salt, pigments, or calcite temper-or even used as hammer stones and paving stones when they are broken (Hayden 1987b:191). Additionally, looking at the ways maize can be prepared across different regions and cultures (Beck 2001), such as whether it is soaked in alkaline solution and ground as wet *nixtamal* or prepared as a dried meal or flour, can indicate the tools needed for each method. In this way, the tools found may reflect not only the presence of maize, but the methods by which it was processed.

Sometimes information on foods being prepared comes directly from the tools themselves in the form of residue. Under certain conditions, ancient starch grains, phytoliths, pollen, and other plant remnants can be extracted from ground stone tools and identified. Geib and Smith (2008) looked at pollen washes from manos and metates from the American Southwest and found that, indeed, maize pollen was recovered from the artifacts. However, they cautioned that the presence of specific pollen did not mean that the plant was actually ground on a particular metate. Rather, its presence may have been related to how the pollen is spread, such as by insect or wind, and the fact that pollen was produced when a plant was flowering and, thus, may not persist on the seeds at the time of processing (Geib and Smith 2008:2085).

Artifacts used for food preparation, such as stone tools and ceramic vessels, can yield organic plant residues such as lipids, starch grains, and phytoliths. Studies of these residues by gas chromatography-mass spectrometry (Del Pilar Babot and Apella 2003; Buonasera 2007; Reber and Evershed 2004), stable carbon isotope analysis (Hart et al. 2007; Reber et al. 2003) and microscopic analysis (Bozarth and Guderjan 2004; Briuer 1976; Pearsall et al. 2004; Shafer and Holloway 1979; Sobolik 1996; Zarillo and Kooyman 2006) can, under certain conditions, be used for species identification. In particular, phytolith analysis can be used to determine the presence of maize, squash, beans, manioc, and other important crop species on stone tools (Piperno 2009; Piperno and Holst 1998). These methods have been used to study artifacts from Canada, the United States, South America, and southern Central America, but seem underutilized in the Maya area. This may, however, be due to issues of preservation (Jones 1994a).

There is much information that can be gained from the analysis of food processing tools such as manos and metates. The tool forms present at a site can indicate much more than just cultural style preferences; they can also reveal the processing methods and, therefore, the types of foods being utilized. In the case of maize, the grinding tools may indicate whether it was the foundation of a society's diet or just a part of a more diverse subsistence pattern.

BACKGROUND

Maize

In order to understand the concept of maize-dependent subsistence, it is necessary to understand maize itself. A New World domesticate, maize is very adaptable to different environments and able to produce relatively large amounts of nutrient-dense kernels that are highly storable and portable (Raymond and Deboer 2006:338). These characteristics likely contributed to its spread across Mesoamerica and, eventually, to the rest of the world.

Genetic evidence supports a single domestication for maize in the Balsas River drainage of western Mexico at around 9188 B.P. or 7200 B.C., deriving from the wild teosinte plant (Matsuoka et al. 2002; Benz 2006). This was followed by two dispersal events, one northward into the North American continent and another into Mesoamerica, South America, and the Caribbean (Matsuoka et al. 2002:6084). By the time the Spanish arrived, maize was found from Canada to as far south as Chile (Staller 2010:8).

How and why maize was developed from teosinte is not certain. The young teosinte seed stalks can be eaten before they harden or mature seeds can be popped like popcorn (Beadle 1977:621). Recent research suggests that the initial reason may not have been for use as a food product, but rather for its sweet syrup (Smalley and Blake 2003). Like sugarcane, both teosinte and maize have stalk sugar that can be expressed into syrup. This syrup can be used as a sweetener, like honey, and fermented to make alcoholic beverages. As alcohol consumption is often an integral part of ritual behavior and social gatherings, this characteristic may have been just as important as the seeds, especially as early cob sizes were quite small compared to modern maize (Blake 2006:69). Whether by design or chance, however, as the plant stalk size increased, so did the cob and the number and size of the kernels. Together with a relatively short growing season, these characteristics would have made maize an ideal food for mobile societies. In fact, the presence of maize predates sedentary agricultural society by at least a thousand years (Raymond and DeBoer 2006:338).

Ethnographic accounts from 16th Century Spanish clerics and explorers document the importance of maize among the Maya. Diego de Landa (1994:56 [1566]), in his description of Maya society in the Yucatan, wrote “the principal sustenance is maize, of which they prepare various dishes and drinks”. Similar reports from Mesoamerica and the Caribbean also document the importance of maize, which these early chroniclers likened to the grains of the Old World. Even the English name *corn* comes from the 16th Century German word *korn t*hat referred to wheat, oats, and other European grains. The term was later applied to maize as *Indian Corn* or *Turkish Corn* (Staller 2010:21). Once harvested, maize can be dried and stored for 4 to 6 months, depending on conditions such as humidity and insects. Smoking it over a fire for several days may increase storage time for up to a year, according to some early Spanish accounts (Reina and Hill 1980:77).

Although maize is a good source of calories in general, it is deficient in certain essential amino acids and niacin. The disease Pellagra, caused by niacin and tryptophan deficiency, is a common consequence of a maize-predominant, low-protein diet, unless measures such as alkali processing with lime or ash are utilized (Brenton and Paine 2000). The addition of an alkaline substance allows for better absorption of the amino acids lysine and tryptophan, in addition to niacin, in the digestive tract (Serna-Saldivar et al. 1987:247). Without this measure, Pellagra usually results unless these nutrients are supplied by other foods.

Pellagra is characterized by the four “D’s”: dermatitis, diarrhea, dementia and death, as well as bone demineralization, delayed fracture healing, and skeletal changes similar to scurvy (Brenton and Paine 2000:3). This disease has a low occurrence in Mesoamerica, where traditional cooking methods protect against Pellagra. However, it has been a significant problem when maize was introduced into other cultural contexts such as Africa, India, and the Depression-era United States (Katz et al. 1974:766). When beans and squash are added to the diet, as is common in Mesoamerica, they also provide key missing elements and round out the diet to make it more nutritionally complete (Lentz 1999:5).

Soaking and grinding corn is common across New World cultures, including the Maya. This process increases digestibility by removing the outer *pericarp* and reducing the size of the starch particles. Grinding increases the surface area exposed to enzymes, thereby speeding digestion and possibly adding minerals from the metate stone on which it is ground (Stahl 1989:174). This treatment also contributes a significant amount of calcium to the diet, especially from the calcium carbonate in the lime water used for soaking the kernels (Krause et al. 1992:280). The process consists of placing the maize kernels into an alkaline solution and bringing it to a boil, and then removing it from the fire and allowing it to soak overnight. The resulting softened kernels, *nixtamal*, are then rinsed in clean water in preparation for milling into a soft dough called *masa.* Evidence that this process of rinsing nixtamal was already in place during the Preclassic Period comes from remains of ceramic colanders, coated with what appears to be a white lime residue, found in the central Peten and the Belize Valley (Cheetham 2010) and from the Postclassic Period at Lamanai, Belize (White and Schwarcz 1989:466).

It seems a logical conclusion that the development of this preparation technique is what allowed the transition to maize-dependence in Mesoamerica-and among the Maya. The argument is strengthened by the evidence of malnutrition in areas where maize dependence occurs outside of its original cultural context. In this sense, Maya society and maize evolved together, each becoming dependent on the other.

To test this theory, Katz et al. (1974) investigated 51 New World traditional native societies (from North to South America) in regions suitable for maize growth. They evaluated each society regarding the levels of maize production, consumption, and processing methods used. What they found was that alkali processing was used in all high-producing, high-consuming societies, but was not used in those that were low-producing, low-consuming. They noted that the most common sources of alkali were lime, lye, or wood ash depending on available resources. Among the Lacandon Maya, burned freshwater mussel shells were used (Katz et al. 1974:772). The use of lime was found only in the Southwestern United States and Mesoamerica.

The level of maize use and production varies among societies and across regions in modern times-and was likely to have done so in the past. For example, while maize was present in the Chavin civilization of Andean Peru, foods such as potatoes and quinoa were the more important crops (Burger and Van Der Merwe 1990:92). Maize was very important to the Maya, not just as a food item, but also culturally and spiritually. It plays a prominent role in their creation myths and can be found in the writings of the Popol Vuh of Guatemala (Tedlock 1996) and in the Books of Chilam Balam of the Yucatan (Roys 2008). The maize plant is unique in the Maya area and totally dependent on humans for survival and propagation. Johannessen and Hastorf (1994:443) also point out its physical resemblance to people, standing tall and straight as a man with tassel-like hair and leaf-like waving arms. It is an image of the young Maya maize god.

Maya Subsistence

Much has been written on the topic of the subsistence and agriculture of the ancient Maya. How they were able to sustain the large, densely populated Classic Period cities has inspired much research and theory. What has come out of this research is that the ancient Maya had multiple methods of growing and obtaining food-and that these methods differed across time and region (Fedick 1996; Stahl 1996; Turner et al. 2003). The slash-and-burn, long fallow swidden agriculture that is common in Mesoamerica today was just one of many methods used in ancient times and was not likely the predominant method used by highly populated Classic Period cities (Drucker and Fox 1982:180). Instead, the ancient Maya adapted their methods to the wide variety of microenvironments that existed in their tropical landscape.

For example, the site of Caracol in southern Belize had a peak population estimated to be approximately 115,000, perhaps even over 150,000 during the Classic Period (A. Chase and D. Chase 1994:5, 1998:61). The site is extensively terraced, indicating a carefully planned, intensive agricultural system (A. Chase and D. Chase 1994:6). No pollen has been recovered from these terraces, as much of the original soil has been replaced by clay from the natural processes of erosion and bioturbation (Healy et al. 1983:406). However, maize pollen has been found in core samples recovered from the southern reservoir that were carbon dated to the Classic Period (Healy et al. 1983:407). Phytolith soil analysis at Caracol demonstrates that these plant remains are not generally preserved (Jones 1994a:38), although a single maize phytolith was recovered from one of the terrace soil samples (Webb et al. 2004:1044).

In contrast to Caracol, Santa Rita Corozal was not highly populated compared to other Maya sites. The Corozal Postclassic Project determined that there were two periods of significant population growth, first in the Early Classic, and then again in the Late Postclassic (Table 1) (D. Chase and A. Chase 2004). The population at Santa Rita Corozal is estimated to have surged from approximately 150 people during the Preclassic, to 1500 by the Early Classic (D. Chase and A. Chase 2004:246). The next increase came in the Late Postclassic (1300-1530 A.D.) when there were about 6800 residents occupying the site (D. Chase and A. Chase 2004:247). This is comparably less than the Postclassic population at Mayapan, which was estimated at 11,000-12,000 (D. Chase 1990:206).

The resources available to the residents of Santa Rita Corozal would have been varied. The ocean and nearby rivers provided ample fish, turtles, mollusks, and other sources of protein. In addition, there were terrestrial animals such as deer, peccary, turkey, and dog (Morton 1988). The soil of the region is suitable for maize agriculture and Gann (1939:56) referred to it as an ideal environment for cultivation. Plant remains dating to the Classic Period and earlier in northern Belize include not only maize, but also avocado, allspice, cacao, nanze, hackberry, guava, sapodilla, squash, hogplum, and mamey (Turner and Miksicek 1984:185). In addition, there is evidence that beans, chile, and root crops, such as manioc, sweet potato, and jicama were available as domesticates (Colunga-Garcia and Zizumbo-Villareal 2004:106; Hather and Hammond 1994). Linguistic evidence also confirms the importance of cultivated and aquatic resources for the Classic and Postclassic Maya (Rule 1980:23).

Unlike Caracol, there is neither evidence of terracing at Santa Rita Corozal nor signs of other constructions, such as canals or raised fields. They did not appear to use intensive agricultural systems like those found elsewhere in Belize. Wetlands in northern Belize were manipulated for agricultural use by using raised fields and canals (Siemens 1982; Turner and Harrison 1978:338). For example, Cobweb Swamp in northern Belize has canals that show evidence of human modification beginning between the Middle Preclassic to Early Classic Periods (Jacob 1995).

The lack of evidence for intensive agriculture at Santa Rita Corozal is supported by stone tool analysis in the region. Dockall and Shafer (1993) compared use-wear on flaked stone tools from Colha and Santa Rita Corozal to those from Pulltrouser Swamp. Tools from Pulltrouser Swamp show microscopic wear related to soil working, which is expected given the system of raised fields and canals. At Santa Rita Corozal and Colha there is less evidence of soil working and greater evidence of woodworking and chopping. This data supports a non-intensive agricultural system that involved land clearing and field rotation (Dockall and Shafer 1993:171).

Modern Maya milpa farmers average a 1:4 to 1:10 year crop-to-fallow ratio due to weed invasion and dramatically decreased yields (as much as 75%) by the third year of cultivation (Johnson 2003:132). Maize plants, in particular, are susceptible to fast growing weeds that out-compete them for the same soil nutrients and it is this, rather than overall soil depletion, that causes a decrease in yields (Lambert and Arnason 1980, 1986). According to Johnson (2003), weeding and mulching enhance crop yields and lengthen cultivation by slowing weed growth, optimizing soil moisture and temperature, and renewing soil nutrients through the decomposition of the pulled weeds left in place to rot. In this way, he suggests that a ratio of 6:12 or even 8:8 are possible, permitting a farmer to have only 2 or 3 plots of land to maintain continuous cultivation rather than the 10 needed with traditional slash-and-burn methods (Johnson 2003:146).

It seems reasonable that the residents of Santa Rita Corozal would have been able to use a form of agriculture involving field rotation that could have been adapted to increasing population levels. By using shortened fallow cultivation methods, yields could have been increased to meet higher demand without having to use other intensification methods such as terracing, raised fields, or wetland manipulation.

Reconstructing Diet

As previously discussed, determining when and where maize became the predominant food crop among the Maya has included multiple lines of evidence including stone tool analysis, macrobotanical remains, and linguistics. In addition, skeletal analysis is also an increasingly important resource in combination with isotope analysis.

Maize and other subtropical grasses, such as sugarcane and amaranth, follow the C4 photosynthetic pathway. As a result, they have different levels of stable carbon isotopes (carbon-13/ carbon-12 ratio) than those that follow the other pathways (Tykot 2006:132). The C3 pathway includes most other species of shrubs, trees, and temperate grasses, while the CAM

(Crassulacean Acid Metabolism) pathway includes bromeliads, succulents, and agave. Maize is the major C4 food crop in Mesoamerica and it leaves a signature behind in the bones of the people and animals that consume it (Tykot 2006:133). While amaranth is also a New World C4 domesticate, there is no evidence that it was a dietary staple among the ancient Maya (Lentz 1999:13). It was used in Mexico, in particular by the Aztec, and early Spanish chroniclers described its use for food as well as in ceremonies (Sauer 1950:568). In the Maya area, amaranth pollen has been found in northern Belize at Albion Island, Pulltrouser Swamp, and Cobweb Swamp (Jones 1994b:208; Turner and Miksicek 1984:183). It was also recovered from a washing at Nohmul structure 20 (Diane Z. Chase, personal communication 2011). However, the pollen from domestic amaranth is almost identical to that of wild varieties, which include species of common disturbance weeds (Turner and Miksicek 1984:183).

Analysis of stable carbon isotopes in bone collagen and apatite can be used in some cases to determine the level of maize consumption. Bone collagen, produced from dietary protein sources, can be used to determine the diet during the last several years prior to death. Bone apatite in tooth enamel is representative of total caloric intake and not just protein. Since teeth are formed early in life, they represent diet during childhood (Tykot 2006:136).

Marine food sources, such as fish and marine mammals, have isotopic values similar to C4 plants, which has implications when reconstructing the diet of coastal populations (Schwarcz 2006:316; Tykot 2006:138). Evaluation of nitrogen isotope values can demonstrate whether significant marine resources were consumed. Unlike maize or terrestrial herbivores such as deer, marine fish are high in nitrogen-15. Additionally, the consumption of maize-fed animals can affect isotopic values. While there is evidence that dogs were sometimes fattened on maize and then eaten or ritually sacrificed, this does not seem to be the case for the majority of deer or other animals that have been studied (Schwarcz 2006:317; White et al. 2006:145).

Isotopic studies across the Maya area show that maize consumption varied both temporally and geographically based on local resources and distance from the coast. Studies by White et al. (1993) at Pacbitun, Belize, an inland site 8 km from the closest river (Figure 14), show that maize consumption increased during the Classic Period and peaked during the Late Classic. This was also when the population was at its greatest and intensive hillside terracing was practiced. Then, overall C4 levels started to decline and evidence of status and gender differentiation in maize consumption increased during the Terminal Classic. The site was abandoned at about A.D. 900. Nitrogen isotopes indicated that the main protein source, terrestrial herbivores, remained relatively constant during this time. The authors interpret this data to represent a possible shortage of maize, where the maximum production capacity was reached-yet still fell short of demand (White et al. 1993:370).

The authors then compared the results from Pacbitun to those at Lamanai, Belize, located near the New River and closer to the coast. Comparatively, Lamanai showed less maize dependence; maize consumption actually decreased from the Early to Late Classic Period (White et al. 1993:368). There was also greater elite access to marine foods at Lamanai than at Pacbitun. Lamanai was not abandoned at the end of the Classic Period, but survived into the Historic era. The study also compared these results to the much farther inland and southern site of Copan, Honduras. Isotopic values at Copan showed the highest level of maize consumption and the lowest amount of marine foods of the three sites studied (White et al. 1993:369). The combined average percentage of C4 dietary components found were 50% for Lamanai, 66% for Pacbitun, and 71% for Copan. In contrast, a study by Tykot (2002:222) shows collagen data from inland and riverine sites in the Peten with values of about 70% during the Preclassic that remained relatively stable through the Classic Period.

An additional isotopic study by Coyston et al. (1999) at Lamanai and Pacbitun confirmed that Pacbitun was more maize dependent than Lamanai. They did not find the same evidence of maize being an elite food at Pacbitun, but suggest rather that it was maize-fed animals, such as dogs and turkeys, that were high status foods and therefore more accessible to elite males (Coyston et al. 1999:239).

Analysis of teeth for dental caries and enamel hypoplasia can also help in the interpretation of bone isotope studies. Dental caries are a common result of high carbohydrate, starchy diets (Whittington 1999:152), while hypoplasia and pitting of tooth enamel are evidence of malnutrition, anemia or infectious disease (White 1997:175). In the case of Lamanai, decreased C4 levels were accompanied by decreased dental caries but with stable levels of enamel hypoplasia are associated with weaning stress rather than malnutrition (White 1997:175). The author suggests that these results, together with stable N15 levels, show decreasing maize dependence due to a voluntary shift to C3 plants during the Late Classic Period that is culture-based, rather than environmentally-based. The lack of signs of increasing nutritional stress and the fact that Lamanai survived through the Postclassic Period supports this conclusion. The stability in type and amount of animal protein consumed suggests a switch to wild or cultivated

C3 plants; the low incidence of dental caries rules out a major dependence on starchy carbohydrates, such as root crops or ramon nuts (White and Schwarcz 1989:465-468). During the Postclassic and Historic Periods, there is once again isotopic evidence of a maize dependant diet at Lamanai-and a corresponding increase in dental caries (White and Schwarcz 1989:465). Dental studies at Copan from the Classic Period (Whittington 1999) support a significant amount of maize consumption based on analysis of caries and antemortem tooth loss.

