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PRECLASSIC MAYA SOCIAL COMPLEXITY AND ORIGINS OF INEQUALITY AT CAHAL PECH, BELIZE

A Dissertation in

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by

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ABSTRACT

One of the central questions in anthropological archaeology is why social, economic and political inequality developed and what the long-term effects of hierarchical sociopolitical organization were at local and regional levels. The earliest complex societies, characterized by a distinctive set of pan-regional social, political, and economic institutions, first appeared in the southern Maya lowlands during the Preclassic Period (~1200 BC–AD 300). The timing of these cultural changes was variably influenced by internal social dynamics, long-distance economic interaction, increasing reliance on agriculture, and climate change.

This dissertation examines the emergence of socio-economic inequality at the site of Cahal Pech (Belize), one of the first permanently inhabited settlements in the southern Maya lowlands, based on archaeological survey and excavation, high-resolution AMS ^{14}C dating, stable carbon and nitrogen isotope analyses on human and faunal remains, and trace element characterization of obsidian and ceramic artifacts. A high-resolution Bayesian radiocarbon chronology was developed to understand the timing and tempo of building phases within the Cahal Pech civic-ceremonial site core and peripheral residential settlements. These results are compared to the largest compiled database of published radiocarbon dates from Preclassic cultural contexts at sites in five major regions of the southern lowlands to interpret the expansion and decline of complex social groups. Comparisons to paleoclimate proxy datasets suggest that fluctuating climate regimes promoted alternating phases of integration and fragmentation of early hierarchally organized societies. Stable climatic conditions during the Middle Preclassic Period (900-300 cal BC) fostered the centralization of populations and the formation of large regional polities across the southern lowlands. An extended drought at the end of the Late

Preclassic (AD 150-300) likely contributed to the decline of some major polities in the central Petén region of Guatemala, but smaller sites such as Cahal Pech in the Belize Valley were more resilient and persisted in to the Classic Period. AMS radiocarbon dating and stable carbon and nitrogen isotope analyses of human skeletal remains from this critical time period at Cahal Pech suggest a more diverse diet incorporating wild and domestic foods promoted resilience in the face of social reorganization and changing ecological systems at the end of the Preclassic Period. During the Late and Terminal Classic periods (AD 300-900), elites buried in the site center had developed a hyper-specialized and narrow maize-based diet. In contrast, commoner households consumed an increasingly broad diet as a fallback as elite demands for maize increased and periods of acute drought became more prevalent in the Terminal Classic.

To understand the role of households in the development of socioeconomic inequality, the production, distribution, and consumption of resources between households and the Cahal Pech civic-ceremonial epicenter was also examined through trace element characterization of obsidian and ceramic artifacts. Technological and portable X-ray fluorescence (pXRF) analyses of obsidian indicates that the site core and households consumed imported obsidian blades from southern Guatemala beginning in the Early Preclassic, a pattern which persisted throughout the site's occupation. Four primary compositional groups of Preclassic period ceramics are visible in instrumental neutron activation analysis (INAA) data and indicate differential consumption of pottery between commoner households and the elite site epicenter. Comparisons between obsidian and ceramic networks suggest that households at Cahal Pech provisioned themselves through overlapping and contrasting procurement strategies that included long-distance exchange with other high-status groups, as well as independent domestic procurement. Stratified institutional economies may have developed out of inter-regional exchange networks. As a diachronic study in social change, this project also contributes to our understanding of modern and prehistoric cultural development in response to changing social, economic, and climatic conditions.

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Jaime welcomed me to the BVAR Project in 2012 to continue Preclassic research in the Cahal Pech settlement. His vast experience and wealth of knowledge on Maya archaeology have been an invaluable resource as I learned the archaeology of the Belize Valley. Jaime is also one of the most generous project directors I have encountered, and is always providing his students with opportunities and support through a strong sense of collaboration. Dr. Julie Hoggarth, the co-director of the BVAR Project, has also been one of my primary mentors, colleagues, and a dear friend throughout my time on BVAR Project and at Penn State. Both Jaime and Julie have become part of my Belize family, and continue to provide me with encouragement to pursue my academic goals everyday beyond the field.

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Chapter 1

INTRODUCTION

Complex societies appeared across many regions of the ancient world between 5000 BC and 1000 BC. These novel social formations developed in the context of population expansion along with new types of subsistence production, management of labor, and distribution of economically important goods by emergent leaders. The result was the establishment of hierarchically organized economic, social, and political networks, with high-status individuals and political centers forming central nodes within increasingly interconnected socio-political systems (Cowgill 2012; Earle 1987, 2002; Flannery 1999; Turchin 2003; Willey 1991). In Mesoamerica, the appearance of permanent villages, population expansion, the introduction of pottery technology, and a commitment to agriculture between 2000-1000 BC resulted in the establishment of increasingly complex economic, social, and political networks within and between communities (Blake and Clark 1999; Chase and Chase, 2012:259; Clark and Cheetham 2002; Estrada-Belli, 2011; Rosenswig 2010; Stanton 2012:270-276). Despite several decades of investigations, the processes impacting the development of early complex groups in the Maya lowlands during the Preclassic Period (~1200/1000 BC-AD 300) remains incompletely understood (Table 1.1). Archaeologists working in the region have recognized that the hallmarks of Classic Maya society developed earlier during the Preclassic Period. Research at large political centers (e.g., Mirador, Tikal, Ceibal) indicates that by the Late Preclassic (300 BC-AD 300) Maya society was hierarchically organized, with large centralized polities serving as the focal points of civic and ritual activity (Doyle 2017; Estrada-Belli 2011; Freidel and Schele 1988; Hansen et al. 2002; Inomata et al 2013, 2017; Stanton 2012, 2005). Evidence of stratified political organization includes the public display of carved stone monuments with glyphic texts describing the activities of divine kings and their courts, construction of monumental temples and palaces, and conspicuous consumption of status-enhancing prestige goods, often found in burial contexts (Chase and Chase 2012; Martin and Grube 2008).

Table 1.1: Lowland Maya chronological periods.[1]

Period	**Calibrated Date Range**
Colonial	AD 1519–1821
Postclassic	AD 900/1000–1500
Terminal Classic	AD 800–900/1000
Late Classic	AD 600–800
Early Classic	AD 300–600
Late Preclassic	300 BC–AD 300
Middle Preclassic	1000–300 BC
Early Preclassic	1200–1000 BC

The goal of this dissertation is to identify the processes contributing to emergent complexity during the Preclassic Period and its long-term effects upon the Maya social and economic systems at the site of Cahal Pech, located in the Belize Valley of west-central Belize (Figure 1.1). Cahal Pech provides a unique case study for understanding the origin and development of prehistoric lowland Maya society because of its continuous occupational history beginning first in the Early Preclassic and ending during the Terminal Classic Period (Awe 1992). During the Early Preclassic (1200-900 BC), the ancient Maya of the Belize Valley lived in small farming villages composed of relatively egalitarian and economically autonomous households (Awe 1992; Brown 2007; Clark and Cheetham 2002). Population expansion and agricultural intensification during the Middle Preclassic and into the Late Preclassic at Cahal

[1] Dates throughout the text are reported in uncalibrated radiocarbon dates unless otherwise denoted by cal BC or cal AD.

Pech were accompanied by the construction of public architecture restricted to larger house groups (Awe 1992; Ebert et al. 2016; Peniche May 2016), a pattern signaling increasing centralization of economic power and the emergence of higher status individuals within local communities. At this time the appearance of increasingly standardized ceramics, the beginning of specialized household craft production (Awe 1992), and evidence of long-distance exchange networks dealing in exotic items (e.g., obsidian and jade; Awe et al. 1994; Garber and Awe 2005; Powis et al. 2016) have been identified throughout the Belize Valley. By the Classic Period, the presence of monumental architecture, stone monuments, and the elaborate elite burials identify Cahal Pech as the seat of an important regional polity governed by a dynastic lineage (Awe 2013; Awe and Zender 2016). In this study, the results of targeted excavation, radiocarbon dating, stable isotope, and geochemical analyses from archaeological contexts at Cahal Pech are used to document complex and non-linear relationship between sociopolitical dynamics and climate change during the Preclassic Period. As a diachronic study in social change, this project contributes to our understanding the fluctuating cultural and natural conditions favoring the emergence of early complex societies in the Preclassic Period Maya lowlands.

Social Complexity and Origins of Inequality

Explaining the historical dynamics of the rise and fall of cultural complexity remains a fundamental task in archaeology The episodic centralization and decentralization of complex chiefdoms and states, often described as cycling, is a long-term and dynamic process

Figure 1.1: Map of Maya lowlands with major sites mentioned throughout the text. The inset map shows the location of Cahal Pech within the Belize Valley.

that has been documented in multiple regions of the world in prehistoric and historic contexts (e.g., Near East, Rosen and Rivera-Collazo 2011, Wright 1984; Wright and Johnson 1975; Europe, Shennan et al. 2013; Mesoamerica, Cowgill 2012, Kennett and Marwan 2015, Marcus 1993, Marcus 1998, Smith 1992; Eastern North America, Anderson 1996; Southwest U.S., Bockisnky et al. 2016). The earliest hierarchically organized societies that appeared in the Maya lowlands during the Preclassic period can be defined as regionally integrated agrarian communities with centralized decision making hierarchies based on differential social status. This study focuses on documenting several major characteristics that were crucial to the emergence of institutionalized inequality in the Maya region including social integration, political centralization, economic stratification, and socio-political cycling (Table 1.2).

Social integration can be defined as participation in social and economic networks, which promoted collective interdependency at both the local and regional levels (Durkheim 1997[1893]). Communities often become socially integrated once they are permanently settled on the landscape, which encourages population growth, aggregation, and centralized decision making (Carneiro 1970; Earle 1987:288; Fried 1967:37-38; Service 1962). Regional settlement pattern studies have traditionally been used by archaeologists to identify the number of administrative levels as a proxy for hierarchically organized social networks (Drennan and Uribe 1987:60; Renfrew 1982). The presence of settlement hierarchies composed of a continuum of categories with graded membership ranging from centrally located royal palaces to peripherally located lower-status households has been well documented for many Classic Period sites (e.g., Caracol, Chase and Chase 2004; Tikal, Culbert 1991:328; Haviland and Moholy-Nagy 1992). Preclassic period settlement systems, however, have been difficult to detect and define in the archaeological record. The transition to sedentary village life in the Maya lowlands occurred between 1200 and 900 BC (Early Preclassic), when people began to aggregate into small hamlets (Awe 1992; Clark and Cheetham 2002; Estrada-Belli 2011; Inomata et al. 2015; Lohse 2010). The exact timing and nature of initial settlement, however, remains unknown as few sites have produced extensive contextual evidence of occupation dating to the Preclassic. A focus on investigations within monumental site centers has also hindered the detection of the regional settlement systems since Preclassic deposits are often deeply buried beneath larger Classic Period masonry architecture

Table 1.2: Characteristics of early complex Maya societies and their archaeological correlates.

CHARACTERISTICS OF EARLY COMPLEX SOCIETIES	**ARCHAEOLOGICAL CORRELATES**
Regional - Social Integration	
• Increasing population density • Regional expansion of interaction networks	• Permanent, multi-household village sites • Multi-tiered settlement hierarchy • Shared stylistic traditions
Site - Political Centralization	
• Two-tiered decision making hierarchy • Coordination of labor above household level	• Public works • Monumental architecture • Increased size/quality of architecture for some households
Household/Individual - Economic Stratification	
• Ascribed leadership positions • Differential access to subsistence resources and/or prestige goods • Control of subsistence production and/or distribution • Presence of an institutional economy	• Differential burial treatment • Status differences in diet • Long-distance exchange of prestige goods • Specialized part-time craft production
Regional - Cycling	
• Shifts in levels of administrative hierarchy • Shifts in organizational stability • Fluctuating resilience/vulnerability to exogenous forces (e.g., environmental/climate change)	• Shifting paramount centers through time • Evidence for inter- and intra-group conflict • Evidence for risk management strategies (e.g., subsistence diversification)

Social integration within the Maya lowlands during the Preclassic Period can be more easily identified through analyses of shared stylistic traditions that serve as a proxy for interaction networks (see Foias 2004; Marcus 2003). Accompanying the transition to sedentism was the adoption of pre-Mamon ceramic technology (Chase and Chase 2012). The earliest pottery can be grouped into four distinct regional ceramic complexes in the Belize Valley (Cunil complex), Northern Belize (Swasey complex), the central Petén (Eb/K'awil complex), and the Pasión region (Real/Xe complex). Clark and Cheetham (2002:302) argued that the spatial extent of each pre-Mamon ceramic complex represents the probable extent of regional social interaction networks (Clark and Cheetham 2002:297). During the Middle Preclassic, population expansion and economic growth throughout the Maya lowlands was accompanied by the adoption of a more standardized Mamon ceramic tradition (monochrome, red-slipped; Willey et al. 1967), which signals the emergence of new integrative networks between different parts of the Maya region (Ball and Taschek 2003).

The number of decision-making levels within a social group, reflecting increasing complexity, can also be present at the site level in the form of political centralization (Earle 1987:290). While settlement hierarchies provide a measure of political centralization at the regional level (Renfrew 1973, 1982), scholars have also emphasized the development of centralized decision-making roles for management of subsistence resources locally (e.g., Brumfiel and Earle 1987; Wittfogel 1957). Abundant agricultural land for swidden agriculture and relatively low population density in the Maya lowlands during the Preclassic would not have necessarily required (or facilitated) the management of subsistence resources by emergent leaders. The appearance of other forms of public works, such as monumental architecture, serves as a more appropriate measure for centralization in the Maya case since construction required the

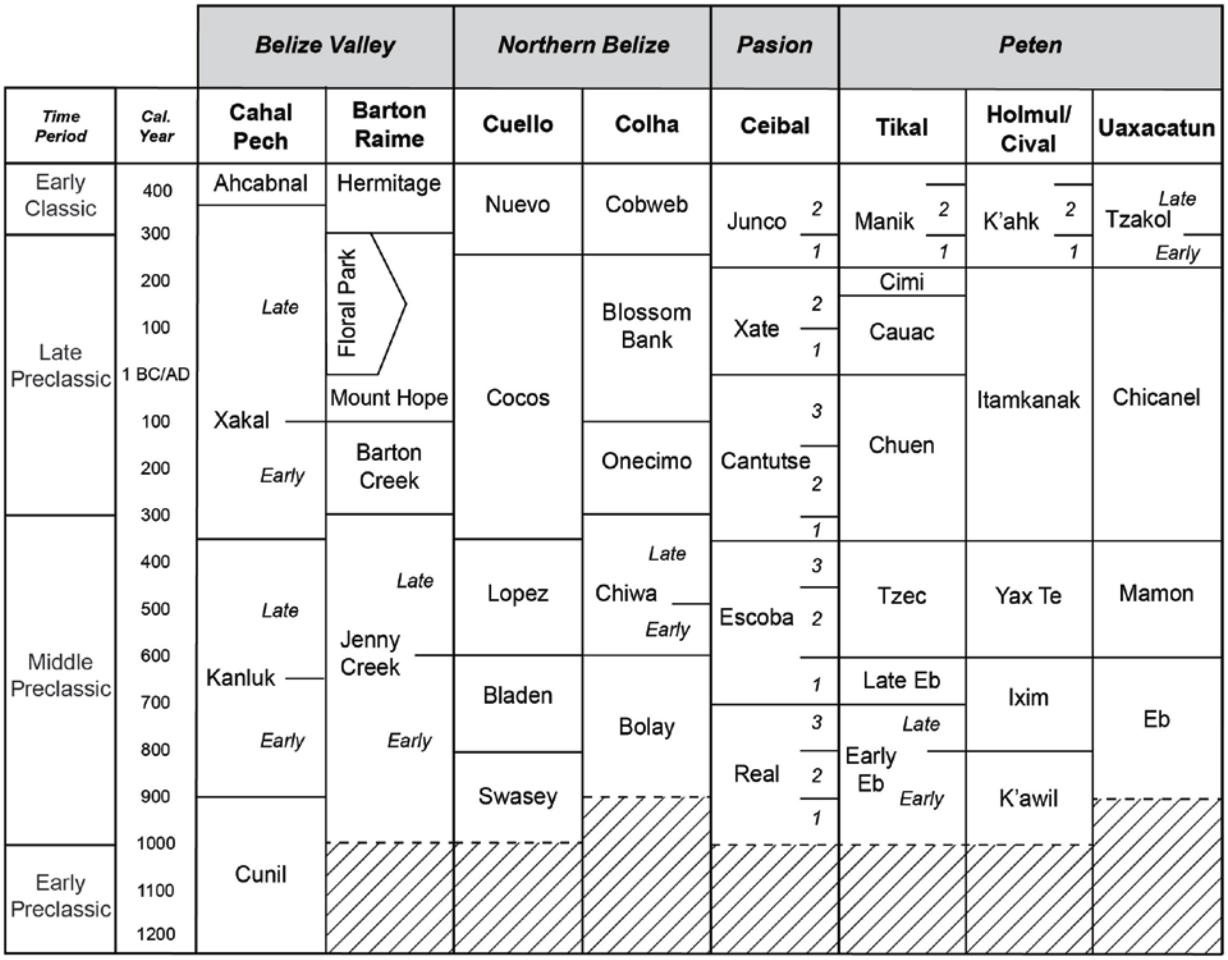

Figure 1.2: Ceramic chronologies of Cahal Pech (Belize Valley) and other regions of the Maya lowlands.

mobilization and centralized organization of labor (Childe 1950:12; Trigger 1990:135; Peebles and Kus 1977). The size and elaboration of structures are used by archaeologists studying the Classic Period to estimate labor costs in person days, with the most costly domestic buildings most frequently located in elite palace compounds (e.g., Abrams 1994; Carmean 1991).

The construction of monumental buildings (e.g., pyramidal temples) within formal ceremonial complexes occurred across many parts of the Maya lowland after 700 BC (Middle Preclassic), suggesting the appearance larger-scale centralized labor organization (Doyle 2012:356). By the Late Preclassic, immense public buildings at the sites of El Mirador, Calakmul, and Nakbe indicate their status as paramount centers of multi-tiered chiefdoms or early states (Estrada-Belli 2011:44-48; Freidel and Schele 1988; Hansen 1998, 2001). Residential architecture is also a strong expressions of status based on wealth and political centralization in agrarian societies, with the size, quality of construction, and construction materials directly related to a household's access to labor construction materials (Feinman and Neitzel 1984; Hayden and Cannon 1983; Netting 1982; Smith 1987; Wilk 1982). Essential to understanding the relationship between the centralization of organization and labor expenditures are the time spans of construction episodes. Rapid and large-scale building projects can be used to help estimate the size of labor crews (Earle 1987:290).

Economic stratification between individuals and households is another defining characteristic of social complexity in the Maya lowlands, where ascribed leadership positions were based on differential access to resources. Traditional archaeological interpretations of economic stratification have focused on the analysis of burial contexts to understand the relationship between wealth and status differentiation (Binford 1971; O'Shea 1984; Tainter 1978). Burial data from the Middle Formative at Cahal Pech have identified differentially ascribed status through analyses of grave type (elaborate vs. simple grave construction), grave context (located within public architecture vs. domestic space), and presence or absence of exotic grave goods (Awe 2012; Chase 1992; Grove and Gillespie 1992). Tomb construction and the types of associated grave goods represent the quantity and quality of resources invested in burials, especially for high status individuals. Research on the emergence of economic stratification has also focused on elite control of specialized craft production (Brumfiel and Earle 1987; Clark and Parry 1990; Earle 1997; Hayden 2001). Elite status was maintained through the monopolization of regional distribution systems (Clark 1987), which generated economic and social debt for subordinate members of society (Clark and Blake 1994; D'Altroy and Earle 1985).

More recently archaeologists have presented alternative models that highlight social differentiation both vertically by social status and horizontally through economic specialization (e.g., Hirth 2009, 2012). Specialization refers to an economy where consumers are not involved in all aspects of production (Costin 2005:1063). Household craft specialization has often been viewed as an adaptation to larger-scale economic developments (Costin 1991; Hirth 2009). Craft production may have been integrated into the domestic economy as a risk minimization strategy to buffer against resource shortfalls where agricultural land was scarce (Arnold 1985; Fitzhugh 2001; Hayden 2001), while also serving to raise the overall well-being of the household (Hagstrum 2001). In the Belize Valley region of the Maya lowlands, however, craft production first appears when population density was low and there was an abundance of open agricultural lands (Awe 1992). In this case, specialized domestic production and the distribution of specific goods may have been used as a strategy by some households to link people into networks of interdependency within the institutional economy, contributing to their prosperity and prestige within a developing institutional economy that was organized above the level of the household (Costin 1991; Hirth 2009). Examining the distribution between craft production and consumption within the Cahal Pech community, and with other groups in the Maya region, is necessary to understand the economic behaviors that structured both domestic and institutional economies among early stratified communities.

The success of early complex groups was challenged by internal socio-political developments such as intra-group conflict, and competition for resources in the face of population growth, and external environmental change. While resilient societies possessed an adaptive capacity that allowed them to absorb external disturbance, increasingly complex groups were prone to “rigidity traps” whereby the high degree of social connectivity and suppression of innovation lowered the adaptive capacity of a system (Hegmon et al. 2008:313; Holling and Gunderson 2002). The result was the fragmentation of polities and sometimes the development of completely new social systems (Carneiro 1970; Wright 1994; Steward 1955:51).

Contrasting the social and political trajectories of early agrarian societies remains key to documenting the cyclical evolution of complex societies (Anderson 1996; Cowgill 2012; Marcus 1993, 1998; Wright 1994; Wright and Johnson 1975). The most in-depth treatments of societal cycling in the Maya region is Joyce Marcus’s “dynamic model”, which illustrates the episodic rise, decline, and reorganization of Classic and Postclassic Period Maya kingdoms based on epigraphic and ethnohistoric data (1993, 1998). The dynamic model characterizes Maya prehistory as recurring peaks and valleys that correspond to alternating periods of centralization and decentralization of specific polity’s (Figure 1.2). During peaks in the cycle, regional kingdoms were concentrated at paramount centers with territorially, were politically consolidated, and exhibited multi-tiered settlement hierarchies (e.g., Copán, Tikal, Calakmul, and Palenque). Valleys occurred during times when polities (i.e., independent political units) broke down into more decentralized and unstable organizational forms.

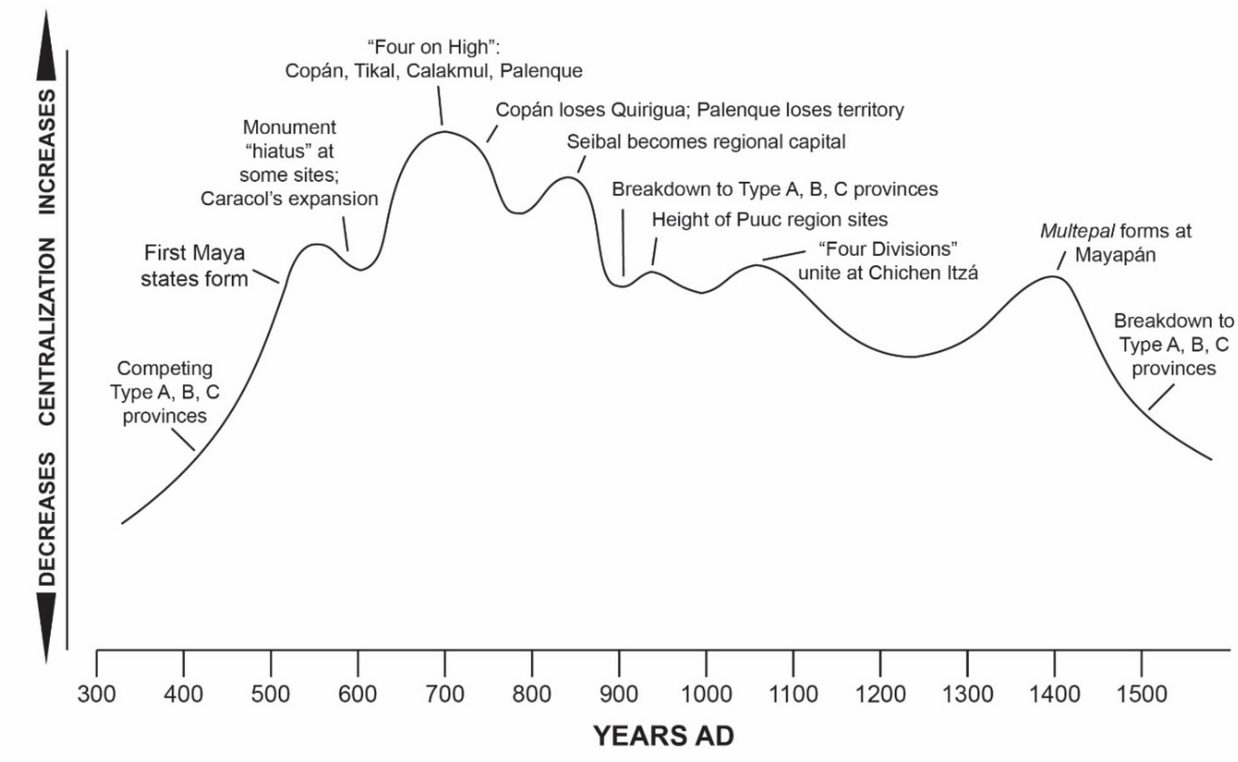

Figure 1.3: The dynamic model applied to the Classic and Postclassic period Maya lowlands (modified after Marcus 1993: Fig. 26).

While hieroglyphic and historic texts provide detailed information of the causes and consequences of political cycling during the Classic Period, the timing and nature of similar processes remains largely unknown for Preclassic Period Maya communities. Archaeological data has documented continued growth throughout the Middle and Late Preclassic period at some Maya centers (e.g., Ceibal, Inomata et al. 2017; Nakbe and El Mirador, Hansen 1998). Recent paleoclimate studies have suggested that population decline and the abandonment of major political centers in the Petén occurred during a period of extended drought occurring between AD 100 and AD 300 at the end of the Late Preclassic (Akers et al. 2016; Dunning et al. 2014; Kennett et al. 2012: Medina-Elizalde et al. 2016). Despite these dramatic changes at the end of the Preclassic Period, new and resilient political centers emerged in all regions of the

Maya lowlands after AD 300, in some cases flourishing for over six to seven centuries. Understanding the timing and nature of earlier Preclassic social and political cycles provides a framework for understanding the complex social and environmental factors that influenced localized adaptations to climate change and the episodic growth and decline of later Classic Period societies.

Previous Archaeological Research on the Preclassic Period Cahal Pech

The monumental site core of Cahal Pech is situated on top of a natural limestone escarpment within the modern town of San Ignacio, bordering the alluvial bottomlands along the Belize River approximately 2 km south of the confluence of the Macal and Mopan Rivers (Figure 1.3). While the presence of Cahal Pech was known to archaeologists in the early 20th century (Thompson 1939:278-282), systematic research was not undertaken at the site until the 1950's. The results of preliminary mapping and test excavations conducted by Linton Satterthwaite, who was the first to refer to the site as Cahal Pech ("the place of the ticks") in writing, were published in a short section in his article "Reconnaissance in British Honduras" (Satterthwaite 1951:22). More detailed field notes suggest that Satterthwaite focused his investigations on several small test units in the Cahal Pech civic-ceremonial site core (Figure 1.4). He also documented five plain stela and an uncarved altar (Awe 1992:57). Based on materials recovered from excavations of seven structures, Satterthwaite suggested that the site was occupied throughout much of the Preclassic Period prior its Classic Period apogee (Satterthwaite 1951:22).

Gordon Willey visited Cahal Pech in 1953 as part of his introductory settlement survey field trip to the Belize Valley. After a long morning of chopping a narrow path through the

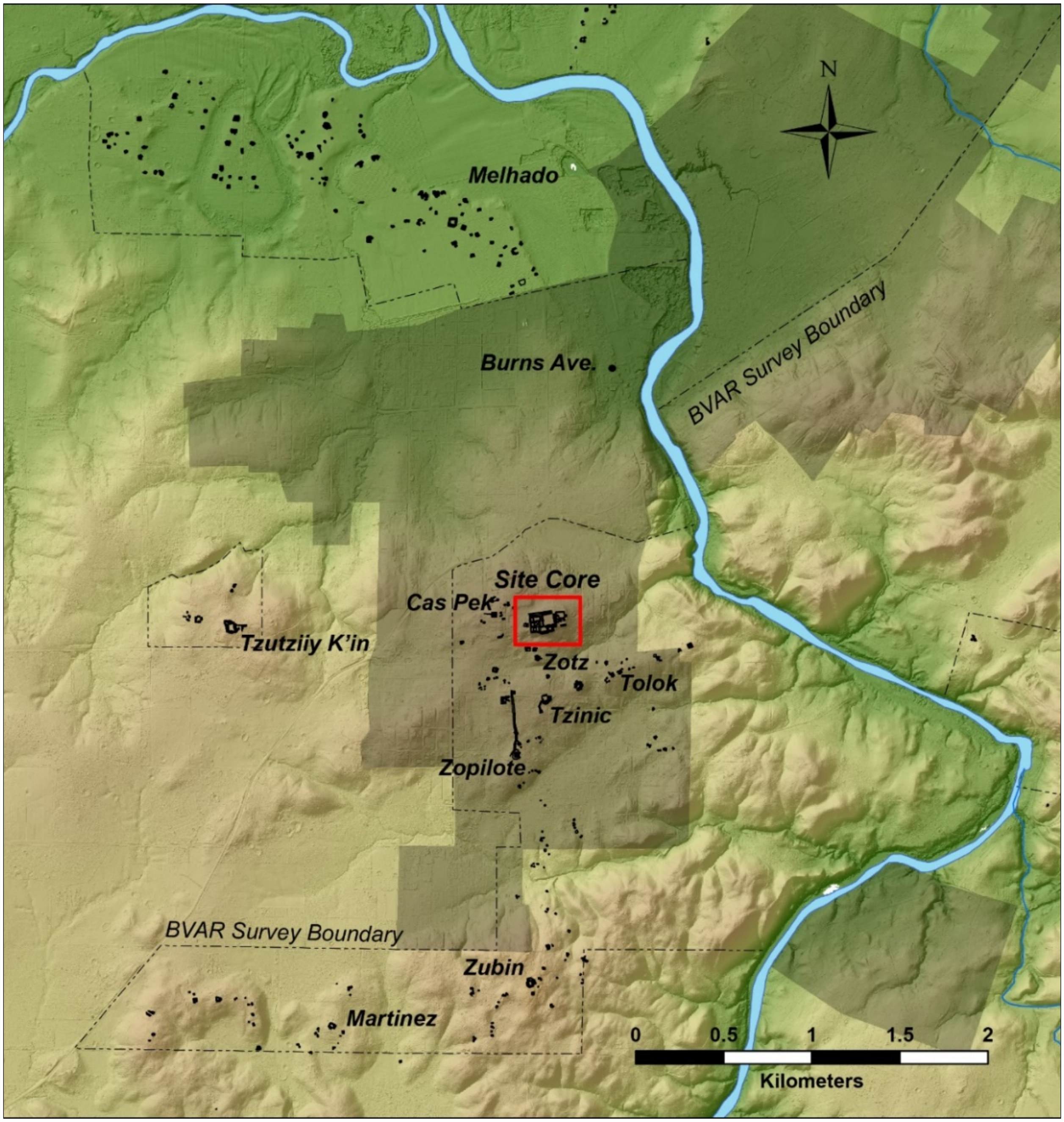

Figure 1.4: Map of Cahal Pech settlement zone with site core and major households labeled.

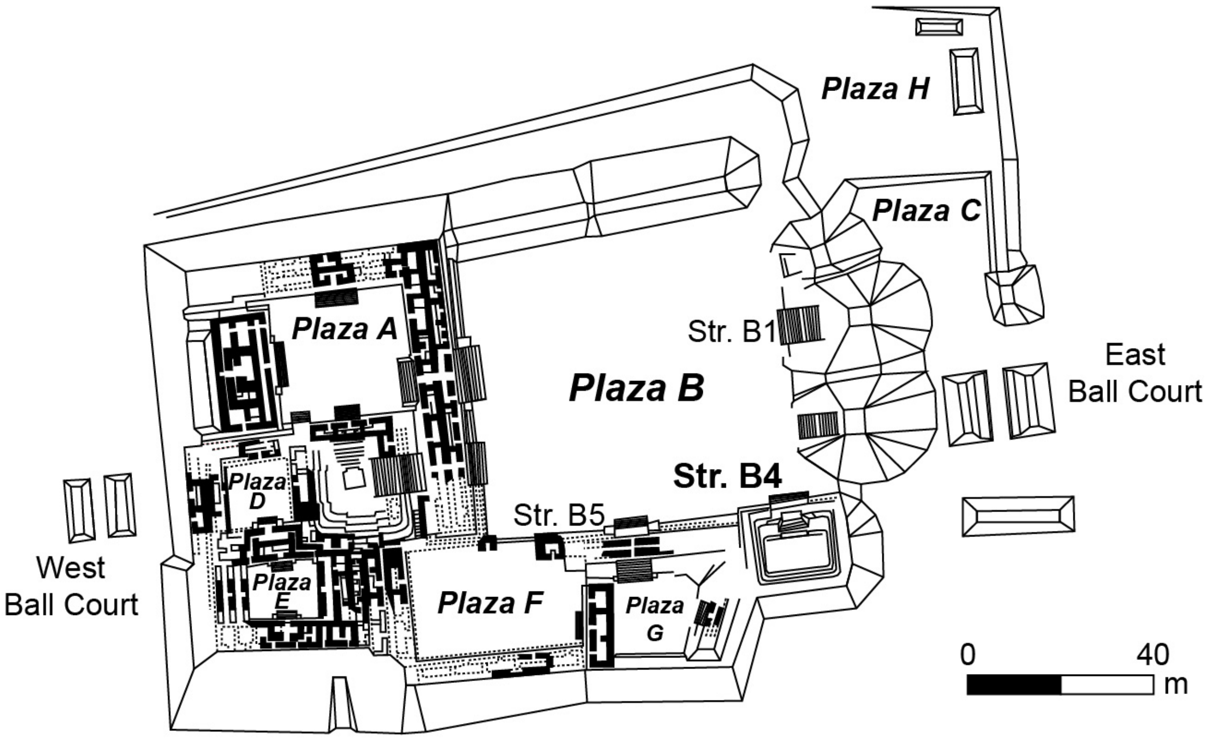

Figure 1.5: Monumental site core of Cahal Pech (map courtesy of the BVAR Project).

sweltering jungle and discovering “only two or three little mounds”, Willey terminated the Cahal Pech survey. Ultimately he decided to focus his research at the site of Barton Ramie, located approximately 16 km down the Belize River in more favorable survey and mapping conditions (Willey 2004:23), but he continued to work at Cahal Pech with his graduate student, William Bullard. Together they mapped and placed test units in several house mounds at the Melhado Group, located approximately 1 km north of the Cahal Pech site core (Willey and Bullard 1956). Preliminary ceramic analyses identified Preclassic levels overlain by more substantial Classic Period occupation, indicating the longevity of the residential group. Willey and Bullard also reported the presence of similar house mound groups extending from the Melhado Group to the Cahal Pech site center, and suggested that they served as residences for the site’s supporting population from the Preclassic through Classic periods (Willey and Bullard 1956:313-315).

Belize Valley Archaeological Recognizance Project Investigations

After a 30 year hiatus, archaeological research resumed at Cahal Pech in the 1980's under the auspices of the Belize Valley Archaeological Recognizance (BVAR) Project, directed by Jaime Awe. Initial settlement survey and excavations undertaken between 1988 and 1992 focused on documenting house mounds immediately south of the site core that were threatened by looting and the construction of the growing modern neighborhoods of San Ignacio. A second goal of renewed research at Cahal Pech was to develop the site as an archaeological park for tourism (Awe 1992; Awe and Brisbin 1993). During preliminary test excavations in Plaza B and Structure B4 in the site core, Awe and his colleagues encountered some of the most extensive Preclassic levels in the Maya area (Figure 1.5). Stratigraphic trenches in this building produced a continuous construction sequence of Early Preclassic domestic structures superimposed by later Middle and Late Preclassic platforms and temples (Awe 1992; see also Awe and Healy 1995; Healy et al. 2004). This discovery launched over 30 years of continuous fieldwork aimed at defining the nature and timing of the site's earliest occupation and subsequent growth into one of the largest Classic Period polities in the Belize Valley.

Based on materials from the Structure B4 excavations, Sullivan and Awe (2013) later defined the Cunil ceramic complex dating to between 1200 and 900 BC, associated with the earliest farming village settlement at Cahal Pech (see also Awe 1992; Cheetham 1995; Clark and Cheetham 2002). Cunil pottery consisted primarily of utilitarian cooking and storage vessels, but also includes decorated bowls and plates with iconography connecting the Belize Valley region to ideological developments associated with displays of wealth and authority taking place at contemporaneous sites along the Gulf Coast and Oaxaca (Garber and Awe 2009). Excavations in house groups surrounding the site core have also provided some limited evidence for Cunil phase household settlement, suggesting the initial settlers of the Belize Valley lived within small localized hamlets (Awe 1992; Ebert and Fox 2016; Iannone 1996). While current data suggest little evidence for institutionalized social inequality, the presence of non-local exotics (e.g., jade, obsidian, marine shell) within Cunil/Kanocha levels also indicates integration into regional economic networks (Awe 1992; Garber et al. 2004).

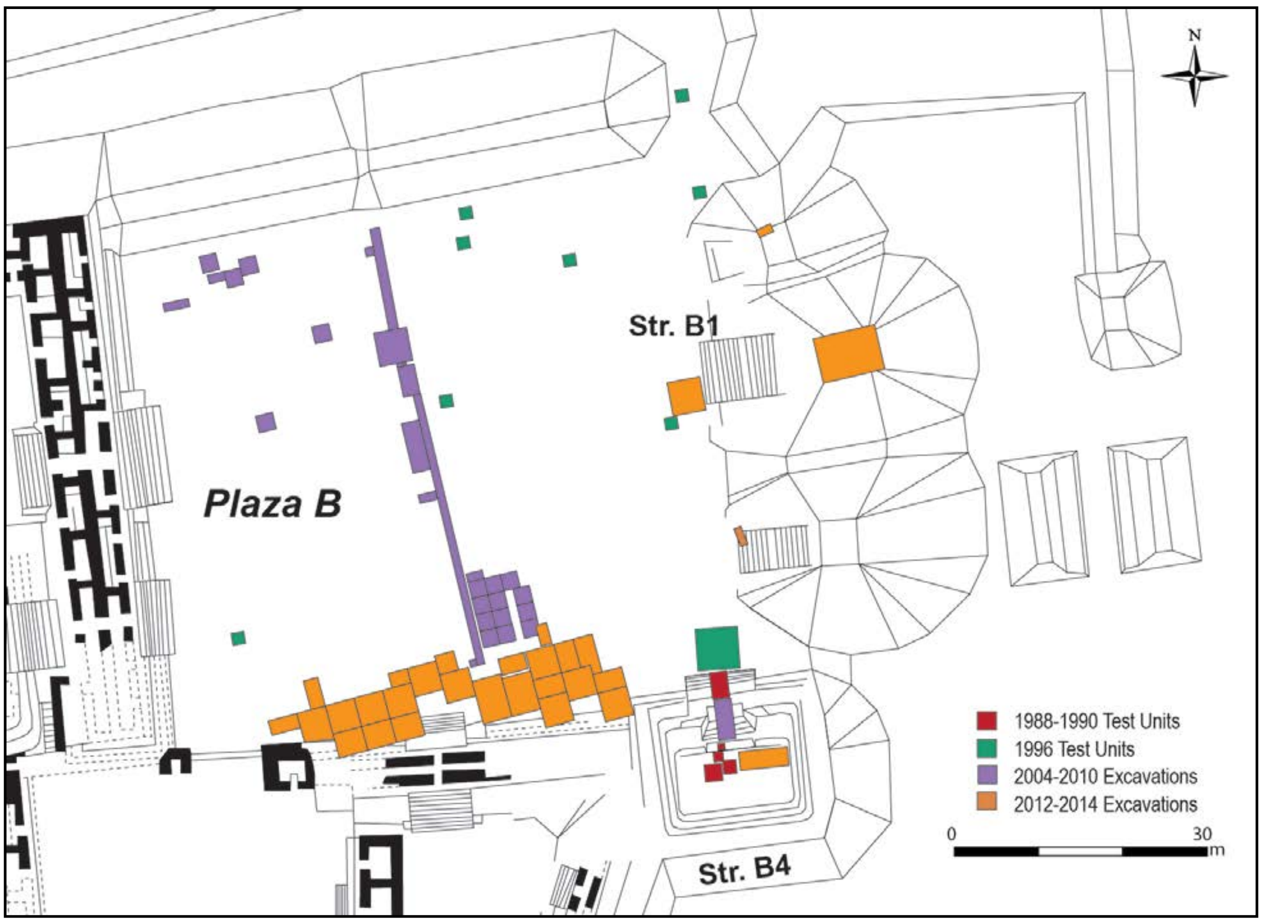

Figure 1.6: Map of major excavations in Plaza B.

Since Awe's initial research on Preclassic developments at Cahal Pech, excavations have concentrated on exposing public architecture within the civic-ceremonial core to understand their function and relationship to economic growth during the Middle and Late Preclassic (Garber et al. 2010; Horn 2015; Peniche May 2013, 2014a, 2014b). Based on a series of test units placed across Plaza B, David Cheetham (1996) identified the presence of at least eight small domestic house groups, which were later covered by a series of large raised platforms constructed from high-quality cut limestone. Sherman Horn (2015) analyzed the Middle Preclassic ceramic, lithic, and shell assemblages from a more targeted 52 m north-to-south trench across Plaza B excavated during the 2004-2010 field seasons to document the economic systems in the Cahal Pech site core. He suggested that differential consumption of restricted high-value goods and exotic trade items reflected status and were positively correlated with the size of residential architecture and higher status households (Horn 2015).

Nancy Peniche May (2016) conducted large horizontal excavations ~186.5m^2 in the southern part of Plaza B between 2012-2016 for her dissertation research exploring the relationship between ritual activity, public architecture, and the development of socio-political power during the Middle Preclassic. Her excavations documented the construction of new styles of large public buildings and the high-status residences that appeared in the Middle Preclassic, replacing small Early Preclassic domestic structures within the site core. Peniche May (2016) suggested that the construction of public buildings, including round platforms, were associated with a more socially restricted set of ritual and economic activities used by emergent high-status households to create and maintain unequal socio-political relationships within the community. Much larger and more formally organized civic centers with Middle Preclassic public architecture have been documented at other sites in the region including Blackman Eddy, Xunantunich (Group E), Pacbitun, Actuncan, and Barton Ramie (Awe 1992; Brown et al. 2013; Garber et al. 2004; Healy et al. 2004b; Willey et al. 1965).

While much of the earliest architecture in the Cahal Pech epicenter is buried beneath later monumental Classic Period construction (Healy et al. 2004), Preclassic household groups surrounding the site center have been more accessible for BVAR excavations and analyses. Over the last 30 years, survey and excavations have documented both elite and non-elite residential settlements to the east and south of the site core, with over 75% of all mounds tested yielding evidence of Preclassic construction or architectural modifications (Awe 1992:356). Intensive programs of excavations at the outlying settlement groups Zubin (Iannone 1996), in addition to the nearby household groups of Zopilote (Cheetham 2004; Cheetham et al. 1994), Cas Pek (Sunahara and Awe 1994), and Tolok (Powis 1996) first began in the early 1990's as a compliment to site core research. Radiocarbon dates and associated ceramic materials from these residential groups, in addition to several others (Burns Avenue Group, Ch'um, Melhado, Tzutziiy K'in, Zinic) indicate that many settlements were founded as small domestic groups during the Middle Preclassic, indicative of population growth around the Cahal Pech site core (Awe 1992:207; Awe et al. 2014; Cheetham et al. 1993; Ebert et al. 2016; Iannone 1996; Powis 1996; Willey and Bullard 1956).

Excavations have also documented the construction of more elaborate domestic and public architecture appearing at the end of the Middle Preclassic. At the Zopilote and Zubin groups, a large temple structure served as the focal points of the groups and continued to be remodeled through the Classic Period (Cheetham 2004; Iannone 1996). At the Tolok and Zotz groups, centrally located round platform buildings, likely used for community-oriented activities or ritual performances, were also constructed during the Middle Preclassic and contained special deposits including burials and cashes (Aimers et al. 2000:83). The presence of exotic trade goods (e.g., obsidian, jade; Powis et al. 2017), imported foods (e.g., Caribbean fish; Powis et al. 1999), and specialized craft production (e.g., shell bead production; Hohmann 2002) within the peripheral households at Cahal Pech suggest that households may have developed independent economic connections as the Cahal Pech settlement systems and became increasingly stratified and complex during the end of the Preclassic Period.

Dissertation Fieldwork

Archaeological fieldwork for this dissertation was carried out in collaboration with the BVAR Project over multiple field seasons from 2012-2015, and builds on previous survey and excavations within the surrounding residential settlements of Cahal Pech. Compared to other regions in Mesoamerica, the upper Belize Valley around Cahal Pech possesses high density populations living in an increasing number of modern towns and villages, as well as large-scale agricultural infrastructure that is continually growing. This urban environment continues to pose challenges for pedestrian archaeological survey methods since the growth of modern settlement has destroyed ancient ruins and agricultural development is creating new vegetation patterns. To address these methodical issues, I performed systematic quantitative analysis of airborne light detection and ranging (lidar) remote sensing data and ground verification to understand the extent and nature of previously undocumented prehistoric settlements at Cahal Pech (Ebert et al. 2016). Airborne lidar survey for the BVAR study area in the Belize Valley was conducted in 2013 as part of the West-Central Belize Lidar survey flown by the National Center for Airborne Laser Mapping (NCALM; Awe et al. 2015; Chase et al. 2014). A preliminary classificatory typology of settlement group types was also created for Cahal Pech based on survey results

(Ebert 2014). Types are derived from the number of mounds, their spatial layout, the presence or absence of formal patio groups and height of mounds. The primary function of the typology was the development of a sampling strategy for more targeted household excavations.

To date, over 140 house groups within a 29 km^2 area have been documented around the Cahal Pech site core based on the analysis of lidar data and pedestrian survey (Awe 1992; Awe and Brisbin 1993; Dorenbush 2013; Ebert and Awe 2014; Ebert 2015). Surface collection of temporally diagnostic ceramics indicate that while most house groups possess evidence for Late Classic (AD 500-800) occupation, many of the larger groups were established as early as the Middle and Late Preclassic periods. There is limited evidence for occupation within the settlement during the Terminal Classic Period, indicating that the political "collapse" of Cahal Pech between AD 850 and 900 impacted residential groups associated with the site (Ebert et al. 2016).

Based on lidar and survey results, I selected three peripheral house groups for more targeted excavations: the Tzutziiy K'in, Zopilote, and Martinez Groups (Ebert and Dennehy 2013; Ebert et al. 2016; Ebert and Fox 2016). The goal of excavations was to understand the material correlates of differential social status between households, and how their economic activities affected the emergence, growth, and persistence of social and economic inequality among the Preclassic Period Cahal Pech community. Excavations also documented detailed construction sequences of domestic buildings, one of the strongest expressions of status in agrarian societies. Excavations at Tzutziiy K'in were conducted over multiple summer field seasons from 2012 to 2015. Limited mapping and test pitting at the Martinez Group was conducted in 2014, with larger scale excavations at this group and the Zopilote group in 2015.

Appendix A presents the results of excavations carried out both within structures and open plazas at each house group in detail.

Detailed analysis of artifact assemblages was performed in 2015. A significant portion of basic lab work (artifact processing, washing, and inventory) was completed during the BVAR field school, as part of laboratory analysis instruction. Diagnostic ceramics were measured and compared to standard typologies for the Belize Valley (Awe 1992; Gifford 1976), focusing on change over time in the percentage of fine wares. Lithic artifacts, including chert and obsidian tools, flaked stone debitage, and ground stone were also analyzed according to raw material and tool types. Shell and faunal material were counted and identified to the species level using standard zooarchaeological morphological analysis. Ceramics, obsidian, bone, and other organic materials were exported to Penn State for additional geochemical analyses and radiocarbon dating under License Number IA/H/3/1/15(17) granted to Jaime Awe by the Belize Institute of Archaeology. Materials from Peniche May's excavations in Plaza B and excavations by Brendan Culleton and Douglas Kennett in 2012 at Structure B4 in the Cahal Pech site core were also included in the export for laboratory analyses. These data, presented throughout the dissertation, were used to supplement architectural data to identify trends related to changing social status and wealth at Cahal Pech during the Preclassic Period.

Research Questions

To understand the social, economic, and environmental conditions that promoted social complexity and differentiation, this study documents changes in the archaeological record at Cahal Pech based on excavations, artifact analyses, radiocarbon dating, geochemical sourcing analyses, and stable carbon and nitrogen isotopic analyses of human/faunal remains. I also synthesize data from the published archaeological literature on the Preclassic Period at Cahal Pech and other lowland Maya sites to answer three primary questions:

1. *What was the timing of Preclassic Period development at Cahal Pech in relation to other contemporaneous sites in the Belize Valley and regions of the Maya lowlands?*

Previous archaeological research at Cahal Pech and elsewhere in the Belize Valley have applied relative ceramic dating and limited radiometric dating techniques to document the growth of sites during the Preclassic Period. Relative ceramic phases often span hundreds of years, however, preventing precise temporal assignments for discrete events that are essential for documenting patterns of culture change (e.g., Adams 1971; Sabloff 1975; Gifford 1976; Andrews 1990; Hammond 1991; Culbert 1993; Demarest et al. 2004). While radiometric dating methods provide finer temporal resolutions, dates often have large measurement errors that also impede clear chronological distinctions (Hoggarth et al. 2016; Kennett et al. 2008).

To address these issues, this study developed a chronology for Cahal Pech combining high-resolution accelerator mass spectrometry (AMS) radiocarbon dating with stratigraphic associations between dates within a Bayesian framework to isolate discrete occupational phases. The results of Bayesian modeling provide more precise and accurate age determinations and a more dynamic framework to correlate parallel historical, archaeological, and environmental datasets (Bronk Ramsey 2015; Bronk Ramsey et al. 2010; Kennett et al. 2011, 2014; 2017; Prufer et al. 2011; Culleton et al. 2012; Inomata et al. 2017; Jazwa et al. 2013; Hoggarth et al. 2014). Bayesian chronological models were also developed for other Maya sites with published radiocarbon data.

Distributions of radiocarbon dates (i.e., summed probability distributions) from specific contexts are also used as a heuristic tool to identify important negative and positive trends in cultural activity. For Cahal Pech, summed probability distributions of radiocarbon dates modeled for sequences in the site core and settlements, considered alongside architectural data, yields an approximation of the initiation and cessation of construction activity that correspond to social and political trends occurring throughout the site during the Preclassic Period. Distributions of dates from human remains show shifts in occupational activity at Cahal Pech, with increases and decreases representing positive and negative demographic trends. As the best dated cultural sequence from the Belize Valley, the Cahal Pech site chronology developed in this dissertation provides a framework for understanding the spatial, demographic, and political growth of other regional political centers during the Preclassic Period.

2. *What economic activities carried out by households were embedded within broader processes associated with emerging social and political complexity?*

Research on the emergence of social and economic stratification in Preclassic/Formative Period Mesoamerica has emphasized elite political control of specialized production (Brumfiel and Earle 1987; Clark and Parry 1990; Earle 1997; Hayden 2001). Archaeologists have suggested that elite status was maintained through the monopolization of regional distribution systems (Clark 1987), which generated economic and social debt for subordinate members of society (Clark and Blake 1994; D'Altroy and Earle 1985). Perspectives that stress the actions of elites in social and economic change discount behaviors that likely occurred at differing local and regional scales with varying effects on households. Households were the most basic economic unit in Preclassic Maya society, and served as a point of engagement in the domestic economy for the acquisition of resources needed for basic daily subsistence, but also articulated directly with broader economic, social, and ecological processes (Ashmore and Wilk 1988; Tringham 2001; Wilk and Rathje 1982; Willey et al. 1965). The irregular distribution of subsistence and non-subsistence resources probably encouraged corresponding economic variation and competition between households (Hirth 2006). Specialized domestic production and the distribution of specific goods may have also been used as a strategy by some households to link people into networks of interdependency within the institutional economy, contributing to their prosperity and prestige (Costin 1991; Hirth 2009).

To address this second question, this study draws on two primary datasets –ceramic and obsidian geochemical composition data– since both materials are abundant in excavated household contexts (burials, middens, construction fill). If differential involvement in craft production was an important feature in the development of social complexity at Cahal Pech, differences in status between domestic groups will be associated with diverse types of craft production (Schortman and Urban 2004:197). Compositional variability of Early to Late Preclassic ceramics determined using Instrumental Neutron Activation Analysis (INAA) from the Cahal Pech core and from my excavations at two settlement groups serve as a proxy for production by separate household units. Additional lines of analyses (metric attribute measurements, typological, and modal analyses) also supplement INAA to facilitate inferences about distinct household production units in the Cahal Pech system that may have varied by socioeconomic status.

Changing status may have been less dependent upon specialized domestic craft production, and alternatively was related to control over the distribution of obsidian blades. Portable X-ray fluorescence (pXRF) was used to document the distribution of different obsidian types between the Cahal Pech core and ten peripheral household groups. In an economy controlled by centralized leadership or influenced by higher status individuals, redistribution of pooled items may result in uniformity in amount and type of goods between households (Winter and Pirres-Feriera 1976). The Cahal Pech obsidian data indicate a different pattern of decentralized domestic procurement of obsidian by individual households from the Middle Preclassic through Terminal Classic Periods.

3. *What environmental and climatic factors promoted the resilience and/or vulnerability of the Preclassic Cahal Pech community?*

Recent paleoclimate research in the Maya lowlands has highlighted variability in human responses to extreme multi-decadal droughts as a factor in the several waves of societal collapse during the Terminal Classic Period between AD 850 and 1100 (Akers et al. 2016; Hoggarth et al. 2016; Kennett et al. 2012; Medina-Elizalde and Rohling 2012). Written records and paleoclimate data from historic contexts similarly show correlations between severe drought and the failure of agricultural subsistence production and demographic decline in the northern lowlands of Yucatán during the Colonial Period (Acuña-Soto et al. 2004; Bricker and Hill 2009; Endfield 2007; García-Acosta et al. 2003; Hoggarth et al. 2017). While less paleoclimate research has focused on understanding societal change and climate change during the Preclassic, an extended period of drought occurring between cal AD 100-300 (Late Preclassic) has been linked to population decline and abandonment of some major polities (e.g., Mirador, Nakbe; Akers et al. 2017; Dunning et al. 2014; Medina-Elizalde et al. 2016). These data suggest that as societies became more complex and interconnected throughout the Preclassic, they also developed vulnerabilities that compromised their ability to adapt to long-term change and eventually leading to dramatic and rapid cultural transformations (Faulseit 2015; Hegmon et al. 2008; Kennett and Marwan 2015).

To understand the role of climate in the development of complexity at Cahal Pech, two different datasets were compared to regional paleoclimate records. First, comparisons to the Cahal Pech radiocarbon chronology suggest that fluctuating alternating wet and dry periods may have promoted early settlement and construction programs in the site core. Relatively wet conditions in the Middle Preclassic also favored population expansion within peripheral household groups. Second, stable carbon and nitrogen isotope analyses of radiocarbon dated human burials suggest that a more diverse diet incorporating wild and domestic foods may have promoted resilience in the face of social reorganization and drought at the end of the Late Preclassic Period. During the Late Classic Period (AD 300-900), isotopic data indicate high-status individuals had a narrow and highly specialized diet, which may have contributed to an unstable system that ultimately contributed in the failure of the Cahal Pech elite dynastic lineage in the face of severe drought at the end of the Terminal Classic Period.

Organization of the Dissertation

This dissertation is composed for four previously published and unpublished co-authored papers aimed at understanding social, economic, and political growth of Cahal Pech at the regional, local, and household levels during the Preclassic Period. While the chapters focus on Cahal Pech as a case study for examining cultural evolution in the Maya region, they also incorporate published data from other sites within the Belize Valley region and Maya lowlands to contextualize these developments more broadly. The chapters are organized to address the three primary research questions discussed above.

Chapter 2 presents the Bayesian radiocarbon chronology developed for Cahal Pech based on high-resolution AMS radiocarbon dating and stratigraphic information from excavated sequences within the civic-ceremonial site core and peripheral settlements. The radiocarbon samples were processed at the Pennsylvania State University Human Paleoecology and Isotope Geochemistry Laboratory and measured at The Keck Carbon Cycle AMS Facility at UC Irvine. Radiometric dates previously reported by Awe (1992; see also Awe and Healy 1995; Healy 2004) and unpublished AMS dates produced by Brendan Culleton for Structure B4 in the Cahal Pech core are also included in the Cahal Pech chronology. The initiation and cessation of construction activity corresponding to social and political trends were identified based on probability distributions of modeled radiocarbon dates. The results indicate that after the site was first settled as a small farming village site around 1200/1100 cal BC, construction activities focused primarily on the expansion of domestic architecture. During the Middle Preclassic, beginning around 800-700 cal BC, the first public architecture (e.g., raised platforms, small temples) and larger residential structures appear at the site, suggesting the development of a centralized hierarchy within the community. The pace of monumental construction slowed in the site core at the end of the Middle Preclassic, but summed probability distributions of radiocarbon dates corresponding to building activities at the site show that populations were growing at a steady rate into the Late Preclassic and Early Classic Period when the first ruling lineage of Cahal Pech was firmly in place.

The Cahal Pech chronology was also compared to a large database (*n*=1198) of published radiocarbon data from the Maya lowlands to contextualize the Preclassic growth the site in the Belize Valley and greater southern lowlands. Based on these radiocarbon data, along with stratigraphic information, we developed Bayesian chronologies and summed probability distributions for 39 sites in five core regions of the lowlands in order to clarify the timing of more localized Preclassic Period developments. Comparing the summed distributions of radiocarbon dates for each region (Belize Valley, Northern Belize, Petén and Southern Belize, Pasión, and the Southeastern Periphery) to regional paleoclimate records, we identified contrasting patterns of sociopolitical change in relationship to fluctuating climatic conditions at the site, local, and regional levels in the southern Maya lowlands. During the Early Preclassic, low population levels in the at Cahal Pech, and elsewhere in the Belize Valley and Northern Belize, may have allowed small communities to adapt to alternating wet and dry periods. The impacts of prolonged multi-decadal and century-long droughts likely became more pronounced in the Late Preclassic Period as population levels began to peak and regional centers became focal points in complex social, political, and economic systems. A drought at the end of the Late Preclassic Period likely influenced socio-political and population decline in some parts of the southern lowlands (e.g., Pasión, Northern Belize regions). Intensified construction programs and increased population growth indicate that the inhabitants of Cahal Pech and other Belize Valley sites flourished in spite of drought conditions. This chapter was prepared as a co-authored work with Nancy Peniche May, Brendan Culleton, Jaime Awe, and Douglas Kennett and is currently under review for publication in *Quaternary Science Reviews.*

Chapter 3 introduces more targeted chronological analyses at the Tzutziiy K'in house group as a framework for understanding the growth and decline of households around the Cahal Pech site center, in addition to the differences between cultural developments within house groups and the site core. Tzutziiy K'in (roughly translating to "sunset" in Yucatec Mayan) is a large house group located atop a small hill approximately 1.8 km west of the Cahal Pech core. AMS radiocarbon dates were sampled from excavations conducted in 2012 at in three structures.

The Tzutziiy K'in chronology documents at least three periods of settlement and household growth. The group was initially settled by the Late Preclassic (325-110 cal BC) as a small farming household, concurrent with other archaeological evidence for population expansion around Cahal Pech, and throughout the Belize Valley. Multiple masonry platforms were constructed in the main plaza at Tzutziiy K'in during the Early Classic Period (AD cal 350-650). Tzutziiy K'in became one of the largest hinterland house groups associated with Cahal Pech during the Late and Terminal Classic Periods (cal AD 650-900) suggesting that a politically and economically important lineage resided at this location. The terminal occupation of the group between cal AD 850-900 may indicate that the political "collapse" of the dynastic royal lineage at Cahal Pech may have similarly impacted large high-status house groups like Tzutziiy K'in. This chapter, prepared as a co-authored work with Brendan Culleton, Jaime Awe, and Douglas Kennett, is published in the journal *Radiocarbon*.

Chapter 4 explores the household level economic adaptations that were embedded within larger social and political developments at Cahal Pech throughout the Preclassic Period. The structural and distributional aspects of domestic economic systems were characterized using geochemical compositional analyses of obsidian and ceramic artifacts excavated from both the Cahal Pech core and house groups. Technological and portable X-ray fluorescence (pXRF) analyses of obsidian dating from the Preclassic through Terminal Classic periods indicate differential use of source materials, suggesting that households at Cahal Pech obtained finished blades through decentralized domestic procurement systems. Instrumental neutron activation analysis (INAA) of ceramics from directly dated contexts in the site core at Plaza B and two house groups (Tzutziiy K'in and Zopilote) provide evidence for contrasting provisioning strategies based on specialized production and exchange of fine decorated ceramics during the

Preclassic Period. INAA identified four primary compositional groups corresponding to changing Early, Middle, and Late Preclassic ceramic production patterns. The Early Preclassic Cunil assemblage is compositionally unique in the Maya lowlands, providing evidence for local production of this early ceramic complex. By the Middle and Late Preclassic, the ceramics from higher status households were compositionally distinct when compared to pottery samples from peripheral household settlements. Comparisons of compositional analyses for ceramic assemblages from Cahal Pech and the site of Holtun in the central Petén indicate that decorated Mars Orange wares were produced locally in the Belize Valley and imported by high status groups in the Petén. This chapter was prepared as a co-authored work with Kenneth Hirth, Casana Popp, Daniel Pierce, Michael Glascock, Sarah B. McClure, Jaime J. Awe, and Douglas J. Kennett, and will be submitted to *Journal of Anthropological Archaeology* for review.

Chapter 5 examines the role of diet in the resilience and adaptability of the Cahal Pech community during periods of climatic stress. High-precision AMS radiocarbon dating and stable carbon and nitrogen isotope analyses conducted on human skeletal remains from the civic-ceremonial site core and peripheral settlement groups at Cahal Pech were used address this issue. Stable isotope results from 45 individuals indicate that during the Preclassic and Early Classic Periods, the inhabitants of Cahal Pech had diverse diets incorporating domesticated and locally available wild resources that were likely used as fallback foods during times of environmental stress. By the Late Classic Period, stable isotope data indicate a pattern of hyper-specialized and narrow maize-based diets for elite individuals. In contrast, commoner households consumed an increasingly broad diet during periods of acute drought in the Terminal Classic Period (~AD 750-1000). Demand for maize production from elite consumers likely influenced more intensive farming and hunting locally around the community. We argue that Late and Terminal Classic population expansion and anthropogenic environmental degradation from agricultural intensification, coupled with socially conditioned food preferences, resulted in an unstable system that ultimately contributed in the failure of Cahal Pech in the face of severe drought at the end of the Terminal Classic Period. This chapter is currently under review for publication in *Current Anthropology*.

Chapter 6 summarizes the major findings of this dissertation and places them within a broader methodological and theoretical consideration concerning historical dynamics of the rise and fall of complex economic, social, and political institutions in Maya prehistory.

Chapter 2

REGIONAL RESPONSE TO DROUGHT DURING THE FORMATION AND DECLINE OF PRECLASSIC MAYA SOCIETIES[2]

Abstract

The earliest complex, stratified societies and a distinctive set of pan-regional social, political, and economic institutions appeared in the southern Maya lowlands during the Preclassic Period (ca. 1200 cal BC–cal AD 300). The timing of these cultural changes was variably influenced by local developments, interaction with other regions of Mesoamerica, and climate change. We present a high-resolution radiocarbon chronology for the growth of the early community at Cahal Pech, one of the first permanent settlements in the southern Maya lowlands. We compare our results to a database containing over 1000 radiocarbon dates from cultural contexts reported from five major regions of the southern lowlands to interpret the expansion and decline of complex social groups. Comparisons to paleoclimate proxy datasets suggest that fluctuating climate regimes may have promoted alternating integration and fragmentation of early hierarchically organized societies. Stable climatic conditions during the Middle Preclassic Period (900-300 cal BC) fostered the centralization of populations and the formation of large regional polities across the southern lowlands. An extended drought at the end of the Late Preclassic (cal AD 150-300) likely contributed to the decline of some major polities in the central Petén, but smaller sites were more resilient and persisted in to the Classic Period. This research provides a framework for understanding the complex social and environmental factors that influenced localized adaptations to climate change and the episodic growth and decline of early complex societies in prehistory.

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[2] Authorship: Claire E. Ebert, Nancy Peniche May, Brendan J. Culleton, Jaime J. Awe, and Douglas J. Kennett

Introduction

The questions of when, why, and how hierarchical societies emerged, expanded, and disintegrated, and why some were more resilient than others, have been topics of archaeological research for decades. The development of the earliest complex prehistoric societies was a long-term and dynamic process driven by various cultural and environmental factors. Complex societies, characterized by institutionalized social and economic inequality, developed in the context of population aggregation along with new forms of management and production of subsistence resources, control of labor, and control of economically important goods by leaders. These activities resulted in the formation of multi-level economic, social, and political networks between groups, allowing paramount centers to become central nodes within increasingly interconnected socio-political systems (Cowgill 2012; Earle 1987, 2002; Flannery 1999; Turchin 2003; Willey 1991). The resilience of early complex societies was challenged by endogenous and exogenous factors, frequently resulting in the fragmentation of paramount polities and sometimes the development of completely new social systems (Carneiro 1970; Wright 1994; Steward 1955:51). This type of socio-political cycling has been documented in multiple regions of the world in prehistoric and historic contexts (e.g., Near East, Wright 1994; Wright and Johnson 1975; Europe, Shennan et al. 2013; Mesoamerica, Marcus 1993, Marcus 1998, 2012, Smith 1992; Eastern North America, Anderson 1996; Southwest US, Bocinsky et al. 2016).

Increasing emphasis has been placed on examining the role of coupled socio-natural systems in the historical dynamics related to the emergence and disintegration of past complex societies (de Menocal 2001; Dillehay and Koata 2004; Gavrilets et al. 2010; Kennett and Marwan 2015; Kirch and Zimmer 2010; Rosen and Rivera-Collazo 2012; Turchin 2003). Archaeologists working in the Maya region have drawn from several sources to build models that define cycles of socio-political organizational change during the later Classic and Postclassic periods (~AD 250-1500). Most notably, Marcus (1993, 1998) developed the “dynamic model” based primarily on glyphic texts recording dynastic histories, political alliances, and conflicts between divine kings from several lowland polities (see also Martin and Grube 2008; Schele and Freidel 1990). Under the dynamic model, Classic Period Maya prehistory is characterized by recurring peaks and valleys between cal AD 250 and 900/1000, which correspond to the centralization and decentralization of political systems, as well as to broad-scale regional variability in social integration and political complexity (Marcus 1998). During a prominent peak in the cycle, between cal AD 400 and 700, elite dynasties located at paramount centers (e.g., Tikal, Calakmul, Caracol, Naranjo) were territorially extensive with a multi-tiered settlement hierarchy. The expansion of these sites is coincident with a period of high precipitation recorded in regional paleoclimate records (Douglas et al. 2016; Kennett et al. 2012; Hodell et al. 2005; Medina-Elizalde et al. 2010), which favored stable environmental conditions and fostered agricultural production, population expansion, and aggregation. Valleys in the cycle often correspond with periods of climatic stress. During the Terminal Classic Period, paleoclimate data document numerous severe multi-decadal droughts between cal AD 820 and 1100 that likely influenced several waves of societal collapse, first in the southern lowlands and then in the northern regions of the Yucatán Peninsula (Akers et al. 2016; Curtis et al. 1996; Haug et al. 2003; Hodel et al. 1995, 2005; Hoggarth et al. 2016; Kennett et al. 2012; Medina-Elizalde et al. 2010; Webster et al. 2007).

Significant cycles of social and political development also occurred earlier in the Maya lowlands during the Preclassic Period (1200/1000 cal BC-cal AD 350; Table 2.1). This period represents one of the most critical transitions in Mesoamerican prehistory, when the development of sedentary village life, increased reliance on maize agriculture, and the adoption of ceramic technology first appear. Archaeological research at large lowland centers demonstrates that by the Late Preclassic Period, Maya society had become complex and hierarchically organized, with centralized polities serving as focal points for civic and ritual activity (Chase and Chase 2012:259; Estrada-Belli 2011; Schele and Freidel 1990; Hansen et al. 2002; Inomata et al 2013, 2015; Stanton 2012, 2005). The appearance of monumental architecture, development of long-distance exchange networks, and the beginnings of craft production during this time also signal the formation of an elite class that centralized wealth and power in the region. Paleoclimate research has indicated that the expansion and contraction of Preclassic Maya society was influenced in part by environmental factors. Particular attention has been paid to an extended period of drought at the end of the Late Preclassic (~cal AD 100-300), which has been linked to population decline and abandonment of some major lowlands polities, as well as a hiatus in construction activity in some parts of the southern lowlands (Haug et al. 2003; Dunning et al. 2014; Medina-Elizalde et al. 2016; Webster 2002).

In this paper, we examine the cultural and climatic context for the development of Cahal Pech, an important Preclassic Period regional center located in the Belize River Valley of modern-day Belize (Figure 2.1). Cahal Pech provides a unique case study for understanding the origin and development of prehistoric lowland Maya society because it has a long occupational history beginning first between ~1200-1000 cal BC (Early Preclassic) and ending during the Terminal Classic Period (cal AD 850-900/1000). We developed a high-resolution Bayesian radiocarbon chronology to understand the timing and tempo of development within the Cahal Pech civic-ceremonial site core and for the residential settlement surrounding the center. We then compare Cahal Pech chronology to a large dataset of over 1200 published radiocarbon dated cultural contexts within the Belize Valley and other major regions of the southern Maya lowlands. Bayesian radiocarbon chronological models and summed probability distributions were created for five core regions of the lowlands in order to clarify the timing of localized Preclassic Period social, political, and economic developments in relation to regional paleoclimate records. The results of this study serve to clarify long-term trends in socio-political dynamics at the local and regional levels in the southern Maya lowlands, and help to interpret the role of climate change as one possible mechanism for cultural evolution during the Preclassic Period. Constraining the timing of cultural change in relation to past climate change has implications for understanding long-term global social and environmental developments in both the past and the future.

Table 2.1: Chronological periods for the Maya lowlands.

Period	**Calibrated Date Range**
Colonial	AD 1519–1821
Postclassic	AD 900/1000–1500
Terminal Classic	AD 800–900/1000
Late Classic	AD 600–800
Early Classic	AD 300–600
Late Preclassic	300 BC–AD 300
Middle Preclassic	1000–300 BC
Early Preclassic	1200–1000 BC

Figure 2.1: Locations of major Preclassic Period sites and paleoclimate records mentioned in the text. The regions examined in this paper include 1) the Belize Valley and Vaca Plateau, 2) Northern Belize, 3) the Petén and Southern Belize region, 4) Pasión region, and 5) Honduras. Inset shows the location of Cahal Pech and other major Preclassic Belize Valley sites.

Background

Preclassic Climate Regimes

Archaeological and paleoclimate studies have highlighted variability in human responses to environmental change as a potential factor in the episodic expansion and breakdown of prehistoric and modern societies (An et al. 2005; Axtell et al. 2002; Brenner et al. 2002; Dillehay and Kolata 2004; Douglas et al. 2016; Haug et al. 2003; Hoggarth et al. 2016; Iannone 2014; Kennett et al. 2012; Kennett and Marwan 2015; Ridley et al. 2015; Zhang et al. 2011). In the Maya region, early paleoclimate proxy studies from lake sediment records in the northern Yucatán showed temporal variations in sedimentation rates and evaporation and precipitation records based on oxygen isotopes ($\delta^{18}O$) of ostracods and gastropods, which corresponded to multi-decadal dry episodes from the Preclassic through Postclassic Periods (Curtis et al. 1996; Hodell et al. 1995, 2005; Rosenmeier et al. 2002). These drought events correlate closely with broader climate histories from the Cariaco Basin sediment Ti record, especially at the end of the Classic Period when the most extended and severe droughts likely influenced the Terminal Classic Maya "collapse" (Haug et al. 2003). More recently, high-resolution speleothem records from both the northern and southern lowlands have supported the hypothesis that multi-decadal droughts played a role in several waves of societal collapse between cal AD 850 and 1100 (Akers et al. 2016; Kennett et al. 2012; Medina-Elizalde and Rohling 2012; Webster et al. 2007). The first wave of collapse was focused on the southern lowlands, and resulted in the decentralization of political and economic systems, abandonment and depopulation of large urban centers, and the disappearance of traditions associated with divine rulership (Aimers 2007; Demarest et al. 2004; Ebert et al. 2014; Webster 2002). The second wave of collapse centered on the major northern lowland polity of Chichén Itzá between cal AD 1000 and 1100, which occurred during the most acute drought recorded in the regional paleoclimate records (Hoggarth et al. 2016; Kennett et al. 2012). Written records and paleoclimate evidence from historic datasets similarly demonstrate a close correspondence between socio-political reorganization and climate variability, especially in the context of severe drought that impacted subsistence production and local demographics in the northern lowlands of Yucatán during the Colonial Period (Acuña-Soto et al. 2004; Bricker and Hill 2009; Endfield 2007; García-Acosta et al. 2003; Hoggarth et al. 2017).

While many paleoclimate records from the northern and southern lowlands span the Preclassic Period, less research has been devoted to understanding climate cycles during this time. Two recently published speleothem records from these regions are beginning to clarify the timing of short-term pulses and long-term trends in Preclassic climate regimes (Figure 2.2). The Itzamna speleothem record from Río Secreto, Playa del Carmen in northern Yucatán provides the highest resolution paleoclimate record for the Preclassic Maya lowlands (Medina-Elizalde et al. 2016). The record is dated with six uranium-thorium series measurements and provides estimates for rainfall every 8-10 years. Oxygen isotope ($\delta^{18}O$) measurements (n=2545) of incremental stalagmite growth show pulses in rainfall and drought from approximately 1040 cal BC and cal AD 400. Several droughts, characterized by a reduction in precipitation levels between 35% and 50% relative to average amounts, punctuate the record approximately every century during the Middle Preclassic. A gradual negative shift in average $\delta^{18}O$ values occurs in the Itzamna record around 520 cal BC, marking the beginning of a humid period during the Middle Preclassic, when estimated precipitation levels increased by over 20% across the northern Yucatán (Medina-Elizalde et al. 2016).

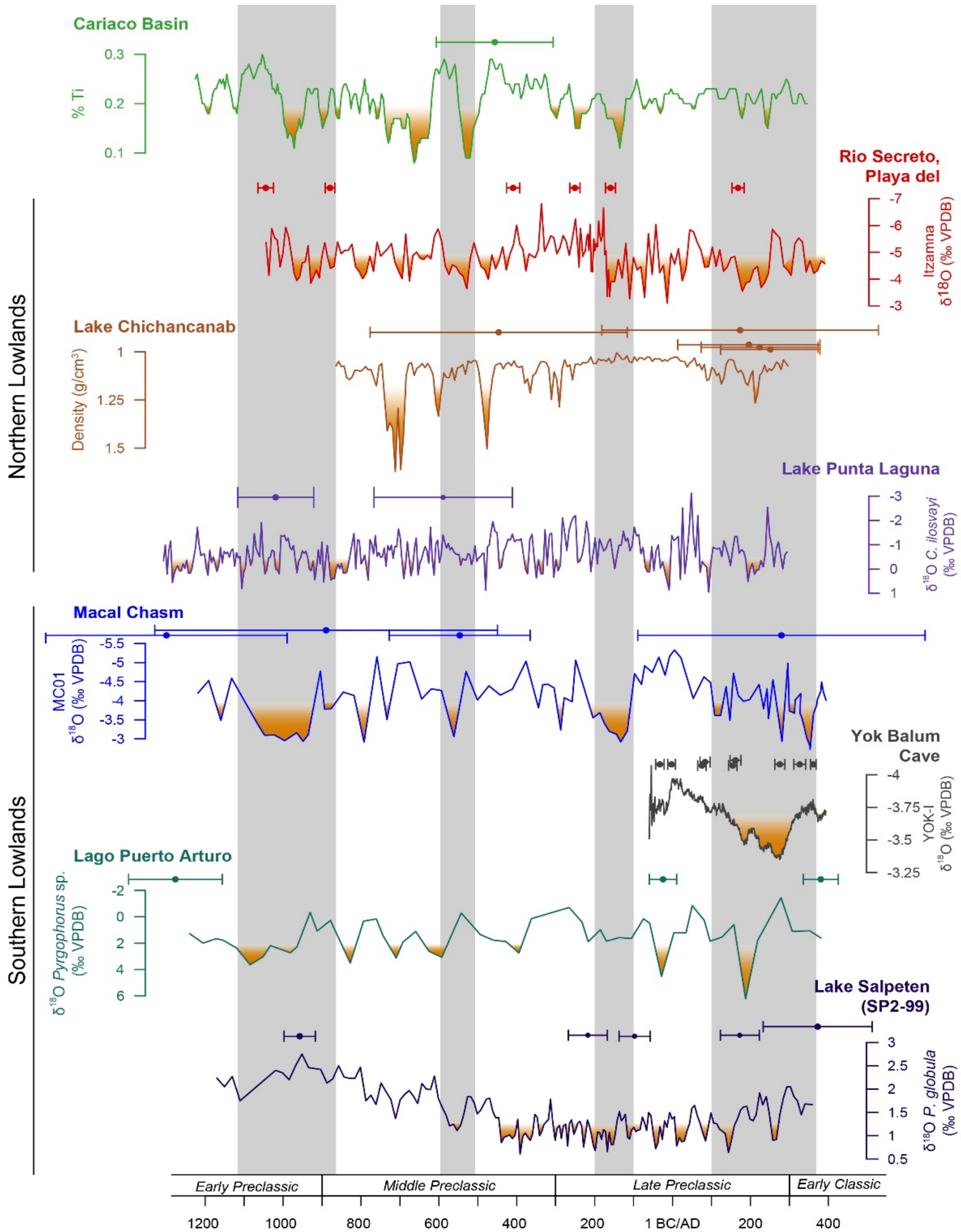

Figure 2.2: Preclassic paleoclimate records from the circum-Caribbean region and the northern and southern Maya lowlands, including: A) Cariaco Basin Ti record (Haug et al. 2003), B) Rio Secreto "Itzamna" $\delta^{18}O$ speleothem record (Medina-Elizalde et al. 2016), C) Lake Chichancanab sediment density (Hodell et al. 2005), D) Lake Punta Laguna ostracod (*Cytheridella ilosvayi*) $\delta^{18}O$ record (Curtis et al. 1996), E) Macal Chasm (MC01) $\delta^{18}O$ speleothem record (Akers et al. 2016), F) Yok Balum Cave (YOK-I) $\delta^{18}O$ speleothem record (Kennett et al. 2012), G) Lago Puerto Arturo gastropod (*Pyrgophorus* sp.) $\delta^{18}O$ record (Wahl et al. 2014), and H) Lake Salpetén gastropod (*P. globula*) $\delta^{18}O$ record (Rosenmeier et al. 2002). Major multi-century dry events from the Macal Chasm speleothem record are highlighted in gray.

This shift to wetter conditions is mirrored in $\delta^{18}O$ values from lake sediment core records from other parts of the northern lowlands (Punta Laguna, Hodell et al., 1995; Curtis et al., 1996; Lake Chichancanab; Hodell et al. 2005), as well as in the central Petén (Lake Salpetén, Douglas et al. 2016, Rosenmeier et al. 2002; Lago Puerto Arturo; Wahl et al. 2013, 2014), indicating that humid conditions were present in the greater Maya lowland region during the end of the Middle Preclassic Period.

The site of Macal Chasm, located 22 km southeast of the Belize Valley in the Vaca Plateau of west-central Belize, has produced the closest paleoclimate proxy record to the site of Cahal Pech. A total of 660 $\delta^{18}O$ and $\delta^{13}C$ measurements were sampled from the MC01 speleothem at a resolution of 15-24 years for the Preclassic section of the record (Akers et al. 2016; Webster et al. 2007). The record is anchored with 21 uranium-thorium dates, with average measurement errors between 250-380 years. The appearance of major dry events begin after 2000 cal BC, and coincide with more intense El Niño phases and a southern shift of the Intertropical Convergence Zone (Akers et al. 2016). While short-term shifts in wet and dry conditions punctuate the record, multi-decadal major dry intervals in the Macal Chasm record are associated with sustained values of $\delta^{18}O$ and $\delta^{13}C$ significantly higher (greater than 1‰ and 3‰, respectively) than bracketing periods. Major dry events are recorded for the periods between 1110-890 cal BC, 590-550 cal BC, 190-110 cal BC, and cal AD 250-330. Many of these same droughts are present in the Itzamna record from the northern Yucatán and other proxy records from the lowlands. Some of these dry events span over two centuries, though they generally consist of shorter-term droughts of varying intensities with brief wet intervals (Akers et al. 2016).

While the timing and magnitude of climatic fluctuations varied across different regions of the Maya lowlands (Aimers and Hodell 2011), the comparison of the Itzamna and Macal Chasm speleothem records with climate proxies from other parts of the Maya area (southern and northern lowlands) show clear and congruent long-term climate trends within the limits of dating errors of individual records. Increasing emphasis has especially been placed on a prolonged period of climatic volatility at the end of the Late Preclassic Period as a catalyst for social and political reorganization in the southern lowlands (Dunning et al. 2014; Haug et al. 2003; Kennett et al. 2012; Medina-Elizalde et al. 2016; Wahl et al. 2014). The onset of dryer climatic conditions during the Late Preclassic is characterized by several droughts over the course of approximately two centuries (~200-1 cal BC), with precipitation reduced by up to 65-75% for this period generally. The most acute droughts in the Preclassic Period occurred after cal AD 160, following a slightly wetter interval between cal AD 1 and 150 (Kennett et al. 2012; Dunning et al. 2014; Medina-Elizalde et al. 2016). In the northern lowlands, the Itzamna speleothem record documents two successive multi-decadal droughts centered at ~cal AD 190 and 230, lasting approximately 31 and 22 years, respectively (Medina-Elizalde et al. 2016). Severe precipitation reduction in the northern lowlands is also recorded by increased levels of gypsum deposition in Lake Chichancanab sediments (Hodell et al. 2005) and by positive shifts in average $\delta^{18}O$ values in the Lake Punta Laguna record between cal AD 125 and 210 (Hodell et al. 1995; Curtis et al. 1996). Similar trends in climatic fluctuations also occurred in the southern lowlands at the end of the Preclassic. The sub-annually resolved YOK-I speleothem record, from Yok Balum Cave in southern Belize, shows two major droughts during the Late Preclassic, the second of which was the most extreme and lasted over a century (cal AD 200-300; Kennett et al. 2012). Lake sediment core records from Lago Puerto Arturo in the Mirador Basin (Wahl et al. 2014) and Lago Salpetén (Douglas et al. 2016) also indicate reduction in precipitation and increased levels of evaporation over several centuries at the end of the Late Preclassic Period. These extreme dry conditions temporally parallel the cessation in the construction of monumental architecture and depopulation of some major centers (e.g., Nakbe and Mirador) in the Petén (Beach et al. 2015; Dunning et al. 2012; Wahl et al. 2007; Webster 2002).

Preclassic Period Archaeological Records

The establishment and expansion of Preclassic Period Maya society occurred in several pulses, each characterized by distinctive economic innovations and socio-political changes, all within the context of fluctuating climatic regimes. Radiocarbon dates from sites located on the southern periphery of the Maya lowlands in Honduras document the presence of small localized hunting and foraging populations in the area between 8000 and 4000 cal BC (e.g., El Gigante Rockshelter; Scheffler et al. 2012). In the central part of the southern lowlands (Guatemala, Belize) Archaic Period occupation is not well defined until ~1500 cal BC, when directly dated deposits containing chipped stone tools, faunal remains, and maize pollen document the presence of preceramic populations in Belize (Clark and Cheetham 2002; Iceland 1997, 2005; Lohse 2010; Rosenswig 2015; Stemp et al. 2016). The transition to sedentary village life first occurred in the Maya lowlands at the end of the Early Preclassic Period (1200/1000 cal BC), when people began to aggregate in small, relatively egalitarian villages within economically autonomous households (Awe 1992; Clark and Cheetham 2002; Estrada-Belli 2011; Inomata et al. 2015; Lohse 2010). Accompanying the transition to sedentism was an increasing commitment to maize agriculture, long-distance interaction with other groups in Mesoamerica, early public architecture programs, and the adoption of ceramic technology (Chase and Chase 2012). Distinctive and diverse pre-Mamon ceramic complexes associated with these early village communities have been documented in four core regions of the southern lowlands: west-central Belize in the Belize Valley (Cunil/Kanocha ceramic complex), Northern Belize (Swasey ceramic complex), central Petén (Eb ceramic complex), and the Pasión area (Real/Xe ceramic complex). Many of these early ceramics bear symbols connecting them with contemporaneous iconographic traditions developing elsewhere in Mesoamerica along the Gulf Coast and Oaxaca (Cheetham 1998; Garber and Awe 2009; Hammond 2006; Inomata et al. 2013; Sullivan and Awe 2013; Valdez 1988). A similar pattern of early settlement, ceramic use, and construction of public architecture by the end of the Early Preclassic and beginning of the Middle Preclassic may also be present in the Yucatan region at the sites of Komchen, Yaxuná, and Xocnaceh. The initial settlement at these sites is represented by the early Nabanche (Ceballos Gallareta and Robles Castellanos 2012) and Ek and ceramic complexes (Ringle 1999; Stanton 2012), though the precise dates both ceramic complexes remain debated.

During the Middle Preclassic Period, population expansion and economic growth across the southern lowlands were accompanied by the adoption of a more standardized Mamon ceramic tradition (monochrome, red-slipped; Willey et al. 1967) and intensified construction programs of public architecture (Doyle 2017; Estrada-Belli 2011; Hansen 1998; Inomata et al. 2013). Taken together, these signal the centralization of economic power and the emergence of higher status individuals within local communities (Chase and Chase 2012; Clark and Hansen 2001; Hansen et al. 2002; Inomata et al. 2013). Higher-status individuals often lived in larger households, and placed burials beneath house floors to promote continuity of settlement at the site and reinforce ties to land and access to resources (McAnany 1995). Lowland Maya society experienced a fluorescence during the end of the Middle Preclassic and into the Late Preclassic

Period, when large civic-ceremonial centers and archaeological evidence for institutionalized elite rulership first appear (Awe et al. 2009; Demarest 2004; Estrada-Belli 2011:44-48; Freidel and Schele 1988; Hammond 1980:189; Hansen 2005). These cultural changes were relatively abrupt, and are best represented at the sites of Mirador and Nakbe, where an elite ruling class was able to mobilize labor for massive construction projects and tap into long-distance exchange networks to acquire exotic prestige items to reinforce their authority (Hansen 1998, 2001; Hansen and Guenter 2005). At Nakbe, monumental architecture including ball courts, an E-Group architectural assemblage, and monumental stucco masks on public buildings first appeared around 600 cal BC (Hansen 1992, 1998). After 400 cal BC, the site of Mirador emerged as the largest and most complex Preclassic polity (i.e., independent political entity) in the Maya lowlands, extending over 3 km^2 with several massive temple complexes. Accompanying the fluorescence of the El Mirador Basin sites is evidence for kingship represented by elite Maya tombs placed within public architectural complexes and contained a wealth of local and exotic grave goods (Estrada-Belli 2011). Beginning around 300 cal BC, the appearance of hieroglyphic texts carved stone monuments with the “ajaw” (i.e., divine king) glyph demonstrate the existence of rulership at this site and likely elsewhere in the region (Saturno et al. 2006). These texts also linked Maya rulers with the cosmos to bolster their political competitiveness (Chase and Chase 2012).

Settlement data document the abandonment of the large polities of Mirador and Nakbe, as well as other sites in the Petén, between AD 150 and 250 at the end of the Late Preclassic Period (Beach et al. 2015; Dunning et al. 2012, 2016; Hansen et al. 2008; Webster 2002). Several studies have suggested that these paramount centers were depopulated in the face of deteriorating climatic conditions during what has been referred to as a “mega-drought” (Akers et al. 2016;

Haug et al. 2003; Hodell et al. 2005; Kennett et al. 2012; Medina-Elizalde et al. 2016). Responses to severe drought, however, appear variable across the southern lowlands. Persistence in site occupation, with populations contracting around centralized locations that later developed into large Classic Period polities, has been documented in Northern Belize (Rosenswig and Kennett 2008). Some Belize Valley sites show shifts in monumental traditions, including a decline in the construction of eastern triadic groups (e.g., Cahal Pech, Awe 2008; Awe and Helmke 2005; Ebert et al. 2016a), and in some cases reorganization of the monumental site centers (e.g., Tikal, Martin 2003; Schele and Freidel 1990). Glyphic texts on carved stone monuments that placed emphasis on dynastic rulership appeared at the end of the Late Preclassic, representing a new form of political competitiveness between polities (Chase and Chase 2012).

The Belize Valley Preclassic and Cahal Pech

The site of Cahal Pech is located in the Belize Valley of the west-central portion of the modern country of Belize. Fragments of eight plain stelae and four altars within the monumental epicenter and lavish royal burials within large monumental architecture indicate a civic-ceremonial function for the site during the Classic Period. A program of stratigraphic excavations conducted in the ceremonial center within Plaza B and at Structure (Str.) B4, on the south side of the plaza, by the Belize Valley Archaeological Reconnaissance (BVAR) project was aimed at understanding the foundation and early growth of Cahal Pech into a major civic-ceremonial center during the Preclassic Period (Figure 2.3; Awe 1992; Awe and Helmke 2005; Healy et al. 2004a; Horn 2015; Peniche May 2014, 2016). Str. B4 is a 5.5m high temple located at the southeastern corner of Plaza B, and has produced the longest dated construction sequence at Cahal Pech (Figure 2.4). A series of excavations conducted from 1988 through 2012 documented at least 13 discrete construction episodes (Awe 1992; Healy and Awe 1995; Healy et al. 2004; Ishihara-Brito and Awe 2013). The uppermost strata of the building are composed of Classic Period materials and contain intrusive Terminal Classic Period burials (Awe 1992). Materials located below Floor 3 (Str. B4/10th) are associated with Early through Late Preclassic Period occupation. Plaza B is the largest open courtyard in the Cahal Pech civic ceremonial core, measuring approximately 50 x 60m (Figure 2.5). Large scale horizontal exposures and test pits (Awe 1992; Healy et al. 2004; Horn 2015; Peniche-May 2016) have identified contexts representing the earliest village settlement and the earliest ceramics in the Belize Valley during the Cunil ceramic phase (~1200-900 cal BC) within Plaza B and Str. B4. Archaeological evidence and direct dates also document the founding of Early Preclassic Period settlements by at least 1000 cal BC at nearby Belize Valley sites of Blackman Eddy (Garber et al. 2004), Xunantunich (Brown et al. 2013), and Actuncan (LeCount et al. 2002). Initial occupation at these sites is associated with the appearance of the Cunil/Kanocha ceramic materials that are usually found at the bottom of deeply stratified Classic Period sequences.

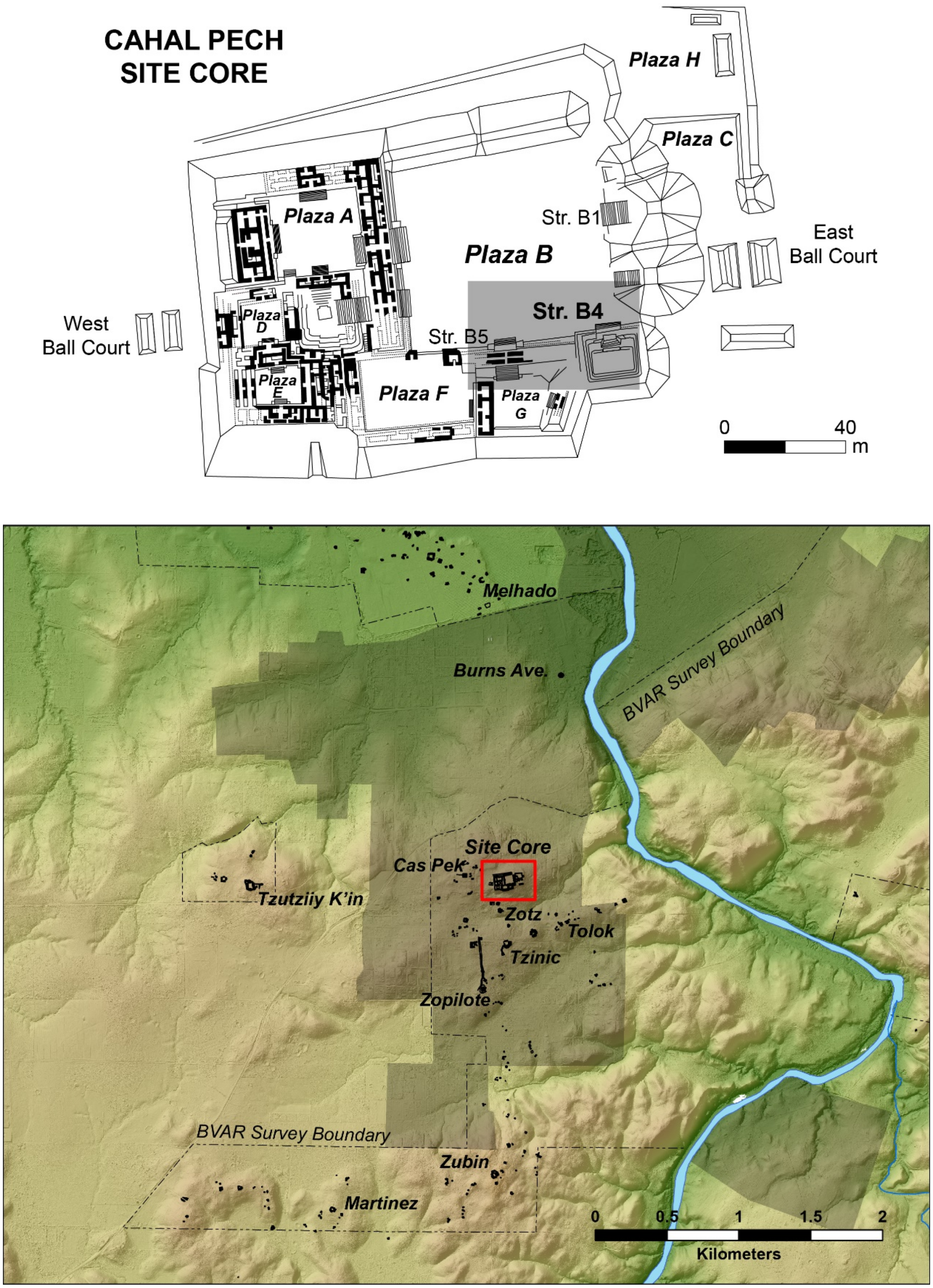

Figure 2.3: Map of the Cahal Pech site core with approximate locations of excavations in Plaza B and Structure B4 shaded in gray. The lower map shows the location of the site core in relation to outlying settlement with the extent of the modern town of San Ignacio shaded.

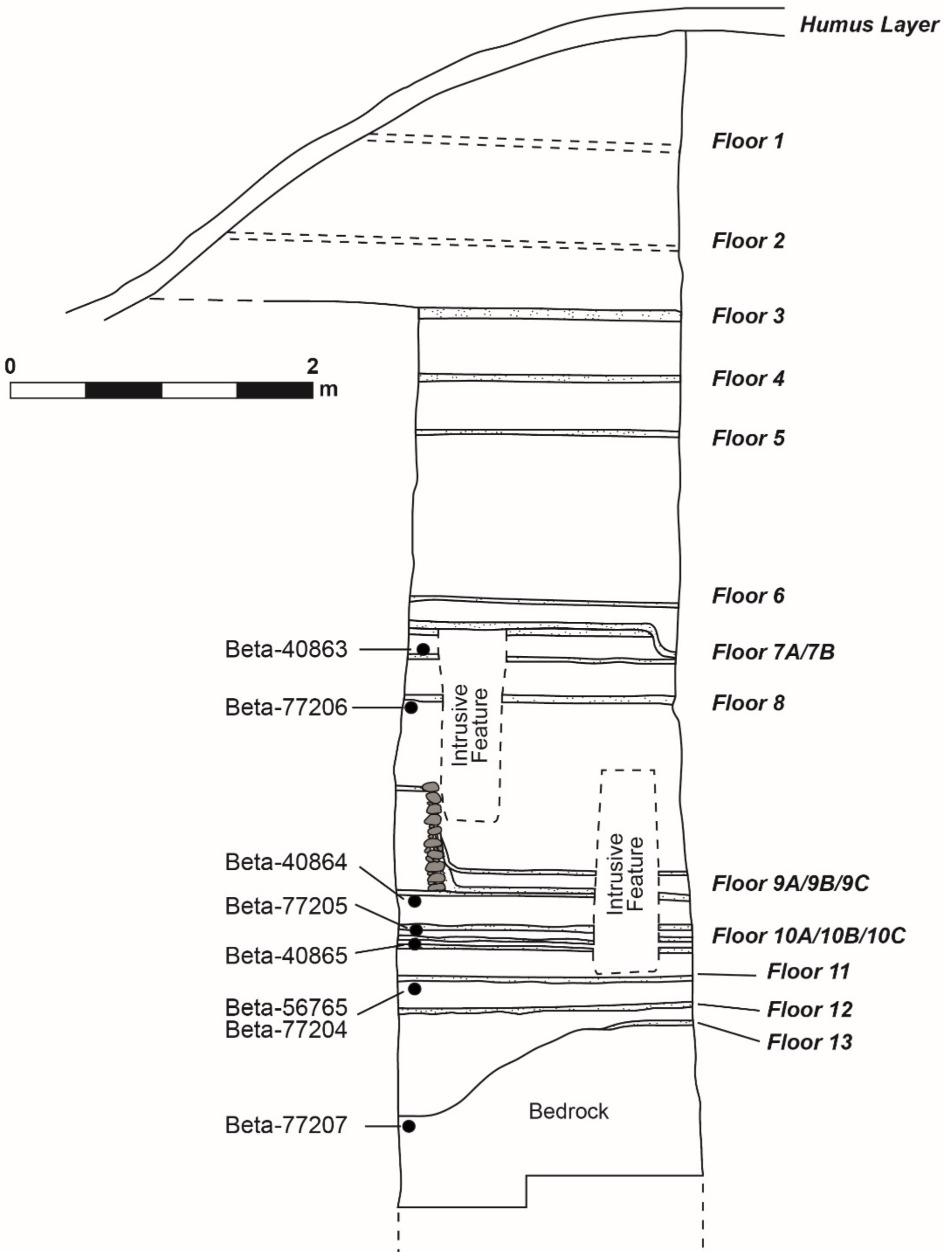

Figure 2.4: Profile of Structure B4 Unit 5, showing locations of ^{14}C samples reported by Awe (1992) and Awe and Healy (1995) in relation to construction phases (drawing after Sullivan and Awe 2013).

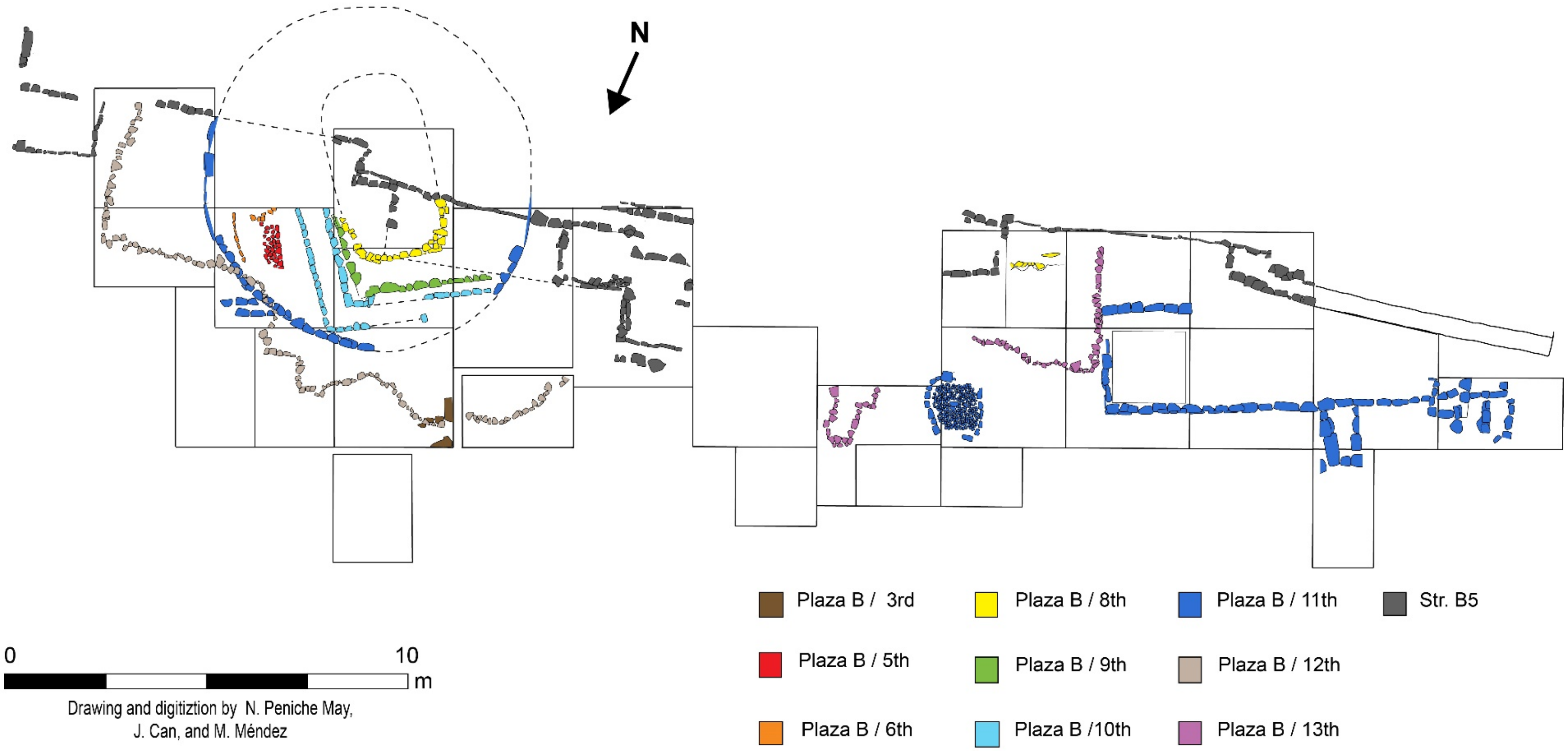

Figure 2.5: Plan map of Plaza B with Preclassic construction phases discussed in text (after Peniche May 2016).

At the beginning of the Middle Preclassic (Early Facet Kanluk; 900-650 BC) architecture within the Cahal Pech site center increased in size to include large raised platforms constructed from high-quality cut limestone (Awe 1992; Healy et al. 2004; Horn 2015). During this time the inhabitants of Blackman Eddy also constructed plastered platforms that may have been used for public functions, including communal feasting (Brown 2003; Brown and Garber 2005, 2008; Garber et al. 2004). At Xunantunich, a large pyramidal structure was constructed in Group E, and evidence exists for the differential distribution of specialized craft production at several locations around the site (Brown et al. 2013, 2016). The clearest evidence for institutionalized social differentiation appears in the Late Preclassic Period (350 cal BC-cal AD 350) at Cahal Pech, when the presence of monumental architecture and the first elaborate burials indicate it was the seat of power for a regional center (Awe 2013; Awe and Zender 2016; Awe et al. 2009; Healy et al. 2004a; Novotny 2015). A carved monument discovered in a tomb in the southern perimeter of the site core is stylistically dated to the early facet of the Late Preclassic period, representing the earliest stelae reported in Belize, also suggests the development of more complex socio-political relationships (Awe et al. 2009). Other large, formally organized civic centers were also established during the Late Preclassic throughout the Belize Valley including Blackman Eddy, and Xunantunich Group E, Pacbitun, Actuncan, and Barton Ramie (Awe 1992; Brown et al. 2013; Garber et al. 2004; Healy et al. 2004b; Willey et al. 1965).

While much of the earliest architecture in the Cahal Pech epicenter is buried beneath later monumental Classic Period construction, Middle and Late Preclassic Period household groups surrounding the site center are more accessible for excavation and analysis. Both elite and non-elite residential settlements dating to the Middle and Late Preclassic have been documented to the east and south of the site core. Radiocarbon dates and associated ceramic materials from several of the larger house groups indicate that at least six residential settlements (Cas Pek, Tolok, Tzutziiy K'in, Zinic, Zopilote, and Zubin) were established by the end of the Middle Preclassic and occupied through the Classic Period (Awe 1992; Ebert et al. 2016a; Healy and Awe 1995; Iannone 1996; Powis 1996). More recent pedestrian survey has documented Late Middle Preclassic residential settlements to the north and west of Cahal Pech (Ebert et al. 2016; see also Willey and Bullard 1956).