Overall, isotopic studies show the highest C4 consumption at inland sites, such as Copan, and correspondingly lower levels at sites that are closer to coastal and riverine environments, such as Lamanai. The availability of a wider variety of C3 plants and aquatic foods is likely the reason for the difference (Wright and White 1996:186). An interesting exception is Mojo Cay, Belize, which has carbon isotope values similar to those in the Peten. Tykot (2002:222) points out that nitrogen isotope values at Mojo Cay indicate that this effect is likely due to consumption of reef fish and other marine foods-and not to a high maize intake.

Skeletal analysis at Santa Rita Corozal found generally good health among the 164 individuals recovered during excavation (D. Chase 1997). While this is a relatively small sample of the living population, it is still notable that there were only three cases of porotic hyperostosis and only one of dental calculus. To date, isotope studies have not been done at Santa Rita Corozal.

Maize Grinding Tools

As previously discussed, grinding maize kernels into small particles has nutritional benefits and improves palatability by removing the tough outer pericarp. The ubiquity of these milling tools at Maya sites indicates that the Maya knew of these benefits very early. Styles of manos and metates vary, but they can be broken down into basic categories. Manos may come in various shapes, but are generally designed to be either one- or two-handed. Metates may be flat, curved, bowl or trough shaped. They can come with or without legs-and can be of any size. Any kind of rock may be used for a grinding stone, although limestone is the most available resource in the Maya lowlands, especially as the Yucatan peninsula is essentially a limestone shelf.

At Santa Rita Corozal, limestone is the most common substance used for manos and metates (Table 11). Local stone varieties (limestone and other sedimentary stone) accounted for 90% of the manos and 71.5% of the Metates. Imported volcanic stone (granite, basalt and other igneous or metamorphic rock) accounted for 8.3% of manos and 23.7% of the metates. The greater percentage of metates made from non-local stone may reflect a preference for the harder, less grainy texture of volcanic rock such as vesicular basalt that is noted in ethnographic studies (Hayden 1987:14). The use-life of metates made of this type of rock is greater than that of softer, less dense stone. Use-life estimates based on ethnography range from an average of 20 to 40 years, or in some cases up to 100 years, depending on how often a metate is used (Hayden 1987:193). Softer limestone metates would be expected to have a shorter use-life.

The form of these tools reflects their function; in other words, their design and material is a result of the specific intended use. The Maya would have certainly figured out the most efficient methods for processing different food items-and this is evident in the variety of these tools. Food processing can consist of pounding, as with a mortar and pestle, circular or rotary grinding motion, as with a one-handed mano and bowl-shaped metate, or reciprocal back-and-forth grinding motion as with a two-handed mano on a flat or trough-shaped grinding surface. When grinding significant amounts of maize, it is reciprocal motion that is the most efficient method. When the maize kernels have been soaked or precooked-and are soft- as is the custom among the Maya, it is the flat metate and two-handed manos that are associated with this activity. When the maize kernels (or other substance being ground) are hard, then a trough metate is preferred; the sides keep the items being processed contained so that they do not scatter or bounce off the grinding surface (Adams 1999:492). In some modern Maya households in Honduras, trough metates are used primarily for grinding chiles and herbs for this reason (Spink 1984:137).

Experimental studies and ethnographic accounts show that the increased surface area of a larger mano, together with the greater use of upper body strength that this technique allows, results in larger amounts of maize being processed in a shorter of time. Therefore, the two-handed method is preferred for maize grinding. With flat metates, having a slope to the grinding surface reduces the physical effort needed to be expended by facilitating a downward and forward motion of the two-handed mano. In this way, the effort is distributed across the entire upper body, rather than just the muscles of one arm-as when using a one-handed mano (Horsfal 1987:348).

Efficient maize grinding would be important in communities where maize was a major dietary component, as the daily preparation of nixtamal and masa would be a time-consuming task. A study by Krause et al. (1992) showed that, in modern day rural Guatemala, women who ate only maize and not modern bread products consumed about two pounds of maize per day per person-all of which is prepared in the traditional lime-soaked fashion and then made into tortillas. Other per person/per day estimates include 1.1 lbs (Highland Maya), 1.3 lbs (Yucatan) and 1.7 lbs (Honduras and Guatemala) (Morris 1990:188).

Grinding enough maize to feed a family would therefore be a significant investment of time and energy every day. Estimates of processing time of about three hours a day for a family of five have been proposed, based on ethnographic examples using similar stone implements (Horsfal 1987:348). The factors affecting the total time would include: the number of family members and how much they eat; the size and material of the mano and metate used; the technique of the person doing the grinding; and, the number of people in the household who perform the task.

Additionally, masa dough may be ground multiple times until the desired texture is reached, which may vary depending on the end product. A study in highland Guatemala showed that each batch of masa was ground two or three times to reach the desired texture for tortillas (Searcy 2005:92). At Chichen Itza, Stromsvik (1931) described the local women as being able to grind one *almudo* of maize (about 9.5 lbs) in two hours, with an additional hour per meal being needed to make enough tortillas for the family for the day (Stromsvik 1931:145).

In addition to tortillas, maize can be consumed as *tamales,* which is dough stuffed with meat or vegetables and then wrapped in leaves. Alternatively, a soft gruel such as *pozole,* or a variety of beverages which may or may not be fermented, can be the end product. The *comal,* a flat ceramic disc on which tortillas are cooked, appears in the Maya area mainly during the Postclassic Period (Fournier 1998:24), so it is likely that tortillas were not the main form of maize before this time. Linguistics also suggests that the words *comal* and *tortilla* may have originally referred to multiple objects that were flat or round-and that their current meanings are more recent developments (Hill 2006:636).

So, while grinding times are highly variable, it is clear that the daily preparation of maize occupied a significant portion of any day. Being able to complete the task as efficiently as possible would have been an important consideration.

Santa Rita Corozal

The site of Santa Rita Corozal is located on the coast of northern Belize on Chetumal Bay, between the New and Hondo Rivers (Figure 1). Though best known for its Postclassic deposits, investigations at Santa Rita Corozal have demonstrated continuous occupation from the Preclassic Period to Historic times (D. Chase and A. Chase 2005:125; 2006). What began as a small settlement on a bluff overlooking the bay, by the end of the Postclassic Period had become a major center and the likely capital of the Chetumal region (D. Chase and A. Chase 1988:65-68). The site was briefly abandoned in 1531, when the Spanish arrived and established the town of Villa Real. After only 18 months, the Spanish forces relocated south to Honduras and Santa Rita Corozal was re-occupied by the Maya. However, it likely never recovered its previous population levels and regional status (D. Chase 1981:27-28; D. Chase and A. Chase 1988:67). Today, its remains lie beneath the modern Belizean city of Corozal Town.

The first investigations at Santa Rita Corozal occurred in the late 1800's and early 1900's by Thomas Gann. He was a British doctor serving as medical officer in the Corozal region of what was then British Honduras (Gann 1900; Gann 1918; Gann and Gann 1939). An amateur archaeologist, he began exploring the local mounds in the area. His excavations uncovered an array of ceramic vessels and figurines, ritual caches, burials and some rare painted murals. However, even at the end of the 19th Century, Gann noted that the site was rapidly being dismantled as a source of rocks for the construction needs of the local people. The murals he described were removed by modern people and the mound that once housed them was bulldozed in 1975 (D. Chase 1981:29).

Later excavations at Santa Rita Corozal included those by Ernestine Green (1973); in 1971, she evaluated site distribution patterns in northern British Honduras. Green was looking at characteristics of several known sites in the region to determine what criteria may have been important for site selection. Santa Rita Corozal was noted as having had many desirable qualities, such as proximity to coastal and riverine environments, which provided navigable waters for trade routes, natural resources, and land suitable for agriculture. Green suggested that the social and political importance of Santa Rita Corozal during the Postclassic Period may have been a factor as well. She noted a slightly positive association between proximity to Santa Rita Corozal and site density in the region (Green 1973:289).

In 1973, Norman Hammond's Corozal Project mapped and surveyed several sites in the Corozal District, focusing mainly at Nohmul and Cuello. A single excavation was made at Santa Rita Corozal to determine the ceramic sequence (Pring 1973). Surface collections and a test pit were undertaken in front of Santa Rita Corozal Structure 7, a pyramid which had first been described by Gann (Pring 1973:63). Findings revealed that occupation at Santa Rita Corozal was evident during the Preclassic Period and that the pyramid had been constructed during the

Early Classic Period. Postclassic sherds found in the area further suggested that the structure may have had some function during this period as well.

Raymond Sidrys (1983) described an archaeological survey of northern Belize by his UCLA-based project in 1974. This investigation sought to add to the database of information regarding the transition from Terminal Classic to Postclassic Period in the central Maya lowlands. Ceramic analysis and geological sourcing of stone tools were used to compare local and imported items. From this data, trade networks and inter-regional political relationships were suggested, such as a Late Postclassic relationship between Santa Rita Corozal and the Yucatan (Sidrys 1983:127). At Santa Rita Corozal, the survey recovered Preclassic and Early Classic ceramic material, confirming occupation during these times. Based on increasing amounts and variety of ceramic materials in later times, Sidrys suggested that the growing population during the Classic Period signified increased regional prominence. By the Terminal Classic he viewed Santa Rita Corozal as an important satellite of Aventura (Sidrys 1983:126) and by the Postclassic had become the region's capital.

From 1979 through 1985, the Corozal Postclassic Project (CPP) headed by Dr. Diane Chase and Dr. Arlen Chase continued investigations at the site in an effort to document as much as possible before the site was covered by the expanding city of Corozal Town (Figure 2). Although materials from all time periods were uncovered, the focus of the project, as the name implies, was on the Postclassic Period. Research topics included site and social organization, ritual behavior, the transition from Classic to Postclassic, and a correlation of ethnohistoric accounts to archaeological data (D. Chase and A. Chase 1988:2; D. Chase and A. Chase 2004:243). Findings confirmed a long occupation at the site, with a majority of material remains dating to the Late Postclassic Period. Data from Santa Rita Corozal shed much needed light on the Postclassic Period-a time that was often thought to be a general decline in Maya civilization following the "collapse" of the Classic Period. Santa Rita Corozal was a vibrant community that thrived beyond the Classic Period, unlike many other cities.

The impressive number of Postclassic effigy caches and figurine vessels identify Santa Rita Corozal as a center of calendric ritual and are correlated with its status as a regional Postclassic capital (D. Chase 1985; D. Chase and A. Chase 2008, 2009). The presence of imported items indicates participation in trade networks by the Middle Preclassic (D. Chase and A. Chase 1989:26). Known as an exporter of cacao and honey, Santa Rita Corozal had ties both local and long distance, extending beyond the Maya area by the Late Postclassic (A. Chase and D. Chase 1981:42; D. Chase and A. Chase 1989:29). Findings supported an established relationship between Santa Rita Corozal and sites in the northern Yucatan, specifically Mayapan during the Postclassic Period (A. Chase and D. Chase 1981:43; D. Chase 1981:30; D. Chase and A. Chase 1982; 1986:3). Marine and riverine trade routes and networks were important during the Postclassic, particularly on the east coast of the Yucatan (A. Chase and P. Rice 1985:6). This naturally places Santa Rita Corozal in an ideal location for a center of regional and long distance trade.

The Postclassic organization at Santa Rita Corozal is one of decentralization. The arrangement of structures supports an informal barrio model rather than the concentric ring model for settlement, as described by Landa (D. Chase 1986:364). Findings from the Corozal Postclassic Project show that, while there may have been a central ceremonial core section of the town during the Classic Period, this centralization is not indicated from the structures built during the Postclassic. Although it is not possible to know the full original extent of the site, there were at least five barrios present during the Late Postclassic Period, with a variety of structure types represented in each area (D. Chase 1982:579).

Six basic structure types have been described by the Corozal Postclassic Project (D. Chase 1986:355); they range from simple, single room structures, visible only as line-of-stone on the ground, to multi-room constructions on raised platforms. Frequently, Postclassic residences were built directly on the ground rather than on platforms or earlier structures. This means that the simple line-of-stone outlines can be hard to see and easily overlooked, which may result in an underestimation of the population (D. Chase 1990; D. Chase et al. 2008:7).

Based on the presence of caches and burials, the larger multi-room constructions and raised platforms are thought to have served as elite residences and areas of administrative and ritual activities, although the specific functions are not distinct (D. Chase 1982:580). Residential groups were arranged around a central plaza area that frequently included a multi-room palace or shrine. While there is ample refuse indicating domestic and ritual activity, there is nothing that indicates specific kitchen areas within the structures (D. Chase and A. Chase 2004:248). This raises the questions as to whether food preparation was also decentralized and as to whether maize grinding occurred on a household level rather than in an area dedicated to that function. An analysis of manos and metates should be able to help answer that question;

however, most of these tools were recovered from humus layers, fill, walls, and rubble and did not come from good in-situ, use-related context.

Environment and Climate

The Yucatan Peninsula encompasses parts of Mexico, Belize, and northern Guatemala. It is comprised of a layered limestone and dolomite platform hundreds of feet thick. On the eastern coastline, the Rio Hondo fault zone is where Santa Rita Corozal and Chetumal Bay are located. It is an area of geologic depressions containing lakes, swamps, wet savannah, rivers, and offshore islands (Wilson 1980:9). Rainfall is seasonal, totaling 1500 ml annually, with the rainy season extending from May through October-and November to April being the dry season (Wilson 1980:24). This is more than adequate for maize cultivation, which requires at least 500 ml annually of regular, predictable rainfall (Dahlin et al. 2005:234). The Rio Hondo region has evidence of some of the earliest forest disturbance and agriculture, including maize, in the Maya Lowlands-possibly by as early as 3400 B.C. (Dunning et al. 1998:93; Pohl et al. 1996:368).

Research by Curtis et al. (1996) looked at past climate history from oxygen isotopes in lake sediments near Coba in the Yucatan (to the north of Santa Rita Corozal). Their findings showed a period of relative drought during much of the Classic Period, with peak dry years in A.D. 585, 862, 986 and 1051 (Curtis et al. 1996:43). By A.D. 1100 the climate had become more humid and remained that way until approximately A.D. 1368. These cycles of wet and dry fluctuations have occurred throughout the Holocene and significantly influenced both the natural environment and the agricultural practices of the Maya (Curtis et al. 1996; Hodell et al. 2000:30-32). Drought conditions peaked during the Terminal Classic Period with the driest conditions occurring in the Northern Lowlands of the Yucatan (Dahlin 2002:337). Increased rainfall levels during the Postclassic Period would have been beneficial for maize agriculture and enhanced production for a growing population.

METHODS AND MATERIALS

This study evaluated the data for manos and metates from Santa Rita Corozal collected by the Corozal Postclassic Project from 1979 through 1985. Not included were other ground stone tools, such as pestles and bark beaters, or fragments that were too small, too eroded, or without enough surface area to be reasonably identified as a mano or metate. Most of the tools are highly fragmented. Although some complete and nearly complete metates were recovered, none of these were present in the current collection, so they were unavailable for direct examination. The manos and metates of Santa Rita Corozal have previously been categorized by shape, type, and source material by Jaeger (1988), and this was noted on the field object card for each item, along with the measurements. Metates were assigned to three basic categories: flat, concave (also called turtleback), and basin/trough. Manos were categorized by cross-sectional shape into one of ten types.

For the purposes of this study, the tools were organized by suitability for maize grinding. Manos were divided into one of three categories; one-handed, two-handed and undetermined. The metate categories remained essentially the same, but the combined trough/basin category was separated. Those metates with a sharply defined, steep-walled central channel that are indicative of reciprocal motion are identified as "trough", while those with a more rounded cross-section, sloping walls and a bowl-like shape are categorized as "basin." The presence or absence of feet was not considered, as the highly fragmented nature of the assemblage made an accurate assessment of this characteristic impossible. It is the form of the grinding surface that is the focus of the analysis.

Mano and Metate Forms

Two-handed manos are typically used on either the flat or trough-style metates. The contact between the mano and the grinding surface creates wear patterns, and these can be seen in the shape of the mano. Those used in a trough metate tend to be blunt ended. Manos on a flat surface are elongated and can have ends that are rounded, tapered or overhang. Overhang and knob-ended manos are formed by being greater in length than the width of the metate. The ends of the mano that hang over the edge do not wear away because they are not in contact with the surface of the metate. The repetitive reciprocal motion forms a ledge or rounded knob as the grinding surface is worn down over time (See Figure 5).

Having an end piece of a mano can therefore be helpful in determining if it was originally one or two-handed, even if the fragment was reused at a later time. If only a middle section of a mano fragment is present, then looking at the length may be helpful. By definition, two-handed manos are longer than one-handed. Hard et al. (1996:259-260) classify manos less than 15 cm in length as being “small”, and those 15 cm or longer as being “large.” Large manos are two-handed and small manos are generally one-handed, although they point out that ethnographic studies show that some manos classified as small are used in a two-handed fashion. Determining a minimum length for two-handed types was difficult for specimens at Santa Rita Corozal as there were few complete manos and even fewer complete metates.

Looking at the assemblages from other sites, where there were a greater number of complete specimens, is helpful in establishing guidelines.

At Mayapan, a Postclassic site in the Yucatan, Proskouriakoff (1962) documented 320 complete metates and 18 complete “corn grinding” or two-handed manos associated with the trough-style metates, which were the predominant type found at Mayapan. The trough metates measured 25 to 65 cm in total width, with the trough channels measuring 16 to 35 cm. The manos measured 12.6 to 23.5 cm in length. Also noted were two knob-ended fragments and only 15 flat tripod metate fragments. Similarly, at Chichen Itza, Anderson (1991:140) records that of 53 trough metates complete enough to determine the width, the measurements range from 18 to 72 cm and the average trough width was 20.5 cm (range 15 to 42 cm). At Santa Rita Corozal, the 15 complete and nearly complete trough metates described by Jaeger (1988:101) range in total width from 30.8 to 48.8 cm. The narrower range of sizes is likely due to the small sample size. The trough channel measurements are not noted and, as mentioned previously, the specimens are not present in the collection for examination.

Complete flat metates are rarely found, especially as they are more susceptible to breakage due to their relative thinness when compared to the bulkier trough metates. Stromsvik (1931) noted several three-legged flat metates at Chichen Itza. Five fragments that were large enough to measure the width of the grinding platform ranged from 9 to 11.5 inches (22.9 to 29.2 cm) (Stromsvik 1931:154-155). For a sample of nine manos that he described as being used with the trough metates, Stromsvik provided a representative range of 5.5 to 9.75 inches (14 to 24.8 cm) in length (Stromsvik 1931:156-157). At Santa Rita Corozal, the only complete metate with a flat surface is a very small one, measuring a mere 9.1 by 8 cm. With such a small surface area, it is likely that this was used for grinding small amounts of substances other than maize, such as herbs or salt; it may even have been used as a palette or whetstone. Small, portable whetstones have been documented in modern Highland Maya villages for use in kitchens, or out in the fields, for sharpening cutting tools (Hayden 1987:208-211). It is possible that these stones were used for similar purposes in ancient times for sharpening stone tools. Alternatively, this object may have been used as a child's practice toy; miniature tools used in this manner have been documented ethnographically among the Maya (Hayden 1987:191).

For the purposes of this study, the criterion for categorizing manos as two-handed was that determined by Proskouriakoff at Mayapan, the minimum length being 12.6 cm. This was the lower end of the size range for manos used with the trough metates (Proskouriakoff 1962:339). Manos at Santa Rita Corozal that were 12.6 cm or greater were therefore categorized as two-handed. Mano fragments without either end present that were at least 12 cm or more in length were also categorized as two handed, as it is likely that their complete size would have been at least 12.6 cm. Additionally, those fragments with ends that were tapered, knob, or overhang were classified as two-handed. Complete manos less than 12.6 cm are classified as one-handed.

Flat and trough metates were classified as maize-grinding types. While it is certainly possible to process maize on almost any grinding surface, it is reciprocal motion that is the most efficient method for grinding larger amounts of maize kernels. Therefore, these are the types expected to be the primary forms present in a maize dependent society. Basin and concave styles suggest a more circular grinding motion that is used with a one-handed mano.

RESULTS

Of the 300 manos and fragments, there were 22 that were either complete or fragments with both ends present whose length could be measured and were less than 12.6 cm. These were classified as one-handed manos. There were 70 manos that could be classified as two-handed by possessing a length of 12.6 cm (or greater), or by their end shape. There were 208 fragments too small to be assigned to either type (Table 12). Of the two-handed variety, there were 11 complete manos, and they ranged in length from 12.6 to 24.2 cm. Of the fragments, four were overhang-type end pieces. The remaining 55 were either 12 cm or greater in length, had tapered ends, or both.

Of the 207 metate fragments, there were 79 flat, 55 concave, 32 trough, 16 basin, and 25 miscellaneous pieces (including feet and other fragments too small to determine type) (Table 13). A miniature flat metate (P38A/18-2) was also included in this category. Therefore, 111 metates were of the reciprocal maize-grinding type and 71 metates were of the non-reciprocal type.

Distribution Analysis

For Santa Rita Corozal, manos and metates were recovered from all areas of the site, and from all temporal contexts ranging from Preclassic to Historic (see D. Chase and A. Chase 1988). Of the 55 structures (including buildings, platforms and chultuns) investigated by the Corozal Postclassic Project, there were only seven that did not yield any of these tools: Structures 18, 23, 40, 55, 70, 154, and 200. In the Northeast site sector, this category included Structures 55

(Op P7) and 70 (Op P5). Structure 55 was not excavated, and cursory investigations did not yield any artifacts, so its function and period of construction are unknown (D. Chase and A. Chase 1988:14). Structure 70 was an east-facing, raised building with a frontal terrace constructed during the Late Postclassic (D. Chase and A. Chase 1988:17).

In the North Central sector of the site, structure 40 (Op P15) was a Classic Period construction rebuilt during the Late Postclassic. It showed evidence of at least three constructions, and had been previously excavated by Gann. It was noted that this area had been greatly disturbed by earthmoving equipment (D. Chase and A. Chase 1988:35). Structures 7 and 236 both contained mano fragments, but no metates. Structures 18 (Op P2J)and 23 (Op P2E) were located in an area that had undergone significant clearing and digging for the towns new water tower, so little remained of the original structures. Protoclassic and Terminal Classic remains were recovered in this area (D. Chase and A. Chase 1988:36).

In the Southwest sector of Santa Rita Corozal, excavation of Structure 154 (Op P17) showed it to be a single phase Late Postclassic construction that contained a cache and a burial (D. Chase and A. Chase 1988:63). Finally, in the Bay sector, Structure 200 (Op P14) revealed burials that dated to the Postclassic (Figure 3). Because the structure was partially washed away by the waters of Corozal Bay, the function of this construction could not be determined (D. Chase and A. Chase 1988:64). All the other structures investigated yielded manos, metates or both kinds of grinding stones.

Metate Distribution

The most frequent metate form was the flat style and these were found in all sectors of the site (Tables 6 and 7). Some operations that did not have evidence of flat type metates were P2 (Structures 7, 18, 23), P23 (Structure 162), P25 (Structure 236) and P34 (Structure 167 and 179) located in the South Intermediate Sector. Structure 7, the central pyramid (Figure 13), had only manos; no metates were recovered there. Structure 162 was a mound noted to have a large amount of Postclassic trash (D. Chase and A. Chase 1988:43). Only one metate fragment of undetermined type was found at this location. Structure 236 had no metates, but did yield two mano fragments. Structures 167 (P34A) and 179 (P34B) were two buildings located on a large platform; both were also associated with large amounts of Postclassic trash (D. Chase and A. Chase 1988:45). Each structure yielded only one metate fragment, concave and trough respectively. This locus also produced only one mano fragment that was too incomplete to determine type. There were a total of 18 structures without any metates. Seven of them (43.8%) were in the North Central Sector of Santa Rita Corozal (Table 9).

The Operation with the largest number of flat metates is Op P6 in the Northeast Sector (Figure 7). This locus produced a total of 13 flat metate fragments. However, Op P6 consisted of multiple buildings, including Structures 74, 77, 79, and Platform 2. Each of these structures had from one to six metate fragments identifiable as flat types. Structure 74, constructed in the Late Postclassic, was associated with food storage and preparation activities (D. Chase and A. Chase 1988:17); it had four flat and one undetermined metate fragments. Structure 77, which had multiple Postclassic constructions and re-floorings (D. Chase and A. Chase 1988:26-27), had six flat metate fragments and two of undetermined type.

The individual structures with the largest number of flat metates are Structures 39, 81 and 156. Structure 39 (Op P20) in the North Central Sector yielded eight flat metate fragments (Figure 9). This structure was built during the Late to Terminal Classic Period, but had an Early Classic burial as well as evidence of a Late Postclassic occupation (D. Chase and A. Chase 1988:36).

In the Northeast Sector, Structure 81 (Op P8) produced eight fragments of flat-style metates (Figure 8). This building was a multi-room Postclassic structure with a frontal terrace; it contained a shrine and an altar. This building also produced caches, effigy vessels and a burial (D. Chase and A. Chase 1988:17-19, 25).

Structure 156 (Op P18) is located in the South Intermediate Sector on a raised platform (Figure 10). Seven flat metate fragments were recovered from this locus. Multiple levels of occupation and construction were noted, ranging from the Late Classic, Terminal Classic, Postclassic, and Historic Periods (D. Chase and A. Chase 1988:42). All other structures, except for those previously noted, had flat metate fragments ranging in quantity from one to five. In total, there were 79 fragments of flat type metates recovered.

In contrast to the widely distributed flat metates, trough metates were found almost exclusively in the Southern Intermediate Sector. The one exception to this is Structure 81 (Op P8) in the Northeast Sector (Figure 8). One complete trough metate (P8C/84-1) was used in the construction of a wall in this structure. This is the only trough metate found outside of the Southern Intermediate sector.

The buildings with the largest number of trough-type metates are Structures 218, 189 and 182 (Figure 4). Structure 218 (Op P38) was a multi-roomed, line-of-stone construction with a cache and two burials dating to the Late Postclassic Period. There were also artifacts associated with early Spanish contact found at this location (D. Chase and A. Chase 1988:59-60). This building had the greatest number of trough-style metate fragments (nine) as well as one flat, one basin, four indeterminate fragments, and the miniature metate mentioned previously.

Structure 189 (Op P30) was a Postclassic structure built over a Late Preclassic locus that included 3 hearths. This structure contained a cache and numerous burials (D. Chase and A. Chase 1988:61-62). A total of six trough style metates were found here. Two of these were complete metates found beneath the Postclassic structure in the Preclassic level with two other fragments. Additionally, two concave, one basin, one flat, and two trough metate fragments were present in the upper Postclassic levels.

Similar to Structure 189, Structure 182 (Op P28) was a Late Postclassic structure built over an earlier platform dating to the Late Preclassic (D. Chase and A. Chase 1988:43-44). Burials and ceramic vessels were present, as well as six fragments of trough metates. Also present were five concave and two flat-type fragments. The metate fragments were recovered from the Postclassic levels. Other features in this sector that contained trough metates were Structures 213 (Op P26), Chultun 12 (Op P31), Structure 216 (Op P33), Structure 167 (Op P34), and

Structure 181 (Op 36); each locus had from one to three fragments.   In all, there were 32 trough metates and fragments recovered from the site.

Mano Distribution

There were a total of 300 manos recovered from all sectors of the site. In addition to the seven structures previously mentioned without any manos or metates, there were no manos found at Structures 36 (Op P9) and 38 (Op P35) in the North Central Section, as well as Structure 167 (Op P34A) in the South Intermediate Sector (Table 10).

Looking at the distribution of all mano types, Structure 81 (Op P8) in the Northeast Sector (Figure 8) had the greatest amount of these items, with a total of 20. Next are Structure 39 (Op P20) in the North Central Sector (Figure 9), and Structure 156 (Op P18) in the South Intermediate Sector (Figure 10) with 19 each, followed by Structure 6 (and Chultun 12) (Op P31) in the South Intermediate Sector (Figure 11) with 18. With 17 each are Structure 73 (Op P6) in the Northeast Sector (Figure 7), and Structure 213 (Op P26) in the South Intermediate Sector (Figure 11). In sum, there were ten structures without any manos at all (Table 10), 13 with greater than ten, and 29 with less than ten (Table 8).

The manos are highly fragmented, and most are not complete enough to determine original size and type. Of the 92 that could be classified as one or two-handed, 70 fall into the latter category. These are found in all sectors of the site. The Operation with the largest number of two-handed manos is Op P6 in the Northeast Sector, with 10 fragments; next, were Op P3 (Northeast Sector), Op P8 (Northeast Sector), Op P13 (Southwest Sector) and Op P19 (South Intermediate Sector), with six each.

The individual building with the greatest number of two-handed type manos was structure 135 (Op P13) in the Southwest Sector (Figure 12) with six fragments-five tapered and one nearly complete with a length of 21 cm (P13B/54-3b). This structure was constructed during the Early and Late Classic Periods, but was occupied through the Terminal Classic. No Postclassic material was found at this location (D. Chase and A. Chase 1988:63).

Structures with the next highest amounts of two-handed manos were Structures 73 (Op P6), 81 (Op P8), 35 (Op P10), and 37 (Op P22); each had five fragments. Structure 37, in the North Central Sector (Figure 13), had one of the few complete two-handed manos; it measured 22.5 cm in length (P22A/12-1). This building had multiple constructions beginning in the Late Preclassic Period, with the latest construction occurring during the Late Postclassic Period. Evidence of occupation into the Historic Period was evident- and, there were caches and burials as well (D. Chase and A. Chase 1988:39-40). The majority of manos were recovered from the upper levels of Postclassic and mixed Historic deposits. One complete, one-handed mano (P22A/56-2), 8.4 cm in length, was found within a special deposit dating to the Terminal Classic.

Temporal Distribution

The majority of materials recovered from Santa Rita Corozal are from the Postclassic Period- not unusual given that this era was the main focus of the Corozal Postclassic Project. However, many structures had multiple levels of construction and occupation during the long history of the site; thus, determining which objects came from which time period is challenging and not always possible with any degree of certainty.

Just as the modern inhabitants of Corozal Town dismantle the remains of earlier structures to use the materials for new construction, so too the ancient residents "mined" earlier deposits for fill to build floors and walls in later constructions. Also, earlier buildings may have been re-occupied or used in a later time period. As a result, a Postclassic structure may have stones from much earlier periods used in its construction; alternatively, a structure from the Classic Period may have Postclassic artifacts on its surface. An example of the former instance is Structure 218 (Op P38), constructed during the Late Postclassic on top of fill dating to the Late Preclassic. An example of the latter instance is Structure 134 (Op P12). This mound showed multiple constructions and occupations from the Preclassic through Late Classic Periods (D. Chase and A. Chase 1988:62-63). However, surface and humus layers yielded Postclassic artifacts that included some mano fragments.

Ethnographic and archeological evidence shows that discarded manos and metates are routinely recycled and reused after they are broken or no longer suitable for their original purpose. Metate fragments used as pavers, architectural fill or stepping-stones are seen in ethnographic studies (Hayden 1987b:191, Horsfall 1987:340). Determining where they initially came from and where and how they were used is not always possible.

A significant percent of the manos and metates recovered at Santa Rita Corozal came from surface and humus layer lots (Table 2). Of the 300 manos recovered, 24 (8%) came from surface collections and 121 (40.3%) were recovered from the upper humus layers. Of the 207 metates, 17 (8.2%) were from surface collections and 98 (47.3%) were from the humus layer. Items collected from the surface are often problematic in that there is no real context. They may be from the Postclassic or Historic periods, as these are the upper-most stratigraphic layers. However, they may also be from earlier periods, having been brought to the surface by activities of looters, earth-moving equipment, construction, land clearing, agricultural activities, and erosion.

Similarly, there is also often a lack of context in the humus layer, where objects are “floating” below the surface, and above the floor of the structure or deeper soil levels. Humus layers frequently contain items diagnostic for the Postclassic, such as ceramic fishing weights and pot lids. In some locations deposits are mixed Postclassic with Historic items such as fragments of glass or metal objects such as nails.

Like surface collections, chultuns are also problematic. While they are associated with nearby structures and may contain artifacts dateable to a particular period, because they are (or at one time were) open to the surface, objects may have been dropped in to these openings at any time. There were four manos (two fragments, two complete) and one metate fragment recovered from within chultuns.

The manos and metates used as construction materials may be contemporaneous to that structure or could have been collected from earlier deposits. In some cases, this provides an upper limit on an items’ temporal context. In other words, a metate used in the wall of a Late Preclassic structure may have originally come from an earlier time, but could not have been from a later period. An example is a complete trough metate, P30D/39-1, found in a wall associated with Postclassic structure 189, in the South Intermediate Sector, which had been sited on a previously used Preclassic locus (D. Chase and A. Chase 1988:61).

Of the metates recovered, 15 (7.2%) were in walls, floors and construction fill. For manos, the number is 23 (7.7%). Special deposits consisting of caches and burials, especially those with ceramics, can be helpful in dating artifacts associated with them. Unfortunately, very few of these tools were found with or adjacent to special deposits. Only four manos (1.3%) and three metates (1.4%) were found in these contexts. Other objects can be relatively dated by their stratigraphy, whether above or below floors, and by other artifacts with which they are associated. Overall, however, there is essentially no use-related context from Santa Rita Corozal for manos and metates. In the future it may be possible to reconstruct each lot in greater detail to more accurately determine temporal context of the manos and metates, but that was not undertaken for the purposes of this thesis. Some of these temporal assignments are, therefore, a "best guess." With these limitations in mind, the breakdown of temporal assignments is listed in Table 3.

DISCUSSION

When looking at the mano data from Santa Rita Corozal, one of most obvious characteristics that emerges is how highly fragmented they are, even the smaller one-handed style. While the elongated mano types are more prone to breakage due to their shape (Horsfall 1987:354), there are few of either kind that have survived intact. Of the 92 that are identifiable, 70 (76 %) are of the two-handed type (Table 12). This may reflect a predominance of two-handed manos in the total assemblage, which would be expected with a maize predominant diet. However, the small sample size of identifiable manos out of the total number is also just as likely to be the reason for this difference. The fact that there are ten different cross-sectional shapes also suggests a variety of uses, as the physical forces applied to a mano during its use-life affects the shape. Logic suggests that if manos are being used for the same function in similar ways-even allowing for individual technique-they should show similar wear-patterns and shaping. It is also possible that not all of the manos were used for food processing, but were employed for other functions such as grinding pigments, temper, or limestone.

The metate data is more complete. Of the 207 fragments recovered, 182 (87.9%) can be classified by grinding surface type. As previously mentioned, maize can be ground on any type of metate. However in a maize-dependent diet, flat metates would be the most representative of the necessary alkali processing techniques-and this would be the type expected to be the most numerous in the archaeological record. At Santa Rita Corozal this is the case, in fact, as 79 metates (38.2%) are flat (Table 13). Trough metates are also associated with maize processing in many areas, as they are formed by a reciprocal grinding motion. These are the third most numerous metates recovered, with 32 (26.6%) being of this type. So overall, 111 metates (53.6%) are of a reciprocal-motion type, 71 metates (34.3%) are of a more circular-motion type, and 25 metates (12.1%) are of undetermined motion. Being able to calculate grinding surface areas would be helpful to make comparisons with other sites; however, the highly fragmented nature of the metates-in particular the flat type-makes this impossible.

The variety of metate types at Santa Rita Corozal can be compared to those found at other sites. As previously mentioned, Chichen Itza had two types, flat and trough, with the trough being predominant. At Calakmul, again the trough is the predominant type, with flat styles also present; however, unlike Chichen Itza, there was a third variety at Calakmul, a trough-like kind with a round basin. Stromsvik (1937:123) recognized the different rotary motion that using this type of metate would have entailed, and he referred to this style as a “grinding slab” rather than a true metate, which should have a “longitudinal stroke.” At Mayapan, Proskouriakoff (1962) described varieties similar to those at Calakmul. The assemblage included a predominant trough type, that could be open at one end, a legged flat sloped variety, and round basins (some of which were footed and may have functioned as mortars).

If bone isotope studies are correct and inland sites had higher levels of maize consumption, then it makes sense that trough and flat types are present. It would therefore be expected that sites closer to the coast, which isotope studies suggest consumed a more varied diet, might have less of the reciprocal maize-type metates and more types with rotary grinding surfaces. This is certainly true for some coastal sites in northern Belize, including Santa Rita Corozal.

Analysis of ground stone tools at Cerros, Belize also show the presence of flat (both with and without feet), trough, basin with defined rim, and shallow concave metates (Garber 1989). Likewise, Caye Coco, Belize, (an island to the south of Santa Rita Corozal in the Progresso Lagoon area, see Figure 14 for map) has similar varieties of metates that include flat (both with and without feet), trough, concave, and basin or mortar (Delu 2007).

At Chunchucmil, located 25 km from the coast in northwest Yucatan, there were no flat metates found at all. The assemblage consists of trough, basin, and quern types (Watanabe 2000:16). This is also an area of poor soils and little rainfall that is unsuitable for maize production (Watanabe 2000:5). With collagen Isotope studies putting C4 dietary protein just below 50% (Mansell et al. 2006:175), this would support an argument that a more varied, less maize dependent diet is reflected in the ground stone tool assemblage.

With reciprocal motion metates being the dominant styles at the site, it is likely that significant maize processing was practiced at Santa Rita Corozal. That the flat variety is the most numerous would support maize being processed in the traditional alkali treated, precooked, or soaked manner. However, it is also important to note that approximately one third of the metates recovered were of non-reciprocal motion type. The presence of four different styles of metates suggests that more than just maize was being processed-or that it was being processed in more than one fashion.

As has already been stated, the majority of specimens recovered from Santa Rita Corozal are from the Postclassic Period (75.7% of manos, 76.8% of metates). This likely reflects not only the greater population during this time and that these deposits would be the more accessible stratigraphically, but also that this time period was the focus of the project. Postclassic deposits received preferential attention and excavation.

All metate forms are also present in Preclassic deposits. Trough forms make up the largest number in the Preclassic (four), but only a total of 11 metates can be assigned to this category. Since all four styles are found in the earliest and latest levels, this would rule out one style evolving from another. In other words, the forms are likely related to specific functions rather than being temporal variations of one of the other types, such as Stromsvik (1931, 1937) suggested at Chichen Itza and Calakmul. The trough metates could not have been the result of the "decline" of the society if they are present in the Preclassic. Likewise, the more finely made flat metates could not be limited to the "prime" years of fluorescence, especially when they are present in all levels from the Preclassic, Classic to Postclassic Periods.