Materials and Methods

Radiocarbon Dating

Samples for AMS ^{14}C dating at Cahal Pech were recovered from stratified contexts during excavations within the site core and from six residential settlements. Samples were collected *in situ* from isolated features, construction fill, and in association with plaster floors and other architectural features. When possible, carbonized short-lived twig samples were selected for dating to reduce erroneous age assignments from the "old wood effect" (Schiffer 1986; Kennett et al. 2002). We also selected four samples of faunal remains for direct dating from the upper levels of Plaza B to avoid problems of old charcoal and to reduce the impact of modern taphonomic disturbance on the radiocarbon measurements. All charcoal and bone samples were prepared along with standards and backgrounds at the Pennsylvania State University Human Paleoecology & Isotope Geochemistry Lab and the University of California-Irvine Keck Carbon Cycle AMS Facility (UCI KCCAMS). Charcoal samples were prepared following standard practices described by Kennett and colleagues (2014). Bone collagen for radiocarbon analyses was extracted and purified using XAD purification to remove all humic and fulvic acids bound to the collagen (Stafford et al. 1988, 1991; Lohse et al. 2014). All dates in

Table 2.2 and Table 2.3 are reported as conventional ^{14}C ages corrected for fractionation, with measured $\delta^{13}C$ following Stuiver and Polach (1977). Date calibrations and stratigraphic models were produced in OxCal v.4.2 (Bronk Ramsey 2009) using the IntCal13 Northern Hemisphere atmospheric curve (Reimer et al. 2013). Calibrated and modeled date ranges are reported at the 2-σ level.

Bayesian Modeling

We developed Bayesian stratigraphic models within OxCal to understand the Preclassic Period occupational history of Cahal Pech, and other contemporaneous Preclassic Period sites in the Maya lowlands (Appendix B). Traditional statistical analysis of radiocarbon dates from archaeological contexts has relied on probability distributions to determine the likelihood that two dated events were sequential or contemporaneous. The Bayesian approach, on the other hand, incorporates *a priori* contextual and stratigraphic information obtained in the field to model sequences of dates and constrain probability distributions (Bayliss and Bronk Ramsey 2004; Bronk Ramsey 2015; Culleton et al. 2012; Higham et al. 2014; Kennett et al. 2014).

Radiocarbon dates from stratified contexts at Cahal Pech were modeled within ordered sequences to estimate the age of events that are not directly dated (e.g., initial clearing of bedrock, placement of plaster floors) to represent discrete construction phases. Strata that separate directly dated deposits were modeled as single *Boundaries* in OxCal. Additional *Boundaries* were placed at the beginning of each sequence to represent the beginning of activity and the end of each sequence to provide an approximate time range for the termination of use of the structure or of site occupation. OxCal modeled sequences and results are presented in Appendix B.

Table 2.2: Radiocarbon dates for Structure B4 and Plaza B South Excavations in the Cahal Pech monumental site core.

Sequence	Lab #	Provenience	Material	Conventional ^{14}C age (BP)	Unmolded 2σ cal range (BC/AD)	Associated Ceramics	Reference
Structure B4							
	UCIAMS-115021	EU10, L4. Above Fl. 4	Charcoal	2225 ± 15	375-205 BC	EF/LF Xakal	
	UCIAMS-115022	EU10 L6. Surface Fl. 6A	Charcoal	2705 ± 15	900-815 BC	EF Xakal	
	Beta-40863[a]	EU5, Fl. 7	Charcoal	2470 ± 90	795-400 BC	LF Kanluk	Awe 1992
	UCIAMS-115023	EU10, L7. Surface Fl. 7	Charcoal	2585 ± 15	805-775 BC	EF Kanluk	
	UCIAMS-115024	EU10, L8. Surface of Fl. 8	Charcoal	2735 ± 20	920-825 BC	EF Kanluk	
	UCIAMS-111159	EU10, L8. In Fl. 8	Charcoal	2505 ± 15	775-545 BC	EF Kanluk	
	Beta-77206[a,b]	EU5, Fl. 8	Charcoal	1950 ± 200	405 BC-AD 540	EF Kanluk	Healy & Awe 1995
	Beta-40864[a]	EU5, Fl. 9	Charcoal	2720 ± 60	1000-795 BC	EF Kanluk	Awe 1992
	UCIAMS-111160	EU10, L10. Fl. 10	Charcoal	2220 ± 15	365-205 BC	Cunil	
	Beta-40865[a]	EU5, Fl. 10C	Charcoal	2740 ± 70	1055-795 BC	Cunil	Awe 1992
	Beta-77205	EU5, Fl. 10A	Charcoal	2800 ± 50	1110-830 BC	Cunil	Healy & Awe 1995
	Beta-77204[a]	EU5, Fl. 11	Charcoal	2710 ± 120	1215-540 BC	Cunil	Healy & Awe 1995
	Beta-56765[a]	EU5, Fl. 11	Charcoal	2730 ± 140	1285-510 BC	Cunil	Awe 1992
	UCIAMS-111158	EU8, L12/13. Fl. 13	Charcoal	2830 ± 15	1030-920 BC	Cunil	
	UCIAMS-111162	EU10, L21. Fl. 13	Charcoal	2845 ± 20	1075-920 BC	Cunil	
	UCIAMS-111161	EU10, L14. Southern posthole	Charcoal	2435 ± 20	745-405 BC	Cunil	
	Beta-77207	EU5, Below Fl. 13, on bedrock	Charcoal	2930 ± 50	1280-980 BC	Cunil	Healy & Awe 1995
Plaza B South Excavations							
	UCIAMS-169810	Lot PL-B-224, Below Fl. 4	Charcoal	180 ± 15	AD 1665-1950	LF Xakal	
	UCIAMS-169811	Lot PL-B-263, Below Fl. 5	Charcoal	205 ± 20	AD 1650-1950	EF/LF Xakal	
	UCIAMS-169812	Lot PL-B-228, Below Fl. 6	Charcoal	155 ± 15	AD 1665-1945	EF/LF Xakal	
	UCIAMS-169813	Lot PL-B-24, Below Fl. 8	Charcoal	2035 ± 15	95 BC-AD 20	EF/LF Xakal	
	UCIAMS-172404	Plaza B/12th, Lot PL-B-146, Below Fl. 10	Faunal Bone	2500 ± 20	775-540 BC	LF Kanluk	
	UCIAMS-172405	Plaza B/10th, Lot PL-B-193, Between Feat. 21 & 26	Faunal Bone	2530 ± 20	795-550 BC	LF Kanluk	
	UCIAMS-174957	Plaza B/9th, Lot PL-B-180, Below Fl. 13	Faunal Bone	2545 ± 20	800-560 BC	LF Kanluk	

Sequence	Lab #	Provenience	Material	Conventional ^{14}C age (BP)	Unmolded 2σ cal range (BC/AD)	Associated Ceramics	Reference
	UCIAMS-169814	Plaza B/8th, Lot PL-B-176, Feat. 19	Charcoal	2525 ± 15	790-550 BC	EF Kanluk	
	UCIAMS-169815	Plaza B/5th, Lot PL-B-167, Below Fl. 16	Charcoal	2760 ± 20	975-835 BC	EF Kanluk	
	UCIAMS-172403	Plaza B/4th, Lot PL-B-168, Below Fl. 17	Faunal Bone	2835 ± 20	1050-925 BC	Cunil	
	UCIAMS-169816	Plaza B/4th, Lot PL-B-169, Below Fl. 17	Charcoal	2820 ± 15	1015-920 BC	Cunil	
	UCIAMS-169817	Plaza B/3rd, Lot PL-B-184, Fill/*Sascab*	Charcoal	2800 ± 20	1010-900 BC	Cunil	
Other Site Core Radiocarbon Dates							
	AA103355	Structure B1, Burial 7a	Human Tooth	1432 ± 46	AD 545-665	Hermitage	Novotny 2015
	AA103356	Structure B1, Burial 7b	Human Tooth	1516 ± 39	AD 425-620	Hermitage	Novotny 2015
	AA103357	Structure B1, Burial 7c	Human Tooth	1748 ± 47	AD 140-395	Hermitage	Novotny 2015

[a] Denotes radiometric measurement.
[b] Denotes date found unacceptable for context by original authors.

Table 2.3: Radiocarbon dates for Cahal Pech residential settlements. All samples are charcoal except for X-27038, which dated a human tooth from the Zubin Group (Novotny 2015).

Settlement Group	Lab #	Provenience	Conventional ^{14}C age (BP)	Unmolded 2σ cal range (BC/AD)	Associated Ceramics	Reference
Burns Ave.	UCIAMS-169809	S. Trench 1, Unit 1 Lvl. 4	2020 ± 15	BC 55-24 AD	EF/LF Xakal	
Cas Pek	Beta-77202 [a]	Str. D1, Floor 7	2020 ± 140	BC 390 - AD 320	LF Xakal	Healy & Awe 1995
	Beta-77203[a]	Str. C, Lvl. 11	2230 ± 50	BC 400-185	LF Kanluk	Healy & Awe 1995
Martinez Group	UCIAMS-164867	Str. 2, Below Fl. 2	1345 ± 20	AD 645-760	Tiger Run	
	UCIAMS-164868	Str. 2, Below Fl. 3	1505 ± 20	AD 435-615	Hermitage	
	UCIAMS-164866	Str. 3, Below Fl. 1	1425 ± 15	AD 605-655	Tiger Run	
	UCIAMS-150915	Str. 3, Below Fl. 2	1490 ± 20	AD 540-625	Hermitage	Ebert et al. 2016
Tolok	Beta-77201	Round Structure, fill	2370 ± 60	BC 760-260	LF Kanluk	Healy & Awe 1995
	Beta-77199[a]	Str. 1, on bedrock	2220 ± 100	BC 540 - AD 5	LF Kanluk	Healy & Awe 1995
	Beta-77220[b]	Str. 14, Lvl 6	6680 ± 60	BC 5710-5505	LF Kanluk	Healy & Awe 1995
Tzutziiy K'in	UCIAMS-121550	Str. 1-5th, final bench const.	1225 ± 15	AD 710-880	Spanish Lookout	Ebert et al. 2016
	UCIAMS-121549	Str. 1-5th, on plaza floor	1245 ± 20	AD 680-865	Spanish Lookout	Ebert et al. 2016
	UCIAMS-123531	Str. 1-4th, fill	1545 ± 15	AD 425-565	Hermitage	Ebert et al. 2016
	UCIAMS-121551	Str. 1-3rd, fill	1595 ± 15	AD 410-540	Hermitage	Ebert et al. 2016
	UCIAMS-123530	Str. 1-2nd, fill	1770 ± 15	AD 225-335	LF Xakal	Ebert et al. 2016
	UCIAMS-123532	Str. 2, Terminal const., fill	1255 ± 15	AD 685-775	Spanish Lookout	Ebert et al. 2016
	UCIAMS-121554	Str. 2, Fl. 3, surface	1365 ± 15	AD 645-675	Tiger Run	Ebert et al. 2016
	UCIAMS-121553	Str. 2, Feature 1, fill	1555 ± 15	AD 425-550	Hermitage	Ebert et al. 2016
	UCIAMS-164869	Str. 2, Below Fl. 6	1880 ± 15	AD 70-210	LF Xakal	
	UCIAMS-164870	Str. 2, Below Fl. 7, paleosol	1865 ± 15	AD 80-215	LF Xakal	
	UCIAMS-164871	Str. 2, Below Fl. 7, paleosol	1890 ± 15	AD 65-205	LF Xakal	
	UCIAMS-164872	Str. 3, Below Fl. 5	1920 ± 15	AD 50-130	LF Xakal	
	UCIAMS-121552	Str. 3, Below Fl. 7, paleosol	2150 ± 20	BC 355-110	EF Xakal	Ebert et al. 2016
Zopilote	UCIAMS-169818	Str. 1, Tomb 1 Burial, inside Vessel 10	1320 ± 15	AD 655-765	Hermitage/ Tiger Run	
	UCIAMS-164876	Str. 1, Fill below Fl. 8	1765 ± 15	AD 230-335	LF Xakal	

Settlement Group	Lab #	Provenience	Conventional ^{14}C age (BP)	Unmolded 2σ cal range (BC/AD)	Associated Ceramics	Reference
Zopilote	UCIAMS-164877	Str. 1, Fill below Fl. 8	1780 ± 15	AD 170-330	LF Xakal	
	UCIAMS-164874	Str. 1, Fill below Fl. 7	2070 ± 15	BC 165-40	EF Xakal	
	UCIAMS-164875	Str. 1, Fill below FL. 7	2070 ± 15	BC 165-40	EF Xakal	
	UCIAMS-164878	Str. 1, Surface Fl. 5	2085 ± 20	BC 170-45	EF Xakal	
	UCIAMS-164873	Str. 1, Surface Fl. 1A	2175 ± 15	BC 355-175	EF Xakal	
Zubin Group	X-27038	Str. A1, Burial 3	1336 ± 46	AD 620-575	Spanish Lookout	Novotny 2015

[a] Denotes radiometric measurement.
[b] Denotes date found unacceptable for context by original investigators.

Dates from Str. B4 were modeled within a single sequence because of the clear stratigraphy present in this building. Units 4 through 5 were excavated from the center part of the summit of Str. B4 during the 1991 BVAR field season, and charcoal samples for radiocarbon dating were collected from Unit 5 (Awe 1992). Units 10 and 11 were later excavated in 2012 to recover additional material for direct dating. These units were extended northward into Plaza B to form a trench (Units 12, 13, and 14) in order to expose a larger stratigraphic section for the structure (Ishihara-Brito and Awe 2013). A total of 13 construction phases have been documented for the structure, with the upper strata (Floors 1 and 2, associated with construction phases Str. B4/13th and Str. B4/12th, respectively) associated with Late to Terminal Classic Period materials. Four dates were not included in the modeled sequence because they were determined to be either too early (UCIAMS-115022, UCIAMS-111159) or too late (UCIAMS-111160, UCIAMS-111161) for the contexts from which they were recovered. Several of these outlier dates may be the result of a wooden post burned *in situ* sometime during the Preclassic, which distributed charcoal throughout the sequence and resulted in several reversals in the sequence.

Excavations in the southern portion of Plaza B along the north walls of Strs. B4 and B5 revealed construction phases spanning the Preclassic through Terminal Classic periods (Peniche May 2016). The final three phases of construction (Floors 1 through 3) have been dated to the Classic Period based on ceramic associations. A total of nine AMS radiocarbon dates were modeled in a sequence based on their stratigraphic context to understand the Early through Late Preclassic periods located in the strata below Floor 4. Three dates from contexts between Floors 4 through Floors 6 believed to be Late Preclassic (UCIAMS-169810, UCIAMS-169811, and

UCIAMS-169812) returned historic dates likely due to taphonomic disturbance, and were not modeled because they are too recent for their context.

A total of 30 radiocarbon dates were derived from six residential settlements within the Cahal Pech hinterland to document the settlement and growth of house groups around the site core. Sequences were modeled in OxCal for the entire Preclassic to Classic Period occupation of each structure within a residential group that had two or more radiocarbon dates. Models for the Tzutziiy K'in Group were modified after Ebert and colleagues (2016a), with the addition of four dates from buildings across the residential group. Seven dates were modeled for Str. 1 at the Zopilote group, and four dates were modeled for Strs. 2 and 3 at the Martinez Group.

Radiocarbon dates from other known Preclassic Period sites in the southern lowlands were also collected from the published literature to compare their developmental trajectories with that of Cahal Pech. Dates come from five core regions in the southern Maya lowlands: (1) the Belize Valley and Vaca Plateau, (2) Northern Belize, (3) the Pasión region, (3) the Petén and Southern Belize, and (5) Honduras. Appendix C reports over 1000 radiocarbon dates organized by region and by site. Associated information was recorded for each date, including the site name and core region, contextual information (specific stratigraphic and spatial relationships), type of material dated (e.g., charcoal, human remains, faunal remains), laboratory sample number, conventional ^{14}C date and error ranges, 2-σ calibrated distributions, whether the sample was dated via Accelerated Mass Spectrometer (AMS) or conventional ^{14}C dating (if reported), and the reference publication. All identified dates are included in this compilation, but a smaller set of dates were used to constrain the Preclassic chronology for each site. Dates were subjected to chronometric hygiene criteria established by Hoggarth and colleagues (2016:31) to eliminate questionable dates and constrain modeled distributions. We applied Bayesian statistics to sets of dates for each site where applicable to produce modeled sequences in OxCal. Descriptions of chronometric hygiene results and Bayesian radiocarbon models are reported in Appendix B by region and site. Some dates fall after the Preclassic Period (conventional ^{14}C yr younger than 1700 BP), and therefore were not considered in our modeled sequences unless they could be tied to an earlier Preclassic Period sequence for a given site. We list Classic through Postclassic Period dates falling after 1700 BP, however, for use in future studies.

Summed Probability Distributions

Cumulative probability distributions of calibrated radiocarbon dates ("summed distributions") have been applied to radiocarbon datasets as a proxy for human activity and to understand culture change worldwide. Summed distributions have most frequently been used to identify local and regional population trends in North America (e.g., Buchanan et al. 2008; Kelly et al. 2013), Europe (Armit et al. 2013; Collard et al. 2010; García-Puchol et al. 2017; Gkiasta et al. 2003; Hinz et al. 2012; Shennan et al. 2013; van Andel et al. 2003), Mesoamerica (Hoggarth et al. 2016), South America (Goldberg et al. 2016), China (Wang et al. 2014), and Australia (Holdaway et al. 2009). The application of summed probability distributions for the reconstruction population histories, however, has met with criticisms since it is often difficult to determine whether the abundance of radiocarbon dates is necessarily proportional to population size and the intensity of occupation (Attenbrow and Hiscock 2015; Contreras and Meadows 2014; Culleton 2008; Kennett et al. 2008). Hoggarth and colleagues (2016; see also Kennett et al. 2014) have argued instead that summed probability distributions of radiocarbon dates from specific contexts, in conjunction with other types of archaeological data, can be used as a heuristic tool to identify important negative and positive trends (i.e., "tipping points") of cultural activity at a particular site or within a region. We selected dates from specific contexts, primarily construction episodes, when possible based on the assumption that dates within a summed probability distribution represent discrete events (Williams 2012). For Cahal Pech, we argue that the summed probability distributions, considered alongside architectural, ceramic, and paleoclimate proxy data yields an approximation of the initiation and cessation of construction activity that correspond to social and political trends occurring throughout the site during the Preclassic Period.

Calibrated radiocarbon dates and summed probability distributions can also be impacted by the radiocarbon curve (Bamforth and Grund 2012; Culleton 2008), small sample size and data density, and measurement precision (Contreras and Meadows 2014; Hinz et al. 2012; Williams 2012), which can potentially introduce biases into interpretation. Maya Preclassic Period dates fall on several steep slopes and plateaus (less steep) in the radiocarbon curve that have reverse affects upon the form of summed probability distributions. While dates intersecting steeper parts of the curve tend to be over-represented, resulting in peaks in the summed probability distributions, plateaus cause calibrated date ranges to be underrepresented within larger datasets (Higham 2007; Michczynski and Michczynska 2006; Weninger et al. 2011). In particular, the Period between 700 and 400 cal BC (2500-2400 yr BP), often referred to as the "Hallstatt Plateau" in Old World archaeology (Hajdas 2008), produces large calibrated date ranges up to 500 calendar years regardless of measurement precision. The effect of this plateau on radiocarbon chronologies has been of concern to European and Near Eastern archaeologists (e.g., Cook et al. 2010; Hamilton et al. 2015), but remains relatively unexplored in the Maya region despite its significant impact on our understanding of directly dated Middle Preclassic Period events.

We examined biases introduced by plateaus in the calibration curve on the summed probability distribution of radiocarbon dates from Cahal Pech in two ways. First, calibrated distributions were plotted against a histogram showing the number of calibrated 2-σ ^{14}C dates binned in 100-year intervals. These data show general positive and negative trends in the summed distributions with attached confidence intervals. Second, we performed a sensitivity test and simulated radiocarbon ages from 1300 cal BC and cal AD 300 (3000-1600 cal BP) in OxCal. The *R Simulate* command was used to specify a calibrated age and a measurement error, which translates the age through the calibration curve to generate a conventional radiocarbon age (yr BP), and then calibrates the simulated conventional age. We developed three separate models to simulate dates at multiple precision levels (±20, 50, and 100 ^{14}C yr). A total of 10 dates were simulated for every 50 calibrated years (total *n*=240) for each model. Comparing the three simulated models, fluctuations in the calibration impose some structure on a random sample of conventional ages through the modeled period (Figure 2.6). Conventional ages between ~750 and 400 cal BC (2500-2400 BP), during the Hallstatt Plateau, are less common while dates on either side are more common. Other steep sections of the curve at approximately 1000 cal BC (~2900 BP), 250-150 cal BC (2200 to 2100 BP), cal AD 200 (1750 BP) also produce spikes in the simulated summed probability curves, resulting in dates becoming more common is the distribution. The span between 150 cal BC and cal AD 50 (2100 and 1900 BP) is characterized by high variability in the calibration curve, which is reflected in the simulated probability distributions, as well. Measurement errors of conventional ages also affect the structure of simulated probability densities. As the error range increases, the intensity of peaks and troughs in the summed probabilities diminishes. This suggests that more precise measurements are necessary to identify a single event within the radiocarbon chronologies.

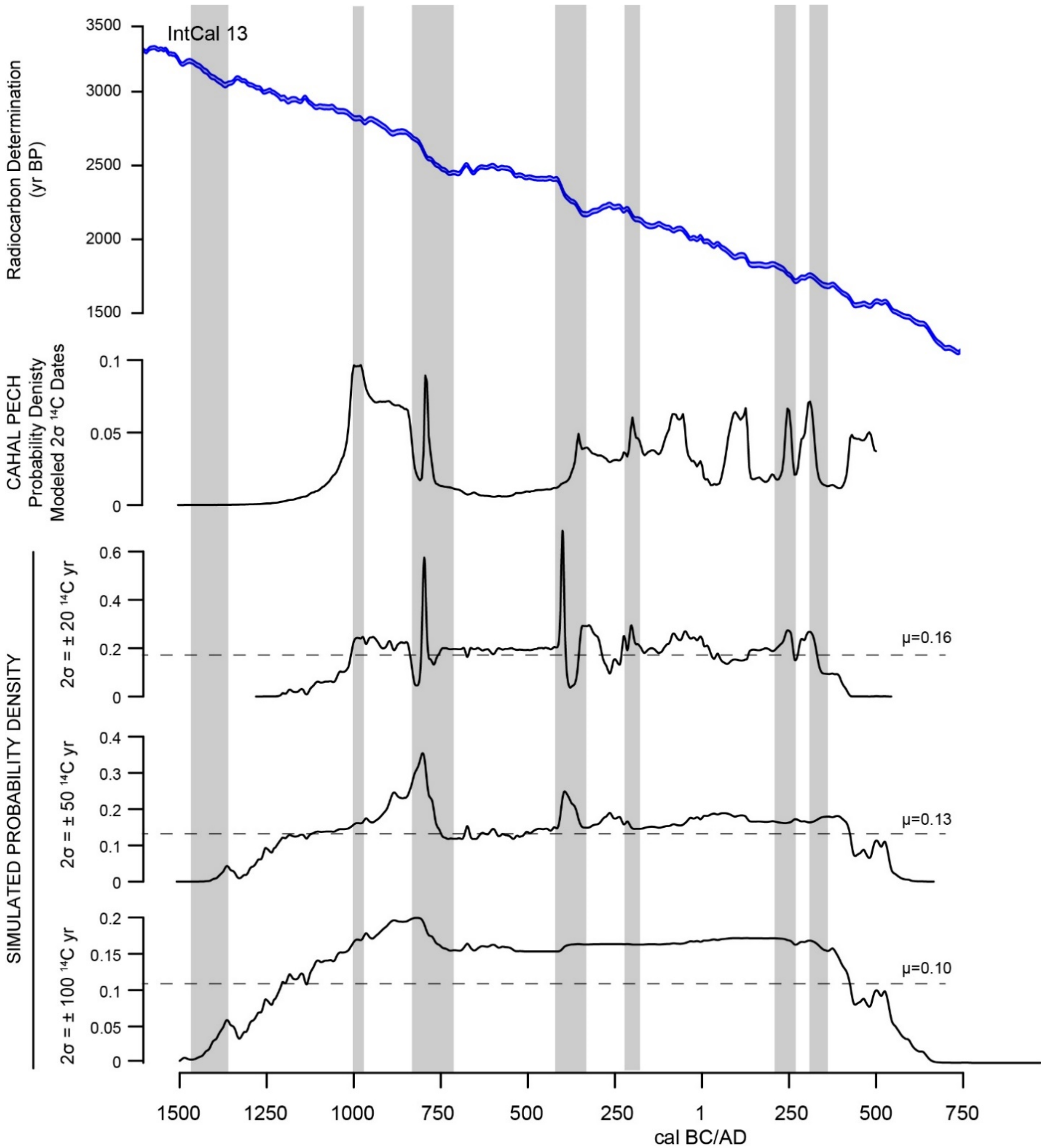

Figure 2.6: Simulated summed probability distributions, each calculated for the same n=240 ^{14}C ages using different measurement errors. These are plotted against the summed probability distribution for the Cahal Pech site core and settlement ^{14}C age. Shaded areas represent steep locations in the IntCal13 calibration curve. Dashed lines indicate mean expected probability

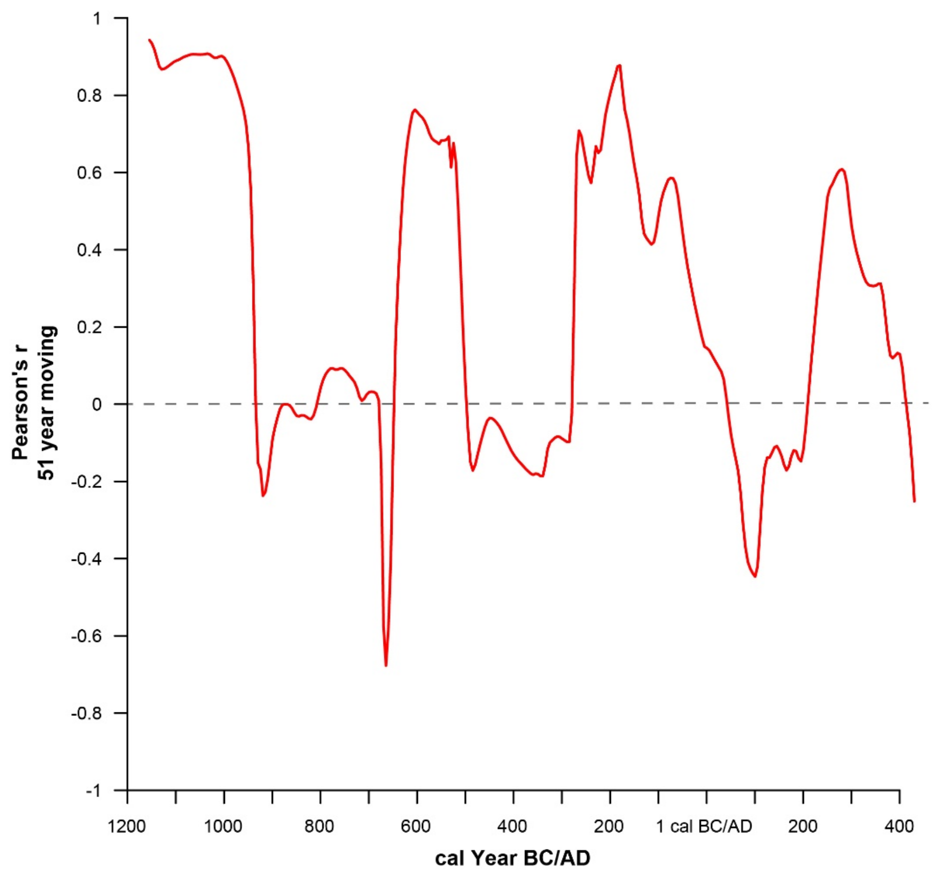

Figure 2.7: Pearson's *r* correlation of modeled radiocarbon dates for Cahal Pech plotted against the simulated radiocarbon ages with measurement error at ±20 ^{14}C years. Values approaching 1 indicate high correlation between the shape of the calibration curve and modeled Cahal Pech date. Values approaching -1 indicate low correlation.

A Pearson's *r* correlation test of modeled radiocarbon dates for Cahal Pech against the highest-resolution simulated frequency (±20 ^{14}C yr; Figure 2.7) suggests that although the overall structure of the probability distribution for Cahal Pech is partly driven by the shape of the calibration curve, the probability distribution is not completely explained as an artifact of the curve.

Results

Chronology for Cahal Pech Site Core

Excavations and AMS ^{14}C dating indicate that Cahal Pech was settled by the end of the Early Preclassic Period, and was inhabited continuously through the Terminal Classic Period. The earliest date from the site comes from Str. B4 and dates to 1205-990 cal BC (Beta-77207). The sample was recovered beneath Floor 13 on the surface of bedrock, which was likely leveled prior to initial construction at Cahal Pech (Figure 2.8; Awe 1992; Peniche May 2016).
A *boundary* at the beginning of the Str. B4 modeled sequence estimates that this leveling event may have occurred as early as 1325-985 cal BC. After the initial founding of the site, the modeled stratigraphic sequences show that late Early Preclassic construction was rapid at both Str. B4 and Plaza B. Activity during this time is associated with the initial construction of agrarian residences at the site, which consisted of the remodeling of a series of superimposed living surfaces composed of tamped earth floors supporting wattle-and-daub superstructures (Awe 1992; Healy et al. 2004; Horn 2015; Peniche May 2016; Sullivan and Awe 2013). These domestic buildings are located below Floor 10 at Str. B4 (B4/1st – B4/4th) and below Floor 17 within Plaza B (Plaza B/1st through Plaza B/4th). Archaeological data indicate a shift in the use of space beginning after 960 cal BC. During this time, Str. B4 underwent several modifications (B4\5th – B4\7th) terminating with the construction of a specialized round structure measuring approximately 1.5m in height and dating to 895-820 cal BC (Beta-40863; Healy and Awe 1995) likely used for public ceremonies (Aimers et al. 2000).

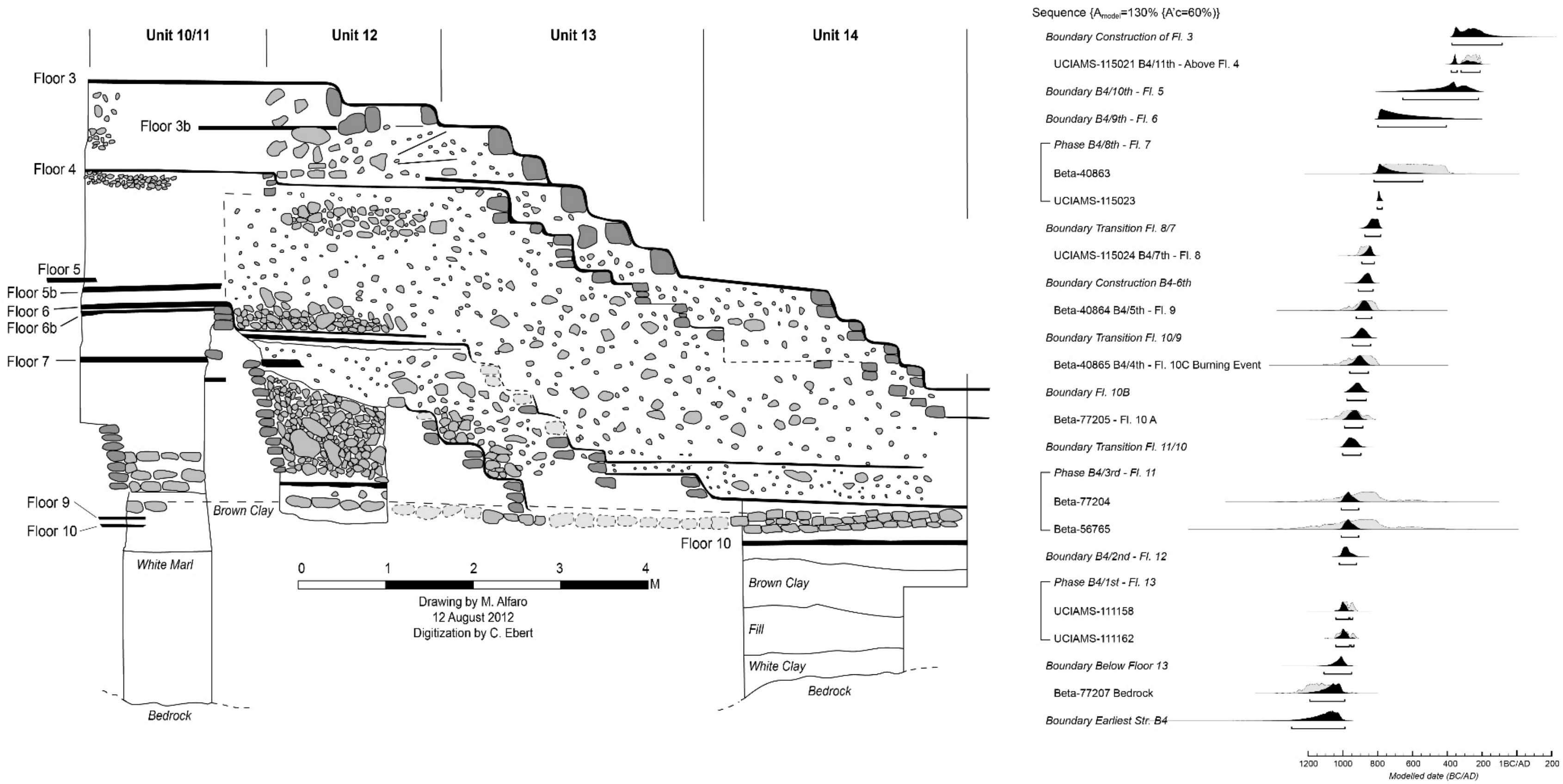

Figure 2.8: Profile and modeled ^{14}C dates for Structure B4.

During the early Middle Preclassic, new styles of large public architecture and high-status residences began to replace small Early Preclassic domestic structures within the site core (Aimers et al. 2000; Awe 1992; Healy et al. 2004). Radiocarbon dates from this phase, however, are impacted by the Middle Preclassic radiocarbon curve plateau (Hallstatt Plateau) and possess large calibrated error ranges (~200 years), obscuring the precise timing of these events. In Plaza B, a second phase of construction (Plaza B/8th – Plaza B/12th) occurred during this interval (Figure 2.9). Phase Plaza B/9th (Floor 13) represents the first in a series of low rectangular platforms that may have served as higher-status residences. The next construction, Plaza B/10th (Floor 12) enlarged the first rectangular platform, and a retaining wall composed of at least five courses of regularly cut limestone blocks was placed on the building. Plaza B/11th consisted of the construction of a specialized keyhole-shaped round structure. A second large building was also built to the west of the round structure, and may have served as an associated residence for a high-status family. The last Middle Preclassic construction episode within Plaza B (Plaza B/12th, Floor 11) was an extensive cobble platform (~98 m2) covering the keyhole structure that was placed between 765 and 535 cal BC. Similar cobbled platforms may have existed in several areas across the plaza in antiquity (Horn 2015, Peniche May 2016). While the pace of the second phase construction in Plaza B is unknown, the cessation of these activities may correspond with a century-long dry period between 600 and 500 cal BC.

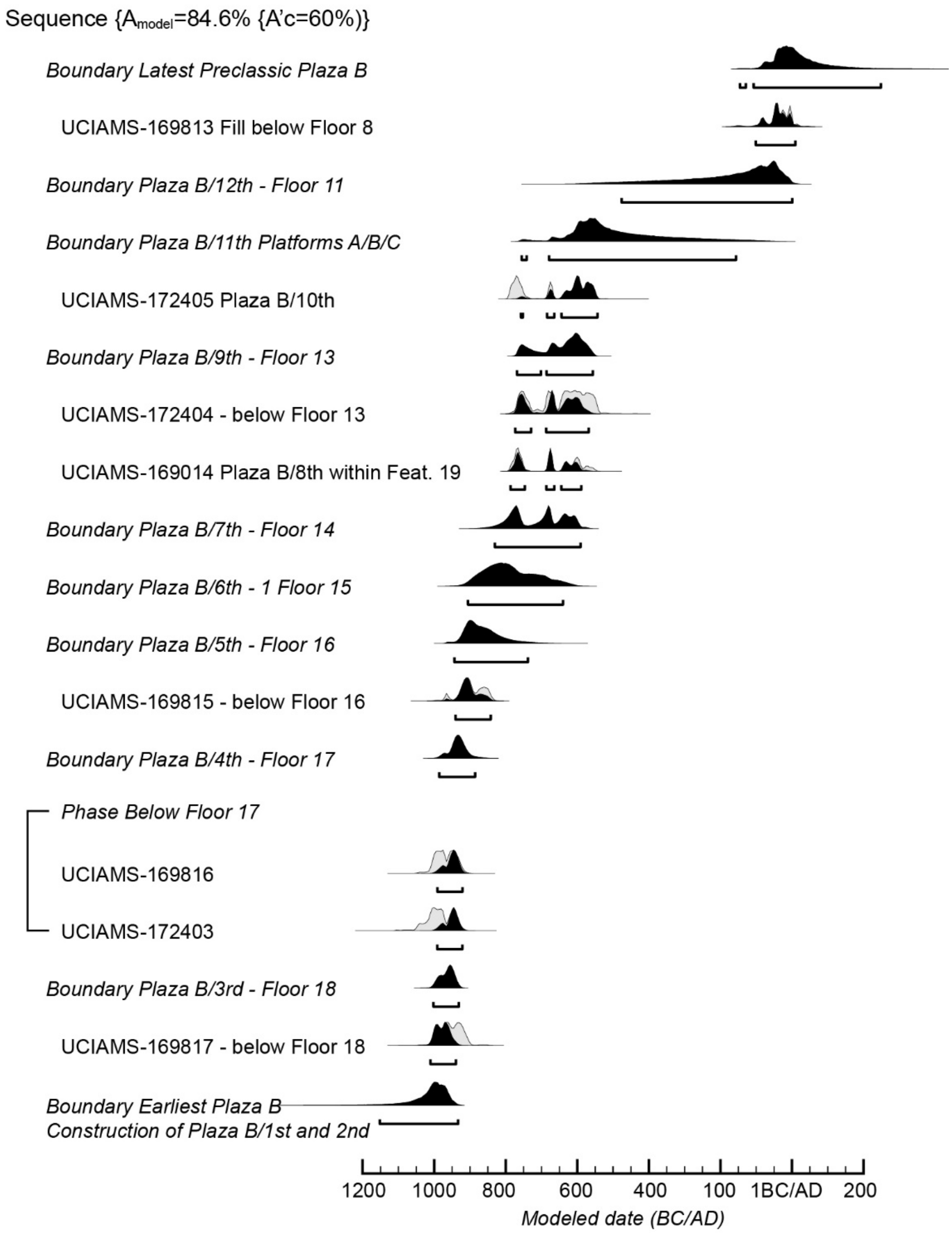

Figure 2.9: Modeled ^{14}C dates for Plaza B.

Construction phases B4/8th through B4/10th occurred at the end of the Middle Preclassic and into the Late Preclassic Period, with remodeling of monumental buildings occurring at punctuated intervals between 600 and 200 cal BC (late facet Kanluk to early facet Xakal ceramic phases). The building corresponding with Str. B4/8th (Floors 7A and 7B) consisted of a 3m tall circular platform made of cut limestone blocks. Two dates (Beta-40863; UCIAMS-115023) from the surface of Floor 7 were modeled within a *Phase* in the Str. B4 sequence and produced calibrated date ranges between 805 and 440 cal BC. During the construction of Str. B4/9th, a plastered surface corresponding to Floor 6 replaced Floor 7. The subsequent placement of Floor 5 (Str. B4/10th) raised the building ~1.2m above the surface of Str. B4/8th, and the plaza floor was elevated 0.5m (Ishihara-Brito and Awe 2013:127). Two low masonry walls of a small building were placed on the summit of this platform. The construction events corresponding to Str. B4/9th and B4/10th were not directly dated, but likely occurred over a long span of time from 795 and 280 cal BC. A single radiocarbon date below Floor 8 in Plaza B provides evidence for construction activity in this part of the site through at least the middle of the Late Preclassic Period 105 cal BC-cal AD 15 (UCIAMS-169813). Relatively little Late Preclassic and Early Classic Period materials were recovered from the Plaza B excavations (Peniche May 2016), and archaeological data also indicate a hiatus in activity at Str. B4 until the Late Classic Period (Awe 1992; Healy et al. 2004). Excavations at Str. B5, located to the west of Str. B4, exposed a Late Preclassic building, perhaps suggesting that construction activity shifted when the plaza was expanded during the Late Preclassic (Peniche May 2016).

Chronology for Cahal Pech Settlement

Radiocarbon dating indicates that there was limited activity within the Cahal Pech settlement zone prior to cal BC 400, though ceramic data from excavations provide some evidence for permanent settlement earlier during the Cunil phase (Ebert and Fox 2016; Iannone 1996). At the Zopilote group, located approximately 0.75 km south of the site core, the first documented construction consisted of a plaster floor (Floor 1A) placed between 355-170 cal BC (UCIAMS-164873) above earlier Cunil deposits, containing high frequencies of residential debris (freshwater shells, chert cores and flake tools) in a paleosol layer beneath Str. 1 (Fig S5). Iannone (1996) also recovered Cunil phase materials in the lowest stratigraphic levels of the Zubin Group. Similar Preclassic Period contexts have been encountered throughout the Maya lowlands and represent the first soils encountered by initial settlers of a region (Beach et al. 2006). Radiocarbon dates and ceramic evidence indicate that the scale of settlement around Cahal Pech increased during the second half of the Middle Preclassic Period (Willey and Bullard 1956; Awe 1992:207; Iannone 1996; Powis 1996). Four radiocarbon dates from two peripheral settlements, Cas Pek and Tolok, date the earliest activity at these groups from 530 and 400 cal BC. Radiocarbon dating from the Tzutziiy K'in Group, located approximately 1.75 km directly west of the Cahal Pech site core, document settlement of that house group prior to the Late Preclassic (325-110 cal BC; Ebert et al. 2016a).

Subsequent larger-scale residential and non-residential construction occurred after 350 cal BC during the Late Preclassic Xakal ceramic phase (Ebert and Fox 2016; Healy and Awe 1995; Healy et al. 2004). The construction of several low masonry platforms at the Zopilote Group (ZPL-1 1st through ZPL-1 6th), which likely functioned as a public temple, were constructed between 170-40 cal BC. The next burst of construction occurred between cal AD 170-335, and involved the consecutive construction of two large temples (ZPL-1 7th and 8th). The construction of these larger public buildings within residential groups occurred in the context of punctuated drought events from 165-1 cal BC. Multiple masonry platforms were also built in the main plaza at Tzutziiy K'in during the middle of the Late Preclassic, corresponding with a wet climatic interval. At Str. 1, a low plastered platform was constructed between 45 cal BC and cal AD 330, and may have functioned as a domestic structure for a high-status family (Ebert et al. 2016a). Cobble platforms similar to those in Plaza B of the Cahal Pech site core are also present at Tzutziiy K'in, dating slightly later to cal AD 65-215 (late facet Xakal). Ceramic associations suggest that this pattern of Late Preclassic growth is consistent with several other large house groups (e.g., Zubin, Zopilote, and Cas Pek) throughout the hinterlands of Cahal Pech.

Smaller scale residential occupation during the Late Preclassic and into the Early Classic Period has also been documented around the Cahal Pech site core (Awe 1992; Healy et al. 2004; Ebert et al. 2016; Ebert and Fox 2016). Construction activity along Burns Avenue in the downtown area of the modern town San Ignacio and subsequent salvage excavations documented the presence of several deposits of cached vessels and human remains that were likely associated with a residential settlement (Awe et al. 2014). A radiocarbon date of 55-25 cal BC (UCIAMS-169809) and ceramic associations place the occupation of the Burns Avenue site during the early and late facet transition of the Xakal ceramic phase. The presence of sterile alluvial deposits above Late Preclassic contexts document the abandonment of this settlement group shortly after this time, perhaps due to flooding from the nearby Belize River (Awe et al. 2014).

Settlement research and radiocarbon dating document the establishment of new residential groups during the Early Classic (Ebert et al. 2016a, 2016b), indicating continued population growth from the Preclassic into the Early Classic Period after the extended Late Preclassic drought. Four radiocarbon dates place settlement at the Martinez Group, south of the Cahal Pech site core, during the Early Classic Period (cal AD 435-615; UCIAMS-164868) with continued growth into the Late Classic Period. Early Classic components were also added in the site core and several settlement groups, including relatively large domestic and non-domestic architecture (Ebert et al. 2016a; Iannone 1996; Powis 1996; Awe and Helmke 2005). By the Late Classic Period, the Cahal Pech settlement system had become considerably more stratified and complex, with over 140 house groups located around the site core (Ebert et al. 2016b).

Summed Probability Distributions for the Southern Maya Lowlands

We developed Bayesian radiocarbon models and summed probability distributions from sites across the southern Maya lowlands to provide evidence for the timing and tempo of cultural activity during the Preclassic Period. These data can be compared to paleoclimate proxy records to help interpret the climatic contexts of site growth and decline (Kennett et al. 2013; Hoggarth et al. 2016). Figure 2.10 shows a comparison of the summed distributions of modeled radiocarbon sequences for the Cahal Pech core in relation to the settlement area, with prolonged dry events documented in Preclassic Period paleoclimate proxy records also highlighted. The probability distributions for Str. B4 and Plaza B show a sharp increase beginning around 1100 cal BC and peaks at 1000 cal BC, corresponding with high levels of domestic construction towards the end of the Early Preclassic Period. Early domestic occupation of the site core occurred during a multi-century dry period in both northern (Medina-Elizalde et al. 2016; Curtis et al. 1996) and southern lowland paleoclimate records (Akers et al. 2016; Webster et al. 2007).

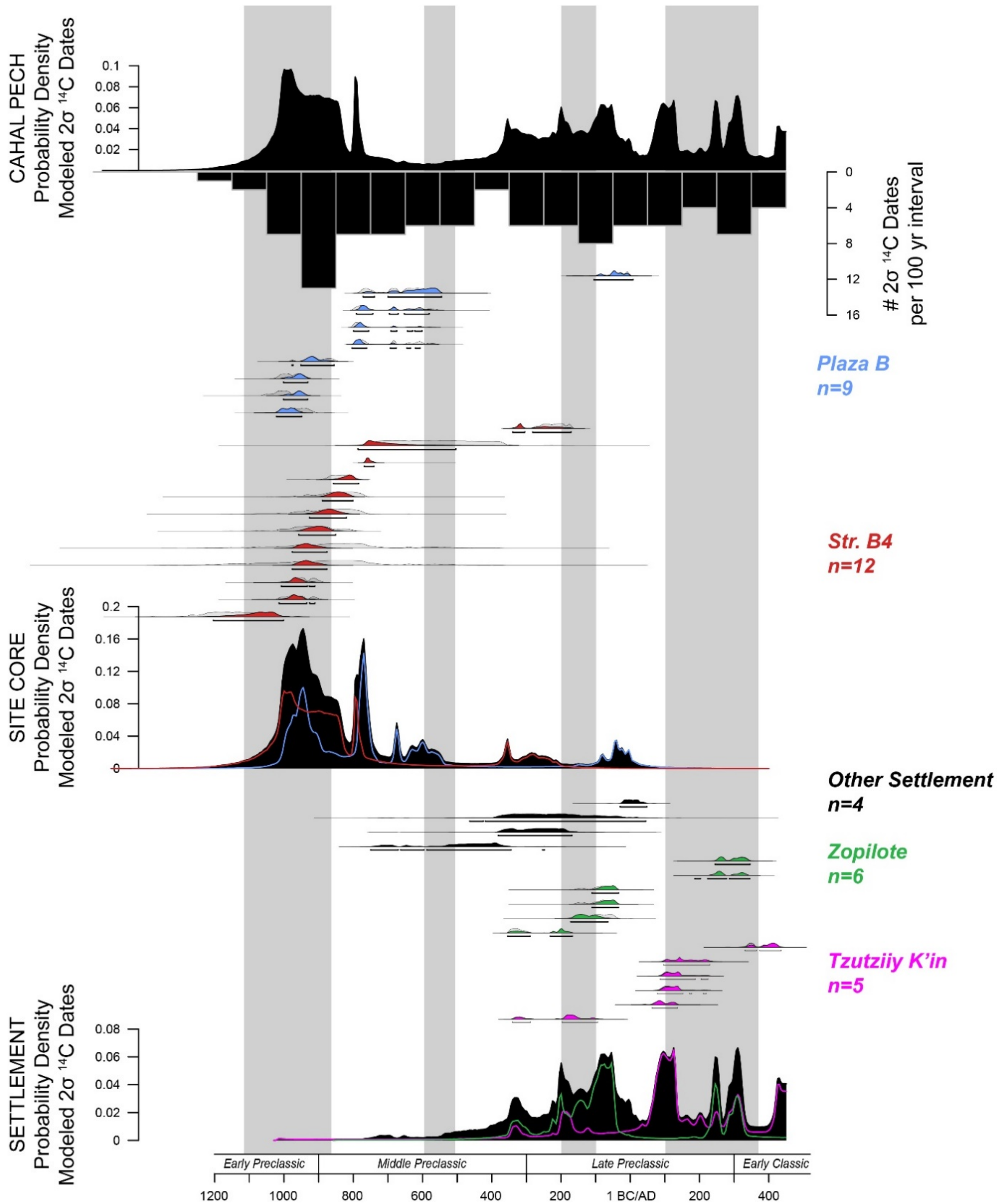

Figure 2.10: Summed probability distributions of all modeled and unmodeled radiocarbon dates from the Cahal Pech site core and settlement, shown with a histogram of radiocarbon dates in 100-year bins. Modeled and unmodeled dates at individual locations across the site are also shown with the summed probability distributions. Multi-century major dry events documented in paleoclimate records are highlighted in gray.

A second peak occurs in the summed distributions for the Cahal Pech site core from 800 to 750 cal BC, and corresponds with a steep portion of the calibration curve that may cause dates to be over-represented. For Str. B4, the peak likely marks a decline in construction at that building. For Plaza B, however, the peak corresponds with the second pulse of activity consisting of a series of large platform buildings that likely functioned as public buildings and high-status residences. Smaller pulses of activity punctuate the site core summed distribution through the end of the Middle Preclassic and into the Late Preclassic Period. These low peaks represent isolated construction events of public buildings, which occur during relatively wet periods in regional paleoclimate records. At the end of the Late Preclassic Period, construction of Str. B4 and Plaza B is discontinued, coinciding with the multi-century Late Preclassic Period drought. Archaeological evidence indicates a shift in construction activities starting at this time, focusing monumental building in other parts of the site core (Awe 1992). The summed distribution for the Cahal Pech settlement also shows an increased level of activity outside the site core beginning at the same time (Ebert et al. 2016a). The summed distribution for the Zopilote Group shows increasingly larger peaks from 350-1 cal BC, corresponding with large scale modifications of the Str. 1 temple building within this group. There is a gap in the Zopilote distribution between ~cal AD 1-200, when construction at the Tzutziiy K'in Group reached its highest levels during the Preclassic Period. Alternating peaks in the summed probabilities for these larger residential settlements demonstrate variability in growth that was likely impacted by household-specific social and economic factors, and perhaps climate conditions.

The radiocarbon chronology and summed distribution of modeled dates for Cahal Pech can be correlated with radiocarbon chronologies from archaeological sequences in other parts of the Maya lowlands to provide a broader context for alternating periods of development and decline of specific polities and the role of climate change. Modeled and unmodeled radiocarbon dates (*n*=440) from a total of 36 sites were used to create summed probability distributions for five core regions in the southern Maya lowlands (Figure 2.11). The summed distribution of 89 radiocarbon dates from 11 sites in the Belize Valley and Vaca Plateau region, located in the western portion of Belize, shows pulses of construction activity beginning first in the Early Preclassic at Cahal Pech. Activity in this part of the lowlands remains relatively stable through Middle and Late Preclassic Periods, despite climatic fluctuations. There is some evidence for a hiatus of monumental construction at Blackman Eddy (Brown and Garber 2005; Garber et al. 2004), Chan (Kosakowsky 2012), Lower Barton Creek (Kollias 2016), and Xunantunich Group E (Brown 2011) during the prolonged Late Preclassic drought, represented by a decline in the regional summed probability distribution after cal AD 100. A similar pattern exists in the regional summed distribution for Northern Belize, which was based on 95 radiocarbon dates from 11 sites. While some earlier Archaic Period dates exist for Northern Belize, the first evidence for Early Preclassic agrarian settlement comes from the sites of Colha (Iceland 1997; Lohse 2010) and Cuello (Hammond 2009) between approximately 1300 and 900 cal BC. A rapid increase of dates beginning around 800 cal BC in this region parallels archaeological evidence for the first large-scale construction activities within the monumental epicenters of these sites, in addition to several others (e.g., K'axob, McAnany and Lopez-Varela 1999; San Estevan, Rosenswig and Kennett 2008). A dry period between 200 and 100 cal BC coincides with a decline of dates for this region. The summed distribution drops significantly after cal AD 100, suggesting that drought had a much more critical impact on local communities in Northern Belize compared to the Belize Valley.

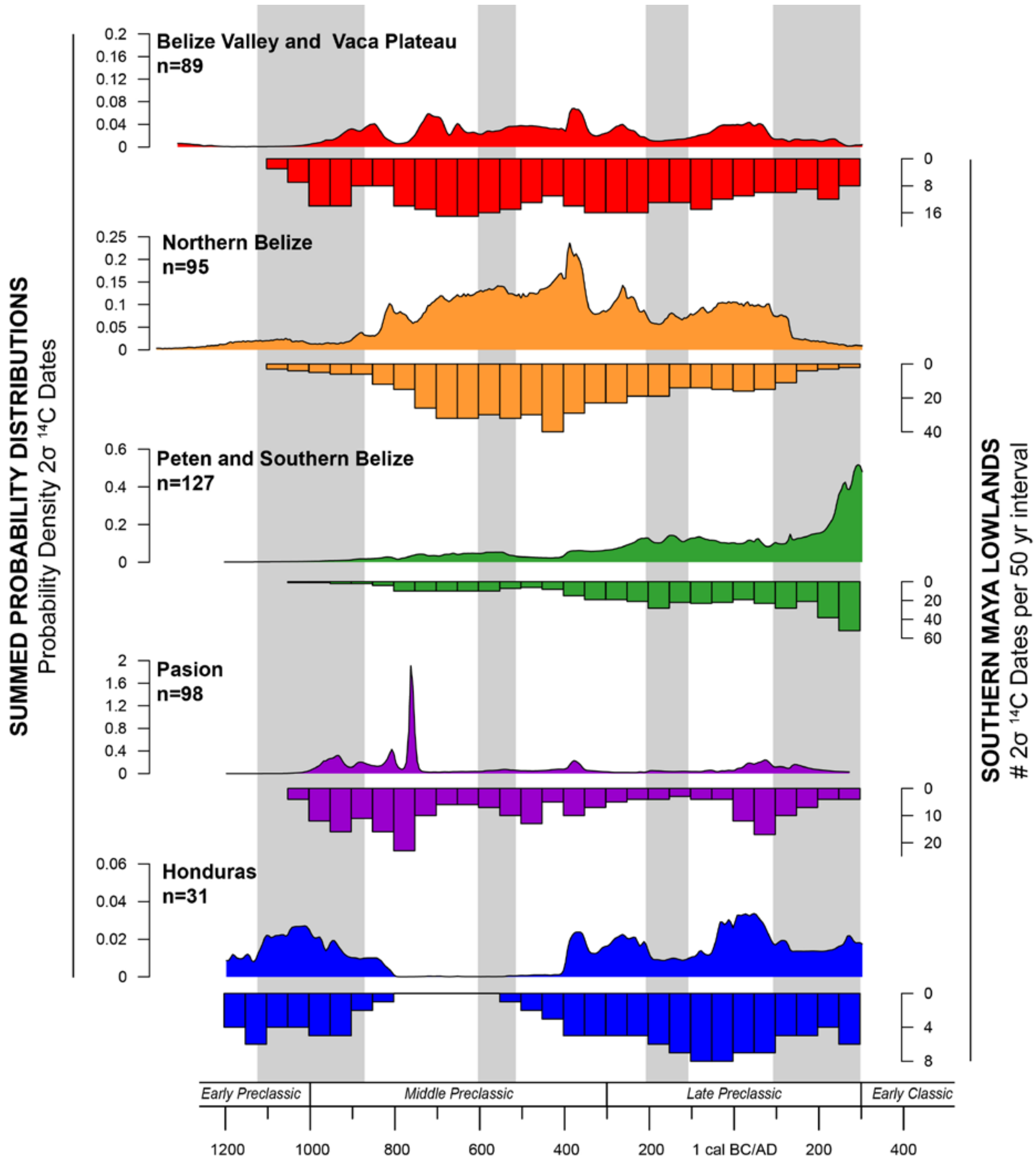

Figure 2.11: Summed probability distributions of Preclassic Period radiocarbon dates from five core regions in the southern Maya lowlands: (1) the Belize Valley and Vaca Plateau, (2) Northern Belize, (3) the Pasión region, (3) the Petén and Southern Belize, and (5) Honduras. Multi-century major dry events documented in paleoclimate records are highlighted in gray.

Radiocarbon data for other parts of the lowlands show more variability in patterning. The summed distribution for the Pasión region is composed of modeled and unmodeled dates (*n*=154) primarily from the site of Ceibal (Inomata et al. 2013, 2015, 2017). The first directly dated evidence for settlement and construction at Ceibal occurs around 1000 cal BC (Inomata et al. 2017). An exaggerated peak in the summed probability distribution is partially occurring around 800 cal BC is driven partially by the calibration curve but also reflecting excavation strategies focused on documenting early monumental constructions in the site's epicenter. Inomata and colleagues (2017) have also documented a significant population decline at Ceibal and other nearby sites (e.g., Caobal, Punta de Chimino) based on architectural and ceramic data beginning in the Late Preclassic around cal 75 BC, after a period of intensified conflict with neighboring groups. They suggest that populations continued to decline in the face of drought conditions, so that by cal AD 300, only a small community remained at the site. This pattern is reflected in the summed probability distribution in the regions as a slight decline beginning around cal AD 100 and continuing through cal AD 300.

The summed distribution for the Petén and Southern Belize region is composed of 127 dates from ten sites. We combined these regions in our analyses based on archaeological and epigraphic data, which suggests polities in Southern Belize may have been linked politically and economically to the Petén during the end of the Preclassic through Classic Periods (Prufer et al. 2011). Very few dates are available prior to 400 cal BC, when a rise in the summed probability distribution first appears. The earliest reported dates between 1600 and 1000 cal BC for the region come from the large Preclassic site of Nakbe (Hansen 2005), though no clear associated contextual or stratigraphic information is reported and therefore we were not able to model these dates. A small number (*n*=3) of dates falling between 900 and 735 cal BC are associated with the early occupation of Tikal (Ralph and Stuckenrath 1962; Stuckenrath et al. 1966) and Holmul (Estrada-Belli 2006, 2008) in the Petén. These dates come from contexts associated with the first ceramics (Eb complex) in this region. Dates become more frequent in the Petén and Southern Belize summed distribution after 400 cal BC, corresponding to a period of humid conditions at the end of the Middle Preclassic. The earliest evidence of hieroglyphic writing from the site of San Bartolo dates slightly after this time, around 300 cal BC (Saturno et al. 2006). A sharp dip appears in the summed probability between cal AD 100-200, which may be attributed to changes in the radiocarbon curve. A peak occurring between cal AD 200 and 300 after the extended Late Preclassic drought, however, is driven by a large number of dates associated with the first monumental constructions at the southern Belize site of Uxbenká (Aquino et al. 2013; Culleton et al. 2012; Prufer et al. 2011), and is located in one of the wettest parts of the Maya lowlands.

A small set of published radiocarbon dates (*n*=31) for four sites in Honduras document early settlement along the southern fringe of the Maya lowlands. The earliest dates from Honduras come from levels corresponding with Archaic Period occupation by mobile hunter-gatherers and horticulturalists at El Gigante Rock Shelter (Scheffler et al. 2012). During the Preclassic, radiocarbon dates from the early fishing-farming village on the coast at Puerto Escondido record low-level occupation in the region (Joyce and Henderson 2001). A gap in the summed distribution between 800 and 400 cal BC can likely be attributed to the paucity of radiocarbon dates from Preclassic sites in this part of the lowlands. After 400 cal BC the summed probability indicates continuous and steady activity through the end of the Late Preclassic Period, albeit at low levels, when the first dates from the Copan Valley (Manahan and Canuto 2009) and the nearby site of Quirigua (Ashmore 2007) appear in the regional radiocarbon record.

Discussion

The formation and breakdown of complex societies in multiple regions of the world occurred over the last 8000 years, and was dependent upon interacting economic, demographic, and political factors. Climate change on decadal and century-long scales is now recognized as another important force in shaping the historical dynamics of these societies (deMenocal 2001; Buckely et al. 2010; Kennett et al. 2012; Kennett and Marwan 2015). Severe droughts are documented in paleoclimate proxy records for the Preclassic Period across the Maya lowlands, though the role they played in the episodic formation and breakdown of complex societies is not well explored. Integrating more precise and accurate chronologies based on radiocarbon dates and other lines of evidence (i.e., ceramic, architectural) is essential for understanding the timing and tempo of Preclassic Period societal change and its relationship to climate change (Douglas et al. 2016). In this study, we developed a Bayesian radiocarbon chronology for the Cahal Pech monumental site core and outlying residential settlement groups to document the episodic growth of social hierarchy at the site in relation to several periods of acute and prolonged drought during the Preclassic Period. This chronology is complemented by a larger dataset of radiocarbon dates from Preclassic Period cultural contexts at sites across the southern Maya lowlands (n=1198) compiled from published literature. Bayesian chronologies and summed probabilities of radiocarbon dates developed from this larger dataset help to identify major "tipping points" in Preclassic cultural and climate change, and to place the Preclassic Period development of Cahal Pech within a broader regional context.

Our analyses of radiocarbon data for Cahal Pech and other southern lowland sites suggest that the transition to settled village life during the Early Preclassic Period was likely variable, though small agricultural villages were present in most parts of the lowlands by 1000 cal BC. In

Belize, radiocarbon dates suggest continuity between Archaic Period (1500-1200/1000 cal BC) mobile hunter-gatherer populations and the first Early Preclassic farming village communities (Clark and Cheetham 2002; Iceland 1997, 2005; Lohse 2010; Stemp et al. 2016; see also Rosenswig 2015). The earliest Maya communities in Belize chose to settle in areas with abundant resources in alluvial valleys or on the margins *bajos*, natural depression that hold shallow lakes and perennial wetlands (Beach et al. 2012; Dunning et al. 2002). The first directly dated ceramics in the Belize River Valley (Cunil ceramic complex) come from Cahal Pech (1280-980 cal BC; Awe 1992; Sullivan and Awe 2013) and Group E at the nearby site of Xunantunich (1220-925 cal BC; Brown et al. 2011), and appear slightly later at the site of Blackman Eddy (990-800 cal BC; Garber et al. 2004). The Cunil ceramic complex is the earliest known in the Maya region, and its appearance at the end of the Early Preclassic Period signals an increased commitment to maize agriculture and the first permanent settlement in the southern Maya lowlands. Excavations at Cahal Pech have documented a relatively small (~0.75 ha) Cunil phase village at the site, with architecture consisting of several simple wattle and daub structures sometimes placed on modified bedrock that served as dwellings or out-buildings (e.g., kitchen, storage facilities; Awe 1992; Garber et al. 2004; Horn 2015; Peniche May 2016). The recovery of Cunil phase ceramics and domestic refuse at the lowermost levels of excavations in the Zopilote and Zubin groups, south of the Cahal Pech core, indicates that similar small villages may have contemporaneously existed in these locations (Ebert and Fox 2016; Iannone 1996). Early Preclassic settlement at Cahal Pech coincides with a multi-century drying trend characterized by smaller punctuated droughts of varying intensities recorded in paleoclimate proxy records from the southern Maya lowlands (Akers et al. 2016; Hodell et al. 1995; Medina-Elizalde et al. 2016; Wahl et al. 2014). Population levels in the Belize Valley were likely very low at this time, however, offering little competition in the resource-rich alluvial valley so that climatic variability had relatively low impact upon initial settlement.

In Northern Belize, archaeologists working at the site of Cuello have documented the construction of small, low domestic platforms associated with the first ceramics (Swasey ceramic complex, 1100-900 cal BC) in the region. This site is located near *bajo* wetlands that extend across much of Northern Belize, suggesting a similar timing in the adoption of sedentism in this resource-rich region of the lowlands (Dunning et al. 1998; Hammond 2009). While current archaeological data provide limited evidence for institutionalized social inequality during the Early Preclassic in the lowlands, the presence of non-local goods (e.g., jade, flake obsidian, marine shell) within early levels link Cahal Pech and other Belize sites into broader regional economic networks (Awe 1992; Awe and Healy 1994; Hammond 2009; Garber et al. 2004; Horn 2015).

Increasingly humid climate conditions prevailed after ~1000-900 cal BC across the Maya lowlands at the beginning of the Middle Preclassic Period, providing a context for changing social and economic practices. Wet conditions allowed Maya farmers to exploit productive soils and seasonal wetlands for more intensive maize agriculture, fostering the growth of many small polities (Dunning et al. 1998, 2002; Luzzadder-Beach et al. 2012). The summed probability distribution of radiocarbon dates for Cahal Pech increases dramatically during this wet period in the paleoclimate records, likely mirroring trends in increasing levels of sedentism, population growth, and agricultural intensification. Similar patterns exist in the summed probability distributions for the Belize Valley more generally, Northern Belize, and Pasión region sites, suggesting that wetter, more stable climate conditions may have influenced Middle Preclassic development in most areas of the lowlands at this time. This pattern may be especially pronounced in the Pasión region, where the local terrain is characterized by considerable fluctuations in seasonal water levels (Dunning et al. 1998). Inomata and colleagues (2015) have argued, based on a lack of residential architecture associated with early contexts (~1000-900 cal BC), that the earliest inhabitants of Pasión site of Ceibal may have been residentially mobile or semi-mobile. Climatic stability in the Middle Preclassic may have provided more reliable water resources and encouraged permanent settlement at Ceibal. In the Petén, early Eb complex ceramics have been recovered from construction fill deposits at Tikal (Culbert 1977; Laporte and Fialko 1993), as well as Cival and Holmul (Estrada-Belli 2011), though well-defined architectural and chronological associations are not present.

Evidence for increasing social complexity and community integration also appear in the Middle Preclassic Period as status and role distinctions became defined by economic, political, and ideological changes (Awe 1992; Chase and Chase 2012; Estrada-Belli 2011; Hansen 2001). The Bayesian chronology for Ceibal and the nearby minor center of Caobal indicates the presence of the first formal public architecture by 950 cal BC, which included an E-Group architectural assemblage with buildings that likely served as a stage for communal ritual performances (Inomata et al. 2012, 2015, 2017; see also Doyle 2012). While the summed probability density for Ceibal is affected by steep areas of the calibration curve during the Middle Preclassic, similar to the summed distribution for Cahal Pech discussed above, a large number of radiocarbon dates coupled with archaeological evidence indicate that monumental building in the civic-ceremonial core of the site peaked after 800 cal BC.

The radiocarbon chronology for Plaza B in the Cahal Pech site core documents a similar shift from a focus on domestic to primarily public architecture slightly later after 700-500 cal BC (late facet Kanluk ceramic phase), though the chronology is less clear for this part of the site's history due to the impacts of the Hallstat Plateau in the radiocarbon calibration curve that result in large calibrated date ranges. The period just before 500 BC, however, coincides with the onset of onset of humid conditions in the Río Secreto speleothem record, characterized by a progressive increase in precipitation beginning around 500 cal BC (Medina-Elizalde et al., 2016:96-97). Increased rainfall levels are also reflected in the higher resolution Cariaco Basin and Macal Chasm paleoclimate records beginning around 500 cal BC. During this time (late Kanluk ceramic phase), there is increased construction in Plaza B compared to earlier time periods (Peniche May, 2013, 2014, 2016). Several large circular and keyhole-shaped platforms ~1-2 m high were constructed in Plaza B during the interval from 700 and 500 cal BC. Similar buildings have been documented for Middle Preclassic contexts at the Tolok and Zotz settlement groups in the Cahal Pech periphery (Aimers et al., 2000; Awe, 1992; Powis, 1996:174), and have also been reported in a small number of other sites in the Belize Valley (Barton Ramie, Willey et al., 1965), Northern Belize (Altun Ha, Pendergast, 1982; Colha, Potter et al., 1984; Sullivan, 1991; Cuello, Hammond, 2009; K'axob, McAnanay, 1995), the Petén (Uaxactun, Hendon, 1999), and some parts of the northern lowlands (Becan, Ball and Andrews, 1978; Xamán Susulá, Peniche May, et al. 2009). These Middle Preclassic structures are often associated with high-status burials or dedicatory caches, and some scholars have argued that they functioned as ancestral shrines for higher status households (Aimers et al., 2000; Hendon, 1999, 2000). While these structures were relatively modest compared to later Classic period temple buildings that dominated the Cahal Pech site core, their construction nonetheless required the organization of labor and investment of resources beyond the level of the household. Additionally, these buildings are also associated with larger residential architecture, perhaps suggestions that higher-status groups were controlling these spaces (Peniche May, 2016).

At the beginning of the Late Preclassic Period (300-400 cal BC), rapid growth of major civic-ceremonial centers occurred across most parts of the southern lowlands. While large political centers of Nakbe and Mirador dominated the Petén, other regions also experienced considerable demographic and political expansion. Settlement data from Cahal Pech document a substantial increase in population beginning in the Late Preclassic Period. Radiocarbon dates parallel this trend, with the construction of larger-scale residential and nonresidential construction in at least five house groups (Burns Avenue Group, Cas Pek, Tolok, Tzutziiy K'in Group, and Zopilote Group) in the Cahal Pech periphery after ~350 cal BC (Awe 1992:207; Ebert et al. 2016a; Iannone 1996; Powis 1996; Willey and Bullard 1956). Settlement expansion in the periphery was concurrent with large-scale construction of monumental architecture in the Cahal Pech site core (Plazas A and B; Awe 1992; Healy et al. 2004a). The cobbled platforms associated with Plaza B/12th (765-535 cal BC), the last dated Middle Preclassic constructions for Plaza B, were completely covered by five successive plastered plaza floors. A single radiocarbon date (105 cal BC-cal AD 15) below Floor 8 indicates that this construction activity was taking place throughout the Late Preclassic. This event occurred just after one of the most severe dry periods recorded for the southern lowlands (Akers et al. 2016), with the return of wet conditions possibly encouraging renewed activity at the site core. Other Belize Valley sites, including Baking Pot (Hoggarth et al. 2014), Chan (Kosakowsky 2012), Lower Barton Creek (Kollias 2016), and the Vaca Plateau site of Caracol (Chase and Chase 1987, 2006) also experienced intensified architectural construction programs. In Northern Belize, over a dozen medium and large regional centers with monumental architecture also emerged during the Late Preclassic Period including Cerros, K'axob, Lamanai, Nohmul, San Estevan, and Santa Rita (Chase and Chase 1987; McAnany and Lopez-Varela 1999; Pyburn 1989; Rosenswig and Kennett 2008).

One of the most prolonged and severe droughts in recorded paleoclimate proxies from throughout the Maya lowlands occurred at the end of the Late Preclassic Period (cal AD 100-300; Akers et al. 2016; Curtis et al. 1996; Hodell et al. 2005; Kennett et al. 2012; Medina-Elizalde et al. 2016). Changes in the frequency of building activity evident in summed probability distributions of radiocarbon dates suggest regionally distinct responses to drought within the southern lowlands. Although no radiocarbon dates with clearly reported contexts are available for the El Mirador Basin sites, settlement data indicate the almost complete abandonment of Nakbe and Mirador in addition to massive depopulation in the area after cal AD 200 (Beach et al. 2015; Dunning et al. 2014, 2016; Hansen et al. 2008; Rice and Rice 1990). Drought may have significantly impacted seasonal water availability in this part of the lowlands, where perennial surface water is scarce across the karstic landscape (Wahl et al. 2006, 2014) and artificial reservoirs were necessary to support concentrated populations (Dunning et al. 1998). The sites of San Bartolo (Saturno et al. 2006) and Cival (Estrada-Belli 2006) were also largely devoid of inhabitants by cal AD 150, though the connection to drought has not been directly investigated at these sites. Summed probability distributions of radiocarbon dates and archaeological data document massive expansion and political centralization at Tikal, Calakmul, and other minor centers (e.g., Holmul, Estrada-Belli 2006) at the beginning of the Early Classic Period (~cal AD 200-300), corresponding with a decline of authority at these earlier centers of power and sociopolitical influence (Hansen 2006; also Martin and Grube 2008). Population decline in the Pasión region at the end of the Late Preclassic at Ceibal and neighboring sites has also been documented based on declining frequencies of ceramic artifacts and evidence for construction activity beginning around 75 cal BC, reaching a low point between cal AD 125-175 (Inomata et al. 2017), coincident with acute Late Preclassic conditions. These trends are mirrored in the summed probability distributions for the Pasión region, coincident with the Late Preclassic drought, suggesting that dry climate conditions may have played a role in construction activity at Ceibal and other sites in the region.

Political re-organization possibly influenced by drought conditions is evident elsewhere in the Maya lowlands, where more varied responses are evident in the record. A declining probability distribution of radiocarbon dates from Northern Belize may reflect local instability during the Late Preclassic Period, when there is evidence for inter-site conflict across the region (Estrada-Belli 2011; Rosenswig and Kennett 2008). At the large port city of Cerros, a large ditch system, possibly built for defensive purposes (Scarborough 1983, 1991:183) and stucco facades displaying "jaguar war complex" imagery (Freidel 1986:101; Freidel and Schele 1988:449) appear between 200 and 50 cal BC. The summed probability distribution for the available Cerros radiocarbon dates also shows a sharp decline after cal AD 200, reflecting the political decline of the site. Coastal populations may have contracted around sites located in more resource rich riparian zones, such as Lamanai and Nohmul, which resumed growth during the Early Classic Period (Pyburn 1989:194). In southern Belize, summed probability of radiocarbon dates from the site of Uxbenká provides strong evidence for the rapid development of this center during the end of the Late Preclassic Period (Aquino et al. 2013; Culleton et al. 2012; Prufer et al. 2011). While the YOK-I speleothem record, located 1.5 km from the Uxbenká site core, documents severe dry conditions at the end of the Late Preclassic (Kennett et al. 2012), relatively high levels of rainfall compared to other locations in the Maya lowland may have allowed the local community to flourish during a period of climatic volatility.

Radiocarbon data provide evidence that Cahal Pech and other sites in the Belize Valley may have also been resilient in the face of severe Late Preclassic drought conditions compared to the Mirador centers and sites in Northern Belize. While relatively little Late Preclassic and Early Classic Period materials were recovered from the Plaza B and Str. B4 excavations, radiocarbon data document continual growth of peripheral settlement groups within the Cahal Pech hinterland through the end of the Late Preclassic and into the Early Classic. Initial construction phases of mounds in several house groups occurred at the end of the Late Preclassic, also reflecting population growth at the site. Excavations from other locations indicate that the focus of construction shifted to other locations within the Cahal Pech civic-ceremonial core during the Late Preclassic and into the Early Classic. Several structures within Plaza A were remodeled into monumental building; Plazas C, D, F, and G grew substantially through the construction of new temple and palatial buildings; and the first phase of the eastern ball court was erected (Awe 1992; Awe and Helmke 2005: Table 1). Str. B1, the central pyramid building of a large eastern triadic group in Plaza B, is associated with some of the most elaborate royal burials at the site, and became the focal point of the site core by the Late Preclassic Period (Awe et al. 2017). Radiocarbon dating of remains of multiple individuals from Burial 7 found within Str. B1 indicates that the earliest royal tomb was constructed by at least cal AD 140-395 (Novotny 2015). Similar large-scale monumental groups with elite burials or caches have been dated to the Late Preclassic at the Belize Valley sites of Chan (Robin 2012), Pacbitun (Healy et al. 2004), and Blackman Eddy (Garber et al. 2004). Intensified construction programs and increased population growth indicate that the inhabitants of Cahal Pech and other Belize Valley sites flourished in spite of drought conditions at the end of the Late Preclassic. Access to reliable surface water from the Belize, Macal, and Mopan Rivers, in addition to abundant fertile agricultural land in the alluvial flood plain may have provided an important foundation for increased economic and political activity and allowed Cahal Pech to be more resilient in the face of climate change during this time. Additional dating work is required to understand the timing of monumental growth at Cahal Pech and elsewhere in the Belize Valley during the transition from the Late Preclassic to the Early Classic Period.

Conclusions

Multiple independent polities emerged rapidly in the Maya lowlands after the initial establishment of sedentary agricultural villages and the adoption of ceramic technology between 1200 and 1000 cal BC. Over the course of the following millennium, lowland Maya populations expanded across the landscape, and numerous large centralized polities with hierarchical political organization developed. Radiocarbon dating and Bayesian chronological models from site core and residential contexts at Cahal Pech offer a new way to explore human-environment interactions in the Belize Valley. The Cahal Pech chronology can be compared to radiocarbon dates from other sites across the Maya lowlands where ceramic-based chronologies are often difficult to correlate or are contentious (see Inomata et al. 2013, 2015; Lohse 2010). The chronology modeled here for Cahal Pech, one of the earliest known Preclassic Period Maya villages with ceramics, helps to clarify the timing of changes that allowed the site to become a large sociopolitical center by the Late Preclassic. After initial settlement of the site around 1200/1100 cal BC, construction activities focused on the expansion of domestic architecture. During the Middle Preclassic, beginning around 800-700 cal BC, the first public architecture and larger residential structures appear at the site, suggesting the development of a centralized hierarchy within the community. The pace of monumental construction slowed in the site core during the Middle Preclassic, but summed probability distributions of radiocarbon dates corresponding to building activities at the site show that populations were growing at a steady rate into the Late Preclassic and Early Classic Period when the first ruling lineage was firmly in place.

Increasing emphasis in Maya archaeology has been placed on examining the timing and variability of Preclassic Period cultural changes as responses to changing environmental conditions (Beach et al. 2015; Chase and Scarborough 2014; Iannone 2014; Kennett et al. 2012; Luzzadder-Beach et al. 2012). Research on later Classic Period Maya society has documented that the formation and consolidation of centralized regional polities was favored during stable climatic regimes between cal AD 400 and cal AD 700 (Kennett et al. 2012; Medina-Elizalde et al. 2010). Our analysis of the available data from the Preclassic Period suggests a more complex picture. Based on the summed probability distributions of radiocarbon dated building episodes and archaeological evidence, we identified contrasting patterns of sociopolitical change in relationship to fluctuating climatic conditions across the lowlands. During the Early Preclassic Period, low population levels in the Belize Valley and Northern Belize, as well as diverse subsistence strategies focused on local aquatic and riparian resources, may have allowed small communities to adapt to alternating wet and dry periods (Dunning et al. 2014). The impacts of prolonged multi-decadal and century-long droughts likely became more pronounced in the Late Preclassic Period as population levels reached their peaks and regional polities became focal points in complex social, political, and economic systems. The multi-century drought occurring at the end of the Late Preclassic Period is one of the most severe drying events recorded in the region during the last 4000 years. The socio-political and population decline in some parts of the southern lowlands in the face of the drought, however, differed from the Terminal Classic Period droughts in that it was followed by the development of new, resilient political centers throughout the lowlands in the Early Classic Period that flourished in some cases for over six to seven centuries. While drought was one possible mechanism stimulating culture change in the Maya region, the results of this research highlights the complex and non-linear relationship between climate change and sociopolitical dynamics. Rather, fluctuating social and natural conditions favored the emergence of multiple adaptive pathways for complex societies. Future research should focus on additional radiocarbon dating efforts from Preclassic Period sites across the Maya lowlands to more precisely document the timing and tempo of responses to long-term climate change and its impact on the complexity of coupled socio-natural systems.

Chapter 3

AMS ^{14}C DATING OF PRECLASSIC TO CLASSIC PERIOD HOUSEHOLD CONSTRUCTION IN THE ANCIENT MAYA COMMUNITY OF CAHAL PECH, BELIZE[1]

Abstract

Archaeologists have traditionally relied upon relative ceramic chronologies to understand the occupational histories of large and socially complex polities in the Maya lowlands. High-resolution accelerator mass spectrometry (AMS) radiocarbon dating can provide independent chronological control for more discrete events that reflect cultural change through time. Here we report results of AMS ^{14}C dating of stratified sequences at the residential group Tzutziiy K'in, associated with the Maya site of Cahal Pech in the Belize Valley. Cahal Pech is one of the earliest permanently settled sites in the Maya lowlands (1200 cal BC), and was continuously occupied until the Terminal Classic Maya "collapse" (~cal AD 800). We use Bayesian modeling to build a chronology for the settlement, growth, and terminal occupation of Tzutziiy K'in, and compare our results to chronological data from the monumental site core at Cahal Pech. The analyses indicate that Tzutziiy K'in was first settled during the Late Preclassic Period between 300-100 cal BC, concurrent with the establishment of several other large house groups and the growth of the Cahal Pech site core. Terminal occupation by high-status residents at this house group occurred between cal AD 850-900. This study provides a framework for interpreting patterns of spatial, demographic, and socio-political change between households and the Cahal Pech site core.

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Introduction

Understanding the development and growth of ancient communities into spatially, demographically, and socio-politically complex polities is one of several critical research issues in Mesoamerican archaeology (Clark and Blake 1994; Clark and Cheetham 2002; Rosenswig 2010; Estrada-Belli 2011; Lesure 2011; Love and Kaplan 2011; Chase and Chase 2012; Joyce 2013; Inomata et al. 2013, 2014, 2015). Archaeologists working in the Maya lowlands traditionally rely upon relative chronological assignments derived from regionally distinct ceramic typologies to interpret the timing of these changes and to track the establishment and expansion of large polities (e.g., Adams 1971; Sabloff 1975; Gifford 1976; Andrews 1990; Hammond 1991; Culbert 1993; Demarest et al. 2004). Relative ceramic phases often span hundreds of years, however, and distinguishing ceramic types can overlap several phases preventing precise temporal assignments for discrete events that are essential for documenting patterns of culture change. Independent chronological controls, such as high-resolution accelerator mass spectrometry (AMS) radiocarbon dating, can be combined with relative ceramic-based date estimates to help improve site chronologies in the Maya region, and in Mesoamerica more generally (LeCount et al. 2002; Webster et al. 2004; Rosenswig and Kennett 2008; Prufer et al. 2011; Culleton et al. 2012; Inomata et al. 2013, 2014, 2017; Hoggarth et al. 2014; Overholtzer 2014; Lesure et al. 2014; Huster and Smith 2015).

In this paper we report the results of high-resolution AMS ^{14}C dating from Tzutziiy K'in, a large hinterland house group associated with the ancient Maya site of Cahal Pech, located outside the modern town of San Ignacio in the upper Belize Valley of west-central Belize (Figure 3.1).

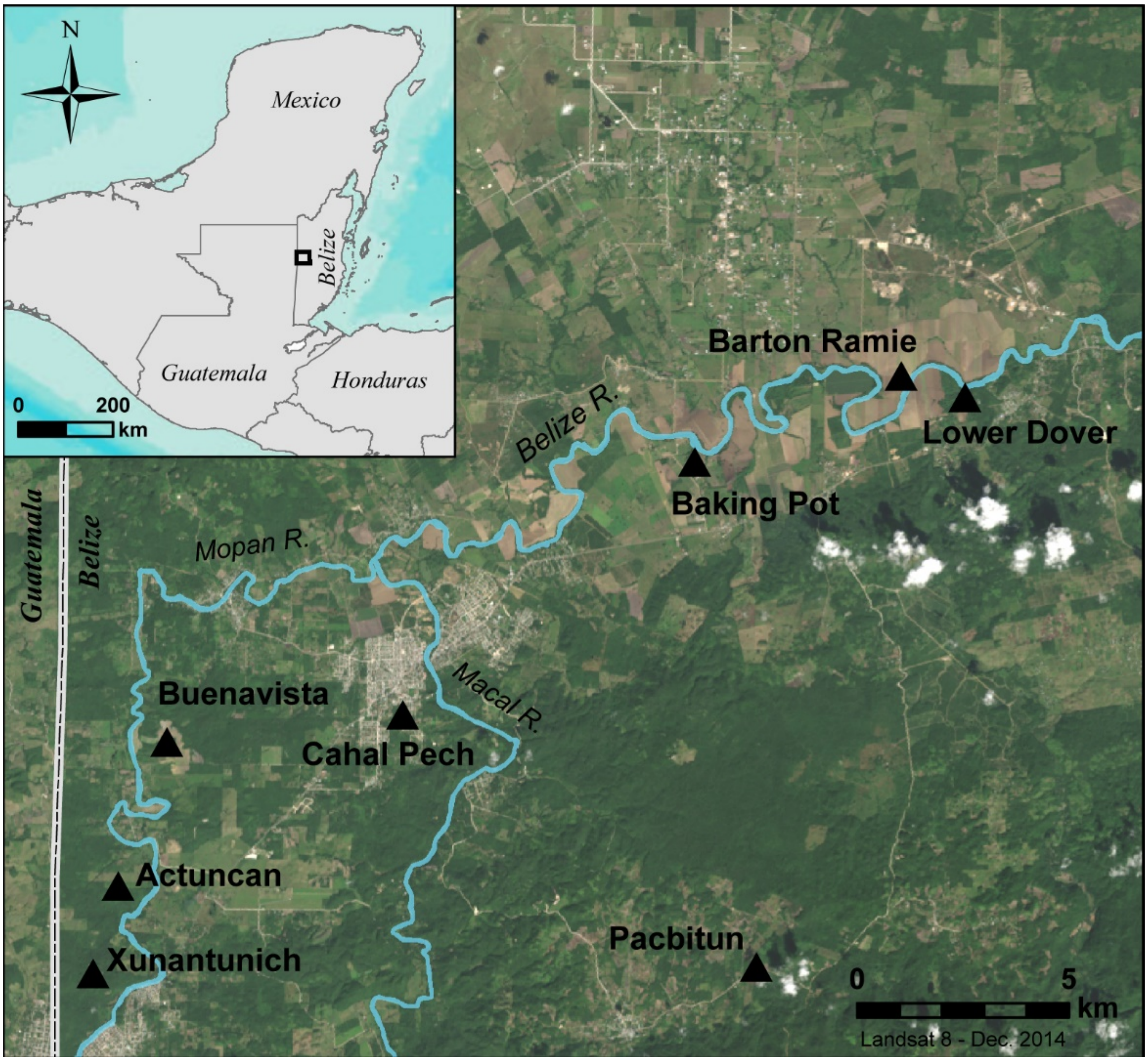

Figure 3.1: Map of the Belize Valley showing the location of Cahal Pech and other major sites mentioned in text. Location of Belize Valley is outlined on the inset map.

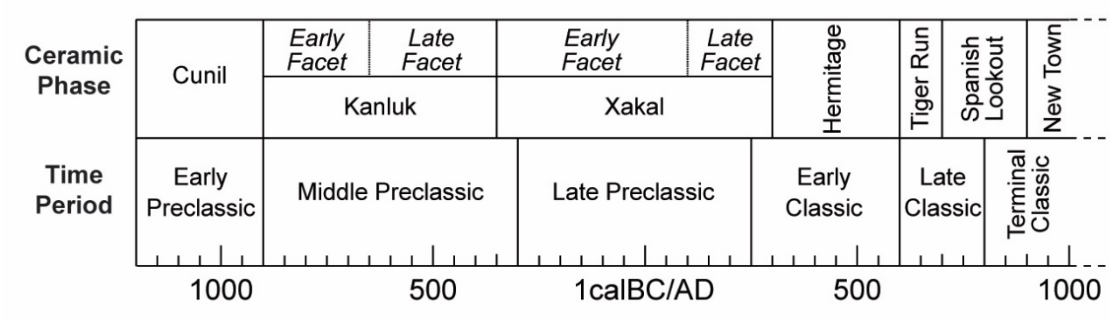

Figure 3.2: Chronological periods and associated ceramic phases for Cahal Pech.

Cahal Pech provides a unique case study for understanding the development of socio-political complexity in the Maya lowlands because of its long occupational history from around 1200 cal BC – cal AD 900 (Figure 3.2 Awe 1992; Healy et al. 2004). AMS ^{14}C dates recovered from excavations at Tzutziiy K'in were modeled within a Bayesian statistical framework using stratigraphic associations between dates to build an occupational chronology for the site. Combining AMS ^{14}C dates with *a priori* contextual (i.e., ceramic) and stratigraphic information using a Bayesian approach provides more precise and accurate age determinations to estimate the timing of events including the settlement and growth of the site (Beramendi-Orosco et al. 2009; Bronk Ramsey 2015; Bronk Ramsey et al. 2010; Culleton et al. 2012; Hoggarth et al. 2014; Huster and Smith 2015; Inomata et al. 2013, 2014; Jazwa et al. 2013; Kennett et al. 2011, 2014; Lesure et al. 2014; Prufer et al. 2011; Smith et al. 2014).

As the first directly dated sequence for a residential settlement at Cahal Pech, our results provide an initial framework for understanding the growth and decline of households around the site center, and differences between cultural developments within house groups and the civic-ceremonial site core. We compare our results to previous radiometric dates from the Cahal Pech site core sampled from Preclassic contexts (Awe 1992; Healy and Awe 1995), and to relatively dated sequences from both the site core and to other hinterland house groups from the Preclassic through Terminal Classic Periods. While the sample of radiocarbon dates for the Tzutziiy K'in settlement group is small, the stratigraphic models presented here can be used to guide future research focused on collecting additional radiocarbon samples at the site for undated events, as well as generating comparable datasets from other house groups to reconstruct broader spatial, demographic, and socio-political developments at Cahal Pech and in the Belize Valley.

Site Background

Archaeological investigations at Cahal Pech have been ongoing since the late 1980s under the auspices of the Belize Valley Archaeological Reconnaissance (BVAR) Project (Figure 3.3). Stratigraphic excavations conducted in the site core in Plaza B identified contexts representing the earliest permanent settlement at Cahal Pech dating to 1200-900 cal BC, associated with the first documented ceramics (Cunil ceramic complex) in the region (Sullivan and Awe 2013). During this time, the Maya of the Belize Valley lived in small, relatively egalitarian, and economically autonomous household groups (Awe 1992; Clark and Cheetham 2002; Healy and Awe 1995). A limited program of radiocarbon dating in the early 1990s was aimed at understanding the timing of the foundation and early growth of Cahal Pech into a major civic-ceremonial center during the Early to Late Preclassic Period (Awe 1992; Awe and Helmke 2005; Healy et al. 2004a). The clearest evidence for social differentiation at Cahal Pech appeared during the Late Preclassic, when the presence of monumental architecture and the first elaborate tombs suggest it was the seat of power for a regional center (Awe 1992, 2013; Garber and Awe 2008; Healy et al. 2004a). Other large, formally organized civic centers were also established during the Late Preclassic throughout the Belize Valley including Blackman Eddy, and Xunantunich Group E, Pacbitun, Actuncan, and Barton Ramie (Awe 1992; Brown et al. 2013; Garber et al. 2004; Healy et al. 2004b). During the Early and Late Classic Periods, Cahal Pech was one of the largest centers in the region, whose geographic position afforded it control over households in the fertile alluvial plains below the site, as well as command of the Belize River as a natural exchange route linking the Central Petén of modern day Guatemala to the Caribbean Sea (Awe 1992).

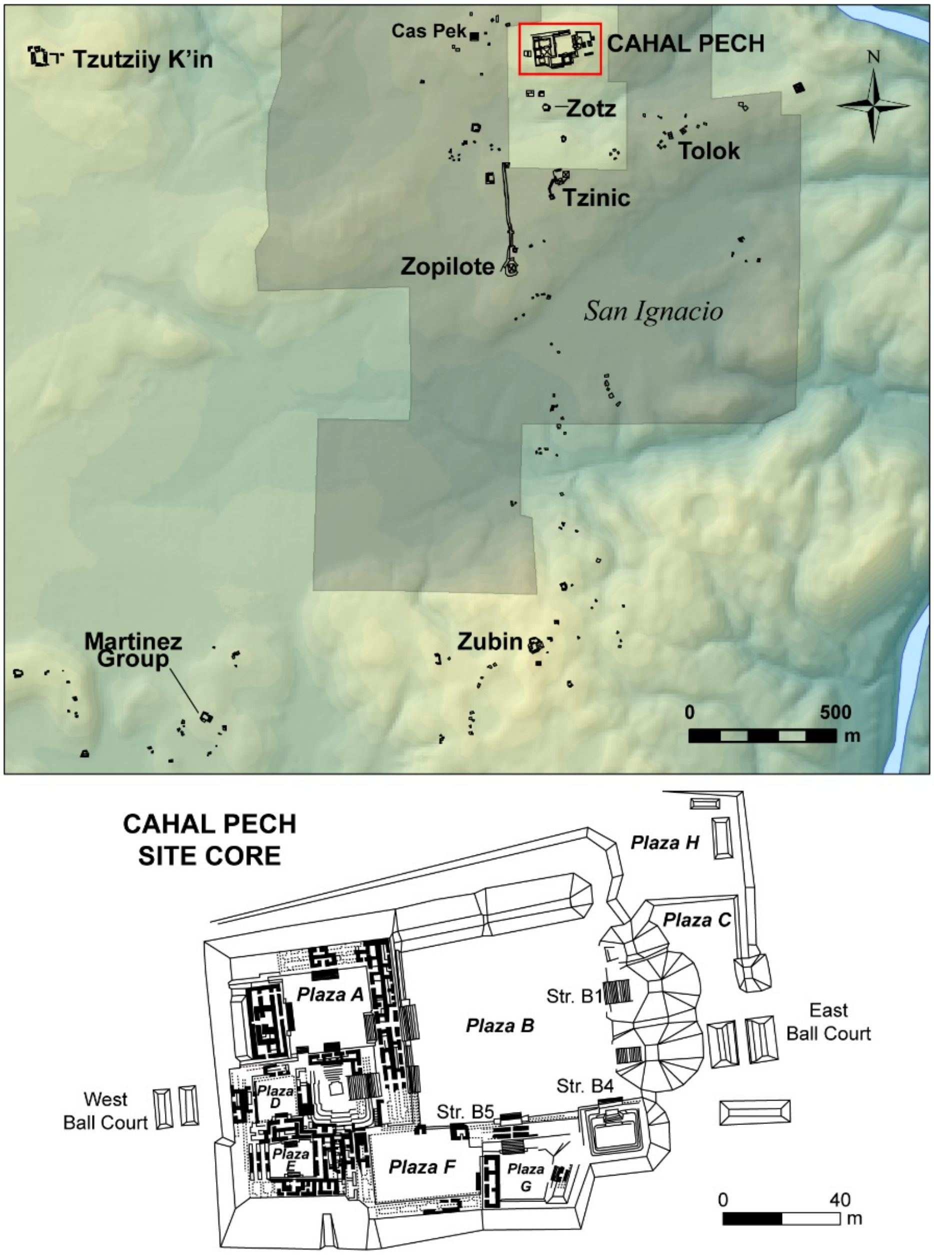

Figure 3.3: Map of Cahal Pech showing the relationship between the site core and known house groups (top), and detail of site core (bottom).

In this paper we focus on understanding the settlement and growth of Tzutziiy K'in (roughly translating to "sunset" in Yucatec Mayan), a large house group located atop a small hill approximately 1.8 km directly west of the Cahal Pech site core (Figure 3.4). A total of seven structures surround the main plaza of Tzutziiy K’in, many of which have been heavily looted. Stratigraphic excavations were conducted in Structures 1, 2, and 3 within the main plaza at Tzutziiy K’in (Ebert and Dennehy 2013).

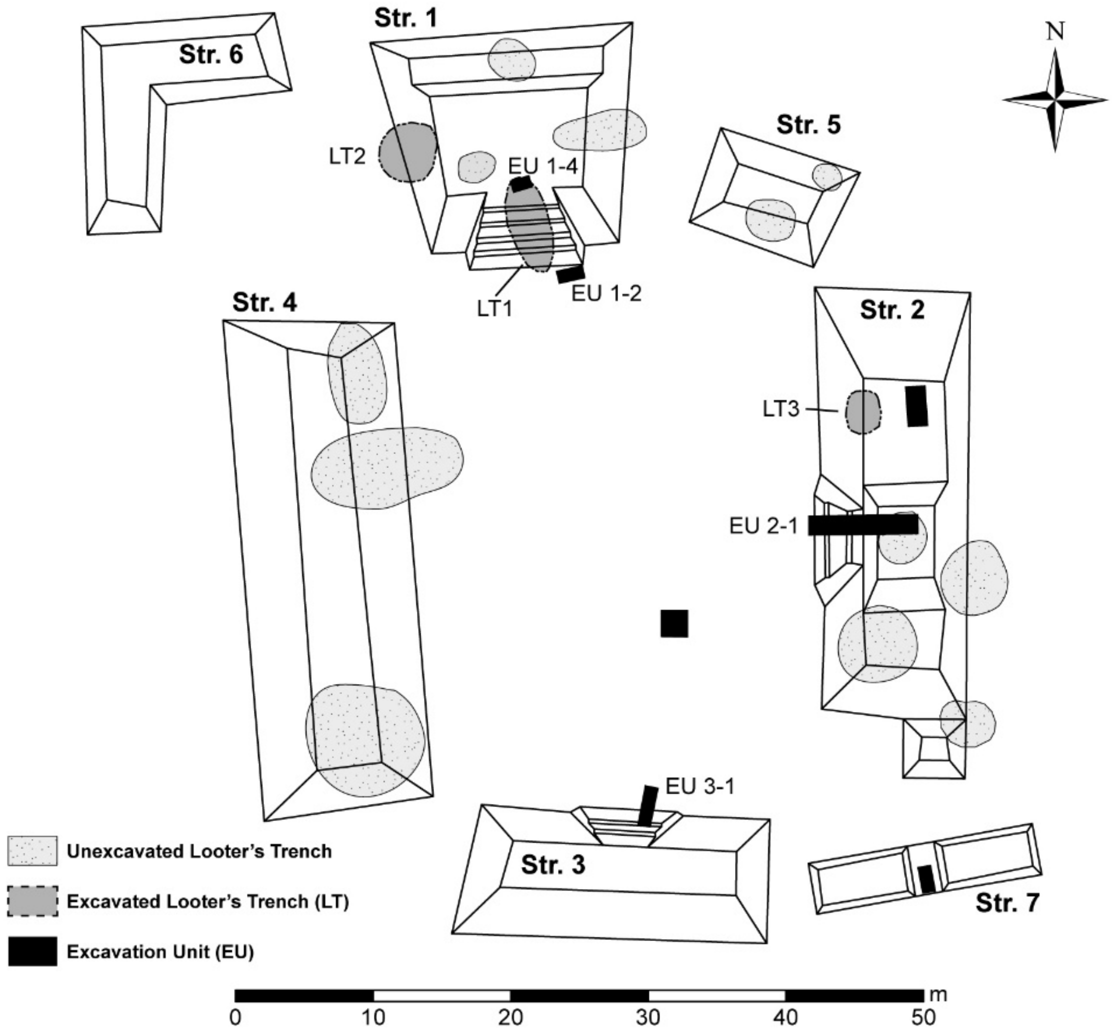

Figure 3.4: Map of Tzutziiy K’in with locations of test excavations and excavated looter’s trenches.

Structure 1, the northern-most structure in the main plaza, was the most heavily looted at the site. Salvage excavations were conducted in looter’s trenches (LT1 and LT2) and profiles exposed by looters were cleared to ascertain the stratigraphy of the construction sequences.

Structure 2 is located on the eastern side of the main plaza at Tzutziiy K'in. Three excavation units were placed along the centerline of Structure 2 (Units 2-1, 2-2, and 2-3) and a single unit was positioned on the north side of the summit (Unit 2-4). Salvage excavation was conducted in a looter's trench located on the west side of the building (LT3) with the goal of recovering additional stratigraphic information about the building. Excavations on Structure 3 consisted of a single 1×3m axial trench placed at the center of the structure and extending into the plaza. Because this structure suffered the least damage from looting at the site, the goal of excavation was to recover chronologically secure contexts. Based on ceramic evidence for the earliest cultural levels at the site, Tzutziiy K'in was likely a small settlement during the end of the Middle Preclassic Period (Kanluk ceramic phase). Beginning in the Late Preclassic people living in this settlement started to build large elaborate architecture and import exotic materials, including obsidian and jade, perhaps demonstrating elevated status based on connections to broader regional trade networks (Ebert and Denney 2013).

Methods

Carbonized twig samples for AMS ^{14}C dating were recovered from stratified contexts during excavations at Tzutziiy K'in Structures 1, 2, and 3. Samples were collected *in situ* from isolated features, construction fill, and in association with plaster floors. Samples were prepared along with standards and backgrounds at the Pennsylvania State University Human Paleoecology & Isotope Geochemistry Lab and the University of California-Irvine Keck Carbon Cycle AMS Facility (UCI KCCAMS) following standard practices as described by Kennett and colleagues (2014). Short-lived twig samples were selected for dating to reduce erroneous age assignments from the "old wood effect" (Kennett et al. 2002; Schiffer 1986). All ^{14}C ages reported in Table

3.1 are reported as conventional radiocarbon ages corrected for fractionation with measured $\delta^{13}C$ following Stuiver and Polach (1977). Date calibrations and stratigraphic models were produced in OxCal v.4.2 (Bronk Ramsey 2009) using the IntCal13 Northern Hemisphere atmospheric curve (Reimer et al. 2013). Calibrated and modeled date ranges are reported at the 2-σ level.

We developed Bayesian stratigraphic models to understand the occupational history of Tzutziiy K'in. Traditional statistical analysis of ^{14}C dates from archaeological contexts has relied on probability distributions to determine the likelihood that two dated events were sequential or contemporaneous. The Bayesian approach, on the other hand, incorporates *a priori* contextual and stratigraphic information obtained in the field within modeled sequences of ^{14}C dates to constrain probability distributions (Bayliss and Bronk Ramsey 2004; Bronk Ramsey 2015; Bronk Ramsey et al. 2010; Buck et al. 1991; Culleton et al. 2012; Douka et al. 2014; Higham et al. 2014; Huster and Smith 2015; Inomata et al. 2013, 2014; Kennett et al. 2014; McClure et al. 2014).

Table 3.1: Calibrated AMS ^{14}C dates from Tzutziiy K'in. Depth below a datum point in centimeters is denoted by "cmbd".

Sequence	UCIAMS#	Provenience	Conventional ^{14}C age (BP)	2-σ cal range (prior)
Structure 1	121550	Str. 1 Unit 1-4 L1 120 cmbd	1225 ± 15	715-880 AD
	121549	Str. 1 Unit 1-2 L2 140 cmbd	1245 ± 20	685-865 AD
	123531	Str. 1 Unit LT1 82 cmbd	1545 ± 15	430-565 AD
	121551	Str. 1 Unit LT1 160 cmbd	1595 ± 15	415-535 AD
	123530	Str. 1 Unit LT1 188 cmbd	1770 ± 15	225-330 AD
Structure 2	123532	Str. 2 Unit 2 L5 233 cmbd	1255 ± 15	685-775 AD
	121554	Str. 2 Unit 3 L3 248 cmbd	1365 ± 15	645-670 AD
	121553	Str. 2 Unit LT3 455 cmbd	1555 ± 15	430-550 AD
Structure 3	121552	Str. 3 Unit 3-1 L10 252 cmbd	2150 ± 20	350-110 BC

Eight AMS radiocarbon dates from Structure 1 (*n*=5) and Structure 2 (*n*=3) at Tzutziiy K'in were modeled stratigraphically within two ordered sequences within OxCal. Strata that separate directly dated deposits were modeled as single boundaries (i.e., events that were not directly dated). Additional boundaries were placed at the beginning of each sequence to represent the beginning of activity at a structure (Structure 1) or the deepest cultural levels reached during excavations (Structure 2). Boundaries were also placed at the end of each sequence that provide an approximate time range for the termination of structure use. The difference command was used to estimate the length of time represented by directly dated elements of a sequence (i.e., how long a structure was used before being remodeled; Culleton et al. 2012:1577). Stratigraphic models generate agreement indices (A) for the posterior distributions of each radiocarbon date in a model to determine how well the modeled dates fit with the available contextual data (Bronk Ramsey 2009). Individual agreement indices are combined (A_{model}) to see if the model as a whole is likely given the data. The model for Structure 1 generated an agreement index of 92.6% and Structure 2 generated an agreement index of 93.5%.

Results

Excavations and AMS ^{14}C dating indicate that Tzutziiy K'in was settled by at least the beginning of the Late Preclassic Period, if not earlier, and was inhabited continuously through the Terminal Classic Period. The earliest ^{14}C date from Tzutziiy K'in dates to 325-110 cal BC (UCIAMS-121552), and comes from a layer of fill at Structure 3 that was placed on top of a black paleosol resting directly on bedrock at the site (Figure 3.5). The fill deposit contained high concentrations of late Middle and Late Preclassic Period ceramics primarily dating to the Kanluk (Savanna Orange) ceramic and Xakal (Sierra Red, Polvero Black) ceramic phases. The layer of fill also contained household debris such as obsidian and chert used for tools, freshwater shell, and fragments of ground stone tools (Ebert and Dennehy 2013). The placement of the fill was likely used to level out the uneven hilltop prior to initial construction at the site. Settlement at Tzutziiy K'in may have occurred earlier in the Middle Preclassic, however, based on the large volume of ceramics and residential debris within the midden fill.