There are not enough specimens that can be securely dated to earlier time periods to determine if there is a significant increase or decrease in proportion of flat metates over time that might correspond to increasing or declining levels of maize dependence. Of the 207 specimens, only 31 are in contexts that suggest Preclassic or Classic Period use. Likewise, out of the 300 manos and fragments, only 49 are identifiable as potentially coming from periods prior to the Postclassic and, of those, only 16 are the two-handed type.

Despite the lack of use-related context, the widespread distribution of flat metates supports the position that maize grinding was done on a domestic household level. Similarly, concave metates are also found in all sectors. However, the cluster of trough metates in the South Intermediate Sector of Santa Rita Corozal (Structures 182, 189 and 218 in particular), suggest a specialized function rather than a widespread household activity. Of the 32 trough metate specimens, 21 (65.6%) are found at these three buildings (Figure 4). They are found in only Preclassic and Postclassic deposits. The lack of Classic Period deposits at these locations is explained by the construction history. In this sector of the site, Postclassic structures were sometimes built directly on top of Preclassic structures or platforms that were apparently not occupied during the Classic Period. If, and where, trough metates were used during the Classic Period is not known.

This cluster could represent the processing of a specialized product, or of grinding maize in a different manner, that may have been for ceremonial or for commercial functions. It would also be consistent with the use of metates for a purpose other than maize grinding. Located near Structure 218, Structure 216 (Figure 6) produced three trough metates (two fragments and one complete). It was a multi-roomed Postclassic structure that contained two shrines and was a locus of stone-point production (D. Chase and A. Chase 1988:54-56). This is further evidence in support of this sector being an area of specialized ritual and economic activity.

The frequency and distribution pattern of metates used for subsistence and daily maize grinding would be expected to be more widespread like that of the flat metates. Chi Square analysis confirms the non-random distribution patterns of both flat and trough types, but the trough score (χ^2= 257.25; df = 51; p = 68.67) shows a much greater significance level ($p < .05$) than the flat score (χ^2= 145.46; df = 51; p = 68.67). However, it is an important point to consider that the distribution patterns of both manos and metates are probably not use-related, but are relative to final deposition and discard. It is still likely, however, that items are discarded in the general vicinity of where they were last used, particularly with heavier items such as metates.

CONCLUSIONS

The diverse riverine and coastal marine environment at Santa Rita Corozal would have provided varied resources in addition to maize agriculture. This is reflected in the lack of evidence of intensive agriculture practices-such as raised fields, canals, or terraces-as well as in the variety of manos and metates found at the site. There perhaps was less maize dependence than at other inland sites with less variety in their ground stone tool assemblages. According to results of bone isotope studies, this would be expected from a coastal site such as Santa Rita Corozal.

Performing bone chemistry studies of this nature at Santa Rita Corozal and other sites would be a way to further investigate this theory. Being able look for a correlation between mano and metate assemblages and levels of C4 dietary intake could be another area of investigation. Additionally, phytolith analysis from the stone tools themselves might also yield useful, more tangible evidence.

However, the goal of this analysis was to determine the level of maize dependence based on the number and types of manos and metates found at Santa Rita Corozal. The question is not whether there was maize, but rather was it predominant. The types of tools that are most typically used for maize processing in a reciprocal grinding motion were compared to the rest of the assemblage. That the majority of types at Santa Rita Corozal are of this variety confirms significant maize processing. But, the presence of other varieties that make up approximately one third of the total suggests that maize was not the only food product being processed. Also, the distribution pattern of trough metates at the site may represent their use for a different function other than maize grinding.

The fact that both flat and trough metates are present simultaneously could represent different preparation techniques for maize: The flat metate for simple, daily consumption; and, the trough metate for special, ceremonial or commercial preparation. Since Santa Rita Corozal was a site of ritual importance, it is possible that maize was prepared as a beverage or specialized food for use in ceremonies. Alternatively, the trough metates may represent the preparation of some other economically important product, an argument supported by the presence of stone tool production in the same sector.

APPENDIX A: TABLES

Table 1: Santa Rita Corozal Population Estimates

Period	Dates	Est. Population
Early Preclassic	1200-900 B.C.E	150
Middle Preclassic	900-300 B.C.E	150
Late Preclassic	300 B.C.E-200 C.E.	1000
Protoclassic	200-300 C.E.	1700
Early Classic	300-550 C.E.	1500
Late Classic	550-900 C.E.	2500
Terminal Classic	900-1200 C.E.	2000
Postclassic-early facet	1200-1300 C.E.	1800
Postclassic-late facet	1300-1530 C.E.	6800

(Data from D. Chase and A. Chase 2004)

Table 2: Mano and Metate Context Layers

Context	Manos (All Types)	Metates (All Types)
Surface	24 (8.0%)	17 (8.2%)
Humus Layer	121 (40.3%)	98 (47.3%)
Wall/Fill/Core	23 (7.7%)	15 (7.2%)
Special Deposits	4 (1.3%)	3 (1.4%)
Chultun	3 (1.0%)	1 (0.5%)
All Other	125 (41.7%)	73 (35.3%)

Table 3: Mano and Metate Temporal Context

Temporal Context	Manos (All Types)	Metates (All Types)
Surface	24 (8.0%)	17 (8.2%)
Postclassic/mixed	227 (75.7%)	159 (76.8%)
Terminal Classic	6 (2.0%)	6 (2.9%)
Late Classic	21 (7.0%)	13 (6.3%)
Early Classic	17 (5.7%)	1 (0.5%)
Preclassic	5 (1.7%)	11 (5.3%)
Total #	300	207

Table 4: Manos: Temporal Context by Type

Temporal Context	Two-Handed	One-Handed
Surface	9 (12.9%)	2 (9.1%)
Postclassic/mixed	45 (64.3%)	15 (68.2%)
Terminal Classic	1 (1.4%)	2 (9.1%)
Late Classic	9 (12.9%)	2 (9.1%)
Early Classic	5 (7.1%)	1 (4.5%)
Preclassic	1 (1.4%)	0
Total #	70	22

Table 5: Metates: Temporal Breakdown by Type

Context	Flat	Trough	Basin	Concave
Surface	6 (7.6%)	3 (9.4%)	2 (12/5%)	3 (5.5%)
Postclassic/mixed	62 (78.5%)	25 (78.1%)	11 (68.8%)	41 (74.5%)
Terminal Classic	2 (2.5%)	0	0	4 (7.3%)
Late Classic	6 (7.6%)	0	2 (12/5%)	4 (7.3%)
Early Classic	1 (1.3%)	0	0	0
Preclassic	2 (2.5%)	4 (12.5%)	1 (6.3%)	3 (5.5%)
Total #	79	32	16	55

Table 6: Total Metate Counts by Number of Structures

#Structures	#All Metates
18	0
6	1
5	2
1	3
2	4
3	5
3	6
3	7
1	8
2	9
2	10
1	11
1	12
2	13
0	14
1	15
1	16
Mean	3.98
Median	2
Mode	0

Table 7: Flat and Trough Metate Counts by Number of Structures

# of Structures	# of Flat Metates
22	0
12	1
8	2
3	3
2	4
1	5
1	6
1	7
2	8
Mean	1.52
Median	1
Mode	0

# of Structures	# of Trough Metates
43	0
3	1
1	2
2	3
0	4
0	5
2	6
0	7
0	8
1	9
Mean	0.62
Median	0
Mode	0

Table 8: Mano Count by Number of Structures

# of Structures	# of Manos
10	0
5	1
11	2
2	3
5	4
0	5
3	6
1	7
0	8
2	9
0	10
2	11
0	12
2	13
1	14
0	15
2	16
2	17
1	18
2	19
1	20
Mean	5.77
Median	2.5
Mode	2

Table 9: Structures without Metates

Structure #	Sector
Plat. 1	NE
7	NC
18	NC
23	NC
33	NC
40	NC
42	NC
55	NE
70	NE
78	NE
80	NE
89	NE
134	SW
154	SW
158	SI
166	SI
200	Bay
236	NC

NE = Northeast Sector; NC = North Central Sector; SW = Southwest Sector; SI = South Intermediate Sector; Bay = Bay Sector.

Table 10: Structures without Manos

Structure #	Sector
18	NC
23	NC
36	NC
38	NC
40	NC
55	NE
70	NE
154	SW
167	SI
200	Bay

NC = North Central Sector; NE = Northeast Sector; SW = Southwest Sector; SI = South Intermediate Sector; Bay = Bay Sector.

Table 11: Mano and Metate Composition

Material	Manos (all types)	Metates (all types)
Limestone	267 (89%)	145 (70.05%)
Granite	12 (4%)	28 (13.53%)
Basalt	5 (1.67%)	7 (3.38%)
Misc. Sedimentary	3 (1%)	3 (1.45%)
Misc. Volcanic	8 (2.67%)	14 (6.76%)
Unidentified	5 (1.67%)	10 (4.83%)
Total	300	207

(Stone composition data from object field cards)

Table 12: Mano Counts by Type

Manos	Number
One Handed	22
Two Handed	70
Undetermined	208
Total	300

Table 13: Metate Counts by Type

Metates	Number
Flat	79
Concave	55
Trough	32
Basin	16
Undetermined	25
Total	207

APPENDIX B: MANO DATA

Mano Data Spreadsheet

Op#	Structure #	Conxt	Timeline	Object #	Object	Material	Type	Details	Hande
P2	str 7	srf	PC	A/1-2	mano (f)	limestone	oval	overhang	2
		srf	PC	A/1-3	mano (f)	limestone	rectangular	tapered	2
		srf	PC	A/20-1	mano (f)	limestone	rectangular		
			EC	B/22-1	mano (f)	limestone	pentagonal		
			EC	B/39-1	mano (f)	limestone	triangular	11.5cm	
			EC	B/59-1	mano (f)	limestone	oval		
		fill	EC	B/151-3	mano (?compl)	limestone	rectangular	12.2cm	1
		fill	EC	B/153-1	mano (f)	limestone	oval		
		fill	EC	B/172-1	mano (f)	limestone	round	tapered	2
		sumit	PC	C/4-1	mano (f)	limestone	plano-convex		
		stairs	PC	F/5-8	mano (f)	limestone	oval or circ.		
		stairs	PC	F/5-9	mano (f)	limestone	rect or square		
		sumit	PC	L/7-1	mano (f)	limestone	plano-convex	tapered	2
P3	str 58	srf	S/LPC/abn	A/1-7	mano (f)	limestone	oval	tapered	2
		srf	LPC/aban	A/1-8	mano (compl)	granite	pentagonal	11.2cm	1
		hum	LPC/aban	B/5-3	mano (f)	limestone	plano-convex	tapered	2
		hum	LPC/aban	B/5-8	mano (compl)	limestone	rectangular	8cm	1
		hum	LPC/aban	B/7-2	mano (f)	limestone	indeterm.		
		hum	post aban	B/10-8	mano (f)	limestone	oval or circ.		
		hum	LPC/aban	B/11-5	mano (f)	limestone	oval		
		hum	LPC/aban	B/11-9	mano (f)	limestone	plano-convex	tapered	2
	plat 1	soil	EC	B/21-1	mano (compl)	limestone	pentagonal	17.5cm	2
		rubl	EC	B/22-1	mano (f)	limestone	oval or circ.		
	str 58	mtrx	LPC	B/39-2	mano (f)	quartzite	oval or circ.		
	plat 1	rubl	EC	B/52-2	mano (f)	limestone	squ-rectang.	elongated	
	Str 58	soil	LPC	B/59-2	mano (f)	limestone	oval		
		soil	LPC	B/59-3	mano (f)	limestone	oval	7cm (2 ends)	1
	plat 1	soil	PreCl	B/67-2	mano (f)	limestone	squ-rectang.		
		mtrx	PreCl	B/73-1	mano (f)	cryst. Limestone	plano-convex	tapered	2
		mtrx	PreCl	B/73-2	mano (f)	limestone	oval or circ.		
	str 58	mtrx	LPC	B/76-1	mano (f)	limestone	oval		
		pit	LPC	B/81-2	mano (f)	limestone	plano-convex	tapered	2
		mtrx	LPC	B/83-1	mano (f)	limestone	oval		
P4	str 69	hum	PC	B/2-9	mano (f)	limestone	circular		
		wall	LC	B/28-1	mano (f)	limestone	oval		
P6	str 73	srf	LPC/aban	A/1-4	mano (f)	granite	pentagonal		
		srf	LPC/aban	A/1-5	mano (f)	limestone	plano-convex	tapered	2
		srf	LPC/aban	A/1-6	mano (f)	granite	oval		
		srf	LPC/aban	A/1-7	mano (f)	quartz	oval	tapered	2
		srf	LPC/aban	A/1-9	mano (f)	limestone	plano-convex		
	str 79	srf	LPC/aban	A/8-3	mano (f)	limestone	rect-rhomboid		
		srf	LPC/aban	A/16-1	mano (f)	limestone	square or rect.		
	str 74/plt 2	hum	LPC/aban	B/6-13	mano (f)	limestone	plano-convex		
	str 74	hum	LPC/aban	C/1-46	mano (f)	limestone	?		
		hum	LPC/aban	C/1-51	mano (f)	limestone	oval		
		hum	LPC/aban	C/1-53	mano (f)	limestone	oval or circular		
		hum	LPC/aban	C/1-68	mano (f)	limestone	circular	16.5cm	2
		hum	LPC/aban	C/2-9	mano (f)	cryst. Limestone	oval		
		hum	LPC/aban	D/1-14	mano (f)	limestone	oval or circular		
	str 73	hum	LPC/aban	E/1-21	mano (f)	limestone	oval or circular		
		hum	LPC/aban	E/2-3	mano (f)	basalt	ovate-rectang.	18.5 cm	2
		soil	LPC	E/8-3	mano (f)	limestone	triangular convex	11.5cm	
		soil	LPC	E/8-4	mano (f)	limestone	?p-c		

		soil	LPC	E/12-5	mano (f)	vesic. Basalt	oval	tapered	2
		hum	LPC	E/33-1	mano (f)	limestone	oval or circular		
			LPC	E/42-4	mano (f)	limestone	square or rect.	8.7cm(2 ends)	1
			LPC	E/42-5	mano (f)	limestone	circular	18cm	2
			LPC	E/63-1	mano (f)	limestone	plano-convex		
			LPC	E/64-4	mano (f)	limestone	circular		
			LPC	E/66-5	mano (f)	limestone	oval		
			LPC	E/66-6	mano (f)	limestone	circular		
	str 77	srf	post aban	F/1-11	mano (f)	limestone	square		
		srf	post aban	F/1-13	mano (f)	?	rectangular		
		bkdrt	post aban	F/4-2	mano (f)	limestone	oval or circular		
		mtrx	LPC	F/16-4	mano (f)	marble	oval or circular		
		mtrx	LPC	F/25-3a	mano (f)	limestone	oval or circular		
		mtrx	LPC	F/28-6a,b	mano (f)	igneous	oval or circular		
		mtrx	LPC	F/29-1	mano (f)	granite	oval or circular		
		mtrx	LPC	F/29-6	mano (f)	basalt	oval or circular		
		mtrx	LPC	F/30-6	mano (f)	limestone	rectangular		
		soil	LPC	F/33-10	mano (f)	limestone	oval	tapered	2
		core	LPC	F/40-1	mano (f)	igneous	oval	7.5cm(2 ends)	1
		fill	LPC	F/41-4	mano (f)	granite	oval or circular		
		soil	LPC	F/43-1	mano (f)	granite	oval or circular		
		mtrx	LPC	F/44-6	mano (f)	limestone	rectangular		
		mtrx	LPC	F/45-1	mano (f)	limestone	oval	tapered	2
		abv fl	LPC	F/51-2	mano (f)	limestone	rectangular	tapered	2
	str 80	hum	LPC	G/1-4a	mano (f)	limestone	square or rect.		
		hum	LPC	G/1-4b	mano (f)	limestone	oval		
		fill	LPC	G/2-8	mano (f)	limestone	oval or circular		
		fill	LPC	G/2-10	mano (f)	?	rectangular		
	str 78-79	hum	LPC/aban	H/7-5	mano (f)	limestone	oval	tapered	2
P8	str 81	srf	aban	A/2-5	mano (f)	limestone	plano-convex	17.6cm	2
		srf	aban	A/3-9	mano (f)	limestone	plano-convex	tapered	2
		soil	LPC	B/17-4	mano (f)	limestone	rect.-rhomboid		
		hum	LPC/aban	C/3-1a	mano (f)	?	rectangular		
		hum	LPC/aban	C/3-1b	mano (f)	?	rectangular		
		hum	LPC	C/4-9	mano (f)	limestone	oval or circular		
		hum	LPC	C/4-16	mano (f)	limestone	oval or circular		
		mtrx	LPC	C/6-2	mano (compl)	limestone	triang. Convex	5.3cm	1
		mtrx	LPC	C/7-1	mano (f)	granite	triang. Convex	16.9cm	2
		mtrx	LPC	C/9-6	mano (f)	limestone	circular	28cm	2
		hum	LPC	C/15-4	mano (f)	limestone	rectangular		
		hum	LPC	C/15-5	mano (f)	limestone	rectangular		
		hum	LPC	C/24-3	mano (f)	limestone	triang. Convex		
		hum	LPC/aban	C/30-1	mano (f)	limestone	plano-convex		
		rubl	LPC	C/46-6	mano (f)	limestone	triang. Convex		
		rubl	LPC	C/46-7	mano (f)	limestone	rectangular		
		mtrx	LPC	C/50-2	mano (f)	limestone	plano-convex	12.8cm	2
		mtrx	LPC	C/58-4	mano (f)	limestone	rect.-rhomboid		
		fill	LPC	C/67-1	mano (f)	limestone	oval or circular		
		fill	LPC	C/75-1	mano (f)	limestone	square or rect.		
	str 83	srf	?	J/2-1a,b	mano (f)	limestone	circular	overhang	2
	str 83	srf	?	J/2-3	mano (f)	limestone	oval or circular		
P10	str 35	hum	LPC	B/4-25	mano (f)	limestone	oval or circular		
		hum	LPC	B/4-26	mano (f)	granite	plano-convex		
			LC	B/6-89	mano (f)	limestone	pentagonal		
			LC	B/6-90	mano (f)	limestone	plano-convex	tapered	2
			LC	B/10-42	mano (f)	limestone	rect.-convex	tapered	2

			EC	B/24-1	mano (f)	limestone	plano-convex	tapered	2
			EC	B/24-2	mano (f)	sandstone	rectangular	tapered	2
			EC	B/27-1	mano (f)	limestone	pentagonal	tapered	2
			EC	B/49-1	mano (f)	limestone	rectangular		
P11	str 89		PC	B/1-1	mano (f)	limestone	oval	9.5cm(2 ends)	1
P12	str 134	srf	PC/Hist	A/1-3	mano (f)	limestone	rectangular		
		hum	PC/Hist	B/1-3	mano (f)	limestone	oval or circular		
		mtrx	EC	B/6-5	mano (f)	limestone	triangular		
		fill	EC	B/10-1	mano (f)	limestone	rectangular		
P13	str 135	floor	LC	B/12-7	mano (f)	limestone	plano-convex		
		hum	LC	B/28-4	mano (f)	limestone	circular	tapered	2
		hum	LC	B/28-5	mano (f)	limestone	oval		
		hum	LC	B/28-6	mano (f)	limestone	rectangular		
		wall	LC	B/34-1	mano (f)	limestone	rect.-rhomboid	tapered	2
		mtrx	LC	B/36-1	mano (f)	limestone	oval		
		wall	LC	B/42-2	mano (f)	limestone	oval or circular		
		wall	LC	B/44-8	mano (f)	limestone	oval		
		wall	LC	B/44-9	mano (f)	limestone	oval or circular		
		rubl	LC	B/54-3a	mano (f)	limestone	oval or circular		
		rubl	LC	B/54-3b	mano (f)	limestone	rectangular	21cm	2
		rubl	LC	B/54-3c	mano (f)	limestone	circular	tapered	2
		rubl	LC	B/54-3d	mano (f)	limestone	pentagonal	tapered	2
		floor	LC	B/55-1	mano (compl)	limestone	plano-convex	8.3cm	1
		floor	LC	B/55-2	mano (compl)	limestone	plano-convex	8.2cm	1
		mtrx	LC	B/60-2	mano (f)	limestone	rectangular	tapered	2
P16	str 42	rubl	EC	A/3-1	mano (f)	limestone	plano-convex		
		rubl	EC	A/9-1	mano (f)	limestone	circular		
P18	str 156	srf	LPC/Hist	A/1-14	mano (f)	limestone	sqare or rect.		
		hum	LPC/Hist	A/2-4	mano (compl)	limestone	plano-convex	13.2cm	2
		hum	LPC/Hist	A/8-19	mano (f)	limestone	ovate-rectang		
		hum	LPC/Hist	A/8-20	mano (f)	limestone	oval		
		hum	LPC/Hist	A/8-21	mano (f)	limestone	oval		
		hum	LPC/Hist	A/8-22	mano (f)	limestone	rectangular		
		hum	LPC/Hist	A/8-23	mano (f)	granite	oval		
		hum	LPC/Hist	A/8-30	mano (f)	limestone	oval or circular		
		hum	LPC	A/9-14	mano (f)	volcanic	plano-convex	11.25cm	
			LPC	A/10-4	mano (f)	limestone	oval		
			LPC	A/10-8	mano (f)	limestone	oval or circular		
		hum	LPC	A/16-7	mano (f)	limestone	oval	10.2cm	
		hum	LPC	A/25-3	mano (f)	limestone	oval		
		hum	LPC	A/30-1	mano (f)	limestone	oval	10.2cm	
		hum	LPC/Hist	A/36-3	mano (f)	limestone	oval or circular		
		hum	LPC	A/43-5	mano (f)	limestone	rhomboid-rect.		
		hum	LPC	A/44-1	mano (f)	limestone	pentagonal		
		hum	LPC	A/51-2	mano (f)	limestone	oval or circular		
		hum	LPC	A/72-5	mano (f)	limestone	oval		
P19	str 159	hum	PC/Hist	A/4-9	mano (f)	limestone	ovate-rectang.		
		hum	PC/Hist	A/11-3	mano (f)	limestone	oval		
		abv fl	PC/Hist	A/20-2	mano (f)	limestone	pentagonal	tapered	2
		abv fl	PC/Hist	A/20-3	mano (f)	limestone	triang-convex	14.9cm	2
			PC	A/41-3	mano (f)	limestone	square or rect.		
		hum	PC	A/55-4	mano (f)	limestone	square or rect.		

		hum	PC	A/55-5	mano (f)	limestone	plano-convex	tapered	2
			PC	A/62-1	mano (f)	limestone	oval		
	str 160	hum	PC	B/3-4	mano (f)	limestone	oval		
		hum	PC	B/11-6	mano (f)	limestone	oval	tapered	2
		hum	PC	B/17-3	mano (f)	limestone	square		
		hum	PC	B/17-4	mano (f)	limestone	ovate-rectang.	tapered	2
		hum	PC	B/17-8	mano (f)	granite	plano-convex	tapered	2
		hum	PC	B/21-10	mano (f)	limestone	plano-convex		
			PC	B/26-3	mano (f)	limestone	oval or circular		
			PC	B/27-6	mano (f)	limestone	oval		
			PC	B/27-8	mano (f)	limestone	oval		
			PC	B/29-4	mano (f)	limestone	ovate-rectang.		
			PC	B/29-5	mano (f)	limestone	circular		
			PC	B/30-1a	mano (f)	limestone	plano-convex		
			PC	B/30-1b	mano (f)	limestone	plano-convex	overhang	2
	str 158	srf	?	C/1-2	mano (f)	limestone	oval		
	chultun 13		PreCl	D/3-7	mano (f)	limestone	?		
P20	str 39	hum	PC/Hist	A/2-5	mano (f)	limestone	?		
		hum	PC/Hist	A/3-12	mano (f)	limestone	plano-convex		
		hum	PC/Hist	A/8-4	mano (f)	limestone	oval		
		hum	PC/Hist	A/12-5	mano (f)	limestone	oval or circular		
		hum	PC/Hist	A/12-15	mano (f)	limestone	oval or circular		
		hum	PC/Hist	A/14-8	mano (f)	limestone	pentagonal	tapered	2
		hum	PC/Hist	A/16-3	mano (f)	limestone	oval or circular		
		hum	PC/Hist	A/17-3	mano (f)	limestone	plano-convex		
		hum	PC/Hist	A/19-3	mano (f)	limestone	oval or circular		
		hum	PC/Hist	A/19-5	mano (f)	limestone	plano-convex		
		hum	PC	A/20-6	mano (f)	limestone	square		
		hum	PC	A/25-1	mano (?compl)	limestone	oval	12.2cm	1
		hum	PC	A/26-1	mano (f)	limestone	square	11.6cm	
		rub	PC	A/28-3	mano (f)	limestone	oval		
		rub	PC	A/29-3	mano (compl)	limestone	rectangular	9cm	1
		fill	PC	A/39-1	mano (f)	limestone	rectangular		
		hum	PC	A/43-4	mano (f)	limestone	?		
		floor	PC	A/44-4	mano (f)	limestone	square	11.6cm	
			PC	A/50-4	mano (f)	limestone	pentagonal		
	str 33	srf	PC	B/1-2	mano (f)	limestone	oval	overhang	2
		srf	PC	B/1-3	mano (f)	limestone	circular		
P21	str 91		TC	A/12-5	mano (f)	limestone	oval		
			TC	A/13-2	mano (f)	limestone	plano-convex	tapered	2
		hum	TC	A/15-4	mano (f)	limestone	circular		
			TC	A/19-1	mano (compl)	limestone	rectangular	4.95cm	1
P22	str 37	hum	PC/Hist.	A/8-2	mano (f)	limestone	oval	tapered	2
		rub	PC	A/11-3	mano (f)	limestone	plano-convex		
		abv fl	PC	A/12-1	mano (compl)	limestone	rectangular	22.5cm	2
			PC	A/15-9	mano (f)	limestone	square	tapered	2
		SD	LPC	A/22-8	mano (f)	limestone	rhomboid rect.	tapered	2
			PC	A/24-5	mano (f)	limestone	triang. /pentag.	tapered	2
		hum	LPC	A/34-1	mano (f)	limestone	oval		
		hum	PC	A/37-8	mano (f)	limestone	oval		
			PC	A/40-6	mano (f)	limestone	rectangular		
		SD	TC	A/56-1	mano (f)	limestone	square or rect.		
		SD	TC	A/56-2	mano (compl)	limestone	plano-convex	8.4cm	1

P23	str 162		PC	A/7-11,12	mano (f)	limestone	oval	tapered	2
			PC	A/24-3	mano (f)	limestone	plano-convex		
		fill	PC	A/34-1	mano (f)	limestone	rectangular		
		fill	PC	A/39-1	mano(?compl)	limestone	plano-convex	7.6cm	1
	str 166		PC	B/13-4	mano (f)	basalt	oval or circular		
		SD	LPC	B/27-1	mano (compl)	limestone	ovate triangular	24.2cm	2
P24	str 92	srf	?	A/1-1	mano (compl)	limestone	plano-convex	8.8cm	1
		hum	PreCl	B/4-8	mano (f)	?chert	oval		
P25	str 236	hum	LPC	A/5-1	mano (f)	limestone	pentagonal		
			LPC	D/3-1	mano (f)	limestone	oval	11.63cm	
P26	str 213	hum	PC	A/3-3a	mano (f)	limestone	oval		
		rub	PC	A/6-21	mano (f)	limestone	square or rect.		
		hum	PC	A/8-31	mano (f)	limestone	oval or circular		
		hum	PC	A/9-6	mano (f)	limestone	square or rect.		
		hum	PC	A/22-1	mano (f)	limestone	square or rect.		
		rub	PC	A/27-3a	mano (f)	limestone	oval or circular		
		rub	PC	A/27-3b	mano (compl)	limestone	pentagonal	8.9cm	1
		rub	PC	A/27-3c	mano (f)	limestone	square		
		rub	PC	A/27-3d	mano (compl)	limestone	rectangular	12.7cm	2
		hum	PC	B/7-1	mano (f)	limestone	triangular		
		mtrx	PC	B/12-2	mano (f)	limestone	plano-covex		
		rub	PC	B/14-3	mano (f)	limestone	?		
		wall	PC	B/23-1	mano (f)	limestone	circular		
		rub	PC	B/31-5a	mano (f)	limestone	oval		
		rub	PC	B/31-5b	mano (f)	limestone	oval		
		rub	PC	B/31-7	mano (compl)	limestone	plano-covex	15.2cm	2
		rub	PC	B/31-8	mano (f)	granite	plano-covex	11.5cm	
P27	str 212	hum	LPC	B/9-1	mano (f)	limestone	square or rect.	tapered	2
	Chultun		LPC	B/25-3	mano (f)	limestone	square or rect.		
			LC	B/41-1	mano (compl)	limestone	rectangle	12.8cm	2
P28	str 182	hum	LPC	B/1-1	mano (compl.)	limestone	oval	7.36cm	1
		hum	LPC	B/2-1	mano (f)	limestone	circular or oval		
		hum	LPC	B/2-9	mano (compl.)	limestone	oval	21cm	2
			LPC	B/23-5	mano (f)	limestone	rectangular	11.5cm	
			LPC	C/7-2	mano (f)	limestone	pentagonal	tapered	2
		bel fl	LPC	C/13-1	mano (compl.)	limestone	pentagonal	14.6cm	2
			LPC	C/14-2	mano (compl.)	limestone	plano-convex	12cm	1
P29	str 215	hum	LPC	B/1-5	mano (f)	limestone	oval		
		hum	LPC	B/3-1	mano (f)	limestone	oval		
			LPC	B/11-4	mano (compl)	?	plano-convex	11.14	1
P30	str 189	abv fl	PC	B/18-1	mano (f)	limestone	oval		
		abv fl	PC	C/5-3	mano (compl)	limestone	oval	7.26cm	1
		abv fl	PC	C/8-1	mano (f)	limestone	oval or circular		
		abv fl	PC	D/10-1	mano (f)	limestone	squ/pln-convex		
P31	str. 6	hum	PC	A/1-28	mano (f)	limestone	oval		
		hum	PC	A/4-2a	mano (f)	limestone	?		
		hum	PC	A/4-2b	mano (f)	limestone	square or rect.		
		hum	PC	A/4-2c	mano (f)	limestone	?		
		hum	PC	A/8-2a	mano (f)	limestone	?		
		hum	PC	A/8-2b	mano (f)	limestone	oval or circular		

		hum	PC	B/5-3a	mano (f)	limestone	oval or circular	tapered	2
		hum	PC	B/5-3b	mano (f)	limestone	oval or circular		
		hum	PC	B/8-1	mano (f)	limestone	oval		
		hum	PC	C/1-3	mano (f)	cryst. Limestone	square or rect.		
		hum	PC	C/1-4	mano (f)	limestone	oval		
		hum	PC	C/2-3	mano (f)	dolomite	square or rect.		
			PC	C/7-2a	mano (f)	limestone	circular		
			PC	C/7-2b	mano (f)	limestone	oval or circular		
			PC	C/13-2	mano (compl)	limestone	pentagonal	6.1cm	1
			PC	C/16-1a	mano (f)	limestone	pentagonal		
			PC	C/16-1b	mano (f)	limestone	square or rect.		
	chult. 12		LPC	D/5-2	mano (compl)	vesic. Basalt	ovate-rectang.	15.4cm	2
P32	str 214	hum	PC	C/5-2	mano (f)	limestone	pentagonal		
			PC	C/21-2	mano (f)	limestone	rectangular	14.3cm	2
P33	str 216	hum	PC	B/3-5	mano (f)	volcanic	circular		
		hum	PC	B/15-5	mano (f)	limestone	rectangular	10.6cm	
P34	str 179	hum	PC	B/3-4	mano (f)	limestone	oval		
P36	str 181	hum	PC	A/1-3	mano (f)	igneous	plano-convex		
		hum	PC	A/2-5	mano (f)	limestone	circular or oval		
		hum	PC	B/6-2	mano (f)	limestone	square or rect.		
		hum	PC	B/9-3a	mano (f)	limestone	plano-convex		
		hum	PC	B/9-3b	mano (f)	limestone	pentagonal		
		rub	PC	B/11-2a	mano (f)	limestone	pentagonal		
		rub	PC	B/11-2b	mano (f)	limestone	square or rect.		
		rub	PC	B/12-2	mano (f)	limestone	rect.-rhomboid	tapered	2
		hum	PC	C/12-1	mano (f)	limestone	circular or oval		
		hum	PC	C/12-2	mano (f)	igneous	plano-convex	tapered	2
		hum	PC	C/13-1	mano (f)	limestone	ovate-rectang.	tapered	2
P37	str 183	hum	PC	A/4-3	mano (f)	limestone	circular or oval		
			PC	C/3-3	mano (f)	limestone	oval		
P38	str 218	hum	LPC/Hist	A/20-3	mano (f)	limestone	square		
		hum	LPC/Hist	B/9-9	mano (f)	granite	?		
		hum	LPC/Hist	B/14-5	mano (f)	limestone	plano-convex	tapered	2
		hum	LPC/Hist	B/27-1	mano (compl)	limestone	rectangular	12.6cm	2
		hum	LPC/Hist	B/37-6	mano (f)	limestone	rectangular		
			LPC/Hist	B/43-6	mano (f)	limestone	square or rect.		

Hum = humus layer; srf = surface; rubl = rubble; mtrx = matrix; abv fl = above floor; bel fl = below floor; SD = special deposit.
Str = structure; Precl = Preclassic; EC = Early Classic; LC = Late Classic; TC = Terminal Classic; PC = Postclassic; LPC = Late Postclassic; Hist = Historic; aban = abandonment.

APPENDIX C: METATE DATA

Metate Data Spreadsheet

Op #	Structure#	Level	Timeline	Object #	Object	Material	Type
P3	str 58	srf	LPC	A/1-6	metate (f)	granite	concave
		srf	LPC	A/1-10	metate (f)	limestone	basin
		srf	LPC	B/1-1	metate (f)	granite	foot only
		hum	post aban	B/10-7	metate (f)	sandstone	concave
		hum	LPC	B/11-6	metate (f)	limestone	flat
		hum	LPC	B/11-7	metate (f)	limestone	flat
		hum	LPC	B/11-8	metate (f)	limestone	concave
		fill	LPC	B/14-1	metate (f)	limestone	flat
		soil	LPC	B/59-1	metate (f)	limestone	basin
P4	str 69	hum	PC	B/2-2	metate (f)	limestone	basin
		hum	PC	B/8-3	metate (f)	limestone	concave
		hum	PC	B/11-5	metate (f)	metamorphic	concave
			LC	B/18-1	metate (f)	limestone	concave
			LC	B/22-2	metate (f)	limestone	concave
			LC	B/27-1	metate (f)	limestone	flat
P6	str 73	srf	LPC/aban	A/1-8	metate (f)	granite	?
	str 74	srf	LPC/aban	A/2-4	metate (f)	vesicular basalt	flat
	str 79	srf	post aban	A/8-2	metate (f)	granite	?
	plat. 2	hum	LPC	B/6-10	metate (f)	granite	?
	str 74	hum	LPC	C/1-43	metate (f)	granite	flat
	str 74	hum	LPC	C/1-44	metate (f)	granite	flat
	str 74	hum	LPC	C/2-10	metate (f)	volcanic	flat
	str 74	hum	LPC	D/1-16	metate (f)	limestone	?
	plat. 2	mtrx	LPC	E/11-2	metate (f)	limestone	basin
	plat. 2	abv fl	LPC	E/20-1	metate (f)	volcanic	flat
	plat. 2	hum	LPC	E/44-1	metate (f)	limestone	concave w/foot
	plat. 2	SD	LPC	E/76-10	metate (f)	granite	flat
	str 77	mtrx	LPC/aban	F/9-2	metate (f)	granite	flat
	str 77	hum	LPC/aban	F/11-10	metate (f)	igneous	flat
	str 77	mtrx	LPC	F/28-3	metate (f)	granite	flat
	str 77	mtrx	LPC	F/29-5	metate (f)	basalt	?
	str 77	soil	LPC	F/33-9	metate (f)	igneous	?
	str 77	soil	LPC	F/33-11	metate (f)	igneous	flat
	str 77	mtrx	LPC	F/37-1	metate (f)	igneous	flat
	str 77	mtrx	LPC	F/44-1	metate (f)	cryst. Limestone	flat
	str 79	hum	LPC/aban	H/1-1	metate (f)	?stone	concave w/foot
	str 79	hum	LPC/aban	H/10-3	metate (f)	limestone	flat
P8	str 81	srf	LPC/aban	A/2-6b	metate (f)	granite	flat
		hum	LPC/aban	B/1-3	metate (f)	?limestone	concave
		wall	LPC	B/16-1	metate (f)	granite	concave
		soil	LPC	B/17-2	metate (f)	vesic. basalt	flat
		hum	LPC/aban	C/3-2	**metate (compl)**	granite	concave w/feet
		hum	LPC/aban	C/3-3	metate (f)	granite	flat
		hum	LPC/aban	C/4-10	metate (f)	?	?
		hum	LPC/aban	C/4-11	metate (f)	granite	flat
		mtrx	LPC/aban	C/7-5	metate (f)	granite	flat
		hum	LPC/aban	C/24-4a	metate (f)	limestone	flat

		hum	LPC/aban	C/24-4b	metate (f)	limestone	flat
		hum	LPC/aban	C/26-1	metate (f)	volcanic	flat
		wall	LPC	C/84-1	metate (compl)	limestone	trough
	str 83	srf	surface	J/1-2	metate (f)	limestone	flat
		srf	surface	J/1-2	metate (f)	limestone	concave w/foot
P9	str 36		LPC	B/1-2	metate (f)	cryst. Limestone	flat
		hum	LPC	B/2-1	metate (f)	sandstone	concave
P10	str 35	bkfill	LPC	A/2-1	metate (f)	limestone	flat w/foot
		wall	EC	B/42-1	metate (f)	limestone	flat
P13	str 135	fill	LC	B/34-2	metate (f)	limestone	concave
		mtrx	LC	B/36-2	metate (f)	limestone	basin
		wall	LC	B/42-3	metate (f)	limestone	?
		wall	LC	B/44-6	metate (f)	limestone	basin
		rub	LC	B/52-1	metate (f)	limestone	flat w/foot
		mtrx	LC	B/60-3	metate (f)	limestone	concave
P18	str 156	srf	LPC/Hist	A/1-4	metate (f)	volcanic	flat w/foot
		srf	LPC/Hist	A/1-5	metate (f)	volcanic	flat
		hum	LPC/Hist	A/7-3	metate (f)	basalt	foot only
		hum	LPC/Hist	A/9-13	metate (f)	limestone	flat
			LPC/Hist	A/10-2	metate (f)	limestone	concave
		hum	LPC/Hist	A/12-7	metate (f)	limestone	concave
		hum	LPC/Hist	A/32-2	metate (f)	limestone	flat
		hum	LPC/Hist	A/33-3	metate (f)	limestone	?
		hum	LPC/Hist	A/46-5	metate (f)	limestone	concave
		hum	LPC/Hist	A/51-1	metate (f)	?	flat
		abvflr	LPC	A/55-5	metate (f)	basalt	flat
		refuse	LC	A/78-8	metate (f)	limestone	flat
P19	str 159	srf	PC/Hist.	A/1-3	metate (f)	limestone	concave
		hum	PC/Hist.	A/3-5	metate (f)	shale ?	flat
		hum	PC/Hist.	A/4-8	metate (f)	basalt	flat
		hum	PC	A/29-5	metate (f)	limestone	flat
		hum	PC	A/30-10	metate (f)	limestone	flat
	str 160	hum	PC/Hist.	B/11-1	metate (f)	cryst. Limestone	flat
		rubl	PC	B/25-1	metate (f)	cryst. Limestone	flat
P20	str 39	hum	PC/Hist.	A/4-19	metate (f)	limestone	concave
		hum	PC/Hist.	A/16-7	metate (f)	limestone	flat
		hum	PC/Hist.	A/16-8	metate (f)	volcanic	flat
		hum	PC/Hist.	A/16-14	metate (f)	limestone	flat
		hum	PC/Hist.	A/17-2	metate (f)	limestone	flat
		hum	PC/Hist.	A/19-4	metate (f)	limestone	concave
		hum	PC/Hist.	A/19-7	metate (f)	limestone	concave
		hum	PC	A/20-5	metate (f)	limestone	flat
			PC	A/28-2	metate (f)	limestone	concave
		hum	PC/Hist.	A/30-4	metate (f)	cryst. Limestone	concave
		fill	PC	A/38-1	metate (f)	limestone	flat
		hum	PC	A/43-2&3	metate (f)	limestone	flat