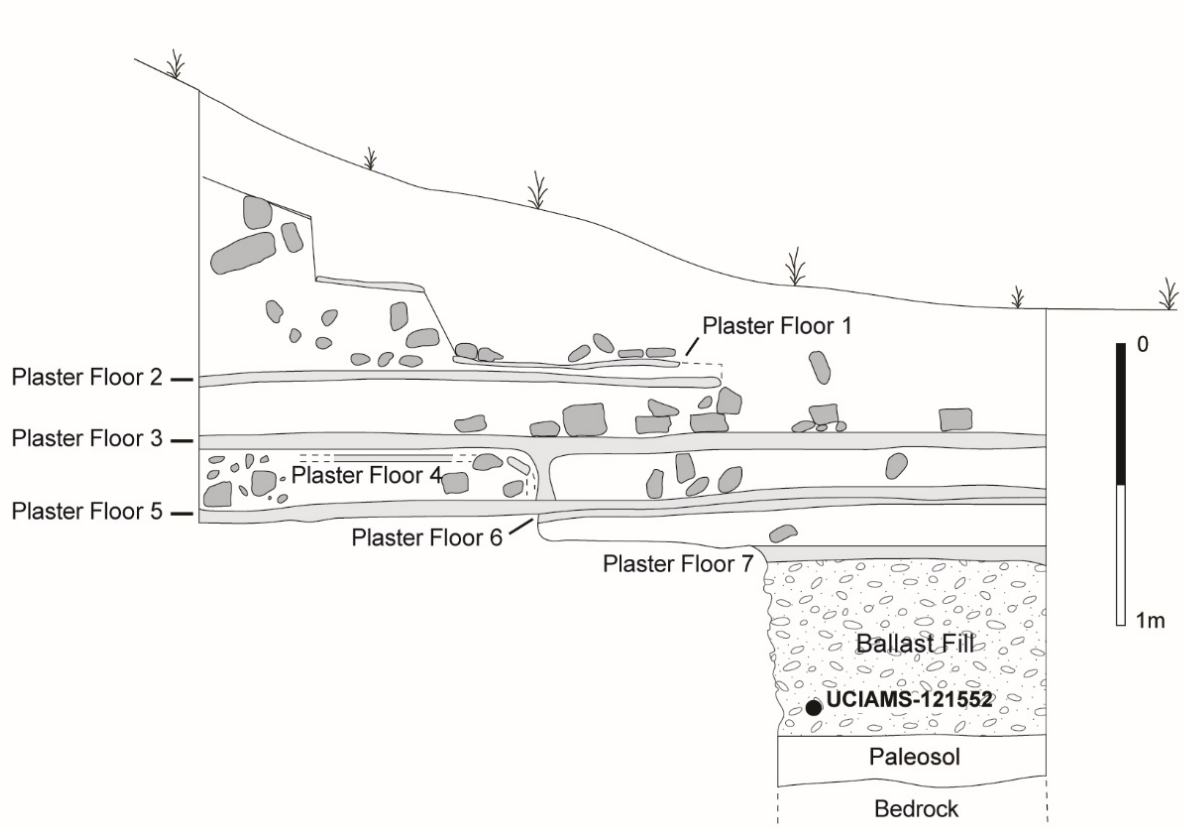

Figure 3.5: Profile of EU 3-1 at Tzutziiy K'in Structure 3 with location of earliest ^{14}C date for the site. Subsequent occupational surfaces are also depicted.

Structure 1 Sequence

Subsequent construction at Structure 3 spans from the Late Preclassic through Late to Terminal Classic Periods. Middle to Late Preclassic ceramics from the Kanluk and Xakal phases are present in strata below Floor 3. The fill between Floors 2 and 3 contained Floral Park and Mount

Hope complex ceramics, representing the Late Preclassic to Early Classic use of the structure. Spanish Lookout and Tiger Run complex ceramics (Belize Red, Mount Maloney Black, Juleki Cream Polychrome) dating from the Late to Terminal Classic (primarily Belize Red types) were recovered in strata above Floor 2, and represent the final construction and use of Structure 3. AMS ^{14}C dates from Structure 1 were modeled within a sequence using stratigraphic and contextual data to estimate the timing of events not directly dated, and to understand the nature and timing of the construction phases for the structure (Figure 3.6 and Table 3.2). Five major construction events were modeled following the first construction phase for the structure, which was the placement of Plaster Floor 1. All of these events involved the construction of platforms and structures and are labeled sequentially as TK-1 # (i.e., Tzutziiy K'in Str. 1):

- **TK-1 1st**: The earliest building was a small, low platform placed on top of Plaster Floor 1. The platform was likely constructed in the Late Preclassic between 45 cal BC - cal AD 330. The ceramic assemblage associated with TK-1 1st is primarily composed of ceramics dating to the Xakal phase, with a smaller number of Kanluk phase ceramics present.
- **TK-1 2nd**: Subsequent activity consisted of the placement of a low apron-molded platform that was built during the very end of the Late Preclassic or during the Early Classic Period. The interior of the structure was composed of a rubble construction fill (cal AD 230-335; UCIAMS-123530). A ^{14}C sample was collected from within construction fill outside of TK-1 2nd, and dates to cal AD 405-530 (UCIAMS-121551). The span of time between the dates from the inside and outside fill, representing the use TK-1 2nd, is estimated between 90-265 cal yr. The structure was likely used throughout the Early Classic Period.

- **TK-1 3rd**: A larger platform, approximately 2m tall, was constructed at the end of the Early Classic Period (cal AD 420-550), and was composed of a series of fill episodes interspersed with construction floors to shape the final façade of the building. During this event a stairway facing the plaza was also added to the south side of TK-1 3rd. The span of time estimated between construction of TK-1 3rd and TK-1 4th is estimated between 5-135 cal yr, indicating that the platform was used for a shorter period of time compared to previous buildings.
- **TK-1 4th**: The penultimate phase of construction consisted of a series of fill episodes interspersed with construction floors that were used to remodel and enlarge Structure 1. The fill within this phase of construction dates to 435-575 cal AD (UCIAMS-123531), at the end of the Early Classic Period. A plaster floor located within the plaza in front of Structure 1 corresponds to this construction phase. A radiocarbon sample collected from directly on top of the floor suggest that it was used during the beginning of the Late Classic Period (cal AD 685-775, UCIAMS- 121549). The span of time estimated between the placement of fill for TK-1 4th and the use of plaza plaster floor is estimated between 135-295 cal yr.
- **TK-1 5th**: The final building included placement of a small superstructure on top the previously constructed building. This may have occurred relatively quickly between 0-150 cal yrs. The superstructure contained a plastered bench running east-to-west across the back of the room. A radiocarbon sample recovered from deposits that postdate the construction of the superstructure produced a 2-σ date range of cal AD 720-880 within the sequence. The final boundary for the Structure 1 sequence represents the terminal use and abandonment of the structure, and is estimated to date to between cal AD 715-1065 during the Terminal Classic Period.

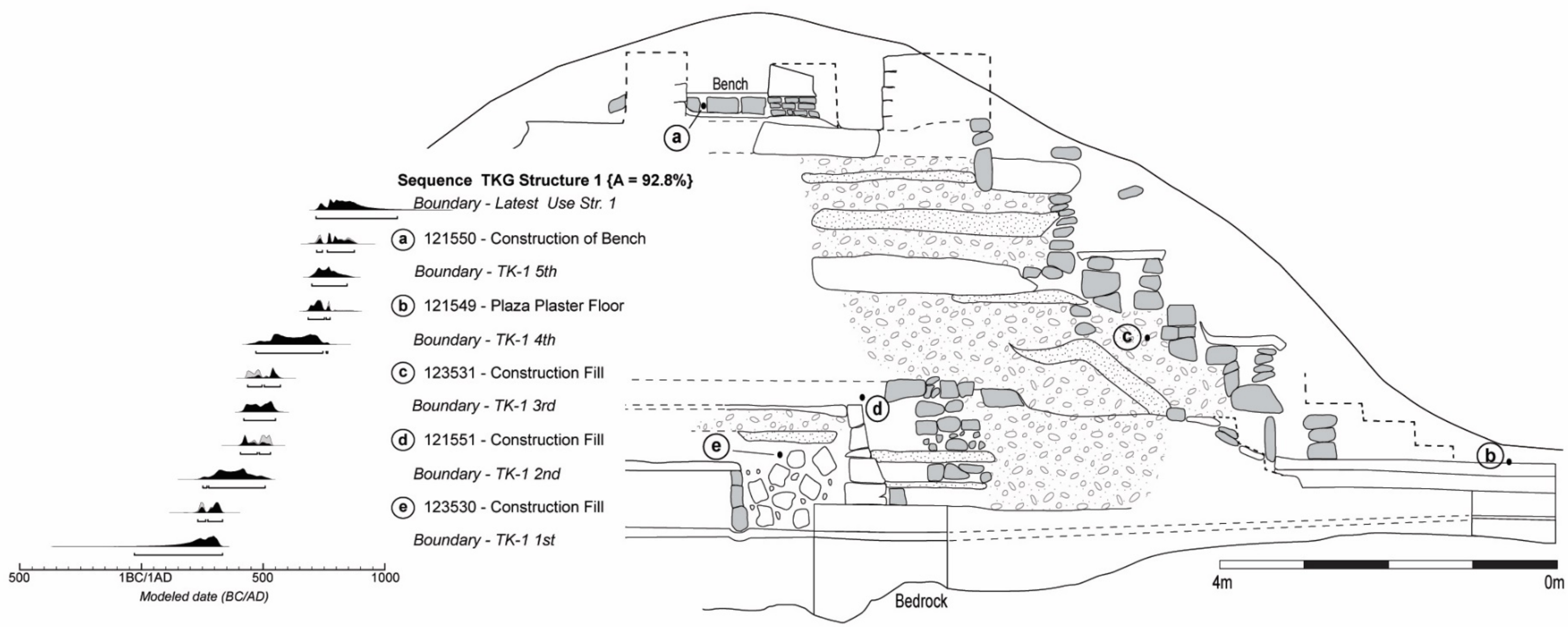

Figure 3.6: Profile of Tzutziiy K'in Structure 1 with location of AMS ^{14}C samples and modeled date calibrations.

Table 3.2: Modeled radiocarbon sequence for Tzutziiy K'in Structure 1.

UCIAMS#	Provenience	Conventional ^{14}C age (BP)	Modelled 2-σ cal range
Boundary	*Latest Use of Structure 1*		AD 715-1065
121550	Construction of Bench	1225 ± 15	AD 720-880
Boundary	*TK-1 5th - Superstructure and Stair Extension*		AD 700-850
Difference	*Plaza Plaster Floor - Construction of Bench*		*0-150 yr*
121549	Plaza Plaster Floor	1245 ± 15	AD 685-775
Boundary	*TK-1 4th: Enlarge Structure*		AD 470-770
Difference	*Construction Fill 3 - Plaza Plaster Floor*		*135-295 yr*
123531	Construction Fill 3	1545 ± 15	AD 435-575
Boundary	*TK-1 3rd - Platform with Stairway*		AD 420-550
Difference	*Construction Fill 2 - Construction Fill 3*		*5-135 yr*
121551	Construction Fill 2	1595 ± 15	AD 405-530
Boundary	*TK-1 2nd: Construction of Apron Platform*		AD 250-510
Difference	*Construction Fill - Construction Fill 2*		*90-265 yr*
123530	Construction Fill	1770 ± 15	AD 230-335
Boundary	*TK-1 1st: Construction of First Platform and Plaster Floor 1*		45 BC - AD 330

Structure 2 Sequence

The sequence for Structure 2 includes several construction events dating from the Early to Terminal Classic Periods (Figure 3.7 and Table 3.3). Excavations at Structure 2, however, did not expose the complete construction sequence for the building, and the earliest boundary in the sequence represents the earliest observed activity at the building in the Early Classic Period (cal AD 350-560). Activity that extends further back into the Early Classic or Late Preclassic Periods is, however, likely. The first ^{14}C date in the Structure 2 sequence was recovered from LT3 Feature 1 and dates to the Early Classic Period (cal AD 430-555; UCIAMS-123532). Feature 1 contained several bone fragments and two human teeth, and may represent a cache or secondary burial typically associated with eastern shrine buildings in the Belize Valley (Awe 2008). Only three diagnostic ceramics were recovered from Feature 1, including one Actuncan Orange Polychrome sherd (Early Classic Hermitage phase). Four plaster floors, visible in profile in LT3 and Unit 2- 1, were placed above Feature 1 and are represented as separate boundaries in the Structure 2 sequence. The placement of the first floor in the series (Plaster Floor 4) occurred at cal AD 440-600, and perhaps was contemporaneous with the use of Feature 1. A ^{14}C sample collected from the surface of Plaster Floor 2 dates to cal AD 645-670 (UCIAMS-121554), falling wholly within the Tiger Run ceramic phase at the beginning of the Late Classic Period. The superimposing Plaster Floor 1 was likely placed soon after at cal AD 650-720.

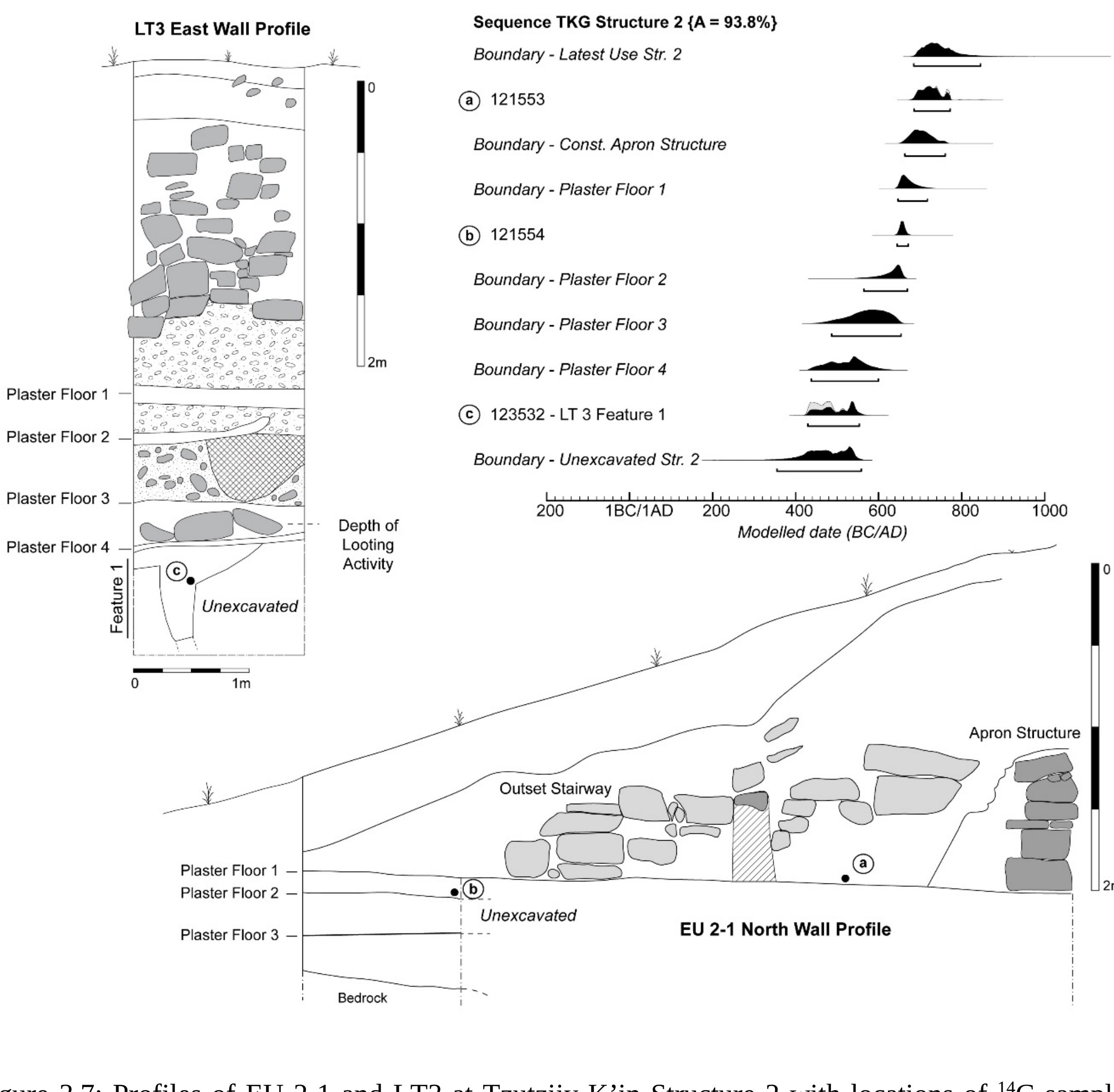

Figure 3.7: Profiles of EU 2-1 and LT3 at Tzutziiy K'in Structure 2 with locations of ^{14}C samples and modeled date calibrations.

Table 3.3: Modeled radiocarbon sequence for Tzutziiy K'in Structure 2.

UCIAMS-#	Provenience	Conventional ^{14}C age (BP)	Modelled 2-σ cal range
Boundary	*Latest Use of Structure 2*		AD 685-850
121553	Construction Fill and Outset Stairway	1555 ± 15	AD 690-770
Boundary	*Construction of Aproned Building*		AD 665-760
Boundary	*Plaster Floor 4*		AD 650-720
121554	Surface of Plaster Floor 3	1365 ± 15	AD 645-670
Boundary	*Plaster Floor 3*		AD 565-670
Boundary	*Plaster Floor 2*		AD 490-655
Boundary	*Plaster Floor 1*		AD 440-600
123532	Feature 1	1255 ± 15	AD 430-555
Boundary	*Unexcavated Structure 2*		AD 350-560

Several discrete construction events were documented through excavations after the placement of the series of plaster floors above Feature 1. During the middle of the Late Classic (cal AD 665-760) a low platform with an aproned façade was placed directly on top of Plaster Floor 1. This was followed by the placement of two parallel walls in front of the aproned building. The space between the walls was filled with rubble to enlarge Structure 2. This rubble fill was put in place between cal AD 690-770 (UCIAMS-121553). Once the fill was in place, a stairway leading into the plaza was built in front of the structure. The placement of the stairway may have occurred concurrently with enlargement of the rest of the structure. The latest use of the Structure 2 occurred between cal AD 685-850, during the Late to Terminal Classic Periods. This boundary estimate is confirmed by the presence of Tiger Run and Spanish lookout phase ceramics associated with the terminal architecture of Structure 2.

Discussion

AMS ^{14}C dating and stratigraphic modeling from Tzutziiy K'in provide new information about the nature and timing of settlement expansion during the Preclassic through Terminal

Classic Periods at Cahal Pech. High-resolution AMS ^{14}C for Tzutziiy K'in have error ranges between 15-20 ^{14}C yr, allowing for more precise age determinations compared to relative ceramic dating, which often places the length of occupational and construction sequences within large blocks of time that sometimes exceed 500 years. Stratigraphic models developed here for Tzutziiy K'in provide a framework for understanding the chronology of this large house group in relation to the spatial, demographic, and political growth of Cahal Pech site core and settlement system (Figure 3.8 and Table 3.4). At least three periods of settlement and growth at Tzutziiy K'in are represented by modeled ^{14}C dates including: (1) Late Preclassic Period settlement, (2) increased site construction and expansion in the Early Classic Period, and (3) Late to Terminal Classic Period remodeling and termination of site occupation.

Table 3.4: Previous radiocarbon date reported from Cahal Pech and the peripheral house groups of Cas Pek, Tolok (after Awe 1992: Table 1 and Healy and Awe 1995: Table 1), and the Martinez Group (Ebert 2015a). Date ranges are reported at the 2-σ level. AMS ^{14}C dates are denoted with a "*".

Site/ House Group	Context	Ceramic Phase	Lab Number	Conventional ^{14}C age (BP)	Calibrated Yr (BC/AD)
Martinez	Str. 3, below Floor 2	Hermitage	UCIAMS-150915*	1490 ± 20	AD 540–625
Cas Pek	Str. D-1, Floor 7	LF Xakal	Beta-77202	2020 ± 140	390 BC–AD 320
Cahal Pech	Str. B-4, Plaza B	LF Xakal	Beta-77206	1950 ± 200	405 BC–AD 535
Tolok	Str. 1 bedrock	LF Kanluk	Beta-77199	2220 ± 100	535 BC–AD 1
Cas Pek	Str. C Level 11	LF Kanluk	Beta-77203	2230 ± 50	400–185 BC
Tolok	Str. 14 platform	LF Kanluk	Beta-77201	2370 ± 60	755–265 BC
Cahal Pech	Str. B-4 7-sub	LF Kanluk	Beta-40863	2470 ± 90	795–405 BC
Cahal Pech	Str. B-4 9-sub	EF Kanluk	Beta-40864	2720 ± 60	1000–800 BC
Cahal Pech	Str. B-4 10a-sub	Cunil	Beta-77205*	2800 ± 50	1110–830 BC
Cahal Pech	Str. B-4 10c-sub	Cunil	Beta-40865	2740 ± 70	1285–500 BC
Cahal Pech	Str. B-4 11-sub	Cunil	Beta-56765	2730 ± 140	1055–800 BC
Cahal Pech	Str. B-4 11-sub	Cunil	Beta-77204	2710 ± 120	975–800 BC
Cahal Pech	Str. B-4 13-sub	Cunil	Beta-77207*	2930 ± 50	1280–980 BC

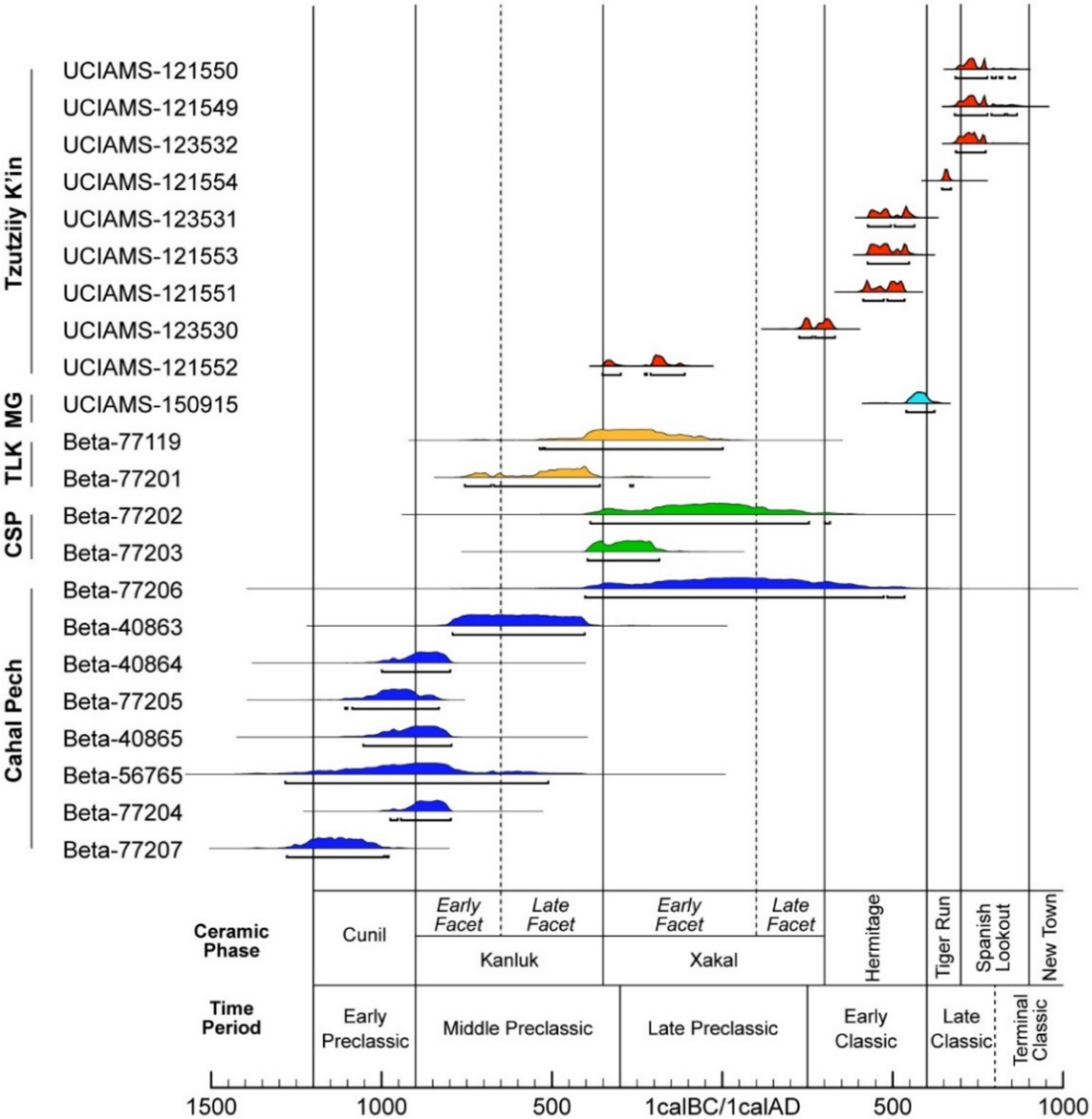

Figure 3.8: Calibrated radiocarbon date distributions from the Cahal Pech site core and hinterland house groups listed in Table 3.4 (CSP – Cas Pek; TLK – Tolok; MG – Martinez Group).

Late Preclassic Period Settlement

Current data suggest that initial settlement of this peripheral household group may have occurred as early as the end of the Middle Preclassic Period, based on ceramic evidence from some of the earliest deposits at Structures 1 and 3. The first directly dated construction within the Tzutziiy K'in main plaza took place during the beginning of the Late Preclassic Period (325-110 cal BC). This is well after the initial Cunil phase settlement at Cahal Pech (1200-900 cal BC; Awe 1992; Healy et al. 2004a), but concurrent with large-scale construction of the first monumental constructions in the Cahal Pech site center (Plazas A and B; Awe 1992; Healy et al. 2004a). Accelerated architectural activity in the core is evident in Plaza A, where Str. A1 Sub 1 reached a height of almost 15 meters. Plaza B was raised and enlarged during the Late Preclassic Period, and Str. B4 underwent several modifications (B-4\7th – B4\10th) beginning with the construction of a specialized round structure dating to 795-405 cal BC (Beta-40863; Healy and Awe 1995) likely used for public ceremonies (Aimers et al. 2000), and terminating with a large, 4m high pyramid that supported a pole and thatch super structure (Awe 1992).

Initial construction phases of mounds in several house groups peripheral to the Cahal Pech site core also occurred in the Late Preclassic, indicative of population growth at the site. Associated ceramic materials date the founding of at least five house groups to the Late Middle and Late Preclassic (Awe 1992:207; Cheetham et al. 1993; Iannone 1996; Powis 1996; Willey and Bullard 1956). Four radiocarbon dates from two peripheral settlements, Cas Pek and Tolok, date the earliest activity at these groups to 530-400 cal BC, with subsequent larger-scale residential and non-residential construction occurring after 350 cal BC during the Xakal ceramic phase (Healy and Awe 1995; Healy et al. 2004a). Ceramic associations suggest that this pattern of Late Preclassic settlement and growth is consistent with several other large house groups (e.g., Zubin, Zopilote, and Cas Pek) throughout the hinterlands of Cahal Pech (Awe 1992; Iannone 1996).

Early Classic Period Expansion

In the Early Classic Period (cal AD 250-600) sites throughout the Belize Valley began to grow in size and complexity. Settlement data document a substantial increase in population beginning in the Early Classic Period (e.g., Barton Ramie, Willey et al. 1965; see also Awe and Helmke 2005), and an increase in construction activity at Cahal Pech (Awe and Helmke 2005), Buena Vista (Ball and Taschek 2004), and Pacbitun (Healey et al. 2004b). At Cahal Pech, several structures within Plaza A were remodeled and the plaza resurfaced; Plazas C, D, F, and G grew substantially through the construction of new buildings; and the first phase of the eastern ball court was erected (Awe 1992; Awe and Helmke 2005: Table 1). Some of the most elaborate royal burials from the site date to the Early Classic Period based on ceramic associations (Awe 2013; Ishihara-Brito et al. 2013; Santasilia 2012). The Early Classic Period also sees the first introduction of Pachuca obsidian from the central Mexican Highlands into the Cahal Pech assemblage, as well as at other sites in the Belize Valley (Awe and Helmke 2005; Ebert 2015b). The presence of exotic artifacts, such Pachuca obsidian, in royal burials and residential contexts demonstrates the participation of Cahal Pech in larger inter-regional exchange networks within and beyond the Maya region.

Peripheral house groups experienced coeval expansion with the Cahal Pech civic-ceremonial core during the Early Classic Period. At the household level, the residents of Tzutziiy K’in began to build larger residential platforms at this time. At Structure 1, TK-1 3rd was constructed at the beginning of the Early Classic and was soon remodeled into TK-1 4th between

5-135 cal yr (mean = 65 cal yr). While excavations at Structure 2 did not reach sterile levels, modeled ^{14}C dates place the earliest construction of the building sometime during the Early Classic Period at cal AD 350-560. This pattern of site growth is noted at several other house groups around Cahal Pech, where Early Classic components were added to include relatively large domestic and non-domestic architecture (Iannone 1996; Powis 1996; Awe and Helmke 2005). More recent settlement research also suggests that some new residential groups were established in the Early Classic (Ebert 2015a), indicating continued population growth from the Preclassic into the Early Classic Period (Awe and Helmke 2005). A ^{14}C date from some of the earliest cultural contexts at the Martinez Group, south of the Cahal Pech site core, is associated with Dos Arroyos Orange Polychrome ceramics diagnostic of the Early Classic Period and date to cal AD 540-625 (UCIAMS-150915; Ebert 2015a).

Late Classic Period Remodeling and Terminal Classic Period Abandonment

By the Late Classic Period (cal AD 650-800), the appearance of monumental architecture, hieroglyphic inscriptions, and elaborate burials at large political centers in the Belize Valley, and throughout the Maya lowlands, signals the presence of ruling elite lineages (Martin and Grube 2008). While no Late Classic Period deposits have been directly dated from the site core at Cahal Pech, architectural data from excavated contexts indicate that the site reached its maximum size during this time. Buildings within public plazas in the western portion of the site were enlarged, and more restricted access plazas in the eastern sector of the site were constructed to function as royal residences (Awe 1992, 2008). The Cahal Pech settlement system also became increasingly stratified and complex during the Late Classic Period. Over 140 house groups have been documented around the site core, most of which possess evidence for Late

Classic occupation (Awe 1992; Awe and Brisbin 1993; Dorenbush 2013; Ebert 2015a; Ebert and Awe 2014). Some house groups became larger and more elaborate, and contained both public and ritual architecture. These elite house groups were surrounded by smaller, less elaborate residential settlements (Awe 1992), indicating increasing centralization of political economic power for some households within the local community.

Tzutziiy K'in was one of the largest hinterland house groups during the Late Classic Period (Ebert and Dennehy 2013). AMS ^{14}C dating of extensive and elaborate multi-component construction episodes at Tzutziiy K'in Structures 1 and 2 indicate that between cal AD 500-900 the residents of the group possessed the resources needed to remodel large buildings on a regular basis. The end of the Classic Period witnessed the largest construction episodes at Structure 1, which included the construction of a superstructure that contained a ceremonial bench (cal AD 720-875). Restricted rooms with benches served as potent political symbols in Classic Period Maya society, and these contexts were often focal points of tribute and gift presentation (Awe 2008). New styles of public architecture also began to dominate large public plazas of house groups at Cahal Pech, especially triadic eastern shrines (Aimers 1998; Awe 2008; Awe, In Press). The triadic eastern shrine at the house group of Zubin was associated with several Late Classic burials and construction episodes (Iannone 2003). Structure 2 at Tzutziiy K'in also resembles a triadic eastern shine. Several bone fragments and two human teeth were recovered from Feature 1 at Structure 2, which may have functioned as a cache or secondary burial. Recent excavations on the northern end of Structure 2 conducted in June of 2015 uncovered a small altar stone placed directly on top of a wall. The presence of ideologically significant artifacts and features indicates the social importance of the structure and may also reflect the socio-political status of the residents of Tzutziiy K'in in the Late Classic Period (Ebert and Dennehy 2013).

The Maya "collapse" at the end of the Terminal Classic Period (AD 800-900) was characterized by the cessation of political institutions and economic relationships centered upon divine kings living at large polities (Demarest et al. 2004; Aimers 2007; Kennett et al. 2012; Webster 2012; Ebert et al. 2014). Polities and populations were also impacted by severe drought, which has been associated with a decline in agricultural productivity, increased inter-polity warfare, and the collapse of elite socio-economic networks across the Maya lowlands (Curtis et al. 1996; Hodell et al. 1995, 2005; Webster et al. 2007; Dunning et al. 2012; Kennett et al. 2012; Medina-Elizalde and Rolling 2012; Iannone et al. 2014). In the Belize Valley, some large polities (e.g., Cahal Pech, Awe 1992, 2006; Buena Vista, Ball and Taschek 2004) may have been abandoned as early as AD 800 (Awe and Helmke 2007). Archaeological and epigraphic evidence from dated stone monuments indicate that the site of Xunantunich (LeCount et al. 2002) and Caracol (Chase and Chase 2004; Martin and Grube 2008) experienced a brief surge in elite activity between AD 820 and AD 860 (Ebert et al. 2014). Recent ^{14}C dating of burials from Baking Pot document a hiatus in activity at that site during the Early Postclassic (cal AD 900–1200) with subsequent reoccupation in the Late Postclassic (cal AD 1280–1420; Hoggarth et al. 2014).

Based on interpretations of ceramic data, the end of political activity at Cahal Pech in the Terminal Classic Period likely occurred prior to the end of the Spanish Lookout ceramic phase (approximately AD 800; Awe 1992, 2012). Several "terminal deposits" documented at the site core are associated with Spanish Lookout phase ceramics, and have been interpreted as indicators of the final activities in elite ceremonial contexts (Awe 2012). Additionally, only one high-status burial has been associated with Terminal Classic contexts (Burial H1 in Plaza H; Awe 2013), indicating a decline in elite mortuary activity in the site core at the end of the Late

Classic Period. Direct dating of construction activity at Tzutziiy K'in documents a similar decline in activity at the beginning of the Terminal Classic, and evidence for continued construction after the Terminal Classic is not supported by current chronological data. The latest ^{14}C date for Structure 1 (cal AD 720-875) falls within the Terminal Classic Period, and the latest date for Structure 2 overlaps with the date ranges for the Late and Terminal Classic Periods (cal AD 690-770). A large number of Terminal Classic Spanish Lookout phase ceramics have been identified in the latest deposits at Structures 1, 2, and 3. These were recovered from mixed deposits above the final occupational surfaces of each structure, and may represent the latest occupation of Tzutziiy K'in. A continued program of direct dating of terminal deposits and architecture from the Cahal Pech site core and within household contexts will help to clarify the timing and nature of socio-political and demographic change during the Terminal Classic Period.

Conclusions

High-resolution AMS ^{14}C dating and stratigraphic modeling for Tzutziiy K'in provides the first absolute chronology spanning the occupational sequence at Cahal Pech and surrounding settlements. Previous efforts to understand the nature and timing of occupation and cultural change within the settlement at Cahal Pech, as well as in the civic-ceremonial site core, have been primarily dependent upon age estimates derived from ceramic typologies. Our chronological data, combined with temporal data from ceramics, provide finer-grained temporal control needed to understand household settlement and growth. Three primary phases of occupation were found within the sequence for Tzutziiy K'in. The house group was settled by at least between 325-110 cal BC during the end of the Middle Preclassic as a small farming household, as population was expanding around Cahal Pech and throughout the Belize Valley.

Multiple masonry platforms were constructed in the main plaza at Tzutziiy K'in during the Early Classic Period (AD cal 350-650), perhaps in response to changing social and economic conditions in the Cahal Pech site core. Tzutziiy K'in became one of the largest hinterland house groups associated with Cahal Pech during the Late and Terminal Classic Periods (cal AD 650-900) suggesting that a politically and economically important lineage resided at this location. The terminal occupation of the group between cal AD 850-900 may indicate that the political "collapse" of Cahal Pech may have similarly impacted large high-status house groups like Tzutziiy K'in. This study highlights the need for additional AMS ^{14}C dating at Cahal Pech, both in the site core and house groups, to establish a more precise and accurate chronology for the socio-political development and decline of this important Maya center.

Chapter 4

MAYA HOUSEHOLD ECONOMIES AND THE ORIGINS OF INEQUALITY IN THE PRECLASSIC BELIZE RIVER VALLEY[1]

Abstract

Maya archaeologists have traditionally attributed the emergence of socio-economic inequality to the development of elite control of local production and regional redistribution during the Preclassic Period (1200 BC–AD 300). In this study, we focus on characterizing household-level economic systems using geochemical sourcing of obsidian and ceramics from the ancient Maya community of Cahal Pech, in the Belize Valley. Technological and portable X-ray fluorescence (pXRF) geochemical analyses of obsidian (*n*=1189) indicate a decentralized domestic obsidian exchange system based on the differential consumption of source material between households throughout the Preclassic. Instrumental neutron activation analysis (INAA) of ceramics (*n*=192) identified four primary compositional groups from high-status households in the civic-ceremonial site center and two peripheral house groups. The Early Preclassic (1200-900 BC) Cunil assemblage is compositionally unique in the Maya lowlands, providing evidence for local production of these early ceramics. In the Middle Preclassic (900-300 BC), INAA data provide evidence for the specialized production and importation of Mars Orange vessels from the Belize Valley into the Petén by high-status households. Ceramic exchange may have been one strategy for linking neighboring high-status individuals into networks of interdependency within a developing institutional economy, contributing to the wealth and status of some Cahal Pech households.

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Introduction

Archaeological studies have long focused on understanding the dynamics of prehistoric economies because the production, distribution, and consumption of resources are embedded within larger social and political processes. Studies of pre-industrial agrarian economies have traditionally been dominated by linear evolutionary models that describe economic change as a consequence of the unidirectional growth of hierarchy, emphasizing strategies used by emergent elites to gain and maintain wealth (Brumfiel and Earle 1987; Arnold and Munns 1994; Clark and Blake 1994; Clark and Parry 1990; Earle 1997; Hayden 2001; Sahlins 1972; Service 1962, 1975). These models suggest that households were passive actors within early agrarian societies, and that domestic production had little economic impact beyond the local niche (Feinman and Nicholas 2000; Schortman and Urban 2004). More recent research in Mesoamerica has focused on examining the structural and distributional aspects of economic organization that occurred at household, community, and regional scales to understand socio-economic developments (Douglas and Gonlin 2012; Feinman and Nicholas 2000; Henderson 2012; Hirth 2009, 2016; Masson et al. 2016). These alternative perspectives highlight the adaptive capacity of households to develop overlapping and contrasting economic strategies that contributed to social differentiation (Blanton et al. 1996; Brumfiel and Earle 1987; Hirth 2009, 2016; Sheets 2000).

Households composed the most basic economic unit in ancient Mesoamerican societies, and articulated directly with broader economic, social, and ecological processes (Ashmore and Wilk 1988; Flannery 1976; Robin 2003; Wilk and Rathje 1982; Willey et al. 1965). They served as the locus of agricultural decision-making, organization of daily tasks, and a point of engagement in the domestic economy for the acquisition of resources needed for basic subsistence. Small-scale specialized craft production, along with subsistence production, formed an essential component of Formative Period Mesoamerican domestic economies. Long-distance exchange of obsidian blades (and raw materials) and the presence of well-developed ceramic technologies in most regions of Mesoamerica, suggests that craft production was already present by the Early and Middle Formative Periods. Craft production and exchange of goods was likely initially integrated into the domestic economy as a risk minimization strategy to buffer against resource shortfalls where agricultural land was scarce (Arnold 1985; Fitzhugh 2001; Hayden 2001), while also serving to raise the overall well-being of the household (Hagstrum 2001).

The importance of the domestic economy grew in proportion to broader institutions that supported economic networks between households and communities (Hirth 2009:15). The institutional economy refers to the way that social, political, and religious activities were structured and supported above the level of the household (Hirth 2017:21). Broader institutional economies developed out of local interactions that integrated households, where the irregular distribution of subsistence and non-subsistence resources among and between people encouraged corresponding variation and competition between households (Hirth 2006; Neff 2014). In this context, tensions between self-interest and collective action likely motivated individuals to strive towards accumulating resources and status (Hayden 2001; Hirth 1993; Freidel and Schele 1988). While institutional economies developed out of local domestic interaction (Hirth 2016), they also served as a point of connection with distant groups across Mesoamerica, facilitating long-distance exchange of exotic resources that promoted the emergence of increasingly complex social groups. Understanding the production and distribution mechanisms of different types of goods within and between the domestic and institutional contexts facilitates modeling of overlapping and contrasting economic strategies that facilitated the emergence of stratification within early Mesoamerican groups.

In this study, we use geochemical source data of obsidian and ceramic artifacts from the lowland Maya site of Cahal Pech, located in the Belize Valley of western Belize (Figure 4.1), to examine the economic behaviors that structured both domestic and institutional economies during the Preclassic Period (1200 BC-AD 300). The first residents of Cahal Pech settled in small, relatively egalitarian, and economically autonomous household groups during the Early Preclassic (1200-900 BC; Awe 1992; Brown 2007; Clark and Cheetham 2002; Ebert et al. n.d.). Population expansion and economic growth at Cahal Pech and other Belize Valley sites during the Middle Preclassic were accompanied by the construction of public architecture restricted to larger house groups, signaling the emergence of higher status individuals within local communities. During this time, the appearance of increasingly standardized Mamon ceramics and evidence for the expansion of long-distance exchange networks dealing in exotic items, including obsidian blades, decorated pottery, jade, and other valuables have been identified throughout the Belize Valley region (Awe 1992; Awe et al. 1995; Hohmann 2002; Kersey 2006; Powis et al. 2016), and elsewhere in the Maya lowlands (Chase and Chase 2012:259; Clark and Cheetham 2002; Clark and Hansen 2001; Estrada-Belli 2011; Inomata et al. 2013, 2017; Rice 2015).

To examine economic development associated with emerging complex society at Cahal Pech, we compare distributions of obsidian and ceramics between domestic and non-domestic contexts dating from the Early to Late Preclassic Periods (1200 BC-AD 300; Table 1).
While there is evidence for the movement of many different commodities over long distances into the Maya region during the Preclassic (e.g., jade and greenstone, Hammond et al. 1977; Powis et al. 2016; granite, Tibbits 2016), our focus is on obsidian and ceramics because they formed the foundation of daily subsistence for the majority of Preclassic Maya households.

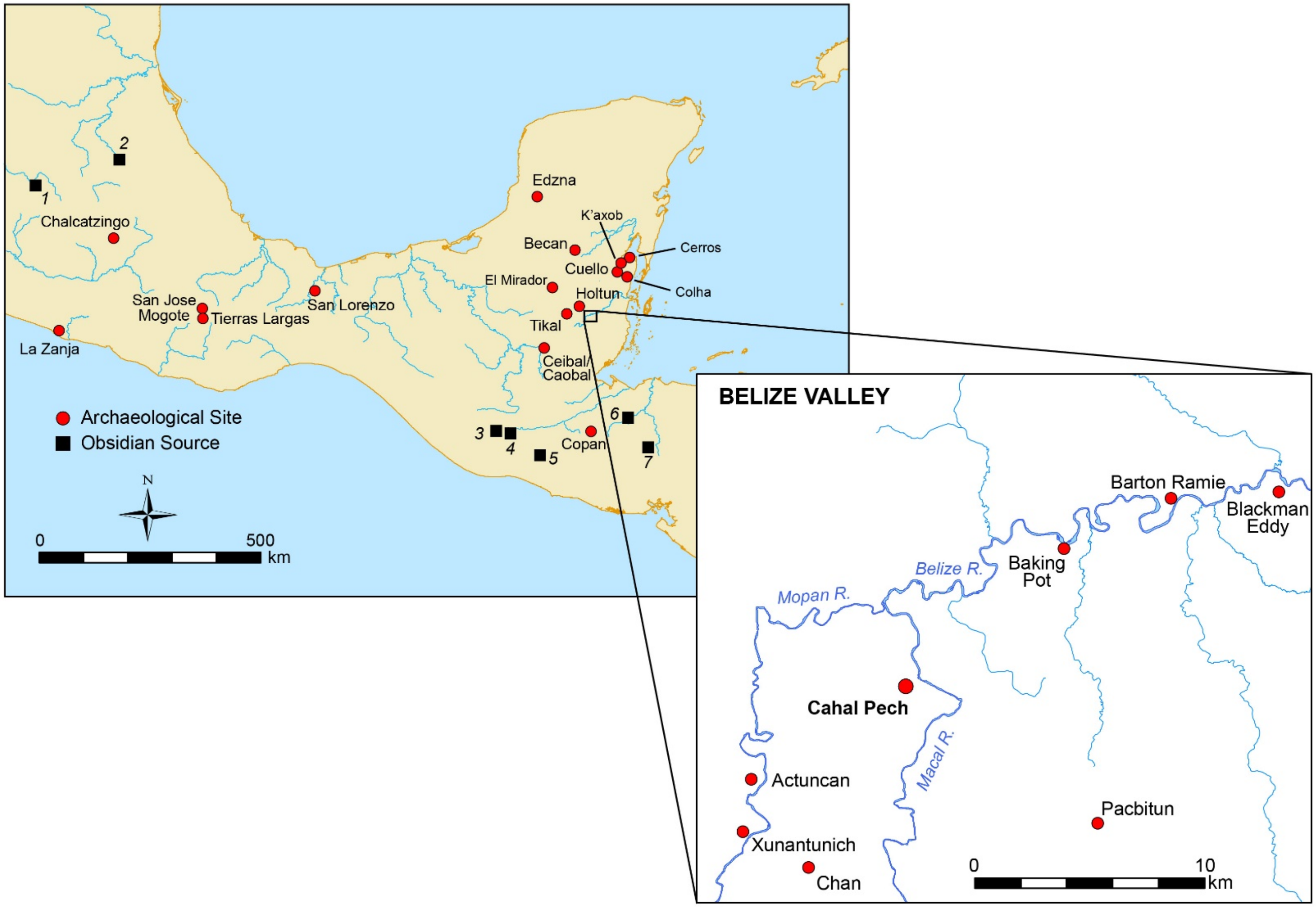

Figure 4.1: Map of Mesoamerica showing the location of Preclassic (Formative) Period sites and location of major obsidian sources mentioned in text. Outset map show the locations of major sites in the Belize River Valley. Obsidian sources: (1) Ucareo–Zinapecuaro, Michoacán, (2) Pachuca, Hidalgo, (3) San Martin Jilotepeque, Guatemala, (4) El Chayal, Guatemala, (5) Ixtepeque, Guatemala (6) San Luis/Source Y, Honduras, and (7) La Esperanza, Honduras.

Obsidian sourcing studies from the Maya lowlands have been applied to understand broad-scale economic networks (e.g., Golitko et al. 2012, 2016; Moholy-Nagy 2013), allowing us to compare our data from Cahal Pech to previously documented consumption patterns. Very few studies, however, have applied geochemical methods to examine local and regional ceramic production and distribution systems among Preclassic Maya communities (see Angelini 1998; Callaghan et al. 2017 for examples). Understanding distributional patterns of both of these key resources and crafts within and between households can be used to determine the suite of activities that defined the domestic economy (e.g., specialized craft production, local and long distance exchange) and how access to different economic networks may have impacted household wealth and status (Costin 1991:295; Feinman and Nicholas 2000; Flannery and Winter 1976; Henderson 2012; Smith 1987).

We performed technological and portable X-ray fluorescence (pXRF) geochemical sourcing of 1189 obsidian artifacts from the Cahal Pech civic-ceremonial site core and peripheral household groups to examine changes in consumption and technology over time. The results indicate that all households relied primarily on imported obsidian blades from three main sources in southern Guatemala: El Chayal, San Martin Jilotepeque, and Ixtepeque. While El Chayal obsidian dominated assemblages from domestic and non-domestic contexts in the Early Preclassic, a pattern that persisted until occupation ended in the Terminal Classic. Differential use of source materials between households, however, suggests that during this interval blades were obtained through decentralized domestic procurement systems.

Table 4.1: Preclassic Chronological periods and ceramic associations for Cahal Pech (after Awe 1992).

Time Period	**Calibrated Yr.**	**Cahal Pech Ceramic Complex**	**Regional Lowland Ceramic Tradition**
Late Preclassic	AD 100-300	Late Facet Xakal	Chicanel
	350 BC-AD 100	Early Facet Xakal	
Middle Preclassic	750-350 BC	Late Facet Kanluk	Mamon
	900-750 BC	Early Facet Kanluk	
Early Preclassic	1200-900 BC	Cunil	Pre-Mamon

Contrasting provisioning strategies were evident in the production and procurement of ceramics. Both long-distance and local economic networks were identified based on Instrumental neutron activation analysis (INAA) of ceramics (*n*=192) from radiocarbon dated Early to Late Preclassic Period deposits in the site core and two peripheral domestic groups. Using INAA we identified four primary compositional groups corresponding to changing Early, Middle, and Late Preclassic production patterns. The Early Preclassic Cunil ceramic assemblage is compositionally distinct from previously analyzed ceramics in the Maya lowlands, suggesting local production and consumption of this pottery type among the earliest occupants of Cahal Pech. By the Middle and Late Preclassic, the ceramics from higher status households were compositionally distinct when compared to peripheral household settlements. Comparative analysis of ceramic assemblages from Cahal Pech and sites in the central Petén region indicate that decorated Mars Orange wares were exchanged between high status households. This represented one avenue for Maya elites to underwrite power and authority in emergent high-status groups.

Provenance Studies of Early Mesoamerican Economies

Reconstructing the social and economic networks that facilitated the movement of key resources, craft items, and shared ideological expressions of wealth within and between communities and regions has been the subject of intensive geochemical provenance investigations in Mesoamerica for decades (Bishop 2014). Obsidian provenance investigations are common because the obsidian consumed in the Maya lowlands comes from multiple sources in the central highlands of Mexico and southern highlands Guatemala and has been well characterized using different geochemical techniques (e.g., INAA and ICP–MS; Boksenbaum et al. 1987; Cobean et al. 1991; Glascock et al. 1988, 1994; Cobean 2002). More recently, portable X-Ray fluorescence (pXRF) has become the method of choice for Mesoamerican obsidian provenance studies because it facilitates the non-destructive analysis of large quantities of samples at relatively high precision and low cost (e.g., Ebert et al. 2015; Glascock et al. 1998; Millhauser et al. 2011; Moholy-Nagy et al. 2013; Nazaroff et al. 2010; Peirce 2016; see also Freund 2013).

Before the widespread adoption of obsidian blade technology, communities across Mesoamerica relied on simple, expedient flaked tools produced from imported materials as their "cutting edge" (Clark 1987:260; Boksenbaum et al. 1987). Obsidian sourcing studies demonstrate that long-distance trade of raw materials and finished tools formed an essential part of inter-regional Formative/Preclassic Period economies, starting at least by 1800 BC in central Mexico (Boksenbaum et al. 1987; Cobean et al. 1991;), Oaxaca (Joyce 1991; Joyce et al. 1995), and along the Gulf (Cobean et al. 1991; Hirth et al. 2013) and Pacific coasts (Ebert et al. 2015). Mesoamerica's percussion flake tradition was gradually supplanted by prismatic pressure blade technology after 1200-1000 BC as more hierarchically organized groups developed along with an expansive trade in finished blades made from high-quality raw material from the highlands of Mexico and Guatemala (Awe and Healy 1994; Clark 1987; Clark and Blake 1994; Hirth 2012; Moholy-Nagy et al. 2013). While some researchers have suggested that controlling access to obsidian blade technology was a critical component in the development of inequality in Formative Mesoamerica (e.g., Clark 1987:275; Clark and Bryant 1997:133; Santley 1984; Spence 1981), technological and sourcing studies indicate that smaller communities and households also played a precocious role in the dynamics of long-distance exchange networks (Hirth et al. 2013; Winter and Pirres-Ferreira 1976). Hirth and colleagues (2013), for example, have documented that obsidian moved through a network of decentralized exchanges between households at the large Gulf Coast center of San Lorenzo, a pattern that continued despite the decline of centralized leadership at the site. A similar pattern has been noted among Formative households at the sites of Tierras Largas and San Jose Mogote in the Valley of Oaxaca, where domestic groups had equal access to obsidian but consumed sources differentially (Winter and Pires-Ferreira 1976). Through time a more homogenous assemblage at the Oaxaca sites suggests redistribution of obsidian perhaps by specific households, or perhaps in a market setting (Hirth 2008, 2016).

Obsidian provenance studies from the Preclassic Maya lowlands have concentrated on reconstructing broad trends in source consumption at the regional level using both geochemical and visual sourcing methods. While there is evidence for the importation of large quantities of blades from highland Guatemala sources in most parts of the lowlands by 1200-1000 BC (Golitko and Feinman 2015; Moholy-Nagy et al. 2013), consumption varied between and within different regions (Golitko and Feinman 2015; Hammond 1972; Rice 2015). Provenance studies have documented the early dominance of El Chayal obsidian at sites in the central Petén (Tikal, Moholy-Nagy et al. 2013; Petén Lakes, Rice 2015; Rice et al. 1985), Pasión (Ceibal, Nelson et al. 1977; Caobal, Aoyama and Munson 2012), and some Belize Valley sites (Cahal Pech, Awe et al. 1995; Blackman Eddy, Kersey 2006). Obsidian from the Ixtepeque source was more common in the Copan Valley (Aoyama 1999), with El Chayal and San Martin Jilotepeque (hereafter SMJ) composing only a very small portion of the assemblage. A general pattern noted among all assemblages is the increase of finished blades imported from all sources through the Preclassic, with relatively little evidence for high-volume local blade production at most sites.

Geochemical studies of archaeological ceramics have also been widely applied in Mesoamerica to understand the production, distribution, and consumption of Formative/Preclassic ceramics. INAA in particular has become the primary method used to source archaeological ceramics owing to easy sample preparation, high analytical precision, and multi-element analytical capacity (Bishop 2014; Minc and Sterba 2016). The results of INAA reflect the total elemental composition of ceramic pastes, with distinct and relatively homogenous compositional groups determined by trace element composition (Bishop and Neff 1989; Glascock 1992; Harbottle 1976; Neff 2000). Identified chemical groups can often be linked to production within specific geographic locations based on raw material types (Weigand et al. 1977) and frequency of samples within a particular group (i.e., criterion of abundance; Bishop et al. 1982).

Formative/Preclassic period ceramic INAA studies have focused on examining regional patterns of exchange and their implications for the development of early complex Mesoamerican societies. Fragments of carved-incised grey and fine paste white pottery imported from the Gulf Coast site of San Lorenzo have been identified stylistically and via INAA at multiple political centers in the Soconusco region, Oaxaca Valley, and the Basin of Mexico (Blomster et al. 2005;

Gomez et al. 2011; Neff and Glascock 2002; Neff et al. 2006; Stoner et al. 2015). Many of these vessels were decorated with ideologically symbolic motifs associated with high status Gulf Coast polities, and consumption of similar pottery by other groups may have served to connect them to San Lorenzo and signal their wealth and authority (Neff 2014). The presence of obsidian from Mexican and Guatemalan sources at San Lorenzo and other Gulf Coast sites suggests that a wide variety of craft items also moved through these broad-scale networks (Cobean et al. 1971; Hirth et al. 2013; Moholy-Nagy et al. 2013).

Very few compositional studies have examined ceramic production and exchange amongst the Preclassic Maya. Most provenance studies have focused on reconstructing interaction networks between Classic Period elite groups based on analysis of polychrome ceramic vessels (Foias and Bishop 1997; Bishop 2003; Halperin and Bishop 2016; Little et al. 2004: Reents-Budet et al. 2003; Straight 2015). One Preclassic study focused on Middle Preclassic Mamon complex ceramics from contexts in the monumental epicenter at the site of Holtun, Guatemala to identify local utilitarian ceramic production, as well as the importation of fine paste Mars Orange serving vessels (Callaghan et al. 2017). Working with late Middle and Late Preclassic ceramic sherds and clay samples from the site of K'axob in Northern Belize, Angelini (1998) also used INAA combined with petrography to document the compostion of local ceramic production practices through the Preclassic.

Preclassic Cahal Pech

Cahal Pech was a medium sized Classic Period Maya center located in the Belize Valley of west-central Belize on top of a natural hill above alluvial flood plains ~2 km south of the confluence of the Macal and Mopan Rivers (Figure 4.2).

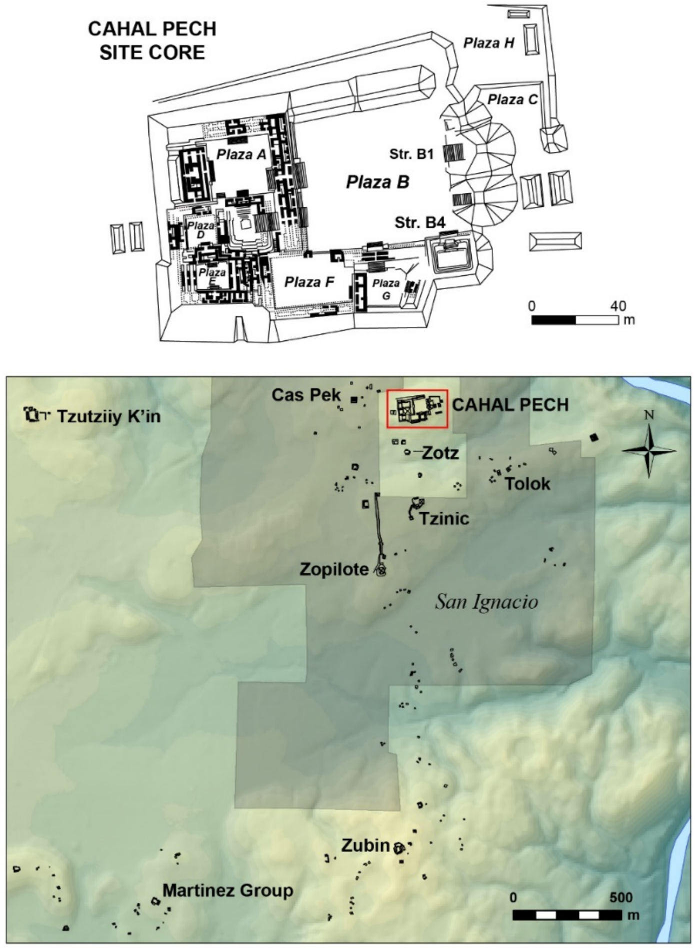

Figure 4.2: Map of Cahal Pech showing the site core and location of major household groups.

Ceramic and radiocarbon data from stratigraphic excavations in the site's epicenter indicate that Cahal Pech was first settled during the Early Preclassic between 1200-1100 BC as a small farming village composed of relatively egalitarian, and economically autonomous house groups (Awe 1992; Clark and Cheetham 2002; Ebert et al. n.d.). Early residential occupation is associated with the appearance of Cunil complex ceramics, the majority of which are unslipped utilitarian wares including large jars, bowls, and gourd shaped *tecomates* (Sullivan and Awe

2013). Excavation of settlement groups peripheral to the Cahal Pech epicenter and sites elsewhere in the Belize Valley at the sites of Xunantunich and Blackman Eddy have also provided ceramic evidence for Cunil phase occupation within small localized villages (Brown 2003; Ebert et al. n.d.; Garber et al. 2004; Iannone 1996). While current data suggest little evidence for institutionalized socio-economic inequality among and between Early Preclassic communities, the presence of El Chayal obsidian flakes and nodules in the earliest levels at Cahal Pech indicate integration of the Belize Valley into broader regional economic networks (Awe 1992; Awe and Healy 1994; Awe et al. 1995; Garber et al. 2004).

Distinctive pre-Mamon ceramic complexes contemporaneous with Cunil appeared in other parts of the Maya lowlands between 1200-900 BC including Northern Belize (Swasey complex), the central Petén (Eb/K'awil complex), and the Pasión region (Real/Xe complex). The distribution of these ceramic complexes within restricted regions likely represents spheres of social and economic interaction among early village settlements (Clark and Cheetham 2002). In addition to utilitarian forms (coarse wares), many of the early assemblages include large serving vessels incised with symbols connecting them to contemporaneous iconographic traditions developing across Mesoamerica (Callaghan and Nievens de Estrada 2016; Cheetham 1998, 2005; Inomata et al. 2013; Valdez 1988).

The Cahal Pech Cunil assemblage contains higher proportions of these serving vessels compared to other early ceramic complexes in the Maya region. Decorated pottery includes slipped bowls and plates, and other specialized types such as censers and effigy bowls depicting *k'an* cross, avian-serpent, and flamed eyebrow designs (Figure 4.3; Awe 1999; Cheetham 1998, 2005:31-33; Garber and Awe 2009; Sullivan and Awe 2013). Similar iconography has also been

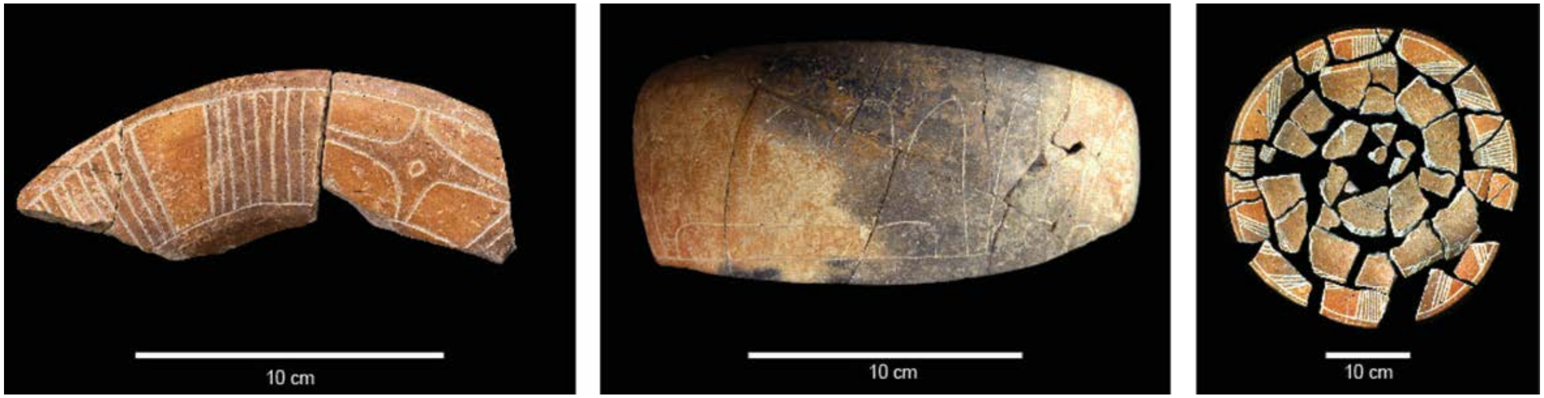

Figure 4.3: Examples of incised Cunil ceramics. From right to left: Baki Red Incised with *k'an* cross, Kitam Incised with flamed eyebrow motif, and refit Zotz Zoned Incised vessel (Photos by J. Awe).

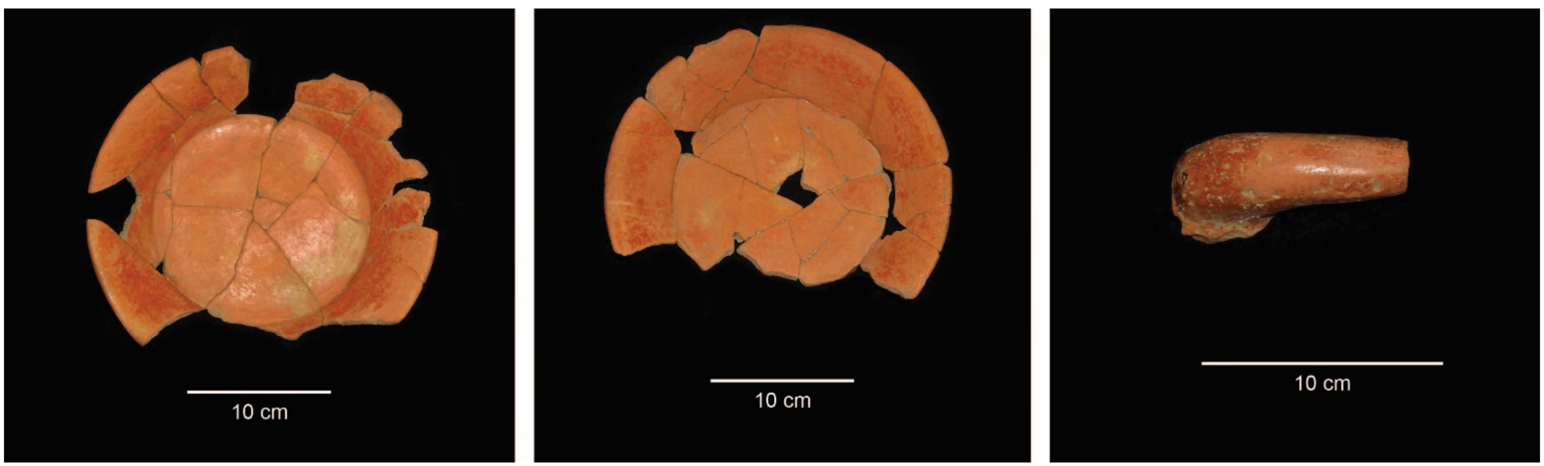

Figure 4.4 Examples of Mars Orange serving vessels from Cahal Pech including large dishes and a chocolate pot spout (Photos by J. Awe).

been found at Cahal Pech on other imported jade and shell artifacts. More limited analyses of contemporary assemblages at Blackman Eddy (Brown 2007; Garber et al. 2004) and Xunantunich (Strelow and LeCount 2001) also identified similar motifs, connecting the Belize Valley region to ideological developments associated with displays of wealth and authority taking place at contemporaneous sites along the Gulf Coast and Oaxaca (Garber and Awe 2009).

During the Middle Preclassic Period, population expansion and economic growth across the southern lowlands were accompanied by the adoption of a more standardized Mamon ceramic tradition characterized by monochrome, red-slipped pottery (Rice 2015; Gifford 1976; Willey et al. 1967). At Cahal Pech, the corresponding Kanluk ceramic complex for this period was composed primarily of coarse paste utilitarian ceramics (Jocote Orange-brown) and fine paste Mars Orange serving wares including slipped Savana Orange and Reforma Incised types (Figure 4.4; Awe 1992; Ball and Tasheck 2003; Gifford 1976). This period is also marked by intensified construction programs of monumental public architecture across the Maya region (Brown and Garber 2005; Chase and Chase 2012; Doyle 2017; Estrada-Belli 2011; Hansen 2001; Inomata et al. 2013, 2017). The construction of large public building, including temples, raised platforms, and more elaborate residences first begins at Cahal Pech between 900-650 BC, suggesting the development of social and economic differentiation within the community (Awe 1992; Ebert et al. n.d.; Healy et al. 2004; Horn 2015; Peniche May 2016). Little archaeological evidence exists for the centralized control of production or redistribution of imported items by higher-status groups at Cahal Pech. While Awe and Healy (1994) documented a transition in obsidian technology in the Middle Preclassic assemblage towards finished prismatic blades from both the El Chayal and SMJ sources were consumed differentially between households at the site (Awe and Healy 1994; Awe et al. 1995; Peniche May 2016). Other crafting activities connected some Cahal Pech households with different long-distance exchange networks. Excavations at Plaza B within the site's epicenter and peripheral Cas Pek house group recovered an abundance of imported marine shell artifacts including refuse and finished shell beads and other ornaments from Middle Preclassic levels (Hohmann 2002; Lee 1996; Peniche May 2016). Evidence for similar crafting activities is not evenly distributed across the site, likely indicating that acquisition of shell via long-distance exchange was directly regulated by households engaged in bead production.

In the Late Preclassic Period, lowland Maya society experienced a fluorescence of large civic-ceremonial centers and evidence for the development of institutionalized elite rulership first appears (Awe et al. 2009; Estrada-Belli 2011:44-48; Freidel and Schele 1988; Hammond 1980:189; Resse-Taylor and Walker 2002). While these cultural developments were most prominent in the Petén (e.g., El Mirador and Nakbe; Hansen 2001), formally organized civic centers were also established throughout the Belize Valley including Cahal Pech, Blackman Eddy, Xunantunich, and Barton Ramie (Awe 1992; Brown et al. 2013; Garber et al. 2004; Healy et al. 2004b; Willey et al. 1965). At Cahal Pech, elaborate Late Preclassic burials in tombs and plazas, and monumental temple architecture appeared during the Xakal ceramic phase (350 BC-AD 350) signaling the development of a royal lineage at the site (Awe 1992; Garber and Awe 2009; Healy et al. 2004). The earliest formal elite burial at Cahal Pech has been directly dated to 170-45 cal BC, and is located in a large masonry platform within Plaza B, the largest open plaza within the site core (Ebert et al. n.d.). The burial was placed within a small crypt surrounded by several caches containing ceramic vessels and figurines in addition to 13 polished greenstone celts. The comparatively elaborate nature of the burial suggests that it is associated with a high status individual, and perhaps one of the first rulers of Cahal Pech (Awe 2013:36). The presence of symbolically significant items such high-quality jade crafts also indicate involvement in exchange of goods that were translated into wealth and prestige (Brumfiel and Earle 1987; Earle 1977).

Evidence for status differentiation appears within the settlement zone after 350 BC in the form of larger-scale domestic buildings at some house groups. The Tzutziiy K'in Group, located approximately 1.8 km west of the Cahal Pech site core, was initially settled by the end of the Middle Preclassic as a small farming household. Multiple masonry platforms were built in the group's main plaza at the end of the Late Preclassic, which may have functioned domestic structure for a high-status family (Ebert et al. 2016). The Zopilote Group is a large terminus group located ~0.75 km south of the site core. The earliest strata at this settlement are associated with Cunil and early facet Kanluk phase residential occupation at the group's main building, Structure 1 (Ebert et al. n.d.). During the Late Preclassic (Xakal phase) several low masonry platforms and temple structures were constructed at the group, which likely functioned as public temple buildings associated with nearby domestic structures. Direct dates from burials and ceramic associations from several other large house groups (e.g., Zubin, Zopilote, Cas Pek, and Burns Avenue groups) suggest that this pattern of social, economic, and spatial growth occurred throughout the hinterlands of Cahal Pech during the Late Preclassic (Awe et al. 2014; Ebert et al. n.d. a, b).

Cahal Pech Obsidian and Ceramic Provenance Determinations

Obsidian Technological and pXRF Geochemical Analyses

Obsidian samples analyzed for this study were derived from surface collection and stratified contexts within the Cahal Pech monumental site core and from ten residential household groups located throughout the site's periphery. Artifacts (*n*=1189) were technologically analyzed and subjected to geochemical sourcing analyses using pXRF (Appendix D and E). Temporal assignments spanning from the Early Preclassic through Terminal Classic periods are based on relative ceramic associations and, where possible, AMS radiocarbon dates of organic plant remains and human/faunal bone (Awe 1992; Healy and Awe 1995; Ebert et al. 2015, n.d.). The analyzed obsidian assemblage at Cahal Pech was composed primarily of finished prismatic blades (Table 4.2). Medial segments of blades are the most common artifact from Preclassic (and later Classic Period) contexts, with blades becoming more common beginning in the Middle Preclassic. Three additional analyzed samples identified as a porphyritic (i.e., glassy) basalt that was shaped into third series blades are not included in the present analyses. While porphyritic basalt is most common in the Tuxtla region of the Gulf Coast (Pool 2007:67), the geochemical composition of basalts across Mesoamerica is not well characterized.

Geochemical characterization of obsidian artifacts was conducted at the Pennsylvania State University using a Bruker Tracer III-V+ SD handheld XRF spectrometer with X-rays emitted from a rhodium tube. Samples were analyzed for 200 seconds measured at 40 kV and 24.8 μA, with a 12 mil Al, 1 mil Ti, and 6 mil Cu (i.e., green) filter placed in the X-ray path. The smoothest surface for each artifact was targeted for measurement to ensure that analysis included the bulk of the X-ray produced. Peak intensities for ten elements (Mn, Fe, Zn, Ga, Th, Rb, Sr, Y, Zr, Nb) were converted to parts per million (ppm) concentrations by normalizing intensities to the Compton peak of rhodium and using a calibration developed for Mesoamerican obsidian based on Bruker standards.

Table 4.2: Comparison of obsidian lithic technology by from Cahal Pech by time period.

Time Period	**Early Preclassic**	**Middle Preclassic**	**Late Preclassic**	**Early Classic**	**Late Classic**	**Terminal Classic**	**Unknown Period**	**Total *n***	**Percent of Assemblage**
Percussion Artifacts	13	3		2	28	1		47	4%
Cores and Core Fragments	2	3			19	2	1	27	2%
Decortication	3	2			1			6	1%
Percussion Core Shaping	2	2	2	2	20	3		31	3%
Pressure Core Shaping									
Initial Series Blades		1			21	4	1	27	2%
Final Series Blades	2	126	39	24	707	114	12	1024	86%
Production Byproduct		1	1	1	3	1		7	1%
Blade Artifact		3	1		13	2	1	20	2%

Obsidian pXRF Results

Cluster analysis of pXRF data identified four primary obsidian source groups composing the Cahal Pech assemblage (Figure 4.5; Table 4.3). The majority of artifacts were imported from the El Chayal source (61.5%, *n*=732), with smaller amounts from the Ixtepeque (19.3%; *n*=230) and SMJ (18.5 %, *n*=220) sources. Two other sources are represented from the central Mexican Highlands in very small amounts, including Ucareo (>0.01%, *n*=1) and Pachuca (>0.01%, *n*=6) blade fragments.

The Early Preclassic obsidian assemblage was derived exclusively from excavated contexts at Structure B4, located in Plaza B of the site core. Obsidian nodules and percussion flakes compose more than half of the Early Preclassic assemblage (~59%, *n*=13), with only a small number prismatic blades (*n*=2; Table 4.4). The presence of some cores and decortication debris suggests that nodules were imported, and flakes produced on site. All the Early Preclassic artifacts were assigned to the El Chayal source. The percussion flake tradition was replaced by prismatic pressure blades as the dominant technology during the Middle Preclassic, a transition that has been documented at other contemporaneous sites in the Maya lowlands (e.g., Tikal, Moholy-Nagy et al. 2013; see also Awe and Healy 1994). The majority of artifacts from this period were identified as medial and proximal fragments of third series pressure blades.

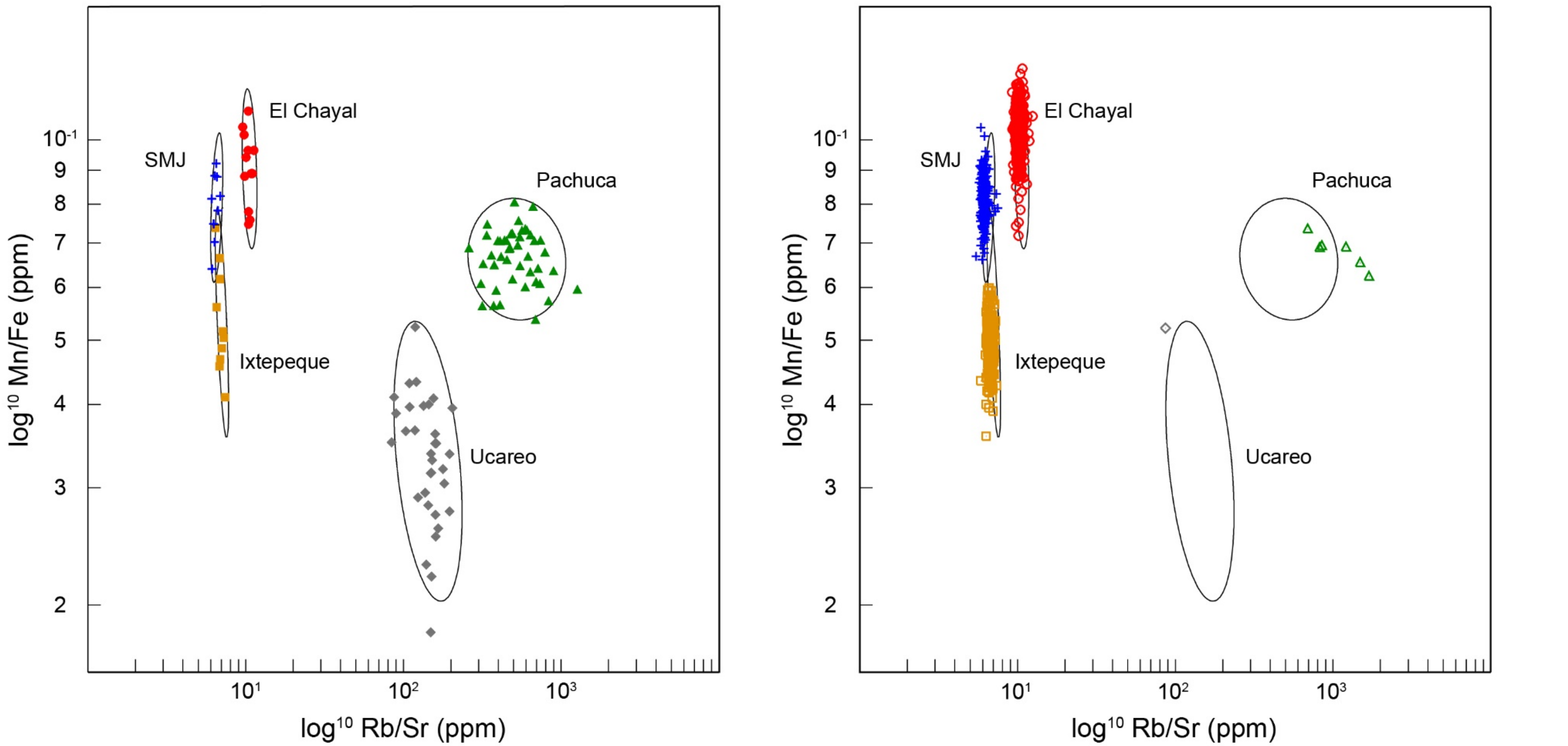

Figure 4.5: Bivariate $\log^{10}$ transformed elemental concentrations for obsidian samples. The plot on the left show source samples with known proveniences. The plot on the right show source assignments for Cahal Pech artifacts. Ellipses represent 90% confidence intervals for group membership.

Table 4.3: Elemental concentrations for 1,189 obsidian artifact from Cahal Pech analyzed by pXRF in parts per million; values are rounded to the first whole number, and the relative standard deviation (%rsd) is reported as a percentage.

Obsidian Source		Mn	Fe	Zn	Ga	Th	Rb	Sr	Y	Zr	Nb
El Chayal *n*=732	mean	744	7127	57	18	11	153	150	21	113	10
	st. dev.	83	766	18	1	2	12	11	2	6	1
	%rsd	11	11	31	3	18	8	7	7	5	13
San Martin Jilotepeque *n*=220	mean	620	7624	51	18	9	119	195	17	115	8
	st. dev.	71	752	15	1	2	9	13	1	6	1
	%rsd	11	10	30	3	19	7	7	7	5	13
Ixtepeque *n*=230	mean	510	10331	47	18	6	103	153	19	166	9
	st. dev.	59	1011	18	1	1	8	11	1	9	1
	%rsd	12	10	39	3	23	7	7	8	5	13
Pachuca *n*=6	mean	1269	18645	278	30	23	222	2	116	928	95
	st. dev.	140	1522	49	3	3	16	1	8	43	4
	%rsd	11	8	18	11	11	7	37	7	5	5
Ucareo *n*=1		444	8728	53	18	12	158	22	27	128	18

Table 4.4: Comparison of obsidian sources through time for context analyzed at Cahal Pech.

Source	**Context**	**Early Preclassic**	**Middle Preclassic**	**Late Preclassic**	**Early Classic**	**Late Classic**	**Terminal Classic**	**Unknown Period**	***Total from Source***
El Chayal *n*=732	All contexts	22	44	19	13	517	106	11	732
	Site Core	22	20	18	7	210	102	9	388
	Settlement		24	1	6	307	4	2	344
San Martin Jilotepeque *n*=220	All contexts		82	18	8	100	10	2	220
	Site Core		65	18	6	34	10	1	134
	Settlement		17		2	66		1	86
Ixtepeque *n*=230	All contexts		10	6	7	194	11	2	230
	Site Core		2	6	5	60	11		84
	Settlement		8		2	134		2	146
Pachuca *n*=6	All contexts				1	5			6
	Site Core				1	3			4
	Settlement					2			2
Ucareo *n*=1	All contexts		1						1
	Site Core		1						1
	Settlement								
Total Period		22	137	43	29	816	127	15	1189

Additional types of obsidian also begin to appear at Cahal Pech in the Middle Preclassic Period. While the inhabitants of the site core primarily consumed blades from the SMJ source, blades from El Chayal are the dominant type found in peripheral household groups.

Imported blades and blade fragments continued to compose the majority of the obsidian assemblage during the end of the Middle Preclassic and into the Late Preclassic at Cahal Pech. One obsidian blade from the Ucareo source in a late Middle Preclassic context from Structure B4 documents connections with the central Mexican Highlands beginning at this time. Blades from the Pachuca source first enter the assemblage during the Early Classic and though the total number in Classic Period sample is small (*n*=6). Pachuca blades were found to be evenly distributed between site core and settlement contexts, however. El Chayal blades continued to dominate the assemblage both in the site core and settlement (63%) throughout the Classic Period, with smaller but relatively even amounts of SMJ obsidian through the Terminal Classic Period. Ixtepeque obsidian composes ~24% of the Late Classic assemblage, and is found in higher proportions in the settlement (*n*=134) compared to the site core (*n*=60) during this period. By the Terminal Classic, El Chayal pressure blade fragments make up over 83% of the assemblages.

Ceramic INAA Sample and Analyses

To understand differences in Preclassic Period ceramic production and consumption associated with status at Cahal Pech, we sampled common types of diagnostic ceramics (total *n*=192) from directly dated contexts in the site's civic-ceremonial core and from two peripheral settlement groups (Appendix F). All sherds selected for analysis were identified to type: variety-mode classification according to standard classifications for Cahal Pech and the Belize Valley

(Awe 1992; Gifford 1976; Sullivan and Awe 2013). A sample of 125 ceramics analyzed from deposits in the Cahal Pech core from excavations in Structure B4 and Plaza B. These contexts were directly radiocarbon dated to the Cunil and Kanluk ceramic phases (Awe 1992; Ebert et al. n.d.; Peniche May 2015). Cunil contexts represent the earliest construction of agrarian residences at Structure B4 and Plaza B, which consisted of the remodeling of a series of superimposed living surfaces supporting wattle-and-daub domestic structures (Awe 1992; Peniche May 2016). Excavations in Plaza B indicate that the area experienced considerable building activity during the Kanluk phase, including the construction of several large masonry platforms that likely functioned as public buildings and high-status residences (Ebert et al. n.d.; Horn 2015; Peniche May 2015). Samples were also chosen from Middle and Late Preclassic contexts at two house groups in the Cahal Pech periphery: the Tzutziiy K'in (*n*=40) and Zopilote (*n*=27) groups. Samples from the Zopilote Group come from late facet Kanluk and early/late facet Xakal phase contexts at Structure 1. These domestic contexts were later covered by a series of Late Preclassic temple platforms. Samples from Tzutziiy K'in are derived from excavations of domestic buildings at Structure 2 and 3, and date to the early/late facets of the Late Preclassic Xakal ceramic phase.

All ceramic samples were prepared for INAA using standard procedures at MURR (Glascock 1992; Neff 1999, 2000). Standards made from NIST certified reference materials of SRM-1633a (coal fly ash) and SRM-688 (basalt rock) in addition to quality control samples (e.g., standards treated as unknowns) of SRM-278 (obsidian rock) and Ohio Red Clay were also prepared using the same methods. Samples were sequentially irradiated for five seconds by a neutron flux of 8×10^{13}n cm^{-2} s^{-1}. The 720-second count yielded gamma spectra containing peaks for nine short-lived elements (Al, Ba, Ca, Dy, K, Mn, Na, Ti, V). Another 200 mg of each sample was also subjected to a 24–hour irradiation at a neutron flux of 5×10^{13} n cm^{-2} s^{-1}. Samples were then allowed to decay for seven days, and counted for 1,800 seconds on a high-resolution germanium detector coupled to an automatic sample changer. The count yielded determinations of seven medium half-life elements (As, La, Lu, Nd, Sm, U, Yb). A final count of 8,500 seconds was carried out on each sample after three to four weeks, yielding 17 long half-life elements (Ce, Co, Cr, Cs, Eu, Fe, Hf, Ni, Rb, Sb, Sc, Sr, Ta, Tb, Th, Zn, Zr). Elemental concentration data from the three measurements are tabulated in parts per million.

Initial identification of commotional groups was based on mean and standard deviations for concentration data for each element within the sample. Hierarchical cluster analysis (HCA) and principal component analysis (PCA) were then applied to elemental data in order refine compositional group membership. PCA indicated that the first four principal components explain over 85% of the variability in the sample. PCA values for individual element and visual inspection of bivariate plots of elemental concentrations resulted in the identification of seven distinct compositional groups in the Cahal Pech Preclassic ceramic sample. A canonical discriminant analysis (CDA) was then applied to the identified groups to capture the primary dimensions of chemical variation. A total of 22 sherds were not assigned to one of the identified compositional groups based on statistical probabilities. Unassigned specimens may represent ceramics from unknown source locations, have unique compositions (i.e., paste recipes), or are similar to more than one compositional group. INAA results for the Cahal Pech sample were also compared to the results of previous analyses by MURR (n > 12,000) using Euclidian Distance searches to identify similarities between the Cahal Pech compositional groups and other identified geochemical compositional groups in Mesoamerica.

Ceramic INAA Results

The Cahal Pech ceramics divide into four primary groups that generally correspond with type: variety classifications from different time periods and contexts (Figure 4.6 and Table 4.5). Three groups containing smaller number of sherds were also identified, though they compose a minor portion of the analyzed samples (4%). Compositional Groups A, B, C, and D contain both pre-Mamon (Cunil ceramic complex; ~1200-900 BC) and Mamon (Kanluk ceramic complex; 900-350 BC) samples primarily from site core contexts.

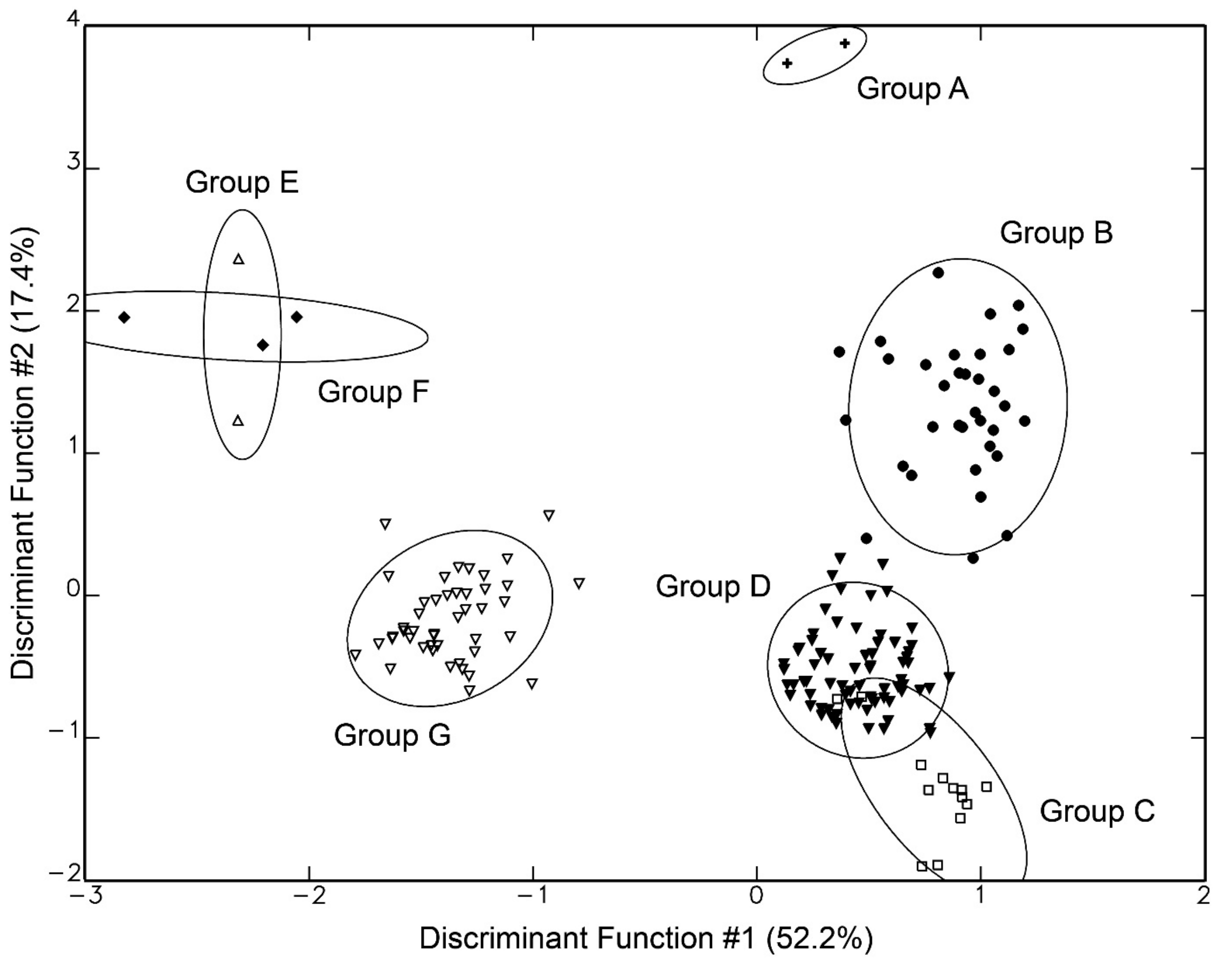

Figure 4.6: Bivariate plot of INAA results displayed based on canonical discriminant functions #1 and #2. Ellipses represent 90% confidence of membership for identified groups in the assemblage.

Table 4.5: Distribution of ceramic composition groups at Cahal Pech identified by INAA listed by chronological period/ceramic phase by context.

Compositional Group	**Context**	**Early Preclassic**	**Middle Preclassic**		**Late Preclassic**		**% Total Assemblage**
		Cunil	**EF Kanluk**	**LF Kanluk**	**EF Xakal**	**LF Xakal**	
Group A (*n*=2)	All contexts	2					1%
	Site Core	2					
	Settlement						
Group B (*n*=34)	All contexts	12	21	1			18%
	Site Core	12	18	1			
	Settlement		3				
Group C (*n*=13)	All contexts		3	7	3		7%
	Site Core		3	5			
	Settlement			2	3		
Group D (*n*=71)	All contexts	21	17	25	7	1	37%
	Site Core	21	17	24			
	Settlement			1	7	1	
Group E (*n*=2)	All contexts		1			1	1%
	Site Core		1				
	Settlement					1	
Group F (*n*=4)	All contexts		2	3			2%
	Site Core			3			
	Settlement		2				
Group G (*n*=45)	All contexts	1	2	11	24	7	23%
	Site Core	1	1	1			
	Settlement		1	10	24	7	
Unassigned (*n*=22)	All contexts	2	5	11	3	1	11%
	Site Core	2	4	9			
	Settlement		1	2	3	1	
Total Period		37	50	58	37	10	100%

Group A consists of two Cunil phase sherds of an unspecified type, the only two samples from excavations at Plaza B with ash temper. Group B (*n*=34) contains all other sherds analyzed for this study with ash temper, as well as vessels characterized by fine texture calcite/quartzite pastes. Many of the finer ceramics are decorated with dull slips and post-slip incising (e.g., Baki Red Incised, Mo Mottled, and Kitam Incised types). Euclidean Distance searches indicate that the Cahal Pech specimens are compositionally unique to previously analyzed samples in the MURR database from the Maya region.

Groups C and D contain ceramic samples attributed primarily to the late facet Kanluk ceramic phase (750-350 BC), with a small number of Cunil phase specimens present in Group D. Group C (*n*=13) possesses the most intra-group chemical variability in the Cahal Pech INAA sample, with higher levels of cobalt, cerium, and greater range of manganese compared to other compositional groups. Group C ceramics are primarily Mars Orange wares (Savana Orange and Reforma Incised types; Gifford 1976:73-76) and were distributed between late Middle Preclassic site core (62%) and settlement contexts (38%).

Group D is the largest compositional group (*n*=71) identified in the Cahal Pech INAA sample. Most specimens come from the site core (87%) and are attributed to the Cunil and Kanluk ceramic complexes. Group D ceramics can be geochemically distinguished based on elements including calcium and potassium. The group is dominated by unslipped coarse utilitarian pottery (57%, e.g., Sikiya and Jocote types), but also contains high frequencies of Savana Orange wares (37%). Euclidean Distance searches indicate that many of the specimens in this group are compositionally similar ceramics previously from the Petén Lakes region of Guatemala and Middle Preclassic Mars Orange ceramics from the site of Holtun, Guatemala (see Callaghan et al. 2017).

Group E (*n*=2) and Group F (*n*=3) ceramics compose only 3% of the total Cahal Pech INAA sample. While both groups are compositionally distinct, they exhibit high degrees of internal compositional variability, which indicates slightly different paste recipes for each sherd. Groups E and F are found relatively evenly between site core and settlement contexts, and are composed primary of Joventud Red sherds from the Kanluk ceramic complex.

Group G (*n*=45) is the second most common group in the Cahal Pech INAA sample, and is composed of sherds from the Late Preclassic Xakal ceramic complex (350 BC-AD 300), suggesting a preferences for this paste recipe within household groups during later time periods. The group is extremely homogenous, characterized by high levels of calcium and little variation in potassium. Specimens in this group are found almost exclusively at peripheral household groups, with ~74% of sherds samples from the Tzutziiy K'in Group and ~65% of the sherds samples from the Zopilote Group assigned to this group. The most common ceramic types include Sierra Red and Joventud Red, with small numbers of unslipped utilitarian wares (Jocote Orange-brown, Sayab Daub Striated). Based upon Euclidian Distance searches, Group G ceramics are similar to samples from other regions of the Maya lowlands including western Belize (e.g., Tipu), indicating that these ceramics were produced locally.

Discussion

The role of households and importance of the domestic economy have often been overlooked in Preclassic Period Maya archaeology. Domestic production has often been described as low-level, suggesting that households had little economic impact beyond their own small niche (Clark and Parry 1990; Costin 2001; Feinman and Nicholas 2000). This idea fails to recognize that households are elastic as decision-making units and are capable of adapting to changing economic circumstances (Hirth 2006, 2016). Households functioned as a point of engagement with larger regional social and economic developments, and understanding the irregular distribution of economically important resources between households can shed light on the social and economic contexts that led to the emergence of institutionalized hereditary inequality. In this study, we used geochemical sourcing methods of obsidian and ceramics from domestic contexts to identify the economic mechanisms driving social and economic inequality among Preclassic Period households and its long-term effects upon the domestic population at the site of Cahal Pech. Our results show that the function of the obsidian and ceramic economies overlapped to supply households with items needed for everyday subsistence. The structures of networks differed, however. While pXRF data document a relatively decentralized network of obsidian procurement throughout the Preclassic, ceramic INAA data suggest the development of craft specialization and distribution beyond the level of the household that contributed to status and wealth of some Cahal Pech households.

The Obsidian Economy

The inhabitants of Cahal Pech were already active participants in long-distance obsidian exchange systems as early as the Early Preclassic Period. These systems connected the Belize Valley with obsidian sources in the southern highlands of Guatemala. The results of pXRF analyses of obsidian indicate the presence of El Chayal percussion flakes and a smaller number of prismatic blades within the earliest Cunil domestic contexts at the site core. The sample size for this period is small (n=22), however, and is derived from only one context (Structure B4) in the Cahal Pech site core. To estimate if the abundance of sources for the Early Preclassic levels falls within the expected range, we conducted a rarefaction analysis. Rarefaction analyses calculate the expected abundance of obsidian sources by time period based on the overall sample size and source diversity for the complete assemblage (Figure 4.7). The results indicate that the number of sources for the Early Preclassic obsidian sample falls below the expected range (90% confidence interval). This suggests that additional excavation may likely document additional sources from Early Preclassic contexts that may connect Cahal Pech to other obsidian exchange networks during this early time period.

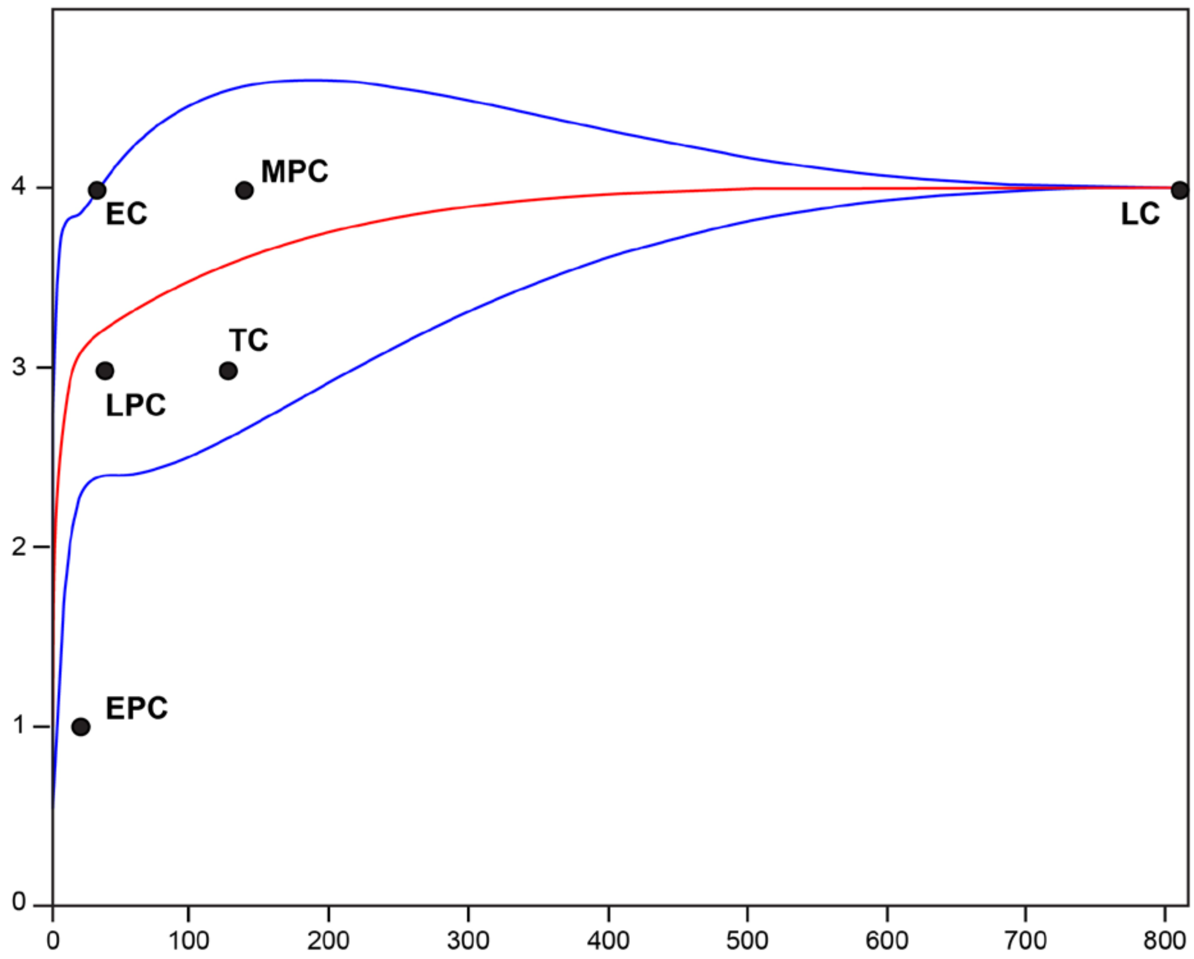

Figure 4.7: Rarefaction curve for the Cahal Pech obsidian sample. The red line indicates the expected abundance of sources based on sample size, with blue lines representing 90% confidence intervals. Time periods and indicated with a dot.

The long-distance procurement networks accessed by Cahal Pech expanded during the Middle Preclassic between 900-300 BC. Two important developments occurred at this time. First, there was a dramatic increase in final series prismatic blades, likely associated with trends in population expansion and economic growth across the southern lowlands. Obsidian blade cores and manufacturing debris are not common in the Preclassic assemblage (or the assemblage for any time period) providing evidence that finished blades were likely imported to Cahal Pech in a pattern consistent with whole-blade trade or processed-blade trade (De León et al. 2009). Second, SMJ obsidian became the dominant source, with El Chayal and Ixtepeque artifacts found less frequently, though different types of obsidian were not evenly distributed between households. While SMJ blades became prevalent in the site core (~75%), El Chayal obsidian remained the primary source for obsidian blades used by peripheral households (~49%). The differential procurement of blades produced from different obsidian types suggests a lack of centralized control over redistribution, and instead that obsidian moved through a network of decentralized exchange relationships operating at the household level (Hirth et al. 2013). By the Late Preclassic, both El Chayal and SMJ blades became more evenly used by the inhabitants of the Cahal Pech site core, with Ixtepeque composing a smaller portion of the assemblage. A small sample size for peripheral house groups (one El Chayal blade) limits our interpretation of obsidian consumption in the settlement versus the site core for this period. Based on patterns in the technological and geochemical data for later periods, however, it appears that decentralized domestic procurement of finish blades persisted through the end of the Classic Period at Cahal Pech.

Comparisons to obsidian provenance studies for other regions of the Preclassic lowlands document a similar broad-scale pattern of local and regional decentralized procurement of finished blades. In order to interpret differences in obsidian consumption between these sites and Cahal Pech through time, we consider sourced assemblages using both geochemical and visual methods with relatively larger sample sizes (*n*≥15). Only two other studies, one at Blackman Eddy in the lower Belize Valley and the other in the Copan Valley of Honduras, have reported obsidian source data for the Early Preclassic Period. The results indicate that Early Preclassic sites developed distinct long-distance networks to provision their households with large quantities of non-local obsidian. Sample sizes for the Belize Valley sites are relatively small for this period, but suggest independent procurement strategies. Whereas Cahal Pech relied solely on El Chayal obsidian (*n*=22), data for contemporaneous contexts at Blackman Eddy (*n*=5) shows a reliance upon obsidian from the SMJ source during the Early Preclassic (Kersey 2006). In contrast, a larger sample (*n*=76) from sites in the Copan Valley show that early communities consumed only obsidian from the Ixtepeque source, which was relatively close to the region (Aoyama 1999: 53; Golitko and Feinman 2015:220).

More provenance data is available for Middle and Late Preclassic obsidian assemblages, which show the development of regional procurement networks (Figure 4.8 and Table 4.6). Sites in the Belize Valley, Petén, and Yucatan increased their reliance upon SMJ obsidian during the Middle Preclassic. Compared to the almost complete reliance of SMJ by other Belize Valley sites (e.g., Blackman Eddy, Kersey 2006; Chan, Meierhoff et al. 2012), Cahal Pech consumption patterns indicate the use of higher proportions of El Chayal blades, more closely resembling those in Northern Belize (e.g., Colha, Brown et al. 2004) and the central Petén (e.g., Central Petén Lakes, Rice 2015, Rice et al. 1985; El Mirador, Fowler et al. 1989; Tikal, Moholy-Nagy et al. 2013).