			TC	A/50-8	metate (f)	limestone	flat
P21	str 91	hum	TC	A/2-3	metate (f)	volcanic	flat
		rubl	TC	A/11-1	metate (f)	limestone	concave
		rubl	TC	A/12-4	metate (f)	limestone	concave
			TC	A/13-3a	metate (f)	granite	concave
			TC	A/13-3b	metate (f)	granite	concave
		wall	LC	A/26-1	metate (f)	limestone	flat
		wall	LC	A/26-4	metate (f)	limestone	flat
P22	str 37	abv flr	PC	A/12-10	metate (f)	granite	?
		hum	PC	A/37-9	metate (f)	limestone	flat
		hum	PC	A/40-12	metate (f)	cryst. Limestone	concave
		srf	PC	C/1-3	metate (f)	limestone	flat
P23	str 162	hum	PC	A/10-3	metate (f)	limestone	?
P24	str 92	hum	PreCl	A/8-5	metate (f)	cryst. Limestone	shallow concave
		hum	PreCl	C/9-8a	metate (f)	limestone	flat
		hum	PreCl	C/9-8b	metate (f)	limestone	flat
		hum	PreCl	C/9-9	metate (f)	limestone	shallow concave
		hum	PreCl	C/9-10	metate (f)	limestone	concave
		hum	PreCl	C/9-15	metate (f)	limestone	basin
		hum	PreCl	C/9-26	metate (f)	limestone	?
P26	str 213	hum	PC	A/6-19	metate (f)	?	trough
		hum	PC	A/15-5	metate (f)	limestone	?
		hum	PC	A/20-3	metate (f)	limestone	?
		SD	PC	B/16-2	metate (compl)	?	trough
		step	PC	B/21-1	metate (f)	limestone	trough
		wall	PC	B/23-2	metate (f)	limestone	?
			PC	B/39-3	metate (f)	limestone	flat
P27	str 212		LC	B/39-1	metate (f)	cryst. Limestone	flat
P28	str 182	srf	LPC	A/1-5	metate (f)	limestone	trough
		srf	LPC	A/1-6	metate (f)	limestone	trough
		srf	LPC	A/2-3a	metate (f)	limestone	basin
		srf	LPC	A/2-3b	metate (f)	limestone	trough
		hum	LPC	B/3-2	metate (f)	limestone	flat
			LPC	B/15-1	metate (f)	limestone	concave
			LPC	B/15-2	metate (f)	limestone	flat
		hum	LPC	C/1-3	metate (f)	limestone	concave
			LPC	C/10-2	metate (f)	?	?
			LPC	C/10-4a	metate (f)	limestone	trough
			LPC	C/10-4b	metate (f)	limestone	trough
			LPC	C/10-4c	metate (f)	limestone	trough
			LPC	C/10-4d	metate (f)	limestone	concave
			LPC	C/10-4e	metate (f)	limestone	concave
			LPC	C/10-4f	metate (f)	limestone	concave

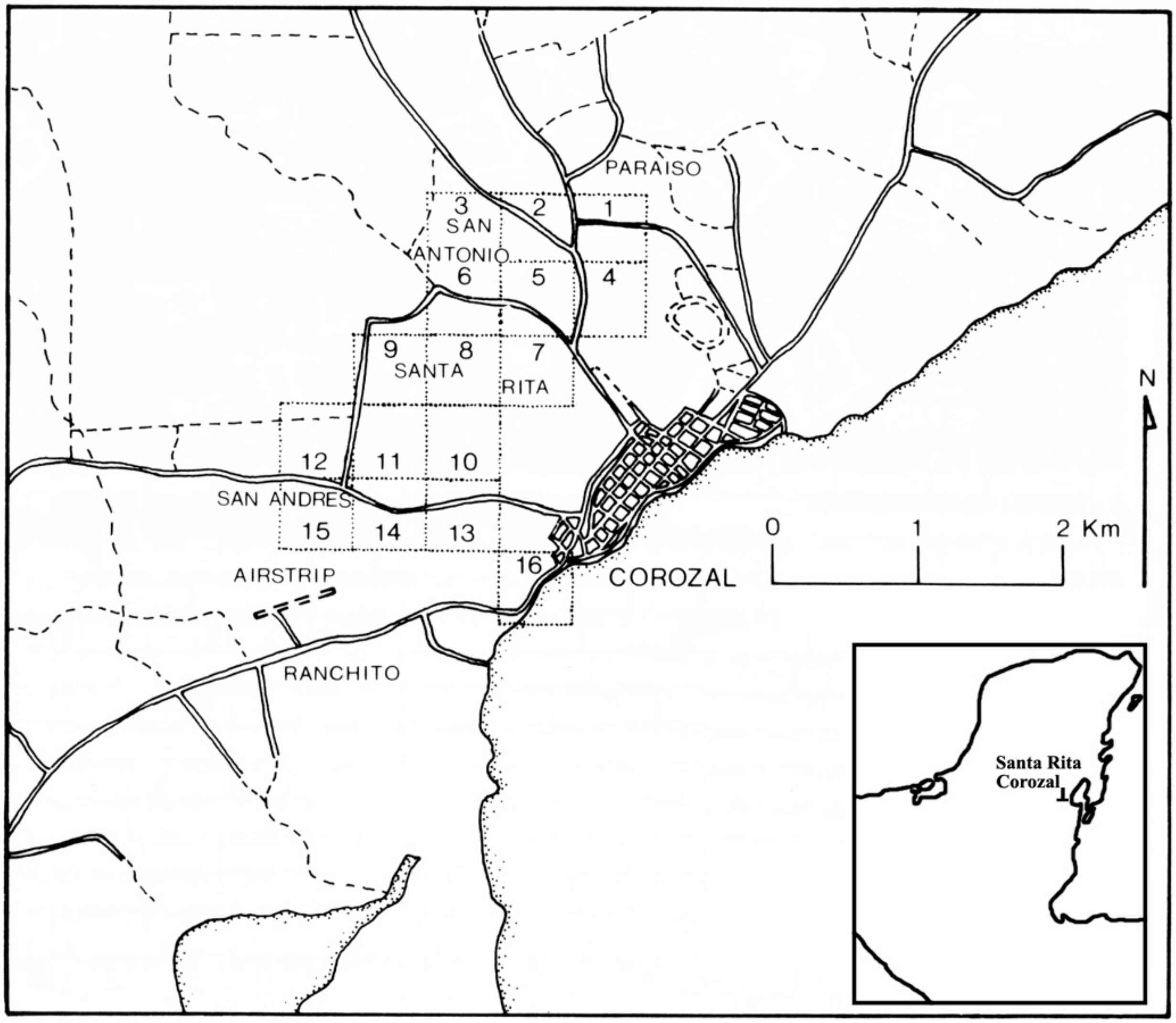
P29	str 215	hum	LPC	B/4-1	metate (f)	limestone	flat
		hum	LPC	B/11-1	metate (f)	limestone	concave
		hum	LPC	B/11-2	metate (f)	**?**	flat
		hum	LPC	B/11-5	metate (f)	cryst. Limestone	concave
P30	str 189	hum	PC	B/1-2	metate (f)	limestone	trough
		wall	PC	B/6-4a	metate (f)	limestone	basin
		wall	PC	B/6-4b	metate (f)	limestone	trough
		abv flr	PC	B/18-2	metate (f)	granite	concave
		hum	PC	C/7-3	metate (f)	?	flat w/foot
		abv flr	PC	C/8-2	metate (f)	granite	concave
		fill/SD	PreCl	D/35-7	metate (compl)	limestone	trough
		wall	PreCl	D/39-1	metate (compl)	limestone	trough
			PreCl	D/48-1	metate (f)	limestone	trough
			PreCl	D/49-1	metate (f)	limestone	trough
P31	str 6	hum	PC	A/2-1	metate (f)	?	basin
		hum	PC	A/3-1	metate (f)	limestone	concave
		hum	PC	A/7-3	metate (f)	limestone	flat
			PC	C/6-2	metate (f)	granite	basin
			PC	C/7-3	metate (f)	vesic. Basalt	flat
			PC	C/13-3a	metate (f)	limestone	flat
			PC	C/13-3b	metate (f)	limestone	basin
			PC	C/13-3c	metate (f)	limestone	concave
			PC	C/13-3d	metate (f)	limestone	concave
	Chult. 12	hum	PC	D/4-1	metate (f)	limestone	trough
P32	str 214		PC	C/19-4	metate (f)	limestone	flat
P33	str 216	hum	PC	A/1-1	metate (f)	limestone	concave
		hum	PC	A/16-1	metate (f)	cryst. Limestone	basin
		hum	PC	A/25-1	metate (f)	limestone	trough
		hum	PC	A/37-1	metate (f)	limestone	basin
		hum	PC	A/39-1	metate (f)	limestone	trough
		hum	PC	B/7-1	metate (f)	limestone	concave
		hum	PC	B/11-3	metate (f)	cryst. Limestone	flat
		hum	PC	B/17-3	metate (f)	limestone	flat
		hum	PC	B/29-1	metate (f)	limestone	concave
		hum	PC	B/38-1a	metate (f)	limestone	concave
		wall	LPC	D/4-1	**metate (compl)**	limestone	trough
P34	str 167	hum	PC	A/6-2	metate (f)	volcanic	concave
	str 179	hum	PC	B/11-3	metate (f)	limestone	trough
P35	str 38	hum	PC	B/1-14	metate (f)	limestone	?
		hum	PC	B/1-17	metate (f)	cryst. Limestone	flat
P36	str 181	hum	PC	B/7-1	metate (f)	limestone	concave
		hum	PC	B/7-2	metate (f)	?	concave
		rubl	PC	B/11-3	metate (f)	limestone	trough
			PC	B/14-2	metate (f)	limestone	trough
			PC	B/17-2	metate (f)	volcanic	flat
			PC	B/22-2	metate (f)	cryst. Limestone	concave

P37	str 183	hum	PC	A/3-2	metate (f)	limestone	basin
			PC	A/6-4a	metate (f)	limestone	flat
			PC	A/6-4b	metate (f)	limestone	flat
		hum	PC	A/11-2	metate (f)	cryst. Limestone	flat
			PC	A/20-1	metate (f)	limestone	concave
			PC	A/22-5a	metate (f)	limestone	?
			PC	A/22-5b	metate (f)	limestone	concave
			PC	A/23-34	metate (f)	limestone	flat
			PC	A/23-35	metate (f)	granite	flat
P38	str 218	hum	LPC/Hist	A/18-2	metate (compl)	granite	small flat
		hum	LPC/Hist	A/20-4	metate (f)	cryst. Limestone	?
		hum	LPC/Hist	A/24-5	metate (f)	granite	?
		hum	LPC/Hist	B/11-5	metate (f)	granite	?
		hum	LPC/Hist	B/36-1	metate (f)	granite	?
		hum	LPC/Hist	B/37-5	metate (f)	granite	basin
			PC	B/38-3	metate (f)	limestone	flat
			PC	B/44-1a	metate (f)	limestone	trough
			PC	B/44-1b	metate (f)	limestone	trough
			PC	B/44-1c	metate (f)	limestone	trough
			PC	B/44-1d	metate (f)	limestone	trough
			PC	B/44-1e	metate (f)	limestone	trough
			PC	B/44-1f	metate (f)	limestone	trough
			PC	B/44-1g	metate (f)	limestone	trough
			PC	B/44-1h	metate (f)	limestone	trough
			PC	B/44-1i	metate (f)	limestone	trough

str = structure; srf = surface; hum = humus layer; mtrx = matrix; abv fl = above floor; SD = special deposit; rubl = rubble; bkfill = backfill; refuse = refuse deposit.

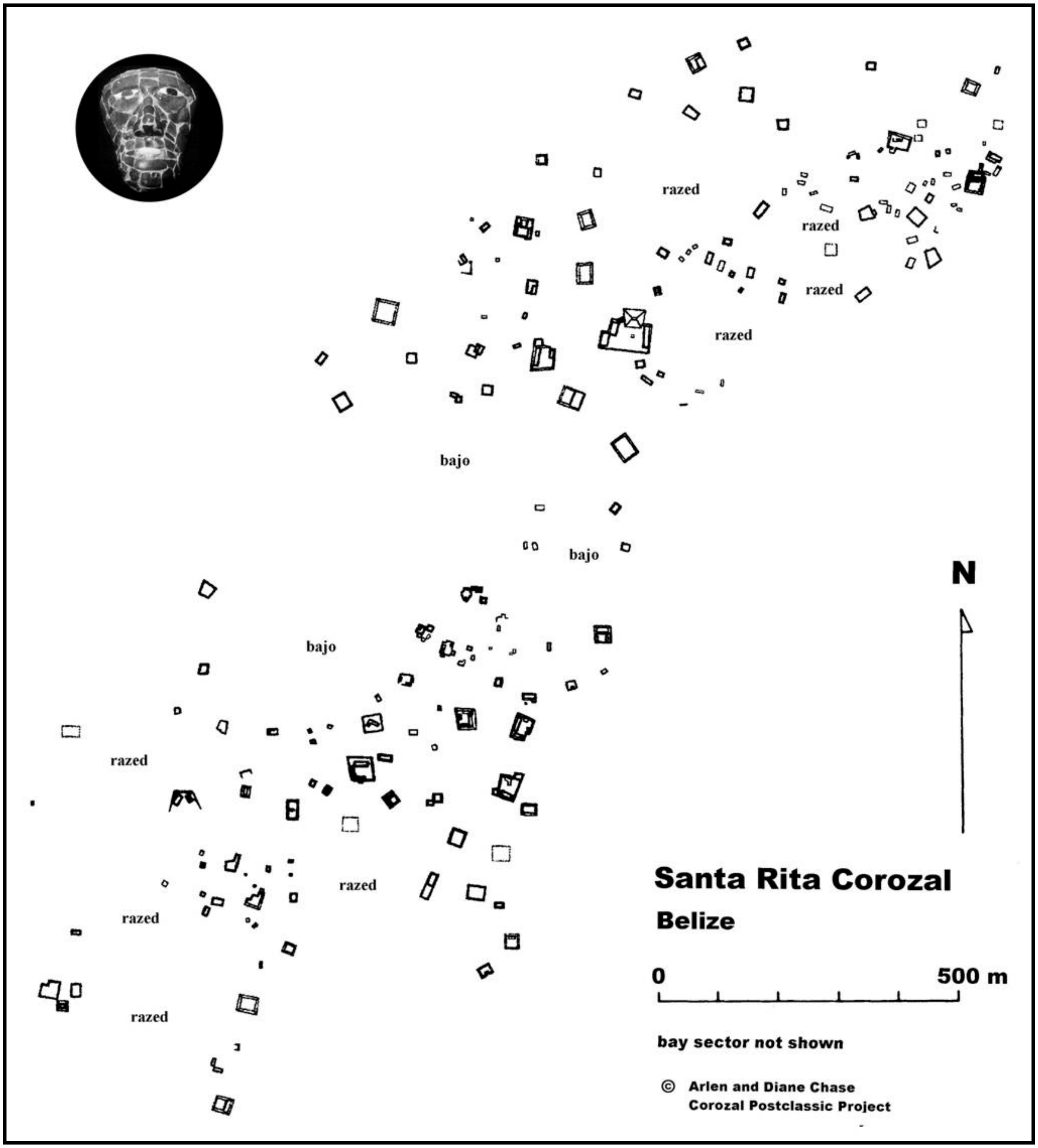
PreCl = Preclassic; EC = Early Classic; LC = Late Classic; TC = Terminal Classic; PC = Postclassic; LPC = Late Postclassic.