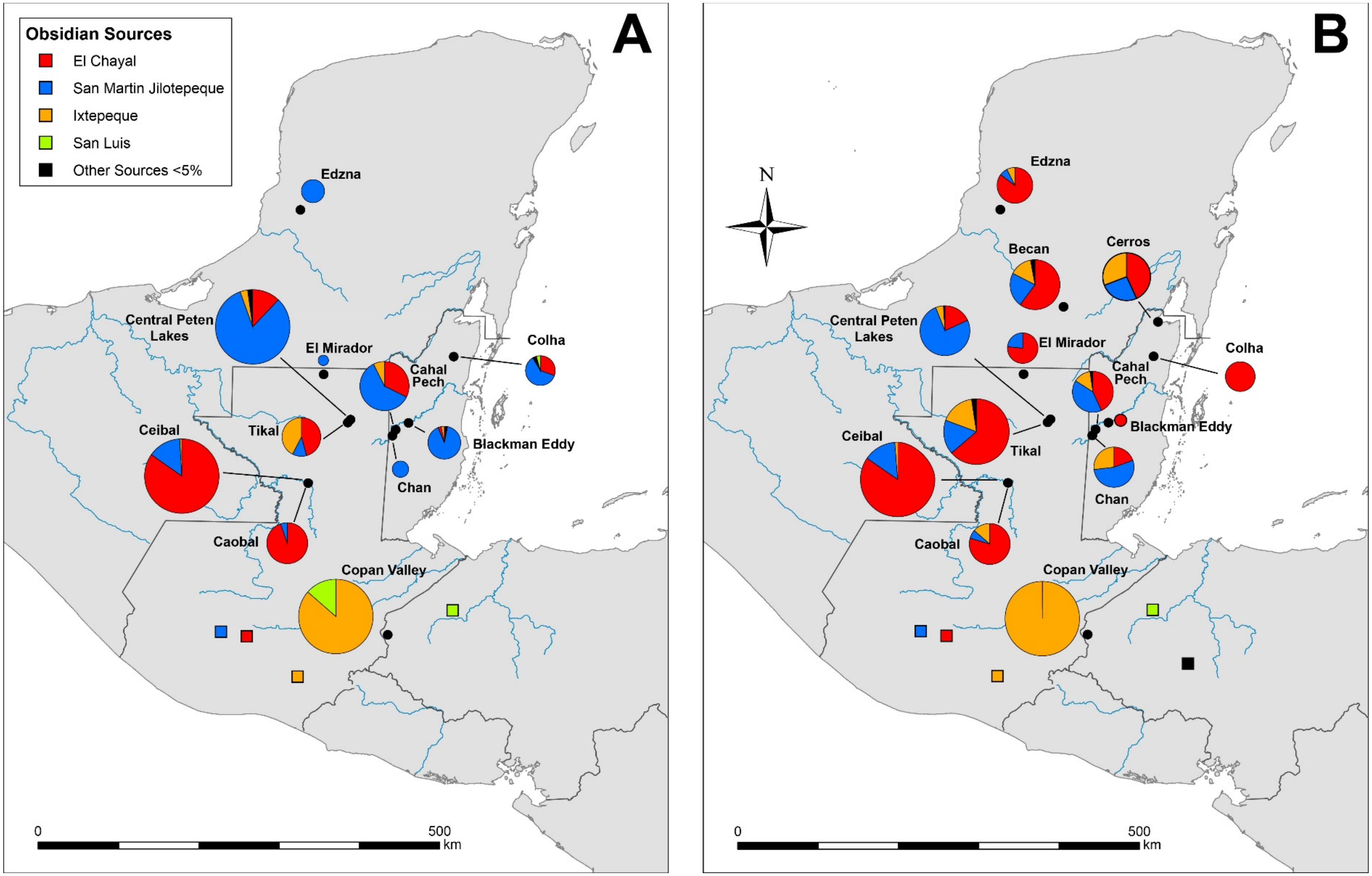

Figure 4.8: (A) Middle Preclassic and (B) Late Preclassic Period obsidian frequencies from Cahal Pech and other lowland Maya sites. Pie charts represent assemblages analyzed from individual sites, and sized on a logarithmic scale based on analyzed sample size for each time period. Sources that compose less than 5% of the total assemblage are combined.

Table 4.6: Comparison of Preclassic obsidian sources (in %) from Cahal Pech and other Preclassic lowland Maya sites. All percentages have been rounded off to whole numbers unless >1%; totals may not equal 100%.

Region	Site	Period	Total *n*	El Chayal	SMJ	Ixtepeque	Other	Citation
Belize Valley	Blackman Eddy	EPC	5		100%			Kersey 2006
		MPC	32	3%	91%	3%	3%	
		LPC	3	100%				
	Cahal Pech	EPC	22	100%				This study
		MPC	136	32%	60%	7%		
		LPC	44	43%	41%	14%	2%	
	Chan	EPC						Meierhoff et al. 2012
		MPC	6		100%			
		LPC	41	20%	54%	27%		
Northern Belize	Cerros	EPC						Nelson 1985
		MPC						
		LPC	16	100%				
	Colha	EPC						Brown et al. 2004
		MPC	23	30%	61%	4%	4%	
		LPC	35	60%	71%			
Central Petén	Becan	EPC						Dreiss and Brown 1989, Rovner 1981
		MPC						
		LPC	103	60%	22%	15%	3%	
	Central Petén Lakes	EPC						Rice et al. 1985, Rice et al. 2015
		MPC	91	12%	82%	3%	2%	
		LPC	99	18%	76%	5%	1%	
	El Mirador	EPC						Fowler et al. 1989
		MPC	3		100%			
		LPC	17	76%	24%			
	Tikal	EPC						Moholoy-Nagy 2013, Nelson et al. 1977
		MPC	59	46%	12%	42%		
		LPC	419	64%	17%	17%	2%	
Pasión	Caobal	EPC						Aoyama and Munson 2012
		MPC	75	95%	5%			
		LPC	44	80%	7%	14%		
	Ceibal	EPC						Aoyama and Munson 2012, Nelson et al. 1978
		MPC	2142	85%	14%	1%		
		LPC	326	85%	14%	1%		
Honduras	Copan Valley/ La Entrada Region	EPC	76			97%	3%	Aoyama 1999
		MPC	2482	0.20%		86%	14%	
		LPC	914	0.10%		100%		
Yucatan	Edzna	EPC						Nelson et al. 1983
		MPC	12		100%			
		LPC	27	85%	7%	7%		

In contrast, the Pasión region sites of Ceibal and Caobal relied on imported blades from El Chayal (85% and 95%, respectively), a pattern reflective of economic ties both with the source and between sites (Aoyama and Munson 2012, Nelson et al. 1978). Ixtepeque obsidian remained the primary material used for prismatic blades in the Copan Valley from the Middle Preclassic through the Late Preclassic period (Aoyama 1999). People living this region of Honduras also developed exchange networks with people living nearby the San Luis source in Honduras, suggesting a higher degree of economic integration with the southeastern periphery of the Maya lowlands (Golitko and Feinman 2015:220).

Based on social network analyses of obsidian consumption throughout the Preclassic, Goltiko and Feinman (2015:221) suggest that a shift in focus to El Chayal obsidian in the Late Preclassic broadly corresponds with the development of more tightly integrated exchange networks between different regions of the lowlands (see also Resse-Taylor and Walker 2002:89). A Shannon-Weaver index for obsidian assemblages from different regions was calculated to examine the changes in the number of sources (diversity) and amounts of obsidian sources (equitability) that may be reflective of regional economic networks (Figure 4.8). High diversity values (H_s) reflect assemblages with more even distribution of abundance between sources compared to an assemblage with the same number of sources but a high abundance of a few types. Equitability (E_s) independent of diversity was also calculated to measure the heterogeneity of assemblages, with values approaching 1.0 indicating an even distribution of obsidian types.

Diversity and equitability values for Preclassic lowland obsidian assemblages suggest a pattern of increasing diversity and equitability values is present for most regional assemblages from the Middle to the Late Preclassic (Figure 4.9).

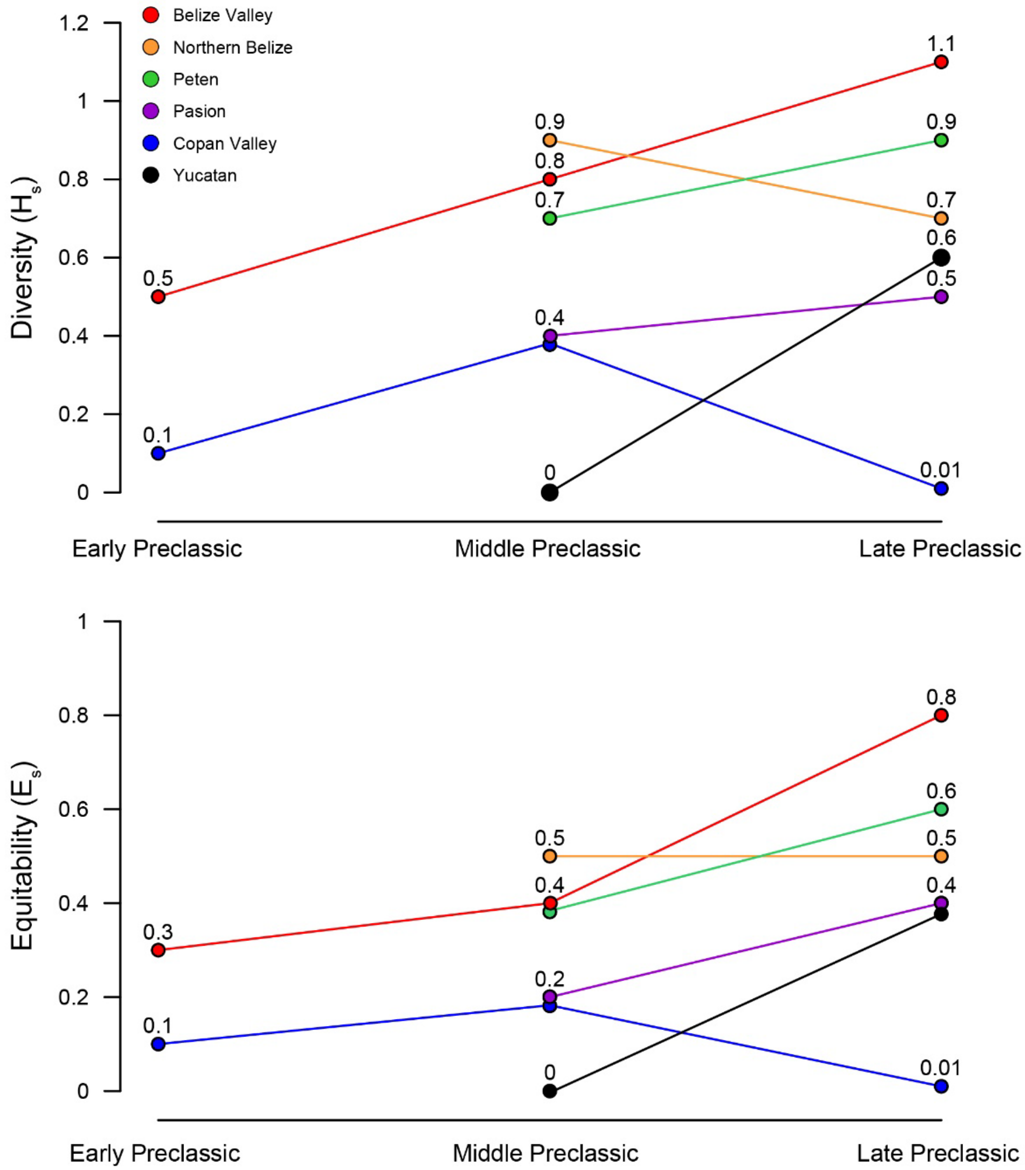

Figure 4.9: Diversity and equitability values of Preclassic obsidian assemblages from six regions of the Maya lowlands.

Decreasing diversity and equitability can be attributed to the almost complete reliance on Ixtepeque obsidian in the Copan Valley and increasing consumption of El Chayal obsidian in Northern Belize. A wide range of values for the Late Classic Period also reflects continuity in decentralized procurement within networks operating at the regional level. Continuity in consumption of high proportion of El Chayal obsidian (80-85%) at the Pasión sites Ceibal and Caobal are reflected by only slight increases in diversity and equitability values.

In contrast, Belize Valley and Petén assemblages became the most diverse and contained higher proportions of SMJ and Ixtepeque obsidian, perhaps indicating stronger network ties to these sources. The Late Preclassic also saw the introduction of blade artifacts from the central Mexican Highlands at many sites, which likely influences diversity values. While obsidian artifacts from highland Mexico, and specifically the Pachuca source are more common at some sites (e.g., Becan, Dreiss and Brown 1989, Rovner 1981; Tikal, Maholoy-Nagy 2013), an obsidian blade from the Ucareo source was recovered from late Middle Preclassic levels in the Cahal Pech core. The blade was recovered from Structure B4 and is associated with a high status residence and a circular platform building used for public ceremonies, suggesting increasing contact with people as far away as the Basin of Mexico possibly by higher-status individuals at Cahal Pech.

The Ceramic Economy

Less research has focused on using geochemical methods to examine Preclassic Maya ceramic production and exchange systems. We used INAA of Cahal Pech ceramics to document the development of local household production and the expansion of elite exchange networks from the Early through Late Preclassic Periods. The earliest pre-Mamon (Cunil) ceramics in the Belize Valley appeared at Cahal Pech within Early Preclassic domestic contexts in the site core, with their presence signaling an increased commitment to maize agriculture and the first permanent settlement in the Belize Valley (Awe 1992; Clark and Cheetham 2002; Ebert et al. n.d.). We identified three compositional groups (A, B, and D) using INAA that contained diagnostic Cunil ceramic types, indicating a preference for these paste recipes during the Early

Preclassic. Both Groups A and B contained high proportions of fine paste slipped and grooved-incised Cunil vessels derived exclusively from the Cahal Pech site core. Specimens in these two groups were also found to be compositionally unique compared to previously analyzed ceramics in the MURR database, suggesting that Cunil ceramics were produced and distributed locally at Cahal Pech and between communities within the Belize Valley.

Early Preclassic ceramic and obsidian samples analyzed for this study were limited to the Cahal Pech site core, and sourcing data do not indicate differential consumption of these items between households. The differential distribution of Cunil utilitarian versus decorated serving wares between compositional groups, on the other hand, may suggest individual (household) specialized production. Specialization refers to an economic form where not all consumers of a particular craft participated in its production (Costin 2005:1063). While vessels attributed to Groups A and B were primarily decorated types, the Cunil complex sherds in Group D are utilitarian, including unslipped jars and bowls used for daily tasks including water storage and cooking (Cheetham 2010; Sullivan and Awe 2013). Because the Group A and B Cunil serving vessels possess incised motifs with significant ideological meaning, they may have been produced and used as a publicly visible medium to communicate differences in wealth and status within the Early Preclassic Cahal Pech community (Clark and Blake 1994).

The Middle Preclassic in the Belize Valley, and the Maya lowlands more generally, was characterized by the adoption of a more standardized Mamon ceramic tradition dominated by monochrome, red-slipped pottery (Awe 1992; Gifford 1976; Willey et al. 1967). At Cahal Pech, the Kanluk complex ceramic assemblage was composed primarily of Jocote Orange-brown utilitarian ceramics and fine Mars Orange Paste serving wares including undecorated and decorated types (e.g., Reforma Incised; Awe 1992; Ball and Taschek 2003). In the absence of direct evidence for household production (e.g., identification of production areas, Costin 2005; presence production tools, Jordan and Prufer 2017; Masson et al. 2016), a correlation between compositional groups for Middle Preclassic Jocote vessels and earlier Cunil utilitarian wares suggests local production of these types for domestic consumption. Typological studies from sites in the Belize Valley have also documented high frequencies of Mars Orange ceramics (~60-50%) in Middle Preclassic ceramic assemblages, suggesting nearby production (Awe 1992; Gifford 1976; Kosakowsky 2012; LeCount 1996; Peniche May 2016; Ball and Taschek 2003). A progressively decreasing distribution of Mars Orange wares to the west in the central Petén has previously been interpreted to reflect its probable movement into that region from western Belize (Callaghan et al. 2017; Rice 1979).

At Cahal Pech, Over 77% of the Savana Orange sherds analyzed by INAA were assigned to compositional Groups C (*n*=27) and D (*n*=35). These sherds were derived primarily from site core contexts associated with high-status residences and public architecture, including a series of specialized round structures and raised masonry platforms that were likely used for public ceremonies within Plaza B (Awe 1992; Peniche May 2016). The platforms are also located next to an Eastern Triadic temple structure (Structure B1) dating to the Late Middle Preclassic, which functioned as a ritual architectural complex and contained some of the earliest and most elaborate caches and high-status burials at Cahal Pech (Awe et al. 2017). Euclidean Distance searches for the Cahal Pech Mars Orange ceramics within the MURR database identified compositionally similar ceramics from the site of Holtun, in the central Petén (Figure 4.10A). Non-local Mars Orange sherds from Holtun, associated with an ideologically important E-Group architectural complex in that site's civic-ceremonial epicenter, formed a distinct compositional group (Group 1; Callaghan et al. 2017).

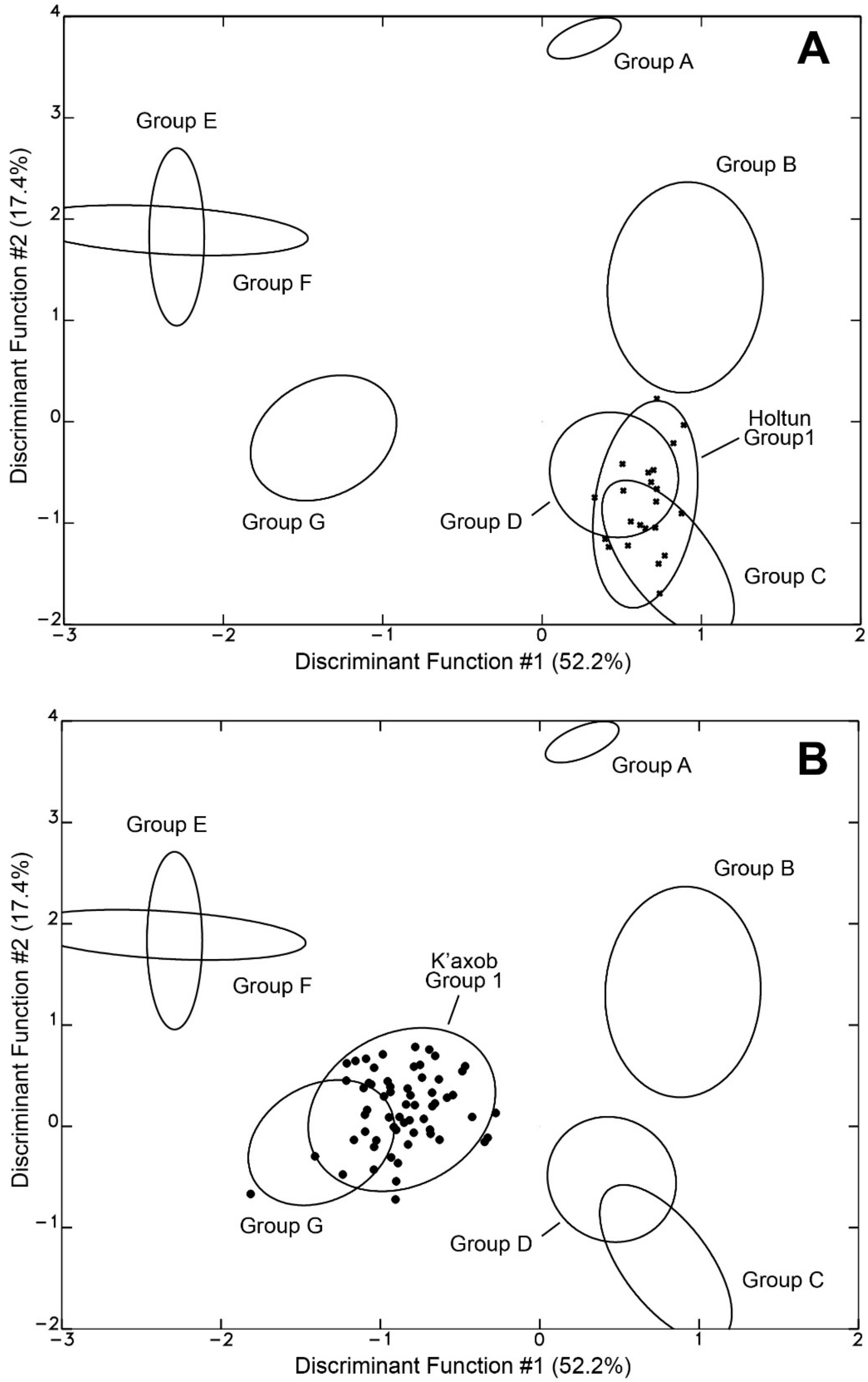

Figure 4.10: Bivariate plots of Cahal Pech ceramic compositional groups compared to other Preclassic assemblages based upon canonical discriminant functions #1 and #2. (A) Middle Preclassic Group 1 ceramics at Hotlun, Guatemala. (B) Late Preclassic Group 1 ceramic from K’axob, Belize. Ellipses represent 90% confidence of membership for identified groups in the assemblage.

Though Holtun and Cahal Pech assemblages possess similar paste recipes, higher frequencies of Mars Orange paste wares in the Cahal Pech assemblage (77%) versus Holtun region (~12%; Callaghan and Neivens de Estrada 2016), suggest the Belize Valley as the likely origin of Mars Orange ceramics. Additionally, the monumental contexts where Mars Orange ceramics were recovered also suggest the development of an institutional economy underwritten by inter-regional exchange networks between high status groups.

The Late Preclassic (early/late facet Xakal ceramic phase) at Cahal Pech and sites across the lowlands saw the introduction of distinctive Chicanel style ceramics, characterized by matte or waxy-finish red and black slips (Awe 1992; Gifford 1976). The development of this regional ceramic style and more tightly integrated obsidian exchange networks corresponds to the rapid growth of major civic-ceremonial centers (Ebert et al. n.d.), development of shared monumental architectural traditions (Reese-Taylor and Walker 2002), and the ability of incipient elites at these sites to tap into long-distance exchange networks to acquire exotic prestige items to reinforce their authority. At Cahal Pech, a program of large-scale monumental construction occurred in the site center (Plazas A and B; Awe 1992; Healy et al. 2004). Accelerated architectural activity in the core is evident in Plaza A, where Structure A-1 reached a height of almost 15 m. Plaza B was raised and enlarged during the Late Preclassic, and the first royal tomb in Structure B1 (Burial 7) was constructed by the end of the Preclassic.

The expansion of households in the Cahal Pech periphery was concurrent with large-scale construction of monumental architecture in the Cahal Pech site core. Radiocarbon and architectural data document the construction of larger-scale residential buildings construction in at least five house groups (Burns Avenue Group, Cas Pek, Tolok, Tzutziiy K'in Group, and Zopilote Group) in the Cahal Pech periphery after ~350 cal BC (Awe 1992:207; Ebert et al.

2016, n.d.; Iannone 1996; Powis 1996). The Xakal complex ceramics sampled for INAA in this study derive from contexts at the peripheral Tzutziiy K'in and Zopilote settlement groups. The majority (~96%) of these ceramics are restricted to compositional Group G, which includes common Xakal types (Sierra Red, Joventud Red, Sayab Daub-striated) with both utilitarian (e.g., large jars, spindle whorls) as well as more specialized forms (e.g., serving dishes, spouted vessels). While most of the later samples were derived from household contexts, the correlation between time period and context may have important implications for understanding diachronic patterns of ceramic production and consumption at Cahal Pech, and more broadly within the lowland region. Group G paste types dominate later periods, indicating a shift in the clay and temper used for production for all functional categories of ceramics. Because our sample from Cahal Pech is derived primarily from peripheral households, Group G ceramics may represent differential production between the households and site core. The shift in paste recipe at Cahal Pech may also correspond to the adoption Chicanel style ceramics as a result of the development of regional interaction networks. Euclidean Distance searches within the MURR database indicate that nearly all of the Cahal Pech Group G specimens are most compositionally similar to assemblages from the eastern Maya lowlands. When compared to the Late Preclassic assemblages of similar types (Sierra Red and Joventud Red) produced locally at the site of K'axob in Northern Belize (Angelini 1998), the Group G ceramics from Cahal Pech overlap significantly, perhaps indicating broadly shared ceramic production traditions in the eastern periphery of the Maya lowlands (Figure 4.9B). Additional INAA analyses of Late Preclassic ceramics from the Cahal Pech site core and from other Maya sites are necessary to characterize differential production and consumption patterns that may be associated with local tradition and status.

Conclusions

The Preclassic Period was a critical transition for social and economic organization across the Maya lowlands. Archaeological evidence indicates that by the Late Preclassic Maya society had become complex and hierarchical, with small village settlements developing into large centralized polities serving as the focal points of economic, political, and ritual activity (Chase and Chase 2012; Doyle 2017; Estrada-Belli 2011). Research has tended to stress the actions of elites in these developments, with less focus on the role of households and how they functioned within increasingly complex socio-economic networks. Domestic economies were essential links in local communities to larger regional socio-economic systems among early Maya societies, and household production and exchange likely shaped the function of broader institutional economies.

The geochemical compositional analyses presented in this study allowed us to examine the structure, function, and development of local domestic and developing institutional economic systems in the Preclassic Period at the Belize Valley site of Cahal Pech. Results indicate that economic networks became increasingly complex and interconnected from the Early to Late Preclassic Periods, with the function of production and exchange varying by the type of goods consumed through time. Both obsidian pXRF and ceramic INAA data indicate that households were self-sufficient and procured or produced most of the items necessary for daily activities. Obsidian source data connect Preclassic households at Cahal Pech to a diversity of economic networks operating between the Belize Valley, highland Guatemala, and highland Mexico. Blade consumption patterns, however, suggest a relatively decentralized form of domestic procurement of finished blades that did not necessarily contribute to unequal economic relationships at Cahal Pech. INAA data show that ceramics were differentially consumed through time. Local production of specialized ceramic serving vessels with ideologically significant designs first appear at Cahal Pech during the Early Preclassic Cunil phase, and were produced and consumed locally. The patterning of INAA data also provides evidence for the development of inter-regional exchange of specialized Mars Orange pottery between high-status groups at Cahal Pech and sites in the central Petén. Production and distribution of these specialized vessels may have been used as one strategy by high-status households to link people into networks of interdependency within a developing institutional economy that ultimately contributed to their prosperity and prestige (Clark and Blake 1994; Costin 1991; Hirth 2009). By the Late Preclassic, INAA data also link Cahal Pech to the development of a regional ceramic production tradition of locally produced waxy slipped pottery. Future research focused on characterizing obsidian and ceramic assemblages from other Preclassic contexts at Cahal Pech and other Belize Valley sites will help us reconstruct the adaptive capacity of households to changing social and economic conditions based on production and exchange. Variation in assemblages may reveal the economic strategies that shaped both local and regional economies and contributed to institutionalized social and economic differentiation.

Chapter 5

THE ROLE OF DIET IN RESILIENCE AND VULNERABILITY TO CLIMATE CHANGE: RADIOCARBON AND STABLE ISOTOPE EVIDENCE FROM CAHAL PECH, BELIZE[1]

Abstract

The Terminal Classic Period (AD 750-1000) collapse of lowland Maya social, economic, and political systems has been temporally correlated with severe and extended drought in regional paleoclimate records. Ancient Maya society also experienced a protracted multi-century drought earlier during the end of the Late Preclassic Period (~AD 100-300). While some large Preclassic polities declined, many more flourished through the Early Classic. Why were the impacts of the Terminal Classic climate change more dramatic? What allowed some earlier Maya communities to be more resilient in the face of climate change? AMS radiocarbon dating and stable carbon and nitrogen isotope analyses of human skeletal remains from 45 individuals at the ancient Maya community of Cahal Pech from this critical time period suggest more diverse diets incorporating wild and domestic foods may have promoted resilience in the face of changing socio-ecological systems at the end of the Preclassic. During the Late Classic Period (AD 300-900), isotopic data indicate high-status individuals had a narrow and highly specialized diet, which may have created a more vulnerable socio-economic system that ultimately disintegrated as a result of anthropogenic landscape degradation and severe drought conditions during the Terminal Classic.

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Introduction

The resilience and adaptability of complex socio-natural systems are critical issues facing contemporary societies worldwide, especially in the context of anthropogenic climate change. Archaeologists have placed increasing emphasis on examining the long-term processes that promoted alternating resilience and vulnerability of past societies in response to climate fluctuations. Severe multi-century drought conditions documented in paleoclimate proxy records are recognized to have played a key role in the disintegration of ancient lowland Maya social, economic, and political systems during the Terminal Classic Period (AD 750-1000; Douglas et al. 2016; Hodell et al. 1995; Iannone 2014; Kennett et al. 2012). Climatic change also impacted earlier Maya communities, when protracted drought resulted in the decline of large urban centers (e.g., Nakbe, El Mirador) and the depopulation of some regions at the end of the Preclassic Period (AD 100-300; Dunning et al. 2014). The socio-political developments occurring after this extended Late Preclassic drought differed from those during the Terminal Classic, as more resilient political centers (e.g., Tikal) developed throughout the lowlands and flourished for six to seven centuries.

Why were the impacts of Terminal Classic Period drought more dramatic? What factors supported the resilience of some Preclassic Maya communities in the face of climate change? Resilient social systems have an adaptive capacity that allows them to absorb external disturbance while still retaining essential structures and functions (Hegmon et al. 2008; Holling and Gunderson 2002). Diversity contributes to societal resilience by providing a source of options to buffer against external disturbance. As systems become more complex and interconnected they tend to become less diverse economically, socially, and politically, creating vulnerabilities that potentially compromise their ability to adapt to long-term change and eventually lead to dramatic and rapid cultural transformations (Faulseit 2015; Hegmon et al. 2008).

In this study we examine the role of diet in the resilience and vulnerability of social, economic, and political systems at the Maya site of Cahal Pech, Belize during periods of climatic stress from the Preclassic through Terminal Classic Periods (Figure 5.1 and Table 5.1). Cahal Pech provides a unique case study for understanding long-term adaptations to climatic change because of the site's continuous occupation from ~1200 cal BC through cal AD 900 (Awe 1992; Ebert et al., n.d.). Archaeologists working in the southern lowlands have used stable carbon and nitrogen isotope data to reconstruct past diets, testing the hypothesis that anthropogenic environmental degradation contributed to the collapse of Classic Maya society (Somerville et al. 2013; Wright 2006). The link between societal resilience, dietary change, and climate, however, has not been explored closely in the Maya region.

Table 5.1: Chronological periods Cahal Pech (after Awe 1992).

Period	**Calibrated Date Range**
Terminal Classic	AD 800–900/1000
Late Classic	AD 600–800
Early Classic	AD 300–600
Late Preclassic	300 BC–AD 300
Middle Preclassic	1000–300 BC
Early Preclassic	1200–1000 BC

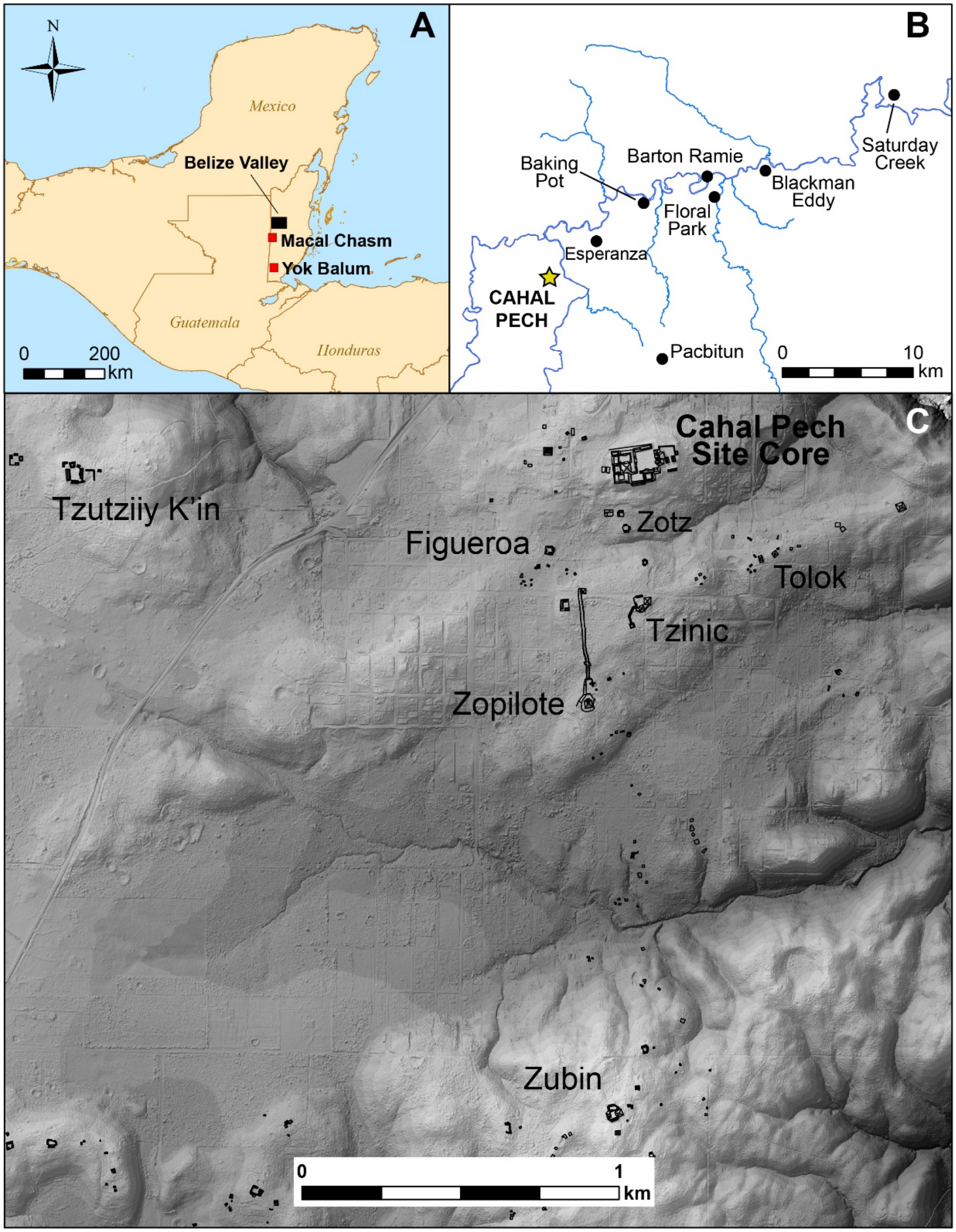

Figure 5.1: (A) Maya lowlands showing location of Belize Valley and paleoclimate proxy records. (B) Belize Valley with major sites sampled for previous stable isotopes analyses, with location Cahal Pech highlighted. (C) Cahal Pech showing location of civic-ceremonial site core in relation to peripheral residential settlement groups from where skeletal samples were collected.

We conducted high-precision AMS ^{14}C dating and stable carbon and nitrogen isotope analyses of human skeletal remains from the civic-ceremonial site core and peripheral settlement groups at Cahal Pech to address this issue. Stable isotope results indicate that Preclassic and Early Classic diet at the site was broad and diverse, including an array of locally available wild resources that were likely used as fallback foods during times of environmental stress. By the Late Classic, the presence of monumental architecture, stone monuments, and the elaborate elite burials identify Cahal Pech as the seat of an important regional site governed by a dynastic lineage (Awe 2013; Awe and Zender 2016). Elite individuals also developed a highly specialized maize-based diet during this period, which was distinct from the broad diet consumed by people in surrounding household settlements. Demand for specific foodstuffs from elite consumers likely influenced more intensive maize production and hunting locally around the community. We argue that Late and Terminal Classic population expansion and anthropogenic environmental degradation from agricultural intensification, coupled with socially conditioned food preferences, resulted in a less resilient system. This “rigidity trap” (Hegmon et al. 2008) ultimately contributed in the failure of the Cahal Pech socio-political system in the face of severe drought at the end of the Terminal Classic Period. Understanding the factors promoting resilience in the past can help mitigate the potential for similar sudden and dramatic shifts in our increasingly interconnected modern world.

Climatic Context of the Maya Lowlands

Research on lowland Maya paleoclimate from proxy records has documented climatic fluctuations from the Preclassic through Terminal Classic Periods. We consider two speleothem paleoclimate records from Belize, Macal Chasm (Akers et al. 2016) and Yok Balum Cave

(Kennett et al. 2012), to understand the climatic setting for the growth and decline of Cahal Pech and associated periods of drought and dietary change. Dry intervals in the Yok Balum record correlate closely with historic accounts of droughts resulting in famine and high mortality during the Colonial Period (AD 1519-1821) in northern Yucatan (Hoggarth et al. 2017). Lake sediment cores from across the northern and central lowlands also show congruent long-term patterns of drought prehistorically across different paleoclimate archives (e.g., Hodell et al. 1995; Medina-Elizalde et al. 2010). These data suggest that the most severe and protracted droughts impacted the entire Maya region and posed serious risks to agricultural production. Major droughts evident in the records can be correlated with direct dates and stable isotope data from human remains at Cahal Pech to identify corresponding changes in dietary trends (Figure 5.2).

The Macal Chasm and Yok Balum speleothem records show two severe droughts at the end of the Late Preclassic (cal AD 100-300), the second of which lasted over a century (Akers et al. 2016; Kennett et al. 2012). These extreme dry conditions are contemporaneous with the depopulation of the major Preclassic centers of Nakbe and El Mirador (Dunning et al. 2014), though evidence exists for population continuity and site growth at Cahal Pech and other Belize Valley sites (Ebert et al. n.d.). A relatively wet period identified in both Belize speleothem records during the Early Classic (~cal AD 400-660) promoted the centralization of a number of large polities, agricultural intensification, and population increase. Climatic instability during the eighth century culminated in two of the most severe droughts in the records between cal AD 820-900 and cal AD 1020-1100. Several studies have found correspondence between these droughts and increased warfare, the disintegration of political systems based on divine dynastic rulership, and demographic declines across the Maya lowlands (Ebert et al. 2014; Hoggarth et al. 2016; Kennett et al. 2012; Medina-Elizalde et al. 2010).

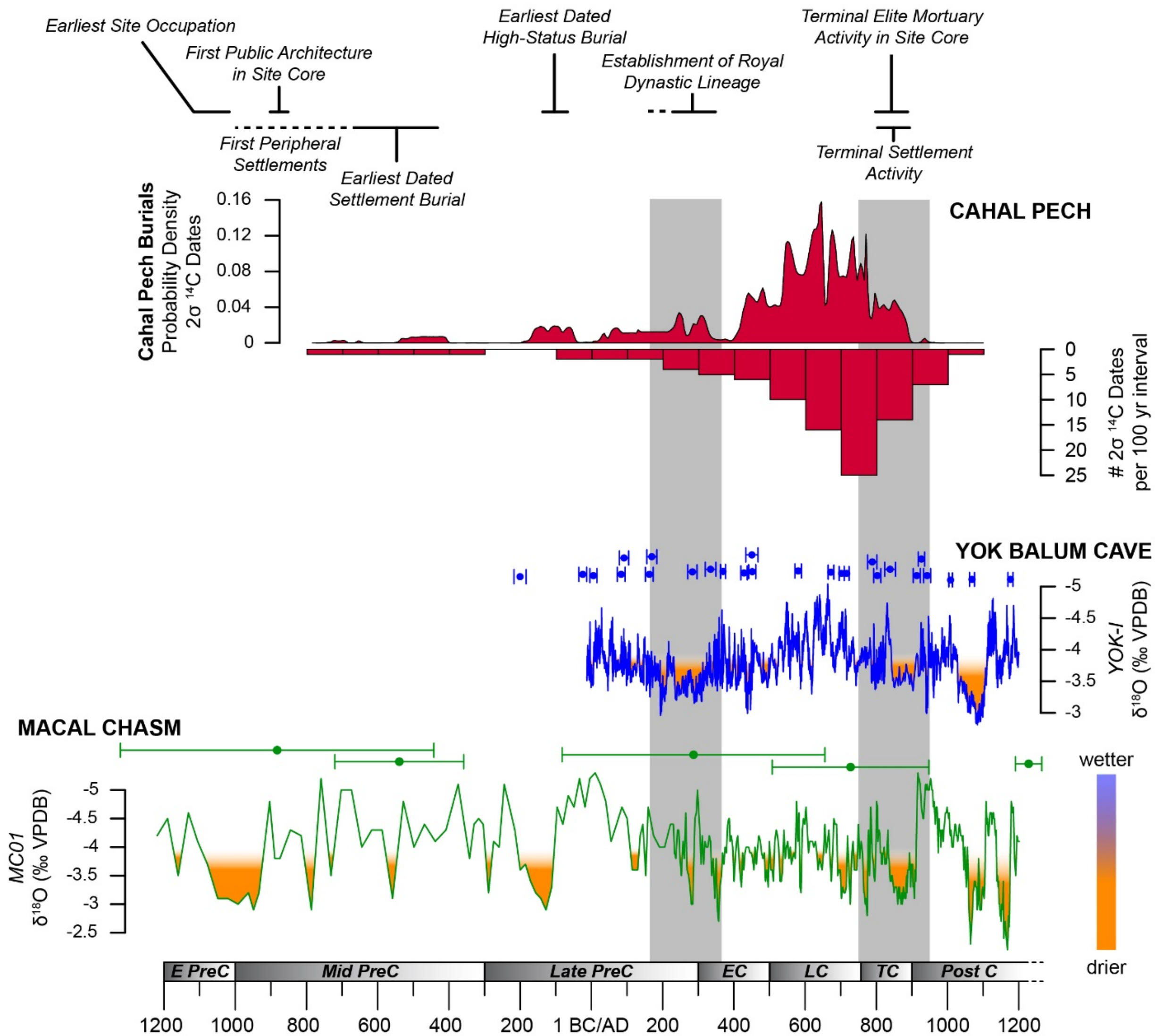

Figure 5.2: Summed probability distribution of Cahal Pech human burial dates shown with a histogram of 2σ calibrated ranges in 100-year bins. Directly dated historical events (2σ calibrated range) in the Cahal Pech radiocarbon sequence are indicated at top. The Yok Balum (YOK-I; Kennett et al. 2012) and Macal Chasm (MC01; Akers et al. 2016) speleothem records show $\delta^{18}O$ isotope data between 1200 cal BC-cal AD 1200, with major Late Preclassic and Terminal Classic droughts highlighted in gray. The U-Th and ^{14}C dates anchoring paleoclimate sequences are included for each record.

The impacts of shifting climate regimes also influenced the adaptive capacity of Maya agricultural systems to absorb disturbance in the face of anthropogenic landscape disturbance and population expansion (Beach et al. 2016; Kennett and Beach 2013).

Archaeological Evidence for Ancient Maya Diet at Cahal Pech

The medium-sized Maya political center of Cahal Pech is located in the upper Belize Valley of western Belize. Archaeological investigations by the Belize Valley Archaeological Reconnaissance (BVAR) Project have identified domestic architecture in the site core providing evidence for one of the earliest farming village settlements in the Maya lowlands. Initial settlement corresponds with the appearance of ceramics (Cunil ceramic complex) in the Belize Valley region during the Early Preclassic Period (1200-900 cal BC; Awe 1992; Ebert et al., n.d.). Specialized ceramic colanders used to produce *nixtamal* (lime-treated maize; Sullivan and Awe 2013), impressions of corn cobs on pottery from household contexts, and maize cupule fragments indicate that maize formed an important component of the diet from an early date (Lawlor et al. 1995). The Preclassic Cahal Pech community also exploited a variety of other plants from the surrounding forest and house gardens, including squash (*Curcurbita* sp.) and fruits (Weisen and Lentz 1997). Excavations in Preclassic midden contexts have yielded a large sample (n>25,000) of terrestrial, freshwater, and marine faunal remains representing a diet in which maize was not the only source of protein (Powis et al. 1999; Stanchly and Awe 2015:230).

By the beginning of the Classic Period, maize had become a staple food of great social significance for the ancient Maya. The concept of life, death, and renewal as represented by the Maize God is a recurring theme in Late Preclassic and Classic Period iconography (Miller and Martin 2004; Taube 2005). Several royal burials from Cahal Pech reflect this ideology associated with the resurrection of the Maize god, or contain jade items with Maize God imagery directly linking maize production and consumption with rulership (Awe 2013, n.d.). Intensified agricultural production during the Classic Period, including terraces and ditched systems documented by airborne lidar analyses, supported growing residential populations and monumental construction programs in the Belize Valley (Ebert et al. 2016b).

Stable Isotope Dietary Analyses

Stable carbon ($\delta^{13}C$) and nitrogen ($\delta^{15}N$) isotope measurements of human bone collagen are widely used as a proxy for prehistoric human diet (Ambrose and Krigbaum 2003; DeNiro and Epstein 1978, 1981). Values for $\delta^{13}C$ are determined by photosynthetic pathways used by C3 (trees, shrubs) and C4 (grasses) plants. Maize was the most common C4 plant consumed across the Maya lowlands, and $\delta^{13}C$ values of bone collagen track the importance of this domesticate as a staple crop through time (White 1999). Metabolic fractionation for human consumers produces $\delta^{13}C$ values for bone collagen of -20±1‰ for a diet composed of C3 plants and more enriched values of -7±1‰ for a C4 plant-based diet. Nitrogen isotope ratios in human bone are introduced in the process of protein digestion, increasing incrementally by 3-5‰ between trophic levels (Hedges and Reynard 2007). Marine vertebrates are generally more enriched in $\delta^{15}N$ relative to terrestrial vertebrates. Enriched $\delta^{15}N$ is also correlated with arid conditions (Ambrose 1991) and forest loss which reflect alterations in nitrogen sources to plants (Lohse et al. 2014).

Maya archaeologists have suggested complex relationships between dietary diversity and social status across time and space based on $\delta^{13}C$ and $\delta^{15}N$ values for human bone collagen (White 1999; Sommerville et al. 2013; Wright 2006). While previous isotope studies for Cahal Pech have been limited in sample size, high $\delta^{13}C$ and $\delta^{15}N$ values from Middle Preclassic burials

(n=7) from the site core and three settlement groups (Tolok, Cas Pek, and Zotz) have been interpreted as evidence for increased maize and marine fish consumption for some high-status individuals (White et al. 2006; Powis et al. 1999). Stable isotope data from a sample of Classic Period (AD 600-900) individuals from the Cahal Pech core (n=2) and settlement (n=14) indicate a more homogenous diet composed primarily of maize-based protein (Piehl 2006).

Materials and Methods

A total of 45 human individuals from the Cahal Pech site core and settlement contexts were directly AMS ^{14}C dated and stable carbon and nitrogen isotopes were measured to examine dietary change through time and its relationship to resilience or vulnerability in the face of drought. We also include isotope data for eight individuals from previous studies (Green 2016; Powis et al. 1999; Piehl 2006). Chronological information for these individuals is based on contextual ceramic associations. An additional 45 samples of fauna from Cahal Pech and the nearby site of Baking Pot were also processed for stable isotope analyses (Table 5.2).

Table 5.2: Variation in mean carbon ($\delta^{13}C$) and nitrogen ($\delta^{15}N$) isotope values for archaeological fauna from Belize Valley sites of Cahal Pech and Baking Pot.

Species	**Common Name**	***n***	**$\delta^{13}C$ (‰ VPDB)**	**St. Dev.**	**$\delta^{15}N$ (‰ Atm N_2)**	**St. Dev.**
Canis familiaris	Dog	3	-19.5	4.2	5.2	2.0
Chelonia	Freshwater turtle	3	-22.5	0.5	4.9	1.1
Mazama americana	Red brocket deer	3	-20.0	1.1	6.4	1.1
Meleagridae	Turkey	1	-17.0		4.4	
Nasua narica	Coati	1	-13.5		10.1	
Odocoileus virginianus	White-tailed deer	31	-20.1	2.4	5.6	1.3
Sylvilagus sp.	Forest rabbit	3	-20.0	0.3	4.3	0.4
Total		45				

AMS Radiocarbon Dating and Stable Isotope Analysis Methods

Cortical bone was preferentially sampled when available to maximize collagen yield. Approximately 1000 mg of dry bone from each sample were cleaned of adhering sediment with an X-acto® blade. Bone collagen was extracted and purified using the modified Longin (1971) method with ultrafiltration (Brown et al. 1988) or XAD-purification for more poorly preserved samples (Lohse et al. 2014; Stafford et al. 1998). Samples were demineralized for 24–48 hours in 0.5 N HCl at 5 °C, followed by a brief (<1 h) alkali bath in 0.1 N NaOH at room temperature to remove humates. The resulting pseudomorph was rinsed to neutrality in multiple changes of Nanopure H2O and then gelatinized for 12 h at 60 °C in 0.01 N HCl. Ultrafilitration methods (Brown et al. 1988) for the purification of or well-preserved collagen samples. For these samples, the gelatin solution was pipetted into pre-cleaned Centriprep® 30 ultrafilters (retaining > 30 kDa molecular weight gelatin) and centrifuged 3 times for 30 min, and diluted with Nanopure H2O and centrifuged 3 more times for 30 min to desalt the solution (ultrafilter cleaning methods are described in McClure et al. 2011: 28–29). Ultrafiltered collagen was lyophilized and weighed to determine percent yield as a first evaluation of the degree of bone collagen preservation.

XAD-purification was used for more poorly preserved samples according to procedures described by Stafford et al. (1998), with modifications described by Lohse et al. (2014). Contaminants were eliminated by breaking down bone collagen into individual amino acids by hydrolysis in 2mL 6 N HCl for 22 hours at 110 °C, releasing humic and fulvic acids into solution. Supelco ENVI-Chrom® SPE (Solid Phase Extraction; SigmaeAldrich) columns were prepped with 2 washes of methanol and rinsed with 10 mL DI H2O. With a 0.45 mm Millex Durapore filter attached, the SPE Column was equilibrated with 50 mL 6 N HCl and the washings discarded. Next, 2 mL collagen hydrolysate as HCl was pipetted onto the SPE column and driven with an additional 10 mL 6 N HCl dropwise with the syringe into a 20 mm culture tube. The hydrolyzate was finally dried into a viscous syrup by passing UHP N2 gas over the sample heated at 50 °C for ~12 hours.

A total of 20 samples failed processing preparation due to poor preservation (Table 5.3), and were not submitted for additional AMS ^{14}C and stable isotope analyses. Preservation tended to be biased towards burials recovered from residential contexts. These individuals were often buried within simple cysts underneath house floors. Burials from monumental contexts, especially in the site core, tended to be placed in lime plastered chambers or beneath plastered floors and were more poorly preserved. This observation may indicate that the plaster is elevating the pH within the burial matrix, resulting in alkaline soils that degrade bone collagen.

Table 5.3: Poorly preserved burials (*n*=20) from Cahal Pech that failed AMS ^{14}C and stable isotope processing.

Provenience/Burial	Sex	Age	Time Period
Cahal Pech Str. B1 Burial 8	M	30-40	Late Preclassic
Cahal Pech Str. B4 Burial 1/-6	I	A	Late Preclassic
Zubin Str. A1 Burial A1-B/10	I	4-5	Late Preclassic
Zubin Str. A1 Burial A1-B/9	I	25-40	Late Preclassic/Early Classic
Cahal Pech Str. B1 Burial 11	M	40+	Early Classic
Cahal Pech Str. B1 Burial 12	M	A	Early Classic
Zotz Str. 7 Burial 7	I		Early Classic
Cahal Pech Plaza A Burial A3-1	I	8-10	Late Classic
Figueroa Str. 2 Burial 2			Late Classic
Tzinic Str. 2 Burial 4			Late Classic
Tzinic Str. 2 Burial 5			Late Classic
Tzinic Str. 2 Burial 6			Late Classic
Tzinic Str. 8 Burial 1			Late Classic
Zopilote Str. 1 Tomb 1, Indiv. 2			Late Classic
Zotz Str. 2 Burial 3			Late Classic
Zotz Str. 2 Burial SE side			Late Classic
Zubin Str. A1 Burial A1-B/3, Indiv 5	M	A	Late Classic
Zubin Str. A1 Burial A1-B/4	I	I	Late Classic
Cahal Pech Str. B1 Burial 9	I	A	Terminal Classic
Cahal Pech Str. B1 Burial 13	F	40+	?

Carbon and nitrogen concentrations and stable isotope ratios were measured at the Yale Analytical and Stable Isotope Center with a Costech ECS 4010 Elemental Analyzer with Conflo III interface. Sample quality was evaluated by % crude gelatin yield, %C, %N, and C:N ratios. C:N ratios for 42 samples fell between 3.10 and 3.5, indicating good collagen preservation (DeNiro 1985; van Klinken 1999). Samples with C:N ratios outside of this range did not meet quality control standards (*n*=7; Table 5.4), and are therefore not considered for additional analyses in this study. We also include stable isotope data derived from human bone collagen from an additional six individuals reported from previous studies in our analyses (Green 2016; Piehl 2006; Powis et al. 1999). We reanalyzed 20 individuals from these studies for AMS radiocarbon dating, and our stable isotope results generally fall within ±2 ‰ of previously reported results, which is in the expected range of variation for an individual (Table 5.5; DeNiro and Epstein 1978). Variation may also be the result of different preparation methods between labs, with previous analyses not inducing purification of samples beyond the gelatinization stage.

AMS radiocarbon samples (~2.5 mg) were combusted for 3 hr. at 900°C in vacuum-sealed quartz tubes with CuO wire and Ag wire. Sample CO_2 was sent to KCCAMS (University of California, Irvine) where it was reduced to graphite at 550°C using H_2 and a Fe catalyst, with reaction water drawn off with Mg(ClO4)2 (Santos et al. 2004). Graphite samples were pressed into targets in Al boats and loaded on the target wheel for AMS analysis. ^{14}C ages were corrected for mass-dependent fractionation with measured $\delta^{13}C$ values (Stuiver and Polach 1977), and compared with samples of Pleistocene whale bone (background, >48 ^{14}C kyr BP), late Holocene bison bone (~1850 ^{14}C BP), late AD 1800s cow bone, and OX-1 oxalic acid standards for calibration.

Table 5.4: Burials from Cahal Pech that failed C:N quality control measures (*n*=7). Samples are listed by relative time period based on ceramic associations.

Provenience	**Sex**	**Age**	**Time Period**	**δ^{15}N (‰ Atm N_2)**	**δ^{13}C (‰ VPDB)**	**%N**	**%C**	**C:N**
Tzutziiy K'in Str. 2 Looter's Trench 3			Early Classic			0.3	1.4	5.5
Figueroa Str. 2 Burial 3a			Late Classic	7.8	-16.5	1.1	3.8	4.0
Zubin Str. A1 Burial A1-B/2	I	I	Late Classic	18.7		0.6	2.5	5.1
Zubin Str. A1 Burial A1-B/6	I	I	Late Classic			0.3	1.4	6.1
Cahal Pech Plaza A Burial A3-1	I	8-10	Late Classic				0.6	
Cahal Pech Plaza H Tomb 1	M	OA	Terminal Classic	12.4		1.8	5.9	3.8

All dates are reported as conventional ^{14}C ages corrected for fractionation, with measured δ^{13}C following Stuiver and Polach (1977). Date calibrations were produced in OxCal v.4.2 (Bronk Ramsey 2009) using the IntCal13 Northern Hemisphere atmospheric curve (Reimer et al. 2013). Given the proximity of Cahal Pech to the Belize River and the likelihood of some amount of riverine food in the ancient Maya diet, an unquantified freshwater reservoir effect (R_f) may impact some or all of the skeletons, but are relatively minimal (Hoggarth et al. 2014: 1062)

Figure 5.3 shows the calibrated date ranges from all Cahal Pech burials for the Preclassic through Terminal Classic Periods, with the summed probability distribution of dates plotted at the bottom. Relative ceramic phases are also indicated. The summed probability distributions show shifts in occupational activity at Cahal Pech, with rises and falls represented general positive and negative demographic trends. Calibrated distributions were plotted against a histogram showing the number of calibrated 2-σ ^{14}C dates binned in 50-year intervals. These data show general positive and negative trends in the summed distributions with attached confidence intervals. Considered alongside stable isotope and paleoclimate proxy data, the summed distributions of burial dates also helps to identify the timing of dietary shifts, represented in stable isotope data, which correspond to climatic trends.

Table 5.5: Comparison of previously reported stable carbon and nitrogen isotope results from previous isotope studies compared to reanalysis of samples performed for this study.

Provenience	Previous Studies		This Study	
	$\delta^{13}C$ (‰ VPDB)	**$\delta^{15}N$ (‰ Atm N_2)**	**$\delta^{13}C$ (‰ VPDB)**	**$\delta^{15}N$ (‰ Atm N_2)**
Cahal Pech Plaza B EU-13 Burial[a]	-10.2	8.6	-10	8.2
Cahal Pech Plaza B Op. 1o-10 Burial[a]	-10.7	9.5	-13.1	11.1
Cahal Pech Plaza G Burial 1a[a]	-8.5	9.9	-9.3	8.7
Cahal Pech Str. B4 Burial B4-1[a]	-8.5	10	-8.2	9.8
Cahal Pech Str. B4 Lvl. 5 Burial[a]	-9.3	10.8	-9.2	10.1
Cahal Pech Str. C2 Burial 1[a]	-9.9	10.7	-9.9	9.9
Figueroa Str. 2 Burial 4[b]	-8.8	10	-11.7	9.3
Tolok Str. 14/15 Burial 10[c]	-13.8	8.4	-12.6	8.5
Tolok Str. 14/15 Burial 2 [b]	-10.4	8.5	-11.5	8.3
Tolok Str. 14/15 Burial 3 [b]	-12.1	8.3	-11.8	8.6
Tolok Str. 14/15 Burial 4 [b]	-12.2	8.2	-11.5	8.4
Tolok Str. 14/15 Burial 8[c]	-13	8.4	-11.8	7.8
Tzinic Str. 2 Burial 1 [b]	-10.1	9.4	-11.3	11.7
Tzinic Str. 2 Burial 2 [b]	-10.9	9.9	-11.3	11.7
Tzinic Str. A2 Burial 1 [b]	-13	7.2	-12.3	7.4
Zotz Str. B2 Burial 1 [b]	-12.5	9.2	-12.8	9.6
Zotz Str. B2 Burial 3 [b]	-9	11.2	-9.2	11.1
Zotz Str. B2 Burial 4 [b]	-11.1	7.8	-8.8	7.9
Zotz Str. B2 Burial 5 [b]	-10.2	9.6	-10.6	9.2
Zotz Str. B2 Burial 6 [b]	-11.9	9.9	-9	10.4

[a] Stable isotope data from Green 2016.
[b] Stable isotope data from Piehl 2006.
[c] Stable isotope data from Powis et al. 1999.

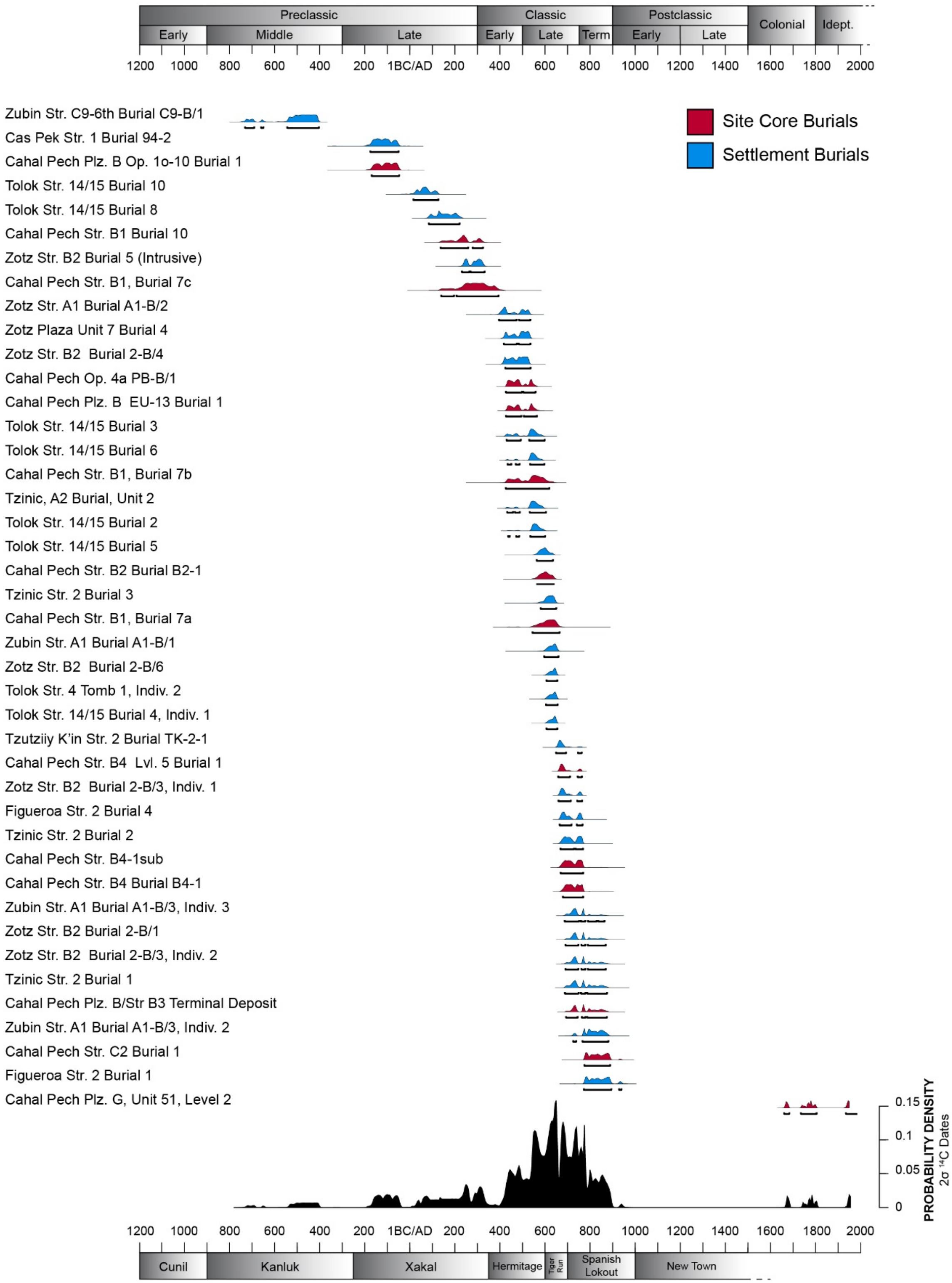

Figure 5.3: Calibrated 2σ dates for Cahal Pech burials, with summed probability distribution of burials plotted at the bottom. Relative chronological periods considered in this study (top) and associated ceramics for Cahal Pech (bottom) are also indicated.

For statistical analyses, five different groups were formed for the analyzed individuals based on the relative temporal and contextual associations (Table 5.6). The *t*-test for independent groups (two parameters) assuming unequal variance was used to determine significant differences between the means within each group (Ruxton 2006). Additionally, the non-parametric Mann–Whitney *U* test (two parameters) for independent samples was used where applicable due to the small sample size since not all samples were normally distributed. Significance was set at α=0.05 for all tests (Table 5.7).

Box plots comparing $\delta^{13}C$ and $\delta^{15}N$ values for purified human bone collagen from site core and settlement contexts through time were also created to illustrate statistical relationships between groups (Figure 5.4 and 5.5). One human sample (Tolok Str. 14/15 Burial 9) was not included because $\delta^{15}N$ values were not reported for this individual (Powis et al. 1999). Comparing early and late time periods, no significant differences are evident in $\delta^{13}C$. In contrast, $\delta^{15}N$ is significantly different between early and late populations at Cahal Pech (t = -3.32; df = 42; p = .002).

We also examined if there was an age or sex effect influencing isotope values. Enriched $\delta^{15}N$ values in sub-adults (less than 5 years old) has been shown to reflect some breast-feeding among some populations (Katzenberg and Pfeiffer 1995; Richards et al. 2002). We compared both $\delta^{13}C$ the $\delta^{15}N$ values for all individuals in the sample for which age could be determined (sub-adults n = 5, adults n = 24). There was no significant difference between sub-adults and adults for either $\delta^{13}C$ (t = -0.6; df = 5; p = 0.487) or $\delta^{15}N$ (t = -1.04; df = 7; p = 0.166). Comparing stable isotope values for sex differences across all time periods (Table S6), there was not a significant difference for $\delta^{13}C$ between males (n = 12) and females (n = 8). However there was a significant difference for $\delta^{15}N$ values (t = -1.97; df = 18; p = 0.032), with males having more enriched values. However, when sex differences were evaluated by time period, there were no significant differences between male and female diets, indicating that changes in $\delta^{13}C$ and $\delta^{15}N$ values through time is likely not influenced by dietary difference between sexes.

Table 5.6: Results of statistical analyses for stable carbon and nitrogen isotope data by time period and context.

Groups	***n***	**Variables**	***t*-test (*p*)**	**Mann-Whitney *U* (*p*)**
Preclassic and Early Classic vs. Late and Terminal Classic	21; 23	$\delta^{13}C$	0.174	0.358
		$\delta^{15}N$	<0.001	0.001
Preclassic and Early Classic Site Core vs. Settlement	6; 15	$\delta^{13}C$	0.050	0.080
		$\delta^{15}N$	0.046	0.067
Late and Terminal Classic Site Core vs. Settlement	5; 17	$\delta^{13}C$	<0.001	0.008
		$\delta^{15}N$	0.365	0.938
Preclassic and Early Classic Site Core vs. Late and Terminal Classic Site Core	6; 5	$\delta^{13}C$	0.054	0.067
		$\delta^{15}N$	0.372	0.412
Preclassic and Early Classic Settlement vs. Late and Terminal Classic Settlement	15; 17	$\delta^{13}C$	0.200	0.224
		$\delta^{15}N$	<0.001	0.001

Table 5.7: Results of statistical analyses for sex differences. Mann-Whitney *U* not performed for some groups due to insufficient sample size. Statistically significant values are bolded.

Groups	***n***	**Variables**	***t*-test (*p*)**	**Mann-Whitney *U* (*p*)**
All Time Periods Female vs. Male	8; 12	$\delta^{13}C$	0.378	0.425
		$\delta^{15}N$	**0.032**	**0.038**
Preclassic and Early Classic Female vs. Male	4; 4	$\delta^{13}C$	0.075	--
		$\delta^{15}N$	0.068	--
Late and Terminal Classic Female vs. Male	4; 8	$\delta^{13}C$	0.162	--
		$\delta^{15}N$	0.258	--

Results

High-precision AMS ^{14}C dates and stable carbon and nitrogen isotope values for Cahal Pech burials are presented in Table 5.8. The age and sex of each individual was determined using standard osteological methods (see Green 2016), and presented when available. Radiocarbon dates show continuous mortuary activity at Cahal Pech beginning in the Middle Preclassic, with the first directly dated burial dating between 735-400 cal BC. Six burials date to the Late Preclassic between 180 cal BC-cal AD 335. The majority of Cahal Pech burials date to the Classic Period. A total of 12 burials date to the Early Classic, and 16 to the Late Classic. Only three burials, including one from the site core and two from the peripheral settlement, date to the Terminal Classic Period. The latter burials temporally correspond to the cessation of elite mortuary activity and architectural construction in both the Cahal Pech core and settlement (Awe 2013; Ebert et al. 2016a). One intrusive burial from Plaza G in the Cahal Pech core yielded a Historic Period date (cal AD 1660-1950).

Values for $\delta^{13}C$ and $\delta^{15}N$ for humans and fauna are plotted in Figure 5.4. Average values for seven species of Belize Valley fauna provide baseline data for the local food web. There is considerable overlap in human diet across all time periods from both the site core and surrounding settlement. These ranges ($\delta^{13}C$ = -14.5 to -7.8‰; $\delta^{15}N$ = 7.3 to 11.7‰) are consistent with expected variation for Maya populations consuming maize along with other terrestrial plant and meat resources (Somerville et al. 2013). We also assigned samples to two temporal categories based on the correspondence of the calibrated ^{14}C dates with the Late Preclassic and Terminal Classic droughts identified in paleoclimate records (Table 5.9 and 5.10). No significant differences are evident in $\delta^{13}C$ between periods.

Table 5.8: Calibrated AMS ^{14}C dates and stable carbon ($\delta^{13}C$) and nitrogen ($\delta^{15}N$) isotope values from human burials at Cahal Pech. Samples are listed by sex (M = male, F = Female, I = Indeterminate). Ages are listed in years when determination was possible or by relative age range (A=Adult, YA=Young Adult, OA=Old Adult) following Green 2016: Table A1. Sample preparation methods are also indicated.

Provenience	Sex	Age	Lab #	^{14}C age (BP)	2σ Range (BC/AD)	$\delta^{13}C$ (‰ VPDB)	$\delta^{15}N$ (‰ Atm N_2)	%C	%N	C:N	Method
Site Core Burials											
Cahal Pech Plz. B Op. 1o-10 Burial 1	I	A	167920	2085 ± 20	170-45 BC	-13.1	11.1	11.5	4.1	3.3	XAD
Cahal Pech Str. B1 Burial 10	M	30-50	170054	1790 ± 20	AD 135-325	-9.2	9.5	17.9	6.3	3.3	XAD
Cahal Pech Str. B1 Burial 7, Indiv. 3	F(?)	A	X27037	1748 ± 47	AD 140-395 [a]						
Cahal Pech Op. 4a PB-B/1	I	A	166049	1550 ± 15	AD 425-560	-10.4	7.9	41.2	14.7	3.3	UF
Cahal Pech Plz. B EU-13 Burial 1	I	OA	164842	1545 ± 15	AD 425-565	-10.0	8.2	42.3	15.1	3.3	UF
Cahal Pech Str. B1 Burial 7, Indiv. 2	M	A	X27036	1516 ± 39	AD 425-620 [a]						
Cahal Pech Str. B2 Burial B2-1	I	A	164843	1465 ± 20	AD 560-645	-8.8	9.6	46.0	16.2	3.3	UF
Cahal Pech Str. B1 Burial 7, Indiv. 1	F	A	X27035	1432 ± 36	AD 545-665 [a]						
Cahal Pech Str. B4 Lvl. 5 Burial 1	M	YA	164844	1315 ± 15	AD 560-645	-9.2	10.1	44.7	16.2	3.2	UF
Cahal Pech Str. B4-1sub	F	A	151860	1280 ± 25	AD 670-770	-7.8	9.6	46.9	16.7	3.3	UF
Cahal Pech Str. B4 Burial B4-1	F	40-50	170055	1270 ± 20	AD 680-770	-8.2	9.8	18.4	6.5	3.3	XAD
Cahal Pech Plz. B/Str. B3 Terminal Deposit	M(?)	A	155962	1230 ± 15	AD 690-875	-13.0	10.0	27.6	9.8	3.3	XAD
Cahal Pech Str. B2 Burial CP-B2-2					AD 600-700[b]	-9.3	9.8				
Cahal Pech Str. A2 Burial 1	I	A			AD 600-700 [b]	-8.6	8.4				
Cahal Pech Str. C2 Burial 1	I	3-5	166048	1180 ± 15	AD 775-890	-9.9	9.9	45.4	16.1	3.3	UF
Cahal Pech Plaza G, Unit 51, Level 2	I	12-16	166050	190 ± 15	AD 1660-1950	-9.3	8.7	43.1	14.9	3.4	UF
Peripheral Settlement Burials											
Zubin Str. C9-6th Burial C9-B/1	M	A	151863	2415 ± 25	735-400 BC	-11.7	8.4	42.5	15.3	3.2	UF
Tolok Str. 14/15 Burial 9, Indiv. 1[b]	I	<6			650-300 BC	-14.5	--			3.9	
Cas Pek Str. 1 Burial 94-2	M	35-45	167921	2095 ± 20	180-50 BC	-11.0	10.7	19.2	7.3	3.1	XAD
Tolok Str. 14/15 Burial 10	F	16-23	151861	1935 ± 25	AD 15-130	-12.6	8.5	44.5	15.9	3.3	UF
Tolok Str. 14/15 Burial 8	F	17-26	164851	1860 ± 20	AD 85-225	-11.8	7.8	44.4	15.6	3.3	UF
Tolok Str. 14/15 Burial 7 [b]	I	6-8			AD 200-300	-13.0	8.4		8.3	3.6	
Zotz Str. B2 Burial 5 (Intrusive)			166058	1765 ± 15	AD 230-335	-10.6	9.2	46.7	16.0	3.4	UF
Zotz Str. A1 Burial A1-B/2			172402	1610 ± 20	AD 395-535	-10.3	7.3	15.4	14.8	3.2	XAD
Zotz Plaza Unit 7 Burial 4			166056	1590 ± 15	AD 415-540	-10.1	7.4	50.2	16.9	3.5	UF
Zotz Str. B2 Burial 2-B/4	I	A	166057	1580 ± 15	AD 420-540	-8.8	7.9	46.1	15.8	3.4	UF

Provenience	Sex	Age	Lab #	^{14}C age (BP)	2σ Range (BC/AD)	δ^{13}C (‰ VPDB)	δ^{15}N (‰ Atm N_2)	%C	%N	C:N	Method
Tolok Str. 14/15 Burial 3	M	25-35	170057	1525 ± 20	AD 430-600	-11.8	8.6	21.7	7.6	3.3	XAD
Tolok Str. 14/15 Burial 6	F	35+	164850	1520 ± 15	AD 430-600	-12.5	8.2	42.6	15.2	3.3	UF
Tzinic, A2 Burial, Unit 2			170060	1515 ± 20	AD 430-605	-12.3	7.4	9.7	3.3	3.4	XAD
Tolok Str. 14/15 Burial 2	F	A	164847	1515 ± 15	AD 435-605	-11.5	8.3	42.1	14.9	3.3	UF
Tolok Str. 14/15 Burial 5	F	25-40	164849	1470 ± 15	AD 560-640	-12.0	8.2	44.0	15.4	3.3	UF
Tzinic Str. 2 Burial 3			170059	1440 ± 20	AD 580-650	-11.2	9.2	13.2	4.5	3.4	XAD
Zotz Str. B2 Burial 2-B/6	I	A	164853	1415 ± 15	AD 605-655	-9.0	10.4	40.9	14.4	3.3	UF
Zubin Str. A1 Burial A1-B/1	I	A	151862	1415 ± 25	AD 595-665	-8.4	8.4	44.4	15.6	3.3	UF
Zopilote Str. 1 Burial 1 [c]	I				AD 600	-9.3	9.4				
Tolok Str. 14/15 Burial 4, Indiv 1	M	25-35	164848	1415 ± 15	AD 605-655	-11.5	8.4	33.7	11.7	3.4	UF
Tolok Str. 4 Tomb 1, Indiv. 2	I	YA	170058	1415 ± 20	AD 600-660	-12.5	8.6	20.3	7.1	3.4	XAD
Tzutziiy K'in Str. 2 Burial TK-2-1	M	A	164846	1335 ± 20	AD 645-765	-10.2	10.0	41.1	14.4	3.3	XAD
Zotz Str. B2 Burial 2-B/3, Indiv 2	I	SubA	166055	1325 ± 15	AD 655-765	-9.4	10.9	49.8	17.1	3.4	UF
Zotz Str. B2 Burial 2-B/3, Indiv 1	M	A	166054	1310 ± 15	AD 660-765	-9.2	11.1	50.7	17.3	3.4	UF
Figueroa Str. 2 Burial 4	I		166051	1300 ± 15	AD 650-770	-11.7	9.3	42.2	15.1	3.3	UF
Tzinic Str. 2 Burial 2	I		167924	1285 ± 20	AD 665-770	-11.3	11.7	15.2	5.3	3.4	XAD
Zubin Str. A1 Burial A1-B/3, Indiv 3	M	A	166053	1240 ± 15	AD 685-865	-13.3	8.2	41.5	14.2	3.4	UF
Zubin Str. A1 Burial A1-B/3, Indiv 4	M	14-20				-13.3	8.4	11.9	4.0	3.5	XAD
Zotz Str. B2 Burial 2-B/1	M	A	164852	1235 ± 15	AD 690-870	-12.8	9.6	41.2	14.2	3.4	UF
Tzinic Str. 2 Burial 1	I		167923	1235 ± 20	AD 685-880	-11.3	11.7	7.2	2.4	3.5	XAD
Zubin Str. A1 Burial A1-B/3, Indiv 2	F	18-25	166052	1215 ± 15	AD 725-885	-12.3	8.9	42.3	14.8	3.3	UF
Figueroa Str. 2 Burial 3b [c]	I				AD 600-900	-10.5	9.8				
Figueroa Str. 2 Burial 1			170056	1175 ± 20	AD 770-940	-10.9	9.9	15.2	5.2	3.4	XAD

[a] Radiocarbon dates on human teeth from Novotny 2015. No stable isotope data was reported.
[b] Stable isotope data from Powis et al. 1999. Dates based on ceramic associations.
[c] Stable isotope data from Piehl 2006. Dates based on ceramic associations.

Table 5.9: Mean $\delta^{13}C$ values and confidence intervals (CI) for Cahal Pech human burials by time period and location.

Time Period/ Context	***n***	**$\delta^{13}C$ (‰ VPDB)**	**St. Dev.**	**80% CI (‰)**	**90% CI (‰)**	**95% CI (‰)**
All Late to Terminal Classic	23	-10.6	1.7	± 0.5	± 0.8	± 1.0
All Preclassic to Early Classic	21	-11.0	1.4	± 0.4	± 0.6	± 0.8
Site Core Burials						
Late to Terminal Classic	5	-8.7	0.8	± 0.6	± 1.0	± 1.5
Preclassic to Early Classic	6	-10.1	1.6	± 0.9	± 1.6	± 2.4
Settlement Burials						
Late to Terminal Classic	17	-11.0	1.6	± 0.5	± 0.8	± 1.1
Preclassic to Early Classic	15	-11.4	1.1	± 0.4	± 0.6	± 0.0

Table 5.10: Mean $\delta^{15}N$ values and confidence intervals (CI) for Cahal Pech human burials by time period and location.

Time Period/ Context	***n***	**$\delta^{15}N$ (‰ Atm N_2)**	**St. Dev.**	**80% CI (‰)**	**90% CI (‰)**	**95% CI (‰)**
All Late to Terminal Classic	23	9.7	1.0	± 0.5	± 0.8	± 1.0
All Preclassic to Early Classic	21	8.6	1.0	± 0.3	± 0.5	± 0.6
Site Core Burials						
Late to Terminal Classic	5	9.5	0.7	± 0.4	± 0.8	± 1.2
Preclassic to Early Classic	6	9.4	1.1	± 0.7	± 1.1	± 1.7
Settlement Burials						
Late to Terminal Classic	17	9.7	1.1	± 0.4	± 0.6	± 0.8
Preclassic to Early Classic	15	8.4	0.9	± 0.3	± 0.5	± 0.7

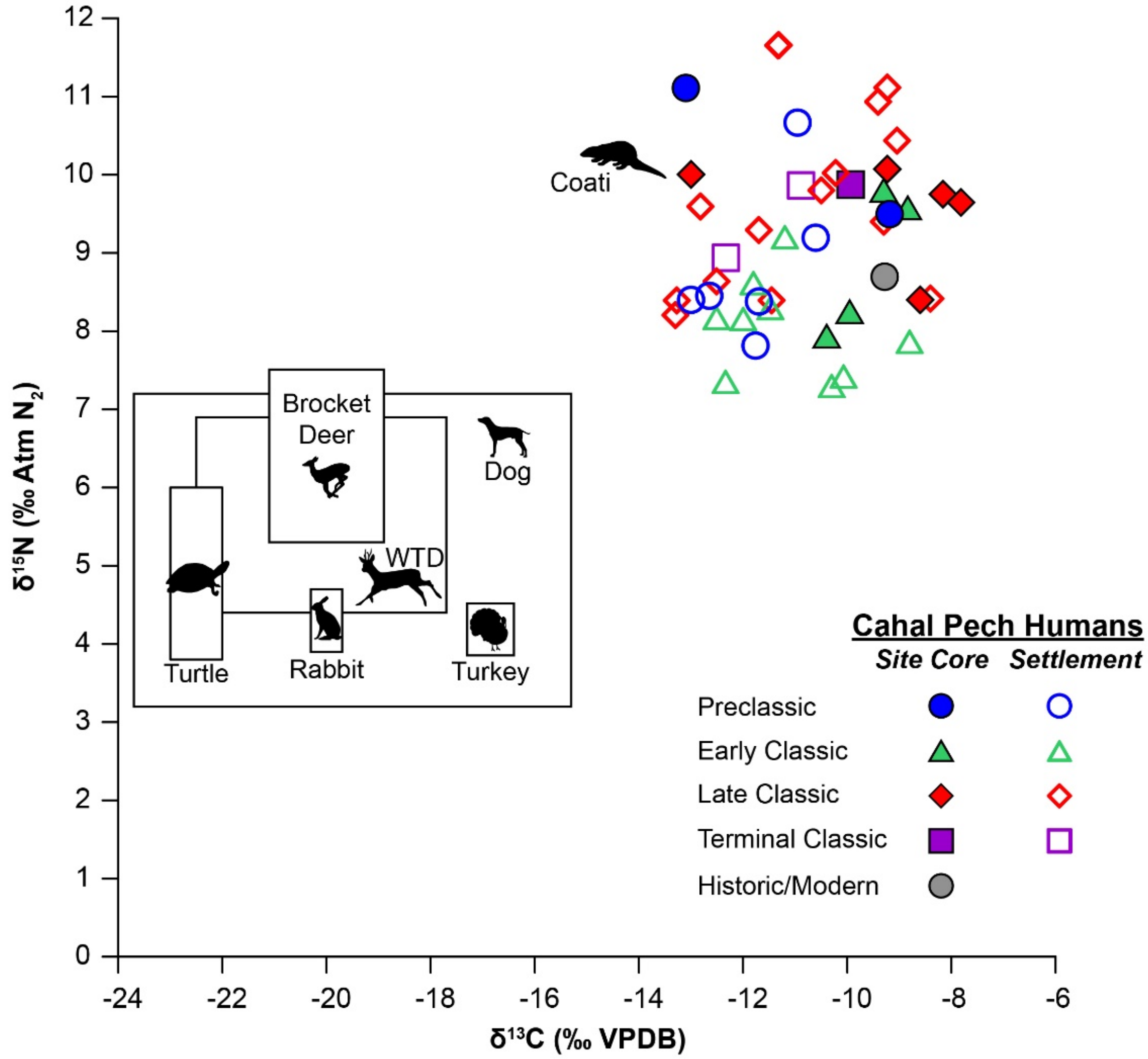

Figure 5.4: Bivariate plot of $\delta^{13}C$ and $\delta^{15}N$ values for human bone collagen from Cahal Pech (n=45) and faunal bone collagen from the Belize Valley (n=45). Boxes around faunal samples represent mean values with 1σ standard deviation. White tailed deer are abbreviated “WTD”.

In contrast, $\delta^{15}N$ is significantly different between early and late populations at Cahal Pech. The mean $\delta^{15}N$ for the Late and Terminal Classic (9.7‰) is enriched by ~1.0‰ indicating a significant temporal dietary shift at the 99% confidence interval (Figure 5.5).

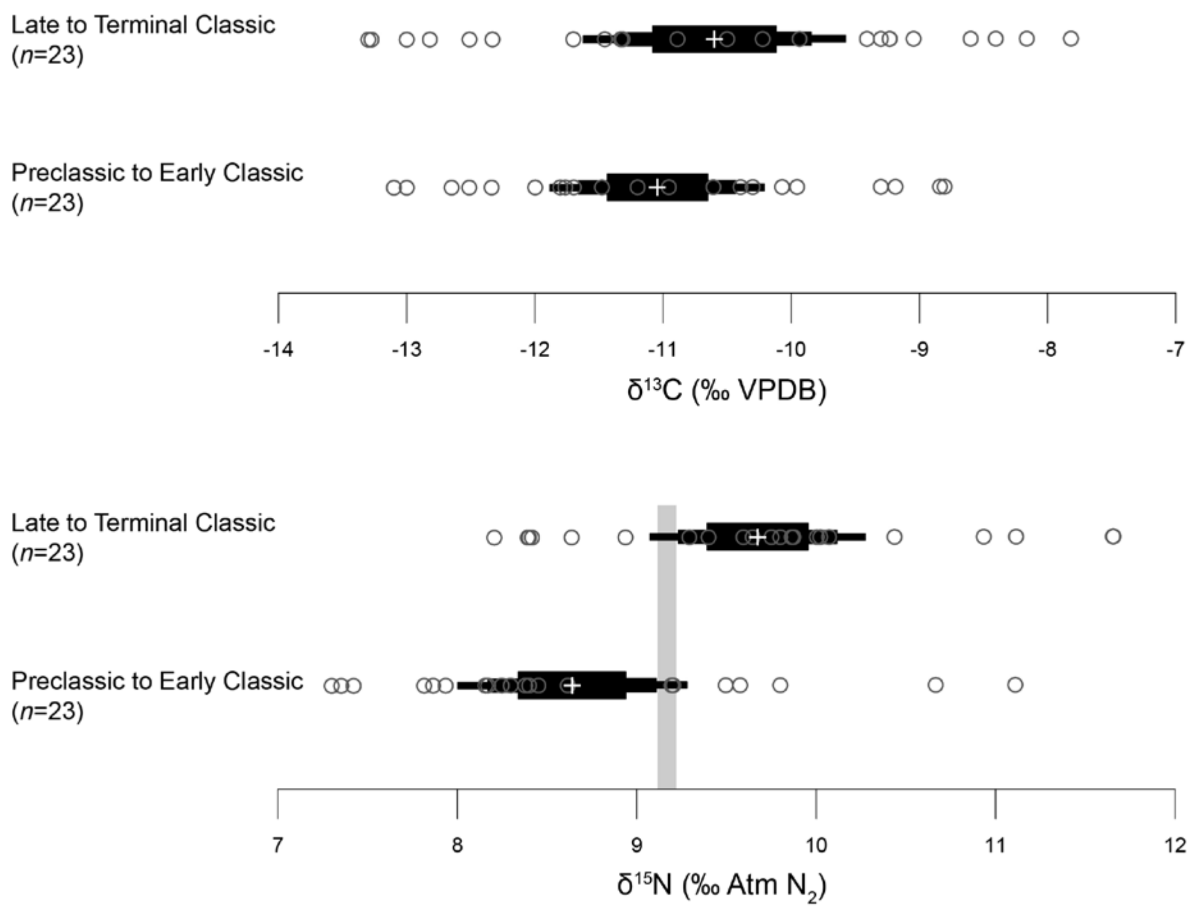

Figure 5.5: Mean carbon ($\delta^{13}C$) and nitrogen ($\delta^{15}N$) isotope values for all Cahal Pech sampled by early (Preclassic to Early Classic) and late (Late Classic to Terminal Classic) temporal categories. Data points are shown as open circles with the means for each context indicated by a cross. The bullet graph shows the 80, 95, and 99% confidence intervals (thickest to thinnest bullets) around the mean. Gray line highlights that statistical differences at the 99% confidence interval for $\delta^{15}N$ values between early and late burials.

Burials were also divided within two temporal categories (early and late) according to their context in the Cahal Pech site core or the settlement (Figures 5.6 and 5.7). Site core burials were interred primarily within ceremonial contexts including tombs, crypts, or other special contexts in monumental architecture, and represent the remains of high status individuals that were likely royals or part of the ruling elite class (Awe 2013). Settlement burials, alternatively, are located beneath house floors and represent the sustaining farming population at Cahal Pech. Burials from each temporal period sampled by context were treated independently, and error ranges for 80% confidence, 95% confidence, and 99% confidence intervals were calculated separately on the basis of each sample (Table 5.10). One individual interred in a terminal deposit at Plaza B was removed from these analyses, since these deposits are associated with site re-visitation by post-abandonment populations. During the early temporal period (Preclassic and Early Classic periods, 1200 cal BC-cal AD 300), mean $\delta^{13}C$ values for individuals interred in the settlement are -11.4‰, with a mean $\delta^{15}N$ value of 8.4‰. Site core individuals during the same period have mean $\delta^{13}C$ (-10.1‰) and $\delta^{15}N$ values (9.4‰) that are enriched by 1‰ compared to the settlement. As Figure 5.6 and 5.7 show, the mean $\delta^{13}C$ and $\delta^{15}N$ values for site core burials is significant different at the 95% confidence interval compared to settlement burials, suggesting higher consumption of C4-based foods and animal protein by higher status individuals.

During the late temporal period (Late and Terminal Classic Periods, cal AD 300-900), the diet of site core individuals became increasingly restricted and distinct compared to individuals from settlements. The mean $\delta^{13}C$ for the site core (-8.7‰) becomes enriched by approximately 1.5‰ compared to the preceding time period. Site core burials also have mean $\delta^{13}C$ values significantly different at the 99% confidence interval from settlement burials dating to the same period. There is no significant increase in $\delta^{15}N$ values within the site core group compared to the preceding period. Within the settlement, mean $\delta^{13}C$ values increase slightly from the preceding time period. A significant shift in $\delta^{15}N$ for this later period compared to the early period in the settlement (significantly different at the 95% confidence interval) may reflect differential consumption of animal protein among individuals from this group, and perhaps also drought conditions.

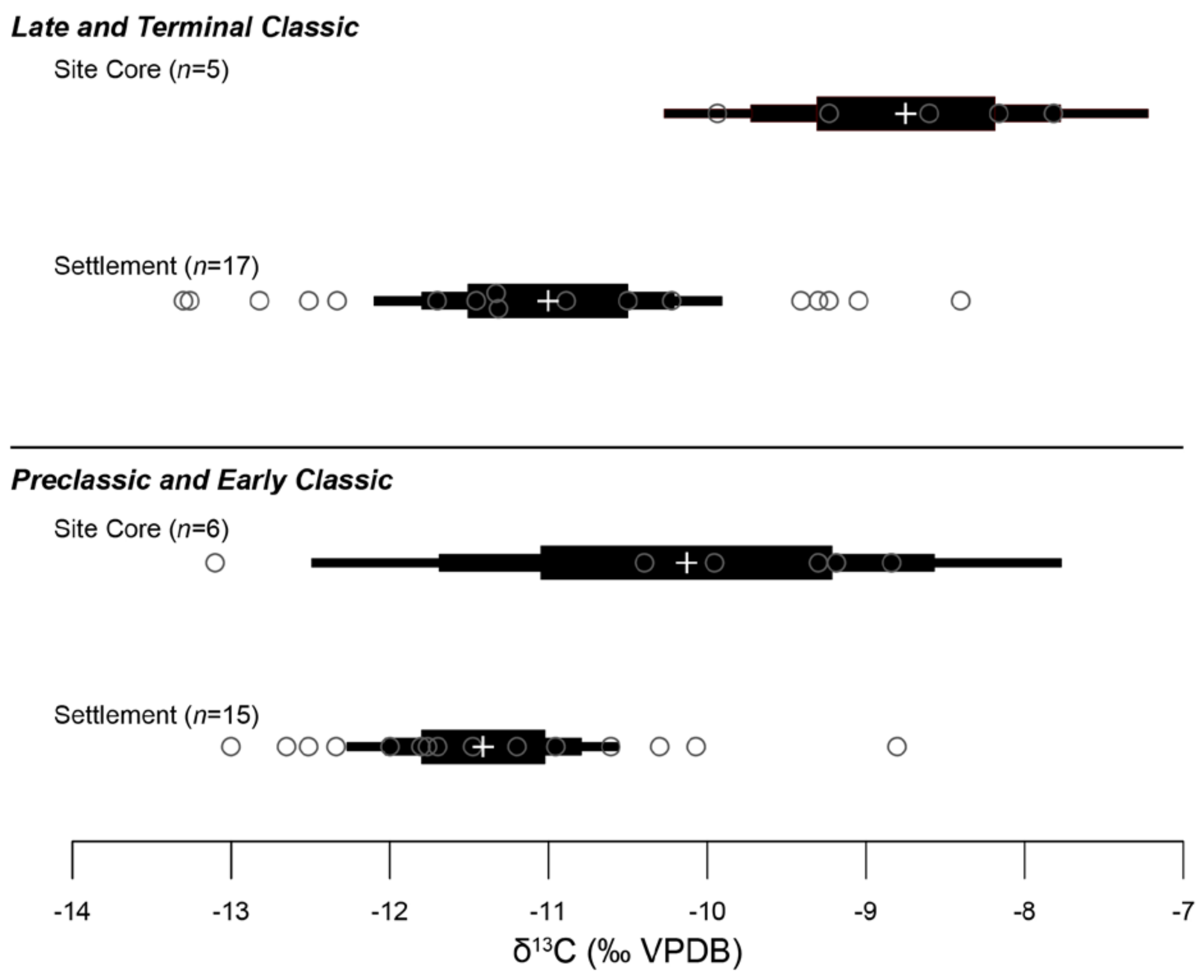

Figure 5.6: Mean carbon ($\delta^{13}C$) isotope values for Cahal Pech site core and settlement burials. Data points are shown as open circles with the means for each context indicated by a cross. The bullet graph shows the 80, 95, and 99% confidence intervals (thickest to thinnest bullets) around the mean. Gray line highlights that statistical differences at the 99% confidence interval for Late and Terminal Classic site core burials relative to settlement burials.

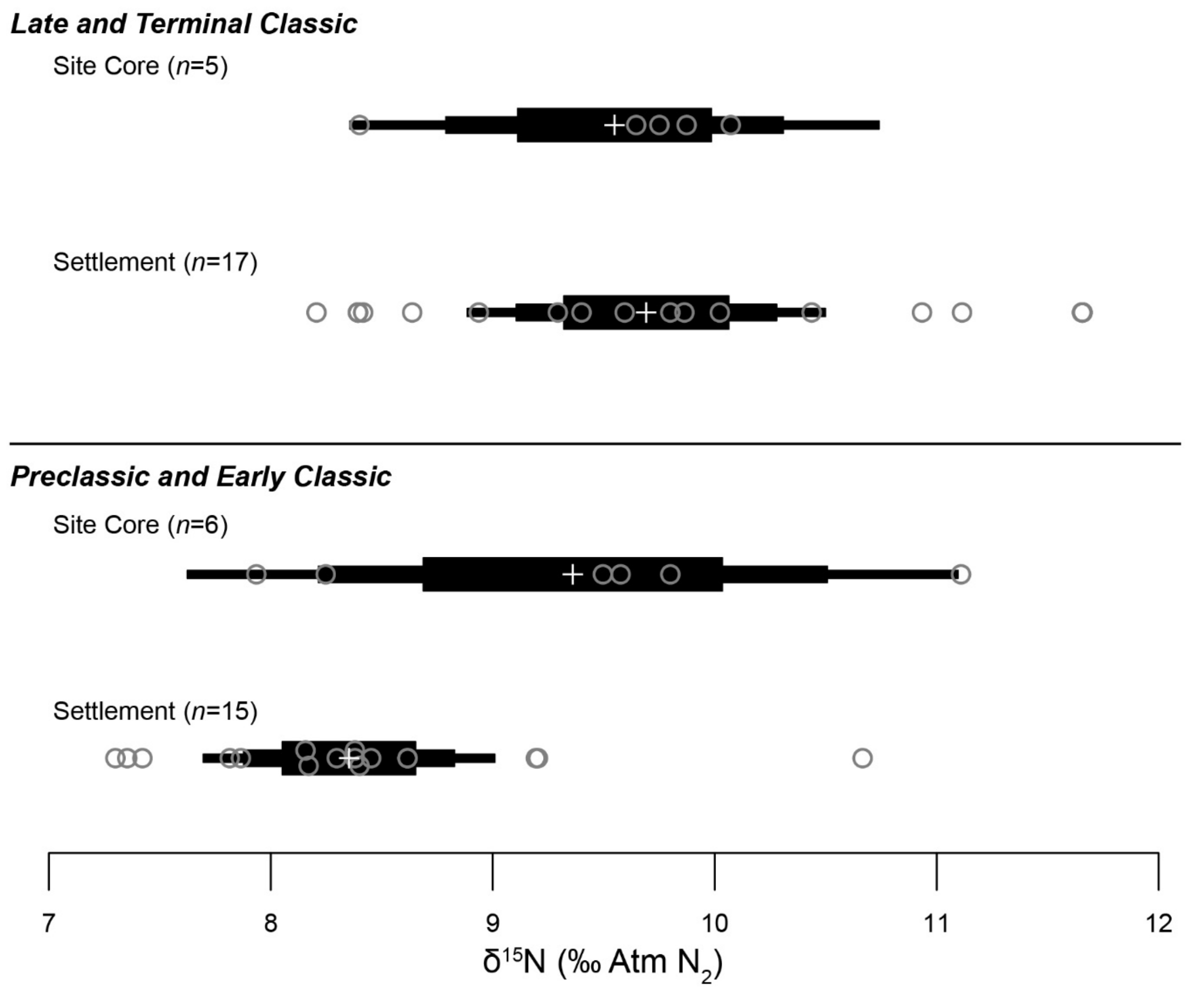

Figure 5.7: Mean nitrogen ($\delta^{15}N$) isotope values for Cahal Pech site core and settlement burials. Data points are shown as open circles with the means for each context indicated by a cross. The bullet graph shows the 80, 95, and 99% confidence intervals (thickest to thinnest bullets) around the mean.

Discussion

We used stable isotope analyses of AMS radiocarbon dated human burials to understand the linkages between dietary diversity and the resilience of populations living at the ancient Maya site of Cahal Pech. These data were also compared to paleoclimate proxy records to help interpret the climatic contexts of site growth and decline during two severe droughts (Late Preclassic vs. Terminal Classic). Summed probability distributions of radiocarbon dates show that steady and uninterrupted site growth at Cahal Pech began ~1200 cal BC during the Early Preclassic. This likely represents low-level early occupation with growth from the Preclassic to the Early Classic. Isotopic data from burials dating to this interval suggests that the early inhabitants of the site had more resilient dietary practices in the context of severe drought. Directly dated burials, in addition to dates from early construction activity in peripheral settlements (Ebert et al. 2016a, n.d.), provide evidence for population growth across the site after AD 400. Within the monumental core, the construction of several large temple and palace buildings and directly dated human burials document the construction of the first tomb (Burial 7, Str. B1) associated with an elite linage between cal AD 140-395 (Novotny 2015).

We argue that the resilience of complex social systems at Cahal Pech from the Preclassic through Early Classic Periods was dependent in part upon a broad subsistence strategy that helped to absorb shocks to maize-based food production in the context of drought. The results of stable isotope analyses of human skeletal remains from the Preclassic and Early Classic suggest that the inhabitants of Cahal Pech, both from the site core and settlement, had a broad and diverse diet. While most site core individuals from this period consumed high quantities of C4 foods (i.e., maize), $\delta^{15}N$ values overlap with individuals interred in settlement contexts and span several trophic levels. Consumption of marine and fresh water fish, present in household and site core assemblages, may account for elevated $\delta^{15}N$ values for some of these individuals (Powis et al. 1999; White et al. 2006). Lower $\delta^{13}C$ values for most individuals living in the residential settlement for this period suggest that maize was less important in the diet, and that wild plants were also consumed widely. Paleobotanical and faunal evidence recovered from household contexts also indicate that a range of wild and domesticated plant and animal resources were procured from slash-and-burn farming, household gardens, and hunting (Awe 1992; Powis et al.

1999; Weisen and Lentz 1997). This broad subsistence strategy persisted through the severe drought at the end of the Preclassic between cal AD 100-300, likely taking advantage of wild resources that could be exploited as fallback foods during climatic fluctuations.

A key component of growing hierarchies and societal integration for the Late Classic Maya was agricultural intensification and increasing reliance upon maize as a staple crop (Kennett and Beach 2013), which made populations more vulnerable to drought conditions. Stable isotopes document statistically significant shifts in $\delta^{13}C$ and $\delta^{15}N$ values at Cahal Pech between status groups. The $\delta^{13}C$ signal for elite individuals from the site core became significantly enriched by the Late Classic. This pattern is consistent in the stable isotope data for elite diet at other large Late and Terminal Classic lowland Maya sites (e.g., Altar de Sacrificios and Dos Pilas, Wright 2006; Altun Ha, White et al. 2001; Pacbitun, White et al. 1993). Many of these studies show that elites had greater access to maize, in addition to a greater diversity of foods including high proportions of animal protein and imported exotic foods (e.g., marine fish, Somerville et al. 2013). While Caribbean marine fish species have been found at Cahal Pech, our results show a different pattern of highly restricted $\delta^{13}C$ and $\delta^{15}N$ values for elite individuals that corresponds to a hyper-specialized maize-based diet in the Late and Terminal Classic. This stands in contrast to an increase in the range of $\delta^{13}C$ and $\delta^{15}N$ values of individuals from the settlement during the same time. Individuals living in more rural settings may have expanded their diets in part as a response to increasing aridity in paleoclimate records beginning after ~AD 660 (Kennett et al. 2012). Households likely developed alternative subsistence strategies, as they were also stressed by elite demands for increased maize production (Webster 1985).

Shifts in $\delta^{15}N$ values during the Late and Terminal Classic point to other types of accumulating sociopolitical, economic, and environmental stresses, which added to vulnerabilities at Cahal Pech. High $\delta^{15}N$ values often correlate with arid conditions, with reductions in rainfall corresponding to enrichment within a trophic level (Ambrose 1991). Landscape alterations including agricultural developments and forest loss also drive $\delta^{15}N$ enrichment (Lohse et al. 2014). A positive shift in $\delta^{15}N$ values when considering all analyzed individuals at Cahal Pech corresponds with a trend towards drier climatic conditions beginning in the Late Classic, and possibly deforestation related to agricultural intensification. While no spatial relationship exists between $\delta^{15}N$ values and distance from the site core, deforestation and agricultural expansion could have influenced a positive shift in $\delta^{15}N$ values for some individuals. AMS ^{14}C dating of human burials indicates an abrupt cessation of elite mortuary and political activity at the site between cal AD 775-890, corresponding with a multi-decadal dry interval in the Macal Chasm and Yok Balum paleoclimate records. There is only limited evidence for occupation in surrounding settlements after ~cal AD 900, indicating that vulnerability to drought conditions ultimately affected the demographic decline at peripheral settlement groups in addition to the disintegration of the Cahal Pech socio-political system.

Conclusions

Stable isotope research in the Maya region has focused on examining the relationships between diet, social status, and ecological degradation during the Terminal Classic Period. The role of diet and differential resilience of groups to climate change remains underexplored. AMS radiocarbon dates and stable carbon and nitrogen isotope data from 45 human burials from the Belize Valley site of Cahal Pech suggest that diet played a key role in societal resilience and vulnerability in the face of multi-century droughts in the Late Preclassic and the Terminal Classic Periods. A mixed diet that incorporated wild and domestic resources promoted resilience to and persistence of populations through drought during the end of the Preclassic Period. Dense populations and a highly interconnected socio-political system developed at Cahal Pech in the Late Classic. Maize was economically and ideologically central to this system, and stable carbon isotope data indicate that elite individuals from the site core developed a preference for a highly specialized maize-based diet. Nitrogen isotope data also document dietary change across the entire Cahal Pech population that reflects increasing aridity and/or deforestation after cal AD 660. Elite economic demands for increased agricultural production, increased dietary reliance on maize agriculture, and extreme dry conditions undermined and ultimately influenced the collapse of Cahal Pech. These data provide a long-term perspective on factors that affected resilience and decline of ancient lowland Maya society, and contribute to our understanding of vulnerability to climate change in modern times.

Chapter 6

CONCLUSIONS

Vast individual differences in personal wealth, power, and access to resources exist within and between modern societies. A fundamental task for archaeology is explaining the origins and evolution of small, relatively egalitarian communities into socio-economically complex societies that more closely resemble those in our modern globalized world. The development of complex societies, characterized by institutionalized social and economic inequality, was a long-term and dynamic process driven by various cultural and climatic factors that promoted both the development of these new social forms. The archaeological research presented in this dissertation aims to understand the mechanisms driving these developments at the lowland Maya site of Cahal Pech, Belize during the Preclassic Period (1200 BC-AD 300). Building on a foundation of over 30 years of previous investigations of the Preclassic Period at Cahal Pech, my study combines traditional archaeological survey and excavation methods with innovative applications of archaeometric analyses (high-resolution AMS radiocarbon dating, geochemical compositional analyses, and stable isotope dietary analyses) to develop multiple lines of evidence that document emerging cultural complexity at the site, household, and individual levels. As a diachronic study in social change, this project also contributes to our understanding of modern cultural development in response to changing social, economic, and climatic conditions.

The results of AMS radiocarbon dating and Bayesian chronological modeling form the best dated archaeological sequence published to date for the Belize Valley. The temporal data presented here provide new information to interpret the timing and pace of the spatial, demographic, and socio-political growth of Cahal Pech during the Preclassic Period. Previous research at the site has primarily relied on relative ceramic dating, which often places sequences within large blocks of time that sometimes exceed 500 years. Radiometric methods have been applied to temporally situate specific contexts in the civic-ceremonial core and peripheral household groups (Cas Pek and Tolok Groups; Awe and Healy 1995; Healy et al. 2004), but the limited number of dates with large measurement errors has inhibited precise temporal assignments. The updated Cahal Pech chronology presented in this dissertation was developed using high-resolution AMS radiocarbon dates, with measurement error ranges between 15-20 ^{14}C years. These dates were combined with stratigraphic information from targeted excavations of discrete contexts across the site. Bayesian modeling also allowed us to incorporate previously reported radiocarbon dates from Cahal Pech to facilitate more precise identification of important temporal trends associated with emergent social complexity.

The Cahal Pech chronology provides evidence for one of the earliest known settled farming villages in the southern Maya lowlands during the Early Preclassic Period (Figure 6.1). Radiocarbon data also indicate that the Cunil ceramic complex, associated with initial settlement at Cahal Pech, is the earliest known directly dated ceramic tradition in the southern Maya lowlands. Cunil ceramics include utilitarian pottery and serving vessels incised with symbols connecting them to contemporaneous iconographic traditions that developed across Mesoamerica (Sullivan and Awe 2013). The first recorded activity at the site consisted of clearing followed by the construction of domestic architecture in the site center (1205-990 cal BC). The pace of construction increased dramatically through the end of the Early Preclassic, providing evidence for the expansion of this agricultural village. The first phase of site occupation corresponds with a multi-century drought recorded in regional paleoclimate records (Akers et al. 2016; Hodell et al. 1995; Medina-Elizalde et al. 2016). Archaeological data suggests, however, that sparse settlement and low population density may have allowed the local community to easily adapt to dry conditions in the resource-rich Belize Valley.

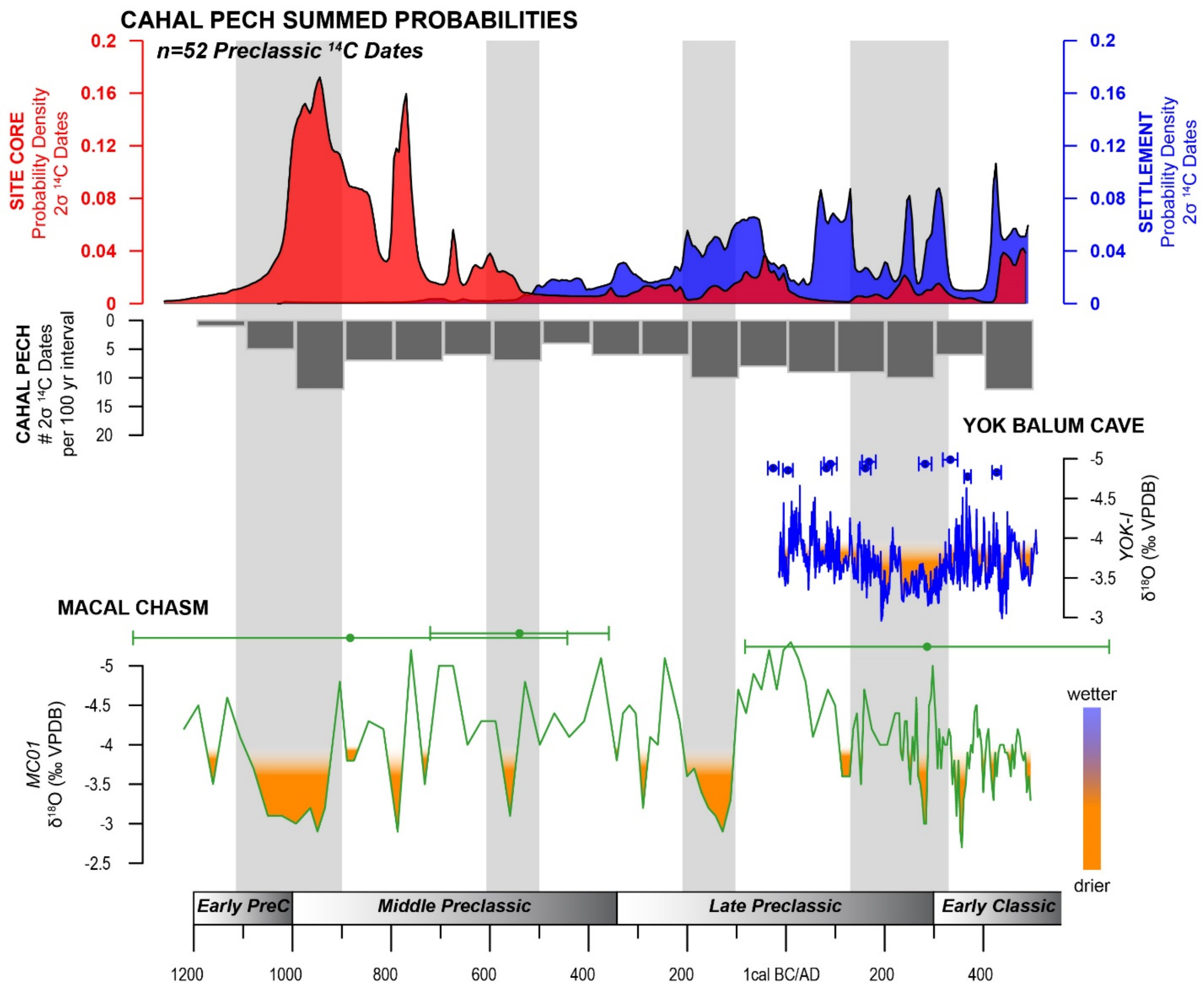

Figure 6.1: Temporal estimates for the settlement, growth, and occupation activity of Cahal Pech based on summed probability distributions of Preclassic Period radiocarbon sequences from the site core and peripheral settlement, including human burials. Summed distributions are plotted against the Macal Chasm (MC01) $\delta^{18}O$ speleothem (Akers et al. 2016) and Yok Balum Cave (YOK-I) $\delta^{18}O$ speleothem records (Kennett et al. 2012). Multi-century droughts are highlighted in gray.

Evidence for inequality first appeared at the beginning of the Middle Preclassic Period, when activity shifted to focus on the construction of public architecture and high status residences. During this time, Structure B4 was remodeled into a ~1.5m tall temple building (895-820 cal BC) and a series of high-status residences and large raised platform buildings used for public ceremonies were constructed in Plaza B (765-535 cal BC). Though these platform structures were small compared to later Classic Period temples, the planning and construction of these buildings required the centralized organization that is associated with the appearance of status differentiation at Cahal Pech. These developments occurred during a relatively wet period in regional paleoclimate records (Akers et al. 2016; Medina-Elizalde et al. 2016), with activities in the site core likely mirroring trends in increasing levels of sedentism, population growth, and agricultural intensification around Cahal Pech.

Bayesian chronological models of construction sequences from targeted household excavations show corresponding trends in the growth of peripheral households beginning in the Middle Preclassic. The Tzutziiy K'in group, a large settlement located ~1.75 km west of the Cahal Pech core, shows three primary phases of settlement and growth. The first directly dated construction activity at Tzutziiy K'in, consisting of leveling of the site for the construction of small domestic buildings, occurred during the end of the Middle Preclassic (325-110 cal BC) when humid conditions prevailed across the Maya region (Akers et al. 2016; Medina-Elizalde et al. 2016). Multiple masonry platforms, which may have functioned as residences for a high-status family, were built during the Late Preclassic (45 cal BC-cal AD 330), during another wet climatic interval. Radiocarbon and ceramic dating from other locations in the Cahal Pech settlement zone parallel the growth of Tzutziiy K'in, with the construction of larger-scale residential and nonresidential construction in several house groups (Burns Avenue, Cas Pek, Melhado, Tolok, Zopilote, and Zubin Groups) in the Cahal Pech periphery after ~350 cal BC.

Relatively little Late Preclassic and Early Classic Period materials were recovered from the Plaza B excavations examined here, and current radiocarbon dating suggests that remodeling of monumental buildings occurred infrequently between 600 cal BC and 200 cal BC. A single date from Plaza B provides evidence for construction activity at least through the middle of the Late Preclassic (105 cal BC-cal AD 15). An extreme multi-century drought at the end of the Late Preclassic (~cal AD 100-300) has been linked to the cessation of construction and abandonment of some major polities in the Petén (e.g., Mirador, Nakbe; Akers et al. 2017; Dunning et al. 2014; Medina-Elizalde et al. 2016), but additional dating work in Plaza B, and elsewhere in the site core, was necessary to evaluate the role of climate in these changes within the Cahal Pech site core. Indeed, directly dated human remains from the site core show that populations were growing at a steady rate during this dry interval. In the Cahal Pech periphery zone, radiocarbon dates from stratified deposits in addition to human remains, document continued population growth and the establishment of new residential groups (e.g., Zopilote, Martinez Group) during the Early Classic.

Geochemical compositional analyses focused on using portable X-ray fluorescence (pXRF) analyses of obsidian and instrumental neutron activation analysis (INAA) of ceramics provide evidence for the structure, function, and development of Preclassic economic systems that supported the growth of Cahal Pech. Obsidian source data from a large sample of artifacts (*n*=1189) connect Preclassic households at Cahal Pech to a diversity of long-distance exchange networks operating between the Belize Valley, highland Guatemala, and highland Mexico. Previous sourcing of obsidian from Early Preclassic contexts (*n*=13) using INAA suggested that Cahal Pech relied exclusively on obsidian nodules and flakes from the El Chayal (Awe and Healy 1994; Awe et al. 1995). Our technological and pXRF analyses obsidian from Early

Preclassic levels (*n*=22) confirm El Chayal as the only source during this time period, but we documented two finished prismatic blades from Early Preclassic contexts. The presence of obsidian blade technology in the early levels at Cahal Pech is not entirely surprising because blade exchange is well documented in other regions of Mesoamerica between 1200 BC and 800 BC (Clark 1987; Clark and Lee 1984:225). Our results indicate the use of blade technology slightly earlier than previously documented for Cahal Pech (Awe and Healy 1994). Obsidian blade cores and manufacturing debris are not common in the Early Preclassic assemblage (or the assemblage for any time period) providing additional evidence that blades were imported to the site, a pattern that persisted through the end of the Terminal Classic Period.

Because Early Preclassic ceramic and obsidian samples analyzed for this study were limited to contexts within the Cahal Pech core, geochemical data cannot be used to identify differential consumption or limited access to these items by some groups (see Peniche May 2016:451). The differential compositions of Early Preclassic Cunil pottery, on the other hand, may suggest early household specialized production. INAA identified three distinct compositional groups containing Cunil ceramics. Two groups (Groups A and B) were composed primarily of decorated serving vessels. They were also found to be compositionally unique compared to previously analyzed ceramics in the MURR database (*n*>12,000), indicating these ceramic types were produced and distributed locally. The Cunil phase sherds assigned to the third group (Group D) were exclusively utilitarian vessels, including unslipped jars and bowls. Based on compositional differences, Group A and B may represent differential household ceramic production. The production and consumption of these decorated pots may have been used as a publicly visible medium to communicate social differences within the Early Preclassic Cahal Pech community (Clark and Blake 1994).

Geochemical data from both obsidian and ceramics indicate that long-distance trade and exchange networks available to the residents of Cahal Pech expanded in the Middle Preclassic. New types of obsidian appear at the site, including imported blades from the San Martin Jilotepeque and Ixtepeque sources. While San Martin Jilotepeque blades became prevalent in domestic contexts within the Cahal Pech core, El Chayal obsidian remained the primary source for obsidian blades used by peripheral households. The differential procurement of blades produced from different obsidian types suggests a lack of centralized control over redistribution (e.g., Clark 1987; Santley 1984). Our data show instead that obsidian moved through a network of decentralized exchange relationships operating at the household level (Hirth et al. 2013). These results indicate that the exchange of finished blades likely did not contribute to unequal economic relationships between households at Cahal Pech.

Ceramic INAA data provide evidence for contrasting economic strategies that may have facilitated the emergence of differential household status during the Middle Preclassic. The results of INAA identified compositionally distinct fine ware ceramics from higher-status households in the site core compared to utilitarian pottery sampled from two peripheral settlements (Tzutziiy K'in and Zopilote groups). In particular, high frequencies of fine paste Mars Orange dishes and bowls were assigned two compositional groups (C and D) associated with high-status residences and public architecture within Plaza B in the Cahal Pech site core. Comparisons to INAA data from other regions of the Maya lowlands identified compositionally similar Mars Orange ceramics from Middle Preclassic contexts at the site of Holtun, located in the central Petén region of Guatemala (Callaghan et al. 2017). While the Holtun ceramics were derived from similar high-status site core contexts in the monumental epicenter, higher frequencies of Mars Orange wares in the Cahal Pech assemblage (~77%) versus Holtun (~12%)

suggest that this pottery type was likely produced and exported from the Belize Valley. Production and distribution of these specialized vessels may have been used as one strategy by emergent high-status households at Cahal Pech to link people in other regions of the lowlands into networks of interdependency within a developing institutional economy organized above the level of the household.

The results of the geochemical work indicate the need for additional research to draw more concrete inferences about production units that may have varied by socio-economic status. While obsidian sourcing studies have been applied across the Maya lowlands to document the development of broad scale economic networks (e.g., Golitko et al. 2012, 2016; Moholy-Nagy 2013), very few studies have applied geochemical methods to examine local and regional ceramic production and distribution systems among Preclassic Maya communities (see Angelini 1998; Callaghan et al. 2017). Combining additional INAA research with other lines of technological evidence, such as petrography, show great promise to provide finer-scale information on variation in production, function, and target consumers of specific types of ceramics. If different households or sites specially produced ceramics, unique combinations of raw materials (clay and temper, or “paste recipes”) should vary through time and space. Future work will focus on applying these methods at Cahal Pech and other sites in the Belize Valley in an effort to pinpoint discrete production locales of both Cunil and Middle Preclassic Mars Orange ceramics.

Stable carbon and nitrogen isotopic analyses of a large assemblage of directly AMS ^{14}C dated human remains from the Maya region provide additional evidence for economic adaptations that allowed Cahal Pech to expand throughout the Preclassic Period. Stable isotope results indicate that during the Preclassic and Early Classic periods, diet included a variety of wild and domesticated plant and animal resources. Access to locally available wild resources in the sparsely populated Belize Valley likely allowed individuals to adapt to alternating wet and dry periods, playing an important role in promoting resilience in the face of drought at the end of the Late Preclassic. By the Late Classic, isotopic data indicate that elite and royal individuals buried in the site core developed a narrow and highly specialized maize-based diet. In contrast, commoner households consumed an increasingly broad diet as climate conditions became more arid during the Terminal Classic Period (~AD 750-1000). As demand for specific foodstuffs from elite consumers likely influenced more intensive maize production and hunting locally around the community, households likely developed alternative subsistence strategies. We argue that Late and Terminal Classic Period population expansion and anthropogenic environmental degradation from agricultural intensification, coupled with socially conditioned food preferences, resulted in a less resilient system that ultimately disintegrated due in part to severe drought conditions at the end of the Terminal Classic.

Broader Relevance to Maya Archaeology and Future Directions

The research presented in this dissertation has focused on developing comparative approaches to understanding the impact of different social, economic, and environmental conditions on the emergence of social complexity. Multiple lines of quantitative and qualitative evidence were integrated in order to identify the underlying processes and behaviors that resulted in multiple adaptive pathways for complex sociopolitical institutions to emerge and grow. Previous archaeological research on social complexity in the Maya lowlands has focused primarily on the growth of large regional centers. Using Cahal Pech as a case study for the growth of small-scale farming communities into complex societies in the Maya lowlands, I developed regional, local (site), and household/individual level datasets to define the dynamic cultural and environmental processes simultaneously impacting the development Preclassic lowland Maya communities.

The results of this study indicate that tracing cultural developments through refined site-specific chronologies is necessary for the study of prehistoric social complexity. While ceramic seriation and epigraphic texts have formed the foundation of Classic Period Maya site chronologies, traditional ceramic-based chronologies for the Preclassic Period (which lacks writing) are coarse grained, difficult to correlate, or are contentious. Much of my research at Cahal Pech attempted to temporally situate Preclassic developments documented through the excavation of discrete site core and settlement contexts. Working in collaboration with members of the Belize Valley Archaeological Reconnaissance Project, I collected and analyzed samples of organics and human/animal bone for high-precision AMS radiocarbon dating. Bayesian statistical techniques were applied to produce a revised site chronology using these new radiocarbon dates and a priori stratigraphic and archaeological data collected in the field. The value of modeling chronological data from different contexts is that sequences can be directly compared within and between domestic and non-domestic contexts to track variability in growth that may be associated with social status.

I have also compiled a large chronometric database of published radiocarbon dates from sites across the southern Maya lowlands, and the sheer volume compared to other regions of the ancient world holds great potential to re-evaluate Preclassic Maya culture history using Bayesian analytical methods. Researchers have worked to develop site-specific and regional Bayesian chronologies (e.g., Uxbenká, Culleton et al. 2012; Pasión Region, Inomata et al. 2017; Northern lowlands, Hoggarth et al. 2016), but inter-regional chronological comparisons have not been previously undertaken. The research presented here represents a first step towards this goal. I have worked to compile published radiocarbon dates for the southern Maya lowlands (n=1196) spanning the Archaic through Postclassic Periods. These data are presented in Appendix C. While this is not an exhaustive dataset, it represents the largest compilation of radiocarbon data for the region to date. My hope is that archaeologists will continue to add to this list as they publish their radiocarbon research in the future.

Based on the regional Maya radiocarbon dataset, I also developed Bayesian chronological models for 36 sites (including Cahal Pech) in five core regions of the southern lowlands, focusing primarily on Preclassic cultural sequences. The results, in some cases, are more precise chronologies that can be compared between sites and regions to provide evidence for the differential timing for major socio-economic developments. For other sites, chronological models could not be developed because of a lack of radiocarbon dates or dates without clear stratigraphic contexts. The Middle Preclassic "Hallstatt Plateau" in the radiocarbon curve also produces large calibrated date ranges up to 500 calendar years, prohibiting precise temporal control for contexts from many sites dated to this important interval. Future archaeological efforts should focus on developing larger radiocarbon datasets from stratified deposits at Cahal Pech, other sites in the Belize Valley, and across the southern Maya lowlands to produce comparable chronological information necessary to document Preclassic Period developments.

Nevertheless, this new database of Preclassic radiocarbon dates provides an invaluable resource to compare and contrast the trajectories of sites across the lowlands with broad-scale variability in social integration and political complexity. By placing the chronological models within a summed probability distribution for the entire Maya region, I have also produced an extended dynamic model for the episodic growth and decline of lowland Maya society from the

Preclassic through the Classic Period (Figure 6.2). This new model shows several small pulses of activities represented by low peaks in the summed distribution between 1300-900 cal BC. These pulses likely represent the formation and breakdown of the earliest ranked societies in the region (i.e., "tribal societies", Clark and Cheetham 2002). The period between 800 cal BC to 1 cal BC shows gradually larger peaks in the summed distribution, representing accumulative levels of activity that correspond with increasingly social integration and political centralization. Beginning around AD 100 there is a rapid decline in the summed probability distribution, during which time communities may have existed as more decentralized and unstable organizational forms. This pattern largely conforms to expectations of political cycling (i.e., chiefly cycling) documented in many other regions of the ancient world (Anderson 1996; Cowgill 2012; Marcus 1993, 1998; Wright 1994; Wright and Johnson 1975). This extension of the dynamic model provides future researchers with a testable hypothesis to test the nature and timing of both local and regional development of social complexity during the Preclassic Period.

The dating precision of paleoclimate climate records also continues to improve in the Maya region, which has led many archaeologists to place an increasing emphasis on the variability of human responses to environmental change (i.e., droughts and humid periods) as a potential factor in the episodic expansion and breakdown of complex lowland societies. While more recent paleoclimate researchers have turned their attention to understanding fluctuating climate cycles during the Preclassic Period, our understanding of local adaptions to these drought remains incomplete. The breakdown of large centralized polities in the Petén region of Guatemala at the end of the Late Preclassic (~cal AD 100-300) during a "mega-drought" has

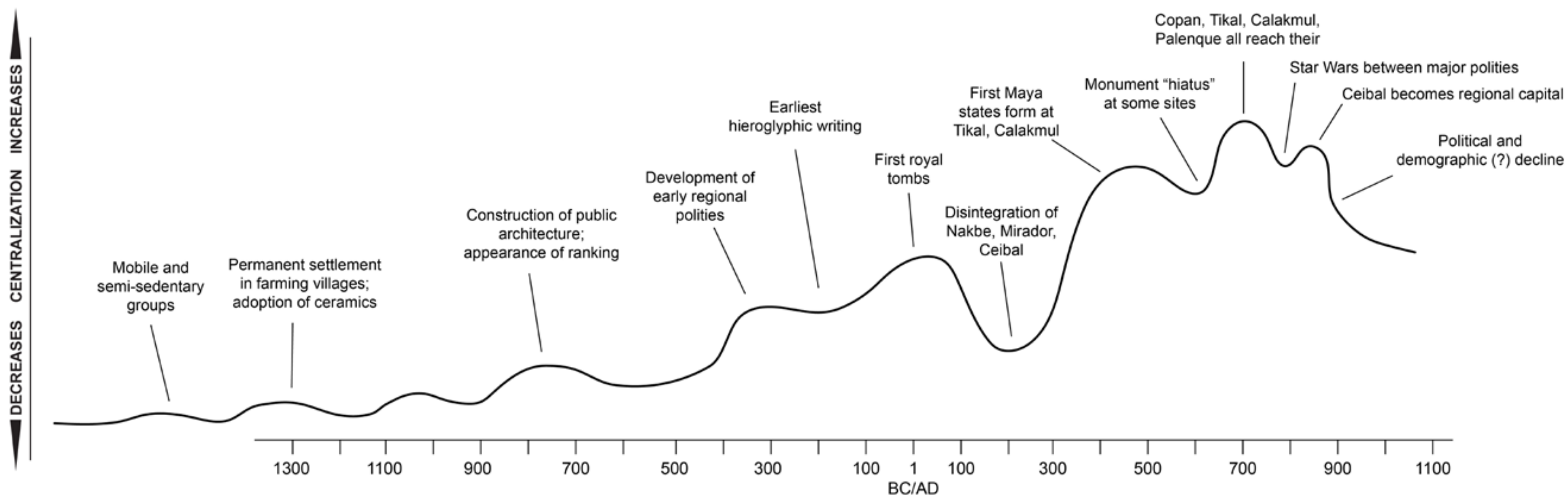

Figure 6.2: The extended dynamic model, showing the estimates for the timing of Preclassic Period developments based on a summed probability distribution of modeled and unmodeled radiocarbon dates for the entire southern Maya lowland region.

received the most attention (Akers et al. 2016; Dunning et al. 2014; Kennett et al. 2012: Medina-Elizalde et al. 2016). Chronological and stable isotope dietary research from Cahal Pech demonstrate that localized environmental conditions and economic choices promoted resilience (or vulnerability) during periods of climatic volatility. Additional comparisons between more precise local and regional chronologies and paleoclimate records will provide both a local and regional perspective on response to drought during the Preclassic.

This study also builds upon a long tradition of geochemical methods to examine the structure and function of ancient economies in the Maya region, and Mesoamerica more generally. Comparisons between the patterning of obsidian and ceramic geochemical data for Cahal Pech was aimed at bridging the gap between our understanding of the function of early domestic economies and the development of broader institutional economies associated with social complexity. By focusing on local developments, this work complements and augments previous research focused primarily on the development of long-distance economic systems and the control of these networks by elites during the Preclassic. We show that Maya households employed overlapping and contrasting economic strategies that allowed them to adapt to new social and economic conditions. Geochemical analyses of large collections of artifacts from Preclassic Period excavations across the Maya region hold the potential for clarifying the structural and distributional dimensions of economic organization that occurred at household, community, and regional scales.

Major societal transformations occurred throughout the Maya lowlands during the Preclassic Period. While this dissertation takes a step forward in our understanding of the social, economic, and environmental processes associated with these changes at the site of Cahal Pech, each of the chapters presented here will also initiate future research. Additional excavations at

Cahal Pech and other Belize Valley sites targeting Preclassic Period deposits in both civic-ceremonial and domestic contexts will help us to constrain the timing and nature of cultural developments in this region in relation to past climate change. Large collections of previously excavated Preclassic materials, including obsidian, ceramics, and human burials, also exist for Maya lowland sites. Systemic geochemical and stable isotope analyses hold the potential to produce comparable datasets, which will help to clarify local and regional developmental trends. These data will provide a long-term perspective on factors that affected growth and decline of ancient lowland Maya society, and contribute to our understanding of global social and environmental developments in both the past and the future.

Appendix A

SETTLEMENT EXCAVATIONS AT CAHAL PECH (2012-2015)

Introduction

The goal of the 2012-2015 settlement excavations at the site of Cahal Pech was to understand how ancient Maya households affected the emergence, growth, and persistence of social and economic inequality during the Preclassic Period (1200 BC–AD 350) periods. Cahal Pech provides a unique case study for understanding the development of social inequality in the Maya lowlands because of its long occupational history spanning from 1200 BC–AD 900 (Awe 1992; Healy et al. 2004a). A secondary goal of the 2015 Cahal Pech settlement excavations was to understand changes in material culture from the Preclassic to the Early Classic Period (AD 350-500) within hinterland house groups. During the Early Classic sites throughout the Belize Valley began to grow in size and complexity. Settlement data documents a substantial increase in population beginning in the Early Classic (e.g., Barton Ramie, Willey et al. 1965; see also Awe and Helmke 2005), and an increase in construction activity within the civic-ceremonial cores at Cahal Pech (Awe and Helmke 2005) and the nearby sites of Buena Vista (Ball and Taschek 2004) and Pacbitun (Healey et al. 2004b).

While much of the earliest architecture in the Cahal Pech site core is buried beneath later Classic period monumental construction, Preclassic house groups surrounding the site center are more accessible for excavation and analysis. Over the last 30 years both elite and non-elite residential settlements dating to the Middle and Late Preclassic have been documented to the east and south of the site core. In 2014, BVAR integrated light detection and ranging (lidar) remote sensing data into their settlement research in order to document previously unknown settlement in the Belize Valley (Awe et al. 2015; Ebert et al. 2016). Over 140 house groups and single mounds with a 29 km^2 area have been documented around Cahal Pech, some of which possess evidence for Middle and Late Preclassic occupation (Awe 1992; Awe and Brisbin 1993; Dorenbush 2013; Ebert and Awe 2014; Ebert 2015). The 2015 Cahal Pech settlement excavations focused three groups peripheral to the civic-ceremonial site core: Tzutziiy K'in, the Zopilote Group, and the Martinez Group. Excavations also provide a diachronic perspective on social changes in the organization of the economy from the Preclassic through the Classic period across the community at Cahal Pech.

Tzutziiy K'in

Site Setting and Mapping

The Tzutziiy K'in Group (roughly translating to "sunset" in Yucatec Mayan) is a large house group located atop a small hill approximately 1.8 km directly west of the Cahal Pech site core. The group was first documented through survey and excavations in 2012 (Ebert and Dennehy 2013). A total of seven structures surround the main plaza of group, many of which have been heavily looted (Figure A.1). A second, smaller open plaza is located to the east of the main plaza and is bounded to the north and east by two range structures. A second smaller, open plaza is located to the east of the main plaza and is bounded to the north and east by two range structures (these structures are not numbered). Another large mound is located to the east of the architectural core of the site, though it is almost entirely looted. Two possible *aguadas* are also associated with the site. The largest is located to the south and downhill of the main plaza. While it has been disturbed by bulldozing, the presence of cut limestone blocks within the depression suggests possible construction. A second, smaller *aguada* is located east of the main architecture.

Clearing of grass on adjacent property to the east of TK revealed terracing, likely agricultural, downhill of the site. Future work will document the extent and nature of terracing associated with the site.

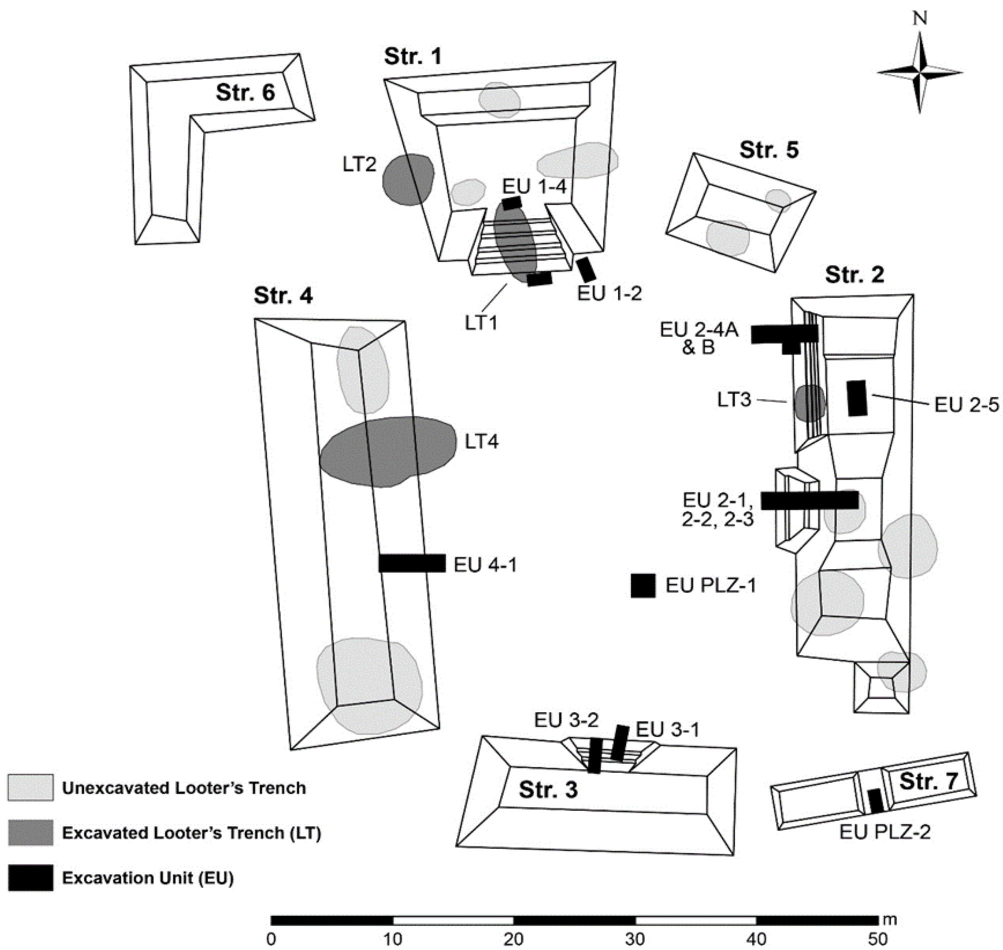

Figure A.1: Map of Tzutziiy K'in showing location of excavation units.

Magnetometer survey was performed at TK in the main plaza in order to locate subsurface features for excavation. Magnetic surveys can be used for detailed mapping of subsurface archaeological (e.g., architectural, thermal) features. Magnetometers are able to detect the presence of items with strong dipolar signatures that represent magnetic anomalies. Metal items, features composed of burned soil, and rocks (i.e., architecture) are easily detectable. At TK, the magnetometer survey performed by Dr. Hector Neff was used for a low-resolution exploratory survey on the plaza to locate architecture and burning features that contain potentially datable materials, focusing on the recovery of carbonized organic material for radiocarbon dating (Figure A.2).

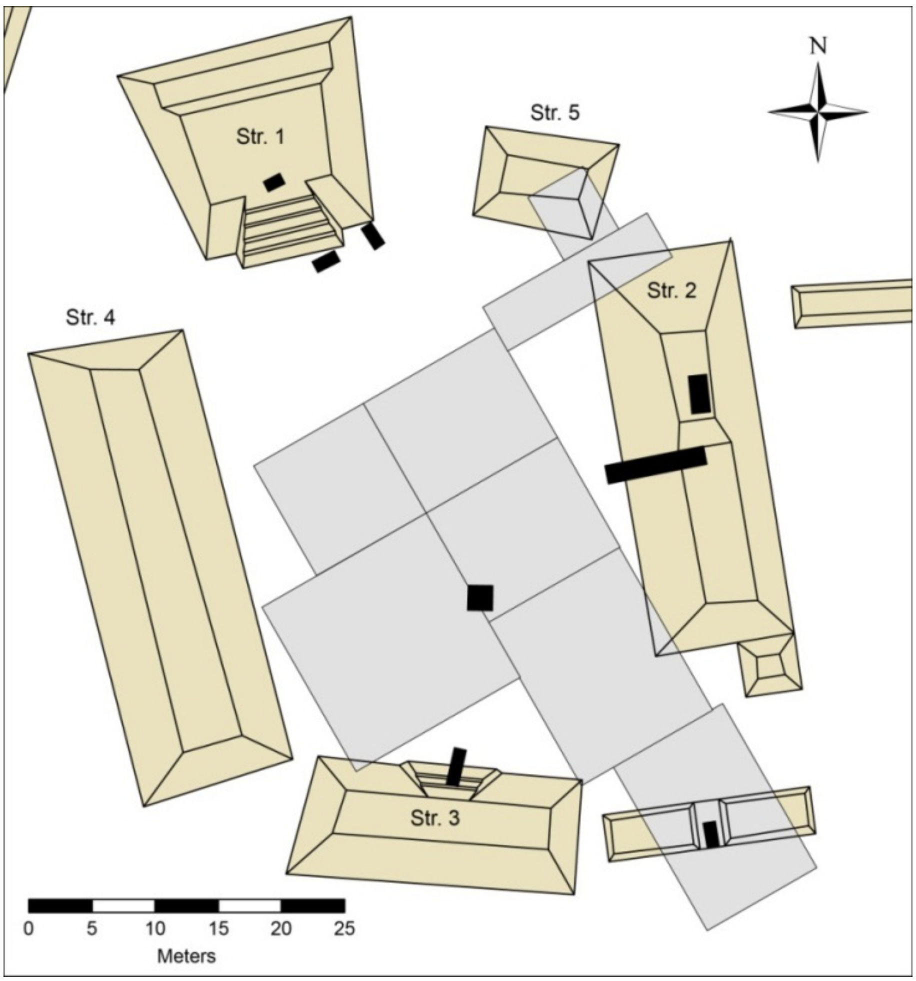

Figure A.2: Locations of 2012 excavation units and grid used for magnetometer survey at Tzutziiy K’in.

The magnetometer survey revealed several subsurface anomalies in the plaza. Large dipoles along the east of the plaza and in front of the west structure were later identified as metal objects resting on the surface, including nails and a machete file. A less obvious long anomaly runs the span of the plaza, more or less west-to-east, which initially was hypothesized to be composed of subsurface architectural features. This was investigated by a unit in the plaza, PLZ-1 (Figure A.3).

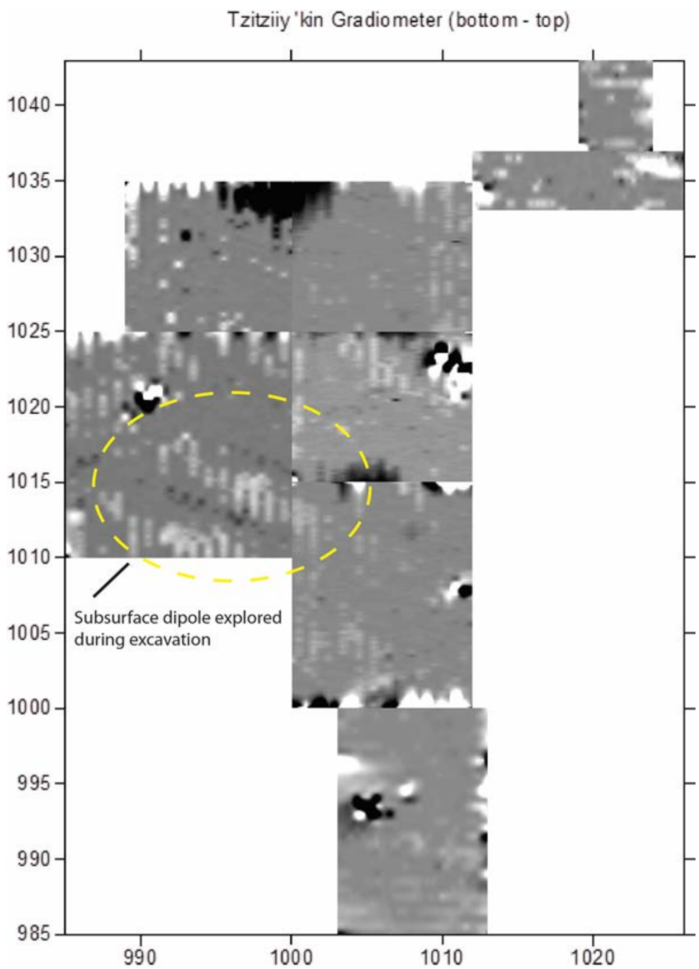

Figure A.3: Results of magnetometer survey showing the location of large subsurface dipole in plaza targeted for excavation.

Stratigraphic excavations were conducted during the 2012 field season in Structures 1, 2, and 3, and also within two areas of the main plaza (Ebert et al. 2016). Structure 1, the northern-most building in the main plaza, was the most heavily looted at the site. Salvage excavations were conducted in looter's trenches (LT1 and LT2), and profiles exposed by looters were cleared to document the stratigraphy of the construction sequences. Structure 2 is located on the eastern side of the main plaza at Tzutziiy K'in. Three excavation units were placed along the centerline of Structure 2 (Units 2-1, 2-2, and 2-3) and a single unit was positioned on the north side of the summit (Unit 2-5). Salvage excavation was conducted in a looter's trench located on the west side of the building (LT3) with the goal of recovering additional stratigraphic information about the building. Excavations on Structure 3 consisted of a single 1×3m axial trench placed at the center of the structure and extending into the plaza. Because this structure suffered the least damage from looting at the site, the goal of excavation was to recover chronologically secure contexts (Ebert and Dennehy 2013).

Preliminary radiocarbon dating of organic materials recovered from the 2012 Tzutziiy K'in excavations provided an initial framework for understanding the growth of the residential group, and differences between cultural developments within house groups and the civic-ceremonial site core (Ebert et al. 2014, 2016). Charcoal samples (n = 9) for AMS radiocarbon dating were recovered from stratified contexts within Structures 1, 2, and 3 excavations. The results of dating and Bayesian chronological modeling identified three primary phases of occupation for this residential group. Tzutziiy K'in was initially settled by the Late Preclassic (325-110 cal BC) as a small farming household, as population was expanding around Cahal Pech and throughout the Belize Valley. Multiple masonry platforms were constructed in the main plaza at Tzutziiy K'in during the Early Classic period (cal AD 350-650), perhaps in response to changing social and economic conditions in the Cahal Pech site core. Tzutziiy K'in became one of the largest hinterland house groups associated with Cahal Pech during the Late and Terminal Classic periods (cal AD 650-900). The terminal occupation of the group between cal AD 850-

900 may indicate that the political “collapse” of Cahal Pech may have similarly impacted large high-status house groups like Tzutziiy K’in (Ebert et al. 2016). Excavations conducted at the group in 2015 focused on exposing stratified deposits in Structures 2, 3, and 4 to supplement the radiocarbon dating program begun in 2012.

Structure 1 Excavations

Structure 1, the northern-most structure in the main plaza, was the most heavily looted at the site. Salvage excavations were conducted in looter’s trenches and profiles exposed by looters were cleared to gain an understanding of the stratigraphic construction sequences. Initial investigations began in Looters Trench 1 (LT1) on the south side of the structure centerline, an area likely targeted by looters as the location of a burial. Looters tunneled into the structure from the plaza approximately 5.5 meters, exposing an earlier interior platform construction (also exposed in looter’s trench LT2 on the southwest corner of Structure 1). Two units were placed within the extent of LT1 to clarify stratigraphic sequences. Unit 1-1 was placed inside of Structure 1, taking advantage of the interior of the structure exposed by LT1. Unit 1 was a 1.5 by 1 meter unit, with the goal of excavation to correlate construction sequences from the interior of Structure 1 with another unit, Unit 1-2, placed south of Structure 1 in the plaza. Both units were excavated to bedrock. The top of the structure was also cleared of humic and looter’s debris, exposing a complex series of interior benches that composed a superstructure (described in detail below).

A centerline profile exposed a total of four major construction episodes for Structure 1 (Figure 5). The earliest construction (TK-1 1st; Figure 5A) consisted of a small platform placed on top of a plaster floor (which does not extend completely to the plaza in front of the structure).

This structure is visible in LT1, LT2 and in another looter's trench at the back of the structure. Subsequent construction (TK-1 2nd; Figure 5B) consisted activities focused on building an apron-molded platform with an interior of rubble fill and a single construction floor. A radiocarbon date (TKG-03) taken from within the fill of the platform places construction in the Early Classic, between 220-335 cal AD. Another radiocarbon sample (TKG-11), collected from just outside of the TK-1 2nd produced a 2σ date range of cal AD 420-535. This suggests that the structure was in used through the Late Preclassic and into the Early Classic Period.

The largest construction episode (TK-1 3rd; Figure 5C) for the structure was composed of a series of fill episodes interspersed with construction floors in order to give shape to the structure, which had a stairway facing the plaza. In profile, only the first step was intact. The stairway would have corresponded with a thick plaster floor composing the top of the structure. The radiocarbon sample TKG-6 was collected just below the plaza floor that corresponds to the third construction episode at Structure 1, and produced a Late Classic date of 685-862 cal AD.

The final phase of construction corresponds with the superstructure found at the top of the building during excavations (Figure A.4). There may have been up to seven steps leading up to the top of the building. The superstructure, part of the terminal phase of construction on Structure 1 was heavily disturbed by looting. Nonetheless a small room on top was uncovered. A constructed wall 2m long and 1m tall sat in the middle of the room, which may indicate that the room had two doorways, however this remains unclear due to looting activity. The partitioning wall was placed directly in front of a bench that runs east-to-west across the room. The bench

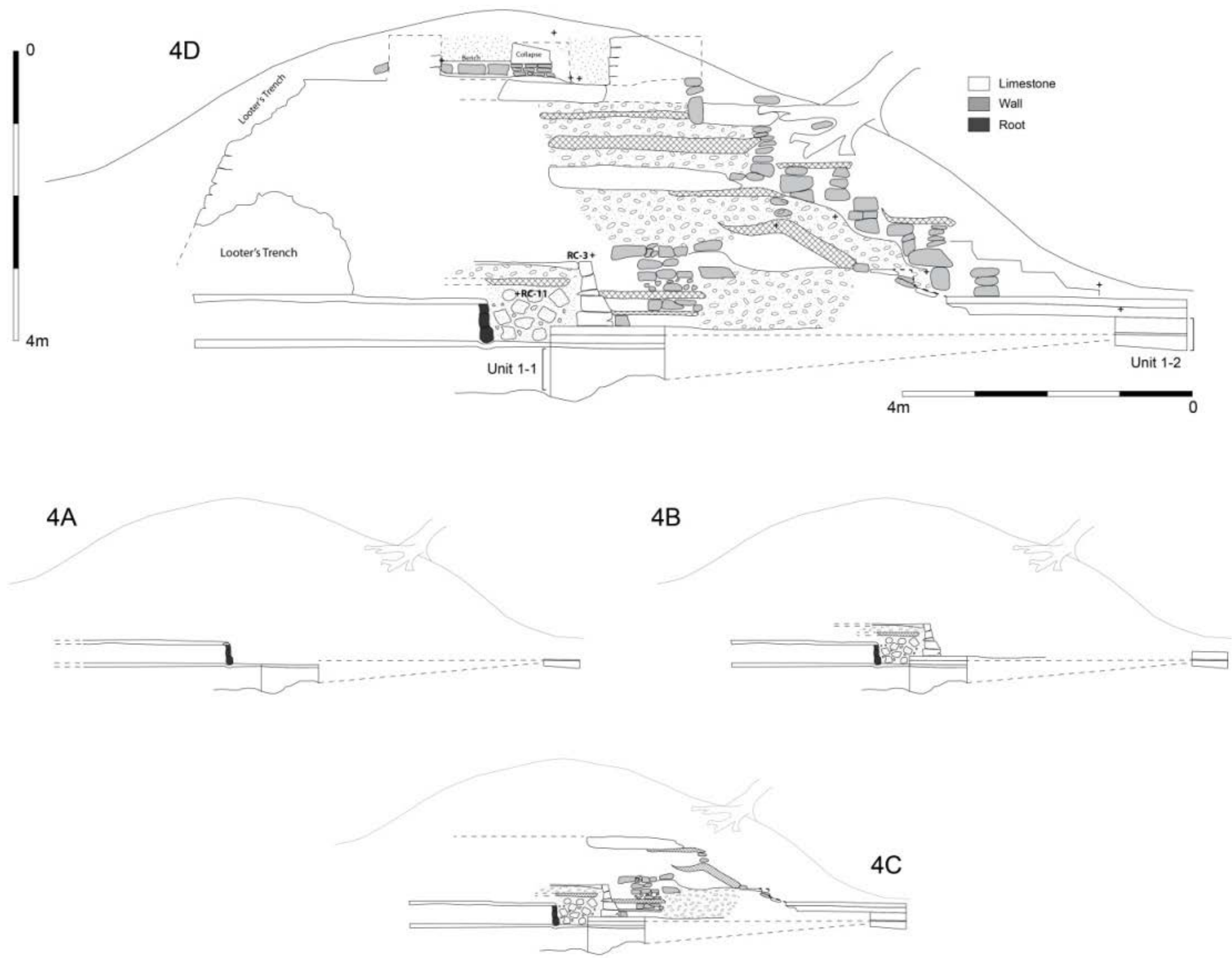

Figure A.4: (A) Earliest construction at Structure 2; (B) Construction of apron-mold platform; (C) Penultimate and largest construction phase on the structure; (D) Terminal construction of Structure 1 with superstructure exposed.

continued to the back of the building, terminating in a wall that would be the back of the room. Both the bench and the partitioning wall were plastered over in a single event, suggesting that their construction was contemporaneous. A radiocarbon sample TKG-8 produced a 2-σ date range of AD 713-879, and post-dates the placement and plastering of the bench.

Preliminary ceramic analysis of diagnostic ceramics collected from LT1 was conducted to the ceramic group level where possible. Results suggest that construction at Structure 1 spans from the Preclassic through Terminal Classic Periods (Figure A.5). Of the 91 diagnostic sherds collected, 35 were of unknown types. While it is not a completely representative sample, it suggests that occupation and construction at the site began fairly early, possibly as early as ca. 500 BC. Radiocarbon dates for TK-1 3rd and TK-1 4th indicate that largest episodes of construction at Structure 1 took place in the Late Classic. Ceramic analyses are in agreement with these dates as the majority of diagnostics come from the Spanish Lookout Complex.

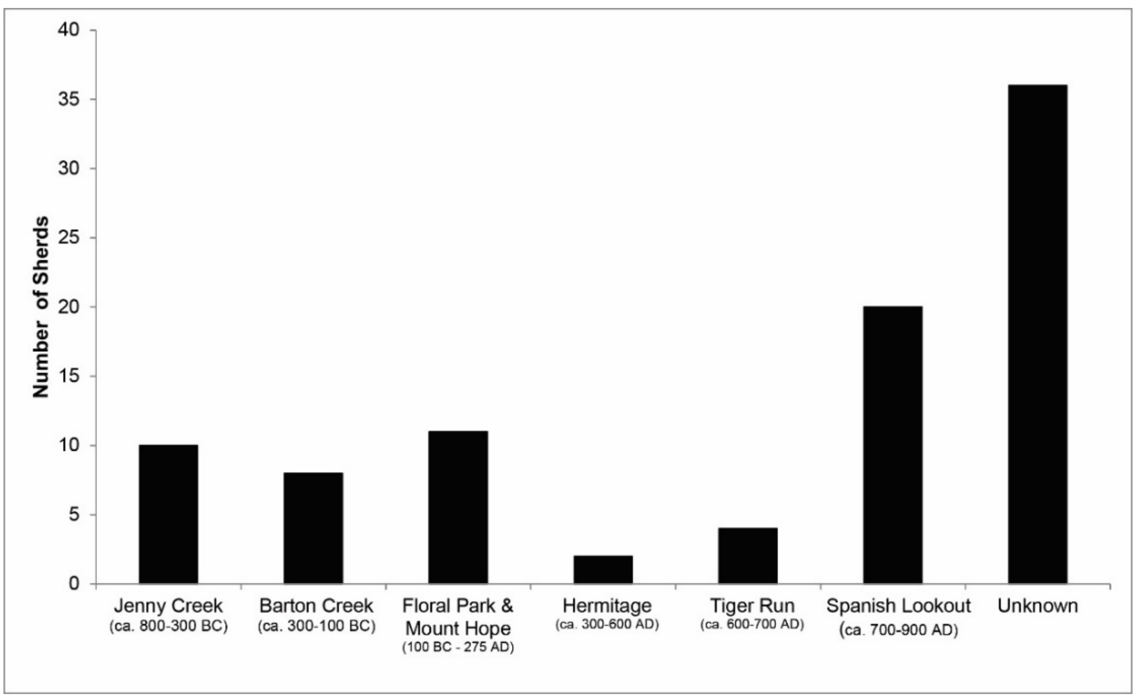

Figure A.5: Count of diagnostic sherds from Structure 1 by ceramic phase, with corresponding date noted.

Structure 2 Excavations

Structure 2 is located on the eastern side of the TK Group main plaza. A pattern identified at other Maya centers including Cahal Pech, eastern structures are often significant locations in terms of ritual and religious activity (Chase 1994; Chase and Chase 1994). Structure 2 is composed of two parts: a larger main northern structure and a small, low addition to the south that extends to the edge of the main plaza. The large main structure was additionally separated into a taller northern summit and a lower southern platform.

Structure 2 was targeted for excavation because of its location on the main plaza. Three units were placed along the centerline on Structure 2 (Units 2-1, 2-2, and 2-3) and a single unit was positioned on the summit, on the north side of the building (Unit 2-5). The goal of excavation in all units was to examine the construction sequence of the building and to recover temporally diagnostic artifacts and materials. The structure was heavily looted and units were placed in order to avoid damaged areas. Salvage excavation was conducted in a looter's trench located on the west side of the building (LT3) with goal of recovering additional stratigraphic information about the building.

Units 2-1, 2-2, and 2-3

The 2012 excavations focused at Structure 2 primarily on a series of three connected units in order to understand the construction of the building (Figure A.6). Unit 2-1 began as a 1.5 x 3 meter unit placed on top of Structure 2 running approximately east-to-west down the center of the building. The unit was placed in order to avoid several large looters trenches had destroyed much of the building. After initial clearing of humic debris from the top on the structure and in the unit, large limestone cobbles were uncovered, including several that were aligned along the north side of the unit, running east-to-west. The unit was then extended 7 meters (Unit 2-2 and 2-3) into the plaza in front of Structure 2 in order to continue exposing the wall alignment and other associated architectural features that composed the western edge of the building. Figure 7 shows exposed architecture from all three contiguous units.

Figure A.6: Exposure of Units 2-1, 2-2, and 2-3 on Structure 2, showing location of Feature 1 in western portion of unit.

Excavation conducted in 2012 at Structure 2 documented a sequence of several construction events dating from the Early to Terminal Classic periods and two distinct features (Ebert and Dennehy 2012; Ebert et al. 2016). Feature 1 consisted of a large amount of medium sized cobbles (5-10 cm in diameter) arranged into a circular shape approximately 1 meter in diameter. The remnants of a complete jar rim were recovered beneath Feature 1. Feature 2 consisted of a large roughly shaped circular limestone altar, approximately 50 cm in diameter (Figure A.7). The altar stone was cracked in half roughly down the middle when initially encountered, and n markings or carvings adorned either surface. A similar altar stone was encountered during the excavation of Unit 2-4 on the northern side of Structure 2 in 2015 (see below).

Figure A.7: Photograph of Unit 2-2 showing northern stepped wall as well as sloping apron wall and altar stone.

The 2015 excavations focused on exposing the earlier components of the Structure 2 sequence, recovering temporally diagnostic materials from these levels, as well as understanding the function of this eastern building. Because much of the southern part of the structure had suffered damage from looting, excavations focused on the northern portion of the structure. Unit 2-4 was a 1.5x5.5 m axial trench placed to run east-to-west perpendicularly to the architecture. After the initial excavation levels 1 through 2, which cleared humus and collapse, the units was excavated in two separate areas, Unit 2-4A in the eastern potion and Unit 2-5B in the western portion exposing Burial TK-2-1. Unit 2-4A was excavated to bedrock approximately 2 meters below the terminal plaza surface (Figure A.8).

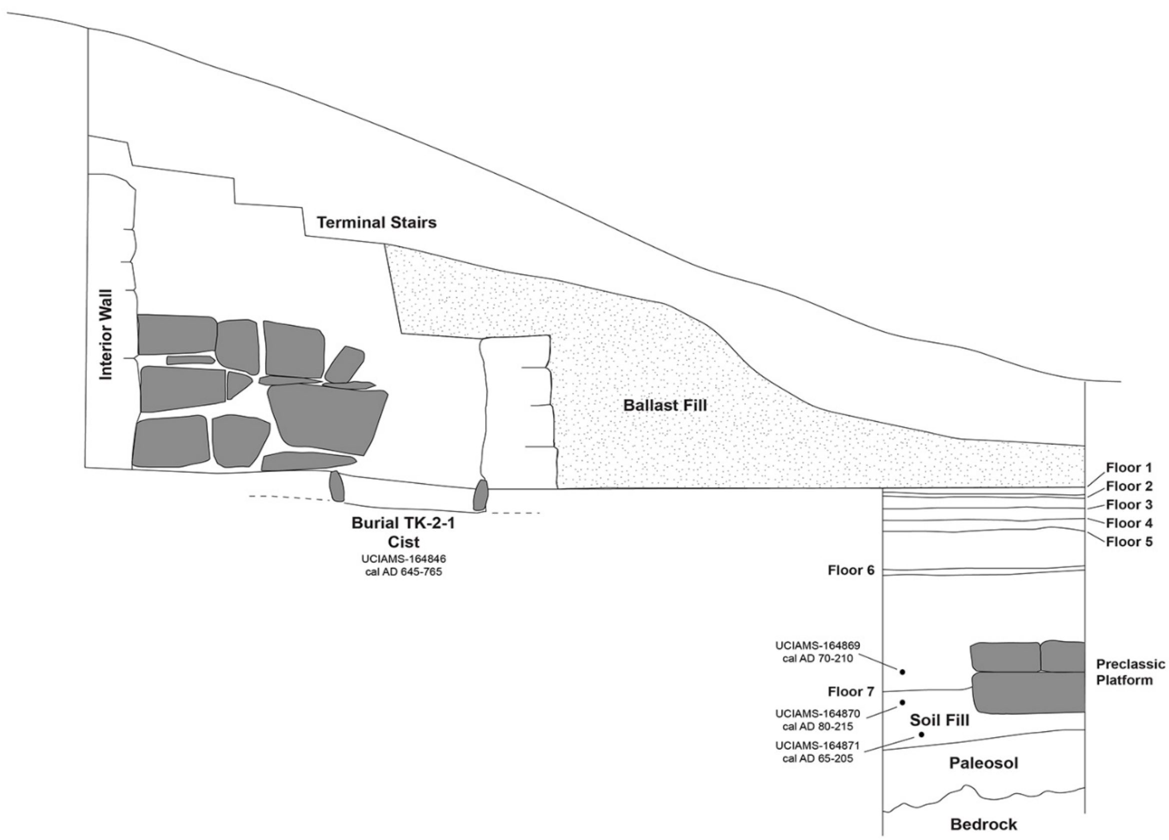

Figure A.8: South profile of Unit 2-4.

A total of five construction phases were recorded in this unit:

TK-2 1st: The first phase of construction at the building consisted of a soil layer placed on top of a paleosol layer. The paleosol strata has been documented beneath architecture across Tzutziiy K'in (e.g., Structure 3; Ebert et al. 2016) and has been directly dated the end of the Middle and beginning of the Late Preclassic period. Similar Preclassic contexts have been encountered throughout the Maya lowlands and represent the first soils encountered by initial settlers of a region (Beach et al. 2006). Very few artifacts were found within this paleosol matrix beneath Structure 2, and perhaps those present have been vertically displaced from superseding levels through time.

TK-2 2nd: The second phase of construction consisted of a masonry stone platform. This building runs at an angle across the unit, and is not part of the Classic period construction of Structure 2. Rather, it may represent an earlier Preclassic period component of the site. Floor 7, a thin plaster floor, abuts the interior portion of the masonry platform, and perhaps was located at the interior of this structure. The fill below Floor 7 contained a few diagnostic sherds dating to the Kanluk and early facet Xakal ceramic phases including several Sierra Red dish rims, one Sierra Red/Polvero Black basal flanges, two Joventud Red jar rims, and 8 Savana Orange bowl rims sherds. Three charcoal samples from this strata produced a date range of cal BC 65-215.

TK-2 3rd: The third phase of construction at Structure 2 consists of a series of five plaster floors (Floors 2-6). These floors were only exposed in the eastern portion of the unit. Three of these floors were also recorded in Units 2-1, 2-2, and 2-3. A radiocarbon sample collected directly from the surface of plaster Floor 2 produced a date range of cal AD 650-670 (UCIAMS-121554), placing all subsequent construction activities at the structure within the Late Classic (Ebert et al. 2016). Floors 2 through Floors 5 were thin and located fairly close together, within the same 20 cm level. Floor 6 was thicker (~3 cm), and was located approximately 20 cm below Floor 5.

TK-2 4th: The penultimate construction phase at Structure 2 consisted of Floor 1, approximately 6-10 cm thick, running from plaza surface and abutting a wall composed of cut limestone blocks. Associated with this level was an uncarved shaped stone interpreted as an altar that was placed on top the wall (Figure A.9). A 1 x 2.5m extension was placed to the east of Unit 2-4 to completely expose the altar stone. A thick masonry wall corresponding to this phase of construction was also exposed on the interior of this structure. The presence of a few Middle Preclassic ceramics (Savana Orange bowls) suggests that fill between the two walls was disturbed, likely during the placement of Burial TK-2-1 (described in more detail below). Ceramics contained in this fill, however, dated primarily Spanish Lookout phase (Table 1). TK-2 4th corresponds with the construction phase TK-2 2nd recorded during 2012 investigations (Ebert and Dennehy 2012). These excavations in Units 2-1, 2-2, and 2-3 recorded a sloping apron wall is located in the north side of the unit, associated with Floor 1. Located on the floor in front on the apron wall was a similar large altar stone.

Figure A.9: Photo of Unit 2-4 showing terminal stairs, western wall, and altar stone.

TK-2 5th: The fifth phase of construction at Structure 2 represents the terminal occupation at the structure, which has mostly collapsed and eroded. Three steps located towards the top of the building, however, remained in situ. Large amount of Late to Terminal Classic ceramic material (Belize Red plates, Cayo Unslipped jars, Alexanders Unslipped jars) were collected from this level. Several broken *mano* fragments were also recovered. This level likely corresponds to phases TK-2 4th and TK-2 3rd recorded during the 2012 excavations at Structure 2 (Ebert and Denny 2013).

Burial TK-2-1

Burial TK-2-1 was encountered during excavations in Unit 2-5B, and is associated with construction activity of TK-2 4th. The burial was located within the interior of the structure, behind the eastern most wall of Structure 2 that composed the front of the structure during phase TK-2 4th (Figure A.10). The burial was placed inside a simple cist that was excavated into Floor 1, with small stones outlining the shallow (~5-10cm deep) burial pit. The burial itself was resting on top of an earlier plaster floor, which likely corresponded with either Floors 3 or 4 (TK-2 3rd) based on depth below datum measurements.

Figure A.10: Plan view of Unit 2-4 showing location of Burial TK-2-1.

Osteological analysis was performed by BVAR osteologists Ashley McKeown (Texas State University) and Kirsten Green (University of Montana). The remains of a single adult male were present in the burial. The individual interred in this tomb was in an extended, prone position with the head to the south. The cranium was located directly behind the altar, but had been crushed beneath a large stone. The face, however, appears to have been oriented to the west suggesting that the head was resting on its left side at the time of internment. Preservation of many post-cranial elements was poor, and elements of the thorax were absent. The presence of some in situ phalanx fragments and the right radius suggests that the arms extended along the sides of the torso with the hands lateral to the hips. The legs of the individual were fairly well preserved. The feet were not present, and may have been removed by later construction activity that also cut into the floor upon which the burial was placed. An AMS radiocarbon date of the femur of the individual places the time of death in the Late Classic period between cal AD 645-765 (UCIAMS-164846).

Few artifacts were associated with the burial. Some worn undiagnostic sherds were present within the matrix around the individual, but these may have been come from the superseding fill associated with TK-2 5th. A single grave good found with the burial was a small pot in the shape of a frog (Figure A.11). This pot has been interpreted as representing a *woj* frog or toad (*Rhinophrynus dorsalis*), who's loud calls are common during the rainy season across the Maya Lowlands. Toad and frogs are also common throughout Maya iconography, and are associated with fertility (Schlesinger 2001: 230). The pot was located on top of the individual's pelvis, likely corresponding this symbolic nature of the iconography. Two charcoal samples were collected in association with the burial, one from the matrix on top of the legs and a second from beneath the remains, but have not been dated.

Figure A.11: *Woj* pot associated with Burial TK-2-1.

Unit 2-5

Unit 2-5 was placed on the summit of Structure 2, on the north side of the building. The goal of excavation was to encounter datable material and to better understand the stratigraphy of the structure. The unit was 1.5 by 3 meters and was placed running approximately north-to-south. Immediately in front of this unit was a deep looter’s trench (see Looter’s Trench 3 below). Unit 2-4 was placed just behind the looter’s trench to help relate to the stratigraphy in each excavation.

The first level of excavation focused on clearing humic layer debris from the surface of the structure, and uncovered ceramics, chert, one jute shell, a fishing net weight, and one *incensario* fragment (bulky ceramic with applique). Chert items found include cores, flakes, at least one bifacial hoe fragment. Similar types of artifacts were recovered throughout excavation of the entire unit, in addition to obsidian blade fragments. The first level ended at a highly eroded plaster floor in the southern portion of the unit, presumably the terminal construction for the building. Floor 1 was identified at a fairly shallow depth on the east side of the unit, with the plaster floor at its most shallow depth in the northeast corner of the unit. A second plaster floor was seen in profile below the first, though it was also eroded (Figure A.12).

Below the first two floors was a layer of white marl construction fill. Beneath the marl was a level of ballast fill approximately 20-40 cm thick with some larger stones throughout. The marl and ballast fill episodes capped a third plaster floor that spanned across the entire unit except in the northern most section. Floor 3 was located at depths of approximately 120-140 cmbd. Immediately below the third plaster floor a layer of white marl was present, interspersed with more compact fill consisting of 10YR 6/2 matrix with small rocks and carbonized plant materials throughout. Several radiocarbon samples were collected (TKG-31, TKG-32, and TKG-34) from the fill that are contemporaneous to the fill episodes. Further excavation into the construction fill revealed a mass of cut stones, perhaps the remains of a short collapsed wall in the southeastern portion of the unit. North of the wall, the pattern of white marl and soil fill continued, while to the south (outside of the construction) the area was filled in with ballast stones.

Excavation of Unit 2-4 was terminated at approximately 185-190 cmbd due to time constraints. The unit was covered with a tarp and backfilled. Future endeavors at the unit will continue with excavation and focus on recovering a larger sample of radiocarbon samples in order the construct a relatively precise chronology for construction of Structure 2. Additionally, ceramic analysis will aid in developing a chronological framework and constructing models for the development of the group.

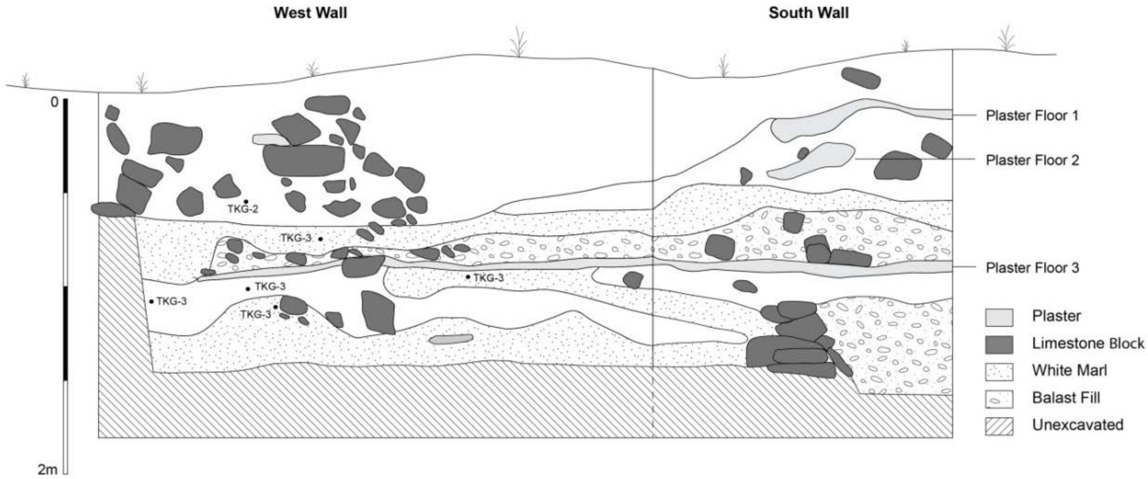

Figure A.12: West and South wall profiles of Unit 2-4.

Looter's Trench 3

As part of excavations on Structure 2, Looter's Trench 3 (LT3) was cleared of looting debris for further investigation (Figure A.13). Modern looting likely took place approximately 20-30 years before the 2012 season at the site, and it appears that the looter's back dirt and trench may have collapsed in onto itself. LT3 was a deep vertical hole dug approximately 7 meters down into the structure from its surface. In the profile exposed by the looting activity, the exterior face of the west wall of Structure 2 is visible, along with several floors beneath that level (Figure 14). During clearing, only diagnostic artifacts and special finds were collected in order to gain a better temporal understanding of the construction.

While formal ceramic analysis has yet to be undertaken, initial examination of ceramics during excavation suggest that looters penetrated Preclassic through Terminal Classic construction. One small jade bead was recovered from looters back dirt on the surface of

Structure 2. Despite the presence of this item, it does not appear that looters encountered any formal burials or other rich deposits. After LT3 was cleared to an undisturbed level, all artifacts were collected.

Immediately beneath looting activity lay 4 large boulders approximately 80cm to 1m in diameter. Human bone fragments were present on top of the boulders. After the boulders were removed, a larger amount of bone fragments appeared. They lay above a plaster floor that was broken in two separate locations (Features 1 and 2), and were re-plastered in antiquity. The western most Feature 1 was targeted for additional investigation as it was easily completely exposed. The extent of Feature 2 is unknown though it likely continued further into the structure.

Feature 1 consisted of a conical pit dug in construction fill (5YR 8/1 white sandy loam with plaster inclusions) directly above bedrock. Several more bone fragments and two teeth were recovered from the feature. No other artifacts were found. The function of Feature 1 remains unclear. Due to its size, it could not hold a complete primary burial, but may have instead represented some type of cache or secondary burial typically associated with eastern shrine buildings in the Belize Valley (Chase 1994; Chase and Chase 1994). A radiocarbon sample (TKG-20) collected from the matrix within Feature 1 produced a 2-σ date range of 432-550 AD. The Early Classic date of the feature indicates that it was constructed prior to the bulk of construction activity uncovered in Units 2-1, 2-2, and 2-3.

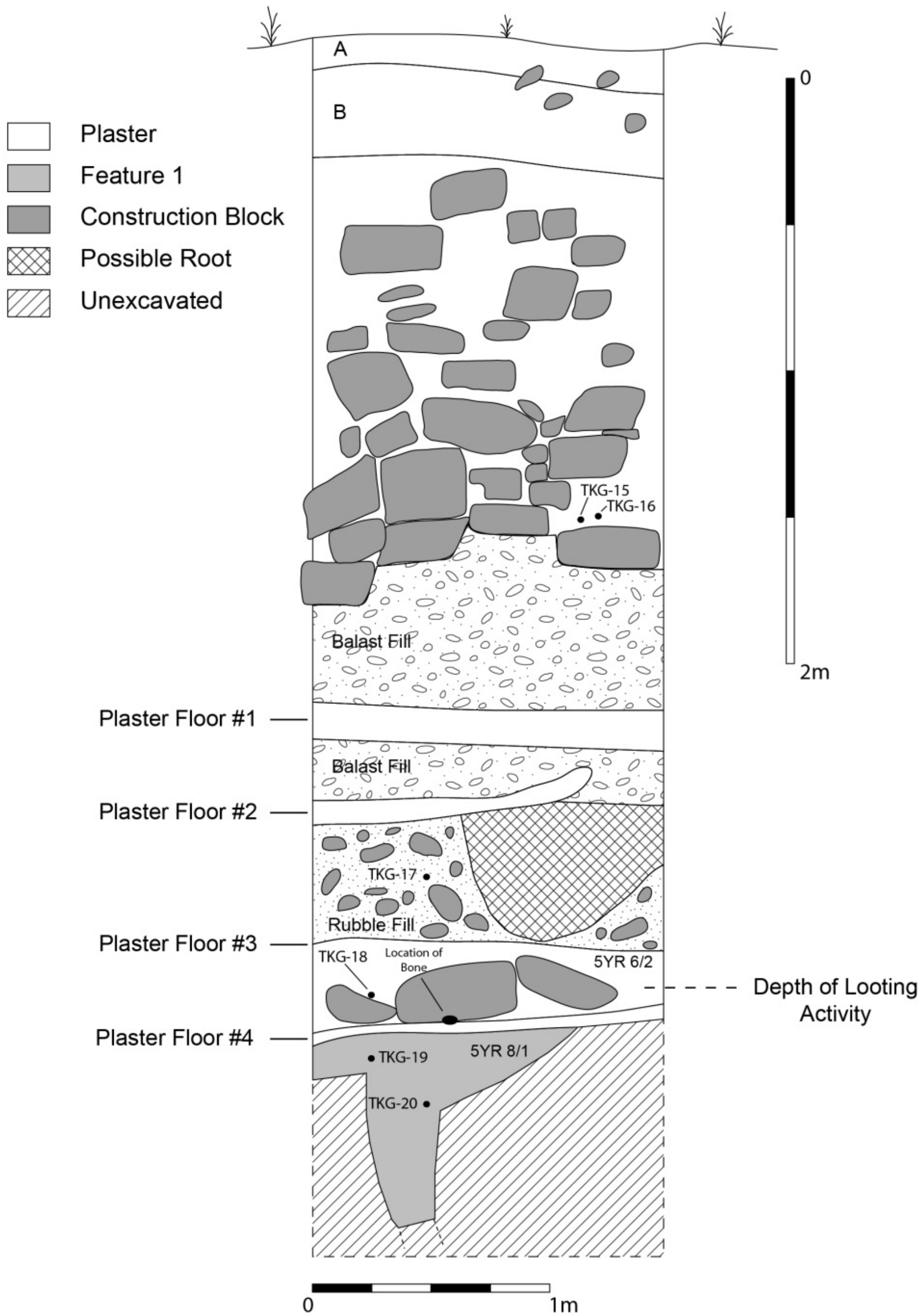

Figure A.13: Profile of LT3 exposure Feature 1.

Structure 3 Excavations

Unit 3-1

Excavations on Structure 3 consisted of a single 1 by 3 meter axial trench placed at the center of the structure and extending into the TK Group plaza. Because this structure suffered the least damage from looting at the site, the goal of excavation was to recover chronologically secure contexts. A total of eight distinct construction events were identified at Structure 3 (Figure A.14).

The first two levels of excavation exposed a plaster floor (Floor 1) covering stairway leading up the front of the structure, the final construction phase of Structure 3. The first step of three had a longer run (80 cm) than the second and third steps (25-30 cm). The first step of the structure was later revealed to be part of the penultimate construction phase. It appears to be a low platform that was plastered over by Floor 2. Floor 2 runs under the second and third steps into the structure suggesting that it originally functioned as a low platform, composing an earlier structure. Large cut stone blocks were present in the southeast corner of unit, which may have composed the northern edge of stairway of the structure.

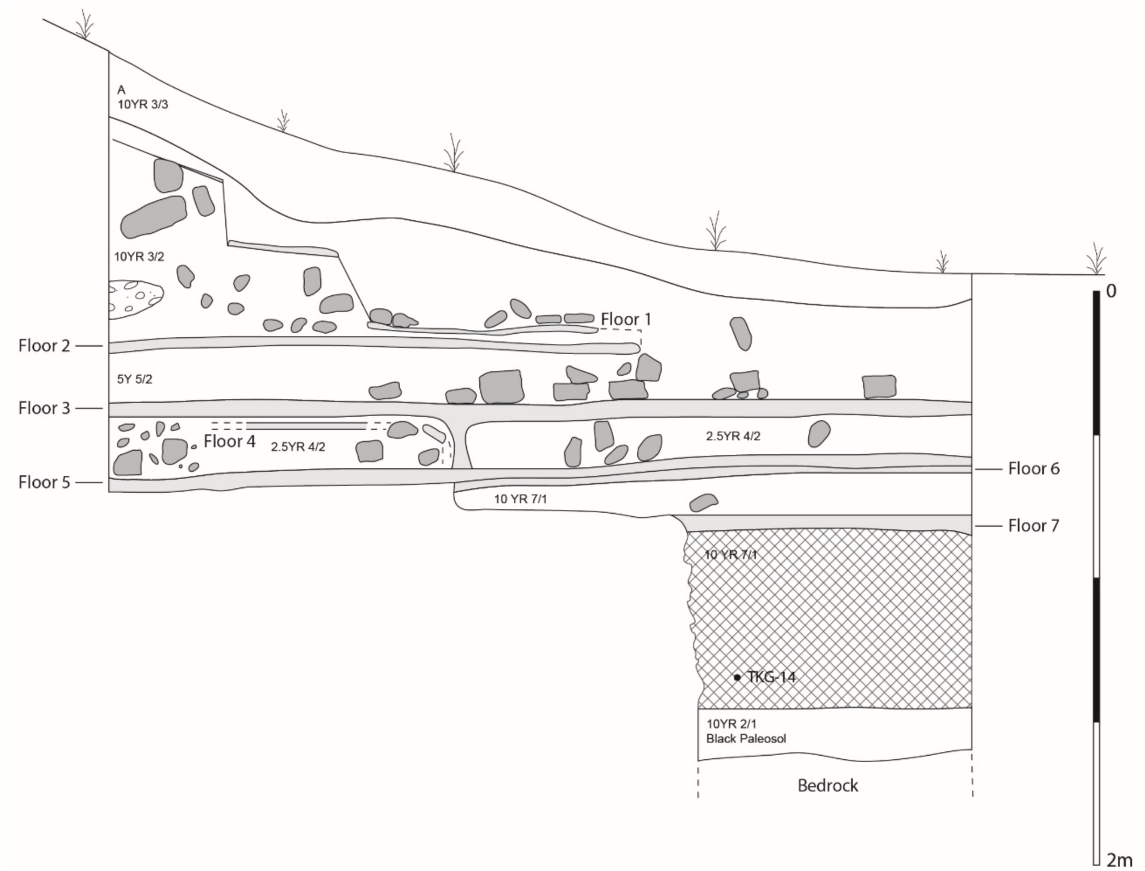

Figure A.14: North wall profile of Unit 3-1.

Beneath the final and penultimate construction phases, Floor 3 was encountered. Floor 3 extended completely across unit except in the southwest corner of unit, where it likely existed at one point but was degraded. Floor 3 slopes up slightly, located at a depth of 166 cmbd at north/front of the structure and 173 cmbd on south side of unit.

Excavations continued to investigate the materials below Floor 3 in the next construction phases, represented by Floor 4. The matrix above Floor 4 consisted of a compact light tan gray fill with plaster inclusions. Ceramics and chert were recovered from the fill, as from the rest of the excavation up to this point. However additionally freshwater shells (*jute*) and three pieces of slate were also recovered. After fill was removed, Floor 4 was encountered. Although mostly degraded, Floor 4 represents the construction of another low platform, and is only present in the portion of the unit inside the structure.

Beneath this level, another flat floor (Floor 5) extended across the entire unit, beneath the Floor 4 platform and into the plaza. Floor 6 rests immediately below Floor 5, and extends across the unit as well, and is interpreted as a plastering event. Preliminary examination of ceramics recovered below Floor 5 (Lots 1032-1037) contained Preclassic ceramics, primarily from the Sierra Red Group. Approximately 10 cm below Floor 6, the final floor (Floor 7) in the Structure 3 construction sequence was encountered.

A layer of "midden" fill was identified immediately beneath Floor 7, containing high concentrations of ceramics, obsidian, chert, freshwater shell, marine shell, bone, several granite mano fragments. Freshwater shell was present in the form of 2 jute shells. One radiocarbon sample (TK-14) was collected from 35 cm below the base of Floor 7. The sample was taken from inside a large limestone block with what appears to be natural holes in various sizes. Radiocarbon analysis produced a 2-σ date range of 325-110 BC, and dates the placement of the fill below Floor 7, but has not yet been analyzed. A change in soil color and type to a black clay paleosol (10 YR 2/1) signaled the termination of the midden fill. Similar strata have been encountered throughout the Maya lowlands and represent the first soils encountered by initial settlers of a region (Beach et al. 2006). Very few artifacts were found in the paleosol matrix, and perhaps have been vertically displaced from superseding levels through time. Excavation ended when bedrock was encountered at a level of about 3 meters below datum.

Based on this evidence, the fill below Floor 7 may have been used to level out the TK Group hilltop prior to construction. Magnetometer data suggests that bedrock is unevenly shallow in the main plaza with some areas naturally higher (e.g. at PLZ-1) than others (e.g. those in the southern portion of the plaza). The residents of the group were able to harness enough manpower to shape the hill during the Late Preclassic period before extensive construction activities took place. Earle (1991) has proposed that the primary method emerging elites in chiefdoms used to mobilize labor and to control resources is through property rights. Perhaps the TK Group may have already held more sway during the Preclassic compared to their neighbors living in smaller surrounding plazuela groups.

Unit 3-2

Unit 3-2 was a 1x3 m axial trench placed parallel to Unit 3-1 excavated in 2012. The goal of excavation was to collect additional datable material from this structure. Both excavations recorded a total of eight distinct construction events for Structure 3 dating from Late Preclassic through Terminal Classic periods (Ebert and Denehy 2013). The earliest direct date (UCIAMS-121552) from Tzutziiy K'in comes from the paleosol level beneath Structure 3 (Unit 3-1), and dates the initial settlement of the group to 350-110 cal BC during the beginning of Late Preclassic (Ebert et al. 2016). The paleosol matrix deposit contained high concentrations of late Middle and Late Preclassic ceramics primarily dating to the Kanluk (Savanna Orange) ceramic and Xakal (Sierra Red, Polvero Black) ceramic phases. The fill also contained household debris including as obsidian and chert used for tools, freshwater shell, and fragments of ground stone tools. The placement of the fill was likely used to level out the uneven hilltop prior to initial construction at the site. Middle to Late Preclassic ceramics from the Kanluk and Xakal phases were found in strata below Floor 3 in both units. Three charcoal samples were collected from these levels. The fill between Floors 2 and 3 contained Floral Park and Mount Hope complex ceramics, representing the Late Preclassic to Early Classic use of Structure 3. A charcoal sample was collected from this context and will be targeted in the future for direct dating. Spanish Lookout and Tiger Run complex ceramics (Belize Red, Mount Maloney Black, Juleki Cream Polychrome) dating from the Late to Terminal Classic (primarily Belize Red types) were recovered in strata above Floor 2. Late and Terminal Classic ceramics are associated with the final construction and use of the structure.

Lithic Analysis

Items produced from local chert and exotic materials, including obsidian and jade, comprise the lithic assemblage at the TK Group. Preliminary lithic analysis was conducted for all chert tools and debitage recovered from Unit 3-1. Results of these analyses are assumed to be largely similar for the whole group. Locally produced artifacts include chert tools (primarily cores with some large biface fragments and two blades) with cortex present on more than 50% of the total assemblage (Figure A.15). Cortex was also present on over 50% of all debitage recovered from the unit, indicating early stage reduction. This suggests local acquisition of raw materials and expedient tool production, a pattern noted in other regions of the Maya Lowlands (Aoyama 2007). Johnson and Andrews have suggested that locally available chert in the Belize River Valley is of low quality, resulting in onsite use of expedient technologies (Johnson and Andrews 2010:86) consistent with household production and on-site consumption. The presence of finished obsidian tools indicates some form of trade during occupation at the TK Group. Future inquiries into the nature of the lithic assemblage at the site will focus on XRF analyses to source obsidian artifacts.

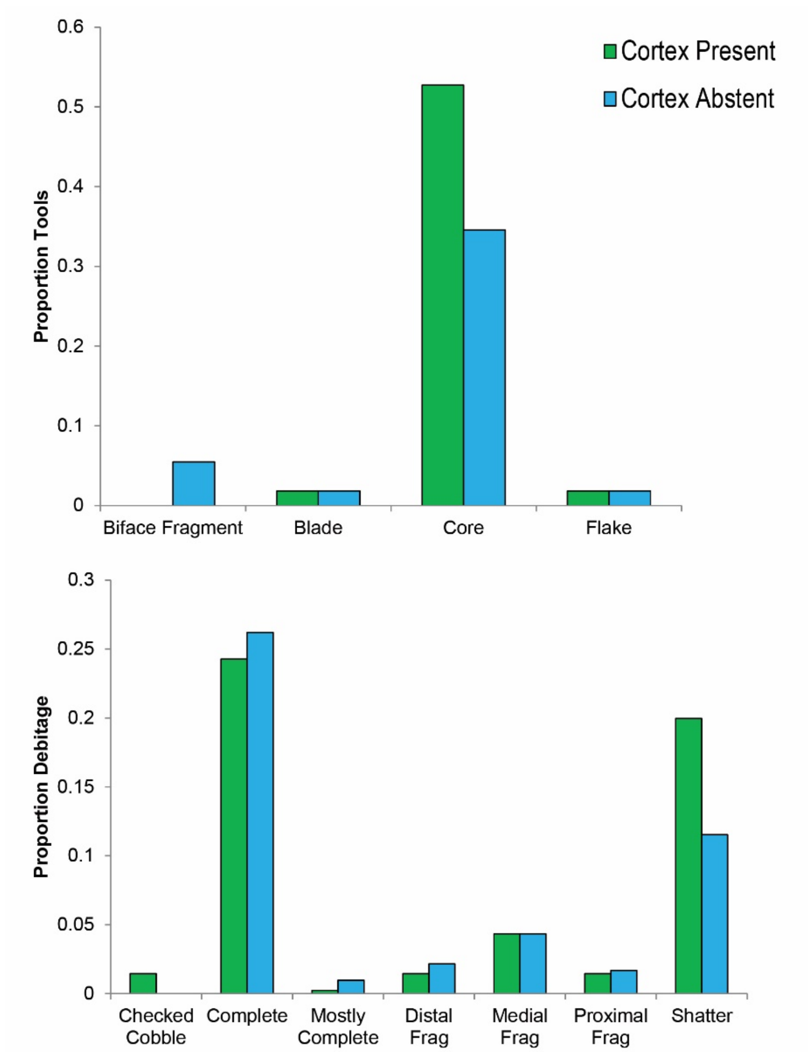

Figure A.15: Relative proportions of lithic tools and debitage with and without cortex by type.

Structure 4 Excavations

Two excavations took place in Structure 4. The first excavation was Unit 4-1 (1.5 x 3.5m east-to-west axial trench), and was placed near the centerline of structure, avoiding large tree roots present on either side of the unit. The second was a salvage excavation of a large looter's trench (LT4) located on the northern side of the structure. The goal of excavation for in Unit 4-1 was to align strata in the middle section of the structure with those exposed in LT4, which extends further into the center structure. Together, these two units exposed the complete construction sequence for Structure 4.

Excavations in Unit 4-1 exposed a series of five floors within the structure (Figure A.16). Floor 5 is the earliest construction recorded, and was composed of a fairly thin (~1cm) plaster floor resting on top of the paleosol layer documented throughout the rest of the group (Ebert and Dennehy 2013; Ebert et al. 2016). Floor 4 was located approximately 15 cm above Floor 5, and was composed of a thick (~5cm) plaster floor. No temporally diagnostic ceramics were recovered from these contexts. Floor 3 consisted of cobble floor that likely corresponds to a low platform exposed during the excavations in LT4. This cobble platform is similar in composition to cobble layers exposed in Plaza B in the Cahal Pech site core that date to the Late Preclassic period (Peniche May 2014).

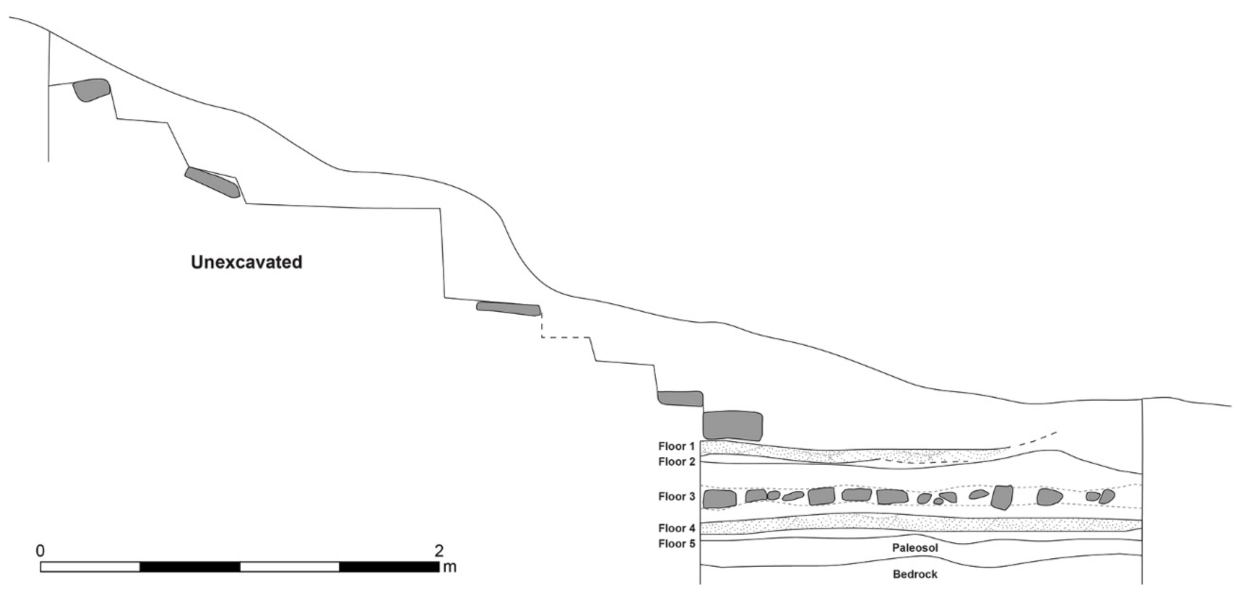

Figure A.16: North profile of Unit 4-1.

The fill below this floor contained Xakal phase ceramics (Sierra Red, Polvero Black), corroborating the early date of the cobble layer. Floor 1 was a highly compact and thick (~6cm) plaster floor, and was placed immediately on top of Floor 2, which was eroded and only visible in profile. Floor 1 is also present in the profile of LT4. The fill below Floor 2 contained primarily Late Preclassic Xakal phase ceramics. The latest activity documented by Unit 4-1 was the terminal use of the structure, which is dated to the end of the Late Classic based on the presence of Spanish Lookout phase ceramics.

The excavation of LT4 recorded two construction phases subsequent to placement of Floor 1 (Figure A.17). The first was the placement of a masonry wall, which may have served as a construction wall at the front (east) side of the structure. A series of steps were placed on top of this wall, and correspond to a thick plaster floor located at the top of the structure. The LT4 profile records a total of five possible steps. Unit 4-1 records the same five steps, with an additional four leading to the top of the structure in the center of the building. The terminal construction at Structure 4 was the construction on a superstructure on the north side of the building. A fairly thick plaster floor was placed between two low walls. No vault stones were found, suggesting that the walls served as the foundation for a perishable superstructure. A similar superstructure may have also present at Structure 1, and this context was directly dated to the Late to Terminal Classic period (UCIAMS-121550; cal AD 715-880). Ceramics from LT4 were mixed due to looting activity, and dated from the Preclassic to Late Classic periods, though Late Classic Spanish Lookout phase ceramics dominate the assemblage.

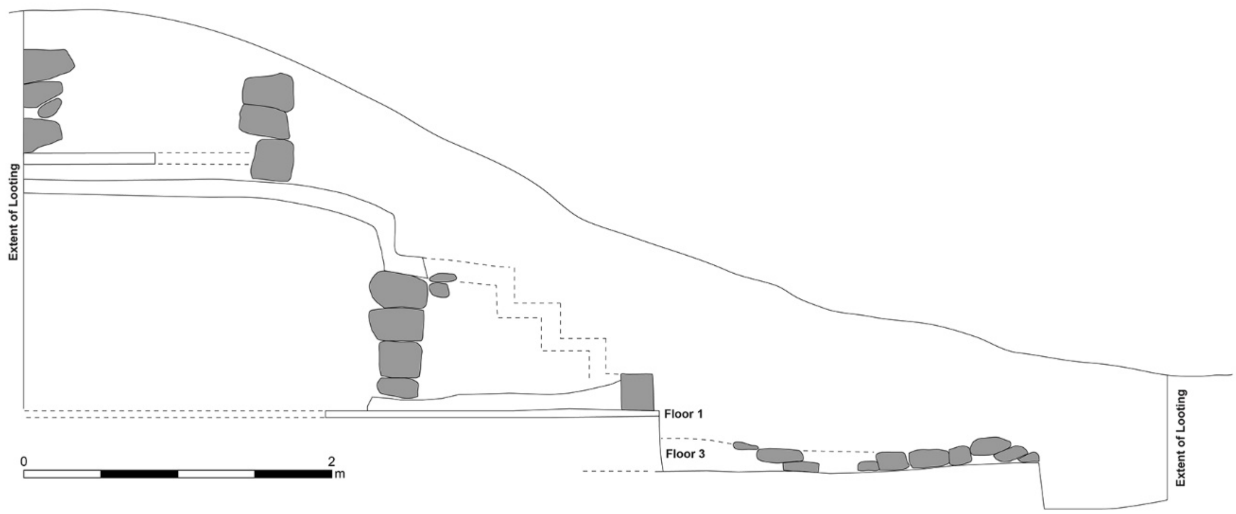

Figure A.17: South profile of LT4.

Plaza Excavations

Two units were placed in the main plaza at the TK Group. PLZ-1was a 2 by 2m unit placed in the southern portion of the plaza in order to investigate the presence of a long anomaly running approximately east-to-west identified during magnetometer survey. Excavations proceeded in two levels, with the first level revealing the possible presence of a plaster floor. While highly degraded, this floor is consistent with the depth of the floor found in front of Structure 2. After the first level, the unit was bisected and excavation continued in the northern most 1 by 2m portion of the unit. The second level consisted of rubble fill, which sat immediately on top of bedrock. Bedrock was encountered at a shallow depth of 80 cm below ground surface. The bulk of the artifact assemblage recovered was composed primarily of chert debitage, though few artifacts were recovered overall. The shallow depth of bedrock at this location likely is the cause of the large magnetometer anomaly. Bedrock was encountered at a much greater depth in other, nearby excavations at the TK Group (e.g., Unit 3-1 and PLZ-2 described below). Evidence for landscape modification exists in these areas, specifically leveling out the uneven hilltop upon which the TK Group was constructed.

PLZ-2 was a 1 by 2m unit running north-to-south placed on the south side of the main plaza at the TK Group. The goal of the excavation was to investigate the composition of a man-made gradual rise that bounds the main plaza to the south, as well as to gain temporal information concerning the timing for the placement of the feature in relation to the construction in the rest of the group. After initially clearing the humic debris, a midden fill matrix was encountered. The fill was composed of a 10YR 4/2 dark grey brown organic rich matrix with domestic artifacts including utilitarian ceramic, *mano* fragments, 4 obsidian blade fragments, and a large amount of chert material (mostly cores and flakes) throughout. In the west wall of the unit, a wall was present constructed from cut stone blocks. One piece of carbon was recovered from area beneath a mano at a depth of 78 cmbd on west wall. The sample originates from below the wall and predates its placement. Below the wall, two episodes of rubble fill were encountered, both composed of a sandy loam that contained a large amount of small rocks. Each construction episode was distinguished by a "floor", likely the result of packing the fill into place. Few artifacts were recovered from the fill. Beneath the fill episodes, the same buried A Horizon was present in Unit 3-1, Structure 3, indicating that this area of the plaza was level prior to construction as well.

Initial interpretation of the construction sequence suggests that the midden fill was laid down prior to placement of a large stone wall, and that the wall acted as a retainer for fill that was subsequently added to level off the area. Additional exposing of the wall revealed that it extends into the plaza, with a perpendicular alignment running east-to-west abutting the wall in the plaza. Exposed limestone to the east mirror this pattern and suggest that the architecture may have served to mark a passage way across the rise, and entrance into the plaza of the main plaza at the TK Group.

Tzutziiy K’in Summary

The first season of research at Tzutziiy K’in has yielded interesting chronological information and data concerning the populations living around Cahal Pech. Initial excavations revealed that the group was first settled sometime during the Late Preclassic and was inhabited, likely continuously, through the Terminal Classic period. Settlement at similar large groups near Cahal Pech, for example the Cas Pek Group, have congruent chronological sequences (Cheetham et al. 1993). Beginning in the Late Preclassic occupation at Tzutziiy K’in was firmly established, consistent with previously documented evidence of demographic expansion at Cahal Pech and its hinterlands during this time (Awe 1992).

Early occupation at the group was likely small-scale, and construction of platforms did not begin until the Early Classic. Initial construction of Structure 1 prior to ca. AD 400 was small, consisting of a low platform, and may have not required much labor investment. On the other hand, a considerable amount of labor was focused on leveling out the site before any large-scale construction took place, as revealed in excavations at Structure 3 and on the edge of the plaza. It appears that, over time, settlement expanded into the area surrounding Tzutziiy K’in, in addition to larger scale construction episodes in the main plaza. The final construction episodes on both Structures 1 and 2 were large-scale and date to the Late Classic. It is clear that during the Terminal Classic period the residents of Tzutziiy K’in were likely high-status. The scale of construction suggests that the residents of Tzutziiy K’in possessed the resources needed to remodel buildings often. The modest bench located in the superstructure of Structure 1 may be associated with the status of the individuals who occupied the house groups in the Late Classic. At sites like Copan, benches served as potent political symbols, and in royal or high-status contexts are often the public focal points of tribute and gift presentation (Stuart 1995: 368; Webster et al. 1998). While the identity and exact status of the residents of the site remains unknown, perhaps they were closely affiliated with the ruling elite at Cahal Pech or served in some sort of administrative capacity. Future work will focus on refining chronological and stratigraphic interpretations at the group, which will elucidate the sequence of construction activities. The sequence of these activities will be compared to data from Cahal Pech to investigate the relationships between Tzutziiy K'in and the ceremonial center.

Future work will also focus on expanding excavations at Tzutziiy K'in in order to better understand the group and its socioeconomic connections with Cahal Pech and in a broader context within the Belize Valley. Excavations will be expanded in the group, and agricultural features will be explored. In the lab, detailed analysis of artifact assemblages will be performed. Ceramics will be compared to a standard typology for Cahal Pech and Baking Pot, focusing on change over time in percentage of wares indicative of craft specialization. Lithic artifacts, including chert and obsidian tools, flaked stone debitage, and ground stone, will be examined to determine if tool production took place within the house group or if tools were obtained through trade. The presence or absence of exotic materials, such as marine shell, jade, and obsidian would indicate long-distance trade. Geochemical analysis (e.g., XRF, INAA) of these artifacts will be used to determine source locations and reconstruct long-distance exchange. Household studies have generally been neglected in the Maya region in favor of research emphasizing ritual, ceremonial, and elite aspects of ancient Maya society. As new insights into the scale and timing of social changes within households are developed and refined, they can help generate more general models of the mechanisms through which sociopolitical development occurs at the household, community, and regional scales.

Zopilote Group

The Zopilote Group is a large terminus group located approximately 0.75 km south of the Cahal Pech monumental core at the end of the Martinez Sacbe (Awe and Brisbin 1993). The Martinez Sacbe was initially constructed in the Late Preclassic period and extends approximately 280 m north of the platform group, and may have extended all the way to the site core in antiquity (Cheetham et al. 1993; Cheetham 2004). First recorded in 1992 by the BVAR Project, the Zopilote Group is composed of two primary temple structures (Structures 1 and 2) set atop a raised platform modified from natural bedrock (Figure A.18). Structure 1 and 2, in addition to three smaller structures located to the east of the main platform, have all experienced heavy looting activity likely during the 1970s and 1980s. Three large "depressions" are also located around the main platform, and have been interpreted as quarries for construction material at the group (Cheetham 2004).

Previous investigations at the Zopilote Group were undertaken by Cheetham and colleagues (1993, 1994; see also Cheetham 2004), and focused on documenting the construction sequence of superimposed temple structures at Structure 1. Test excavation on the front stairway on the north side of the structure, and salvage excavation of a large looter's trench on the west side of the structure documented a total of 10 construction phases (Figure A.19) with estimated dates for construction ranging from the Middle Preclassic (~750-300 BC) through Terminal Classic periods (ca. AD 700-850; Cheetham 2004). The base of a plain stela (Stela 8) associated with Late Classic period terminal construction phase was also encountered at the base of Structure 1 (Cheetham et al. 1994).

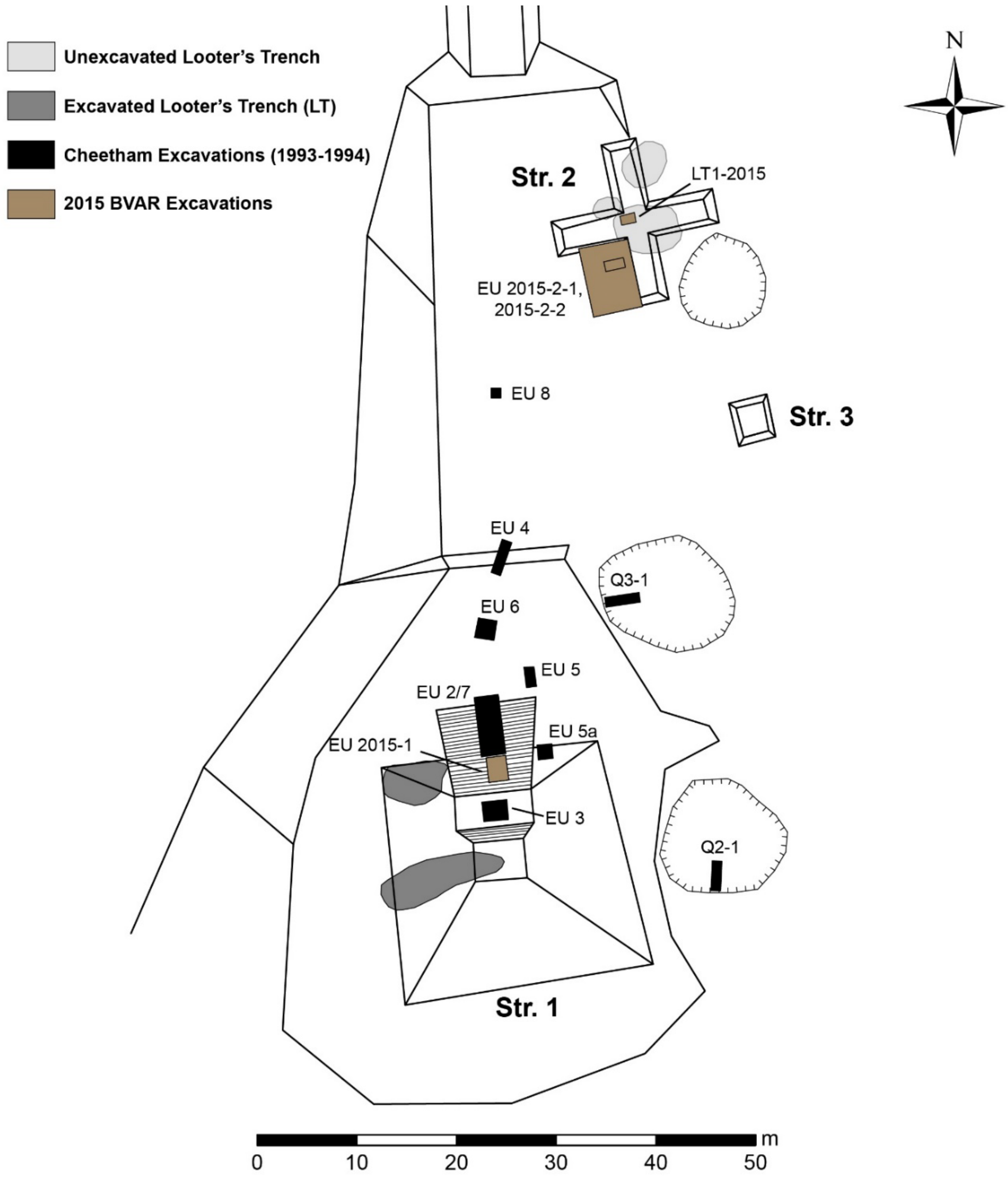

Figure A.18: Map of the Zopilote Group showing BVAR excavations from 1993-1994 and 2015.

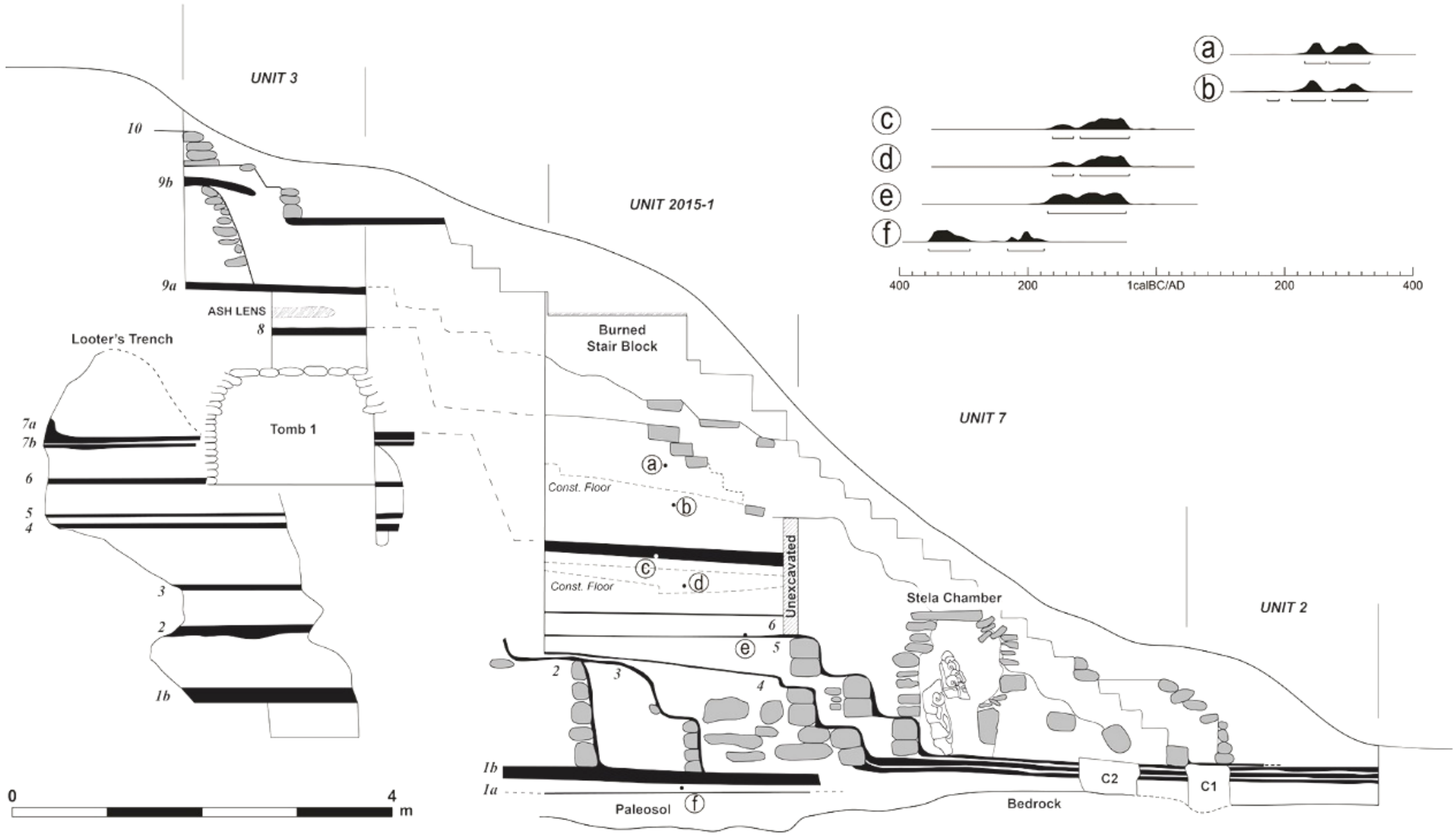

Figure A.19: Profile of Zopilote Structure 1, showing ten phases of construction (after Cheetham 2004), and the locations of Tombs 1 and 2. Radiocarbon samples collected from Unit 2015-1 are lettered a-f and correspond to calibrated date ranges.

Cheetham and colleagues (1993) placed an additional test excavation at Structure 2, located on the east side of the causeway north of Structure 1. Results of this work suggested that the building was constructed in a single episode during the Late Classic period. Additionally, Cheetham (2004) suggests that the structure was constructed to house a vaulted tomb, though no cultural materials were recovered.

The importance of the Zopilote Group is also supported by the presence of two vaulted tombs located at Structure 1. Tomb 1 was associated with the penultimate construction (ZPL-1 9th), though the tomb itself was dug into Preclassic period levels. Tomb 1 contained the remains of two individuals. The primary burial was of a young adult male, placed in an extended position with the head to the south. This individual was likely high status, as suggested by the presence of several jade inlays located near the cranium. A secondary burial was the cranium of a young adult male placed between two bowls at the feet of the primary burial. Grave goods associated included a small jade human effigy pendant, two jade beads, a stingray spine, two *spondylus* shell earflares, a disc-shaped shell *adorno*, a large fresh-water shell, two small stone balls, a stone bead, and elaborately decorated stucco veneer fragments that likely adorned a ceramic vessel at the time of internment (Cheetham et al. 1993: 162). Nine Hermitage and Tiger Run phase (AD 300-650) ceramic vessels were also recovered from within Tomb 1, including a Dos Arroyos Polychrome plate (Vessel #1) and Saxche Orange Polychrome bowl depicting a scene of a militaristic procession (Vessel #2; Cheetham et al. 1993).

Tomb 2 was located beneath the staircase of the penultimate construction episode (ZPL-1 9th). Below a large capstone were the disarticulated remains of at least two infants, and one fetus within a loose dirt fill. A carved stela, Stela 9, was located below the infant remains. Approximately 200 small bowls containing 225 human phalanges were associated with Stela 9.