APPENDIX D: FIGURES



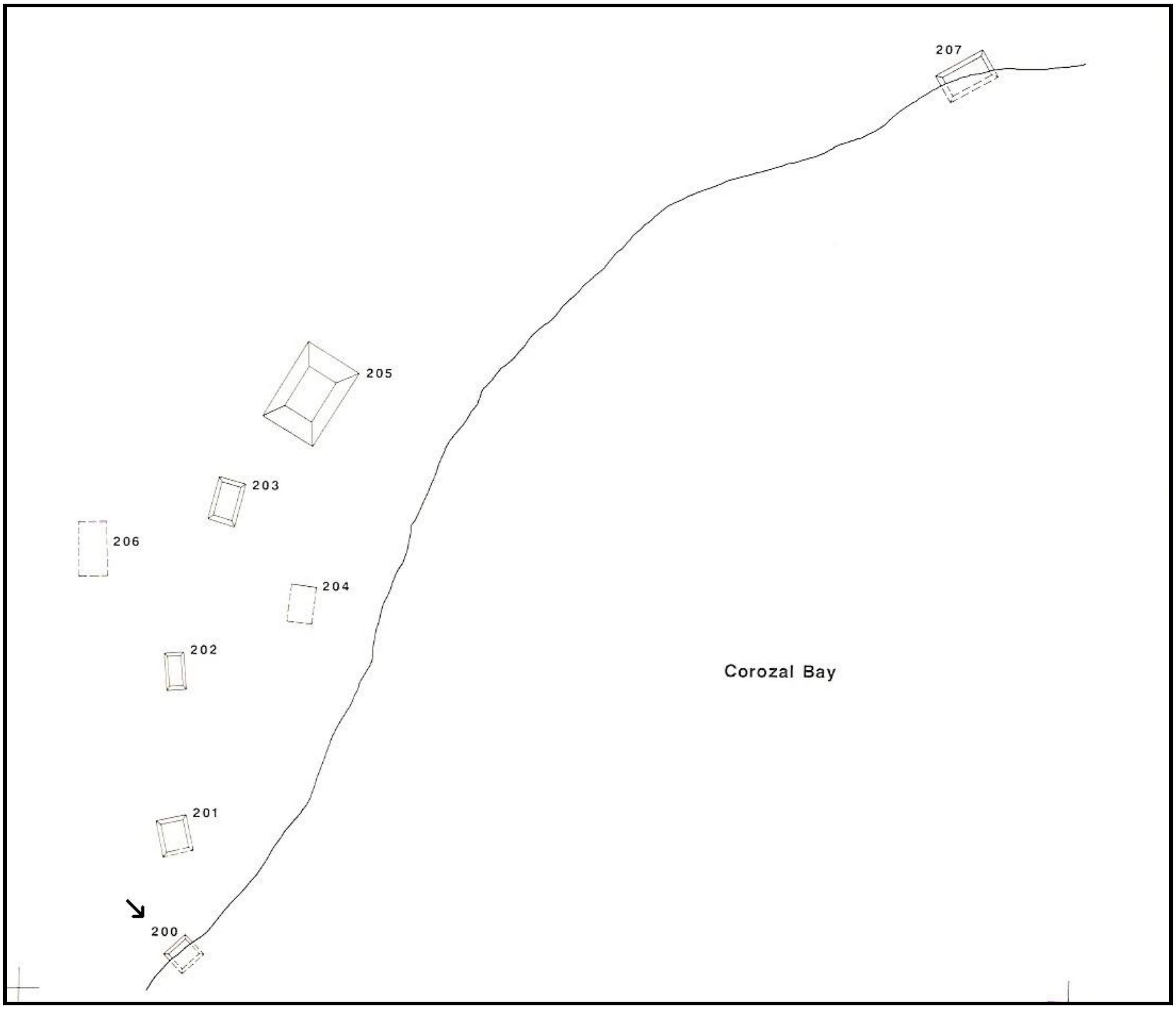
(Map courtesy of Dr. Diane Chase and Dr. Arlen Chase, used with permission)

Figure 1: Map of Santa Rita Corozal Location



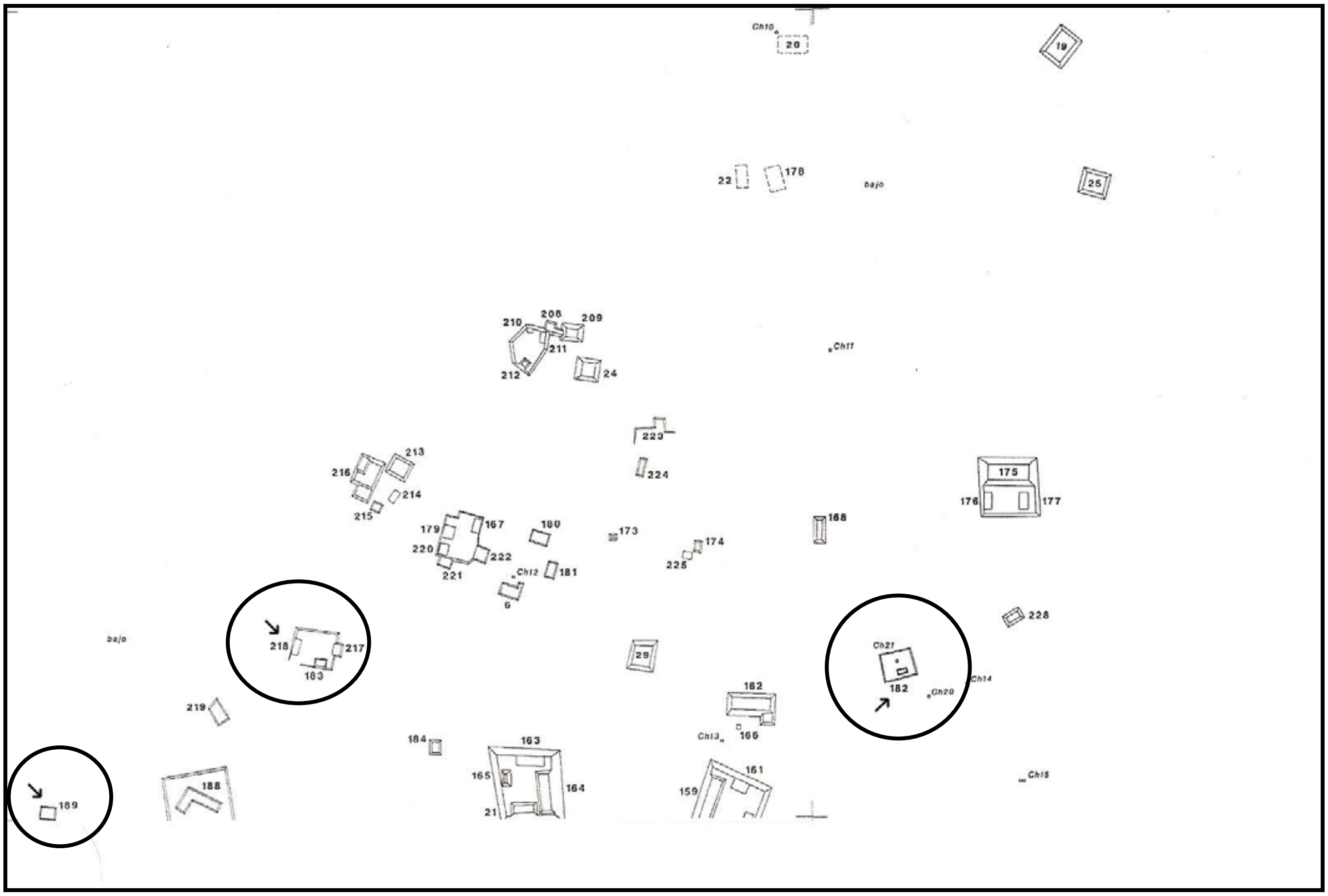
(Map courtesy of Dr. Diane Chase and Dr. Arlen Chase, used with permission)

Figure 2: Site Map of Santa Rita Corozal; Overview Showing Structures



(Map from D. Chase and A. Chase 1988:98)

Figure 3: Bay Sector; Structure #200



(Map from D. Chase and A. Chase 1988:92-93)

Figure 4: South Intermediate Sector; Structures with Greatest Trough Numbers

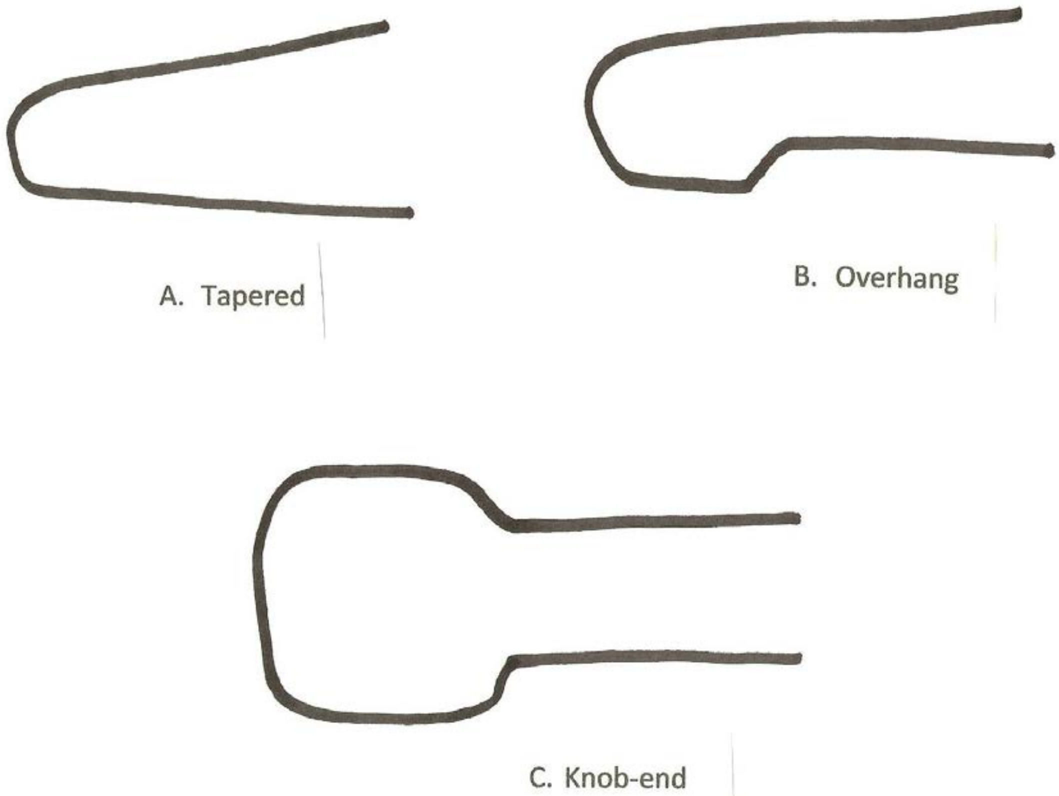
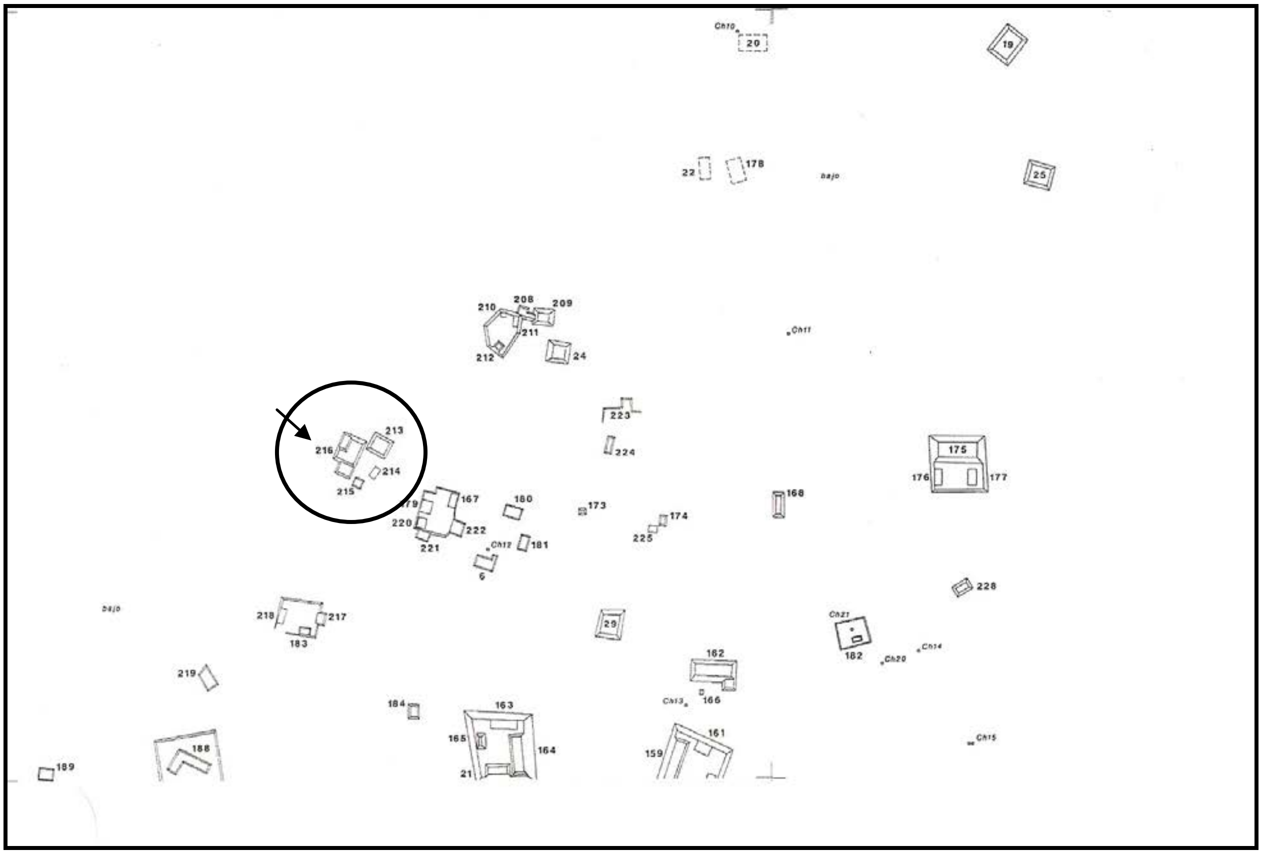
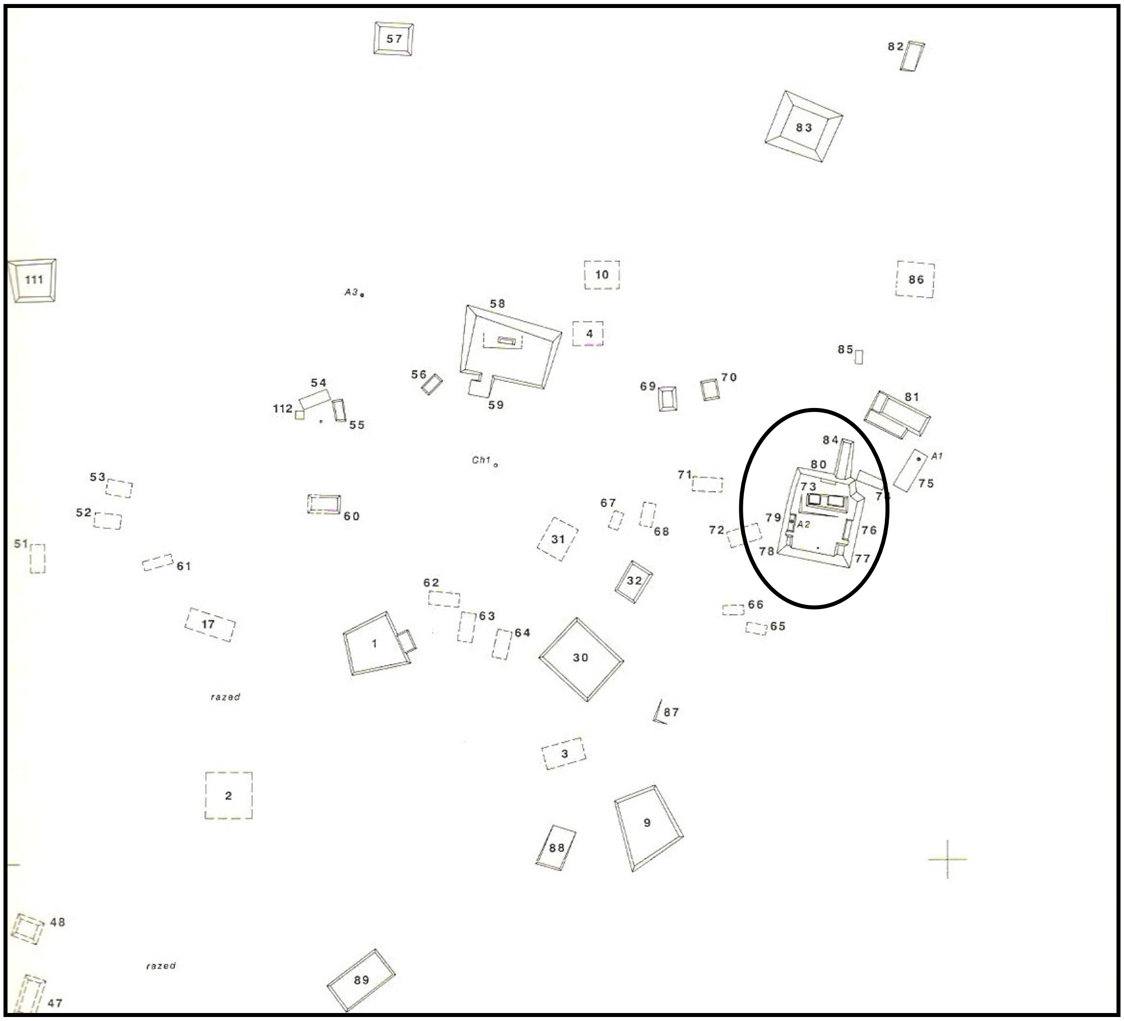


Figure 5: Mano End Shapes



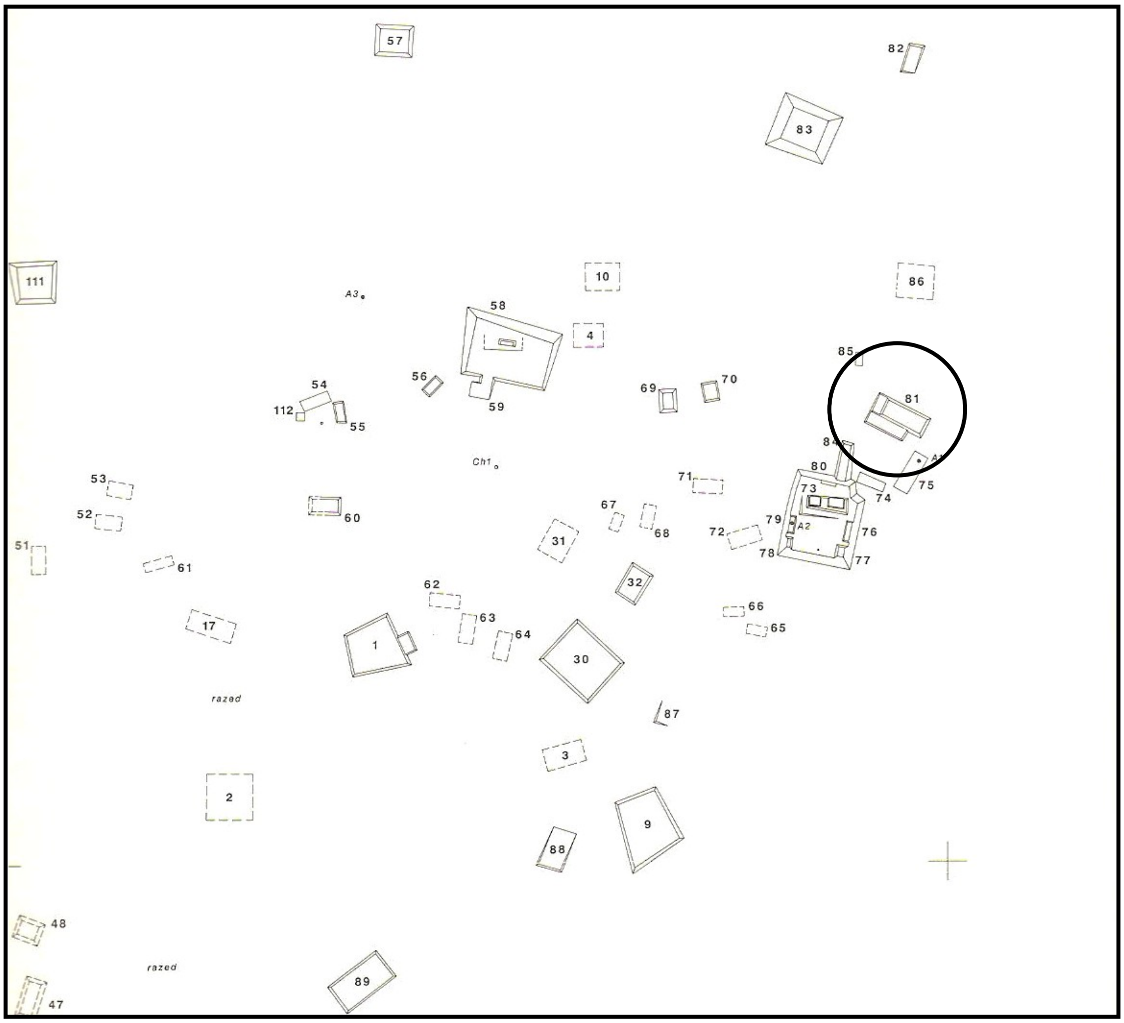
(Map from D. Chase and A. Chase 1988:92)