Additionally, 45 mandibular incisors and other fragments of human were located at the base of the stela (Awe et al. 2009). Stela 9 is the only example of a carved stone monument from Cahal Pech, and Awe and colleagues (2009) have argued that the monument dates to the Late Preclassic period based on the style of carving and iconography. They suggest that, “the motif of the Cahal Pech Stela [9], an anthropomorphic figure in a jaguar mouth, may be linked to the old pan-Mesoamerican concept of animal companion spirits,” (Awe et al. 2009: 185) and that it shares elements found on carved monuments associated with the Gulf Coast Olmec culture (Awe et al. 2009; Cheetham 2004). The stela was likely removed from its original location, perhaps associated with ZPL-1 4th (Late Preclassic period) and interred within later Classic period architecture at Structure 1 (Cheetham 2004: 196).

Structure 1

In 2015, BVAR archaeologists revisited the Zopilote Group with the goal of recovering materials for AMS radiocarbon dating from stratigraphic trenches to refine the coarser-grained ceramic chronology for the group. Excavations by Cheetham and colleagues at Structure 1 were placed near the top and towards the base of the 11 m tall structure. The front stairway, on the north side of the building, was cleared to locate the extent on these units and expose terminal architecture. A 2x2 m unit (Unit 2015-1) was placed to cover a stair block located in the middle of the structure, and abutting the southern wall of Unit 7 excavated in 1993 (Cheetham et al. 1994). Excavation of Unit 2015-1 uncovered the ten construction phases previously documented. The earliest construction episodes (ZPL-1 1st trough ZPL-1 3rd) encountered by Cheetham and colleagues (1992:159) were associated with ceramics from the Kanluk (900-350 BC) and Xakal (350 BC-AD 350) ceramic phases. These early platforms may have supported perishable superstructures. It was hypothesized, however, that earlier occupation occurred at the Zopilote group prior to the construction of ZPL-1 1st in the Middle Preclassic (Cheetham et al. 1993). Evidence for the growing ideological and ritual importance of the group appears during the Late Preclassic. Large amounts of burnt plaster were documented the base ZPL-1 5th through ZPL-1 7th, which may be associated with frequent burning incense in these area (Cheetham et al. 1993, 1994). Burning was also documented during the 2015 excavations on top of the central stair block associated with the terminal phase of constructions (ZPL-1 10th).

Excavation of Unit 2015-1 found an earlier occupational phase at Structure 1 not previously documented by Cheetham and colleagues (1993). Excavations reached a plaster floor (Floor 1a), located above a paleosol layer composed of black clay. Floor 1a represents the earliest construction activity at the group, and does not appear to be associated with the temple platforms that composed later construction episodes. The paleosol layer contained high frequencies of freshwater shells (*n*=445), chert cores and flakes (*n*=85), and fragments of utilitarian ceramic vessels (*n*=110). This strata likely represents the initial residential occupation at the site. The occupation of this surface is dated by the presence of Cunil and transitional Cunil/Kanluk ceramic materials (Sullivan and Awe 2013). This includes rim sherds of Uck Red and Cocoyol Cream vessels and a strap handle from a Sikiya Unslipped/Jocote vessel. Additionally, the assemblage contained one sherd with similar shape and surface treatment to Savana Orange (Savana variety, Kanluk phase) with ash temper typical of Cunil ceramics (Sullivan and Awe 2013), further supporting that the level represents a transitional Cunil/Early Facet Kanluk phase (ca. 1000-650 BC). One whole Cocoyol Cream vessel was reconstructed from this level, and has a smooth cream paste with fire clouding, and a thick oxidized core (Figure A.20; see Sullivan and Awe 2013 for type description). The vessel is shaped as a gourd halved lengthwise with stem may have served as a spout, and is a new form for the Cunil phase (J. Awe, personal communication). An intentionally made hole at the base of the vessel has been interpreted as a possible kill hole, perhaps indicating ritual activity early during the beginning of the Middle Preclassic period.

Figure A.20: Cocoyol Cream vessel.

To understand the timing and tempo of construction at Structure 1, six samples of charcoal recovered from the stratigraphic sequence of Unit 2015-1 were chosen for AMS radiocarbon dating. A charcoal sample from below Floor 1b (ZPL-1 1st) yielded a date 2-σ range of 355-175 cal BC (UCIAMS-164873), suggesting that construction of platforms at Structure 1 began during the beginning of the Late Preclassic. This date is later than that originally proposed by Cheetham and colleagues (1993, 1994), which was based the presence of some Kanluk ceramic materials. One special find, a figurine head representing a dog, was documented from this level (Figure A.21).

Figure A.21: Dog figurine associated with Late Preclassic construction phase ZPL-1 1st.

The next burst of construction activity took during end of the Late Preclassic. A series of three AMS radiocarbon dates associated with the construction of ZPL-1 5th through ZPL-1 7th dated between 170-40 cal BC (UCIAMS-164878, UCIAMS-164875, UCIAMS-164874), suggesting that the construction of these temple platforms during the end of the

Late Preclassic was fairly rapid. Late Preclassic construction at the Zopilote Group corresponds with the large-scale construction of the first monumental buildings in the Cahal Pech site center (Plazas A and B; Awe 1992; Healy et al. 2004a). This accelerated architectural activity has also been documented in Plaza A of the site core, where Str. A1 Sub 1 was built to a height of almost 15 meters. Plaza B was also raised and enlarged during this time, and Structure B4 underwent several modifications (B-4\7th – B4\10th) beginning with the construction of a specialized round structure dating to 795-405 cal BC (Beta-40863; Healy and Awe 1995) used for public ceremonies (Aimers et al. 2000), and terminating with a large, 4m high pyramid that supported a pole and thatch super structure (Awe 1992). The construction of temple platforms at the Zopilote Group suggests ritual activity taking during the Late Preclassic period in the site center was likely connected to similar activities taking place within peripheral architectural groups.

Direct dating of deposits from Structure 1 in Unit 2015-1 also lends support for continued growth of Cahal Pech from the Late Preclassic to the Early Classic periods. Two charcoal samples from within the fill of ZPL-1 8th date to cal AD 170-330 (UCIAMS-164877) and cal AD 230-335 (UCIAMS-164876), indicating and that this building was constructed during the beginning of the Early Classic. This represents one of the largest construction episodes at Structure 1, and within the Zopilote group in general, and corresponds to similar site growth occurring within the monumental core of Cahal Pech and expansion of other peripheral house groups (Ebert et al. 2016). At Cahal Pech, several structures within Plaza A were remodeled and the plaza resurfaced; Plazas C, D, F, and G grew substantially through the construction of new buildings; and the first phase of the eastern ball court was erected (Awe 1992; Awe and Helmke 2005: Table 1). Some of the most elaborate royal burials from the site date to the Early Classic (Santasillia 2012; Ishihara-Brito et al. 2013; Awe 2013). More recent settlement research also suggests that some new residential groups were established in the Early Classic (Ebert et al. 2016), indicating continued population growth from the Preclassic into the Early Classic period (Awe and Helmke 2005). Future research will focus on continued dating of deposits from Structure 1 to understand the relationship between construction activities within the Cahal Pech site core and peripheral architectural groups.

Structure 2

The 2015 excavations at the Zopilote Group also focused on exploring the form and function of Structure 2 in relation to the rest of the group. This structure was targeted as the possible location of a Terminal Classic period ceramic deposit. One characteristic feature of Terminal Classic contexts in the Belize Valley are large surficial ceramic deposits located in the corners of plazas, in front of stairs, and in the doorways of public architecture and date the final use of a structure. These terminal deposits have been attributed to numerous activities including termination rituals, feasting events, refuse disposal in primary middens, or reoccupation by squatters (Awe 2012; see also Hoggarth et al. this volume). Excavations focused on the western side of Structure 2 as it was least impacted by looting activity. The eastern face of Structure 2 was almost completely destroyed and there was also a larger looter’s trench the structure’s summit.

Unit 2-1 was an irregularly shaped, informal unit, and was placed initially to clear humic debris and collapse from the western face of Structure 2, so that a more formal unit could be placed strategically. During clearing, numerous artifacts were recovered that suggested a terminal deposit had been encountered. These included a high frequency of ceramic sherds, chert fragments (worked and unworked), and a large fragment of a mano. Most of the ceramic fragments discovered were from utilitarian vessels dating to the Spanish Lookout ceramic phase. Furthermore, there were several large stones that were interspersed throughout the humus layer. These stones were most likely collapsed from the upper part of Structure 2, perhaps suggesting that many of the artifacts from the surface and collapse may not be in situ.

After the humus layer and associated collapsed stones were removed from the excavation unit several architectural elements were revealed. A large wall oriented east-to-west was uncovered that abutted a second wall to form roughly a 90 degree angle (Figure A.22). We hypothesize that Structure 2 was a cruciform platform, however, due to the extensive amount of looting this can only be observed on the western side of the structure. Additionally, exploratory test pitting within the looter's pit at the structure summit confirmed that the building was constructed on top of bedrock within a single episode during the Late to Terminal Classic periods (Cheetham et al. 1993). Around 50 cm in front of where these wall features meet, a semi-circle of stones created a niche feature on the uppermost part of the excavation unit. The purpose of this feature is unknown, but it should be noted that there some ceramic fragments taken from the inside of this feature.

Upon the removal of the humus layer and the initial exposure of architectural features, we encountered an extensive ceramic deposit consisting primarily of Terminal Classic ceramics (Figure A.23). The deposit extends from the most westerly end of the excavation unit up into the circular niche feature. Over 25,000 ceramic sherds were uncovered, approximately 9% of which were diagnostic (*n*=2,344). In some sections the concentration of ceramic sherd appeared to be stacked on top of each other, resulting in a ceramic layer that in some areas was more than 50 cm thick. In many cases the stacked sherds were from the same vessel, and a large number can likely be refits into partial or whole vessels.

Figure A.22: Photo of Zopilote Structure 1 after removal of ceramic deposit.

The sherds were found in higher proportions towards the intersection of the southern and eastern walls of Structure 2, typical of terminal deposits found at other Belize Valley sites (e.g., Cahal Pech and Xunantunich, Awe 2012; Baking Pot, Hoggarth et al. 2014, Hoggarth and Sullivan 2015). Floor 1 is also better preserved in this area, indicating that it was the original location for the deposit. The sheer number of ceramic sherds and thickness of sherds located within the terminal deposit at Structure 2 may suggest that this deposit was not formed in a single event, but was perhaps the result of several episodes of activity. Several other types of artifacts were also recovered from the deposit, including chert cores and flakes (*n*=787), 4 obsidian blade fragments, and 1 mano fragment. Two special finds included a chert point and a slate tube that was likely the handle for wrench.

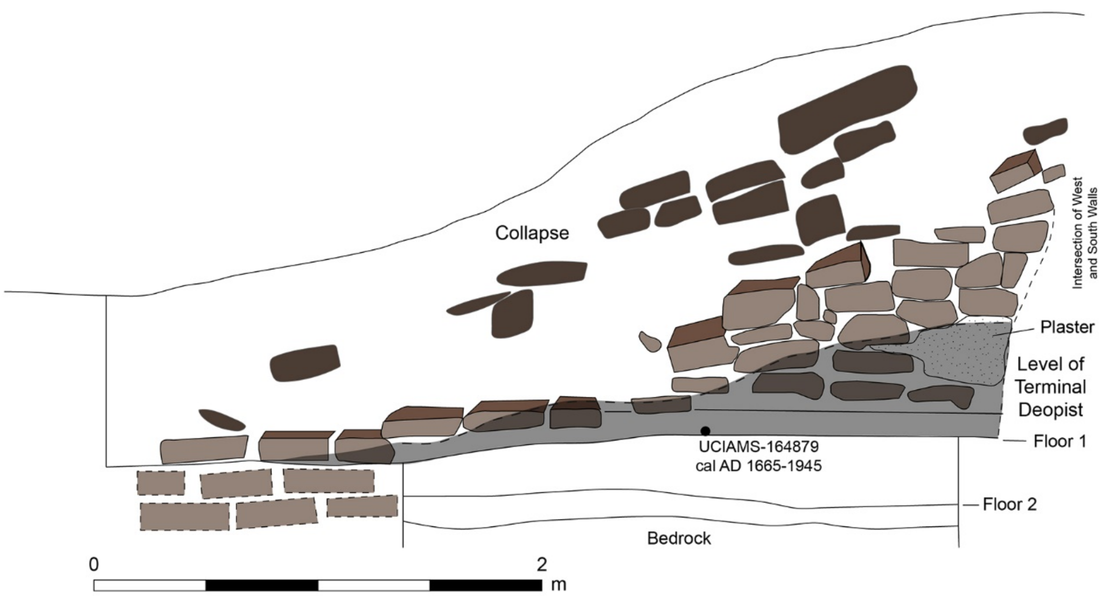

Figure A.23: South profile of ceramic deposit at Zopilote Structure 2.

A low wall was also documented running across the top of the ceramic deposit, but did not compose part of the primary wall of Structure 2. Rather the wall, which was one to two courses thick, was composed of cut stones removed from the top Structure 2. The wall also does not seem to be associated with the placement of the terminal ceramic plausible that this feature may have been used to restrict space in some way, as it resembles similar low walls found at other sites (e.g., Xunantunich, Lower Dover) that are associated with reoccupation of area after the abandonment of Cahal Pech.

Because of time constraints preliminary ceramic analysis was also conducted on a small sample of diagnostic sherds from the deposit. Future work during the 2016 BVAR field season will analyze the complete assemblage. Preliminary analysis indicates that many of the sherds date to the Spanish Lookout phase. The following types were identifiable: Alexander Unslipped, Belize Red, Cayo Unslipped, Dolphin Head Red, Monkey Falls Striated (Gifford 1976). Fragments of a Terminal Classic period Pedregal Modeled *incensario* depicting the right hand portion of the face of the Jaguar God of the Underworld was also found within the deposit (Figure A.24; J. Awe, personal communication 2015). This *incensario* gives insight into what types of activities that may have been taking place at Structure 2. *Incensarios* were used in ritual burning of incense for various types of religious purposes among the ancient Maya. In addition, Maya epigraphers associate the symbolism of the Jaguar God of the Underworld with fire rituals and the male dynastic lineages. This may suggest that the *incensario* was associated with some type of act of ancestral reverence conducted by the Terminal Classic Maya (Taube 1992).

Figure A.24: Photo of Pedregal Modeled *incensario* depicting the Jaguar God of the Underworld.

Excavations continued below the terminal deposit in a 1x2 m unit that ran parallel to the west arm of Structure 2. A plaster floor (Floor 1) was encountered immediately below the terminal deposit. A charcoal sample collected from on top of Floor 1 yielded a date of cal AD 1665-1945 (UCIAMS-164879). This date is much later than expected based on ceramic associations, and is likely attributable to heavy looting activity or bioturbation at Structure 2 that may have displaced the sample vertically. Direct dating of additional samples of organic materials associated with the ceramic deposit may help to clarify its age. A second floor (Floor 2) was located approximately 8-10 cm below Floor 1. These two floors may be the same floors recorded in front of Structure 1 associated with the penultimate and terminal phases of that building. Relatively few artifacts were recovered, all of which were ceramics. The excavation unit ended approximately 50-60 cm below Floor 2 when bedrock was discovered. The northern wall seems to have built on top of bedrock as no other platform was discovered.

Excavations at Zopilote Structure 2 revealed the architectural construction sequence and potential domestic/ritual activities that were being conducted by the ancient Maya. This structure is cruciform in shape and seems to have been constructed in a relatively short amount of time. Further research in ceramic analysis, radiocarbon dating, and micro level associated domestic and ritual activity within the site may uncover what the purpose Structure 2 served for the ancient Maya. Our preliminary hypothesis is that the large terminal deposit discovered on the western side could represent ritual activities associated with ancestral worship, but further research is needed to conclude this assertion. Yet the possibility remains that the activities at Structure 2 could indicate a wider cultural pattern when cross compared with other similar discoveries in the Belize Valley and beyond. Only through extensive analysis can these discoveries be cross compared with each other to give archaeologist an adequate view of how these sites may have function through the eyes of the ancient Maya.

Martinez Group

The Martinez Group is a medium sized residential group located approximately 2 km south of the Cahal Pech site core. The group was first recorded in 2014 during ground-truthing survey of lidar data for the Cahal Pech settlement area (Awe et al. 2015; Ebert 2015). The group is located on top of a slightly raised platform, composed of 4 buildings arranged around a central courtyard. Structure 1 is the largest structure, and though heavily looted, resembles an eastern pyramidal structure. Structures 2, 3, and 4 are low platforms. A natural depression in the limestone bedrock located immediately south of the groups was modified to resemble a sunken plaza (Figure A.25).

Exploratory shovel test pits were placed in both plazas to estimate the depth of bedrock across the group as part of the 2014 BVAR survey program. A total of 14 shovel test pits were dug in the main plaza and the sunken plaza in order to assess the depth of bedrock across the group, as well as to collect diagnostic ceramics. Unfortunately, ceramics recovered from the shovel test pits were highly eroded and burned by recent agricultural activity in the area, though they likely date to the Late Classic period. A 1x1 m test unit (PLZ-1) was placed in front of Structure 4 in plaza, and confirmed shallow depth of bedrock in the area, indicating that the platform upon which the group was built was modified from a natural bedrock outcrop. A second 1x1 m test unit (3-1) placed in the center of Structure 3 encountered two plaster floors located near surface of the structure. Below the floors was a thick midden deposits with a large number of ceramics and chert, which included high frequency of Early Classic period ceramics including Dos Arroyos polychrome plates. A radiocarbon date from organic remains recovered from this deposit dates to cal AD 540-625 (UCIAMS-150915; Ebert et al. 2016).

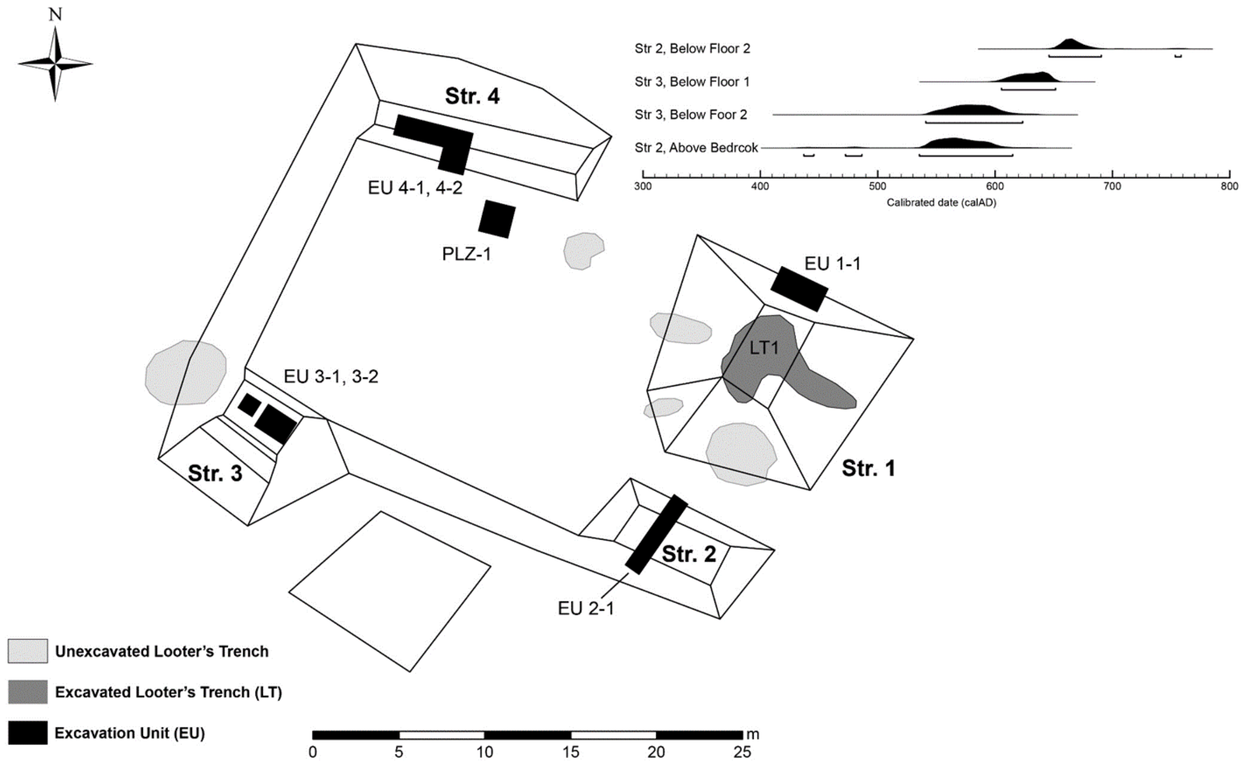

Figure A.25: Map of the Martinez Group showing location of excavations units and calibrated date ranges for radiocarbon samples from Structures 2 and 3.

During the 2015 BVAR field season, excavation units were placed in all four structures at the Martinez Group in order to investigate the establishment and growth of pit (LT1) in the center of the structure. While very artifacts were recovered, excavations indicate that the structure's middle was composed of a cobble fill with no floors present. Unit 1-1 was placed on the north side of Structure 1 where the structure was relatively this domestic group. Excavations at Structure 1 began with the clearing of a large looter's undisturbed by modern looting activity. Excavations focused on clearing humic debris and collapse in order to document the construction phases of the structure. The first documented construction was of the northern wall, which was placed on top of bedrock and contained a cobble fill which contained Spanish Lookout phase ceramics (Belize Red, Mount Maloney Black, and Alexander's Unslipped). Several Preclassic sherds were also present, including two Polvero Black dish rims with basal flanges. The wall was composed of double-thick limestone masonry, which was plastered. The second phase of construction consisted on an outer wall, with at least two terraces present, though it was mostly collapsed. The second wall was capped by a thick (~15 cm) plaster floor that may represent the summit of the structure.

Structure 2 is a low platform located on the south east site of the Martinez Group. A 5x1 m unit, Unit 2-1, was placed bisecting the building north-to-south. The goal of excavations was to collect chronological information regarding the construction of the structure and its relationship to other structures within the Martinez Group (Figure A.26). The first construction at Structure 2 was the placement of a plaster floor (Floor 3) above a fill layer the capped bedrock. A radiocarbon date of organic material from within this fill dates between cal AD 435-615 (UCIAMS-164868), indicating initial construction took place during the Early Classic to Early Late Classic periods. Floor 3 abutted a small stone wall located on the north side of the excavation unit, which may have been used to delineate the extent of the structure. The floor was either broken or poorly preserved in the middle of the unit.

Floor 2 was placed approximately 50 cm above Floor 3, on top of a layer of ballast fill. The ballast fill contained Spanish Lookout Phase ceramics including Cayo Unslipped jars, Belize

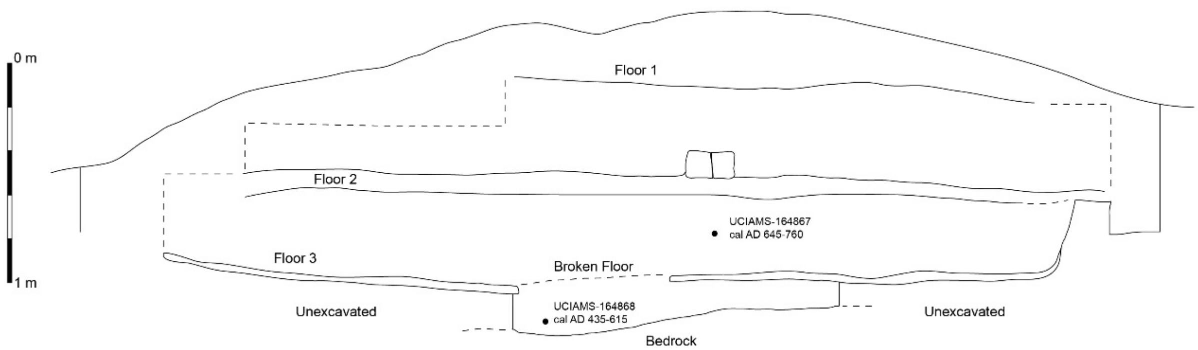

Figure A.26: South profile of Unit 2-1 at Structure 2.

Red plates, and crudely shaped jar supports; chipped stone tools; and obsidian blades. A chert eccentric was also recovered from the fill, and have been interpreted as either representing a dog or perhaps the potent iconographic symbol of the flamed eyebrow (Figure A.27). A radiocarbon date suggests that the fill was placed during the Late Classic period between cal AD 640-760 (UCIAMS-164867). Floor 1 was located approximately 50 cm above Floor 2, and represents the terminal surface of Structure 2. Floor 1 did not extend as far north in the unit as Floor 2, and the presence of several cut limestone blocks in the northern portion of the unit may indicate a series of steps may have composed the north side of terminal architecture at the structure. Several other special finds were recovered from the collapsed architecture above Floor 1, including chert point fragments, a polished hammer stone, and an antler earplug (Figure 28B and 28C). It is unknown whether these artifacts are associated with Structure 2, or were displaced from Structure 1 by looting activity.

The 2015 excavation at the Martinez Group expanded upon Unit 3-1 placed in the center of Structure 3. A 1.5x2 m unit (Unit 3-2) was placed so that it ran parallel to the norther wall of Structure 3 and Unit 3-1. The goal of excavations at Structure 3 was to expose more of the Early

Classic period ceramic deposit contained within the structures, and to gain a better sense of the architecture that composed the low platform.

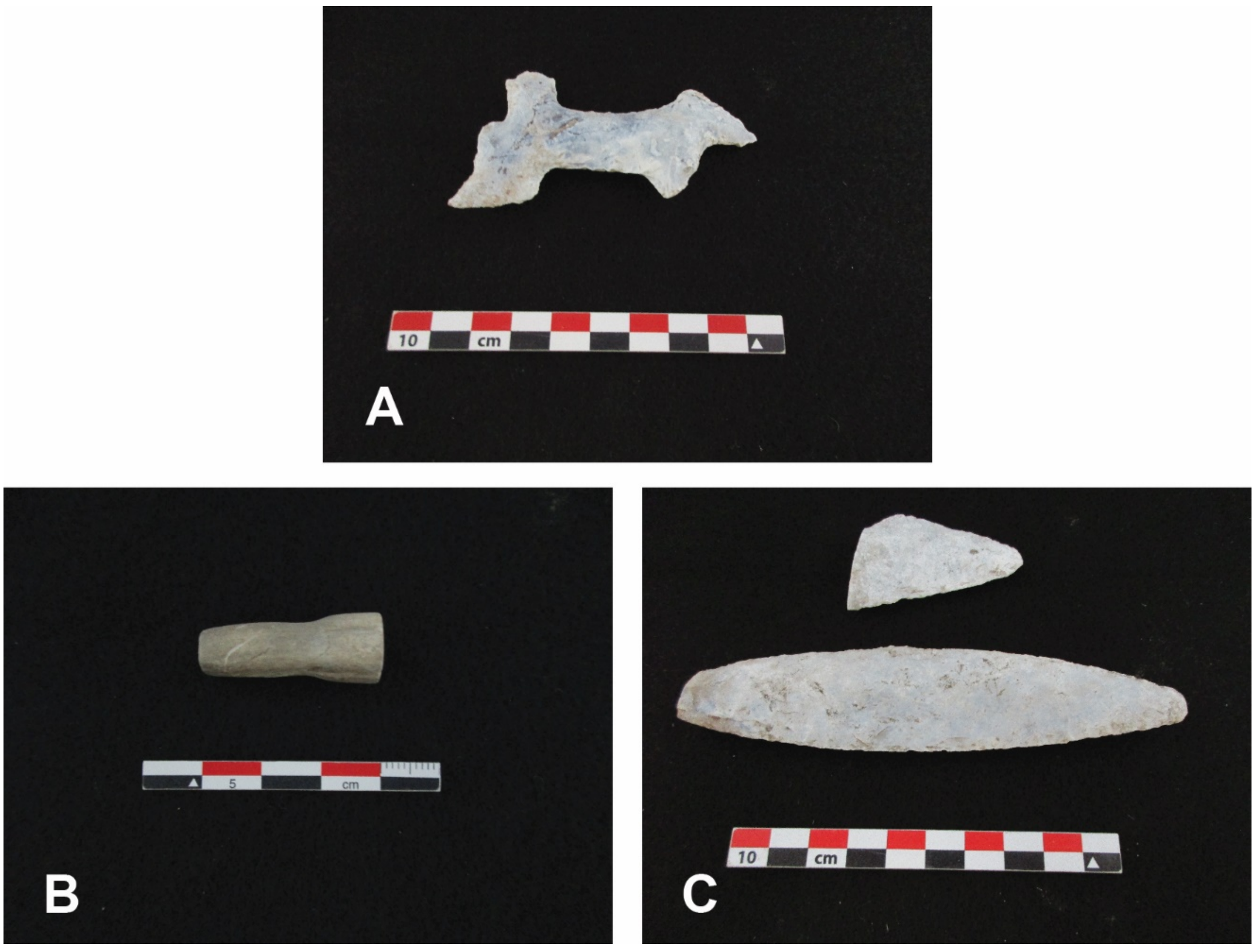

Figure A.27: Special finds from Unit 2-1 including A) chert eccentric, B) antler earplug, and C) chert points.

Excavations encountered two plaster floors (Floors 1 and 2) just below the ground surface. Floor 1 was placed approximately 8 cm above Floor 2. A radiocarbon date from below Floor 1 indicates that the both plaster floors were placed during the Late Classic period between cal AD 605-655 (UCIAMS-164866). These two floors capped the ceramic deposits, which measured approximately 1.5 m in depth and was mixed with ballast to form the shape of the structure. Most of the diagnostic ceramics from the deposit date from the Spanish Lookout (Belize Red and Platon Punctated plates, Garbutt Creek Red bowls, Alexanders Unslipped jar, Mount Maloney Black bowls) through Hermitage ceramic phases (Dos Arroyos Polychrome, Minanha Red, Balanza Black) with some earlier types represented by a few sherds (Sierra Red, Polvero Black).

Excavations were undertaken at Structure 4 to understand the architectural elements present in this low-lying platform at the northwestern side of the Martinez Group. Bedrock was located at a shallow depth beneath the structure, approximately 1m below the ground surface. A single plaster floor (Floor 1) was encountered during excavations, located approximately 50 cm above bedrock. Ceramics from this fill date to the Late Classic Spanish Lookout phase, and include Belize Red plates, Cayo Unslipped jars, and supports for vessels. The terminal architecture of the structure was composed of an alignment of large cut stones that formed the south wall of the structure. The alignment was located at a very shallow depth, approximately 20-40 cm below the ground surface.

Excavations south of the Cahal Pech site core at the Martinez Group suggests that new residential groups were established in the Early Classic (Ebert 2015) indicating continued population growth from the Preclassic into the Early Classic period (Awe and Helmke 2005). The structures are the Martinez Group consist of between two to three construction phases, perhaps indicating the sites rapid growth begging ca. cal AD 450. Compared to other groups at Cahal Pech (e.g., Tzutziiy K'in), however, the Martinez group experienced a relatively short occupational history of about three hundred years. There is little evidence that the group was occupied through the Terminal Classic period, perhaps suggesting that it was abandoned before the collapse of Cahal Pech ca. AD 850 (Awe 2013).

Conclusions

Understanding the development and growth of the ancient Maya community of Cahal Pech from the Preclassic into the Early Classic period is one of several critical research issues addressed by the BVAR Project. Continued excavations within the periphery of the Cahal Pech monumental core are helping BVAR researchers to understand the nature and timing of occupation and cultural change within the settlement at the site. Excavations conducted during the 2015 field season focused on three groups: Tzutziiy K'in, the Zopilote Group, and the Martinez Group. Previous excavations and direct dating indicated that the large residential group Tzutziiy K'in was settled by the Late Preclassic (325–110 cal BC) as a small farming household and grew into a large, elite residential group in the Late and Terminal Classic periods (cal AD 650-900; Ebert et al. 2016). The 2015 excavations at Tzutziiy K'in expanded upon this research, focusing on excavations in Structures 2, 3, 4 to collect additional materials for direct dating. Excavations at Structure 2 also uncovered an altar stone and a burial which provide evidence for the growing importance of ritual during the Late Classic Period. Structure 2 resembles an eastern triadic shine, a type of public architecture typically associate with ritual and religious activity at Belize Valley sites (Awe 2008; Awe et al. In Press; Chase and Chase 1995). In 2012, several bone fragments and two human teeth were recovered from Feature 1 (LT3) at Structure 2, which may have functioned as a cache or secondary burial. Additionally, a possible altar associated with Early Classic period construction phases (Ebert et al. 2016) was exposed in excavation in the center of the structure (Ebert and Dennehy 2013). The presence of ideologically significant artifacts and features indicates the social importance of Structure 2 and may also reflect the socio-political status of the residents of Tzutziiy K'in in the Late Classic Period.

The focus of 2015 excavations at the Zopilote Group was to collect organic samples for direct dating of Preclassic contexts. Extensive excavations by Cheetham and his colleagues (1993, 1994) suggests that the group functioned as an important temple complex as early as the Middle Preclassic period. Preliminary results of radiocarbon dating suggests construction of a series of temple structures built at the group at Structure 1 was first initiated in the Late Preclassic between 355-175 cal BC. However, the 2015 excavation also documented possible Middle Preclassic deposits with Cunil ceramic materials below the temple structures. The Cunil strata may represent the first settlement at the group, which was primarily residential in nature. The Zopilote Group remained an important locus of ritual activity through the Late and Terminal Classic periods. Future research concerning the terminal ceramic deposits from Structure 2 at the group will work to test the hypothesis that the deposit represents activities associated with ancestral worship that took place after the site was abandoned (Awe 2012). Comparison to ethnohistoric documentation of ritual acts of ancestor remembrance performed by the Lacandon Maya may provide a modern correlate with this archaeological interpretation.

Excavations at the Martinez Group conducted in 2015 were focused on understanding the construction of the group starting at the end of the Early Classic Period (Ebert et al. 2016). The group was first documented by BVAR during the 2014 survey (Ebert 2015). The Martinez Group is a relatively small residential group, though it possessed a large eastern shrine building (Structure 1), perhaps associated with the higher status of its residents compared to neighboring groups. Additionally, several special finds found during excavations of Structure 2 indicate the ability of the residents of the Martinez Group to obtain prestige items. Direct dating of deposits from Structures 2 and 3 indicate that the group was occupied into the Late Classic period. There was limited evidence for occupation of the group during the Terminal Classic period, between cal AD 850–900, which may indicate that the political "collapse" of Cahal Pech may have similarly impacted residential settlements around the site (Ebert et al. 2016). Settlement research from the 2015 BVAR field season and Cahal Pech highlights the need for future excavations in groups around the site. Additional AMS radiocarbon dating at Cahal Pech, both in the site core and house groups, will help to establish a more a precise and accurate chronology for the socio-political development and decline of this important Maya center.

Appendix B

OXCAL CODE FOR CAHAL PECH BAYESIAN CHRONOLOGICAL MODELS

Site Core Sequences

```
Plot()
 {
  Sum("SUM CHP Site Core")
  {
   Sequence("Preclassic Plaza B")
   {
    Boundary("Earliest Plaza B - Construction of Plaza B/1st and 2nd");
    R_Date("UCIAMS-169817 - below Floor 18", 2800, 20);
    Boundary("Plaza B/3rd - Floor 18");
    Phase("Below Floor 17")
    {
     R_Date("UCIAMS-172403", 2835, 20);
     R_Date("UCIAMS-169816", 2820, 15);
    };
    Boundary("Plaza B/4th - Floor 17");
    R_Date("UCIAMS-169815 - below Floor 16", 2760, 20);
    Boundary("Plaza B/5th - Floor 16");
    Boundary("Plaza B/6th - Floor 15");
    Boundary("Plaza B/7th - Floor 14");
    R_Date("Plaza B/8th within Feat. 19 - UCIAMS-169814", 2525, 15);
    R_Date("UCIAMS-172404 - below Floor 13", 2545, 20);
    Boundary("Plaza B/9th - Floor 13");
    R_Date("Plaza B/10th - UCIAMS-172405", 2530, 20);
    Boundary("Plaza B/11th Platforms A/B/C");
    R_Date("Plaza B/12th - below Floor 11", 2500, 20);
    Boundary("Floor 10");
    Boundary("Floor 9");
    R_Date("UCIAMS-169813 within fill below Floor 8", 2035, 15);
    Boundary("Latest Preclassic Plaza B");
   };
   Sequence("Str. B4")
   {
    Boundary("Earliest Str. B4");

  R_Date("Beta-77207 - on bedrock", 2930, 50);
    Boundary("Below Floor 13");
    Phase("B4/1st - Fl. 13")
    {
     R_Date("UCIAMS-111162", 2845, 20);
     R_Date("UCIAMS-111158", 2830, 15);
    };
    Boundary("B4/2nd - Fl. 12");
    Phase("B4/3rd - Fl. 11")
    {
     R_Date("Beta-56765*", 2730, 140);
     R_Date("Beta-77204*", 2710, 120);
    };
    Boundary("Transition Fl. 11/10");
    R_Date("Beta-77205 - Fl. 10 A", 2800, 50);
    Boundary("Fl. 10B");
    R_Date("B4/4th - Fl. 10C Burning Event, Beta-40865", 2740, 70);
    Boundary("Transition Fl. 10/9");
    R_Date("B4/5th - Fl. 9, Beta-40864", 2720, 60);
    Boundary("Construction B4-6th");
    R_Date("B4/7th - Fl. 8, UCIAMS-115024", 2735 , 20);
    Boundary("Transition Fl. 8/7");
    Phase("B4/8th - Fl. 7")
    {
     R_Date("UCIAMS-115023", 2585, 15);
     R_Date("Beta-40863*", 2470, 90);
    };
    Boundary("B4/9th - Fl. 6");
    Boundary("B4/10th - Fl. 5");
    Difference("B4/9th - B4-10th", "B4/9th - Fl. 6", "B4/10th - Fl. 5");
    R_Date("B4/11th - Above Fl. 4 - UCIAMS-115021", 2225, 15);
    Boundary("Construction of Fl. 3");
    R_Date("164844", 1315, 15);
    R_Date("151860", 1280, 25);
    R_Date("170055", 1270, 20);
    Boundary("Latest B4");
   };
  };
 };
```

Peripheral Household Group Sequences

```
Plot()
 {
  Sum("SUM Cahal Pech Settlement")
  {
   Sequence("TKG Str. 1")
   {
    Boundary("TK-1/1st - platform const");
    R_Date("TUCIAMS-123530", 1770, 15);
    Boundary("TK-1/2nd - apron building");
    R_Date("UCIAMS-121551", 1595, 15);
    Boundary("TK-1/3rd - platform w/ stairs");
    R_Date("UCIAMS-123531", 1545, 15);
    Boundary("TK-1/4th");
    R_Date("UCIAMS-121549", 1245, 15);
    Boundary("TK-1/5th - superstructure and stair extension");
    R_Date("UCIAMS-121550", 1225, 15);
    Boundary("Latest TK-1");
   };
   Sequence("TKG Structure 2")
   {
    Boundary("Earliest Str. 2");
    Phase("TK-2-3-10/11")
    {
     R_Date("UCIAMS-164871", 1890, 15);
     R_Date("UCIAMS-164869", 1880, 15);
     R_Date("UCIAMS-164870", 1865, 15);
    };
    R_Date("Feature 1 - UCIAMS-121553", 1555, 15);
    Boundary("Plaster Floors 1-3");
    R_Date("UCIAMS-121554", 1365, 15);
    Boundary("Plaster Floor 4");
    Boundary("Const. Apron building");
    R_Date("UCIAMS-123532", 1255, 15);
    Boundary("Outset stairway");
   };
   Sequence("TKG Str. 3")
   {
    Boundary("Earliest TKG Str. 3");
    Sequence(Str. 3 Floors)
    {
     R_Date("UCIAMS-121552", 2150, 20);
     Boundary("Floor 6");
     R_Date("UCIAMS-164872", 1920, 15);
    };
    Boundary("Latest TKG Str. 3");
   };
   Sequence("ZPL Str. 1")
   {
    Boundary("Earliest Str. 1 - below Floor 1a");
    R_Date("UCIAMS-164873", 2175, 15);
    Boundary("ZPL-1 1b - ZPL-1/5th");
    R_Date("UCIAMS-164878", 2085, 20);
    Boundary("ZPL-1/6th");
    Phase("ZPL-1/7th const")
    {
     R_Date("UCIAMS-164874", 2070, 15);
     R_Date("UCIAMS-164875", 2070, 15);
    };
    Boundary("ZPL-1/7th");
    Phase("ZPL-1/8th const")
    {
     R_Date("UCIAMS-164877", 1780, 15);
     R_Date("UCIAMS-164876", 1765, 15);
    };
    Boundary("ZPL-1 Tomb 1 Const");
    R_Date("UCIAMS-169818", 1320, 15);
    Boundary("Latest Classic Period Str. 1");
   };
   Sequence("Martinez Group Str. 2")
   {
    Boundary("Earliest MG Str. 2");
    R_Date("UCIAMS-164868", 1505, 20);
    Boundary("Floor 3");
    R_Date("UCIAMS-164867", 1345, 20);
    Boundary("Floor 1/2 and Latest MG Str. 2");
   };
   Sequence("Martinez Group Str. 3")
   {
    Boundary("Earliest MG Str. 3");
    R_Date("UCIAMS-150915", 1490, 20);
    Boundary("Floor 2");
    R_Date("UCIAMS-164866", 1425, 20);
    Boundary("Floor 1 and Latest MG Str. 3");
   };
   R_Date("Tolok - Beta-77201", 2370, 60);
   R_Date("Cas Pek - Beta-77203", 2230, 50);
   R_Date("Tolok - Beta-77199", 2200, 100);
   R_Date("Burns Ave - UCIAMS-169809", 2020, 15);
   R_Date("Zubin - X27038", 1336, 46);
  };
 };
```

Appendix C

RADIOCARBON DATES AND CHRONOLOGICAL MODELS FROM THE SOUTHERN MAYA LOWLANDS

A total of 1196 radiocarbon dates were collected from the published literature from five core regions in the southern Maya lowlands (including 62 dates from Cahal Pech discussed in Chapter 2): (1) the Belize Valley and Vaca Plateau, (2) Northern Belize, (3) the Pasión region, (3) the Petén and Southern Belize, and (5) Honduras. While this is not a completely exhaustive dataset, it represents the largest compilation of published Preclassic Period radiocarbon dates.

Table C.1 shows radiocarbon dates organized by region and by site. Associated information was recorded for each date, contextual information (specific stratigraphic and spatial relationships reported), type of material dated (e.g., charcoal, human remains, faunal remains), lab number, conventional ^{14}C date and error ranges, 2-σ calibrated distributions, whether the sample was dated via Accelerated Mass Spectrometer (AMS) or conventional ^{14}C dating, and reference publications.

Dates were subjected to chronometric hygiene criterial established by Hoggarth and colleagues (2016:31) to eliminate questionable dates and constrain modeled distributions. These criteria include:

1. Dated material should ideally be from a short-lived species (e.g., seeds, twigs from plants), or bone when available.
2. The association with cultural remains cannot be ambiguous and the date should be supported by additional archeological evidence. A lack of contextual information or not reporting uncalibrated conventional dates yields ambiguous associations.

3. Dates from bone (human or faunal) and/or shell require additional pretreatment, purification, and assessment of reservoir effects or other environmental corrections. When not corrected for diagenesis or reservoir effects, calibrated date ranges can potentially be erroneous.
4. Only radiocarbon dates with measurement precisions below ±100 ^{14}C years should be considered for modeling, unless they can be constrained through modeling, since larger errors contribute to "blurred probability distributions" and impede clear chronological distinctions (see also Kennett et al. 2008).
5. Dates derived from experimental techniques that have yielded questionable results in the region should be rejected until proven more reliable.

Dates that passed these criteria were retained for our analyses. Table C.1 includes a description of reasons for rejection where applicable.

Dates derived from contexts in stratigraphic association were modeled using the *Sequence* and/or *Phase* commands in OxCal v.4.2 (Bronk Ramsey 2009) using the IntCal13 Northern Hemisphere atmospheric curve (Reimer et al. 2013). In cases with dates from stratified contexts that did not pass the chronometric hygiene standards, we assess the statistical fit between the date and associated samples before eliminated them from modeled sequences. Multiple dates from the same context were modeled using the *Combine* command, since the dates are assumed to be contemporaneous unless otherwise noted. Dates that were found to be outliers in the models were removed with the *Outlier* command (highlighted in red in Table C1). Some dates fall after the Preclassic Period (conventional ^{14}C year younger than 1700 BP), and therefore were not considered in our modeled sequences unless they could be tied to an earlier

Preclassic Period sequence for a given site. We list Classic through Postclassic Period dates falling after 1700 BP, however, for use in future studies. Only dates derived from site core, settlement, and rock shelter contexts (i.e., habitation contexts) were used to assess the development of Preclassic lowland society, though we list samples from Cave and other ritual contexts if they were encountered (e.g., Actun Tunichil Muknal, Helmke and Awe 2007; Actun Uayazba Kab, Galvan 2016; Wrobel et a. 2017; Chechem Ha Cave, Moyes 2005, Moyes et al. 2009; Kayuko Naj Tunich, Prufer et al. 2011). Below is a description of the results of Bayesian modeling and the summed probability distributions by region and by site.

Belize Valley and Vaca Plateau

A total of 209 published ^{14}C dates were documented for 17 sites in the Belize Valley and Vaca Plateau, located in the west-central region of modern day Belize. In this study we added an additional 35 new dates from the site core and settlement at Cahal Pech (total *n*=62). When applying chronometric hygiene to the Belize Valley and Vaca Plateau radiocarbon dataset, 18 dates were deemed unacceptable mostly because of large measurement error. Sites with only Classic and Postclassic dates not included in the analyses of the present study include Actuncan (*n*=1; LeCount et al. 2002: Table 3), Buenavista (*n*=3; Helmke et al. 2008:45; Peuramaki-Brown 2012:683), Caledonia (*n*=1; Awe 1985:430), Chaa Creek (*n*=2; LeCount et al. 2002: Table 3), and Las Ruinas de Arenal (*n*=2; Taschek and Ball 1999). Current research by Hoggarth and colleagues (n.d.) is focusing on modeling radiocarbon sequences from these sites, and others across the Belize Valley, to constrain the chronology for the Late and Terminal Classic period in the region. The remaining 183 dates retained after chronometric hygiene were modeled in in OxCal within sequences and summed probability distributions for 10 sites.

Actun Halal

A series of five radiocarbon dates have been analyzed for Actun Halal rock shelter (Lohse 2008: Table 1). These are the earliest dates for the Belize Valley, and represent Archaic Period and Early Preclassic contexts. All dates have acceptable error ranges. Because there was no additional contextual information provided beyond depth below datum levels, the samples could not be modeled within a sequence. Rather, the unmodeled posterior distributions for the site were placed within a summed probability distribution. This model yielded a calibrated distribution for the dates spanning between 4340-395 cal BC.

Baking Pot

Twelve AMS ^{14}C dates have been published for the site of Baking Pot (Hoggarth et al. 2014: Table 1). All dates are derived from human remains from the monumental site center (n=2) and surrounding residential settlement (n=10). Three burials date to the Late Preclassic Period (UCIAMS-132227, UCIAMS-132231, and UCIAMS-132235), with the rest of the burials recovered from Classic and Postclassic Period contexts. All dates were accepted for our analyses based on the chronometric hygiene criteria. Four dates derived from house mound M-96 in the settlement were placed in a *Sequence* based on a previous chronological model developed by Hoggarth and colleagues (2014). All unmodeled and modeled ^{14}C dates from Baking Pot span the interval between 405 cal BC to cal AD 1420.

Barton Ramie

Four radiocarbon dates come from Preclassic Period contexts at the site of Barton Ramie. Three dates were analyzed during the initial excavations in 1952-53 by Willey and colleagues

(1965) and come from house mound contexts at the site. These dates were considered unacceptable by the Willey and colleagues because they were found to be too early for contexts from which they were recovered. Two radiocarbon samples were later combined to give a ^{14}C date of 3200 ± 110, falling during the Early Preclassic period (Q-1575; Hammond 1976: 62). All dates were rejected from the present study because they have large measurement error ranges (greater than ± 100 ^{14}C yrs).

Blackman Eddy

A total of 17 radiocarbon dates have been reported for the site of Blackman Eddy (Brown 2008: Table 1; Brown and Garber 2005: Table 4.2; Garber et al. 2002: Table 2). The dates are derived from Preclassic contexts associated with Structure B1, the largest monumental building in the site core. All dates were deemed acceptable based on chronometric hygiene criteria and were placed in a *Sequence* and modeled in *Phases* based on stratigraphic descriptions of construction events described by Garber et al. (2004). *Boundaries* representing undated events (e.g., placement of floor) were also placed within the model to constrain date ranges for each construction phase. Three dates were identified as model outliers (Beta-103959, Beta-122281, Beta-162572) due to poor agreements within the model (less than A=60%), and were removed from the sequence using the *Outlier* command in OxCal. Two dates associated with a possible feasting event documented archaeologically on top of the B1-5th platform were combined using the *Combine* command. The modeled dates from Structure B1 span the interval between 990 cal BC to 120 cal BC.

Caracol

Though extensive archaeological research has been carried out at the site of Caracol for over 30 years, few radiocarbon dates have been reported. A total of 13 published dates derive from contexts in the monumental site core from Plazas A and B (Chase and Chase 1987: Table 1; Chase and Chase 2006: Figure 6). Seven dates are available for Structure A6, which is located on the eastern side of Plaza A and was associated with a Late Preclassic E-Group architectural assemblage. One date (Beta-18059) was rejected because of a large measurement error. A second date (Beta-43519), derived from a fragment of a burned lintel sealed beneath a floor, was also rejected because it appears to be too early for the context, and may represent old wood.

The remaining five dates for Structure A6 were modeled within a *Sequence* based on stratigraphic position and associated cultural materials (after Chase and Chase 2006: Figure 6). Two lintel dates (Beta-42004 and Beta-42005) associated with the final Preclassic Period construction at Structure A6-1st were modeled using the *Combine* command in OxCal, since we expect that their placement would be contemporaneous. This produced a modeled distribution between 190 cal BC to cal AD 130 for the placement of the lintels. While the model generated for Structure A6 meets the threshold of acceptance (A_{model} = 109.2%; Bronk Ramsey 1995), date reversals at the beginning of the sequence results in poor agreements for some samples. Because of this, we rejected sample Beta-61209 from our analyses as an outlier, and removed it using the *Outlier* command in OxCal. We suggest that additional stratigraphic and chronometric data is needed to clarify the timing of construction of this Preclassic building.

Two other structures from Plaza B, Structures B6 (Beta-18066) and B19 (Beta-18055), also have Preclassic Period radiocarbon dates, but these were found to be unacceptable after chronometric hygiene based on their large measurement error ranges. The remaining dates reported for Caracol come from Late Classic Period contexts and were modeled within a summed probability distribution for the site, which ranges from 350 cal BC to cal AD 1015.

Chan

A total 33 radiocarbon dates have been analyzed and reported for the site of Chan. All are acceptable based on chronometric hygiene standards, with error ranges of ± 40 yr (Novotny 2015; Kosakowsky 2012). All samples were collected from stratified contexts within the main monumental architectural group at the site. Twenty-four of the samples are charcoal and nine were from human remains. A total of 14 dates were associated with Preclassic materials, with the remaining dates from Early and Late Classic period contexts. *Sequences* were created for the entire Preclassic to Classic period occupation of each structure that had two or more dates (Structures 5, 6, 7, and 8) and modeled based on stratigraphy (Kestle 2004; Kosakowsky and Robin 2010: Figure 1; Novotny and Kosakowsky 2009; Figure 1; Meierhoff et al. 2004) and associated ceramic data described by Kosakowsky (2012). *Boundaries* representing the "earliest" and "latest" activity for each structure were placed on either end of the sequences to constrain date ranges. One date for Structure 11 (Beta-256798) was not modeled within a sequence, but placed within the summed probability distribution for the site along with the modeled sequences for other structures at Chan.

Structure 5 has the longest date sequence at Chan, spanning from 385 cal BC to cal AD 770. One sample from Structure 5 (Beta-256811) produced a poor agreement (A=55.8%) as the date is likely too late for the context, and thus was removed from model using the *Outlier* command in OxCal. Two dates for Structure 6 (Beta-256803 and Beta-256804) span the Preclassic through the Late Classic (385 cal BC to cal AD 975). Six dates that date the construction of Structure 7 (Beta-256801, Beta-256802, Beta-256805, Beta-278920, Beta-278921, Beta-278922) span from 805 cal BC to cal AD 550. The span of two Classic period dates modeled for Structure 8 is cal AD 415-670.

Several additional ^{14}C dates on human remains have been reported for the contexts in Chan's Northeast Group. Dates are derived from three burials with multiple individuals, often times with the tomb being reentered to place additional internments (Novotny 2015). These dates are primarily Late Classic. All unmodeled and modeled ^{14}C dates from Chan span the interval between 805 cal BC to cal AD 975.

Lower Barton Creek

Six AMS ^{14}C dates have analyzed from contexts throughout the monumental site core at Lower Barton Creek, a minor center south of the site of Lower Dover in the Belize Valley (Kollias 2016). Two dates (UCIAMS-167256 and UCIAMS-167259) produced post-bomb radiocarbon, and are therefore not acceptable for chronological modeling. The remaining four dates all fall within the Preclassic Period. Three dates were modeled within a *Sequence* for Plaza A. Two dates were placed in *Phase* for Floors 1&2 (UCIAMS-167254 and UCIAMS-167257), with an earlier date for Floor 3 (UCIAMS-167258) at the beginning of the model. A date from the matrix below Floor 3 in Plaza C (UCIAMS-167255) was included in summed probability distribution for the site, but not modeled within a sequence. The modeled and unmodeled posterior distributions of ^{14}C dates from Lower Barton Creek suggest a period of Middle and Late Preclassic construction activity between 765-110 cal BC.

Minanha

A total of 36 radiocarbon dates have been published for the Vaca Plateau site of Minanha. Of these dates, 32 were not included in our modeling because no conventional ages were reported (Stronge 2012: Table 2.1). The radiometric ages are reported for the remaining four dates, all with acceptable error ranges (Lamoureux St-Hilaire et al. 2016: Table 1). Only one sample (Beta-254850) is associated with Preclassic contexts at the residential Group MRS4. Although there is a later Classic Period date for this architectural group (Beta-254848), we only considered the Preclassic date in our analyses as stratigraphic relationship for these dates are not clear.

Pacbitun

A total of 22 radiocarbon dates have been reported by Healy (1990, 1999) for Pacbitun. Five dates (Beta-25377, Beta-25372, Beta-25378, TO-612, and Beta-19859) are not acceptable based on chronometric hygiene criteria (errors equal or exceed ±100 yrs). Additionally, the majority of dates (18 reported by Healy 1990) are described only according to ceramic phase and do not have associated contextual information. They are excluded from this study, although we hope that the contextual information may be integrated into future work once this information is available. Four dates (Beta-93773, Beta-93775, Beta-93776, Beta-93778; Healy 1999) from Structure 8 in Plaza B of the site's monumental core are associated with individual construction events and modeled in a *Sequence* based on stratigraphic position. The Plaza B sequence spans the interval from 900-405 cal BC during the Middle Preclassic. The overall modeled summed probability spans from cal 915 BC to cal AD 1025.

Xunantunich – Group E, Site Core, and San Lorenzo Settlement

Twenty-one dates have been reported for the major center of Xunantunich (Brown et al. 2011: 212; LeCount et al. 2002: Table 3). All dates meet the chronometric hygiene criteria. Two dates, both acceptable error range, come from Early Preclassic contexts within Group E at Xunantunich, location south of the Classic Period monumental center of the site (Brown et al. 2011: 212). We consider these dates for the present study. Because the stratigraphic relationship between the two samples it is unclear, these two dates placed within a summed probability distribution without being modeled in a sequence.

The remaining samples from Xunantunich are derived from architectural profiles of the Castillo (Structure A-6) in the main plaza, and other Classic Period contexts in the site center. Eight Classic Period radiocarbon dates are also reported the associated minor center of San Lorenzo (Yaeger 2000; LeCount et al. 2002: Table 3). While we do not consider these samples for the present study, as they do not directly articulate with the Preclassic Group E contexts, research by Hoggarth and colleagues (n.d.) incorporates radiocarbon data from Xunantunich and San Lorenzo.

Northern Belize

A total of 242 radiocarbon dates from 22 sites in Northern Belize were collected from published sources. Of these dates, 43 were rejected based on the chronometric hygiene criteria. An additional 10 dates were also rejected because the original investigators found that they were either too early or too late for their contexts. Nine sites have dates that fall after the Preclassic and were not considered in this study. These include Altun Ha (*n*=1; Stuckenrath et al. 1966:371), Aventura (*n*=4; Sidrys 1976), Calendonia (*n*=1; Sidrys 1976); Laguna de On (*n*=10; Stafford 1998: Table 1), Nohmul (*n*=1; Hurst and Lawn 1984), Patchachacan (*n*=1; Sidrys

1976), San Jose (*n*=1; Stipp and Eldridge 1975), Santa Rita Corozal (*n*=17; Chase and Chase 1988: Table 2; Hurst and Lawn 1984), and Tiger Bay Cave (*n*=1; Sidrys and Berger 1979).

The remaining dataset for Northern Belize sites was composed of 205 dates from 11 sites that were modeled in sequences and summed probability distributions in OxCal.

Caye Coco

Rosenswig and colleagues (2014: Table 1; Rosenswig and Masson 2002) have published seven dates from the site of Caye Coco, a habitation site located on Progresso Lagoon in northern Belize. Four dates are associated with Terminal Classic and Postclassic occupation at the site (Rosenswig and Masson 2002), and are not considered for this study. Three dates come from Archaic and Middle Preclassic contexts containing patinated stone tools and flakes without associated ceramics (Rosenswig et al. 2014). Two dates from Pit Feature 2 (UCIAMS-17908 and UCIAMS-17909) are associated stratigraphically with Level E, representing aceramic occupation at the site, and were combined within a *Phase* spanning between 6370-4615 cal BC. The calibrated 2σ range of 895-800 cal BC for a third ^{14}C date (UCIAMS-17911) places it within the earliest ceramic phase in northern Belize.

Cerros

Cerros is a large Late Preclassic site situated on Corozal Bay in northern Belize. The site experienced rapid expansion at the beginning of the Late Preclassic Period, but declined abruptly after AD 150. A program of direct dating began in the 1970s and continued through the early

2000s in order to understand the timing and tempo of these changes (Cliff 1982; Freidel and Scarborough 1982; Scarborough 1991; Walker 2005). A total of 13 dates have been recorded for the site. Two of these dates (SMU-774 and SMU-881) have large error ranges and were rejected by the original investigators working at the site (Walker 2005). A third date (Beta-188403) was also rejected as the sample was too late for the context and dated to the historic period.

A total of 9 dates were modeled for Structures 2A, 4AB, and 5E at the site according to the stratigraphic information provided by Walker (2005:18). *Boundaries* representing the "earliest" and "latest" activity at the site were placed on either end of the sequence to constrain date range. *Boundaries* representing undated events (e.g., placement of floor) were also placed within the model. Using the prior distributions of unmodeled dates and posteriors of modeled dates from Cerros, the summed probability distribution spans the period between 410 cal BC to cal AD 230.

Chan Chen

Three radiocarbon dates have been published for the site of Chan Chen (Sidrys 1976). All dates have acceptable error range, but were not modeled because they come from separate structures. Two (UCLA-1921B and UCLA-1921D) have calibrated date ranges falling during the Late Preclassic Period, and were placed within the summed probability distribution for the Northern Belize region.

Colha

A total of 21 radiocarbon dates have been reported from Archaic and Preclassic period contexts from the site of Colha. Five dates (Beta-8698, TX-7459, TX-7460, TX-8106, TX-8020) were rejected after chronometric hygiene because their error ranges were too large. Four dates (TX-8295, CAMS-8397, CAMS-8398, CAMS-8398) were modeled in a *Sequence* for Zone C based on reported stratigraphic position (cm below surface; Iceland 1997: Table 2.2). The remaining dates for the site were not modeled within the sequence as stratigraphic relationships could not be established. The summed probability of the prior distributions of unmodeled dates and posteriors of modeled dates for Colha spans the period between 1390 to 200 cal BC.

Cuello

The site of Cuello has been a focus of Preclassic Period radiocarbon studies in the Maya lowlands since the 1970s (Hammond et al. 1976, 1977). These initial studies were based on 18 acceptable charcoal dates that indicated the site was occupied between ~2000-200 cal BC, with the earliest Swasey ceramic phase component of the site spanning between 2000-1000 cal BC during the Early Preclassic. These early radiocarbon dates were thought at that time to represent the earliest ceramics in the Maya lowlands. Several radiocarbon samples (UCLA-1985bc, UCLA-1985d, UCLA-1985f, UCLA-2012b, UCLA-2012c, UCLA-2012g) were found unacceptable by the investigators during initial processing and were not included in the first site chronology. Subsequent charcoal dating work based on materials recovered from the 1978-80 excavations at Cuello has been used to develop a shorter chronology for the site, with the Swasey phase spanning later in the Middle Preclassic between 800-400 cal BC (Hammond et al. 2009:56). The disparity between the two chronologies for the site was resolved through the dating of purified bone collagen from burials, allowing investigators to assess the levels of contamination, and therefore reliability, for each sample (Housley et al. 1991; Law et al. 1991). The revised "short" chronology for Cuello has now been adopted by researchers, and excludes the original 1975-1976 dates. The revised chronology indicates the earliest Swasey phase inhabitants settled at Cuello around 1200 cal BC, concurrent with settlement elsewhere in the southern Maya lowlands.

In total, 84 dates have been reported for Cuello from the main trench excavation and other discrete contexts within the site core (Hammond et al. 2009: Table 3.1; Law et al. 1991: Table 4; Hammond et al. 1991: Table 2). After chronometric hygiene considerations, which removed several dates with large error ranges (AA-458, Q-1901, Q-1903, Q-1904, Q-1916, Q-1918; OxA-1808; OxA-1809), we modeled the post-1976 dates (*n*=51) reported by Hammond and colleagues (2009: Table 3.1) in OxCal for the main trench according to the modified "short" chronology. Dates were modeled within a *Sequence*, and placed in phases based on master matrix of the main trench excavations conducted in 1978-1980 (Hammond et al. 2009: Figure 3.1). Dates from Burial 62 (Phase IA) and Burial 10 (Phase V) were combined as they were sampled from the same individuals. Both of these combinations showed good agreement (A_{model} = 95.4% [OxA-1649/2103], 95.4% [OxA-1653/1654/1655]). We excluded on Postclassic Period date from bone collagen (OxA-2018) from the model because it could not be tied to the rest of the sequence.

The initial modeling, which included all dates that passed the chronometric hygiene criteria, resulted in a low agreement index (A_{model}=1%) suggesting that were several outliers within this Sequence. Generally, if the model agreement index lower than 60%, this suggests the possibility of an outlier date (Bronk Ramsey 1995). A total of 14 dates were identified as outliers, highlighted in red, since they had low agreement indices. A new modeled Sequence was then created after removing the outlier dates, resulting in an acceptable agreement index of

89.6%. The modeled posterior distributions for this updated Main Trench Sequence span from the end of the Early Preclassic Period (915 cal BC) through the Late Preclassic (220 cal BC).

Hats Kaab

Three Preclassic Period radiocarbon dates have been reported for the site of Hats Kaab (Runggaldier et al. 2012:92), all of which are acceptable based on the chronometric hygiene criteria. Because the dates are derived from three distinct contexts that could not be tied together stratigraphically, the unmodeled were placed within a summed probability distribution spanning the Late Preclassic from 385 cal BC to cal AD 130.

Ka'Kabish

Seven radiocarbon dates have been published for the small site of Ka'Kabish, all of which span the Middle Preclassic Period (Haines et al. 2014: Table 1; McLellan and Haines 2013: Table 1). All dates were deemed acceptable by the criteria of chronometric hygiene. Six dates were recovered from the lowermost strata in Operation 8 in the plaza of Group D of the monumental core. These dates are associated with a cache of 25 vessels that may represent the remains of Middle Preclassic feasting activities (Haines et al. 2014:341). The Operation 8 dates were *combined* within a *Sequence* in OxCal since they all derived from the same context. This serves to constrain the date ranges of the feasting event between 740-410 cal BC. One date from within the major temple Structure D-9 also recorded Middle Preclassic construction (830-430 cal BC; AA-92052). This date was left unmodeled within the summed probability distribution for the site.

K'axob

A total of 25 AMS ^{14}C dates from stratified contexts in the main plaza anchor the chronology for medium-sized site of K'axob (McAnany and López Varela 1999: Table 3). All dates were accepted for modeling based on the chronometric hygiene criteria, though the original investigators identified several unacceptable dates based on their context. The dates are primarily derived from Preclassic Period contexts excavated from Operation I, located on the east size of the large pyramidal Structure 18. We modeled 16 dates within a *Sequence* for Operation I according to construction *phases* described by McAnany and López Varela (1999: Table 2), with *Boundaries* placed in-between to constrain the posterior distributions of the dates. Several charcoal samples had paired freshwater shell dates (AA-14444, AA- AA-14449, AA-14450, and AA-114455). We do not include the shell dates in the Operation I *Sequence* since it is unclear how a possible reservoir effect may impact their accuracy. The investigators working at K'axob identified two samples (AA-14446 and AA-14442) that they believed were too old for the contexts which they were derived (Construction Phase VII). We retained theses dates, however, as they showed good agreement in our modeled *Sequence* (98.4% and 101.6% respectively). One sample (AA-14451) was removed from the model using the *Outlier* command in OxCal because of poor agreement (7.5%), suggesting that the date is too old for its context.

Five additional dates are reported from other excavations from throughout the K'axob site core at Operations VIII, X, XI, XII. Three samples (AA-14459, AA-14460, and AA-14456) are reported with unacceptable calibrated ranges for their contexts. The remaining acceptable samples were placed within a summed probability distribution along with the Operation I sequence. The earliest dates for K'axob are derived from a deeply buried paleosol context just above bedrock, representing the earliest cultural activity during the Middle Preclassic (750-455 cal BC) at K'axob. The latest date falls at the end of the Late Preclassic during the Nohalkax ceramic phase (350 cal BC-cal AD 60).

Ladyville

There are two ^{14}C dates reported for the BAAR site 191 outside of the modern town of Ladyville near the present day coast of northern Belize (Kelly 1993). The site is most notable for the presence of Archaic lanceolate points that were encountered during surface collection. While both dates are associated with a hearth located at the site, Tx-7549 had large measurement error and was rejected based on chronometric hygiene criteria. The second date, Tx-6794, places site activity between 2145-1770 cal BC.

Lamanai

The northern Belize site of Lamanai, located along the New River Lagoon, has one of the longest spans of occupation in the southern Maya lowlands from the Early Preclassic through the modern 21st century. Recent AMS ^{14}C dating and Bayesian modeling for the monument site center was undertaken by Hanna and colleagues (2016) in order to refine an early chronology developed older in the late 1970s. A total of 34 dates are reported for the site. We adopt this new chronology and the Bayesian models for our analyses. Fifteen samples come from excavations conducted in Structures N10-2, N10-7, and N10-9, associated with the site's Jaguar Temple, and produced a series of uncorrected radiometric dates that spanned the Classic and Postclassic periods. During the 2002-2003 field seasons, 17 wood charcoal samples were selected for direct dating from structures N10-77 and N10-12 located in Plaza N10 at the site. Two samples from Structure N10-2 (GX-4665 and GX-4659) date to the end of the Late Preclassic Period, but these samples have large measurement errors and were rejected based on our chronometric hygiene criteria. The remainder of the dates reported for Lamanai span the period between cal AD 585-1395, and because they are not tied stratigraphically to earlier sequences, are not included in our analyses.

San Estevan

Four AMS ^{14}C dates have been reported for the site of San Estevan (Rosenswig and Kennett 2008). Two dates (UCIAMS-17900 and UCIAMS-17901) produced post-bomb radiocarbon, and are therefore rejected for modeling. The remaining two dates (UCIAMS-17902 and UCIAMS-17902) are derived from Early Preclassic Period contexts. The prior distributions of these unmodeled dates was used for the summed probability distribution for the site, which spans the period between 2565 cal BC to 15 cal BC.

Pasión Region

We recorded a total of 189 published dates from five sites in the Pasión region of Guatemala. Twelve dates had measurement error greater than ± 100 ^{14}C yr and were rejected based on our chronometric hygiene criteria. Our chronological models for this region of the lowlands are based primarily on those developed by Inomata et al. (2017; see also Inomata et al. 2013, 2105) for the sites Caobal, Ceibal, and Punta de Chimino. Bayesian radiocarbon models were developed for these sites by combining ceramic phase data with stratigraphic sequences, and calendrical dates for the Classic Period. The six dates from of Augateca were not included in this study because they fall after 1700 BP.

Altar de Sacrificios

Contexts from the site of Altar de Sacrificios were among the first to be analyzed using radiocarbon dating in the southern Maya lowlands (Smith 1972). A total of 12 radiocarbon dates have been reported for the site of Altar de Sacrificios, all but one of which (GX-166) are derived from contexts in the monumental site core. Radiometric dating techniques resulted in large error ranges for 11 of the dates, leading us to reject them based on our chronometric hygiene criteria. One Preclassic date (GX-208) was deemed acceptable and in included in this present study and the overall summed distribution for the Pasión region.

Caobal

Munson had previously modeled radiocarbon dates from Coabal (*n*=9), a peripheral settlement associated with the large site of Ceibal (see below) to understand the construction of several structures at that small site from the Preclassic through Terminal Classic (Munson 2012). The Preclassic dates from Caobal were subsequently incorporated into the larger Bayesian model in OxCal for Ceibal and the Pasión region by Inomata and colleagues (2017).

Ceibal

The large Pasión site of Ceibal possess one of the best dated Preclassic Period sequences from the southern Maya lowlands. A total of 151 Preclassic radiometric and AMS ^{14}C dates have been reported for the site. An additional nine dates from the smaller associated settlement of Caobal are also included in the dataset for this site (Berger et al. 1976; Inomata et al. 2013, 2014, 2017; Munson 2012). For this study, we used the modeled *Sequence* spanning from the Preclassic through Terminal Classic periods developed by Inomata and colleagues for Ceibal

(Inomata et al. 2017, updated from previous chronological sequences presented by Inomata et al. 2013, 2015). The dates for Preclassic contexts at Ceibal were modeled within a Bayesian framework that incorporated data on ceramic phases and stratigraphic relations to constrain the probability distributions of calibrated dates. A second goal of Bayesian modeling was to more precisely estimate the start and end of associated ceramic phases. Outlier dates with a less than 60% agreement index were removed from the model using the *Outlier* command in OxCal (Inomata et al. 2013, 2015, 2017). The samples from both sites were derived mainly from primary deposits (e.g., on-floor deposits, shallow middens, burials, and caches) in order to eliminate problematic dates (e.g., contaminated samples, old wood) often associated with stratigraphic mixing cause by repeated renovation at ancient Maya sites. A smaller number of samples were derived from construction fills and other secondary contexts when deemed necessary. A total of 19 dates were considered unacceptable by the original investigators based on high degrees of uncertainty (large error range) or measurement errors, and were not included in the model. All other reported dates are acceptable based on our chromomeric hygiene criteria.

Punta de Chimino

A total of 11 radiocarbon dates from the site center at Punta de Chimino have been obtained from charcoal and human bone for the site of Punta de Chimino (Bachand 2006: Table 20; Inomata et al. 2017), all of which were acceptable based on our chronometric hygiene criteria. Two dates (AA-67903 and AA-60976) were rejected, however, as the investigator (Bachand 2006) suggests that they are old wood dates. Our Bayesian model for this site is also based on the model created by Inomata et al. (2017). The modeled and unmodeled posterior distributions of radiocarbon dates from Punta de Chimino suggest occupation at the site spanning between 770 cal BC to cal AD 800, with heightened activity at the beginning of the Late Classic Period.

Petén and Southern Belize

A total of 340 radiocarbon dates were recorded from 29 sites in the Petén region of Guatemala and from Southern Belize. We combined these regions based on archaeological and epigraphic data that suggests polities in the southwestern portion of Belize were politically and economically linked to the Petén, and especially the site of Tikal, during the Preclassic through Classic Periods (Leventhal 1992:152; Bill and Braswell 2005; Prufer et al. 2011; Wanyerka 2009). We also include the site of Palenque, located in the modern Mexican state of Chiapas, in this data set due to its relative geographic proximity to the Petén compared to other parts of the lowlands. There is also a dearth of direct radiocarbon dates from other Chiapas sites, and placing Palenque within the Petén dataset helps to better contextualize the site's dates.

After chronometric hygiene, we rejected seven dates from this dataset based on large measurement error. An additional 24 dates from sites of Tikal and Uxbenká were also rejected as no conventional ^{14}C was reported. Sites with Classic and Postclassic period dates from the Petén that were not modeled as part of this study include Las Quebradas (*n*=1; Hurst and Lawn 1984), Palenque (*n*=16; Couoh 2015; Nieto Calleja and Schiavon Signoret 1990; Stuckenrath 1963), Kinal (*n*=1; Stipp and Eldridge 1975), Topoxte, (*n*=3; Wurster and Hermes 2000); San Felipe (*n*=3; Stuiver 1969), Zacpetén (*n*=7; Pugh and Rice 2009). Several Classic Period dates reported from Southern Belize, and not included in this study, come from the sites of Kaq'ru' Ha' (*n*=4; Novotny 2016), Kayuko Naj Tunich cave (*n*=9; Prufer et al. 2001), several cave and surface sites in the Maya Mountains (*n*=21; Prufer 2002), and underwater sites in Port Honduras (*n*=8;

McKillop 2002). The remaining 182 dates from seven sites were placed in stratigraphic models and summed probability distributions in OxCal.

Buenavista-Nuevo San José

Four radiocarbon dates were recently published for the small center of Buenavista-Nuevo San Jose, located in the southern periphery of major site of Motul de San José on a high hill above Lake Petén Itza. Excavations at the largest structure at the site, Structure 4, revealed a stratified sequence dating from the Middle Preclassic through the Late Classic Periods (Castellanos and Foias 2017). Radiocarbon dating focused on understanding the earliest evidence of occupation at the structure. All four dates meet the chronometric hygiene criteria. The dates are associated with the first three construction phases of Structure 4, and were modeled in a within a *Sequence* based on associated architectural construction phases (Castellanos and Foias 2017: Fig. 3). *Boundaries* were placed at the end and beginning of the modeled sequence and between construction phases to constrain the modeled posterior radiocarbon distributions. The sequence for the first three construction phases spans between 795 and 410 cal BC during the Middle Preclassic.

Cenote

One date from the Petén site of Cenote (P-3062) has been reported from excavations conducted by Orrego and Chase in the Petén (Hurst and Lawn 1984). The date from the site has a calibrated date range that falls during Late Preclassic between 20 cal BC - cal AD 215.

El Perú-Waka'

Eight radiocarbon samples have been dated from Structure O14-04 at the Mirador Group in the monument site core at El Perú-Waka' (Rich 2008: Table 1). One date (Beta-239741) was rejected since the error exceeded ±100 years, in addition to the date being unreasonably old considering the context. Rich (2008) suggests that this sample was likely contaminated during the collection process. Two additional charcoal dates (Beta-239736 and Beta-239737) from the structure were considered too old for their context by Rich (2008) and were also rejected. The remaining five dates were deemed acceptable based on chronometric hygiene criteria, and were modeled within a *Sequence* according to the stratigraphic information described by Rich (2008) for Structure O14-04. The model constrains the dates, with modeled posteriors distributed between cal AD 125-860.

Holmul Region

The Holmul region is located in the in northeastern Petén, Guatemala, and encompasses the large Preclassic ceremonial center of Cival and the Classic period center of Holmul and the smaller centers of Dos Aguadas and K'o. While these sites were independent polities, we consider them together as they were geographically bounded within a karstic basin along the middle course of the Holmul River and share linked cultural developmental trajectories (Estrada-Belli 2006). A total of 10 radiocarbon dates have been reported for the Holmul region, all of which date to the Middle to Late Preclassic Periods. All dates were deemed acceptable following our chronometric assessment. While all of the dates have some stratigraphic information reported, we were not able to place them in a Bayesian chronological model because either they come from different sites or the associations between samples is unclear. Two samples from the same context within Building B at Holmul (Beta-240205 and Beta-240206), associated with a Late Middle Preclassic stucco mask, were *combined* in OxCal, yielding a date of 405-230 cal BC. Two dates (Beta-338042 and WW-9275) from the site of Dos Aguadas were also associated with a Preclassic Period stucco mask at Group E, Pyramid 1 at that site. These dates were also *combined* and yielded a date of 165-40 cal BC. The prior distributions of unmodeled dates, in conjunction with the modeled posteriors produce a summed probability distribution for sites in Holmul region spanning from 905 cal BC to cal AD 320.

La Joyanca

Recent radiocarbon research at the site of La Joyanca, located in the northwestern Petén has focused on understanding population growth and expansion of the site throughout its occupation (Arnauld et al. 2017). All dates are acceptable based on our chronometric hygiene criteria. Out of a total of 21 radiocarbon age determinations, 10 dates fall during the Preclassic Period. Because dates were not analyzed from sequential stratigraphic contexts, the samples could not be modeled within a sequence. Rather, the unmodeled posterior distributions for the site were placed within a summed probability distribution. This model yielded a calibrated distribution for the dates spanning between 1115 cal BC-cal AD 1165.

Nakbe

Twenty-two dates have been reported for the large Preclassic Period polity of Nakbe spanning the period between 1650-205 cal BC (Hansen 2005). While all dates are acceptable based on our chronometric hygiene criteria, clear associated contextual information necessary to construct a stratigraphic model has not been published. Therefore the dates could not be modeled within a stratigraphic sequence, and are therefore also not included in the regional summed probability distribution for the Petén.

San Bartolo

The site of San Bartolo possesses some of the earliest examples of Maya hieroglyphic writing, dating to the Late Preclassic Period around 200-300 cal BC. Most examples of Preclassic Maya writing are derived from surficial contexts and are dated based on correlations between inscriptions and the Gregorian calendar. Saturno and colleagues (2006) also obtained a total of 10 AMS ^{14}C dates from sealed architectural deposits to understand the appearance of writing at San Bartolo in the Las Pinturas temple. All the dates from these contexts meet our chronometric hygiene criteria, and were modeled within a *Sequence* based on associated architectural construction phases (Saturno et al. 2006: Figure 3). Two *Phases* for the sub-IV and the final construction phases of the Las Pinturas temple were also placed within the model. *Boundaries* were placed at the end and beginning of the model and between construction phases to constrain the modeled posterior radiocarbon distributions. The modeled posteriors produce a calibrated ^{14}C distribution for the Las Pinturas temple spanning from 400 cal BC to cal AD 50. The construction phase Sub-IV associated with painted hieroglyphic blocks is dated between cal BC 400-55.

Tikal

Over 112 radiocarbon dates spanning from the Early Preclassic through Late Classic periods have been published for contexts in the monumental site center at the major site of Tikal in the Petén (Berger 1968; Fergusson and Libby 1963; Ralph and Stuckenrath 1962; Sydris and Berger 1979: Table 1; Stuckenrath et al. 1966). Much of the dating work has been aimed at articulating the ancient Maya and modern European calendar systems in order to date Classic period historical events described in glyphic texts on stone monuments across the lowlands (Kennett et al. 2013; Martin and Skidmore 2012; Thompson 1935; Satterthwaite and Ralph 1960). To this end, efforts have been directed towards dating wooden lintels and beams temples throughout the Tikal site core that bear carved dates fixed in the Long Count calendar system. For many studies, series of dates were produced from the same lintel in order to document when the wood was cut, carved, and dedicated (e.g., Kennett et al. 2013). Many samples taken from across the beam to reduce the possibility of erroneous dates from old wood. We do not consider these dates (n=56) for this study as they do not represent discrete events associated with Preclassic Period growth at Tikal. Nevertheless, we report them in Table C.1 as they represent an important line of radiocarbon dating research in the Maya lowlands. It should be noted that dates for samples P-235 through P-251 were originally produced using the Libby half-life of 5568 years rather than the 5730-year half-life conventionally used today. We report corrected dates using the 5730-year half-life and with revised uncertainties following Kennett and colleagues (2013).

A total of 55 charcoal samples have also been analyzed from stratified contexts within the Tikal site core at the North Acropolis and Great Plaza. No conventional ^{14}C yr was reported for 21 of these dates (Coe 1990:989), so they are not considered in the present study. The remaining 35 dates are all acceptable according to the chronometric hygiene standards, though six dates (P-566, P-563, P-567, P-572, P-573, and P-575) are reported as unacceptable based on their context (Stuckenrath et al. 1966) and so are included in our analyses. The remaining dates have associated contextual information, but their stratigraphic between samples relationship was not clear in many cases. Therefore, we placed the unmodeled dates in a summed probability distribution that spans from 810 cal BC to cal AD 990.

Uaxactun

Two radiocarbon dates have been published for the well know site of Uaxactun, and are some of the earliest dates for the Maya lowlands (Deevy et al. 1959). Both dates (Y-368 and Y-367) come from monumental contexts in the civic-ceremonial core at the site. The dates for the site have measurement errors below ±100 14C yr, and meet our chronometric hygiene standards. Only one date (Y-367) come from Preclassic Period contexts, however, and was incorporated into the regional summed probability.

Uxbenká

To date, 109 AMS ^{14}C dates have been reported for the southern Belize site (Aquino et al. 2012: Table 1; Culleton et al. 2012: Table 2; Prufer et al. 2011: Table 1; Prufer et al. 2017: Table S1). Samples are derived for monumental architectural groups from and household contexts throughout the site's peripheral settlement. All the dates for the site have measurement errors below ± 25 ^{14}C yr, and meet our chronometric hygiene standards.

Culleton and colleagues (2012) used stratigraphic information from excavations conducted in the Uxbenká site core (Groups A, B, and D) to select a sample of 26 ^{14}C dates that were incorporated into a Bayesian analysis of the site chronology. *Sequences* were modeled for each architectural group to understand the developmental history of Uxbenká's urban core (Culleton et al. 2012). We used these sequences in our study. A suite of 15 samples from Group B in the Uxbenká monumental core were also analyzed by Aquino and colleagues (2012). Three samples (UCIAMS-105493, UCIAMS-105415 and UCIAMS-105414) produced post-bomb radiocarbon, though associated conventional ages for these dates was not reported (Aquino et al. 2012). Another sample produced an unacceptable radiocarbon determination of 1095±20 BP, and was thought to be intrusive in the sequence. The remaining 11 dates were placed in our summed probability distribution for Uxbenká as unmodeled dates since their stratigraphic location could not easily determine and therefore they could not connected to the previously modeled chronology for the site. Dates reported by Prufer and colleagues (2011: Table 1) that were not used in the model *Sequences* for the site core groups were also included in the summed probability distribution as unmodeled dates.

We also placed dates for the monumental Group I and seven household settlements at Uxbenká within *sequences* based on the stratigraphic information provided by Keith Prufer (personal communication, see also Prufer et al. 2011, 2017). The dates reported for each group were modeled according to stratigraphic unit, with *Boundaries* at the end and beginning of each sequence to constrain the modeled posterior radiocarbon distributions. The summed probability distribution for the modeled and unmodeled posterior distributions of ^{14}C dates for Uxbenká span the time period from the Late Preclassic (cal AD 70) to the Terminal Classic (cal AD 890).

Honduras and El Salvador

Researchers working at seven sites in the southeastern periphery of the Maya lowlands in southern Guatemala, Honduras, and El Salvador (Cerén), have reported 95 radiocarbon dates. We also include the site of Quirigua in southeastern Guatemala in this dataset because of the site's close ties to Copan, located 50 km to the south, during the Classic Period (Ashmore 2007).

A total of 10 dates were rejected after the application of chronometric hygiene. Three sites had later Classic period dates that were also not included in the modeling: Cerén (*n*=7; Sheets and McKee 2002: Table 1.2), La Canteada (*n*=2; Sidrys and Berger 1979: Table 1), and Los Naranjos (*n*=5; Delibrias et al. 1972). The final dataset considered for the present study was composed on 70 ^{14}C dates from four sites.

Copan

Researchers at Copan have employed several direct dating techniques to understand the development and disintegration of the site and its surrounding settlement. The best known study by Webster and colleagues (2004) used paired obsidian hydration and AMS ^{14}C dates from 11 small residential sites to document the continuity of settlement in the Copan Valley at the end of the Late Classic period. To test the accuracy of obsidian hydration dates, they implemented a series of concordance experiments to compare obsidian hydration with absolute ^{14}C dates (*n*=16). Their results suggested that obsidian hydration was an appropriate dating technique for Late Classic residential contexts at Copan. While lab numbers associated with the dates from this experiment were not reported, we do include them in our study. Additionally, all these dates are acceptable based on the chronometric hygiene standards. Additional ^{14}C dates from Copan are primarily derived from souring settlements (El Bosque and Los Achiotes; Manahan and Canuto 2009). All these dates were accepted after consideration of chronometric hygiene criteria. Two dates associated with the Hieroglyphic Stairway in the site core have also been reported (Graham and Berger 1972). Sample UCLA-1419, however, has a measurement error greater than ± 100 ^{14}C yr and was rejected based on our chronometric hygiene criteria. The summed probability distribution for the unmodeled dates span between 475 cal BC and cal AD 1400.

El Gigante Rockshelter

A series of 17 radiocarbon dates from charcoal and other organic materials have been reported for El Gigante Rockshelter (Scheffler et al. 2013: Table 1), located on the southeast periphery of the Maya lowlands along the Estanzuela River in southwestern Honduras on the fringe of the southern Maya lowlands. The date from this site represent Archaic Period through Middle Preclassic contexts. Two samples (Beta-156243 and Beta-156244) have measurement errors over ±100 ^{14}C yr, and therefore were rejected for this study. Using the prior distributions of unmodeled dates and posteriors of modeled dates from El Gigante, the radiocarbon distribution spans the period between 8640 cal BC – cal AD 235.

Quirigua

Twenty-one radiocarbon dates have been analyzed from the monumental contexts at the southern Guatemala site of Quirigua (Fishman and Lawn 1978; Hurst and Lawn 1987). Seven of these dates do not meet the chronometric hygiene criteria. An additional two dates (P-3098 and P-3102) were also found unacceptable by the original investigators as they dated too early for the contexts from which they were derived. Of the remaining dates, four occur during the Preclassic period, and are included in our overall summed probability assessments for the Honduras region.

Puerto Escondido

Eleven radiocarbon dates have been recorded for the site of Puerto Escondido, located near the Caribbean coast of Honduras (Joyce and Henderson 2001: Table 1.2). Samples of wood charcoal were derived from excavations of two low, earthen mounds to documents some of the earliest village live on the southeastern frontier of the southern lowlands. While no contextual information is provided for the samples themselves, samples are associated with occupational surfaces characterized by the repeated reconstruction of perishable residential structures. The investigators believe that the dates, which span between 1695 cal BC-AD cal 610, are consistent with their stratigraphic position with the exception of sample Beta-129130, which was derived from a mixed fill deposit and represents a reversal in the sequence (Joyce and Henderson 2001: 11). Because there was not associated stratigraphic contexts, the samples could not be modeled. Rather, the unmodeled posterior distributions for the site were placed within a summed probability distribution.

Table C.1: Radiocarbon dates from the Southern Maya lowlands. The calibrated 2-σ date ranges of radiocarbon dates modeled in OxCal are in blue. Dates rejected based on chronometric hygiene criteria are highlighted in gray.

OXCAL CODES BY REGION DEVELOPED FOR THIS STUDY

BELIZE VALLEY AND VACA PLATEAU

Actun Halal

```
Plot()
 {
  Sum("Actun Halal")
  {
   R_Date("Beta-221897", 5380, 50);
   R_Date("Beta-221896", 3800, 50);
   R_Date("Beta-221898", 3580, 50);
   R_Date("Beta-221895", 3080, 50);
   R_Date("Beta-221899", 2410, 60);
  };
 };
```

Baking Pot (see Hoggarth et al. 2014**)**

Blackman Eddy

```
Plot()
 {
  Sum("Blackman Eddy Structure 1")
  {
   Sequence(Preclassic Str. B1)
   {
    Boundary("Earliest Str. B1");
    Phase("Str. B1-8th-13")
    {
     R_Date("Beta-122281", 2990, 60)
     {
      color="Red";
      Outlier();
     };
     R_Date("Beta-162573", 2800, 40);
     R_Date("Beta-159142", 2750, 40);
     R_Date("Beta-122282", 2730, 50);
    };
    Boundary("Transition 8/7");
    Phase("Str. B1-7th")
    {
     R_Date("Beta-162571", 2420, 40);
     R_Date("Beta-162570", 2460, 40);
     R_Date("Beta-159144", 2450, 40);
     R_Date("Beta-162572", 2340, 60)
     {
      color="Red";
      Outlier();
     };
    };
    Boundary("Transition 7/6");
    R_Date("Beta-159146", 2430, 40);
    Boundary("Transition 6/5");
    Phase("Str. B1-5th")
    {
     R_Date("Beta-122279", 2500, 50);
     R_Date("Beta-103956", 2440, 60);
    };
    Boundary("Transition");
    Combine("Feasting Event")
    {
     R_Date("Beta-229800", 2400, 40);
     R_Date("Beta-229801", 2380, 40);
    };
    Boundary("Transition 5/4");
    R_Date("Beta-103959", 2480, 50)
    {
     color="Red";
     Outlier();
    };
    Boundary("Transition 4/3");
    Phase("Str. B1-3rd")
    {
     R_Date("Beta-159141", 2290, 40);
     R_Date("Beta-159145", 2240, 40);
     R_Date("Beta-159147", 2190, 40);
    };
    Boundary("End 1");
   };
  };
 };
```

Caracol

```
Plot()
 {
  Sum("Caracol")
  {
   Sequence("Str. A6")
   {
    Boundary("Str. A6-2nd");
    R_Date("Beta-61209", 1900, 50)
    {
```

```
    color="red";
    Outlier();
   };
   Boundary("A6-1st begin const")
   R_Date("Beta-18060", 1980, 80);
   Boundary("A6-1st finish const.");
   R_Date("Beta-43519 - A6-1st Floor", 2070,
60);
   Boundary("Transition");
   Combine("A6-1st Lintels")
   {
    R_Date("Beta-42004", 2020, 60);
    R_Date("Beta-42005", 1990, 60);
   };
   Boundary(Transition);
   R_Date("Beta-18061", 1870, 90);
   Boundary("Latest Str. A6");
  };
  Sequence("Str. A3")
  {
   Boundary("Earliest Str. A3");
   R_Date("Beta-18063", 1240, 100);
   Boundary("Bench Const");
   R_Date("Beta-18062", 1340, 60);
   Boundary("Final Str. A3");
  };
  R_Date("Beta-18056", 1310, 50);
  R_Date("Beta-18051", 1220, 70);
  R_Date("Beta-18065", 1160, 70);
 };
};
```

Chan

```
Plot()
 {
  Sum("Chan")
  {
  Sequence("Str. 5")
  {
   Boundary("Earliest Str. 5");
   R_Date("Beta-256809", 2200, 40);
   Boundary("Cadle Begin");
   Phase("Cadle")
   {
    R_Date("Beta-256797", 2270, 40);
    R_Date("Beta-256811", 1980, 40)
    {
     color="red";
     Outlier();
    };
    R_Date("Beta-256808", 2290, 40)
    {
     color="red";
     Outlier();
    };
    R_Date("Beta-256812", 2250, 40);
   };
   Boundary("Cadle End");
   R_Date("Beta-256805", 2040, 40);
   R_Date("Beta-256815", 1770, 40);
   R_Date("Beta-278919", 1510, 40);
   R_Date("Beta-278918", 1350, 40);
   Boundary("Pesoro Begin");
   Phase("Pesoro")
   {
    R_Date("Beta-278917", 1230, 40);
    R_Date("Beta-256810", 1170, 40);
    R_Date("Beta-256813", 1260, 40);
   };
   Boundary("Pesoro End");
   R_Date ("Beta-256814", 1150, 40);
   Boundary("Latest Str. 5");
  };
  Sequence("Str. 6")
  {
   Boundary(Earliest Str. 6);
   R_Date("Beta-256803", 2210, 40);
   Boundary("Tansition");
   R_Date("Beta-256804", 1170, 40);
   Boundary(Latest Str. 6);
  };
  Sequence("Str. 7")
  {
   Boundary(Earliest Str. 7);
   Phase("Cadle")
   {
    R_Date("Beta-256806", 2540, 40);
    R_Date("Beta-278922", 2050, 40);
    R_Date("Beta-256801", 2180, 40);
    R_Date("Beta-278923", 2440, 40);
    R_Date("Beta-256802", 2460, 40);
   };
   Boundary(Potts);
   R_Date("Beta-278920", 1610, 40);
   Boundary(Latest Str. 7);
  };
  Sequence("Str. 8")
  {
   Boundary(Earliest Str. 8);
   R_Date("Beta-278924", 1550, 40);
```

```
   Boundary("Tansition");
   R_Date("Beta-278921", 1420, 40);
   Boundary(Latest Str. 8);
  };
  R_Date("Beta-256798", 2480, 40);
  R_Date("AA103351", 1536, 48);
  R_Date("AA103348", 1391, 38);
  R_Date("AA103349", 1334, 47);
  R_Date("AA103352", 1315, 47);
  R_Date("AA103353", 1217, 45);
  R_Date("AA103354", 1277, 45);
  R_Date("X27034", 1277, 45);
 };
};
```

Lower Barton Creek

```
Plot()
 {
  Sum("Lower Barton Creek")
  {
   Sequence("Plaza A")
   {
    Boundary(Earliest Plaza A);
    R_Date("UCIAMS-167255", 2465, 20);
    Phase("Plaza A 1&2")
    {
     R_Date("UCIAMS-167254", 2150, 20);
     R_Date("UCIAMS-167257", 2150, 20);
    };
    Boundary(Latest Plaza A);
   };
   R_Date("UCIAMS-167258", 2220, 20);
  };
 };
```

Minanha

```
Plot()
 {
  Sum("SUM Minahna")
  {
   R_Date("Beta-254850", 1770, 50);
   R_Combine("Structure 77S, Intrusive Burial")
   {
    R_Date("Beta-254851", 1200, 40);
    R_Date("Beta-281098", 1170, 40);
   };
   R_Date("Beta-254848", 1050, 40);
  };
 };
```

Pacbitun

```
Plot()
 {
  Sum("Pacbitun")
  {
   Sequence("Unit 1 Sequence")
   {
    Boundary("Earliest");
    R_Date("Beta-93778", 2570, 100);
    Boundary("Level 5 to Level 4");
    Phase("Level 4")
    {
     R_Date("Beta-93776", 2570, 100);
     R_Date("Beta-93775", 2400, 60);
    };
    Boundary("Level 4 to Level 3");
    R_Date("Beta-93773", 2450, 50);
    Boundary("Latest");
   };
  };
 };
```

Xunantunich Group E

```
Plot()
 {
  Sum("Xunan Group E")
  {
   R_Date("Beta-275307", 4410, 40);
   R_Date("Beta-275306", 2890, 49);
  };
 };
```

Caye Coco

```
Plot()
 {
  Sum("Caye Coco")
  {
   Sequence("Pit 2")
   {
    Boundary("Earliest Pit 2");
    R_Date("UCIAMS-17908", 7415, 20);
    R_Date("UCIAMS-17909", 5835, 20);
    Boundary("Latest Pit 2");
   };
   R_Date("UCIAMS-17911", 2675, 15);
  };
 };
```

Cerros

```
Plot()
 {
  Sum("Cerros")
  {
   Sequence("Str. 2A")
   {
    Boundary("Earliest Str. 2A");
    R_Date("SMU-775", 2210, 80);
    Boundary("Str. 2A-Sub 2/3");
    R_Date("SMU-776", 2010, 40);
    Boundary("Latest Str. 2A");
   };
   Sequence("Str. 4AB")
   {
    Boundary("Earliest Str. 4AB");
    R_Date("Beta-188411", 1960, 40);
    R_Date("Beta-188408", 1920, 40);
    R_Date("Beta-188406", 1890, 40);
    Boundary("Latest Str. 4AB");
   };
   Sequence("Str. 5E")
   {
    Boundary("Earliest Str.  5E");
    R_Date("Beta-188413", 2060, 60);
    Boundary("Str. 5E Floor 2/3");
    R_Date("Beta-188412", 1950, 40);
    Boundary("Latest Str. 5E");
   };
   R_Date("SMU-904", 2250, 60);
   R_Date("Beta-188415", 2000, 40);
   R_Date("SMU-906", 1960, 60);
  };
 };
```

Chan Chen

```
Plot()
 {
  Sum("Chan Chen")
  {
   R_Date("UCLA-1921B", 1865, 55);
   R_Date("UCLA-1921D", 1770, 50);
   R_Date("UCLA-1921C", 1580, 60);
  };
 };
```

Colha

```
Plot()
 {
  Sum("Colha")
  {
   Sequence("Op. 4060 Zone C")
   {
    Boundary("Earliest Op 4060");
    R_Date("CAMS-8398", 2940, 80);
    R_Date("CAMS-8399", 2930, 60);
    R_Date("CAMS-8397", 2780, 60);
    R_Date("TX-8295", 2620, 38);
    Boundary("Latest Op 4060");
   };
   R_Date("Tx-4060/4151", 2680, 50);
   R_Date("Tx-4062", 2660, 50);
   R_Date("Tx-6155", 2600, 70);
   R_Date("Tx-4061", 2530, 70);
   R_Date("Tx-3566", 2530, 50);
   R_Date("Tx-4152", 2520, 80);
   R_Date("Beta-8694", 2510, 80);
   R_Date("Tx-4467", 2490, 60);
   R_Date("ML-8135-D", 2347, 58);
   R_Date("CAMS-263", 2340, 80);
   R_Date("CAMS-264", 2310, 10);
  };
 };
```

Cuello

```
Plot()
 {
  Sum("Cuello")
  {
Sequence("Cuello Main Trench")
   {
    Boundary("Earliest Main Trench");
    Phase("Phase IA")
    {
     R_Combine("Burial 62")
     {
      R_Date("OxA-2103", 2840, 100);
      R_Date("OxA-1649", 3000, 60);
     };
     R_Date("Q-1917", 2720, 50);
     R_Date("LJ-4917", 2420, 60);
    };
    Boundary("Transition Phase IA-II");
    Phase("Phase  II")
    {
     R_Date("Q-1923", 2480, 60);
     R_Date("Q-1924", 2400, 60);
     R_Date("Q-1925", 2380, 60);
    };
    Boundary("Transition Phase II-III");
    Phase("Phase  III")
    {
     R_Date("LJ-4923", 2510, 60);
     R_Date("LJ-4919", 2490, 70);
     R_Date("LJ-4922", 2520, 70);
    };
    Boundary("Transition Phase III-IIIA");
    Phase("Phase  IIIA")
    {
     R_Date("OxA-2016", 2390, 70);
     R_Date("Q-1911", 2455, 45);
     R_Date("Q-1914", 2540, 45);
     R_Date("LJ04918", 2470, 70);
     R_Date("OxA-2017", 2560, 70);
    };
    Boundary("Transition Phase IIIA-IV");
    Phase("Phase  IV")
    {
     R_Date("Q-1912", 2470, 50);
     R_Date("OxA-362", 2390, 90);
    };
    Boundary("Transition Phase IV-IVA");
    Phase("Phase  IVA")
    {
     R_Date("Q-1907", 2315, 50);
     R_Date("Q-1908", 2345, 45);
     R_Date("OxA-1810", 2470, 80);
     R_Date("Q-1902", 2440, 70);
     R_Date("Q-1909", 2420, 45);
     R_Date("LJ-4920", 2420, 70);
    };
    Boundary("Transition Phase IVA-V");
    Phase("Phase  V")
    {
     R_Date("Q-3208", 2265, 36);
     R_Date("Q-3210", 2230, 55);
     R_Date("Q-3197", 2275, 50);
     R_Date("Q-3209", 2235, 50);
    };
    Boundary("Transition Phase V-VA");
    Phase("Phase  VA")
    {
     R_Date("LJ-4916", 2180, 70);
     R_Date("Q-1915", 2305, 45);
     R_Date("Q-3199", 2280, 55);
     R_Date("Q-3211", 2250, 50);
     R_Date("Q-3200", 2260, 45);
    };
    Boundary("Phase VIII-X");
    R_Date("Q-1900", 2040, 40);
    Boundary("Latest Main Trench");
   };
   };
```

Hats Kaab

```
Plot()
 {
  Sum("Hats Kaab")
  {
   R_Date("AA-100288", 2206, 41);
   R_Date("AA-100287", 1989, 52);
   R_Date("AA-100291", 1949, 39);
  };
 };
```

Ka'Kabish

```
Plot()
 {
  Sum("Ka'Kabish")
  {
   Sequence("Group D Op 8")
   {
    Boundary("Earliest Op 8");
    Combine("Unit 1 Level 16/Unit 2 Level 2")
    {
     R_Date("AA-100168", 2520, 42)
     {
      Outlier();
     };
     R_Date("AA-96423", 2466, 37);
     R_Date("AA-96421", 2449, 37);
     R_Date("AA-96420", 2447, 37);
     R_Date("AA-96422", 2418, 37);
     R_Date("AA-100166", 2393, 52);
    };
    Boundary("Latest Op 8");
   };
   R_Date("AA-92052", 2554, 66);
  };
 };
```

K'axob

```
Plot()
 {
  Sum("K'axob")
  {
   Sequence("K'axob Operation I")
   {
    Boundary("Earliest Operation I");
    Phase("Const Phase I-II")
    {
     R_Date("AA-14454", 2451, 48);
     R_Date("OxA-2724", 2470, 60);
     R_Date("OxA-2723", 2460, 60);
    };
    Boundary("Tran early to late Chaakkax");
    Phase("Const Phase III")
    {
     R_Date("OxA-2721", 2470, 60);
     R_Date("OxA-2722", 2390, 60);
    };
    Boundary("Tran late Chaakkax to early
K'atabche'kax ");
    Phase("Const Phase IV-VII")
    {
     R_Date("AA-14451", 2609, 49)
     {
      color="red";
      Outlier();
     };
     R_Date("AA-14447", 2456, 47);
     R_Date("AA-14452", 2408, 49);
     R_Date("AA-14448", 2299, 48);
     R_Date("AA-14445", 2247, 53);
     R_Date("AA-14453", 2169, 55);
    };
    Boundary("Tran early to late K'atabche'kax
");
    Phase("Const Phase VII")
    {
     R_Date("AA-14446", 2243, 49);
     R_Date("AA-14443", 2056, 52);
     R_Date("AA-14442", 2220, 47);
    };
    Boundary("Tran late to terminal
K'atabche'kax ");
    R_Date("AA-14441", 2010, 48);
    Boundary("Tran terminal K'atabche'kax to
Nohalkax ");
    R_Date("AA-14440", 2073, 58);
    Boundary("Latest Operation I");
   };
   R_Date("AA-14458", 2058, 47);
   R_Date("AA-14457", 2121, 51);
  };
 };
```

Lamanai (see Hanna et al. 2016)

San Estevan

```
Plot()
 {
  Sum("San Estevan")
  {
   R_Date("UCIAMS-17903", 2565, 25);
   R_Date("UCIAMS-17902", 1900, 15);
  };
```

PASION REGION (see Inomata et al. 2017)

PETÉN AND SOUTHERN BELIZE

Buena Vista-Nuevo San Jose

```
Plot()
 {
  Sequence("Buena Vista-Nuevo San Jose Str. 4")
  {
   Boundary("Earliest Str. 4");
   R_Date("AA72324", 2500, 35);
   Boundary("Const Floor 4Sub-1");
   R_Date("AA72323", 2467, 35);
   R_Date("AA72325", 2493, 34);
   Boundary("Const Floor 4Sub-2");
   R_Date("AA75154", 2449, 34);
   Boundary("Latest Str. 4");
  };
 };
```

El Perú-Waka'

```
Plot()
 {
  Sum("SUM El Peru-Waka")
  {
   Sequence("El Peru-Waka Str. O14-04")
   {
    Boundary("Earliest Str. O14-04");
    R_Date("Beta-239740", 1800, 40);
    Boundary("Placement Burial 25");
    R_Date("Beta-239739", 1780, 40);
    R_Date("Beta-239738", 1710, 40);
    Boundary("Floor Above Burial #24");
    R_Date("Beta-239735", 1640, 40);
    R_Date("Beta-239742", 1250, 40);
    Boundary("Latest Str. O14-04");
   };
  };
 };
```

Holuml Region

```
Plot()
 {
  Sum("Holmul Region")
  {
   R_Date("?", 2670, 40);
   R_Date("?", 2520, 40);
   R_Date("?", 2196, 46);
   R_Date("?", 2170, 40);
   Combine("Holmul Building B Mask")
   {
    R_Date("Beta-240206", 2300, 40);
    R_Date("Beta-240205", 2270, 40);
   };
   Combine("Dos Aguadas Group E Mask ")
   {
    R_Date("Beta-338042", 2040, 30);
    R_Date("WW-9275", 2090, 25);
   };
   R_Date("?", 1840, 40);
   R_Date("?", 1900, 40);
  };
 };
```