Figure 6: South Intermediate Sector; Structure 216



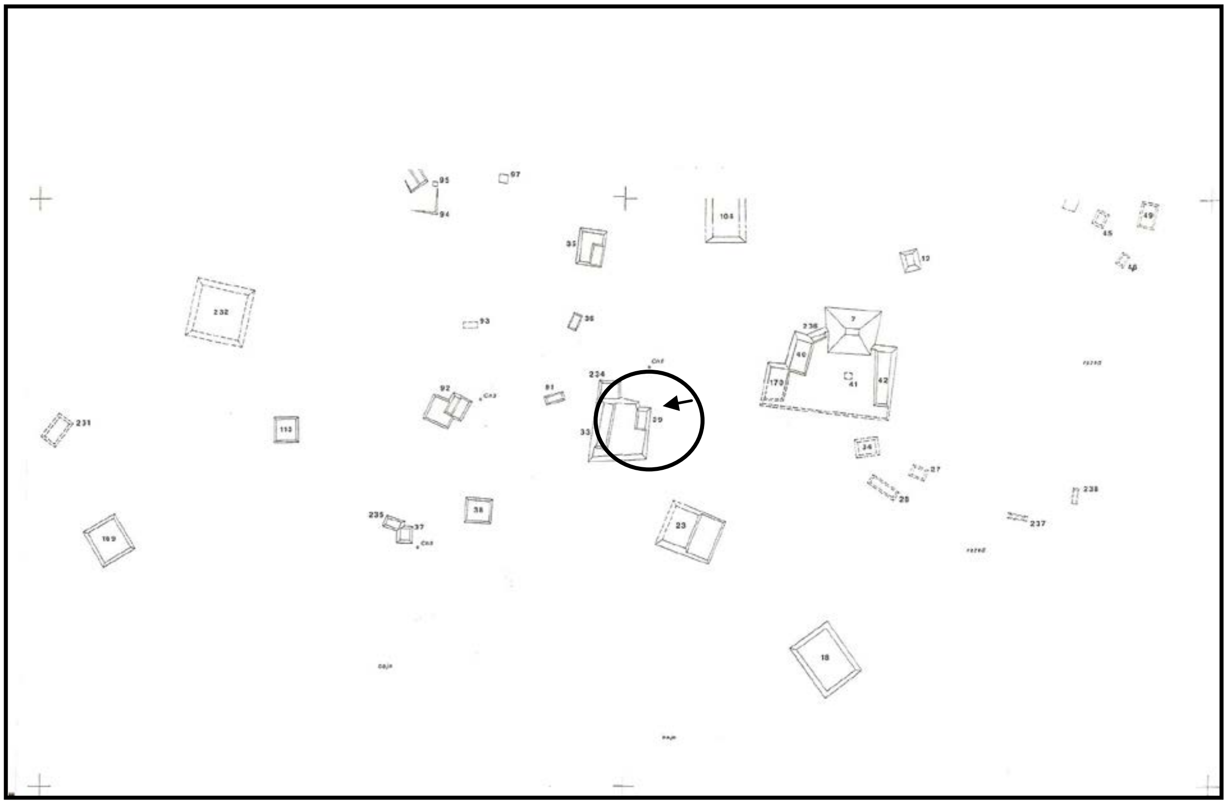
(Map from D. Chase and A. Chase 1988:89)

Figure 7: Northeast Sector; Op 6



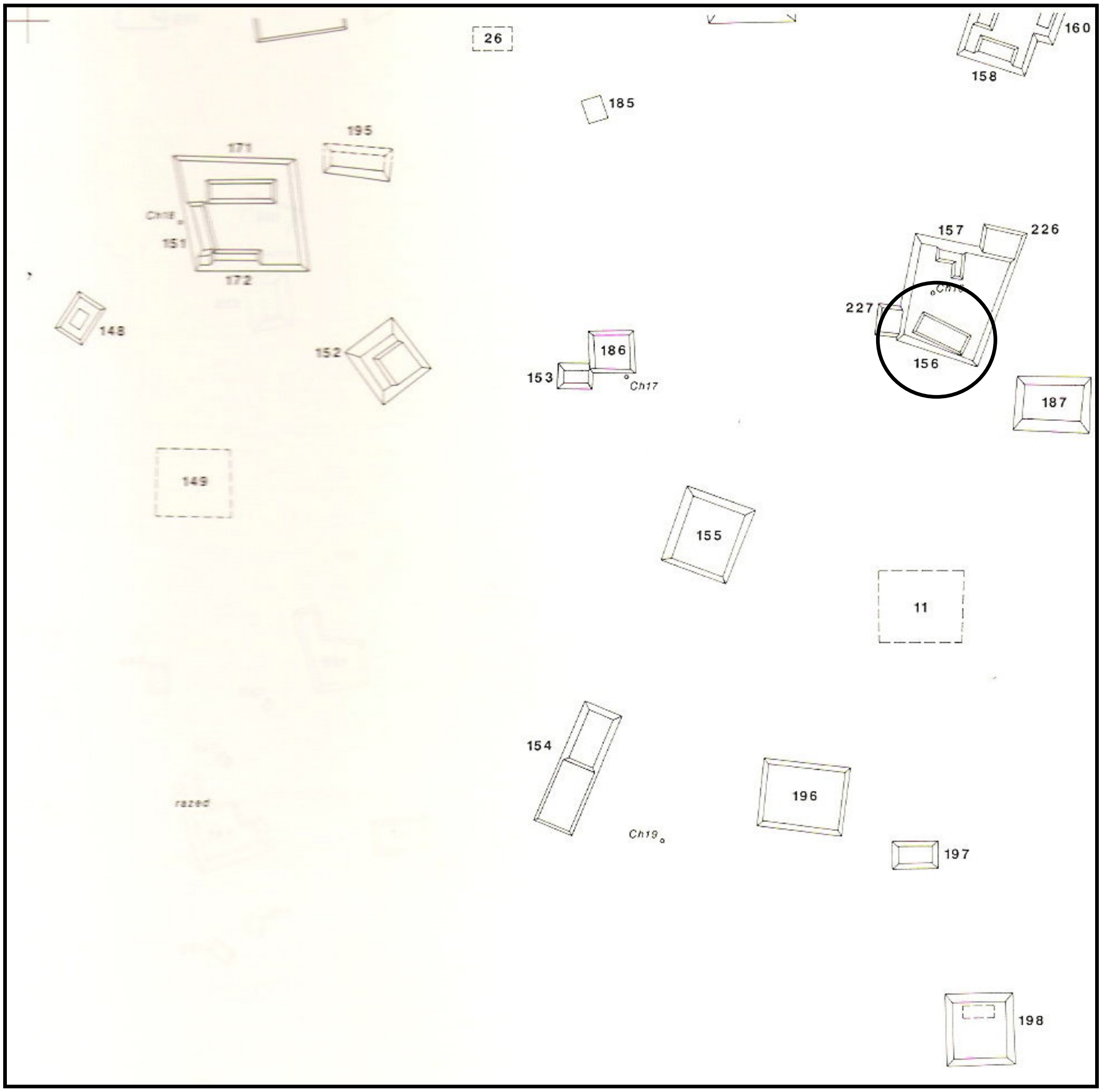
(Map from D. Chase and A. Chase 1988:89)

Figure 8: Northeast Sector; Structure 81



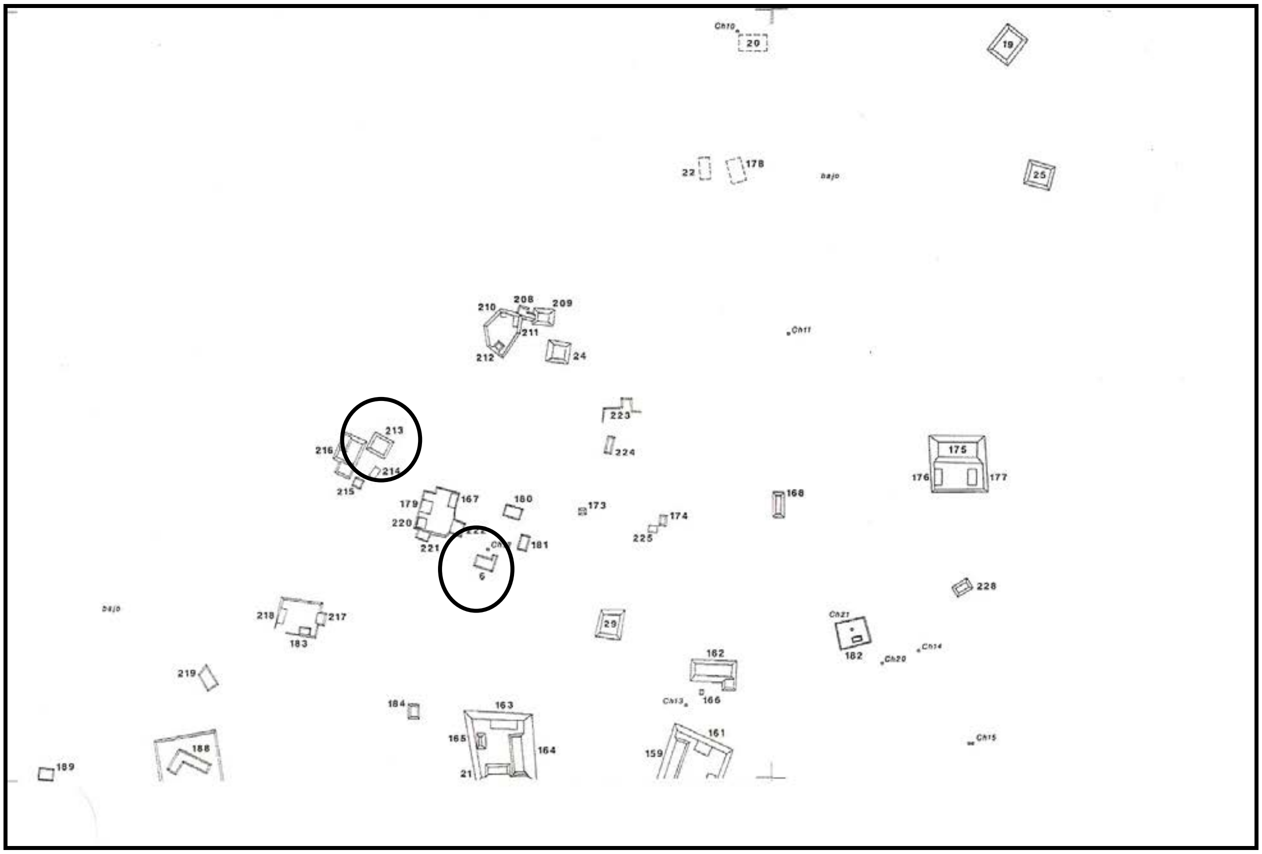
(Map from D. Chase and A. Chase 1988:90-91)

Figure 9: North Central Sector; Structure 39



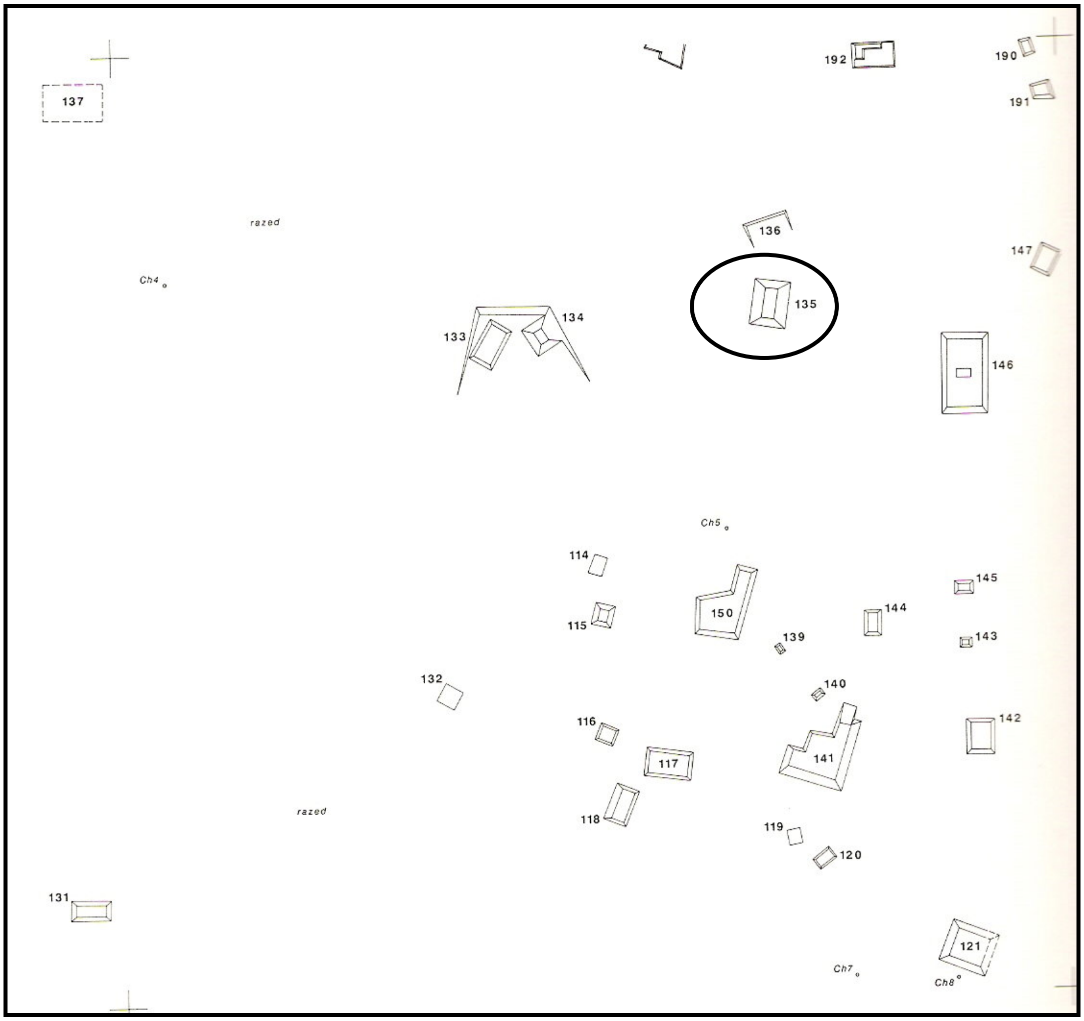
(Map from D. Chase and A. Chase 1988:95)

Figure 10: South Intermediate Sector; Structure 156



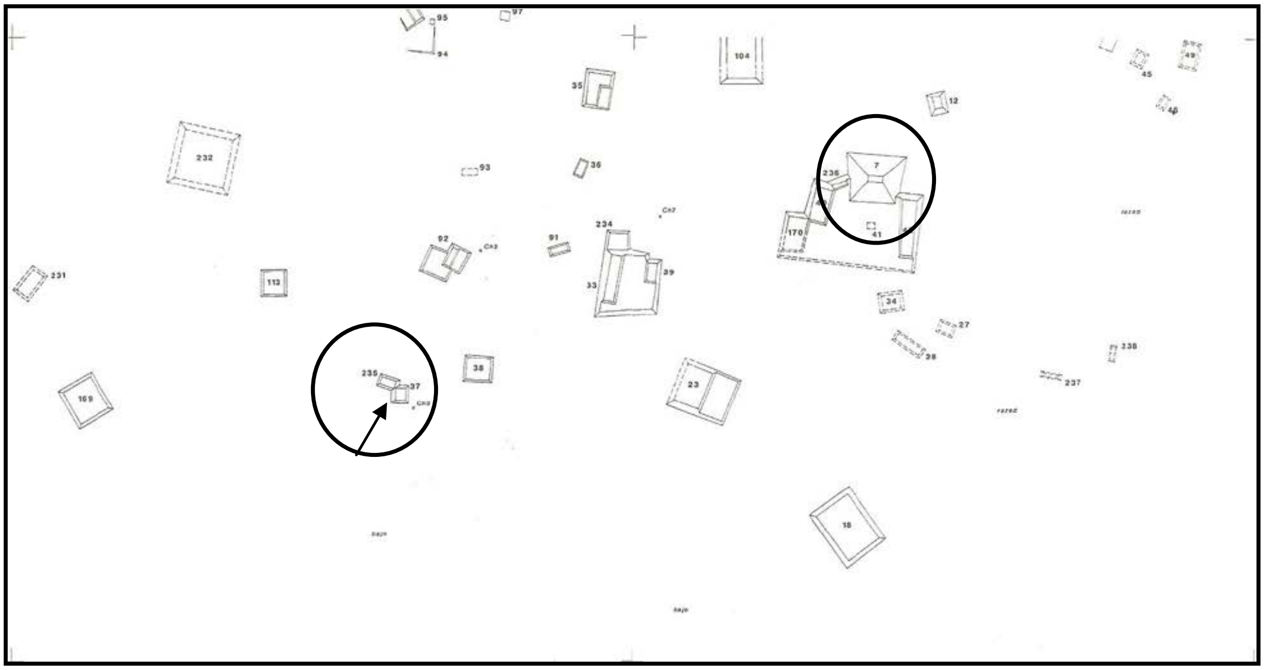
(Map from D. Chase and A. Chase 1988:92-93)

Figure 11: South Intermediate Sector: Structures 6 and 213



(Map from D. Chase and A. Chase 1988:96)

Figure 12: Southwest Sector; Structure 135



(Map from D. Chase and A. Chase 1988:90)

Figure 13: North Central Sector; Structures 7 and 37

(Data from the Electronic Atlas of Ancient Maya Sites, ©2011 Walter R.T. Witschey and Clifford T. Brown. http://MayaGIS.SMV.org Data accessed June 2, 2011. Map by Witschey).

Figure 14: Selected Sites in the Maya Region Mentioned in Text

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