Ja Joyanca

```
Plot()
 {
  Sum (La Joyanca)
  {
   R_Date("Gif-A 100621", 2780, 70);
   R_Date("Gif-A 100628", 2520, 70);
   R_Date("Gif-A 100626", 2470, 70);
   R_Date("Gif-A 102456", 2340, 60);
   R_Date("Gif-A 102458", 2330, 70);
   R_Date("VERA-2493", 2195, 35);
   R_Date("Gif-A 100625", 2110, 70);
   R_Date("VERA-2492", 2005, 35);
   R_Date("Gif-A 100624", 2000, 60);
   R_Date("Gif-A 102617", 1800, 110);
   R_Date("Gif-A 102455", 1670, 60);
```

```
  R_Date("Gif-A 102618", 1520, 60);
  R_Date("Beta 155685", 1460, 50);
  R_Date("Gif-A 100629", 1410, 60);
  R_Date("Gif-A 100623", 1340, 60);
  R_Date("Gif-A 100622", 1330, 70);
  R_Date("Gif-A 100627", 1300, 60);
  R_Date("Gif-A 100620", 1230, 60);
  R_Date("VERA-2491", 1210, 40);
  R_Date("VERA-2494", 1110, 35);
  R_Date("Beta 155684", 960, 40);
 };
};
```

San Bartolo

```
Plot()
 {
  Sum("SUM San Bartolo")
  {
   Sequence("San Bartolo Las Pinturas Temple")
   {
    Boundary("Earliest Las Pinturas");
    R_Date("Beta-206576", 2260, 40);
    R_Date("Beta-206577", 2200, 60);
    Boundary("Transition sub-V to sub-IV");
    Phase("sub-IV")
    {
     R_Date("Beta-206575", 2150, 40);
     R_Date("Beta-206578", 2180, 40);
     R_Date("Beta-206624", 2260, 40);
    };
    Boundary("sub-III and sub-II");
    R_Date("Beta-193509", 2140, 40);
    Boundary("Transition sub-I to final ");
    Phase("final")
    {
     R_Date("Beta-193510", 2070, 40);
     R_Date("Beta-193511", 2050, 50);
     R_Date("Beta-193512", 2100, 40);
     R_Date("Beta-193513", 2050, 40);
    };
    Boundary("Latest Las Pinturas");
   };
  };
 };
```

Tikal

```
Plot()
 {
  Sum("Tikal")
  {
   R_Date("P-750", 2538, 53);
   R_Date("P-759", 2406, 47);
   R_Date("P-755", 2225, 55);
   R_Date("P-751", 2169, 52);
   R_Date("P-752", 2157, 52);
   R_Date("P-286", 2100, 45);
   R_Date("P-288", 2090, 55);
   R_Date("P-560", 2075, 49);
   R_Date("P-753", 2068, 52);
   R_Date("P-756", 2064, 52);
   R_Date("P-758", 2040, 53);
   R_Date("P-298", 2040, 57);
   R_Date("P-289", 2040, 57);
   R_Date("P-754", 2017, 52);
   R_Date("P-287", 2000, 63);
   R_Date("P-285", 1970, 44);
   R_Date("P-561", 1951, 46);
   R_Date("P-535", 1934, 63);
   R_Date("P-757", 1930, 51);
   R_Date("P-565", 1926, 48);
   R_Date("P-562", 1874, 54);
   R_Date("P-768", 1777, 45);
   R_Date("P-284", 1550, 58);
   R_Date("P-281", 1530, 52);
   R_Date("P-569", 1308, 49);
   R_Date("P-574", 1285, 52);
   R_Date("P-279", 1180, 55);
   R_Date("P-278", 1150, 47);
  };
 };
```

Uaxactun

```
Plot()
 {
  Sum("Uaxactun")
  {
   R_Date("Y-368", 1330, 70);
   R_Date("Y-367", 1780, 60);
  };
 };
```

Uxbenká

```
Plot()
 {
  Sum("SUM Uxbenká")
  {
   Sequence("A1 08-4")
   {
    Boundary("Earliest Group A");
    Sequence("West A1 08-4")
    {
     R_Date("UCIAMS-56360 Buried Str. Fill 198cmbd", 1840, 15);
     Date("Burial of Early Str");
     R_Date("UCIAMS-56359 L5 169cmbd", 1780, 15);
     R_Date("UCIAMS-56367 Fea. 1 L4 108cmbd", 1635, 15);
     R_Date("UCIAMS-56368 Fea. 2 L4 120cmbd", 1585, 15);
    };
    Boundary("End of Construction");
   };
   Sequence("A6 07-3")
   {
    Boundary("Clear Plaza Floor");
    R_Date("UCIAMS-33400 ConStr. Wall near A6", 1790, 20);
    R_Date("UCIAMS-46297 A6 L5 367cmbd", 1755, 25);
    Phase("Second A6 fill")
    {
     R_Date("UCIAMS-42807 A6 L5 292cmbd", 1720, 15);
     R_Date("UCIAMS-42805 A6 L5 224cmbd", 1700, 15);
    };
    Boundary("Third A6 fill");
   };
   Sequence("A1 07-5")
   {
    After( )
    {
     XReference("UCIAMS-56359 L5 169cmbd");
    };
    Phase("A1 07-5 Mole Hole")
    {
     R_Date("UCIAMS-42808 Burned layer", 1725, 15);
    };
    Boundary("Nib fill to bury A1/Facade constructed");
    Phase("Thick Plaster Floor")
    {
     R_Date("UCIAMS-42809 A1 L5 floor", 1490, 15);
     R_Date("UCIAMS-46298 A1 L5 floor", 1585, 25);
    };
    Boundary("Deposition above Plaza Floor");
   };
   Sequence(Group B)
   {
    Boundary("Earliest Group B");
    Phase("Early Classic")
    {
     Sequence("Grp B 08-7 U2")
     {
      Boundary("L6 Fill Placed/Str. Constructed");
      Phase("L6 Fill Const")
      {
       R_Date("UCIAMS-56361, L6 143 cmbd", 1735, 15);
       R_Date("UCIAMS-56371, L6 204 cmbd", 1755, 15);
      };
      Boundary("Plaster Floor btwn L6/L5");
      Phase("L5 Fill Const")
      {
       R_Date("UCIAMS-56370, L5 139 cmbd", 1730, 15);
       R_Date("UCIAMS-56369, L5 121 cmbd", 1760, 15);
      };
      Boundary("L4 Plaster Floor");
      R_Date("UCIAMS-57044, L3 95 cmbd on top of L4 Floor", 1745, 15);
      Boundary("L2 Plaster Floor");
     };
    };
    Boundary("Early/Late Classic");
    R_Date("B1 UCIAMS-56364 08-8", 1315, 15);
    Boundary("Latest Group B");
   };
   Sequence("Group D Phases")
   {
    Boundary("Hilltop cleared and leveled");
    Phase("Early Classic")
```

```
    {
     R_Date("UCIAMS-67239 9-13 L4 95 cmbd",
1695, 20);
     R_Date("UCIAMS-67959 9-14 Structure
Fill", 1710, 15);
     R_Date("UCIAMS-67238 9-14 L7 192cmbd
4th Flr Fill", 1775, 20);
     R_Date("UCIAMS-67961 9-14 L7 169cmbd
3rd Flr Fill", 1750, 20);
     R_Date("UCIAMS-67960 9-14 L6 153cmbd
2nd Flr Fill", 1800, 20);
     R_Date("UCIAMS-67955 9-15 L3 136cmbd
Box Luum", 1830, 15);
    };
    Boundary("Plaza Wall Construction");
    Phase("Late Classic")
    {
     R_Date("UCIAMS-67965 9-13 L3 63 cmbd",
1225, 15);
     R_Date("UCIAMS-67957 9-14 L3 105cmbd
Box Luum", 1345, 15);
     R_Date("UCIAMS-67958 9-14 L3 80cmbd
Box Luum", 1465, 15);
    };
    Boundary("Placement of Pavers");
    Boundary("Surface scatters");
   };
   Sequence("SG 20 Op 08-2")
   {
    Boundary("Earliest Op 08-2");
    Phase("Level 3")
    {
     R_Date("UCIAMS-57042", 1960);
     R_Date("UCIAMS-56366", 1865);
     R_Date("UCIAMS-56358", 1810);
    };
    Boundary("Latest Op 08-2");
   };
   Sequence("SG 21 Op 07-16")
   {
    Boundary("Earliest Op 07-16");
    R_Date("UCIAMS-42824", 1775, 15);
    Boundary("Transition");
    Phase("Op 07-16 Late Classic")
    {
     R_Date("UCIAMS-42811", 1275, 15);
     R_Date("UCIAMS-42810", 1365, 15);
    };
    Boundary("Latest Op 07-16");
   };
   Sequence("Group I Str. 1 Unit 1")
   {
    Sequence("Unit 1")
    {
     Boundary("Earliest Unit 1");
     R_Date("UCIAMS-91199", 1700, 15)
     {
      Outlier();
     };
     Boundary();
     R_Date("UCIAMS-91198", 1755, 15);
     Boundary();
     Phase("Level 4")
     {
      R_Date("UCIAMS-91200", 1610, 15);
      R_Date("UCIAMS-91201", 1585, 15);
     };
     Boundary("Latest Unit 1");
    };
    Sequence("Unit 2")
    {
     Boundary("Earliest Unit 2");
     R_Date("UCIAMS-91204", 1625, 15)
     {
      Outlier();
     };
     Boundary("Level 3");
     Phase("Level 2")
     {
      R_Date("UCIAMS-91203", 1570, 15);
      R_Date("UCIAMS-91206", 1580, 15);
     };
     Boundary();
     R_Date("UCIAMS-91205", 1525, 15);
     Boundary("Latest Unit 2");
    };
   };
   Sequence("SG 18")
   {
    Boundary("Earliest Str. 1");
    R_Date("UCIAMS-105386", 1770, 15);
    R_Date("UCIAMS-105385", 1740, 15);
    Boundary("Latest Str. 1");
   };
   Sequence("SG 25")
   {
    Boundary("Earliest Str. 15");
    R_Date("DAMS-003022", 1333, 26)
    {
     Outlier();
    };
    Boundary();
```

```
 R_Date("DAMS-003021", 1760, 26);
 Boundary();
 R_Date("UCIAMS-57043", 1485, 15);
 Boundary("Latest Str. 15");
};
Sequence("SG 28")
{
 Boundary("Earliest Str. 15");
 Phase("Zone 3A Level 3")
 {
  R_Date("DAMS-003013", 1690, 26);
  R_Date("DAMS-003019", 1687, 25);
 };
 Boundary("Latest Str. 15");
};
Sequence("SG 4")
{
 Boundary("Early Str. 1");
 Phase("Pre-construction midden")
 {
  R_Date("UCIAMS-87895", 1775, 20);
  R_Date("UCIAMS-87894", 1565, 20);
 };
 Boundary("Const. Str. 1");
};
Sequence("SG 62")
{
 Boundary("Earliest Str. 3");
 R_Date("UCIAMS-105384", 1720, 15);
 R_Date("UCIAMS-105383", 1580, 15);
 Boundary("Latest Str. 3");
};
R_Date("UCIAMS-42825 ", 1880, 15);
R_Date("UCIAMS-105392", 1845, 15);
R_Date("UCIAMS-105422", 1780, 20);
R_Date("UCIAMS-105381", 1775, 15);
R_Date("UCIAMS-33404", 1775, 20);
R_Date("B2 UCIAMS-56362 08-9", 1770,
15);
R_Date("UCIAMS-105418", 1760, 20);
R_Date("DAMS-002428", 1758, 25);
R_Date("UCIAMS-105390", 1740, 15);
R_Date("UCIAMS-105423", 1730, 20);
R_Date("UCIAMS-42806", 1725, 15);
R_Date("B14 UCIAMS-56365 08-10", 1725,
15);
R_Date("UCIAMS-87157", 1725, 15);
R_Date("UCIAMS-33403", 1720, 25);
R_Date("UCIAMS-91207", 1710, 15);
R_Date("DAMS-002427", 1703, 28);
R_Date("DAMS-002429", 1688, 28);
R_Date("UCIAMS-46299", 1675, 25);
R_Date("DAMS-003029", 1668, 26);
R_Date("UCIAMS-33401", 1635, 20);
R_Date("UCIAMS-67236", 1615, 20);
R_Date("UCIAMS-87161", 1605, 15);
R_Date("UCIAMS-105388", 1605, 15);
R_Date("UCIAMS-87160", 1595, 15);
R_Date("UCIAMS-87168", 1580, 15);
R_Date("UCIAMS-87167", 1575, 15);
R_Date("DAMS-003027", 1550, 24);
R_Date("DAMS-002426", 1534, 28);
R_Date("UCIAMS-105417", 1525, 20);
R_Date("UCIAMS-105374", 1510, 15);
R_Date("DAMS-003025", 1486, 30);
R_Date("UCIAMS-105419", 1485, 20);
R_Date("UCIAMS-105391", 1465, 15);
R_Date("UCIAMS-67954", 1465, 15);
R_Date("UCIAMS-67237", 1440, 20);
R_Date("UCIAMS-42813", 1329, 15);
R_Date("UCIAMS-105425", 1320, 20);
R_Date("UCIAMS-42812", 1310, 15);
R_Date("DAMS-003026", 1299, 25);
R_Date("UCIAMS-105379", 1290, 15);
R_Date("UCIAMS-105382", 1255, 15);
R_Date("UCIAMS-102521", 1250, 15);
R_Date("UCIAMS-105396", 1245, 15);
R_Date("UCIAMS-105413", 1235, 20);
R_Date("UCIAMS-87159", 1380, 15);
R_Date("UCIAMS-105380", 1220, 15);
R_Date("UCIAMS-105416", 1215, 15);
R_Date("UCIAMS-105395", 1215, 15);
R_Date("UCIAMS-105394", 1210, 20);
R_Date("UCIAMS-105420", 1205, 20);
};
```

HOUNDURAS AND EL SALVADOR

Copan

```
Plot()
 {
  Sum("SUM Copan")
  {
   R_Date("Beta-137374", 2250, 70);
   R_Date("Beta-155206", 2240, 90);
   R_Date("Beta-155203", 2220, 40);
   R_Date("Beta-137132", 2100, 60);
   R_Date("UCLA-1420", 1200, 70);
   R_Date("Beta-139616", 1100, 40);
   R_Date("Beta-91487", 1100, 80);
   R_Date("Beta-139614", 1070, 40);
   R_Date("Beta-91486", 1060, 60);
   R_Date("Beta-139615", 1030, 40);
   R_Date("Beta-91488", 1010, 50);
   R_Date("Beta-139617", 980, 40);
   R_Date("Beta-139612", 920, 40);
   R_Date("Beta-139613", 780, 40);
  };
 };
```

El Gigante

```
Plot()
 {
  Sum("El Gigante")
  {
   Sequence("El Gigante")
   {
    Boundary("Earliest El Gigante");
    R_Date("Strata VIIIa - Beta-171699", 9290,
40);
    Boundary("Strata VIIa");
    R_Date("Strata VI - Beta-171700", 9240, 40);
    Boundary("Transition VI-V");
    R_Date("Strata Va -Beta-156246", 9600, 60)
    {
     color="red";
     Outlier();
    };
    R_Date("Strata Vb - Beta-171706", 9210, 60);
    Boundary("Transition V-IV");
    R_Date("Strata IVc3 - Beta-156245", 9590,
60)
    {
     color="red";
     Outlier();
    };
    Boundary("Transition IV-III");
    R_Date("Strata IIIf2 - Beta-171705", 6180,
90);
    R_Date("Strata IIId3 - Beta-156247", 6630,
60)
    {
     color="red";
     Outlier();
    };
    Boundary("Transition Early to Late III");
    R_Date("Strata IIIc - Beta-171704", 3100,
40);
    R_Date("Strata III - Beta-159055", 2280, 40);
    Boundary("Transition III-II");
    R_Date("Strata II - Beta-171703", 3780, 60)
    {
     color="red";
     Outlier();
    };
    R_Date("Strata IIc3 - Beta-171701", 2010,
40);
    Boundary("Transition Strata II-I");
    Phase("Strata Ib")
    {
     R_Date("Beta-156242", 1970, 70);
     R_Date("Beta-171702", 1930, 60);
    };
    Boundary("Latest El Gigante");
   };
   R_Date("ISGS 2965-2", 9450, 70);
   R_Date("ISGS 2966-3", 9970, 70);
  };
 };
```

Los Naranjos

```
Plot()
 {
  Sum("Los Naranjos")
  {
```

```
  R_Date("GIF-1324", 1850, 100);
  R_Date("GIF-1473", 1700, 100);
  R_Date("GIF-1472", 1530, 100);
  R_Date("GIF-1474", 1500, 100);
  R_Date("GIF-1326", 1260, 90);
 };
};
```

Puerto Escondido

```
Plot()
{
 Sum("SUM Puerto Escondido")
 {
  R_Date("Beta-129129", 3320, 40);
  R_Date("Beta-129130", 3250, 100);
  R_Date("Beta-129132", 3050, 40);
  R_Date("Beta-129128", 3030, 50);
  R_Date("Beta-129133", 2900, 40);
  R_Date("Beta-129127", 2900, 50);
  R_Date("Beta-129131", 2870, 40);
  R_Date("Beta-129135", 2850, 40);
  R_Date("Beta-129134", 2830, 40);
  R_Date("Beta-129126", 2730, 40);
  R_Date("Beta-129125", 1530, 40);
 };
};
```

Quirigua

```
Plot()
{
 Sum("Quirigua")
 {
  R_Date("P-3089", 1970, 50);
  R_Date("P-3100", 1970, 50);
  R_Date("P-3095", 1800, 50);
  R_Date("P-3096", 1730, 50);
  R_Date("P-2532", 1490, 50);
  R_Date("P-3086", 1450, 50);
  R_Date("P-3087", 1440, 40);
  R_Date("P-2536", 1400, 50);
  R_Date("P-3084", 1310, 40);
  R_Date("P-3088", 1290, 40);
  R_Date("P-2534", 1140, 50);
  R_Date("P-3097", 420, 40);
 };
};
```

Appendix D

TECHNOLOGICAL AND PORTABLE X-RAY FLUORESENCE ANALYSIS RESULTS FOR OBSIDIAN ARTIFACTS

Sample ID	Provenience	Time Period	Technology	Source Group	Mn	Fe	Zn	Ga	Th	Rb	Sr	Y	Zr	Nb
CHP001	CHP-SR1-024 Surface Collection	LC	3MS	El Chayal	761	6910	47	18	10	146	141	20	112	9
CHP002	CHP-SR1-034 Surface Collection	LC	3MS-bp	Ixtepeque	571	11186	46	18	7	108	160	20	174	11
CHP003	CHP-SR1-034 Surface Collection	LC	3MS	El Chayal	747	7004	41	18	10	151	152	22	112	9
CHP004	CHP-SR1-034 Surface Collection	LC	3PS-sf	SMJ	622	7436	41	17	9	116	190	18	116	7
CHP005	CHP-SR1-034 Surface Collection	LC	3MS	El Chayal	767	7012	48	18	10	151	147	20	113	10
CHP006	CHP-SR1-034 Surface Collection	LC	3MS	El Chayal	733	6302	49	18	10	157	141	23	97	8
CHP007	CHP-SR1-034 Surface Collection	LC	3MS	Ixtepeque	659	12327	45	18	9	125	173	20	182	11
CHP008	CHP-SR1-034 Surface Collection	LC	3PS-sf	El Chayal	651	6515	38	18	10	139	139	22	109	8
CHP009	CHP-SR1-034 Surface Collection	LC	CRF	Ixtepeque	467	9128	35	17	4	93	137	18	154	8
CHP010	CHP-SR1-036 Surface Collection	LC	3MS	El Chayal	733	6598	38	18	10	147	142	20	111	10
CHP011	CHP-SR1-036 Surface Collection	LC	3PS-sf	El Chayal	746	7199	39	18	12	150	141	21	113	10
CHP012	CHP-SR1-036 Surface Collection	LC	3PS-sf	El Chayal	647	6459	50	18	9	137	133	18	104	8
CHP013	CHP-SR1-037 Surface Collection	LC	3PS-sf	El Chayal	663	7095	51	18	10	148	149	20	115	11
CHP014	CHP-SR1-038 Surface Collection	LC	3MS	El Chayal	785	7389	55	18	12	154	155	23	115	11
CHP015	CHP-SR1-038 Surface Collection	LC	3MS	El Chayal	634	6775	35	17	10	144	143	18	109	10
CHP016	CHP-SR1-038 Surface Collection	LC	3MS	El Chayal	863	8345	57	18	15	178	166	22	123	12
CHP017	CHP-SR1-039 Surface Collection	LC	3MS	Ixtepeque	505	10448	37	17	8	106	152	20	171	10
CHP018	CHP-SR1-040 Surface Collection	LC	3PS-sf-h	El Chayal	729	6705	43	18	9	138	140	22	109	10
CHP019	CHP-SR1-041 Surface Collection	LC	3MS	El Chayal	652	6110	49	18	10	133	129	19	100	7
CHP020	CHP-SR1-042 Surface Collection	LC	3PS-sf	Ixtepeque	481	10448	31	17	6	98	152	18	166	9
CHP021	CHP-SR1-046 Surface Collection	LC	3DS	El Chayal	658	6590	43	18	11	145	136	19	107	10
CHP022	CHP-SR1-046 Surface Collection	LC	3MS	El Chayal	813	7345	71	19	12	159	152	18	111	9

Sample ID	Provenience	Time Period	Technology	Source Group	Mn	Fe	Zn	Ga	Th	Rb	Sr	Y	Zr	Nb
CHP023	CHP-SR1-047 Surface Collection	LC	3PS-sf	El Chayal	737	7863	70	19	13	153	153	22	109	12
CHP024	CHP-SR1-047 Surface Collection	LC	3DS	El Chayal	690	7060	51	18	11	149	143	21	115	10
CHP025	CHP-SR1-048 Surface Collection	LC	3MS	Ixtepeque	615	12053	36	17	7	100	152	21	169	8
CHP026	CHP-SR1-049 Surface Collection	LC	3MS	Ixtepeque	593	13681	53	18	8	114	167	20	177	12
CHP027	CHP-SR1-049 Surface Collection	LC	3MS	El Chayal	724	7031	46	18	8	149	147	20	112	10
CHP028	CHP-SR1-051 Surface Collection	LC	3MS	SMJ	760	8942	76	19	12	136	205	19	120	9
CHP029	CHP-SR1-051 Surface Collection	LC	3MS	El Chayal	761	7607	55	18	10	156	152	20	114	9
CHP030	CHP-SR1-051 Surface Collection	LC	3PS-sf-j	El Chayal	720	7580	50	18	8	151	149	19	113	10
CHP031	CHP-SR1-051 Surface Collection	LC	3MS	El Chayal	717	7037	43	18	12	151	147	21	111	11
CHP032	CHP-SR1-051 Surface Collection	LC	CRF	El Chayal	733	7456	40	17	8	139	137	20	110	10
CHP033	CHP-SR1-052 Surface Collection	LC	3PS-sf	El Chayal	757	7270	78	19	8	151	142	20	112	9
CHP034	CHP-SR1-052 Surface Collection	LC	3MS	El Chayal	754	7031	45	18	12	153	150	20	111	9
CHP035	CHP-SR1-052 Surface Collection	LC	CRF	SMJ	610	6925	34	17	9	111	182	15	112	7
CHP036	CHP-SR1-053 Surface Collection	LC	3MS	El Chayal	688	6588	47	18	11	149	143	21	111	9
CHP037	CHP-SR1-055 Surface Collection	LC	3MS	Ixtepeque	467	10050	30	17	6	101	152	20	164	9
CHP038	CHP-SR1-055 Surface Collection	LC	TMS	El Chayal	1111	10766	154	22	12	181	178	20	115	10
CHP039	CHP-SR1-055 Surface Collection	LC	3MS	SMJ	615	7408	44	17	8	125	191	18	116	9
CHP040	CHP-SR1-055 Surface Collection	LC	3MS	El Chayal	767	7695	55	18	12	155	156	23	116	10
CHP041	CHP-SR1-056 Surface Collection	LC	3PS-sf	Ixtepeque	521	10367	36	17	7	106	154	19	169	9
CHP042	CHP-SR1-056 Surface Collection	LC	3MS	El Chayal	825	7631	52	18	12	163	156	21	120	12
CHP043	CHP-SR1-056 Surface Collection	LC	3MS	SMJ	645	8258	51	18	9	122	204	19	118	8
CHP044	CHP-SR1-056 Surface Collection	LC	3DS	Ixtepeque	466	9503	39	18	9	95	143	19	160	9
CHP045	CHP-SR1-056 Surface Collection	LC	3PS-sf	Ixtepeque	495	10396	37	17	6	104	157	19	167	10
CHP046	CHP-SR1-056 Surface Collection	LC	2MS	El Chayal	731	7262	53	18	10	159	156	21	116	12
CHP047	CHP-SR1-056 Surface Collection	LC	3MS	El Chayal	810	7776	60	18	11	162	156	21	113	10
CHP048	CHP-SR1-056 Surface Collection	LC	3MS	Ixtepeque	467	9981	35	17	6	95	146	18	161	8
CHP049	CHP-SR1-056 Surface Collection	LC	3PS-sf	El Chayal	708	6386	39	18	10	144	138	21	107	9
CHP050	CHP-SR1-056 Surface Collection	LC	3PS-sf	El Chayal	708	7118	51	18	10	154	147	22	114	10
CHP051	CHP-SR1-056 Surface Collection	LC	3PS-sf	El Chayal	656	6332	41	17	8	142	138	19	107	9

Sample ID	Provenience	Time Period	Technology	Source Group	Mn	Fe	Zn	Ga	Th	Rb	Sr	Y	Zr	Nb
CHP052	CHP-SR1-056 Surface Collection	LC	3MS	El Chayal	780	6869	44	18	9	151	152	21	112	10
CHP053	CHP-SR1-056 Surface Collection	LC	3MS	Ixtepeque	450	9868	41	17	5	100	148	20	162	8
CHP054	CHP-SR1-056 Surface Collection	LC	3PS-sf	El Chayal	810	7785	57	18	11	167	159	23	122	11
CHP055	CHP-SR1-056 Surface Collection	LC	3PS-sf	El Chayal	697	6353	41	18	9	143	144	21	111	10
CHP056	CHP-SR1-056 Surface Collection	LC	CS-bp	Ixtepeque	428	10454	34	17	7	94	137	17	154	8
CHP057	CHP-SR1-056-2 Surface Collection	LC	3MS	Pachuca	1469	21224	356	35	27	247	3	127	986	102
CHP058	CHP-SR1-056-3 Surface Collection	LC	3DS-pl	El Chayal	648	6199	36	17	9	132	130	19	103	8
CHP059	CHP-SR1-057 Surface Collection	LC	HLC-ps	El Chayal	703	6269	34	17	10	133	130	18	103	9
CHP060	CHP-SR1-058 Surface Collection	LC	TMS	El Chayal	653	6567	40	18	11	141	142	20	112	9
CHP061	CHP-SR1-058 Surface Collection	LC	3MS	SMJ	560	7376	40	17	6	113	188	17	113	7
CHP062	CHP-SR1-058 Surface Collection	LC	3MS	El Chayal	776	7109	41	18	12	152	150	20	113	12
CHP063	CHP-SR1-059 Surface Collection	LC	FLK-c	El Chayal	720	6459	41	18	9	139	137	20	107	8
CHP064	CHP-SR1-060 Surface Collection	LC	3MS	El Chayal	696	6676	46	18	11	144	143	21	109	9
CHP065	CHP-SR1-061 Surface Collection	LC	3PS-sf	SMJ	621	7003	37	18	11	115	188	19	110	8
CHP066	CHP-SR1-061 Surface Collection	LC	3DS	Ixtepeque	565	11003	42	18	7	110	166	19	177	11
CHP067	CHP-SR1-061 Surface Collection	LC	3MS	El Chayal	662	6664	39	18	11	145	148	20	109	9
CHP068	CHP-SR1-061 Surface Collection	LC	NPB-ds	El Chayal	677	6029	35	17	9	132	131	20	105	8
CHP069	CHP-SR1-062 Surface Collection	LC	3PS-sf	SMJ	604	7199	42	18	10	120	184	17	112	7
CHP070	CHP-SR1-062 Surface Collection	LC	NPB-sf	El Chayal	615	6373	45	18	8	135	134	19	104	8
CHP071	CHP-SR1-062 Surface Collection	LC	3MS	El Chayal	783	7222	41	18	10	141	140	20	107	8
CHP072	CHP-SR1-062 Surface Collection	LC	3MS	Ixtepeque	533	9778	29	17	6	98	142	16	159	7
CHP073	CHP-SR1-063 Surface Collection	LC	3MS	El Chayal	693	7583	46	18	9	146	144	23	112	10
CHP074	CHP-SR1-063 Surface Collection	LC	3MS	SMJ	650	8630	51	18	9	120	193	19	115	8
CHP075	CHP-SR1-064 Surface Collection	LC	3MS	El Chayal	655	7836	56	18	12	162	152	19	118	11
CHP076	CHP-SR1-064 Surface Collection	LC	TMS	SMJ	632	9344	62	18	7	122	198	18	120	9
CHP077	CHP-SR1-064 Surface Collection	LC	3MS-sh	El Chayal	722	8053	55	18	13	157	156	21	112	11
CHP078	CHP-SR1-064 Surface Collection	LC	3MS-nt	El Chayal	741	6482	53	18	12	139	136	18	105	8
CHP079	CHP-SR1-064 Surface Collection	LC	PS-sf	El Chayal	729	7424	47	18	11	140	142	21	106	9
CHP080	CHP-SR1-064 Surface Collection	LC	3MS	Ixtepeque	517	10530	39	17	6	97	150	20	166	8

Sample ID	Provenience	Time Period	Technology	Source Group	Mn	Fe	Zn	Ga	Th	Rb	Sr	Y	Zr	Nb
CHP081	CHP-SR1-064 Surface Collection	LC	3MS	El Chayal	733	8282	57	18	11	162	155	20	119	10
CHP082	CHP-SR1-066 Surface Collection	LC	3MS	Ixtepeque	503	11438	39	17	7	96	141	18	159	8
CHP083	CHP-SR1-066 Surface Collection	LC	3MS	El Chayal	703	8953	49	18	10	140	134	21	109	10
CHP084	CHP-SR1-067 Surface Collection	LC	3MS	El Chayal	800	7677	49	18	11	155	153	21	115	11
CHP085	CHP-SR1-067 Surface Collection	LC	3MS	El Chayal	792	7542	57	18	12	159	155	21	116	11
CHP086	CHP-SR1-067 Surface Collection	LC	3PS-sf	El Chayal	721	6628	44	18	12	143	140	20	107	9
CHP087	CHP-SR1-068 Surface Collection	LC	NTB-ds	El Chayal	765	6616	36	17	9	139	134	19	105	9
CHP088	CHP-SR1-068 Surface Collection	LC	3MS	El Chayal	753	6481	52	18	7	143	145	20	109	8
CHP089	CHP-SR1-069 Surface Collection	LC	3PS-sf	El Chayal	759	7357	52	18	11	165	157	21	120	11
CHP090	CHP-SR1-070 Surface Collection	LC	TPS-sf	El Chayal	731	7184	46	18	11	144	146	23	108	10
CHP091	CHP-SR1-071 Surface Collection	LC	3MS	El Chayal	707	6643	44	18	10	147	145	21	111	10
CHP092	CHP-SR1-071 Surface Collection	LC	3MS	El Chayal	760	7296	43	18	9	156	153	21	114	11
CHP093	CHP-SR1-072 Surface Collection	LC	3MS	El Chayal	857	9485	92	19	11	165	165	23	119	11
CHP094	CHP-SR1-073 Surface Collection	LC	3PS-pa	El Chayal	714	6781	43	18	12	151	145	19	111	9
CHP095	CHP-SR1-073 Surface Collection	LC	2MS	El Chayal	746	8126	61	18	12	164	155	23	119	11
CHP096	CHP-SR1-073 Surface Collection	LC	3PS-pa	El Chayal	654	6676	36	17	11	145	135	18	107	9
CHP097	CHP-SR1-074 Surface Collection	LC	3PS-sf	El Chayal	679	6776	41	18	11	144	137	21	106	9
CHP098	CHP-SR1-075 Surface Collection	LC	3MS	El Chayal	797	9075	58	18	11	152	153	20	113	11
CHP099	CHP-SR1-076 Surface Collection	LC	3DS	El Chayal	743	7648	59	18	11	165	155	20	117	13
CHP100	CHP-SR1-076 Surface Collection	LC	3MS	El Chayal	750	6558	43	18	11	142	142	20	108	10
CHP101	CHP-SR1-077 Surface Collection	LC	CSF	El Chayal	710	6816	35	18	11	131	130	18	104	9
CHP102	CHP-SR1-078 Surface Collection	LC	3MS	El Chayal	716	6869	44	18	11	149	146	20	112	10
CHP103	CHP-SR1-078 Surface Collection	LC	3MS	El Chayal	773	7905	59	18	12	164	163	21	118	11
CHP104	CHP-SR1-079 Surface Collection	LC	3MS	El Chayal	749	7425	56	18	8	158	156	23	119	10
CHP105	CHP-SR1-079 Surface Collection	LC	3DS	El Chayal	746	6779	53	18	9	146	143	22	109	10
CHP106	CHP-SR1-081 Surface Collection	LC	3MS	El Chayal	847	7295	57	18	12	159	156	22	117	11
CHP107	CHP-SR1-083 Surface Collection	LC	3MS	El Chayal	691	6412	49	18	9	138	137	21	104	9
CHP108	CHP-SR1-083 Surface Collection	LC	TMS	El Chayal	772	7989	81	19	15	162	156	22	115	8
CHP109	CHP-SR1-083 Surface Collection	LC	3MS	Ixtepeque	453	10468	38	17	5	99	149	20	166	9

Sample ID	Provenience	Time Period	Technology	Source Group	Mn	Fe	Zn	Ga	Th	Rb	Sr	Y	Zr	Nb
CHP110	CHP-SR1-083 Surface Collection	LC	3MS	Ixtepeque	453	9593	31	17	7	98	141	18	155	8
CHP111	CHP-SR1-084 Surface Collection	LC	2CB-ms	SMJ	563	7611	40	17	7	114	186	16	111	7
CHP112	CHP-SR1-084 Surface Collection	LC	3PS-sf	Ixtepeque	511	10314	42	17	6	102	150	18	167	9
CHP113	CHP-SR1-084 Surface Collection	LC	3MS	El Chayal	776	7053	43	18	9	150	143	21	112	10
CHP114	CHP-SR1-084 Surface Collection	LC	3MS	El Chayal	783	7550	57	18	8	151	152	20	114	10
CHP115	CHP-SR1-084 Surface Collection	LC	3DS	El Chayal	719	7017	45	18	9	146	147	19	111	8
CHP116	CHP-SR1-084 Surface Collection	LC	3MS	El Chayal	745	7273	40	17	8	146	142	20	111	9
CHP117	CHP-SR1-084 Surface Collection	LC	3MS	El Chayal	637	7016	40	18	10	147	142	21	107	10
CHP118	CHP-SR1-084 Surface Collection	LC	3UCB-ps-pa	Ixtepeque	470	9771	56	18	7	97	143	19	162	10
CHP119	CHP-SR1-084 Surface Collection	LC	3MS	SMJ	657	9224	58	18	8	129	209	19	124	9
CHP120	CHP-SR1-084 Surface Collection	LC	3MS	Ixtepeque	464	10336	34	17	6	104	154	18	165	9
CHP121	CHP-SR1-084 Surface Collection	LC	2PS-sf	El Chayal	798	6805	37	18	10	140	138	21	109	9
CHP122	CHP-SR1-084 Surface Collection	LC	3PS-sf	Ixtepeque	562	12960	80	19	6	119	173	21	184	10
CHP123	CHP-SR1-084 Surface Collection	LC	TPS-sf	El Chayal	741	7138	56	18	12	146	144	21	108	8
CHP124	CHP-SR1-084 Surface Collection	LC	2PS-sf-pa	Ixtepeque	522	10482	36	17	8	105	157	19	163	10
CHP125	CHP-SR1-084 Surface Collection	LC	3PS-sf	Ixtepeque	479	9977	44	17	6	100	147	20	161	8
CHP126	CHP-SR1-084 Surface Collection	LC	2PS-sf	El Chayal	723	7817	61	18	12	158	157	22	115	9
CHP127	CHP-SR1-084 Surface Collection	LC	3MS-sh	Ixtepeque	489	10747	41	17	7	105	160	20	170	9
CHP128	CHP-SR1-084 Surface Collection	LC	3MS	SMJ	587	7597	37	17	11	122	188	18	116	9
CHP129	CHP-SR1-084 Surface Collection	LC	TMS	El Chayal	790	8200	57	18	9	164	159	19	117	11
CHP130	CHP-SR1-084 Surface Collection	LC	3PS-sf	El Chayal	782	7350	53	18	12	149	152	22	113	10
CHP131	CHP-SR1-084 Surface Collection	LC	3MS	Ixtepeque	540	10859	33	17	8	108	156	19	163	9
CHP132	CHP-SR1-084 Surface Collection	LC	3PS-sf	Ixtepeque	519	10525	31	17	7	104	157	18	171	9
CHP133	CHP-SR1-084 Surface Collection	LC	3DS	El Chayal	769	7469	50	18	8	152	153	20	115	11
CHP134	CHP-SR1-084 Surface Collection	LC	3PS-sf	Ixtepeque	480	10368	33	17	6	101	151	19	165	9
CHP135	CHP-SR1-086 Surface Collection	LC	3DS	El Chayal	626	6855	43	18	12	150	144	18	114	10
CHP136	CHP-SR1-086 Surface Collection	LC	3DS	Ixtepeque	582	11479	51	18	7	104	158	19	172	10
CHP137	CHP-SR1-086 Surface Collection	LC	3MS	SMJ	636	7607	42	18	11	115	193	17	115	8
CHP138	CHP-SR1-086 Surface Collection	LC	3MS	SMJ	613	7582	59	18	9	120	188	18	112	8

Sample ID	Provenience	Time Period	Technology	Source Group	Mn	Fe	Zn	Ga	Th	Rb	Sr	Y	Zr	Nb
CHP139	CHP-SR1-086 Surface Collection	LC	3PS-sf	El Chayal	768	7431	65	18	9	160	160	20	113	10
CHP140	CHP-SR1-086 Surface Collection	LC	TMS-H	SMJ	614	7442	43	18	8	116	191	19	115	7
CHP141	CHP-SR1-086 Surface Collection	LC	2MS	El Chayal	668	6775	43	18	11	146	144	20	114	9
CHP142	CHP-SR1-087 Surface Collection	LC	3MS	El Chayal	805	7659	46	18	10	162	157	20	116	10
CHP143	CHP-SR1-087 Surface Collection	LC	3DS	El Chayal	856	7881	59	18	13	165	162	22	117	12
CHP144	CHP-SR1-087 Surface Collection	LC	3DS	El Chayal	665	7489	48	18	12	148	147	20	109	10
CHP145	CHP-SR1-087 Surface Collection	LC	3PS-sf	El Chayal	799	8322	68	19	11	156	158	25	117	11
CHP146	CHP-SR1-087 Surface Collection	LC	3MS	El Chayal	762	7315	43	18	13	162	155	20	116	9
CHP147	CHP-SR1-087 Surface Collection	LC	CRF	El Chayal	688	6189	38	18	11	132	128	18	102	9
CHP148	CHP-SR1-087 Surface Collection	LC	3MS	El Chayal	683	7508	46	18	9	152	147	21	113	10
CHP149	CHP-SR1-087 Surface Collection	LC	3PS-sf	El Chayal	666	6494	44	18	9	139	140	21	111	9
CHP150	CHP-SR1-087 Surface Collection	LC	3MS	El Chayal	701	6992	54	18	11	154	146	20	112	10
CHP151	CHP-SR1-087 Surface Collection	LC	TPS-sf	El Chayal	719	6495	44	18	8	144	143	20	108	10
CHP152	CHP-SR1-087 Surface Collection	LC	3MS	El Chayal	861	8178	60	18	14	166	161	22	115	12
CHP153	CHP-SR1-087 Surface Collection	LC	3MS	El Chayal	697	6737	34	17	10	153	145	19	110	10
CHP154	CHP-SR1-087 Surface Collection	LC	3MS	El Chayal	726	7558	41	18	9	147	149	22	113	10
CHP155	CHP-SR1-087 Surface Collection	LC	TPS-sf	El Chayal	782	7364	52	18	13	165	155	21	117	9
CHP156	CHP-SR1-087 Surface Collection	LC	3MS	El Chayal	723	7750	55	18	12	160	160	22	115	10
CHP157	CHP-SR1-087 Surface Collection	LC	3MS	El Chayal	695	7523	51	18	12	156	155	20	115	12
CHP158	CHP-SR1-087 Surface Collection	LC	3MS	El Chayal	662	6887	41	18	10	151	144	21	113	11
CHP159	CHP-SR1-087 Surface Collection	LC	3DS	El Chayal	869	8053	68	19	12	166	164	22	118	11
CHP160	CHP-SR1-087 Surface Collection	LC	3PS-sf	El Chayal	732	6879	43	18	8	146	147	21	110	9
CHP161	CHP-SR1-087 Surface Collection	LC	3DS	El Chayal	806	7272	51	18	8	150	152	22	116	9
CHP162	CHP-SR1-087 Surface Collection	LC	CRF-DOF	El Chayal	708	6335	36	17	10	136	132	20	106	10
CHP163	CHP-SR1-087 Surface Collection	LC	3PS-sf	El Chayal	680	6360	44	18	9	141	142	20	106	9
CHP164	CHP-SR1-087 Surface Collection	LC	3PS-sf	Ixtepeque	514	10305	38	17	5	103	152	18	168	8
CHP165	CHP-SR1-087 Surface Collection	LC	3MS	El Chayal	753	6890	45	18	12	148	143	20	110	9
CHP166	CHP-SR1-087 Surface Collection	LC	3PS-sf	El Chayal	695	6533	40	18	9	140	136	20	108	9
CHP167	CHP-SR1-087 Surface Collection	LC	3MS	El Chayal	733	7299	51	18	10	145	145	20	112	9

Sample ID	Provenience	Time Period	Technology	Source Group	Mn	Fe	Zn	Ga	Th	Rb	Sr	Y	Zr	Nb
CHP168	CHP-SR1-090 Surface Collection	LC	3MS	El Chayal	791	8016	49	18	12	157	156	22	119	10
CHP169	CHP-SR1-091 Surface Collection	LC	3MS	El Chayal	788	7550	52	18	13	161	158	21	120	10
CHP170	CHP-SR1-091 Surface Collection	LC	3MS	El Chayal	749	6961	44	18	9	149	153	22	116	10
CHP171	CHP-SR1-091 Surface Collection	LC	3PS-sf	Ixtepeque	499	9848	38	17	7	99	150	20	161	8
CHP172	CHP-SR1-092 Surface Collection	LC	FLK-c	El Chayal	675	6848	45	18	11	140	139	18	106	9
CHP173	CHP-SR1-094 Surface Collection	LC	3MS	El Chayal	797	7645	52	18	13	157	152	24	117	10
CHP174	CHP-SR1-094 Surface Collection	LC	UNF	El Chayal	784	7095	54	18	11	146	143	20	112	9
CHP175	CHP-SR1-095 Surface Collection	LC	3PS-sf	El Chayal	704	6573	40	18	9	142	140	19	110	9
CHP176	CHP-SR1-096 Surface Collection	LC	3MS	Ixtepeque	427	9836	33	17	6	93	159	18	160	9
CHP177	CHP-SR1-098 Surface Collection	LC	OA-perc	El Chayal	624	5962	46	18	11	134	128	19	105	7
CHP178	CHP-SR1-098 Surface Collection	LC	3MS	El Chayal	708	6986	50	18	10	147	142	21	111	10
CHP179	CHP-SR1-100 Surface Collection	LC	3PS-sf	El Chayal	717	6143	50	18	8	139	136	19	105	8
CHP184	Zotz Str. 2, EU 12, Lvl 2, from burial 2-R/6	LC	3PS-sf	El Chayal	656	6192	39	17	9	142	144	19	107	9
CHP185	Zotz Str. 2, EU 12, Lvl 2	LC	3PS-sf	El Chayal	723	6482	48	18	9	150	152	18	112	10
CHP186	Cahal Pech Plaza G, EU PU-8, Lvl 2	LC	3MS	El Chayal	812	7924	59	18	13	171	162	22	115	12
CHP187	Cahal Pech Plaza G, EU PU-8, Lvl 2	LC	CSF	Ixtepeque	488	9814	44	17	4	100	144	17	164	9
CHP188	Cahal Pech Plaza G, EU PU-8, Lvl 2	LC	3MS	Ixtepeque	517	9667	50	18	7	96	147	18	156	8
CHP189	Cahal Pech Plaza G, EU PU-8, Lvl 2	LC	3MS-sh	Ixtepeque	445	8804	29	17	5	89	133	18	151	8
CHP190	Cahal Pech Str. C2, EU 5, Lvl 1	LC	3MS	Ixtepeque	486	9550	46	18	8	104	154	17	165	9
CHP191	Cahal Pech Str. C3, EU 5, Lvl 3	EC	3MS	Ixtepeque	464	9476	34	17	5	103	147	18	163	9
CHP193	Cahal Pech Plaza H/Str. H1, EU H8, Lvl 1, Humus	LC	3PS-sf	El Chayal	802	7089	45	18	11	153	154	22	119	10
CHP194	Cahal Pech Plaza H/Str. H1, EU H7, Lvl 2, Humus	LC	3MS	El Chayal	903	8277	52	18	13	164	167	20	115	12
CHP195	Cahal Pech Plaza H/Str. H1, EU H8, Lvl 2, Humus	LC	3PS-sf	SMJ	545	6978	42	18	10	119	194	16	113	7
CHP196	Cahal Pech Plaza H/Str. C3, EU H5A, Lvl 3	LC	UNF	El Chayal	707	6580	50	18	12	152	149	20	115	10
CHP197	Cahal Pech Plaza H, EU H7, Lvl 4, Humus	LC	3PS-sf	El Chayal	714	6491	44	18	9	138	137	18	107	8
CHP198	Cahal Pech Plaza H/Str. H1, EU H5C, Lvl 4	LC	3MS	El Chayal	765	7335	55	18	14	162	151	21	117	9
CHP199	Cahal Pech Plaza H/Str. C3, EU H5A, Lvl 6	LC	SH	El Chayal	942	9004	110	20	13	187	175	23	128	10
CHP200	Cahal Pech Plaza H/Str. C3, EU H5A, Lvl 7	LC	3MS	El Chayal	604	6119	38	18	10	137	132	18	101	8

Sample ID	Provenience	Time Period	Technology	Source Group	Mn	Fe	Zn	Ga	Th	Rb	Sr	Y	Zr	Nb
CHP201	Cahal Pech Str. C3, EU 5C, Lvl 5	LC	3MS	Ixtepeque	652	13079	63	18	8	125	187	20	188	12
CHP202	Cahal Pech Plaza H/Str. C3, EU H5A, Lvl 8	LC	3DS	El Chayal	760	7462	53	18	12	168	165	22	117	11
CHP203	Cahal Pech Str. B1, EU B1/B3-1, Lvl 1	LPC	3MS	El Chayal	753	6890	46	18	11	149	149	21	111	10
CHP204	Cahal Pech Str. B1, EU B1/B3-2, Lvl 1	LPC	3DS	SMJ	632	7315	39	17	9	115	190	17	111	7
CHP205	Cahal Pech Str. B1, EU B1/B3-1, Lvl 1	LPC	3MS	El Chayal	901	8369	67	19	12	167	163	22	118	11
CHP206	Cahal Pech Str. B1, EU B1/B3-2, Lvl 1	LPC	TMS	SMJ	563	7308	45	18	10	117	182	18	116	8
CHP208	Cahal Pech Str. B1, EU B1/B3-2, Lvl 1	LPC	3MS	El Chayal	640	5871	54	18	10	129	128	18	100	9
CHP209	Cahal Pech Str. B1, EU B1/B3-2, Lvl 1	LPC	3MS	El Chayal	745	6739	44	18	9	156	151	18	115	9
CHP210	Cahal Pech Str. B3, EU 1, Lvl 2	LC	3DS	Ixtepeque	520	10054	35	17	6	103	160	19	171	9
CHP211	Cahal Pech Str. C4/B3, EU C4/BB-E-12-1, Lvl 1	LC	3PS-sf	El Chayal	766	6576	52	18	10	147	147	21	108	9
CHP212	Cahal Pech Str. C4/B3, EU C4/BB-E-12-1, Lvl 1	LC	TMS	SMJ	554	7001	46	18	10	119	192	15	114	8
CHP213	Cahal Pech Str. B1, EU B1/B3-3, Lvl 1	LPC	3DS	El Chayal	719	7114	58	18	10	153	151	23	115	10
CHP214	Cahal Pech Str. H1, EU 11, Lvl 1	TC	TMS	El Chayal	764	6937	47	18	14	157	154	22	113	11
CHP215	Cahal Pech Str. H1, EU 11, Lvl 1	TC	3MS	El Chayal	822	7453	60	18	13	169	164	21	121	12
CHP216	Cahal Pech Str. H1, EU 11, Lvl 2	TC	3PS-sf	El Chayal	722	6426	38	18	10	147	144	20	110	8
CHP217	Cahal Pech Str. H1, EU 11, Lvl 2	TC	2PS-sf	El Chayal	766	7836	63	18	12	173	165	23	119	11
CHP218	Cahal Pech Str. H1, EU 11, Lvl 2	TC	3DS	El Chayal	838	8351	64	19	13	176	177	24	121	12
CHP219	Cahal Pech Str. H1, EU 10, Lvl 2	TC	3MS	El Chayal	912	10088	100	20	14	209	197	22	134	12
CHP220	Cahal Pech Str. H1, EU 9, Lvl 2	TC	3PS-sf	SMJ	609	7599	46	18	10	123	197	18	117	8
CHP221	Cahal Pech Str. H1, EU 11, Lvl 3	TC	3MS	El Chayal	692	6323	45	18	8	143	146	20	110	8
CHP222	Cahal Pech Str. H1, EU 11, Lvl 3	TC	3MS	El Chayal	774	7838	63	18	11	167	163	21	117	11
CHP223	Cahal Pech Str. H1, EU 12, Lvl 3	TC	1PS-sf	El Chayal	767	7867	60	18	14	171	173	22	125	11
CHP224	Cahal Pech Str. H1, EU 10, Lvl 3	TC	3MS	El Chayal	768	7414	53	18	12	167	155	21	119	9
CHP225	Cahal Pech Str. H1, EU 12, Lvl 4	TC	3DS	El Chayal	906	8299	60	18	12	181	171	22	123	11
CHP226	Cahal Pech Str. H1, EU 11, Lvl 5	TC	3MS	El Chayal	704	6382	50	18	9	142	139	19	111	9
CHP227	Cahal Pech Str. H1, EU 11, Lvl 4	TC	3MS	El Chayal	822	8425	57	18	13	178	166	23	122	11
CHP228	Cahal Pech Str. H1, EU 10, Lvl 5A	TC	3PS-sf	El Chayal	790	7407	64	18	12	165	158	22	118	8
CHP229	Cahal Pech Str. H1, EU 9A, Lvl 5	TC	3MS	El Chayal	715	6699	56	18	11	152	149	19	112	10

Sample ID	Provenience	Time Period	Technology	Source Group	Mn	Fe	Zn	Ga	Th	Rb	Sr	Y	Zr	Nb
CHP230	Cahal Pech Str. H1, EU 9A, Lvl 5	TC	3MS	El Chayal	660	6656	44	18	9	151	150	21	114	11
CHP231	Cahal Pech Str. H1, EU 12, Lvl 8	TC	3PS-sf	El Chayal	570	5304	33	17	6	116	115	17	96	6
CHP232	Cahal Pech Str. H1, EU 9A, Lvl 7	TC	CRF	El Chayal	755	6807	52	18	8	149	148	20	111	8
CHP233	Cahal Pech Str. H1, EU 9A, Lvl 7	TC	3PS-sf-hb	El Chayal	771	7308	53	18	9	156	157	22	118	9
CHP234	Cahal Pech Plaza H, EU 9/10 ext, Lvl 1	TC	3MS	El Chayal	766	7882	43	18	12	163	156	22	120	11
CHP235	Cahal Pech Plaza H, EU F, Lvl 3	TC	1UCB-ms	SMJ	587	6622	44	18	8	104	176	16	109	7
CHP236	Cahal Pech Str. H1, EU 14, Lvl 1	TC	3MS	El Chayal	710	6787	50	18	11	152	152	21	116	9
CHP237	Cahal Pech Str. H1, EU Unit 9 Ext, Backfill	TC	3MS	El Chayal	718	6386	44	18	9	137	135	20	100	8
CHP238	Cahal Pech Plaza H, EU 13, Lvl 2	TC	3MS	El Chayal	723	6852	42	18	11	152	145	21	113	10
CHP240	Cahal Pech Plaza H, EU 14, Lvl 3	TC	3MS	El Chayal	681	6711	43	18	10	150	149	20	111	9
CHP241	Cahal Pech Str. H1 Backfill	TC	3MS	El Chayal	804	7902	61	18	12	171	166	22	122	11
CHP242	Cahal Pech Str. H1 Backfill	TC	GBT	El Chayal	875	8429	102	20	14	171	159	19	120	11
CHP243	Cahal Pech Str. H1, EU 9/10 ext interior, Lvl 2	TC	3MS-bp	El Chayal	886	7049	53	18	11	156	150	21	112	11
CHP244	Cahal Pech Plaza H, EU 15, Lvl 1	TC	3RC-sf	Ixtepeque	455	9344	25	17	4	93	144	18	159	9
CHP245	Cahal Pech Str. H1, EU 16, Lvl 1	TC	3MS	El Chayal	708	6596	50	18	9	148	146	22	112	9
CHP246	Cahal Pech DAM-1, EU CHP-DAM-1A, Lvl 1, Humus east of Feature 2	LC	3PS-sf	Ixtepeque	512	9861	45	17	5	94	140	18	154	8
CHP247	Cahal Pech Str. B7, EU 6, Lvl 1	LC	3MS-nt	El Chayal	724	6713	46	18	11	144	139	21	109	8
CHP248	Cahal Pech Str. B6/7-3, EU 3, Lvl 1	LC	3DS	El Chayal	720	7428	58	18	10	154	154	21	116	10
CHP249	Cahal Pech Str. B6, EU B6-2, Lvl 1	LC	3PS-sf	El Chayal	846	7974	109	20	12	162	153	22	115	11
CHP250	Cahal Pech Str. B6, EU B6-2, Lvl 1	LC	3MS	El Chayal	760	7133	46	18	14	155	146	18	109	11
CHP251	Cahal Pech Str. B6/7-3, EU B6/7-1, Lvl 1	LC	3MS	El Chayal	719	6495	44	18	8	144	143	20	108	10
CHP252	Cahal Pech DAM-1, EU CHP-DAM-1A, Lvl 3, Fill Below Floor 2	LC	3MS	Ixtepeque	540	9242	69	18	7	88	130	19	149	9
CHP253	Cahal Pech Str. B6/7-3, EU 5, Lvl 1, Surface Collection	TC	3MS	El Chayal	569	6297	43	18	8	139	133	19	105	8
CHP254	Cahal Pech Str. H1, EU 20, Lvl 1	TC	TMS	Pachuca	1355	19685	319	33	26	238	3	123	986	98
CHP255	Cahal Pech Str. H1, EU 20, Lvl 1	TC	3MS	El Chayal	690	6730	50	18	10	144	142	22	111	9
CHP256	Cahal Pech Str. H1, EU 20, Lvl 1	TC	3PS-sf	Pachuca	1228	17821	261	28	20	213	2	111	908	92
CHP257	Cahal Pech Str. H2, EU 23B, Lvl 1, H2 23B 1	TC	3MS	El Chayal	715	7024	58	18	10	152	151	21	117	10
CHP258	Cahal Pech Str. H2, EU 23B, Lvl 1, H2 23B 1	TC	TPS-sf	El Chayal	675	6376	40	18	9	141	144	21	111	10

Sample ID	Provenience	Time Period	Technology	Source Group	Mn	Fe	Zn	Ga	Th	Rb	Sr	Y	Zr	Nb
CHP259	Cahal Pech Str. H2, EU 23B, Lvl 1, H2 23B 1	TC	TMS	El Chayal	750	6683	50	18	11	146	148	21	110	9
CHP260	Cahal Pech Str. H2, EU 23B, Lvl 1, H2 23B 1	TC	3MS	El Chayal	694	6091	53	18	8	141	138	20	109	10
CHP261	Cahal Pech Str. H2, EU 23B, Lvl 1, H2 23B 1	TC	3DS	El Chayal	612	6087	40	18	10	143	141	20	108	10
CHP262	Cahal Pech Plaza H/Str. H1, EU 22, Lvl 1, Fill	TC	3MS	SMJ	646	8381	67	18	7	122	211	19	118	9
CHP263	Cahal Pech Plaza H/Str. H1, EU 22, Lvl 1	TC	3PS-sf	SMJ	664	8062	60	18	10	123	203	19	118	9
CHP264	Cahal Pech Plaza H/Str. H1, EU 22, Lvl 1	TC	3PS-sf	SMJ	653	7268	34	17	8	114	188	16	117	6
CHP265	Cahal Pech Plaza H/Str. H1, EU 22, Lvl 1	TC	3MS	El Chayal	672	7099	52	18	12	156	155	24	113	10
CHP266	Cahal Pech Str. H2, EU 23B, Lvl 4, H2 23B 4	TC	3MS-sm	El Chayal	708	7042	51	18	9	151	151	21	115	10
CHP267	Cahal Pech Str. H1, EU 22B + 24B, Lvl 3	TC	3MS	El Chayal	728	6900	39	18	11	155	154	21	115	10
CHP268	Cahal Pech Str. H1, EU 22B + 24B, Lvl 3	TC	TMS	El Chayal	890	8467	81	19	15	173	162	22	119	10
CHP269	Cahal Pech Str. H1, EU 22B + 24B, Lvl 3	TC	3MS	El Chayal	714	6946	50	18	11	153	152	22	114	10
CHP270	Cahal Pech Plaza H/Str. H1, EU 20, Lvl 4	TC	3DS	El Chayal	880	8024	83	19	13	161	159	22	118	10
CHP271	Cahal Pech Str. H1, EU 26, Lvl 1,	TC	3MS-nt	Ixtepeque	503	10450	45	18	6	104	158	20	169	10
CHP272	Cahal Pech Plaza H/Str. H2, EU 24, Lvl 2	TC	3DS	El Chayal	937	8726	73	19	13	175	166	22	124	12
CHP273	Cahal Pech Plaza H/Str. H2, EU 24, Lvl 2	TC	3MS	El Chayal	642	6536	69	18	9	140	136	19	105	9
CHP274	Cahal Pech Str. H1/H3 alley, EU 27A, Lvl 3, H1/H3 alley	TC	NPB-sf	El Chayal	668	6375	42	18	11	144	140	20	108	9
CHP275	Cahal Pech Str. H1/H3 alley, EU 27A, Lvl 2, H1-H3 alley 27 l.2	TC	2PS-sf	El Chayal	818	7192	58	18	14	155	151	22	112	10
CHP276	Cahal Pech Plaza H/Str. H1, EU 29, Lvl 2	TC	3PS-sf	El Chayal	694	6574	44	18	11	142	141	19	109	9
CHP277	Cahal Pech Plaza H/Str. H1/H3, EU 30, Lvl 3	TC	3PS-sf	El Chayal	849	7751	62	18	12	162	164	21	117	11
CHP278	Cahal Pech Str. H1/H3, EU 30A, Lvl 4	TC	3MS	El Chayal	932	8812	112	20	14	172	163	24	119	11
CHP279	Cahal Pech Str. H2, EU 32, Lvl 2	TC	3DS	El Chayal	714	6835	48	18	11	149	146	21	110	10
CHP280	Cahal Pech Plaza H/Str. H1, EU 29, Lvl 4B	TC	3PS-sf	El Chayal	702	6899	49	18	8	144	145	21	112	9
CHP281	Cahal Pech Str. B1, EU B1-7West, Lvl 3, Below penultimate steps	EC	3MS	SMJ	565	7352	69	18	9	116	178	18	108	7
CHP282	Cahal Pech Str. B1, EU B1-7West, Lvl 3	EC	2UCB-sf	Ixtepeque	464	9903	40	17	7	103	152	19	163	9
CHP283	Cahal Pech Str. A1/A2 Alley, EU 1, Lvl 1	TC	3DS	El Chayal	738	6474	46	18	8	139	142	20	107	8
CHP284	Cahal Pech Str. B1, EU B1-7W, Lvl 3	EC	3CB-ds	SMJ	716	9276	84	19	12	146	220	18	124	11

Sample ID	Provenience	Time Period	Technology	Source Group	Mn	Fe	Zn	Ga	Th	Rb	Sr	Y	Zr	Nb
CHP285	Cahal Pech Str. A1/A2 Alley, EU 1, Lvl 1	TC	3MS	Ixtepeque	524	10095	66	18	6	107	152	18	165	9
CHP286	Cahal Pech Str. A1/A2 Alley, EU 1, Lvl 1	TC	3MS-sh	El Chayal	685	6300	42	18	11	139	135	19	110	10
CHP287	Cahal Pech Str. B1, EU B1-7West, Lvl 3, Below penultimate steps	EC	3DS	SMJ	596	7445	55	18	10	120	191	18	118	8
CHP288	Cahal Pech Str. A1/A2 Alley, EU 1C-East, Lvl 1	TC	3PS-sf	El Chayal	700	6448	40	17	7	140	138	21	107	10
CHP290	Cahal Pech Str. G2, EU G2-6, Lvl 1, Humis	LC	UNIF-ES	El Chayal	669	6233	40	18	10	137	134	18	108	8
CHP291	Cahal Pech Str. A1/A2 Alley, EU 1F-West, Lvl 1, Collapse	TC	3MS	El Chayal	782	7385	50	18	13	157	151	22	117	9
CHP292	Cahal Pech Str. B1, EU B1-7West, Lvl 7, Below Floor 6	EC	TPS-sf	El Chayal	714	7446	55	18	12	157	154	22	114	10
CHP293	Cahal Pech Str. G2, EU G2-6, Lvl 1	LC	2PS-sf	El Chayal	781	7503	45	18	11	168	161	21	119	11
CHP294	Cahal Pech Str. B5, EU 5-3, Lvl 1	LC	3MS	Ixtepeque	462	9850	34	17	4	99	148	18	162	8
CHP295	Cahal Pech Str. A1/A2 Alley, EU 1E-West, Lvl 1, Above Floor Deposit	TC	3MS	Ixtepeque	540	11275	44	18	10	111	166	22	176	9
CHP296	Cahal Pech Str. A1/A2 Alley, EU 1D-West, Lvl 1, Above Floor Deposit	TC	3PS-gd	El Chayal	625	6390	44	18	11	142	134	19	107	9
CHP297	Cahal Pech Str. A1/A2 Alley, EU 1D-West, Lvl 1	TC	3PS-sf	El Chayal	678	6690	44	18	10	145	140	21	110	9
CHP298	Cahal Pech Str. A1/A2 Alley, EU 1D-West, Lvl 1	TC	3MS	El Chayal	722	6730	42	18	10	145	145	21	113	10
CHP299	Cahal Pech Str. A1/A2 Alley, EU 1C-East, Lvl 1, above floor deposit	TC	3MS	El Chayal	635	6471	43	18	9	145	140	19	107	10
CHP300	Cahal Pech Str. A1/A2 Alley, EU 1B-East, Lvl 1, Above Floor Deposit	TC	3PS-sf	El Chayal	724	6818	41	18	9	147	146	19	111	10
CHP301	Cahal Pech Str. A1/A2 Alley, EU 1B-East, Lvl 1	TC	3DS-pl	El Chayal	637	6617	61	18	10	141	135	18	105	9
CHP302	Cahal Pech Str. A1/A2 Alley, EU 1C-West, Lvl 1	TC	3MS	El Chayal	778	7281	51	18	13	161	155	22	113	10
CHP303	Cahal Pech Str. A1/A2 Alley, EU 1C-West, Lvl 1	TC	3MS-sh	El Chayal	694	7058	87	19	14	148	143	23	107	9
CHP304	Cahal Pech Str. A1/A2 Alley, EU 1C-West, Lvl 1	TC	3MS	El Chayal	793	7210	54	18	10	147	143	20	113	10
CHP305	Cahal Pech Str. A1/A2 Alley, EU 1A-West, Lvl 1	TC	3PS-sf	El Chayal	712	6230	47	18	9	138	134	20	106	9
CHP306	Cahal Pech Str. G2, EU 7, Lvl 1	LC	3PS-sf	El Chayal	671	6490	47	18	10	145	138	21	110	8
CHP307	Cahal Pech Str. G2, EU 7, Lvl 1	LC	3MS	Ixtepeque	561	11628	78	19	8	114	162	22	175	10
CHP308	Cahal Pech Str. G2, EU 7, Lvl 1	LC	3MS	El Chayal	661	6556	52	18	9	144	138	20	107	9
CHP309	Cahal Pech Str. A1/A2 Alley, EU 1B-West, Lvl 1, Above Floor Deposit	TC	3MS	El Chayal	795	7030	47	18	11	154	149	21	116	10
CHP310	Cahal Pech Str. A1/A2 Alley, EU 1B-West, Lvl 1	TC	3PS-sf	El Chayal	741	7383	56	18	11	154	148	21	115	8
CHP311	Cahal Pech Str. B1, EU B1-8West, Lvl 2, Below terminal phase	LC	TMS	El Chayal	694	6777	42	18	12	156	150	20	112	10

Sample ID	Provenience	Time Period	Technology	Source Group	Mn	Fe	Zn	Ga	Th	Rb	Sr	Y	Zr	Nb
CHP312	Cahal Pech Str. B1, EU B1-8West, Lvl 2, Below terminal phase	LC	3DS	El Chayal	716	6904	56	18	11	157	154	22	116	10
CHP313	Cahal Pech Plaza G, EU PL PU-G-3, Lvl 1, Humus	LC	3MS	El Chayal	711	6368	48	18	13	140	139	20	109	9
CHP314	Cahal Pech Str. G2, EU G2-8, Lvl 1, Humus	LC	OA-perc	Ixtepeque	565	11262	61	18	7	109	163	19	171	10
CHP315	CHP07 Surface Collection	LC	CSF	SMJ	589	7276	57	18	9	121	199	18	117	9
CHP316	Cahal Pech Str. G2, EU G2-8, Lvl 1	LC	3DS	El Chayal	750	6968	56	18	12	156	152	22	113	10
CHP317	Cahal Pech Str. G3	TC	3MS	El Chayal	714	6685	42	18	11	148	149	20	111	10
CHP318	Cahal Pech Plaza G, EU PL PU-G-3, Lvl 4, Below Floor 4	LC	NMB-ds	El Chayal	644	5849	39	18	10	130	131	19	103	8
CHP319	Cahal Pech Plaza G, EU PL PU-G-3, Lvl 4	LC	TDS	El Chayal	796	6904	48	18	11	147	143	20	109	10
CHP320	Cahal Pech Plaza G, EU PL PU-G-3, Lvl 4	LC	3MS	SMJ	577	6883	41	18	9	108	177	16	110	7
CHP321	Cahal Pech Plaza G, EU PL PU-G-3, Lvl 5, Below Floor 4	LC	SH	Ixtepeque	516	10703	52	18	6	108	155	21	169	11
CHP322	Cahal Pech Plaza G, EU CHP-pl-G-3, Lvl 6, below floor 4	LC	3DS	El Chayal	800	7046	50	18	11	152	153	23	116	11
CHP324	Cahal Pech Str. B5, EU B5-3, Lvl 4, below floor 3	LC	3PS-sf	El Chayal	728	6990	58	18	7	143	139	20	106	11
CHP325	Cahal Pech Str. B5, EU B5-3, Lvl 4	LC	3MS	Ixtepeque	517	10466	49	18	7	102	161	21	170	11
CHP326	Cahal Pech Str. A1/A2 Alley, Desposit 1 A1/West	TC	3MS	El Chayal	681	6294	39	18	10	146	139	20	110	9
CHP327	Cahal Pech Str. B5, EU B5-4, Lvl 4, Feature 1, below floor 3	EC	3MS	El Chayal	845	7819	60	18	10	159	158	21	112	11
CHP328	Cahal Pech Str. G2, EU G2-5, Lvl 2	LC	3DS	El Chayal	746	7621	75	19	11	150	153	23	109	8
CHP329	CHP23 Surface Collection	LC	3PS-sf	El Chayal	654	7280	50	18	10	150	144	21	112	9
CHP330	Cahal Pech Plaza G, EU PL PU-G-3, Lvl 9, Below Floor 8	LPC	3PS-sf	SMJ	500	6815	41	18	8	106	175	16	108	8
CHP331	Cahal Pech Str. B5, EU B5-4, Lvl 7, below floor 6	EC	TMS	Ixtepeque	627	12144	40	17	6	113	171	18	176	11
CHP332	Cahal Pech Str. G2, EU G2-9, Lvl 1	LC	3MS	El Chayal	762	6772	44	18	13	153	140	18	117	10
CHP333	Cahal Pech Plaza G, EU PL PU-G-3, Lvl 10, Below Floor 8	LPC	3PS-sf	SMJ	540	6922	43	18	9	120	166	15	88	7
CHP334	Cahal Pech Plaza G, EU PL PU-G-3, Lvl 9, Below Floor 8	LPC	3MS	SMJ	612	7627	43	18	8	117	190	19	116	9
CHP335	Cahal Pech Plaza G, EU PL PU-G-3, Lvl 9	LPC	3PS-sf	SMJ	637	8016	52	18	9	124	198	18	119	10
CHP336	Cahal Pech Plaza G, EU PL PU-G-3, Lvl 9	LPC	LF3	SMJ	582	7360	35	17	8	130	175	18	91	9
CHP337	Cahal Pech Plaza G, EU PL PU-G-3, Lvl 9	LPC	3MS	SMJ	576	6707	61	18	8	108	173	15	110	8
CHP338	Cahal Pech Str. H1, EU 30, Lvl 4,	TC	3PS-sf	El Chayal	906	8261	84	19	10	160	161	18	112	10

Sample ID	Provenience	Time Period	Technology	Source Group	Mn	Fe	Zn	Ga	Th	Rb	Sr	Y	Zr	Nb
CHP339	Cahal Pech Plaza G, EU PL PU-G-3, Lvl 4	LC	3MS	El Chayal	792	7804	71	19	13	159	156	20	113	12
CHP340	Cahal Pech Plaza G, EU PL PU-G-3, Lvl 4	LC	NMB-sf	El Chayal	673	6264	39	18	10	137	135	20	105	8
CHP341	Cahal Pech Str. B1, EU B1-8 West, Lvl 2	EC	3MS	El Chayal	768	6770	64	18	11	153	151	21	113	10
CHP342	Zotz Str. 2, Burial 2-B/6	LC	3PS-sf-c	El Chayal	701	6484	42	18	10	145	145	20	107	8
CHP343	Zotz Str. 2, Burial 2-B/6	LC	3PS-sf-c	El Chayal	715	6689	44	17	7	150	149	21	110	10
CHP344	Zotz Str. 2, Burial 2-B/6	LC	3PS-sf-c	El Chayal	730	7011	51	18	11	157	154	19	115	10
CHP345	Zotz Str. 2, Burial 2-B/6	LC	3PS-sf-c	El Chayal	666	7077	49	18	10	156	156	20	113	11
CHP346	Cahal Pech Str. A1/A2 Alley, EU 1B-West, Lvl 1	TC	3PS-sf	El Chayal	666	6462	40	17	9	140	142	20	110	9
CHP347	Cahal Pech Plaza H/Str. H1, EU H7, Lvl 2, Humus	LC	3MS	El Chayal	774	7312	54	18	13	159	156	23	117	10
CHP348	Cahal Pech Plaza B, EU CHP-PB-PU-15, Lvl 15, Below Floor 12	LC	3MS	SMJ	623	7097	36	17	8	115	187	17	115	8
CHP349	Cahal Pech Plaza B, EU CHP-PB-PU-14 ext. 3, Lvl 1, Feature 14	LC	3PS-sf	El Chayal	700	6176	40	18	9	141	134	21	108	8
CHP350	Cahal Pech Plaza B, EU CHP-PB-PU-14 ext. 3, Lvl 1, Feature 14	LC	3DS	El Chayal	661	6464	35	17	9	145	141	19	112	9
CHP351	Cahal Pech Str. B-2, EU B2-1, Lvl 8, Below Floor 8	LPC	3MS	SMJ	621	6879	32	17	8	109	181	16	112	7
CHP352	Cahal Pech Str. B-2, EU B2-1, Lvl 8, Below Floor 8	LPC	3MS	SMJ	792	8742	56	18	11	132	212	18	120	9
CHP353	Cahal Pech Plaza B, EU CHP-PB-PU-17, Lvl 10, Below Floor 6	LPC	TMS	Ixtepeque	535	10090	42	18	8	106	150	19	168	10
CHP354	Cahal Pech Plaza B, EU CHP-PB-PU-19, Lvl 1, Humus	LC	3PS-sf	El Chayal	826	7005	44	18	10	152	145	22	112	9
CHP355	Cahal Pech Plaza B, EU CHP-PB-PU-20, Lvl 7, Below Floor 7	LPC	3ms	Ixtepeque	469	11114	65	18	8	113	163	19	175	12
CHP356	Cahal Pech Plaza B, EU CHP-PB-PU-21, Lvl 1, Humus	LC	CSF-bp	El Chayal	567	6064	37	17	9	130	130	21	103	9
CHP357	Cahal Pech Plaza B, EU CHP-PB-PU-21, Lvl 1, Humus	LC	TMS	El Chayal	925	9456	100	20	13	184	173	21	120	12
CHP358	Cahal Pech Plaza B, EU CHP-PB-PU-19, Lvl 8, Below Floor 11	MPC	3PS-sf	SMJ	540	7201	48	18	6	110	169	16	109	9
CHP359	Cahal Pech Plaza B, EU CHP-PB-PU-19, Lvl 8, Below Floor 11	MPC	3MS	SMJ	582	7243	46	18	8	112	183	19	114	8
CHP360	Cahal Pech Plaza B, EU CHP-PB-PU-19, Lvl 8, Below Floor 11	MPC	3MS	SMJ	653	8102	55	18	11	126	204	18	120	10
CHP361	Cahal Pech Plaza B, EU CHP-PB-PU-19, Lvl 8, Below Floor 11	MPC	3DS	SMJ	832	8817	63	18	12	135	208	16	120	9
CHP362	Cahal Pech Plaza B, EU CHP-PB-PU-16, Lvl 10, Below Feature 11	MPC	3RC-sf	SMJ	638	7570	44	18	8	119	188	17	115	8
CHP363	Cahal Pech Plaza B, EU CHP-PB-PU-19b, Lvl 8, Below Feature 11	MPC	3MS	SMJ	564	7056	36	17	8	114	179	17	114	7
CHP364	Cahal Pech Plaza B, EU CHP-PB-PU-16b, Lvl 11, Below Floor 12	MPC	3MS	SMJ	689	8207	59	18	10	121	203	18	119	8

Sample ID	Provenience	Time Period	Technology	Source Group	Mn	Fe	Zn	Ga	Th	Rb	Sr	Y	Zr	Nb
CHP365	Cahal Pech Plaza B, EU CHP-PB-PU-23, Lvl 8, Below Floor 11b	LPC	3MS	SMJ	644	7685	47	18	10	119	196	19	112	7
CHP366	Cahal Pech Plaza B, EU CHP-PB-PU-23, Lvl 8, Below Floor 11b	LPC	3MS	SMJ	613	7379	41	17	8	116	193	19	115	8
CHP367	Cahal Pech Plaza B, EU CHP-PB-PU-23, Lvl 8, Below Floor 11b	LPC	3MS	SMJ	545	6946	36	17	8	107	176	16	108	7
CHP368	Cahal Pech Plaza B, EU CHP-PB-PU-19c, Lvl 12, Inside Feature 12	MPC	3MS	SMJ	777	9911	86	19	10	136	219	17	119	11
CHP369	Cahal Pech Plaza B, EU CHP-PB-PU-20b, Lvl 12, Inside Feature 12	MPC	3MS	SMJ	577	7517	34	17	8	114	194	19	114	7
CHP370	Cahal Pech Plaza B, EU CHP-PB-PU-19c, Lvl 13, Below stamped earth floor	MPC	3MS	SMJ	585	7659	49	18	10	118	191	16	114	8
CHP371	Cahal Pech Plaza B, EU CHP-PB-PU-22, Lvl 9, Below Feature 11	MPC	3MS	SMJ	592	7369	34	17	10	121	189	17	115	8
CHP372	Cahal Pech Plaza B, EU CHP-PB-PU-22, Lvl 9, Below Feature 11	MPC	3MS	SMJ	623	7574	42	18	9	120	194	16	116	10
CHP374	Cahal Pech Plaza B, EU CHP-PB-PU-25, Lvl 1, Humus	LC	1PS-sf	El Chayal	740	6862	38	18	11	151	149	22	115	11
CHP375	Cahal Pech Plaza B, EU CHP-PB-PU-25, Lvl 1, Humus	LC	3PS-sf	El Chayal	754	7151	60	18	12	143	137	18	107	9
CHP376	Cahal Pech Plaza B, EU CHP-PB-PU-24, Lvl 2, Collapse	LC	3MS	El Chayal	692	6697	42	18	10	143	141	20	111	9
CHP377	Cahal Pech Plaza B, EU CHP-PB-PU-25, Lvl 2, Collapse	LC	3DS	El Chayal	907	8625	78	19	12	174	162	22	124	12
CHP378	Cahal Pech Plaza B, EU CHP-PB-PU-24, Lvl 7, Outside Feature 20	MPC	SDF	El Chayal	667	6586	44	17	8	141	139	22	109	10
CHP379	Cahal Pech Plaza B, EU CHP-PB-PU-19b, Lvl 10, Below Floor 12	MPC	3DS	El Chayal	530	6116	64	18	9	126	124	18	99	9
CHP380	Cahal Pech Plaza B, EU CHP-PB-PU-19b, Lvl 11, Fill	MPC	OA-perc	El Chayal	728	6587	47	18	10	140	142	21	105	9
CHP381	Cahal Pech Plaza B, EU CHP-PB-PU-25, Lvl 3, Str. B5 Collapse	LC	3MS	Ixtepeque	579	11036	42	17	7	110	165	21	176	10
CHP382	Cahal Pech Plaza F, EU CHP-PF-PU-4, Lvl 1, Humus	LC	3MS	Ixtepeque	586	10698	39	17	7	104	160	19	173	9
CHP383	Cahal Pech Plaza F, EU CHP-PF-PU-4, Lvl 3, Below Floor 3	LC	3PS-sf	Ixtepeque	489	9650	30	17	7	99	148	18	161	8
CHP384	Cahal Pech Plaza F, EU CHP-PF-PU-4, Lvl 3, Below Floor 3	LC	OA-perc	El Chayal	694	5961	38	17	7	133	129	18	103	9
CHP385	Cahal Pech Plaza F, EU CHP-PF-PU-4, Lvl 3, Below Floor 3	LC	3CB-ms	El Chayal	690	6297	38	17	9	141	139	22	109	9
CHP386	Cahal Pech Plaza B, EU CHP-PB-PU-26, Lvl 1, Humus	LC	3RC-sf	SMJ	664	7348	46	18	7	120	183	16	109	9
CHP387	Cahal Pech Plaza B, EU CHP-PB-PU-29, Lvl 1, Humus	LC	NMB-sf-nt	El Chayal	650	6005	46	18	8	131	130	18	101	8
CHP388	Cahal Pech Plaza B, EU CHP-PB-PU-27c, Lvl 1, Humus	LC	3MS	Ixtepeque	463	9699	41	17	6	97	149	19	160	9
CHP389	Cahal Pech Plaza B, EU CHP-PB-PU-28, Lvl 10, Below Floor 11-outside Feature 25	MPC	3PS-sf	SMJ	529	6928	37	17	7	108	183	17	111	7
CHP390	Cahal Pech Plaza B, EU CHP-PB-PU-27c, Lvl 8, Below Floor 10	LPC	3PS-sf	SMJ	481	6859	35	17	9	107	175	17	107	8

Sample ID	Provenience	Time Period	Technology	Source Group	Mn	Fe	Zn	Ga	Th	Rb	Sr	Y	Zr	Nb
CHP391	Cahal Pech Plaza B, EU CHP-PB-PU-27c, Lvl 8, Below Floor 10	LPC	3MS	SMJ	612	7528	37	17	8	114	191	16	115	8
CHP392	Cahal Pech Plaza B, EU CHP-PB-PU-27, Lvl 8, Below Floor 10	LPC	3MS	SMJ	668	8299	94	19	9	124	203	16	120	6
CHP393	Cahal Pech Plaza B, EU CHP-PB-PU-29, Lvl 9, Below Floor 10b	LPC	3MS	SMJ	625	7527	38	18	11	118	193	17	116	8
CHP394	Cahal Pech Plaza B, EU CHP-PB-PU-34, Lvl 2, Collapsed Fill	LC	3MS	El Chayal	717	6414	43	18	8	140	140	22	107	10
CHP395	Cahal Pech Plaza B, EU CHP-PB-PU-33b, Lvl 8, Below Floor 11-outside Feature 25	MPC	3MS	SMJ	548	6880	37	17	8	110	183	16	111	7
CHP396	Cahal Pech Plaza B, EU CHP-PB-PU-28, Lvl 11, Below Floor 12-outside Feature 25	MPC	3MS	SMJ	620	6946	37	17	7	109	184	17	114	8
CHP397	Cahal Pech Plaza B, EU CHP-PB-PU-28, Lvl 11, Below Floor 12-outside Feature 25	MPC	3MS	SMJ	543	7035	35	17	10	111	182	19	112	8
CHP398	Cahal Pech Plaza B, EU CHP-PB-PU-33c, Lvl 7, Below Floor 7	LPC	3PS-sf	El Chayal	832	7179	59	18	12	157	153	20	112	11
CHP399	Cahal Pech Plaza B, EU CHP-PB-PU-36, Lvl 1, Humus	LC	3MS	SMJ	602	7584	46	18	9	120	196	17	118	8
CHP400	Tzutziiy Kin Plaza, Below Wall Alignment	LC	2DS	El Chayal	737	7040	47	18	9	152	151	23	112	11
CHP401	Tzutziiy Kin Plaza, EU Plz-2, Lvl 2	LC	3PS-sf	El Chayal	823	6858	57	18	12	147	148	20	112	8
CHP402	Tzutziiy Kin Plaza, EU Plz-2, Lvl 2	LC	3RC-sf	El Chayal	747	6851	47	18	10	150	148	22	112	10
CHP403	Tzutziiy Kin Plaza, EU Plz-2, Lvl 2	LC	3PS-sf	El Chayal	737	6674	44	18	11	150	143	19	113	9
CHP404	Tzutziiy Kin Plaza, EU Plz-2, Lvl 2	LC	3PS-sf	El Chayal	920	7920	62	19	14	165	165	23	120	10
CHP405	Tzutziiy Kin Plaza, EU Plz-2, Lvl	LC	SDF	SMJ	701	8061	49	18	10	126	204	19	122	10
CHP406	Tzutziiy Kin Str. 2, Looter's Trench 3, Backdirt	TC	3MS	Ixtepeque	498	9819	35	17	7	100	149	19	159	9
CHP407	Tzutziiy Kin Plaza, Surface Collection	LC	3PS-sf	El Chayal	815	7523	64	19	14	163	156	23	116	11
CHP409	Tzutziiy Kin Str. 2, EU 2-3, Lvl 5, architectural feature	EC	SH	El Chayal	1001	9321	97	20	14	179	170	23	119	14
CHP410	Tzutziiy Kin Str. 2, EU 2-4, Lvl 4	LC	3MS	Ixtepeque	560	10344	41	17	8	101	148	20	164	10
CHP411	Tzutziiy Kin Str. 2, EU 2-4, Lvl 5	EC	3MS	El Chayal	726	6314	45	18	10	137	137	21	104	10
CHP412	Tzutziiy Kin Str. 2, EU 2-4, Lvl 5	EC	3PS-sf	Ixtepeque	523	9744	40	17	8	99	148	20	161	10
CHP413	Tzutziiy Kin Str. 2, EU 2-4, Lvl 6	EC	3MS	Ixtepeque	509	10961	44	17	6	110	155	21	172	10
CHP414	Cas Pek Str. 1, EU 3, Lvl 6	MPC	2MS	SMJ	650	7892	41	17	8	122	203	17	122	9
CHP415	Cas Pek Str. 1, EU 3, Lvl 6	MPC	TPS-sf	SMJ	612	6680	43	17	7	110	174	17	107	9
CHP416	Cas Pek Str. 5, EU 1, Lvl 1	LC	3PS-sf	SMJ	672	8064	54	18	9	126	202	16	119	10
CHP417	Cas Pek Str. 9, EU 1, Lvl 1	LC	TMS	SMJ	683	8173	44	18	9	122	202	19	120	8

Sample ID	Provenience	Time Period	Technology	Source Group	Mn	Fe	Zn	Ga	Th	Rb	Sr	Y	Zr	Nb
CHP418	Cas Pek Str. 9, EU 1, Lvl 1	LC	3MS-bp	SMJ	602	7349	43	18	9	118	193	18	115	8
CHP419	Cas Pek Str. 9, EU 1 NE-ext, Lvl 1	LC	3PS-sf	SMJ	696	8112	53	18	9	125	201	18	118	10
CHP420	Cas Pek Str. 9, EU 1, Lvl 1	LC	3MS	SMJ	605	7482	44	18	10	116	192	20	118	8
CHP421	Cas Pek Str. 1, EU 3, Lvl 5	MPC	TMS	SMJ	566	7294	45	18	7	116	198	18	117	8
CHP422	Cas Pek Surface Collection	LC	3MS	SMJ	686	7678	49	18	8	120	198	18	120	8
CHP423	Cas Pek Surface Collection	LC	2TPS-sfc	Ixtepeque	496	9577	27	17	5	95	145	16	157	9
CHP424	Cas Pek Str. 1, EU 1, Lvl 3	MPC	3MS	El Chayal	646	6008	42	18	11	137	134	19	104	8
CHP425	Cas Pek Str. 1, EU 3	TC	3PS-sf	El Chayal	863	7505	79	19	11	162	160	21	115	10
CHP426	Cas Pek Str. 1, EU 3	TC	3MS	El Chayal	914	9122	77	19	12	184	181	24	126	11
CHP427	Cas Pek Str. 1, EU 1, Lvl 5	MPC	3DS	Ixtepeque	513	9591	33	17	5	100	150	18	163	8
CHP428	Cas Pek Str. 1, EU 1, Lvl 8	MPC	3MS	SMJ	564	7618	56	18	8	119	200	18	114	8
CHP429	Cas Pek Str. 1, EU 1, Lvl 8	MPC	3DS	SMJ	581	7673	64	18	10	123	200	18	120	8
CHP430	Cas Pek Str. 1, EU Road Unit, Lvl B	MPC	SDF	SMJ	627	6978	39	17	8	119	189	16	106	9
CHP431	Cas Pek Str. 1, EU Road Unit 2, Lvl B	MPC	UNF	SMJ	583	6740	43	18	8	114	181	17	110	10
CHP432	Cas Pek Str. 1, EU Road Unit 2, AB Surface	MPC	3MS	El Chayal	780	7308	52	18	10	163	160	21	118	11
CHP433	Cas Pek Str. 1, EU 1, Lvl 5	MPC	3CB-ds-pl-hlc	SMJ	588	7473	46	18	11	123	199	17	114	7
CHP434	Cas Pek Str. 1, EU 1, Lvl 5	MPC	TMS	SMJ	594	8188	59	18	9	131	214	19	118	9
CHP435	Cas Pek Str. 1, EU 1, Lvl 7	MPC	3MS-em	SMJ	660	7521	47	18	7	118	200	18	114	9
CHP436	Cas Pek Str. 1, EU 1	MPC	3MS	SMJ	601	7396	45	18	7	127	195	16	116	9
CHP437	Cas Pek Str. 1, EU 1	MPC	3PS-sf-c	SMJ	643	8486	50	18	8	132	215	17	124	8
CHP438	Cas Pek Str. 1, EU 3, Lvl 1	LC	3MS	El Chayal	812	7473	55	18	11	163	163	23	116	10
CHP439	Cas Pek Str. 1, EU 3, Lvl 1	LC	TMS	Ixtepeque	527	9818	47	18	8	101	152	19	168	7
CHP440	Cas Pek Str. 1, EU 3, Lvl 1	LC	3MS	Ixtepeque	491	9750	42	17	7	100	154	19	167	9
CHP441	Cas Pek Str. 1, EU 3, Lvl 1	LC	3MS	El Chayal	655	6485	48	18	11	146	147	20	109	9
CHP442	Cas Pek Str. 1, EU 3, Lvl 1	LC	3DS	Ixtepeque	457	9326	37	17	6	99	145	18	157	8
CHP443	Cas Pek Str. 1, EU 3, Lvl 1	LC	3DS-bp	El Chayal	801	7195	48	18	10	159	157	22	116	9
CHP444	Cas Pek Str. 1, EU 3, Lvl 2	LC	3PS-sf	El Chayal	696	6826	60	18	11	166	159	21	115	11
CHP445	Cas Pek Str. 1, EU 3, Lvl 6	MPC	3MS	SMJ	603	7080	43	17	8	117	192	17	113	8

Sample ID	Provenience	Time Period	Technology	Source Group	Mn	Fe	Zn	Ga	Th	Rb	Sr	Y	Zr	Nb
CHP446	Cas Pek Str. 1, EU 3, Lvl 6	MPC	3PS-sf	El Chayal	650	6158	51	18	11	143	142	18	108	9
CHP447	Cas Pek Str. 1, EU 3, Lvl 6	MPC	3DS	SMJ	797	9530	69	19	13	146	242	20	130	10
CHP448	Cas Pek Str. 1, EU 3, Lvl 6	MPC	3MS	SMJ	578	7666	74	19	8	124	202	15	116	9
CHP449	Chum Unknown	MPC	3PS-sf	El Chayal	766	6788	54	18	10	149	150	20	113	10
CHP450	Chum Unknown	MPC	TMS	El Chayal	656	6374	45	18	9	143	139	18	110	8
CHP451	Chum Unknown	MPC	3MS	El Chayal	709	7100	41	18	10	153	157	22	117	10
CHP452	Chum Unknown	MPC	TPS-xp	Ixtepeque	436	9666	38	17	5	91	136	16	156	8
CHP453	Figueroa Str. 3, EU 1, Lvl 1	LC	3PS-sf	El Chayal	714	7159	43	18	10	156	162	20	118	10
CHP454	Figueroa Str. 2, EU 1, Lvl 1	LC	3MS	El Chayal	790	7267	62	18	10	161	161	22	115	9
CHP455	Figueroa Str. 2, EU 1, Burial 4 (Skull #2)	LC	3MS	El Chayal	596	5462	30	17	8	148	136	19	91	9
CHP456	Figueroa Str. 2, EU 1, Burial 4	LC	3DS	El Chayal	642	6266	35	17	7	145	145	21	112	9
CHP457	Figueroa Str. 2, EU 1, Burial 4	LC	3MS	El Chayal	661	6341	44	18	9	146	148	20	111	10
CHP458	Figueroa Str. 2, EU 1, Cache 3 Fill	LC	3MS	El Chayal	762	7281	54	18	11	156	154	23	113	10
CHP459	Linda Vista Surface Collection	LC	3DS	Ixtepeque	401	9450	37	17	5	100	153	20	165	7
CHP460	Linda Vista Surface Collection	LC	3PS-sf	El Chayal	739	6423	43	18	9	142	146	21	111	10
CHP461	Martinez Group Str. 4, EU MG-4-1, Lvl 1, Humus/Collapse	LC	3DS	El Chayal	723	6576	39	18	12	150	151	21	112	10
CHP462	Martinez Group Str. 4, EU MG-4-1, Lvl 1, Humus/Collapse	LC	3DS	El Chayal	664	6251	40	18	9	145	144	20	111	9
CHP463	Martinez Group Str. 4, EU MG-4-1, Lvl 1, Humus/Collapse	LC	3MS	El Chayal	780	8121	83	19	14	168	151	20	114	14
CHP464	Martinez Group Str. 2, EU MG-2-1, Lvl 2, Below Floor 1	LC	3MS	El Chayal	688	6613	47	18	10	148	147	20	110	10
CHP465	Martinez Group Str. 1, EU MG-1-1, Lvl 3, Fill behind wall	LC	3RC-sf	El Chayal	661	6797	58	18	11	150	151	21	114	11
CHP466	Martinez Group Str. 1, EU MG-1-1, Lvl 3, Fill behind wall	LC	3PS-sf	Ixtepeque	495	9500	35	17	6	98	152	19	166	9
CHP467	Martinez Group Str. 2, EU MG-2-1, Lvl 3, Below Floor 2	EC	3MS	El Chayal	762	7180	48	18	9	157	155	22	113	9
CHP468	Martinez Group Str. 1, EU MG-1-1, Lvl 4, Fill behind wall (2nd)	EC	TPS-sf	El Chayal	892	8070	57	18	11	169	165	23	121	11
CHP469	Martinez Group Str. 1, EU MG-1-1, Lvl 4, Fill behind wall (2nd)	EC	3MS	El Chayal	636	6590	46	18	9	151	144	20	115	10
CHP470	Martinez Group Str. 1, EU MG-1-1, Lvl 4, Fill behind wall (2nd)	EC	TDS	El Chayal	742	7245	52	18	10	163	160	22	115	10
CHP471	Tzinic EU 1, Lvl 3, Head Burial	LC	3PS-sf	El Chayal	836	7476	58	18	10	159	154	21	113	10
CHP472	Tzinic EU 1, Lvl 3, Head Burial	LC	3MS	El Chayal	691	6358	40	17	8	150	145	19	110	10

Sample ID	Provenience	Time Period	Technology	Source Group	Mn	Fe	Zn	Ga	Th	Rb	Sr	Y	Zr	Nb
CHP473	Tolok Str. 2, Cist Burial	LC	3MS	El Chayal	796	7084	48	18	14	155	144	21	113	8
CHP474	Tolok Str. 2, Cist Burial	LC	TPS-sf	El Chayal	651	6651	40	18	11	148	142	20	109	12
CHP475	Tolok Str. 2, Cist Burial	LC	3MS	Ixtepeque	425	9580	25	17	8	98	139	18	154	9
CHP477	Tolok Str. 5, EU 1, Lvl 1 ext.	MPC	3MS	El Chayal	690	7062	45	18	8	158	152	25	108	7
CHP478	Tolok Str. 5, EU 1, Lvl 1 ext.	MPC	3DS	El Chayal	773	6823	41	17	7	144	141	22	106	10
CHP479	Tolok Str. 5, EU 1, Lvl 1 ext.	LC	3MS	El Chayal	708	6245	43	18	14	145	139	23	112	8
CHP480	Tolok Str. 6, EU 1, Lvl 1	LC	TMS	Ixtepeque	511	11081	27	17	7	110	157	21	169	9
CHP481	Tolok Str. 9, EU 1, Lvl 1	LC	3MS	El Chayal	608	6063	34	17	8	127	128	22	105	9
CHP482	Tolok Str. 9, EU 1x3, Lvl 1	LC	3MS-sh	Ixtepeque	504	11111	86	19	8	102	156	17	164	12
CHP483	Tolok Str. 6, EU 1, Lvl 1	LC	3MS-sh	Ixtepeque	574	14341	145	21	8	117	185	19	176	10
CHP484	Tolok Str. 5, EU 1, Lvl 1	MPC	3MS-sh	El Chayal	732	7025	169	21	11	140	134	18	104	5
CHP485	Tolok Str. 9, EU 1, Lvl 1	LC	UNF	SMJ	700	8180	60	18	10	123	198	17	116	11
CHP486	Tolok Str. 9, EU 1, Lvl 1	LC	2TPS-ds	SMJ	497	6540	35	17	7	101	166	17	103	9
CHP487	Tolok Str. 9, EU 1, Lvl 1	LC	3MS	SMJ	880	10946	130	21	14	143	216	16	123	11
CHP488	Tolok Str. 7, EU 1, Lvl 1	MPC	3MS	Ixtepeque	469	9922	31	17	5	96	141	20	164	7
CHP489	Tolok Str. 8, EU 1, Lvl 1	LC	3MS	SMJ	488	7391	32	17	9	109	183	17	109	8
CHP490	Tolok Str. 9, EU 1, Lvl 1	LC	3PS-sf	SMJ	655	8415	67	18	8	123	197	14	116	11
CHP491	Tolok Str. 9, EU 1, Lvl 1	LC	SH	SMJ	800	10811	135	21	11	141	227	18	127	9
CHP492	Tolok Str. 9, EU 1, Lvl 1	LC	3MS	SMJ	658	9295	71	19	13	138	220	16	128	10
CHP493	Tolok Plaza, EU PU2-Patio, Lvl 1	MPC	3PS-sf	El Chayal	716	6887	44	17	4	149	141	21	105	9
CHP494	Tolok Plaza, EU PU2-Patio extension, Lvl 3	MPC	3PS-sf	SMJ	528	7444	42	17	3	110	188	18	113	8
CHP495	Tolok Plaza, EU PU2-Patio extension, Lvl 3	MPC	3PS-sf	El Chayal	692	6380	43	18	7	136	134	18	108	10
CHP496	Tolok Plaza, EU PU2-Patio extension	MPC	3MS	SMJ	650	7157	71	18	10	113	177	15	109	5
CHP497	Tolok Str. 4, EU 2x2 ext, Lvl 1	EC	3MS	SMJ	629	7307	36	17	10	115	187	16	112	9
CHP498	Tolok Str. 4, EU 2x2 ext, Lvl 1	EC	3DS	SMJ	583	6613	30	17	7	109	170	17	105	7
CHP499	Tolok Str. 4, EU 2x2 ext, Lvl 1	MPC	3MS	Ixtepeque	564	10029	34	17	6	96	151	19	166	9
CHP500	Tolok Plaza, EU PU2-ext, Lvl 1	MPC	3PS-sf	El Chayal	550	6217	47	18	9	136	137	18	110	9
CHP502	Tolok PU-1st, EU South Trench, Lvl 1	MPC	3PS-sf	El Chayal	689	6636	50	18	10	146	148	21	113	8

Sample ID	Provenience	Time Period	Technology	Source Group	Mn	Fe	Zn	Ga	Th	Rb	Sr	Y	Zr	Nb
CHP503	Tolok PU-1st, EU South Trench, Lvl 1	MPC	SH	El Chayal	952	8782	91	20	14	154	156	18	112	12
CHP504	Tolok PU-1st, EU West Trench, Lvl 1	MPC	3PS-pa	Ixtepeque	471	9621	29	17	5	93	143	21	157	7
CHP505	Tolok PU-1st, EU West Trench, Lvl 1	MPC	3MS	El Chayal	804	7684	47	18	11	158	156	20	114	10
CHP506	Tolok PU-1st, EU West Trench, Lvl 1	MPC	3MS	Ixtepeque	550	10315	38	17	5	95	149	20	158	8
CHP507	Tolok PU-1st, EU West Trench, Lvl 1	MPC	3MS	El Chayal	807	8252	73	19	11	161	155	25	113	15
CHP508	Tolok PU-1st, EU West Trench, Lvl 1	MPC	3MS	Ixtepeque	506	9938	44	17	6	104	145	17	162	8
CHP509	Tolok PU-1st, EU West Trench, Lvl 1-3	MPC	3MS	El Chayal	744	6936	38	18	10	152	145	20	117	10
CHP510	Tolok PU-1st, EU West Trench, Lvl 1-3	MPC	3MS	El Chayal	969	8274	70	19	14	166	151	23	120	10
CHP511	Tolok PU-1st, EU West Trench, Lvl 1-3	MPC	3MS	El Chayal	828	8434	79	19	14	162	159	21	110	14
CHP512	Tolok PU-1st, EU North Trench, Lvl 1-3	MPC	3MS	El Chayal	684	6749	39	18	13	152	146	20	111	9
CHP513	Tolok PU-1st, EU South Trench	MPC	3PS-sf	El Chayal	676	6732	46	18	10	143	138	21	108	9
CHP514	Tolok PU-1st, EU South Partition, Lvl 1	MPC	3MS	Ixtepeque	498	9535	24	17	6	96	142	17	154	9
CHP515	Tolok PU-1st, EU North Trench, Lvl 1-3	MPC	TMS-sh	El Chayal	709	7330	56	18	12	151	146	21	114	11
CHP516	Tolok PU-1st, EU South Trench, Lvl 1	MPC	TDS	El Chayal	1001	8669	145	21	13	160	161	21	108	11
CHP517	Tolok PU-1st, EU South Trench, Lvl 1	MPC	3MS	El Chayal	721	7199	51	18	10	153	144	20	113	10
CHP518	Tolok PU-1st, EU South Trench, Lvl 1	MPC	TPS-sf	Ixtepeque	516	10104	51	18	7	97	139	17	157	9
CHP519	Tolok PU-1st, EU South Trench, Lvl 1	MPC	3PS-sf	Ixtepeque	454	10330	32	17	5	98	154	19	163	9
CHP520	Tolok PU-1st, EU East Trench, Lvl 1	MPC	3MS	Ixtepeque	482	10441	28	17	7	102	148	19	163	10
CHP521	Tolok PU-1st, EU East Trench, Lvl 1	MPC	3DS	El Chayal	686	6443	36	17	8	143	140	17	108	10
CHP522	Tolok PU-1st, EU East Trench, Lvl 1	MPC	3MS	Ixtepeque	450	10011	49	18	7	100	149	19	159	9
CHP523	Tolok PU-1st, EU East Trench, Lvl 1	MPC	3MS	El Chayal	700	7638	125	20	11	142	152	25	113	10
CHP524	Tolok PU-1st, EU North Trench, Lvl 1-3	MPC	3PS-sf	El Chayal	553	7355	54	18	12	153	151	23	110	9
CHP525	Tolok PU-1st, EU South Trench 3, Lvl 1	MPC	3PS-sf	Ixtepeque	635	12380	64	18	7	116	170	20	182	12
CHP526	Tolok PU-1st, EU South Trench 3, Lvl 1	MPC	3MS	Ixtepeque	439	9408	26	17	6	96	142	18	153	9
CHP527	Tolok PU-1st, EU South Trench 3, Lvl 1	MPC	3MS	El Chayal	698	6828	39	18	10	139	135	18	109	10
CHP528	Tolok PU-1st, EU SW Trench, Lvl 1	MPC	3MS	El Chayal	844	7687	59	18	11	161	158	20	121	9
CHP529	Tolok PU-1st, EU SW Trench, Lvl 1	MPC	TPS-sf	Ixtepeque	533	11987	65	18	6	116	167	19	177	8
CHP530	Tolok PU-1st, EU SW Trench, Lvl 1	MPC	3DS	El Chayal	786	6841	46	18	15	152	147	20	108	9
CHP531	Tolok PU-1st, EU SW Trench, Lvl 1	MPC	SH	SMJ	489	6868	55	18	6	106	174	17	105	7

Sample ID	Provenience	Time Period	Technology	Source Group	Mn	Fe	Zn	Ga	Th	Rb	Sr	Y	Zr	Nb
CHP532	Tolok PU-1st, EU SW Trench, Lvl 1	MPC	3MS	Ixtepeque	444	9455	27	17	3	95	146	18	153	9
CHP533	Tolok PU-1st, EU SW Trench, Lvl 1	MPC	3MS	El Chayal	688	7101	45	18	8	150	143	23	113	12
CHP535	Tolok PU-1st, EU West Approach Trench, Lvl 1	MPC	3MS	Ixtepeque	494	10170	30	17	7	102	154	19	165	10
CHP536	Tolok PU-1st, EU West Approach Trench, Lvl 1	MPC	3MS	Ixtepeque	476	9709	36	17	5	95	145	18	158	10
CHP537	Tolok PU-1st, EU West Approach Trench, Lvl 1	MPC	DRS-sf	Ixtepeque	464	9748	49	18	8	102	143	19	160	9
CHP538	Tolok PU-1st, EU West Approach Trench, Lvl 1	MPC	3MS	Ixtepeque	590	9946	28	17	8	100	152	19	165	8
CHP539	Tolok PU-1st, EU West Approach Trench, Lvl 1	MPC	SH	El Chayal	851	7804	55	18	11	157	150	23	110	9
CHP540	Tolok PU-1st, EU West Approach Trench, Lvl 1	MPC	3MS	SMJ	638	7398	35	17	8	110	193	19	113	8
CHP541	Tolok PU-1st, EU West Approach Trench, Lvl 1	MPC	TMS	El Chayal	765	7858	60	18	14	159	153	24	114	10
CHP542	Tolok PU-1st, EU West Approach Trench, Lvl 1	MPC	3MS	SMJ	633	7803	52	18	6	117	196	16	112	8
CHP543	Tolok PU-1st, EU West Approach Trench, Lvl 1	MPC	3MS	El Chayal	762	7818	58	18	12	158	153	23	120	12
CHP544	Tolok PU-1st, EU NW Trench, Lvl 1	MPC	3DS	El Chayal	735	7252	103	19	7	137	141	20	107	8
CHP545	Tolok PU-1st, EU SW Trench, Lvl 1	MPC	TPS-sf	SMJ	565	6771	29	17	7	111	177	15	110	6
CHP546	Tolok PU-1st, EU West Approach Trench, Lvl 1	MPC	3MS	SMJ	562	7441	53	18	10	116	193	16	117	8
CHP547	Tolok PU-1st, EU West Approach Trench, Lvl 1	MPC	3PS-sf	Ixtepeque	505	10653	46	18	9	104	152	18	161	10
CHP548	Tolok PU-1st, EU West Approach Trench, Lvl 1	MPC	3MS	El Chayal	722	7060	44	18	12	149	144	23	113	10
CHP549	Tolok PU-1st, EU West Approach Trench, Lvl 1	MPC	3MS	Ixtepeque	632	11926	57	18	10	108	168	22	172	10
CHP550	Tolok Backdirt/Surface	TC	3DS-pl	El Chayal	577	6258	58	18	9	137	139	19	106	11
CHP551	Tolok PU-1st, EU Approach Trench, Lvl 1	MPC	3MS	El Chayal	753	7894	52	18	12	164	159	18	119	11
CHP552	Tolok PU-1st, EU Approach Trench, Lvl 1	MPC	NPB-sf	El Chayal	617	6055	43	18	10	129	129	21	101	7
CHP553	Tolok Plaza, EU West Approach Trench, Lvl 1	MPC	3MS	Ixtepeque	501	10015	20	17	7	99	146	19	163	9
CHP554	Tolok Plaza, EU West Approach Trench, Lvl 1	MPC	3MS	El Chayal	609	7469	51	18	11	155	152	21	111	9
CHP555	Tolok Plaza, EU West Approach Trench, Lvl 1	MPC	3MS	El Chayal	731	8259	67	18	10	163	153	20	115	11
CHP556	Tolok PU-1st, EU North Taverse Wall, Lvl 1	MPC	3PS-sf	El Chayal	659	6743	66	18	9	143	143	20	109	11
CHP557	Tolok PU-1st, EU West Trench, Lvl 1 - 7m	MPC	3DS	El Chayal	668	5921	37	17	9	127	118	21	100	7
CHP558	Tolok PU-1st, EU West Trench, Lvl 1 - 8m	MPC	3MS	Ixtepeque	677	12749	56	18	7	112	175	19	167	10

Sample ID	Provenience	Time Period	Technology	Source Group	Mn	Fe	Zn	Ga	Th	Rb	Sr	Y	Zr	Nb
CHP559	Tolok PU-1st, EU West Trench, Lvl 1 - 8m	MPC	3RC-sf	SMJ	568	7325	37	17	9	111	181	18	111	8
CHP560	Tolok PU-1st, EU West Trench, Lvl 1 - 8m	MPC	3MS	El Chayal	887	8363	77	19	14	172	169	21	115	11
CHP561	Tolok Str. 14, EU 14 Trench Backfill	TC	3MS	El Chayal	896	8898	87	19	12	182	165	24	129	13
CHP562	Tolok Str. 14, EU 14W1/SE, Lvl 1	MPC	3PS-sf	El Chayal	669	7218	58	18	12	156	157	20	117	9
CHP563	Tolok Str. 14, Backfill	TC	3MS	Ixtepeque	653	11404	56	18	6	110	165	23	169	10
CHP564	Tolok Plaza, EU West Traverse Trench, near round structure	MPC	3DS	SMJ	533	7511	44	17	6	114	191	17	118	8
CHP565	Tolok Str. 14, EU 14W1/NE, Lvl 1	MPC	3MS	Ixtepeque	529	11673	60	18	8	120	178	22	186	10
CHP566	Tolok Str. 14, EU 14W1/NE, Lvl 1	MPC	3MS	El Chayal	744	6869	62	18	8	158	157	22	119	8
CHP567	Tolok Str. 14, EU 14W1/NE, Lvl 1	MPC	FLK	Ixtepeque	569	12240	62	18	2	109	167	20	175	9
CHP568	Tolok Str. 14, EU 14W1/NE, Lvl 1	MPC	3MS	Ixtepeque	610	11241	69	18	6	114	179	20	183	10
CHP569	Tolok Str. 14, EU 14W1/NE, Lvl 1	MPC	3MS	El Chayal	747	7618	77	19	11	169	169	21	121	9
CHP570	Tolok Str. 14, EU 14W1/NE, Lvl 1	MPC	3DS	El Chayal	693	7275	60	18	11	158	150	21	114	10
CHP571	Tolok Str. 14, EU 14W1/NE, Lvl 1	MPC	3RC-sf	Ixtepeque	518	9687	49	18	5	106	157	19	173	6
CHP572	Tolok Str. 14, EU 14W1/NE, Lvl 1	MPC	3MS	Ixtepeque	503	9421	33	17	4	102	156	17	167	7
CHP573	Tolok Str. 14, EU 14W1/NE, Lvl 1	MPC	3MS	Ixtepeque	660	11098	60	18	6	117	181	20	184	9
CHP574	Tolok Str. 14, EU 14W1/NE, Lvl 1	MPC	3MS	Ixtepeque	584	10306	68	18	5	108	161	19	176	9
CHP575	Tolok Str. 14, EU 14W1/NE, Lvl 1	MPC	3MS	El Chayal	640	7327	59	18	9	157	161	21	119	9
CHP576	Tolok Str. 14, EU 14W1/NE, Lvl 1	MPC	3RC-sf	SMJ	533	6557	54	18	5	106	183	18	112	6
CHP577	Tolok Str. 14, EU 14W1/NW, Lvl 1	MPC	3RC-sf	Ixtepeque	554	9538	50	17	5	104	152	19	168	7
CHP578	Tolok Str. 14, EU 14W1/NW, Lvl 1	MPC	3MS-f	El Chayal	693	7904	87	19	12	162	148	21	108	10
CHP579	Tolok Str. 14, EU 14W1/NW, Lvl 1	MPC	3PS-sf-bp	El Chayal	771	6978	59	18	9	157	152	20	112	8
CHP580	Tolok Str. 14, EU 14W1/NW, Lvl 1	MPC	3MS	Ixtepeque	586	10362	56	18	6	105	160	19	178	7
CHP581	Tolok Str. 14, EU 14W1/NW, Lvl 1	MPC	3MS	El Chayal	776	6457	47	18	7	148	144	22	112	8
CHP582	Tolok Str. 14, EU 14W1/NW, Lvl 1	MPC	TMS	Ixtepeque	631	14754	136	21	12	128	175	16	191	11
CHP583	Tolok Str. 14, EU 14W1/NW, Lvl 1	MPC	TMS	El Chayal	714	7036	50	18	10	162	160	21	118	9
CHP584	Tolok Str. 14, EU 14W1/NW, Lvl 1	MPC	3MS	SMJ	633	7776	59	18	8	127	206	20	121	6
CHP585	Tolok Str. 14, EU 14W1/NW, Lvl 1	MPC	3MS	El Chayal	779	7076	58	18	9	160	156	21	121	7
CHP586	Tolok Str. 14, EU 14W1/SE, Lvl 1	MPC	3PS-sf	Ixtepeque	476	10119	43	17	3	106	149	18	171	11

Sample ID	Provenience	Time Period	Technology	Source Group	Mn	Fe	Zn	Ga	Th	Rb	Sr	Y	Zr	Nb
CHP587	Tolok Str. 14, EU 14W1/SE, Lvl 1	MPC	TMS	Ixtepeque	545	10588	51	17	5	112	163	19	178	9
CHP588	Tolok Str. 14, EU 14W1/SE, Lvl 1	MPC	3MS	El Chayal	717	7002	88	19	9	147	153	21	111	9
CHP589	Tolok Str. 14, EU 14W1/SE, Lvl 1	MPC	3MS	Ixtepeque	597	10405	54	18	7	113	162	18	182	10
CHP590	Tolok Str. 14, EU 14W1/SE, Lvl 1	MPC	3MS	El Chayal	851	8416	76	19	9	182	172	25	124	10
CHP591	Tolok Str. 14, EU 14W1/SE, Lvl 1	MPC	3MS	El Chayal	869	8142	84	19	10	160	155	19	115	10
CHP592	Tolok Str. 14, EU 14W1/SW, Lvl 1	MPC	3MS	Ixtepeque	478	9232	46	18	6	98	149	19	163	8
CHP593	Tolok Str. 14, EU 14W1/SW, Lvl 1	MPC	3MS	Ixtepeque	462	10304	36	17	5	110	165	15	179	11
CHP594	Tolok Str. 14, EU 14W1/SW, Lvl 1	MPC	3MS	Ixtepeque	540	10505	85	19	6	113	167	20	181	10
CHP595	Tolok Str. 14, EU 14W1/SW, Lvl 1	MPC	3PS-sf	Ixtepeque	520	10329	47	18	7	115	164	18	176	8
CHP596	Tolok Str. 14, EU 14W1/SW, Lvl 1	MPC	TMS	El Chayal	859	8037	79	19	11	154	157	23	117	11
CHP597	Tolok Str. 14, EU 14W1/SW, Lvl 1	MPC	3MS	SMJ	778	8535	81	19	9	128	219	18	120	8
CHP598	Tolok Str. 14, EU 14W1/SW, Lvl 1	MPC	3PS-sf	El Chayal	749	7685	73	19	13	153	143	23	114	9
CHP599	Tolok Str. 14, EU 14W1/SW, Lvl 1	MPC	3PS-sf	Ixtepeque	466	9149	47	18	5	101	149	19	162	8
CHP600	Tolok Str. 14, EU 14W1/SW, Lvl 1	MPC	3PS-sf	El Chayal	695	6581	48	18	6	150	152	21	113	9
CHP601	Tolok Str. 14, EU 14W1/SW, Lvl 1	MPC	3DS	SMJ	661	8012	63	18	6	126	213	17	117	7
CHP602	Tolok Str. 14, EU 14W1/SW, Lvl 1	MPC	3MS	El Chayal	743	6978	55	18	11	156	152	20	114	9
CHP603	Tolok Str. 14, EU 14W1/SW, Lvl 1	MPC	3MS	SMJ	580	7684	71	18	7	118	203	17	121	7
CHP604	Tolok Str. 14, EU 14W1/NW, Lvl 1	MPC	3PS-sf	El Chayal	738	7127	54	18	8	163	157	19	110	9
CHP605	Tolok Str. 14, EU 14W1/NW, Lvl 1	MPC	PDF	SMJ	585	6283	47	17	6	104	176	17	109	6
CHP606	Tolok Str. 14, EU 14W1/NW, Lvl 1	MPC	3MS-f	El Chayal	775	8667	118	20	10	152	160	21	113	13
CHP607	Tolok Str. 14, EU 14W1/NW, Lvl 1	MPC	3MS	Ixtepeque	496	9701	47	18	6	103	153	18	164	8
CHP608	Tolok Str. 14, EU 14W1/NW, Lvl 1	MPC	3MS	El Chayal	848	7454	58	18	8	162	161	22	116	8
CHP609	Tolok Str. 14, EU 14W1/NW, Lvl 1	MPC	3MS	El Chayal	668	7559	142	21	12	147	140	21	106	9
CHP610	Tolok Str. 14, EU 14W1/NW, Lvl 1	MPC	PSH	SMJ	717	6821	42	18	8	111	195	17	114	7
CHP611	Tolok Str. 14, EU 14W1/NE, Lvl 1	MPC	TMS-bp	Ixtepeque	520	11626	85	19	7	105	158	16	164	9
CHP612	Tolok Str. 14, EU 14W1/NW, Lvl 1	MPC	3MS-f	El Chayal	1034	9410	102	20	14	183	168	20	121	13
CHP613	Tolok Str. 14, EU 14W1/NW, Lvl 1	MPC	3MS-f	El Chayal	804	8529	89	19	12	170	160	23	122	11
CHP614	Tolok Str. 14, EU 14W1/NW, Lvl 1	MPC	3MS	El Chayal	802	7532	68	18	10	171	158	23	119	12
CHP615	Tolok Str. 14, EU 14W1/NW, Lvl 1	MPC	TMS	SMJ	861	10813	109	20	12	151	219	20	129	8

Sample ID	Provenience	Time Period	Technology	Source Group	Mn	Fe	Zn	Ga	Th	Rb	Sr	Y	Zr	Nb
CHP616	Tolok Str. 14, EU 14W1/SE, Lvl 1	MPC	3PS-sf	El Chayal	738	7054	62	18	7	151	160	21	111	6
CHP617	Tolok Str. 14, EU 14W1/SE, Lvl 1	MPC	3MS	El Chayal	763	6857	56	18	9	163	159	20	114	8
CHP618	Tolok Str. 14, EU 14W1/SW, Lvl 1	MPC	3DS	SMJ	605	7512	61	18	11	125	209	18	124	7
CHP619	Tolok Str. 14, EU 14W2/NE, Lvl 1	MPC	TMS	El Chayal	779	7854	57	18	9	149	148	23	116	10
CHP620	Tolok Str. 14, EU 14W2/NE, Lvl 1	MPC	UNF	El Chayal	779	7259	70	19	11	147	141	20	107	9
CHP621	Tolok Str. 14, EU 14W2/NE, Lvl 1	MPC	3MS	El Chayal	948	7829	46	18	9	155	157	23	111	13
CHP622	Tolok Str. 14, EU 14W2/NE, Lvl 1	MPC	3PS-sf	Ixtepeque	473	9697	43	17	7	95	140	18	152	6
CHP623	Tolok Str. 14, EU 14W2/SE, Lvl 1	MPC	FLK	El Chayal	770	7010	45	18	12	149	143	20	110	9
CHP624	Tolok Str. 14, EU 14W2/SE, Lvl 1	MPC	TPS-sf	Ixtepeque	535	10116	35	17	6	100	149	19	156	9
CHP625	Tolok Str. 14, EU 14W2/SE, Lvl 1	MPC	DSC3	El Chayal	724	7016	69	18	9	153	158	21	115	10
CHP626	Tolok Str. 14, EU 14W2/SW, Lvl 1	MPC	3MS	El Chayal	737	7757	64	19	14	161	152	19	119	11
CHP627	Tolok Str. 14, EU 14W2/SW, Lvl 1	MPC	2TPS-pa	El Chayal	745	6835	46	18	13	145	144	19	107	9
CHP628	Tolok Str. 14, EU 14W2/SW, Lvl 1	MPC	3MS-sh	El Chayal	689	7149	44	17	7	144	143	20	114	10
CHP629	Tolok Str. 14, EU 14W2/SW, Lvl 1	MPC	3DS	Ixtepeque	505	10515	30	17	6	100	155	17	168	8
CHP630	Tolok Str. 14, EU 14W2/SW, Lvl 1	MPC	2TPS-sf	SMJ	690	6765	31	17	6	102	170	16	106	7
CHP631	Tolok Str. 14, EU 14W2/NE, Lvl 1	MPC	3MS	El Chayal	862	7652	138	21	7	144	141	21	110	8
CHP632	Tolok Str. 14, EU 14W2/NE, Lvl 1-3	MPC	3MS	Ixtepeque	596	10374	41	18	7	102	147	19	162	10
CHP633	Tolok Str. 14, EU 14W2/SE, Lvl 1-2	MPC	3MS	El Chayal	756	7404	74	19	11	158	153	24	113	9
CHP634	Tolok Str. 14, EU 14W2/SW, Lvl 1-3	MPC	3MS	El Chayal	752	6993	63	18	8	147	145	22	108	10
CHP635	Tolok Str. 14, EU 14W2/SW, Lvl 1	MPC	3MS	El Chayal	769	7289	94	19	13	140	139	17	104	8
CHP636	Tolok Str. 14, EU 14W2/SW, Lvl 1	MPC	3MS-em	El Chayal	616	6628	45	18	15	152	138	16	109	10
CHP637	Tolok Str. 14, EU 14W2/SW, Lvl 1	MPC	3DS	Ixtepeque	455	10196	49	18	6	97	150	21	161	8
CHP638	Tolok Plaza, EU 1 , Lvl 1	MPC	3MS	El Chayal	653	6169	53	18	9	135	132	19	104	8
CHP639	Tolok Plaza, backFill from 1993	TC	3PS-sf	Ixtepeque	648	11768	45	18	7	103	163	20	173	11
CHP640	Tolok Str. 14, EU 14W2/NW, Lvl 1-3	MPC	3MS	El Chayal	706	7117	65	18	11	145	141	19	109	9
CHP641	Tolok Str. 14, EU 14W2/SE, Lvl 1-3	MPC	3MS	SMJ	711	8535	76	19	10	126	200	18	118	10
CHP642	Tolok Str. 14, EU 14W2/SW, Lvl 1-3	MPC	3DS	SMJ	538	6817	43	17	7	107	174	16	109	9
CHP643	Tolok Str. 14, EU 14W2/NE, Lvl 1-3	MPC	3MS	Ixtepeque	487	12462	57	18	8	113	162	19	182	12
CHP644	Tolok Str. 14, EU 14W2/NW, Lvl 1-3	MPC	3MS	SMJ	500	6931	35	17	6	114	180	17	112	9

Sample ID	Provenience	Time Period	Technology	Source Group	Mn	Fe	Zn	Ga	Th	Rb	Sr	Y	Zr	Nb
CHP645	Tolok Str. 14, EU 14W2/NW, Lvl 1-3	MPC	BTF	El Chayal	919	8613	101	20	13	170	155	23	114	11
CHP646	Tolok Str. 14, EU 14W2/NW, Lvl 1-3	MPC	3MS	SMJ	577	6678	35	17	7	105	170	16	109	8
CHP647	Tolok Str. 14, EU 14W3/NE, Lvl 1	MPC	3MS	SMJ	673	7985	45	18	12	123	189	15	111	8
CHP648	Tolok Str. 14, EU 14W3/NE, Lvl 1	MPC	3MS	Ixtepeque	496	9321	31	17	6	92	132	18	150	9
CHP649	Tolok Str. 14, EU 14W3/NE, Lvl 1	MPC	3MS	El Chayal	709	7372	44	18	13	161	155	20	116	10
CHP650	Tolok Str. 14, EU 14W3/NE, Lvl 1	MPC	3MS-f	SMJ	727	7564	90	19	9	116	185	18	111	7
CHP651	Tolok Str. 14, EU 14W3/NE, Lvl 1	MPC	3MS	El Chayal	696	7252	51	18	8	143	146	20	108	9
CHP652	Tolok Str. 14, EU 14W3/NE, Lvl 1	MPC	3MS	SMJ	529	6646	33	17	9	106	170	17	108	7
CHP653	Tolok Str. 14, EU 14W3/NE, Lvl 1	MPC	3DS	El Chayal	808	7830	53	18	12	161	159	22	117	11
CHP654	Tolok Str. 14, EU 14W3/NE, Lvl 1	MPC	3MS	El Chayal	828	8177	56	18	9	161	159	23	113	11
CHP655	Tolok Str. 14, EU 14W3/NE, Lvl 1	MPC	3PS-sf	El Chayal	620	6349	35	17	10	139	132	18	104	10
CHP656	Tolok Str. 14, EU 14W3/NE, Lvl 1	MPC	3PS-sf	Ixtepeque	531	12561	81	19	8	111	162	19	168	11
CHP657	Tolok Str. 14, EU 14W3/SE, Lvl 1	MPC	3MS-sh	SMJ	716	8516	46	18	10	122	201	18	119	8
CHP658	Tolok Str. 14, EU 14W3/SW, Lvl 1	MPC	3RC-ds	SMJ	709	8260	72	18	7	115	195	18	116	7
CHP659	Tolok Str. 14, EU 14W3/SW, Lvl 1	MPC	TDS	Ixtepeque	567	10986	50	18	8	99	143	20	162	9
CHP660	Tolok Str. 14, EU 14W3/SW, Lvl 1	MPC	3MS	Ixtepeque	508	9543	27	17	7	97	138	18	159	8
CHP661	Tolok Str. 14, EU 14W3/SW, Lvl 1	MPC	3MS	El Chayal	739	7181	38	18	9	152	149	20	106	10
CHP662	Tolok Str. 14, EU 14W3/SW, Lvl 1	MPC	3PS-sf	Ixtepeque	412	8908	24	17	6	90	139	18	151	7
CHP663	Tolok Str. 14, EU 14W3/SW, Lvl 1	MPC	3MS	El Chayal	616	6909	82	19	10	149	142	19	104	10
CHP664	Tolok Str. 14, EU 14W3/SW, Lvl 1	MPC	3MS	Ixtepeque	453	12634	106	20	10	104	165	21	168	11
CHP665	Tolok Str. 14, EU 14W3/SW, Lvl 1	MPC	TPS-sf	El Chayal	680	7616	42	18	11	150	147	21	112	11
CHP666	Tolok Str. 14, EU 14W3/NW, Lvl 1-3	MPC	3MS	El Chayal	591	6957	55	18	9	141	145	18	109	9
CHP667	Tolok Str. 14, EU 14W3/NW, Lvl 1-3	MPC	3PS-sf	El Chayal	814	7538	61	18	9	146	143	20	108	11
CHP668	Tolok Str. 14, EU 14W3/SE, Lvl 1-3	MPC	3MS	Ixtepeque	421	10656	30	17	6	100	151	19	161	9
CHP669	Tolok Str. 14, EU 14W3/SE, Lvl 1	MPC	3MS	El Chayal	680	7636	81	19	8	147	145	22	107	12
CHP670	Tolok Str. 14, EU 14W3/SE, Lvl 1-3	MPC	3MS	El Chayal	784	7833	48	18	10	154	144	18	113	10
CHP671	Tolok Str. 14, EU 14W3/SE, Lvl 1-3	MPC	3DS	Ixtepeque	541	10422	59	18	9	100	145	20	159	9
CHP672	Tolok Str. 14, EU 14W3/SE, Lvl 1-3	MPC	3MS	Ixtepeque	465	10970	46	18	9	111	159	20	167	9
CHP673	Tolok Str. 14, EU 14W3/SE, Lvl 1-3	MPC	3MS	El Chayal	577	8038	55	18	14	154	153	21	111	11

Sample ID	Provenience	Time Period	Technology	Source Group	Mn	Fe	Zn	Ga	Th	Rb	Sr	Y	Zr	Nb
CHP674	Tolok Str. 14, EU 14W3/SE, Lvl 1-3	MPC	3MS	Ixtepeque	490	9791	32	17	8	103	142	20	159	8
CHP675	Tolok Str. 14, EU 14W3/SE, Lvl 1-3	MPC	3MS	El Chayal	768	7354	50	18	10	151	148	20	110	10
CHP676	Tolok Str. 14, EU 14W3/SE, Lvl 1-3	MPC	3PS-sf	El Chayal	570	7683	52	18	9	140	143	20	108	10
CHP677	Tolok Str. 14, EU 14W1/b, Lvl 1-3	MPC	3MS	El Chayal	784	7604	65	18	12	170	163	19	124	11
CHP678	Tolok Str. 14, EU 14W1/b, Lvl 1-3	MPC	3PS-sf	El Chayal	743	6654	58	18	8	153	152	19	109	9
CHP679	Tolok Str. 14, EU 14W1/b, Lvl 1-3	MPC	3MS	El Chayal	717	6251	59	18	8	141	140	21	108	6
CHP680	Tolok Str. 14, EU 14W1/b, Lvl 1-3	MPC	3MS	SMJ	633	7363	57	18	8	120	200	17	121	7
CHP681	Tolok Str. 14, EU 14W1/b, Lvl 1-3	MPC	3MS	El Chayal	970	9887	92	20	17	182	177	22	126	13
CHP682	Tolok Str. 14, EU 14W1/b, Lvl 1-3	MPC	3MS	El Chayal	801	8284	76	19	15	179	177	22	120	10
CHP683	Tolok Str. 14, EU 14W1/b, Lvl 1-3	MPC	3MS	Ixtepeque	528	10875	61	18	7	115	170	21	175	8
CHP684	Tolok Str. 14, EU 14W1/b, Lvl 1-3	MPC	TPS-sf	El Chayal	764	7063	69	19	11	150	147	20	113	9
CHP685	Tolok Str. 14, EU 14W1/b, Lvl 1-3	MPC	3MS	El Chayal	895	7358	76	19	11	170	167	24	117	10
CHP686	Tolok Str. 14, EU 14W1/b, Lvl 1-3	MPC	3MS	Ixtepeque	564	11039	46	18	7	113	174	19	175	9
CHP687	Tolok Str. 14, EU 14W1/b, Lvl 1-3	MPC	3MS	El Chayal	1009	8330	122	20	13	170	173	24	115	11
CHP688	Tolok Str. 14, EU 14W1/b, Lvl 1-3	MPC	SH	El Chayal	732	7530	87	19	14	150	150	18	106	11
CHP689	Tolok Str. 14, EU 14W1/b, Lvl 1-3	MPC	TPS-sf	El Chayal	671	6696	56	18	10	149	138	19	112	9
CHP690	Tolok Str. 14, EU 14W4/NE, Lvl 1-2	MPC	3MS	El Chayal	800	8102	74	19	18	155	150	22	113	9
CHP691	Tolok Str. 14, EU 14W4/NE, Lvl 1-2	MPC	TDS	Ixtepeque	425	9144	43	17	4	89	133	16	156	10
CHP692	Tolok Str. 14, EU 14W4/NE, Lvl 1-2	MPC	3MS	El Chayal	743	7624	62	19	17	153	151	21	111	12
CHP693	Tolok Str. 14, EU 14W4/NW, Lvl 1-2	MPC	SH	Ixtepeque	546	10224	32	17	7	99	141	19	162	7
CHP694	Tolok Str. 14, EU 14W4/NW, Lvl 1-2	MPC	3PS-sf	El Chayal	767	6909	45	18	11	150	142	20	108	9
CHP695	Tolok Str. 14, EU 14W4/NW, Lvl 1-2	MPC	3MS	El Chayal	655	7069	79	20	17	149	151	22	110	10
CHP696	Tolok Str. 14, EU 14W4/NW, Lvl 1-2	MPC	3MS	Ixtepeque	525	10082	30	17	7	102	149	19	163	10
CHP697	Tolok Str. 14, EU 14W4/NW, Lvl 1-2	MPC	3DS	El Chayal	676	6160	62	18	7	130	130	21	103	7
CHP698	Tolok Str. 14, EU 14W4/NW, Lvl 1-2	MPC	3DS	Ixtepeque	453	9093	35	17	6	90	134	16	146	8
CHP699	Tolok Str. 14, EU 14W4/NW, Lvl 1-2	MPC	3MS	El Chayal	656	7037	45	18	12	144	141	20	108	9
CHP700	Tolok Str. 14, EU 14W4/NW, Lvl 1-2	MPC	3DS	Ixtepeque	556	11323	59	18	6	101	157	20	164	8
CHP701	Tolok Str. 14, EU 14W4/NW, Lvl 1-2	MPC	3MS	SMJ	666	8442	74	19	9	121	195	18	121	8
CHP702	Tolok Str. 14, EU 14W4/NW, Lvl 1-2	MPC	3MS	Ixtepeque	595	11344	59	18	7	105	160	19	167	9

Sample ID	Provenience	Time Period	Technology	Source Group	Mn	Fe	Zn	Ga	Th	Rb	Sr	Y	Zr	Nb
CHP703	Tolok Str. 14, EU 14W4/NW, Lvl 1-2	MPC	PSH	Ixtepeque	552	9767	41	17	4	94	141	18	154	9
CHP704	Tolok Str. 14, EU 14W4/NW, Lvl 1-2	MPC	CS-ms	Ixtepeque	549	9701	40	17	6	97	135	17	156	9
CHP705	Tolok Str. 14, EU 14W4/NW, Lvl 1-2	MPC	3MS	El Chayal	760	8861	69	19	17	184	161	22	120	12
CHP706	Tolok Str. 14, EU 14W4/NW, Lvl 1-2	MPC	3MS	El Chayal	750	7151	43	18	11	146	136	21	109	9
CHP707	Tolok Str. 14, EU 14W4/NW, Lvl 1-2	MPC	3MS-nt	El Chayal	696	6923	40	18	10	145	136	20	109	7
CHP708	Tolok Str. 14, EU 14W4/NW, Lvl 1-2	MPC	TDS	Ixtepeque	597	11852	89	19	6	114	164	20	175	10
CHP709	Tolok Str. 14, EU 14W4/SW, Lvl 1-2	MPC	3PS-pa	SMJ	547	7102	38	17	8	106	183	18	110	8
CHP710	Tolok Str. 14, EU 14W4/SW, Lvl 1-2	MPC	3MS	Ixtepeque	524	11169	43	18	8	107	162	20	167	9
CHP711	Tolok Str. 14, EU 14W4/SW, Lvl 1-2	MPC	3MS	El Chayal	733	7562	67	19	14	155	153	21	111	10
CHP712	Tolok Plaza, EU PU-3, Lvl 1	MPC	3MS	Ixtepeque	594	11312	38	17	10	112	162	21	171	10
CHP713	Tolok Str. 14, EU 14W4/NE, Lvl 1-2	MPC	3MS	El Chayal	783	7185	49	18	10	148	145	20	109	10
CHP714	Tolok Str. 14, EU 14W4/NE, Lvl 1-2	MPC	3MS	SMJ	693	7539	47	18	9	121	200	20	110	8
CHP715	Tolok Str. 14, EU 14W4/NE, Lvl 1-2	MPC	3MS	El Chayal	825	7595	68	18	11	154	156	22	112	11
CHP716	Tolok Str. 14, EU 14W4/NE, Lvl 1-2	MPC	3PS-sf	Ixtepeque	460	10303	31	17	5	99	151	18	162	9
CHP717	Tolok Str. 14, EU 14W4/NE, Lvl 1-2	MPC	3PS-sf	El Chayal	699	7042	44	18	10	143	144	20	108	8
CHP718	Tolok Str. 14, EU 14W4/NE, Lvl 1-2	MPC	3PS-sf	El Chayal	777	7283	40	18	12	150	145	21	115	10
CHP719	Tolok Str. 14, EU 14W4/NE, Lvl 1-2	MPC	3DS	Ixtepeque	543	9146	30	17	6	94	139	17	153	8
CHP720	Tolok Str. 14, EU 14W4/NW, Lvl 1-2	MPC	3MS	El Chayal	699	6714	46	18	12	152	146	20	110	8
CHP721	Tolok Str. 14, EU 14W4/NW, Lvl 1-2	MPC	SH	Ixtepeque	489	9727	92	19	3	90	142	16	155	9
CHP722	Tolok Str. 14, EU 14W4/NW, Lvl 1-2	MPC	3MS	El Chayal	724	7530	50	18	8	154	156	25	119	12
CHP723	Tolok Str. 14, EU 14W4/SE, Lvl 1-2	MPC	TMS	El Chayal	776	6917	53	18	10	147	145	21	110	9
CHP724	Tolok Str. 14, EU 14W4/SE, Lvl 1-2	MPC	3PS-pa	Ixtepeque	662	11909	73	18	6	104	154	19	165	10
CHP725	Tolok Str. 14, EU 14W4/SE, Lvl 1-2	MPC	3MS-sh	Ixtepeque	538	9446	122	20	5	95	148	18	155	9
CHP726	Tolok Str. 14, EU 14W4/SW, Lvl 1-2	MPC	3MS	El Chayal	778	7513	48	18	7	156	152	22	112	12
CHP727	Tolok Str. 14, EU 14W4/SW, Lvl 1-2	MPC	TMS	El Chayal	771	6978	113	20	13	146	146	23	106	8
CHP728	Tolok Str. 14, EU 14W4/SW, Lvl 1-2	MPC	3MS	El Chayal	767	7485	65	18	10	152	148	20	110	9
CHP729	Tolok Str. 14, EU 14W4/SW, Lvl 1-2	MPC	CS	Ixtepeque	551	9464	44	18	8	86	134	18	149	8
CHP731	Tolok Str. 15, EU 15s1, Lvl 1-2	MPC	PSH	SMJ	548	6274	31	17	5	93	160	18	103	5
CHP732	Tolok Str. 14, EU 14W5/SE, Lvl 1	MPC	3DS	El Chayal	681	6902	39	18	11	148	152	24	112	9

Sample ID	Provenience	Time Period	Technology	Source Group	Mn	Fe	Zn	Ga	Th	Rb	Sr	Y	Zr	Nb
CHP733	Tolok Str. 14, EU 14W5/SE, Lvl 1	MPC	3MS	Ixtepeque	504	9803	34	17	4	98	143	16	160	11
CHP734	Tolok Str. 14, EU 14W5, Lvl 1-2	MPC	3PS-sf	El Chayal	794	7135	45	18	10	152	149	23	111	10
CHP735	Tolok Str. 14, EU 14W5, Lvl 1-2	MPC	BP-sh	Ixtepeque	444	8927	36	17	4	90	131	16	148	9
CHP736	Tolok Str. 14, EU 14W5, Lvl 1-2	MPC	3MS	Ixtepeque	490	9354	16	17	5	94	141	19	159	9
CHP737	Tolok Str. 14, EU 14W5, Lvl 1-2	MPC	3MS	El Chayal	625	6615	49	18	11	140	136	21	109	9
CHP738	Tolok Str. 14, EU 14W5, Lvl 1-2	MPC	3MS	El Chayal	921	9906	112	20	16	173	168	24	113	13
CHP739	Tolok Str. 14, EU 14W6, Lvl 1	MPC	OA-perc	El Chayal	651	6222	40	18	13	137	135	21	104	7
CHP740	Tolok Str. 14, EU 14W6, Lvl 1	MPC	3MS	El Chayal	776	6732	46	18	9	141	142	21	110	10
CHP741	Tolok Str. 14, EU 14W6, Lvl 1	MPC	3MS	El Chayal	732	7208	55	18	9	153	145	20	118	11
CHP742	Tolok Str. 14, EU 14W6, Lvl 1	MPC	TMS	SMJ	497	7440	67	18	4	105	192	17	110	9
CHP743	Tolok Str. 14, EU 14W6, Lvl 1	MPC	3MS	El Chayal	866	7625	61	18	12	160	151	22	113	10
CHP744	Tolok Str. 14, EU 14W6/SW, Lvl 1	MPC	3DS	El Chayal	858	8179	70	19	13	167	154	19	113	11
CHP745	Tolok Str. 14, EU 14W6/SW, Lvl 1	MPC	3PS-sf	Ixtepeque	448	10097	43	18	9	96	145	16	166	8
CHP746	Tolok Str. 14, EU 14W6, Lvl 1	MPC	3PS-sf	Ixtepeque	554	10224	40	17	7	105	151	20	166	10
CHP747	Tolok Str. 15, EU 15s2/NE, Lvl 1	MPC	3PS-sf	SMJ	533	7281	53	18	7	112	182	20	116	8
CHP748	Tolok Str. 15, EU 15s2/NE, Lvl 1	MPC	PDF	El Chayal	799	7523	51	18	12	164	156	21	111	10
CHP749	Tolok Str. 15, EU 15s2/NE, Lvl 1	MPC	3PS-bp	Ixtepeque	405	9142	22	17	6	92	134	17	148	8
CHP750	Tolok Str. 15, EU 15s2/NW, Lvl 1	MPC	SH	Ixtepeque	486	10275	67	18	5	100	146	14	158	8
CHP751	Tolok Str. 15, EU 15s2/NW, Lvl 1	MPC	3PS-sf	SMJ	627	7432	39	17	8	110	183	17	111	7
CHP752	Tolok Str. 15, EU 15s2/NW, Lvl 1	MPC	3PS-sf	El Chayal	694	6304	49	18	7	129	137	19	99	10
CHP753	Tolok Str. 15, EU 15s2/NW, Lvl 1	MPC	3PS-sf	El Chayal	649	6785	47	18	9	140	140	19	103	9
CHP754	Tolok Str. 15, EU 15s2/NW, Lvl 1	MPC	OA	El Chayal	669	6175	27	17	8	134	135	20	106	10
CHP755	Tolok Str. 15, EU 15s2/SW, Lvl 1-2	MPC	3MS	El Chayal	694	6334	38	17	9	137	131	19	105	9
CHP756	Tolok Str. 15, EU 15s2/SW, Lvl 1-2	MPC	3PS-sf	Ixtepeque	390	9088	34	17	4	92	138	19	156	8
CHP757	Tolok Str. 14, Backfill	TC	3PS-sf	Ixtepeque	489	9971	30	17	5	98	143	19	159	9
CHP759	Tzutziiy Kin Str. 3, EU TK-3-2, Lvl 2, Collapse	LC	SH	El Chayal	717	6641	53	18	8	150	152	22	115	12
CHP760	Tzutziiy Kin Str. 2, EU TK-2-4, Lvl 1/3, Humus/Collapse	LC	2PS-sf	El Chayal	656	6893	41	18	9	156	157	20	112	12
CHP761	Tzutziiy Kin Str. 2, EU TK-2-3-9, Lvl 7, Below Floor 5	LPC	3MS	El Chayal	689	6167	47	18	7	132	133	18	105	8

Sample ID	Provenience	Time Period	Technology	Source Group	Mn	Fe	Zn	Ga	Th	Rb	Sr	Y	Zr	Nb
CHP762	Tzutziiy Kin Str. 2, EU TK-2-3B, Lvl 3, Fill below stairs	LC	3DS	El Chayal	707	7564	57	18	10	167	159	21	118	10
CHP763	Zopilote Str. 2, EU ZPL-2-1, Lvl 2, Feature 1: Terminal Deposit	TC	2MS	El Chayal	746	6632	44	18	9	151	147	19	110	8
CHP764	Zopilote Str. 2, EU ZPL-2-1, Lvl 2, Feature 1: Terminal Deposit	TC	3MS	El Chayal	726	6743	50	18	10	154	151	19	115	11
CHP765	Zopilote Str. 2, EU ZPL-2-1, Lvl 2, Feature 1: Terminal Deposit	TC	TPS-sf	El Chayal	712	6431	46	18	10	147	150	20	112	10
CHP766	Zopilote Str. 2, EU ZPL-2-1, Lvl 2, Feature 1: Terminal Deposit	TC	OA	El Chayal	742	6840	59	18	9	192	154	20	112	10
CHP767	Zopilote Str. 1, EU 7, Lvl , Cist #2 at stela base	MPC	3MS	El Chayal	925	8474	90	20	14	174	170	21	121	12
CHP768	Zopilote Str. 1, EU 7, Lvl , Cist #2 at stela base	MPC	CSF-bp	El Chayal	701	6655	64	18	11	151	147	20	111	10
CHP769	Zopilote Str. 1, EU 7, Lvl , Cist #2 at stela base	MPC	3MS	El Chayal	991	9078	86	19	15	181	176	23	123	12
CHP770	Zopilote Str. 1, EU 7, Lvl , Cist #2 at stela base	MPC	CSF	Ixtepeque	535	11727	60	18	7	114	174	21	178	10
CHP771	Zopilote Str. 1, EU 7, Lvl , Cist #2 at stela base	MPC	3PS-sf	El Chayal	889	8200	69	18	10	166	164	21	117	10
CHP772	Zopilote Str. 1, EU 7, Lvl , Cist #2 at stela base	MPC	3MS	El Chayal	705	6611	47	18	10	152	150	20	113	11
CHP773	Zopilote Str. 1, EU 7, Lvl , Cist #2 at stela base	MPC	3PS-sf	Ixtepeque	489	9780	39	17	6	102	152	19	170	10
CHP774	Zopilote Str. 1, EU 7, Lvl , Cist #1	MPC	3PS-pa	El Chayal	888	7449	60	18	10	159	158	23	119	10
CHP775	Zopilote Str. 1, EU 7, Lvl , Cist #1	MPC	3MS	El Chayal	677	6567	50	18	9	152	150	19	112	10
CHP776	Zopilote Str. 1, EU 7, Lvl , Cist #1	MPC	3PS-sf	El Chayal	888	8142	67	19	12	174	170	23	124	11
CHP777	Zopilote Str. 1, EU 7, Lvl , Cist #1	MPC	3MS	El Chayal	782	7401	60	18	10	161	157	21	118	11
CHP778	Zopilote Str. 1, EU 7, Lvl , Cist #1	MPC	3PS-sf	El Chayal	734	6497	41	17	8	144	142	21	112	9
CHP779	Zopilote Str. 1, EU 7, Lvl , Cist #1	MPC	3MS	El Chayal	910	8534	67	19	15	181	177	23	127	13
CHP780	Zotz Str. 2, EU 1, Lvl 3	LC	3DS	El Chayal	892	8800	66	19	14	181	178	23	123	12
CHP781	Zotz Plaza, EU 2, Lvl 2, Humus	LC	TMS	Ixtepeque	662	12837	78	19	9	117	182	23	181	11
CHP782	Zotz Plaza, EU 2, Lvl 2, Humus	LC	3MS	Ixtepeque	623	11447	53	18	6	114	168	21	176	10
CHP783	Zotz Plaza, EU 2, Lvl 2, Humus	LC	TPS-sf	Ixtepeque	517	10617	41	17	6	112	163	21	174	8
CHP784	Zotz Str. 1, EU 3, Lvl 1	LC	3MS	El Chayal	730	6951	49	18	9	152	155	20	113	10
CHP785	Zotz Str. 1, EU 3 ext, Lvl 1, Collapse	LC	3MS	El Chayal	618	6298	46	18	8	141	144	21	109	10
CHP786	Zotz Str. 1, EU 3 ext, Lvl 1, Collapse	LC	3MS	Ixtepeque	461	9095	33	17	5	92	143	18	157	8
CHP787	Zotz Str. 1, EU 3 ext, Lvl 1, Collapse	LC	3MS	El Chayal	603	5829	41	18	10	149	141	20	107	8
CHP788	Zotz Str. 1, EU 6, Lvl 1	LC	3PS-sf	El Chayal	630	6281	38	17	9	146	144	19	107	9

Sample ID	Provenience	Time Period	Technology	Source Group	Mn	Fe	Zn	Ga	Th	Rb	Sr	Y	Zr	Nb
CHP789	Zotz Plaza, EU 1, Lvl 2, Humus	LC	3MS	SMJ	630	7059	47	18	8	119	195	17	114	7
CHP790	Zotz Str. 1, EU 6, Lvl 2	LC	3MS	El Chayal	701	6423	48	18	10	148	148	21	113	10
CHP791	Zotz Str. 1, EU 6, Lvl 2	LC	3MS	Ixtepeque	429	9263	35	17	6	99	149	18	167	10
CHP792	Zotz Str. 1, EU 6, Lvl 2	LC	TPS-sf	El Chayal	633	6098	41	18	9	139	150	21	110	8
CHP793	Zotz Surface Collection	LC	3DS	Pachuca	1107	16738	234	27	20	209	2	119	958	94
CHP794	Cahal Pech Str. G2, EU East Room, Lvl 4	LC	NMB-ms	Pachuca	1307	17817	246	28	21	212	3	109	905	94
CHP795	Cahal Pech Str. G2, EU East Room, Lvl 4	LC	3MS	El Chayal	744	6721	54	18	11	151	151	21	114	10
CHP796	Cahal Pech Str. B4, EU 11, Lvl 4	LPC	3MS	Ixtepeque	543	10516	37	17	7	110	165	20	174	11
CHP797	Cahal Pech Str. B4, EU 11, Lvl 4	LPC	OA	El Chayal	908	8953	80	19	13	179	169	22	124	12
CHP798	Cahal Pech Str. B4, EU 11, Lvl 4	LPC	3MS	SMJ	616	7379	54	18	7	119	192	17	115	8
CHP799	Cahal Pech Str. B4, EU 11, Lvl 4	LPC	3MS	SMJ	588	7397	48	18	8	121	200	16	116	9
CHP800	Cahal Pech Str. B4, EU 2, Lvl 5	LPC	3PS-sf	El Chayal	677	6539	51	18	7	146	145	21	113	10
CHP801	Cahal Pech Str. B4, EU 2, Lvl 5	LPC	3MS	El Chayal	711	6301	51	18	8	140	142	19	108	8
CHP802	Cahal Pech Str. B4, EU 12, Lvl 4	LPC	3PS-sf	SMJ	584	7685	52	18	9	124	203	17	115	8
CHP803	Cahal Pech Str. B4, EU 12, Lvl 1-2	LC	3MS	SMJ	643	7862	48	18	8	123	210	19	121	10
CHP804	Cahal Pech Str. B4, EU , Lvl 1	LC	3MS	SMJ	681	7285	57	18	9	121	197	17	114	10
CHP805	Cahal Pech Str. B4, EU , Lvl 1	LC	3MS	Ixtepeque	475	9324	45	17	5	95	142	18	159	7
CHP806	Cahal Pech Surface Collection	LC	DSH	El Chayal	639	5880	64	18	10	127	123	19	99	9
CHP807	Cahal Pech Str. C5, EU C5-2, Lvl 1	LC	3DS	El Chayal	663	6491	58	18	10	172	147	18	109	11
CHP808	Cahal Pech Str. C5, EU C5-2, Lvl 1	LC	3MS	El Chayal	751	7999	66	19	13	171	173	22	122	11
CHP809	Cahal Pech Str. C5, EU C5-2, Lvl 1	LC	3MS	El Chayal	743	6972	99	20	13	161	157	23	116	11
CHP810	Cahal Pech Str. C4, EU , Lvl 1, Humus	LC	3DS	SMJ	582	7233	59	18	8	118	196	18	114	8
CHP811	Cahal Pech East Ball Court Alley, EU CA-1, Lvl 3	LC	3MS	El Chayal	785	8199	79	19	10	171	166	20	117	11
CHP812	Cahal Pech East Ball Court Alley, EU CA-1, Lvl 3	LC	3MS	El Chayal	738	6851	60	18	10	153	147	20	114	11
CHP813	Cahal Pech East Ball Court Alley, EU CA-1, Lvl 3	LC	3PS-sf	Ixtepeque	567	11181	53	18	5	111	168	22	177	11
CHP814	Cahal Pech East Ball Court Alley, EU CA-1, Lvl 3	LC	3PS-sf	Ixtepeque	548	10428	39	17	7	105	161	21	177	9
CHP815	Cahal Pech Str. C5, EU C5-2, Lvl 2, Fill	LC	3PS-sf	El Chayal	944	8023	70	19	14	166	158	22	115	9
CHP816	Cahal Pech East Ball Court Alley, EU CA-2, Lvl 1, Fill	LC	3PS-sf	El Chayal	768	6984	67	18	9	152	151	20	114	10

Sample ID	Provenience	Time Period	Technology	Source Group	Mn	Fe	Zn	Ga	Th	Rb	Sr	Y	Zr	Nb
CHP817	Cahal Pech East Ball Court Alley, EU CA-1b, Lvl 2	LC	3MS	El Chayal	663	6385	55	18	8	147	140	19	112	10
CHP818	Cahal Pech East Ball Court Alley, EU CA-2, Lvl 2, Fill	LC	3PS-sf	El Chayal	843	7552	71	19	13	166	157	19	113	10
CHP819	Cahal Pech East Ball Court Alley, EU CA-1b, Lvl 2	LC	3MS	SMJ	764	8425	65	18	9	127	216	18	127	10
CHP820	Cahal Pech East Ball Court Alley, EU CA-2, Lvl 2	LC	3MS	El Chayal	795	7933	73	19	12	166	164	22	117	11
CHP821	Cahal Pech East Ball Court Alley, EU CA-2, Lvl 2, Fill	LC	GBF	El Chayal	770	7624	70	19	11	165	157	20	119	10
CHP822	Cahal Pech Str. C5, EU C5-2, Lvl 2	LC	UNF	El Chayal	714	6588	68	18	10	158	152	23	116	10
CHP823	Cahal Pech Str. C5, EU C5-2, Lvl 2	LC	3MS	El Chayal	744	7606	63	18	12	165	162	24	121	12
CHP824	Cahal Pech Str. C5, EU C5-2, Lvl 3	LC	3PS-sf-bp	El Chayal	724	6907	54	18	7	149	150	22	116	11
CHP825	Cahal Pech Str. C5, EU C5-2, Lvl 2	LC	3CB-sf	El Chayal	751	6584	79	19	11	148	146	20	108	8
CHP827	Cahal Pech East Ball Court Alley, EU CA-2, Lvl 3	LC	3PS-pa	Ixtepeque	537	10447	52	18	8	104	153	19	170	9
CHP828	Cahal Pech East Ball Court Alley/Str. C2, EU CA-2, Lvl 2, Fill	LC	3MS	El Chayal	760	7042	52	18	10	153	152	20	112	9
CHP829	Cahal Pech Str. C5, EU C5-2, Lvl 1	LC	3MS	El Chayal	795	7933	73	19	12	166	164	22	117	11
CHP830	Cahal Pech East Ball Court Alley, EU CA-16, Lvl 3,Dirt Fill	LC	3MS	El Chayal	756	6938	74	18	9	155	149	19	108	10
CHP831	Cahal Pech East Ball Court Alley, EU CA-4, Lvl 3, Fill	LC	3MS	Ixtepeque	439	8542	76	18	3	88	135	17	147	7
CHP832	Cahal Pech East Ball Court Alley, EU CA-1b, Lvl 3	LC	3MS	SMJ	703	8046	77	19	9	127	208	17	124	9
CHP833	Cahal Pech East Ball Court Alley, EU CA-1b, Lvl 3	LC	3DS	El Chayal	737	6535	63	18	10	148	149	20	113	8
CHP834	Cahal Pech East Ball Court Alley, EU CA-1b ext, Lvl 3, Fill/cache (?)	LC	SH	SMJ	639	7651	51	18	10	124	199	16	119	8
CHP835	Cahal Pech East Ball Court Alley, EU CA-1b ext, Lvl 3	LC	3DS	El Chayal	735	7354	69	18	9	160	164	22	118	11
CHP836	Cahal Pech East Ball Court Alley, EU CA-1b ext, Lvl 3	LC	3MS	El Chayal	848	7751	65	19	13	172	161	22	122	12
CHP837	Cahal Pech East Ball Court Alley, EU CA-1b ext, Lvl 3, Fill	LC	3MS	El Chayal	790	7785	64	18	10	163	167	24	119	11
CHP838	Cahal Pech East Ball Court Alley, EU CA-2, Lvl 3, Burial CA-B/1	LC	3MS	El Chayal	783	7687	63	19	14	176	168	22	121	11
CHP839	Cahal Pech Str. F2, EU 1, Lvl 1	LC	SP	Ixtepeque	430	9412	40	17	6	101	148	19	164	9
CHP840	Cahal Pech Str. F2, EU 13, Lvl 1, Collapse	LC	3PS-sf	El Chayal	719	6461	62	18	8	149	151	21	111	10
CHP841	Cahal Pech Str. F2, EU 28, Lvl 1, Humus, Collapse	LC	3MS	El Chayal	668	6467	47	18	10	151	145	19	110	9
CHP842	Cahal Pech Str. F2, EU 16, Lvl 1, Collapse	LC	3PS-sf	Ixtepeque	454	10282	52	18	6	107	161	18	174	9
CHP843	Cahal Pech Str. F2, EU 16, Lvl 1, Collapse	LC	3DS	El Chayal	707	7002	63	18	8	154	146	21	113	11

Sample ID	Provenience	Time Period	Technology	Source Group	Mn	Fe	Zn	Ga	Th	Rb	Sr	Y	Zr	Nb
CHP844	Cahal Pech Str. F2, EU 27, Lvl 1, Humus	LC	3PS-sf	Ixtepeque	464	9429	38	17	7	100	144	20	166	9
CHP845	Cahal Pech Str. F2, EU 5, Lvl 1, Collapse	LC	3MS	El Chayal	711	6594	50	18	10	146	149	20	111	9
CHP846	Cahal Pech Str. F2, EU 21, Lvl 8, floor/ballast	LC	3MS-bp	Ixtepeque	433	9838	46	17	5	100	149	20	165	8
CHP847	Cahal Pech Str. F2, EU 28, Lvl 1	LC	3MS	El Chayal	656	6211	58	18	9	151	145	22	110	11
CHP848	Cahal Pech Str. F2, EU 5, Lvl 1, Collapse	LC	3MS	Ixtepeque	433	8559	43	17	4	85	134	15	153	8
CHP849	Cahal Pech Str. F2, EU 21, Lvl 9, Below Floor 8	LC	3PS-sf	El Chayal	683	6632	54	18	10	149	153	21	114	9
CHP850	Cahal Pech Str. F2, EU 26, Lvl 1	LC	TMS	El Chayal	757	6897	58	18	9	154	150	19	117	9
CHP851	Cahal Pech Str. F2, EU 26, Lvl 1	LC	3MS	El Chayal	732	6553	53	18	10	153	147	20	114	9
CHP852	Cahal Pech Str. F2, EU 24, Lvl 3, Below Floor 3	LC	3MS	El Chayal	660	6206	65	18	8	136	138	19	105	9
CHP853	Cahal Pech Str. D1, EU 15, Lvl 3, Construction Fill	LC	3MS	El Chayal	744	7489	75	19	11	163	155	21	116	11
CHP854	Cahal Pech Plaza B, EU B-3, Lvl 1	LC	OA	El Chayal	771	6545	60	18	9	129	140	20	102	9
CHP855	Cahal Pech Str. C2/C3 corner, EU 16, Lvl 1	LC	3PS-sf	SMJ	566	6822	26	17	11	119	162	16	84	8
CHP856	Cahal Pech Str. C2/C3 corner, EU 16, Lvl 1	LC	3MS	SMJ	684	8041	32	18	13	131	200	14	112	10
CHP857	Cahal Pech Str. C2/C3 corner, EU 16, Lvl 1	LC	3MS	El Chayal	740	7313	68	18	10	161	157	23	116	11
CHP858	Cahal Pech Str. C2, EU 1, Lvl 1, Humus	LC	3MS	El Chayal	863	7714	72	19	10	161	166	20	118	9
CHP859	Cahal Pech Str. C2, EU 1, Lvl 1, Humus	LC	3MS	El Chayal	699	7069	55	18	12	155	154	21	112	11
CHP860	Cahal Pech Str. C2, EU 1, Lvl 1, Humus	LC	3MS	Ixtepeque	467	9765	52	18	7	104	155	18	167	9
CHP861	Cahal Pech Str. C2, EU 2a, Lvl 1, Humus	LC	3MS	El Chayal	678	6341	57	18	11	145	141	20	112	8
CHP862	Cahal Pech Str. C2, EU 2a, Lvl 1, Humus	LC	3PS-sf	Ixtepeque	511	9591	42	17	7	103	152	17	163	10
CHP863	Cahal Pech Str. C2, EU 1, Lvl 1, Humus	LC	TMS	El Chayal	685	6200	52	18	11	141	142	19	110	9
CHP864	Cahal Pech Str. C2, EU 2, Lvl 2, Collapse	LC	3PS-sf	El Chayal	771	7131	61	18	12	162	158	22	113	10
CHP865	Cahal Pech Str. C2 Summit, EU 1, Lvl 1	LC	3MS	El Chayal	689	6737	54	18	9	152	152	19	114	10
CHP866	Cahal Pech Str. C2, EU 5, Lvl 1	LC	UNF	El Chayal	662	6329	45	18	10	139	142	20	106	9
CHP867	Cahal Pech Str. C2, EU 5, Lvl 1	LC	3MS	El Chayal	701	6485	53	18	8	148	147	20	107	9
CHP868	Cahal Pech Str. C2, EU 5, Lvl 1	LC	3DS	Ixtepeque	445	9446	42	17	5	99	150	19	164	9
CHP869	Cahal Pech Str. C2, EU 5, Lvl 1	LC	3MS	El Chayal	839	7833	64	18	11	174	169	21	121	11
CHP870	Cahal Pech Str. C2, EU 5, Lvl 1	LC	3MS	El Chayal	768	7438	79	19	9	158	157	20	113	10

Sample ID	Provenience	Time Period	Technology	Source Group	Mn	Fe	Zn	Ga	Th	Rb	Sr	Y	Zr	Nb
CHP871	Cahal Pech Str. C2, EU 5, Lvl 1	LC	3PS-sf	El Chayal	634	6386	48	18	10	140	144	20	107	10
CHP872	Cahal Pech Str. C2, EU 5, Lvl 1	LC	3MS	El Chayal	746	6779	57	18	10	157	151	21	114	9
CHP873	Cahal Pech Str. C2 Summit, EU 1, Lvl 1	LC	NPB-ms	Ixtepeque	485	9198	36	17	6	96	146	19	159	8
CHP874	Cahal Pech Str. C2 Summit, EU 1, Lvl 1	LC	NPB-sf	El Chayal	663	6522	48	18	9	152	145	20	112	10
CHP875	Cahal Pech Str. C2, EU 9, Lvl 1	LC	3PS-sf	El Chayal	683	6702	59	18	9	151	151	20	114	11
CHP876	Cahal Pech Str. C2, EU 1 - West ext, Lvl 1	LC	3PS-sf	El Chayal	667	6203	55	18	8	145	140	20	111	9
CHP877	Cahal Pech Str. C2, EU 1 - West ext, Lvl 1	LC	3PS-sf	El Chayal	667	6644	54	18	8	146	149	20	111	9
CHP878	Cahal Pech Str. C2, EU 1 - West ext, Lvl 1	LC	3PS-sf	Ixtepeque	550	10648	53	18	8	108	164	21	172	9
CHP879	Cahal Pech Str. C2, EU 9 - North ext, Lvl 1	LC	3MS	El Chayal	702	6757	52	18	10	151	152	20	114	9
CHP880	Cahal Pech Str. C2, EU 9 - North ext, Lvl 1	LC	3MS	El Chayal	768	6986	54	18	10	157	155	21	115	9
CHP881	Cahal Pech Str. C2 Summit, EU 1 - West ext, Lvl 1	LC	3MS	Pachuca	1067	17139	226	26	23	206	1	109	889	90
CHP882	Cahal Pech Str. C2, EU 14, Lvl 1	LC	3MS	El Chayal	782	7375	65	18	10	160	159	21	119	9
CHP884	Cahal Pech Str. C2, EU 8, Lvl 4	LPC	3MS	SMJ	554	7237	56	18	7	118	194	16	114	8
CHP885	Cahal Pech Str. C2, EU 14, Lvl 1	LC	3MS	SMJ	561	6851	51	18	7	113	186	17	113	7
CHP886	Cahal Pech Str. H1, EU 2, Lvl 1	TC	3MS	El Chayal	951	9061	85	19	11	180	178	23	124	12
CHP887	Cahal Pech Str. H1, EU 2, Lvl 1	TC	3MS	El Chayal	839	8470	72	19	12	174	176	21	125	12
CHP888	Cahal Pech Str. H1, EU 3, Lvl 1	TC	DOF	El Chayal	968	9685	79	19	15	190	191	23	125	11
CHP889	Cahal Pech Str. H1, EU 3, Lvl 1	TC	3MS	El Chayal	713	6446	44	18	9	145	143	21	109	9
CHP890	Cahal Pech Str. C2, EU 2, Lvl 1	TC	3MS	El Chayal	834	7882	74	19	11	167	166	22	118	11
CHP891	Cahal Pech Str. C2, EU 2, Lvl 1	TC	3MS	El Chayal	675	6841	63	18	12	158	156	21	115	11
CHP893	Cahal Pech Str. C2, EU 15, Lvl 2	LC	SH	El Chayal	782	7800	81	19	12	163	154	21	119	10
CHP894	Cahal Pech Str. H1, EU Tomb 1, Lvl 1	TC	3DS	El Chayal	729	7009	48	18	10	153	155	22	114	9
CHP895	Cahal Pech Str. C2, EU 15, Lvl 2	LC	3DS	SMJ	623	7526	59	18	8	126	204	16	115	8
CHP896	Cahal Pech Str. C2, EU 15, Lvl 2	LC	3MS	Ixtepeque	451	10125	55	18	7	106	158	19	171	9
CHP897	Cahal Pech Str. H1, EU 6, Lvl 3	TC	3MS	SMJ	608	7410	49	18	8	112	180	19	114	8
CHP898	Cahal Pech Str. H1, EU 6, Lvl 3	TC	TPS-sf	SMJ	583	7210	46	18	8	113	181	18	111	8
CHP899	Cahal Pech Str. H1, EU 6, Lvl 3	TC	3MS	SMJ	663	7565	35	17	7	116	185	16	110	10
CHP900	Cahal Pech Str. H1, EU 7, Lvl 3, Tomb 1	TC	3PS-sf	El Chayal	637	6120	31	17	9	134	137	20	105	9

Sample ID	Provenience	Time Period	Technology	Source Group	Mn	Fe	Zn	Ga	Th	Rb	Sr	Y	Zr	Nb
CHP901	Cahal Pech Str. H1, EU 7, Lvl 2, Tomb 1	TC	3MS	Ixtepeque	649	12041	51	18	6	120	177	21	184	10
CHP902	Cahal Pech Str. H1, EU 7, Lvl 2, Tomb 1	TC	3PS-sf	Ixtepeque	500	10391	42	17	5	108	162	20	176	10
CHP903	Cahal Pech Str. H1, EU 7, Lvl 2, Tomb 1	TC	3PS-sf	El Chayal	722	6991	68	18	9	138	147	22	114	7
CHP904	Cahal Pech Str. H1, EU 4A, Lvl 3	TC	3PS-sf	El Chayal	741	6883	56	18	9	158	154	21	114	9
CHP905	Cahal Pech Str. H1, EU 4B/4C, Lvl 4	TC	BTF	El Chayal	739	7426	153	21	15	137	115	14	91	7
CHP906	Cahal Pech Str. H1, EU 4B-c, Lvl 4	TC	3MS	El Chayal	753	6844	46	18	10	153	154	20	113	8
CHP907	Cahal Pech Str. H1, EU 4B-c, Lvl 4	TC	3MS	El Chayal	728	6601	45	18	10	148	148	19	115	8
CHP908	Cahal Pech Str. H1, EU 4B-c, Lvl 4	TC	3MS	El Chayal	679	6612	50	18	9	145	148	20	112	10
CHP909	Cahal Pech Str. H1, EU 4B-c, Lvl 4	TC	NMB-sf	El Chayal	625	6230	42	18	9	139	141	19	110	9
CHP910	Cahal Pech Str. H2, EU 3/06, Lvl 4A	TC	3DS	Ixtepeque	513	9810	42	17	5	100	152	21	169	10
CHP911	Cahal Pech Str. H2, EU 3/06, Lvl 4A	TC	3PS-sf	Ixtepeque	516	9830	45	18	7	105	155	19	173	10
CHP912	Cahal Pech Str. H1, EU 6, Lvl 4	TC	SH	SMJ	517	7531	74	18	8	110	179	13	112	8
CHP913	Cahal Pech Str. H1, EU 4B/4C, Lvl 5	TC	3MS-sh	El Chayal	868	8413	79	19	11	177	172	22	128	10
CHP914	Cahal Pech Str. H1, EU 4B-c, Lvl 5	TC	3MS	El Chayal	667	6473	45	18	10	145	144	20	115	10
CHP915	Cahal Pech Str. H1, EU 4B-c, Lvl 5	TC	3PS-sf	El Chayal	908	8672	94	20	12	174	181	22	124	10
CHP916	Cahal Pech Str. H1, EU 4B-c, Lvl 5	TC	SP-sn	El Chayal	976	9018	97	20	16	177	172	22	121	10
CHP917	Cahal Pech Str. H1, EU 4B-c, Lvl 5	TC	3PS-sf	El Chayal	855	8312	70	19	13	182	172	23	122	12
CHP918	Cahal Pech Str. H1, EU 4B-c, Lvl 5	TC	3DS	El Chayal	875	7713	71	19	12	158	159	18	113	10
CHP919	Cahal Pech Str. H1, EU 4B-c, Lvl 5	TC	3MS	El Chayal	851	8140	67	19	12	174	167	21	121	12
CHP920	Cahal Pech Str. H1, EU 4B-c, Lvl 5	TC	3PS-sf	El Chayal	924	9275	93	20	13	184	175	23	120	12
CHP921	Cahal Pech Str. H1, EU 4B-c, Lvl 5	TC	3MS	El Chayal	869	7997	76	19	11	164	159	22	116	11
CHP922	Cahal Pech Str. H1, EU 4B-c, Lvl 5	TC	3MS	El Chayal	941	8605	80	19	14	175	177	23	124	11
CHP923	Cahal Pech Str. H1, EU 4B-c, Lvl 5	TC	TMS	El Chayal	663	6427	48	18	9	147	140	20	110	10
CHP924	Cahal Pech Str. H1, EU 4B-c, Lvl 5	TC	3MS	El Chayal	803	7938	59	18	11	175	167	22	116	12
CHP926	Cahal Pech Str. H1, EU 4B-c, Lvl 5	TC	3DS	El Chayal	930	8366	117	20	13	171	168	22	118	9
CHP927	Cahal Pech Str. H1, EU 4B-c, Lvl 5	TC	3PS-sf-j	El Chayal	658	6448	51	18	8	147	145	22	111	9
CHP929	Cahal Pech Plaza B, EU 1X-1, Lvl 1	LC	3DS	El Chayal	784	6950	58	18	10	155	154	22	116	10
CHP930	Cahal Pech Str. B4, EU South Trench , Lvl 4	LPC	TMS	SMJ	525	7104	45	18	9	114	191	17	113	8

Sample ID	Provenience	Time Period	Technology	Source Group	Mn	Fe	Zn	Ga	Th	Rb	Sr	Y	Zr	Nb
CHP931	Cahal Pech Plaza B, EU 1X-2, Lvl 2	MPC	3PS-sf	SMJ	638	7326	51	18	9	120	193	19	114	9
CHP932	Cahal Pech Plaza B, EU 1Y-2, Lvl 2	MPC	3MS	Ixtepeque	502	9755	36	17	7	102	155	20	169	10
CHP933	Cahal Pech Str. B4, EU South Trench , Lvl 5	MPC	3MS	SMJ	655	7814	45	18	8	121	207	18	125	7
CHP934	Cahal Pech Str. B4, EU South Trench , Lvl 5	MPC	3MS	SMJ	674	7738	52	18	8	123	204	19	117	8
CHP935	Cahal Pech Str. B4, EU South Trench , Lvl 5	MPC	3MS	SMJ	710	8973	64	18	11	141	229	20	126	10
CHP936	Cahal Pech Str. B4, EU South Trench , Lvl 5	MPC	TMS	SMJ	710	7656	54	18	10	121	199	17	119	9
CHP937	Cahal Pech Str. B4, EU South Trench , Lvl 5	MPC	3MS	SMJ	624	7631	53	18	11	123	207	18	122	9
CHP938	Cahal Pech Str. B4, EU South Trench , Lvl 5	MPC	3PS-sf	SMJ	492	7088	45	18	7	114	196	16	114	7
CHP939	Cahal Pech Str. B4, EU South Trench , Lvl 5	MPC	3PS-sf	Ucareo	424	8139	57	18	12	163	24	24	140	17
CHP940	Cahal Pech Str. B4, EU South Trench , Lvl 5	MPC	3MS	SMJ	671	8789	61	18	8	134	222	17	125	13
CHP942	Cahal Pech Plaza B, EU 1Y-6, Lvl 5	MPC	PDF	El Chayal	612	5648	37	18	11	153	133	20	93	7
CHP943	Cahal Pech Plaza B, EU 1Y-12, Lvl 7	MPC	3MS	El Chayal	688	6349	46	18	9	141	145	19	109	10
CHP944	Cahal Pech Str. B4, EU South Trench , Lvl 5	MPC	PDF	El Chayal	658	6573	47	18	7	144	147	19	112	10
CHP945	Cahal Pech Str. B4, EU South Trench , Lvl 6	MPC	3MS	SMJ	548	7679	55	18	9	126	204	18	122	8
CHP946	Cahal Pech Str. B4, EU South Trench , Lvl 7b	MPC	3MS	SMJ	606	7353	41	17	7	120	198	19	119	7
CHP947	Cahal Pech Str. B4, EU 6C-2, Construction Fill	MPC	3PS-sf	SMJ	666	7296	41	17	7	114	198	18	118	8
CHP948	Cahal Pech Str. B4, EU 6C-2, Construction Fill	MPC	OA-xp	El Chayal	660	6223	44	17	8	148	136	17	108	9
CHP949	Cahal Pech Str. B4, EU 6C-3	MPC	3RC-sf	SMJ	641	8122	55	18	9	128	206	18	123	9
CHP950	Cahal Pech Str. B4, EU 6C-3	MPC	3PS-sf	SMJ	564	7258	33	17	8	115	194	17	113	7
CHP951	Cahal Pech Str. B4, EU 6C-3	MPC	3MS	SMJ	615	7617	44	18	8	126	204	16	118	9
CHP952	Cahal Pech Str. B4, EU 6C-3	MPC	3DS	El Chayal	738	7005	59	18	9	153	152	20	113	9
CHP953	Cahal Pech Str. B4, EU 6D-4, Lvl 3	MPC	3MS	El Chayal	708	6712	46	18	9	155	151	22	115	10
CHP954	Cahal Pech Str. B4, EU 6C-4, Lvl , Construction Fill	MPC	NPB-sf	El Chayal	709	6011	41	18	12	138	136	18	105	9
CHP955	Cahal Pech Str. B4, EU 6D-5, Lvl 6	MPC	3PS-sf	El Chayal	698	7428	74	19	11	159	153	20	116	11
CHP956	Cahal Pech Str. B4, EU South Trench , Lvl 13	EPC	CRF	El Chayal	708	6774	48	18	10	154	149	16	113	8
CHP957	Cahal Pech Str. B4, EU South Trench , Lvl 13	EPC	3CB-ms	El Chayal	740	7313	68	18	10	161	157	23	116	11
CHP958	Cahal Pech Str. B4, EU South Trench , Lvl 13	EPC	CRF	El Chayal	640	6602	65	18	10	146	142	20	105	9

Sample ID	Provenience	Time Period	Technology	Source Group	Mn	Fe	Zn	Ga	Th	Rb	Sr	Y	Zr	Nb
CHP959	Cahal Pech Str. B4, EU South Trench , Lvl 13	EPC	BP-sh	El Chayal	712	7355	57	18	7	160	152	20	117	10
CHP960	Cahal Pech Str. B4, EU South Trench , Lvl 14	EPC	3MS	El Chayal	723	6373	83	19	9	140	144	20	112	8
CHP961	Cahal Pech Str. B4, EU South Trench , Lvl 14	EPC	UNF	El Chayal	729	6557	46	18	11	149	145	20	112	8
CHP962	Cahal Pech Str. B4, EU South Trench , Lvl 14	EPC	DSH	El Chayal	761	6864	48	18	10	155	151	20	113	9
CHP963	Cahal Pech Str. B4, EU South Trench , Lvl 14	EPC	PDB-sf	El Chayal	620	6091	39	17	8	137	131	20	104	9
CHP964	Cahal Pech Str. B4, EU South Trench , Lvl 14	EPC	PDB-sf	El Chayal	637	5968	37	17	9	141	142	19	107	10
CHP965	Cahal Pech Str. B4, EU South Trench , Lvl 14	EPC	NPB-sf	El Chayal	631	6596	39	17	9	144	148	19	109	10
CHP966	Cahal Pech Str. B4, EU South Trench , Lvl 14	EPC	UNF	El Chayal	725	6512	53	18	10	142	144	20	109	10
CHP967	Cahal Pech Str. B4, EU South Trench , Lvl 14	EPC	SDF-c	El Chayal	744	6897	49	18	8	156	153	20	112	10
CHP968	Cahal Pech Str. B4, EU South Trench , Lvl 14	EPC	SH	El Chayal	709	7094	43	18	9	158	152	22	116	11
CHP969	Cahal Pech Str. B4, EU South Trench , Lvl 14	EPC	UNF	El Chayal	841	7905	60	18	12	172	168	22	123	10
CHP970	Cahal Pech Str. B4, EU South Trench , Lvl 14	EPC	PSH	El Chayal	653	6518	49	18	10	141	139	19	105	10
CHP971	Cahal Pech Str. B4, EU South Trench , Lvl 14	EPC	PSH	El Chayal	624	6010	39	18	11	139	135	20	104	10
CHP972	Cahal Pech Str. B4, EU South Trench , Lvl 14	EPC	PSH-bp	El Chayal	680	6022	42	17	8	135	131	19	105	9
CHP973	Cahal Pech Str. B4, EU South Trench , Lvl 14	EPC	OA-perc	El Chayal	723	7494	63	18	10	160	159	21	119	10
CHP974	Cahal Pech Str. B4, EU South Trench , Lvl 14	EPC	SH	El Chayal	755	6954	82	19	9	157	157	20	116	8
CHP975	Cahal Pech Str. B4, EU South Trench , Lvl 14	EPC	DSH	El Chayal	705	6851	51	18	12	152	146	19	112	9
CHP976	Cahal Pech Str. B4, EU South Trench , Lvl 14	EPC	SH	El Chayal	807	7558	52	18	11	166	166	22	118	10
CHP977	Cahal Pech Str. B4, EU South Trench , Lvl 14	EPC	DSH	El Chayal	798	7094	50	18	9	154	150	21	114	10
CHP978	Cahal Pech Str. B4, EU 6E-2, Lvl 2	LPC	3PS-sf	El Chayal	722	6689	49	18	8	151	150	21	112	11
CHP979	Cahal Pech Str.C6, EU 09-05, Lvl 1, Collapse	LC	3MS	El Chayal	721	6611	53	18	10	147	147	20	111	10
CHP980	Cahal Pech Str.C6, EU 09-06, Lvl 1, Collapse	LC	3MS	Ixtepeque	449	9830	53	18	7	108	158	19	170	9
CHP981	Cahal Pech Str.C6, EU 09-06, Lvl 1	LC	3MS	El Chayal	693	6621	62	18	10	147	148	19	113	10
CHP982	Cahal Pech Str.C6, EU 09-06, Lvl 1	LC	3MS	El Chayal	906	8169	80	19	12	176	168	19	121	12
CHP983	Cahal Pech Str.C6, EU 09-07, Lvl 1	LC	3MS	El Chayal	874	7471	81	19	12	157	150	18	114	9
CHP984	Cahal Pech Str.C6, EU 09-01C, Lvl 1, Collapse	LC	3MS	El Chayal	799	7549	71	19	13	168	160	23	118	11

Sample ID	Provenience	Time Period	Technology	Source Group	Mn	Fe	Zn	Ga	Th	Rb	Sr	Y	Zr	Nb
CHP985	Cahal Pech Str.C6, EU 09-02, Lvl 1, Collapse	LC	3MS	El Chayal	705	6324	53	18	8	142	145	21	111	9
CHP986	Cahal Pech Str.C6, EU CHP09-09, Lvl 1, Collapse	LC	3DS	El Chayal	760	7732	66	18	12	165	159	20	115	11
CHP987	Cahal Pech Plaza B, EU 7C-1, Lvl 1	LC	3MS	SMJ	581	7895	68	18	10	123	204	20	120	7
CHP988	Cahal Pech Plaza B, EU 7F-1, Lvl 1	LC	3PS-sf	El Chayal	660	6831	45	18	9	155	148	21	113	10
CHP989	Cahal Pech Plaza B, EU 7F-1, Lvl 1	LC	3MS	El Chayal	713	6932	49	18	10	154	157	21	112	11
CHP990	Cahal Pech Str.C6, EU 2, Lvl 1	LC	3MS	El Chayal	750	7050	68	18	11	159	152	22	117	10
CHP991	Cahal Pech Plaza B, EU 7D-11, Lvl 8	MPC	CS-ct	El Chayal	646	5425	35	17	9	142	130	19	90	7
CHP992	Cahal Pech Plaza B, EU 7D-11, Lvl 8	MPC	DSH	El Chayal	723	6056	33	17	11	141	136	19	107	8
CHP993	Cahal Pech Plaza B, EU 3C-8, Lvl 6	MPC	3MS	SMJ	625	7594	40	17	10	117	184	17	115	10
CHP994	Cahal Pech Plaza B, EU 3C-8, Lvl 6	MPC	3MS	SMJ	642	8019	42	18	10	124	194	20	123	9
CHP995	Cahal Pech Plaza B, EU 7D-12, Lvl 9	MPC	3PS-sf	El Chayal	732	7060	52	18	9	151	152	21	114	10
CHP996	Cahal Pech Plaza B, EU 3C-9, Lvl 7	MPC	3MS	SMJ	653	8704	49	18	11	134	218	18	123	10
CHP997	Cahal Pech Plaza B, EU 3c-13, Lvl 9	MPC	TMS	El Chayal	689	6505	53	18	10	165	145	23	99	9
CHP998	Cahal Pech Plaza B, EU 3C-9, Lvl 7	MPC	3DS	SMJ	674	7848	57	18	8	120	195	15	111	9
CHP999	Cahal Pech Plaza B, EU 7H-7, Lvl 9c	MPC	3MS	El Chayal	670	6330	35	17	9	143	141	20	107	7
CHP1000	Cahal Pech Plaza B, EU 3C-9, Lvl 7	MPC	3MS	SMJ	586	7891	39	17	7	126	211	19	119	9
CHP1001	Cahal Pech Plaza B, Lvl 1	LC	3MS	El Chayal	727	6854	66	18	10	160	159	22	114	11
CHP1002	Cahal Pech Plaza B, Lvl 1	LC	3MS	El Chayal	785	7614	56	18	11	164	159	19	115	13
CHP1003	Cahal Pech Plaza B, Lvl 1	LC	3RC-sf	El Chayal	691	6619	50	18	9	150	152	20	112	9
CHP1004	Cahal Pech Str. B1, EU B1-2Bx, Lvl 5, B1-18	LC	3MS	El Chayal	773	7186	55	18	10	161	161	20	116	10
CHP1005	Cahal Pech Str. B1, EU B1-2Bx, Lvl 5, B1-18	LC	3PS-sf	El Chayal	770	6673	58	18	11	156	153	19	112	10
CHP1006	Cahal Pech Str. B1, EU B1-2Bx, Lvl 5, B1-18	LC	DSC3	El Chayal	733	6617	48	18	9	151	152	20	113	9
CHP1007	Cahal Pech Str. B1, EU B1-2Bx, Lvl 5, B1-18	LC	DSC3-GD	El Chayal	713	6781	59	18	8	151	150	21	116	10
CHP1008	Cahal Pech Str. B1, EU B1-2Bx, Lvl 5, B1-18	LC	DSC3	El Chayal	792	7594	52	18	13	167	170	25	121	11
CHP1009	Cahal Pech Str. B1, EU B1-2Bx, Lvl 5, B1-18	LC	3PS-sf-c	El Chayal	718	6981	75	19	12	156	155	21	115	10
CHP1010	Cahal Pech Plaza B, EU B-3, Lvl 1	LC	3MS	SMJ	645	7630	56	18	5	117	197	17	114	8
CHP1011	Cahal Pech Str. B1, EU B1-2Bx, Lvl 5, B1-18	LC	DSc3	El Chayal	678	6630	55	18	10	147	145	21	116	9
CHP1012	Cahal Pech Str. B1, EU B1-2Bx, Lvl 5, B1-18	LC	3PS-sf	Ixtepeque	526	9654	41	17	6	102	153	19	165	9

Sample ID	Provenience	Time Period	Technology	Source Group	Mn	Fe	Zn	Ga	Th	Rb	Sr	Y	Zr	Nb
CHP1013	Cahal Pech Plaza B, EU B4, Lvl 1, Humus/Collapse	LC	3PS-sf	El Chayal	661	6562	72	18	8	144	142	19	109	11
CHP1014	Cahal Pech Plaza B, EU B4, Lvl 1, Humus/Collapse	LC	3MS	El Chayal	715	6962	51	18	11	156	151	19	112	9
CHP1015	Cahal Pech Plaza B, EU B-5, Lvl 1	LC	3MS	Ixtepeque	539	10260	64	18	6	100	152	19	160	8
CHP1016	Cahal Pech Str. B1-B2, EU B1/B2-1, Lvl 1, Collapse	LC	3MS	El Chayal	738	6942	48	18	11	155	153	21	117	10
CHP1017	Cahal Pech Str. B1, EU B-6, Lvl 1, Fill	LC	3PS-sf	El Chayal	734	6791	50	18	11	148	152	22	112	11
CHP1018	Cahal Pech Str. B1-B2, EU B1/B2-1, Lvl 1, Collapse	LC	3PS-sf	Ixtepeque	536	10041	77	19	7	103	148	19	162	11
CHP1019	Cahal Pech Str. B2, EU B2-1, Lvl 6	EC	PSH	El Chayal	598	5961	52	18	9	153	139	19	96	8
CHP1020	Cahal Pech Str. B2, EU B2-1, Lvl 6	EC	3PS-sf	SMJ	595	7183	48	18	8	118	195	16	112	8
CHP1021	Cahal Pech Str. B1 Stairs	LC	3PS-sf	El Chayal	697	6448	48	18	8	147	147	20	111	8
CHP1022	Cahal Pech Plaza B, EU B7, Lvl 1, Humus/Fill	LC	3DS	Ixtepeque	580	11260	66	18	7	114	165	21	177	8
CHP1023	Cahal Pech Plaza B, EU CHP-PB-PU-14 Ext 3, Lvl 1, Humus	LC	3MS	El Chayal	641	6407	49	18	9	147	146	19	110	9
CHP1024	Cahal Pech Str. B4, EU 10, Lvl 8, Below Floor 7	MPC	3MS	SMJ	577	7104	53	18	9	116	192	18	112	9
CHP1025	Cahal Pech Str. B4, EU 10, Lvl 7	MPC	3PS-sf-pa	El Chayal	800	6251	53	18	11	158	147	22	99	9
CHP1026	Cahal Pech Str. B4, EU 10, Lvl 7	MPC	3PS-sf	SMJ	594	8009	52	18	9	124	205	18	118	10
CHP1027	Cahal Pech Stairs B-H-C, EU Stairs 1AX, Lvl 1, Humus	LC	3MS	El Chayal	671	6428	59	18	10	142	144	19	108	9
CHP1028	Cahal Pech Stairs B-H-C, EU Stairs 4, Lvl 1, Humus	LC	3PS-sf	El Chayal	632	6235	53	18	11	142	141	19	106	9
CHP1029	Cahal Pech Stairs B-H-C, EU Stairs 1AX, Lvl 1, Humus	LC	3PS-sf	SMJ	582	7138	57	18	9	118	192	18	117	8
CHP1030	Cahal Pech Stairs B-H-C, EU Stairs 1AX, Lvl 1, Humus	LC	3DS	El Chayal	727	7094	74	19	9	154	151	21	113	10
CHP1031	Cahal Pech Stairs B-H-C, EU Stairs 6, Lvl 1, Humus	LC	3MS	El Chayal	705	6722	70	19	11	151	148	20	112	10
CHP1032	Cahal Pech Str. B4, EU 11, Lvl 5, Below Floor 1	LPC	CH-bp	SMJ	570	6891	36	17	7	112	188	17	111	8
CHP1034	Cahal Pech Ball Court/Plaza C, EU BC-12-1, Lvl 2	LC	3MS	Ixtepeque	390	8810	43	17	6	100	145	19	161	9
CHP1035	Cahal Pech Ball Court/Plaza C, EU BC-12-1, Lvl 2	LC	3MS	El Chayal	670	6670	54	18	11	145	147	21	115	10
CHP1037	Cahal Pech Ball Court/Plaza C, EU BC-12-1, Lvl 2	LC	3PS-sf	SMJ	561	7593	60	18	8	122	203	18	117	9
CHP1038	Cahal Pech Ball Court/Plaza C, EU BC-12-1, Lvl 2	LC	3MS	Ixtepeque	573	9568	47	18	8	100	151	20	167	9
CHP1039	Cahal Pech Ball Court/Plaza C, EU BC-12-1, Lvl 2	LC	3PS-sf	Ixtepeque	458	9641	51	18	5	92	147	18	163	8
CHP1040	Cahal Pech Ball Court/Plaza C, EU BC-12-1, Lvl 2	LC	3PS-sf	El Chayal	786	7061	62	18	10	155	153	22	115	11

Sample ID	Provenience	Time Period	Technology	Source Group	Mn	Fe	Zn	Ga	Th	Rb	Sr	Y	Zr	Nb
CHP1041	Cahal Pech Ball Court/Plaza C, EU BC-12-2, Lvl 2	LC	3MS	Ixtepeque	409	9595	54	18	8	105	156	19	168	9
CHP1042	Cahal Pech Ball Court/Plaza C, EU BC-12-2, Lvl 2	LC	3PS-sf	El Chayal	740	6984	72	18	9	156	155	20	115	11
CHP1043	Cahal Pech Ball Court/Plaza C, EU BC-12-2, Lvl 2	LC	2PS-sf	El Chayal	893	8196	95	19	11	168	162	23	112	11
CHP1044	Cahal Pech Ball Court/Plaza C, EU BC-12-2, Lvl 2	LC	3MS	Ixtepeque	572	11408	52	18	6	112	171	20	183	9
CHP1045	Cahal Pech Ball Court/Plaza C, EU BC-12-2, Lvl 2	LC	3MS	El Chayal	748	7124	50	18	8	154	156	22	117	9
CHP1046	Cahal Pech Ball Court/Plaza C, EU BC-12-2, Lvl 2	LC	3DS	Ixtepeque	454	9321	51	17	5	96	148	17	160	10
CHP1047	Cahal Pech Ball Court/Plaza C, EU BC-12-3, Lvl 2	LC	3MS	Ixtepeque	440	8967	42	17	5	94	144	18	163	10
CHP1048	Cahal Pech Ball Court/Plaza C, EU BC-12-3, Lvl 2	LC	3MS	El Chayal	819	8298	73	19	12	179	174	24	124	9
CHP1049	Cahal Pech Stairs B-H-C, EU Stairs 7, Lvl 1, Humus	LC	3MS	El Chayal	670	6580	66	18	9	142	144	21	111	10
CHP1050	Cahal Pech Stairs B-H-C, EU Stairs 7, Lvl 1, Humus	LC	3MS	El Chayal	739	6727	49	18	9	149	153	21	111	10
CHP1051	Cahal Pech Stairs B-H-C, EU Stairs 7, Lvl 1, Humus	LC	3MS	Ixtepeque	460	9569	53	18	5	101	153	18	168	9
CHP1052	Cahal Pech Ball Court/Plaza C, EU BC-12-2, Lvl 2	LC	3MS	El Chayal	759	7348	66	18	9	160	157	19	115	11
CHP1053	Cahal Pech Ball Court/Plaza C, EU BC-12-2, Lvl 2	LC	3PS-sf	El Chayal	720	6777	57	18	9	152	150	23	115	10
CHP1054	Cahal Pech Ball Court/Plaza C, EU BC-12-2, Lvl 2	LC	2PS-sf	El Chayal	726	7346	69	19	14	164	162	22	118	13
CHP1058	Cahal Pech Str. C4/B3-E, EU C4/B3-E-12, Lvl 1, Humus	LC	SH	El Chayal	765	6995	56	18	12	163	157	21	117	10
CHP1059	Cahal Pech Stairs B-H-C, EU Stairs 7, Lvl 1, Humus	LC	3DS	El Chayal	634	6501	63	18	11	143	144	23	108	10
CHP1060	Cahal Pech Stairs B-H-C, EU Stairs 7, Lvl 1, Humus	LC	TMS	Ixtepeque	418	9969	56	18	6	102	158	20	166	10
CHP1061	Cahal Pech Ball Court/Plaza C, EU BC-12-3, Lvl 3, East of wall	LC	3DS	SMJ	522	7057	57	18	7	119	192	19	111	9
CHP1062	Cahal Pech Ball Court/Plaza C, EU BC-12-3, Lvl 3, East of wall	LC	3MS	Ixtepeque	580	11414	67	18	6	115	166	19	181	11
CHP1063	Cahal Pech Str. C4/B3-E, EU C4/B3-E-12-7, Lvl 1, Humus/Collapse	LC	3DS	SMJ	509	6995	51	18	9	120	194	17	119	10
CHP1064	Cahal Pech Ball Court/Plaza C, EU BC-12-5, Lvl 2, Below Floor 1	LC	3DS	El Chayal	805	8133	76	19	12	167	161	21	117	12
CHP1065	Cahal Pech Str. B4, EU 11, Lvl 6	MPC	3PS-sf	SMJ	601	7387	39	17	7	121	196	16	117	8
CHP1066	Cahal Pech Ball Court/Plaza C, EU BC-12-5, Lvl 2	LC	3DS	SMJ	672	7901	69	18	11	126	197	17	116	10
CHP1067	Cahal Pech Ball Court/Plaza C, EU BC-12-5, Lvl 2	LC	3MS	El Chayal	670	6501	51	18	10	148	147	20	112	9
CHP1068	Cahal Pech Ball Court/Plaza C, EU BC-12-5, Lvl 2	LC	3DS	SMJ	601	7234	53	18	7	117	193	18	117	8
CHP1069	Cahal Pech Ball Court/Plaza C, EU BC-12-5, Lvl 2	LC	3PS-sf	SMJ	669	8467	75	19	9	128	212	19	124	7

Sample ID	Provenience	Time Period	Technology	Source Group	Mn	Fe	Zn	Ga	Th	Rb	Sr	Y	Zr	Nb
CHP1070	Cahal Pech Ball Court/Plaza C, EU BC-12-5, Lvl 2	LC	BTF	SMJ	530	6812	55	18	7	110	188	17	110	8
CHP1071	Cahal Pech Ball Court/Plaza C, EU BC-12-5, Lvl 2	LC	3DS	SMJ	623	7643	66	18	10	125	204	18	124	7
CHP1072	Cahal Pech Ball Court/Plaza C, EU BC-12-6, Lvl 3	LC	3DS	El Chayal	831	7477	88	19	12	165	160	21	120	12
CHP1073	Cahal Pech Ball Court/Plaza C, EU BC-12-6x, Lvl 2	LC	3MS	El Chayal	626	6710	55	18	10	152	150	20	113	10
CHP1074	Cahal Pech Str. B4, EU 13 North Trench, Lvl 6, Below Floor 5	MPC	3MS	El Chayal	849	7868	68	19	12	161	160	22	117	12
CHP1075	Cahal Pech Str. B4, EU 13 North Trench, Lvl 6	MPC	3PS-sf	El Chayal	712	7186	45	18	10	157	152	19	116	10
CHP1076	Cahal Pech Str. B4, EU 13 North Trench, Lvl 6b	MPC	3DS	SMJ	616	7623	55	18	10	123	200	16	118	8
CHP1077	Cahal Pech Str. B1, EU B1/B3-3, Lvl 1	LPC	3PS-sf	Ixtepeque	491	10173	42	17	5	104	161	20	170	10
CHP1078	Cahal Pech Str. B4, EU 13 North Trench, Lvl 7	MPC	3PS-sf	SMJ	603	7538	55	18	8	119	198	18	120	9
CHP1079	Cahal Pech Str. B4, EU 14, Lvl 4	LPC	3MS-sh	El Chayal	609	6342	45	18	11	142	142	17	107	10
CHP1080	Cahal Pech Str. B1/ Plaza C, EU 1, Lvl 2, B-1-1-101	LC	3PS-sf	El Chayal	751	6976	59	18	10	155	157	22	117	11
CHP1082	Cahal Pech Str. B1, EU 1, Lvl 2, B1-1-101	LC	3MS	El Chayal	737	6903	52	18	10	154	150	20	116	10
CHP1083	Cahal Pech Str. B1, EU B1-2 West, Lvl 8	EC	3MS	El Chayal	642	6204	48	18	9	145	144	20	109	8
CHP1084	Cahal Pech Str. B4, EU B4-NE Corner, Lvl 1	LPC	3PS-sf	El Chayal	792	8038	64	18	12	168	163	22	119	10
CHP1085	Cahal Pech Str. B4, EU B4-NE Corner, Lvl 1	LPC	3MS	El Chayal	903	7679	67	19	12	164	165	22	117	11
CHP1086	Cahal Pech Str. B1, EU B1-5 West, Lvl 4, Burial 12	EC	TMS	El Chayal	663	6731	58	18	9	151	152	21	111	10
CHP1087	Cahal Pech Str. B4, EU B4-NE Corner, Lvl 1	LPC	3PS-sf	SMJ	524	6947	44	18	8	111	189	16	109	8
CHP1089	Cahal Pech Str. B1, EU B1-5 West, Lvl 4, East of Burial 12	EC	3ms	SMJ	649	7413	42	18	9	121	199	16	118	8
CHP1090	Cahal Pech Str. B4, EU B4-NW Corner, Lvl 1	LPC	3MS	El Chayal	674	6228	45	18	9	147	140	20	108	10
CHP1091	Cahal Pech Str. B4, EU B4-NW Corner, Lvl 1	LPC	3DS	El Chayal	800	8374	106	20	8	161	166	18	116	10
CHP1092	Cahal Pech Str. B4, EU B4-NW Corner, Lvl 1	LPC	DSc3	El Chayal	606	6478	39	18	10	144	141	20	111	10
CHP1093	Cahal Pech Str. B4, EU B4-NW Corner, Lvl 1	LPC	3MS	El Chayal	737	7024	54	18	10	155	154	21	116	9
CHP1094	Cahal Pech Plaza G, Surface Collection	TC	3PS-sf	El Chayal	931	8305	86	19	13	178	172	24	124	12
CHP1095	Cahal Pech Str. G2, EU CHP-G2-3, Lvl 2, Collapsed debris	LC	DSC3-gd	El Chayal	806	7620	72	19	10	165	162	21	120	11
CHP1096	Cahal Pech Str. G2, EU CHP-G2-2, Lvl 1	TC	3MS	El Chayal	697	6417	60	18	11	147	148	21	111	11
CHP1097	Cahal Pech Str. B1, EU B1-7 West, Lvl 8, Below 7th Floor/ Buriual 13	EC	3MS	SMJ	629	6874	41	18	9	112	191	16	111	7

Sample ID	Provenience	Time Period	Technology	Source Group	Mn	Fe	Zn	Ga	Th	Rb	Sr	Y	Zr	Nb
CHP1098	Cahal Pech Str. B5, EU B5-4, Lvl 4, below floor 3	LC	NPB-sf	El Chayal	708	6424	45	18	12	148	141	22	111	9
CHP1099	Cahal Pech Str. G2, EU G2-9, Lvl 1, Humus	LC	3MS	El Chayal	773	7219	69	18	11	160	158	21	116	10
CHP1100	Cahal Pech Str. G2, EU G2-9, Lvl 1, Humus	LC	2MS	El Chayal	721	7063	66	18	10	159	156	21	116	10
CHP1101	Cahal Pech Str. G2, EU G2-9, Lvl 1, Humus	LC	3MS	El Chayal	770	7548	65	18	11	168	166	21	119	10
CHP1102	Cahal Pech Str. G2, EU PL PU-G-3, Lvl 10, below floor 8	LPC	3PS-sf	SMJ	548	7239	39	17	7	113	181	17	114	6
CHP1105	Cahal Pech Str. G2, EU G2-11, Lvl 1	LC	3PS-sf-c	El Chayal	832	7890	81	19	13	169	169	23	122	11
CHP1106	Cahal Pech Str. G2, EU G2-12, Lvl 1	LC	3PS-sf	El Chayal	937	8987	94	20	13	185	176	21	127	11
CHP1107	Cahal Pech Str. B5, EU B5-3, Lvl 14, below floor 13	LPC	NPB-ms	El Chayal	647	6340	45	18	11	137	137	19	103	8
CHP1109	Cahal Pech Str. H2, EU 33, Lvl 1	TC	3MS	SMJ	629	8179	58	18	10	131	197	17	118	8
CHP1110	Cahal Pech Str. H1, EU 34, Lvl 1	TC	3PS-sf-c	El Chayal	683	6284	48	18	8	145	145	20	113	9
CHP1111	Cahal Pech Str. H2, EU 33C, Lvl 2, Cache Pit	TC	3PS-sf	El Chayal	856	7680	61	18	11	161	159	20	116	11
CHP1112	Cahal Pech Str. H1, EU 34, Lvl 2	TC	3PS-sf	El Chayal	706	6975	56	18	11	162	150	21	118	11
CHP1113	Cahal Pech Str. H1, EU 39, Lvl 1	TC	3MS	Ixtepeque	466	9756	41	17	5	99	153	18	167	9
CHP1114	Cahal Pech Str. H1, EU 34, Lvl 3	TC	3MS	El Chayal	944	9092	69	19	16	193	180	22	127	14
CHP1115	Cahal Pech Str. H1, EU 35, Lvl 1	TC	3PS-sf	El Chayal	826	7422	68	18	10	157	159	19	112	10
CHP1116	Cahal Pech Str. H1, EU 35, Lvl 3	TC	3MS	El Chayal	727	7469	62	18	13	161	159	21	121	11
CHP1117	Cahal Pech Str. H1, EU 35, Lvl 3	TC	3MS	El Chayal	684	6450	44	18	9	143	143	19	111	9
CHP1118	Cahal Pech Str. H3, EU 46, Lvl 2	TC	3MS	Ixtepeque	536	10041	77	19	7	103	148	19	162	11
CHP1119	Cahal Pech Str. G2, EU G2-19, Lvl 1, Humus	LC	3MS	SMJ	642	7400	65	18	8	118	192	16	117	9
CHP1120	Cahal Pech Str. G2, EU G2-15, Lvl 1, Humus	LC	3DS-em	El Chayal	927	8856	82	19	14	187	175	23	128	11
CHP1121	Cahal Pech Str. G2, EU G2-16, Lvl 1, Humus	LC	PSH	El Chayal	697	6448	48	18	8	147	147	20	111	8
CHP1123	Cahal Pech Str. G2, EU G2-14, Lvl 2	LC	3DS	Ixtepeque	472	9932	40	17	7	103	153	17	169	10
CHP1124	Cahal Pech Str. G2, EU G2-19, Lvl 1	LC	3MS	El Chayal	652	6473	54	18	10	152	148	20	114	10
CHP1125	Cahal Pech Str. G2, EU G2-17, Lvl 2, Below Plaza Floor 1	LC	3MS	El Chayal	747	6936	64	18	10	151	150	18	110	8
CHP1126	Cahal Pech Str. G2, EU G2-18, Lvl 1b, Collapse	LC	3PS-sf	El Chayal	626	6395	52	18	9	146	146	19	110	8
CHP1127	Cahal Pech Str. G2, EU G2-20, Lvl 1b	LC	3MS	El Chayal	781	7898	72	18	9	165	167	21	116	12
CHP1128	Cahal Pech Str. G2, EU G2-20, Lvl 1b	LC	3MS	El Chayal	694	6577	56	18	9	148	144	21	113	9

Sample ID	Provenience	Time Period	Technology	Source Group	Mn	Fe	Zn	Ga	Th	Rb	Sr	Y	Zr	Nb
CHP1129	Cahal Pech Str. G2, EU G2-24, Lvl 1, Humus	LC	3MS	El Chayal	764	7138	67	18	9	155	157	20	115	10
CHP1130	Cahal Pech Str. G2, EU G2-25, Lvl 1	LC	3MS	SMJ	613	7629	57	18	10	122	200	17	119	10
CHP1131	Cahal Pech Str. G2, EU G2-17, Lvl 3	LC	3PS-sf	Ixtepeque	554	10198	58	18	3	111	162	19	177	10
CHP1132	Cahal Pech Str. G2, EU G2-26, Lvl 2B	LC	3DS	El Chayal	701	6931	51	18	11	155	156	20	115	11
CHP1133	Cahal Pech Str. G2, EU G2-26, Lvl 2B	LC	3DS	El Chayal	705	6738	55	18	8	151	154	21	113	11
CHP1134	Cahal Pech Str. G2, EU G2-30, Lvl 1, Humus	LC	3MS	El Chayal	876	7253	119	20	13	158	153	22	110	10
CHP1135	Cahal Pech Str. G2, EU G2-67, Lvl 1	LC	3MS	El Chayal	697	6880	57	18	9	158	157	20	115	10
CHP1136	Cahal Pech Str. B4	TC	3MS	SMJ	533	7184	50	18	8	118	193	16	116	8
CHP1137	Cahal Pech Str. B4	TC	2TMS	El Chayal	672	5503	39	17	9	144	134	18	90	9
CHP1138	Cahal Pech Str. B5, Lvl. 1	LC	3MS	Ixtepeque	408	9787	40	17	5	100	153	19	165	10
CHP1139	Tolok Str. 14, EU PU2-ext, Lvl 1	MPC	3PS-sf	Ixtepeque	429	9759	47	18	7	96	142	19	154	11
CHP1140	Tolok PU-1st, EU West Trench, Lvl 1-3	MPC	3MS	El Chayal	749	6852	53	18	13	151	144	19	107	10
CHP2000	Cahal Pech Plaza B, EU 1Y-6, Lvl 5	MPC	3MS	SMJ	654	7946	59	18	11	131	212	18	123	11
CHP2001	Cahal Pech Str. B4, EU 1, Lvl 1, Humus	LC	3MS	El Chayal	778	6887	64	18	11	152	151	21	115	9
CHP2002	Cahal Pech Str. B4, EU 1, Lvl 1, Humus	LC	3PS-sf	El Chayal	716	6977	58	18	8	154	153	21	115	10
CHP2003	Cahal Pech Str. B4, EU 1, Lvl 1, Humus	LC	3MS	SMJ	678	8110	60	18	9	127	209	18	120	9
CHP2004	Cahal Pech Str. B4, EU 1, Lvl 1, Humus	LC	3RC-sf	SMJ	583	7081	54	18	9	112	187	18	113	8
CHP2005	Cahal Pech Unknown	TC	3DS	El Chayal	750	7093	62	18	9	153	159	21	118	11
CHP2006	Cahal Pech Str.C6, EU , Lvl , Humus	LC	3MS	El Chayal	673	7055	56	18	9	161	161	21	116	10
CHP2007	Cahal Pech Str.C6, EU , Lvl , Humus	LC	3PS-sf	El Chayal	774	6973	71	19	10	157	159	22	115	10
CHP2008	Cahal Pech Str. B2, EU , Lvl 1, SW corner of B2	LC	TMS	El Chayal	799	7097	47	18	12	153	151	21	115	8
CHP2009	Cahal Pech Str. B2, EU , Lvl 1, SW corner of B2	LC	3DS	Ixtepeque	461	10499	48	17	4	100	159	18	163	12
CHP2010	Cahal Pech Str. B2, EU , Lvl 1, SW corner of B2	LC	CRF	El Chayal	658	5867	36	17	6	136	129	19	107	8
CHP2011	Cahal Pech Str. B2, EU , Lvl 1, SW corner of B2	LC	3MS	Ixtepeque	488	10205	44	17	5	104	154	20	172	11
CHP2012	Cahal Pech Str. B2, EU , Lvl 1, SW corner of B2	LC	3RC-sf	Ixtepeque	482	10699	50	18	8	110	165	20	178	9
CHP2013	Cahal Pech Str. C1, EU 13, Lvl 1	LC	PSH	El Chayal	713	7412	79	19	11	161	160	23	119	10
CHP2014	Cahal Pech Str. G2, EU G2-9, Lvl 1, Humus	LC	3PS-sf	El Chayal	780	7826	76	19	11	173	173	22	125	11
CHP2015	Cahal Pech Str. G1, EU G1-1, Lvl 1	LC	CSF-ct	Ixtepeque	534	10285	92	19	8	106	162	20	173	7

Sample ID	Provenience	Time Period	Technology	Source Group	Mn	Fe	Zn	Ga	Th	Rb	Sr	Y	Zr	Nb
CHP2016	Cahal Pech Plaza G, EU CHP-PL-G-4, Lvl 3	LC	3MS	Ixtepeque	526	10476	57	18	7	108	159	18	171	11
CHP2017	Cahal Pech Str. G1, EU G2-3, Lvl 1	LC	HLC-ds-nt	El Chayal	659	5812	50	18	8	139	134	18	104	9
CHP2018	Cahal Pech Str. G2, EU G2-22, Lvl 8	LPC	3MS	El Chayal	717	6375	54	18	8	148	145	19	110	10
CHP2019	Cahal Pech Str. G2, EU G2-22, Lvl 6	EC	FLK-c	El Chayal	662	6158	52	18	9	136	138	22	105	9
CHP2020	Cahal Pech Str. G2, EU G2-17, Lvl 7, Below Floor 6	LPC	3MS	SMJ	777	8995	79	19	12	141	227	19	130	10
CHP2021	Cahal Pech Str. G1, EU 4, Lvl 1, Humus	LC	3PS-sf	El Chayal	925	8054	86	19	14	171	174	23	119	10
CHP2022	Cahal Pech Str. G1, EU G1-3, Lvl 1	LC	3MS	El Chayal	724	6721	62	18	8	152	151	21	114	9
CHP2023	Cahal Pech Str. G1, EU G1-3, Lvl 1	LC	3PS-sf	Ixtepeque	477	9969	57	18	7	108	159	20	169	10
CHP2024	Cahal Pech Str. G2, EU G2-36, Lvl 1	LC	3MS	El Chayal	704	6499	56	18	10	150	148	19	111	11
CHP2025	Cahal Pech Str. G1, EU G1-3, Lvl 1	LC	3MS	SMJ	544	7349	58	18	7	122	198	17	117	9
CHP2026	Cahal Pech Plaza G, EU CHP-PL-G-4, Lvl 2	LC	3PS-sf	Ixtepeque	497	11034	58	18	7	117	169	20	178	10
CHP2027	Cahal Pech Str. G2, EU G2-21, Lvl 1	LC	3MS	El Chayal	773	7154	76	19	9	155	149	19	116	10
CHP2028	Cahal Pech Str. G2, EU G2-25, Lvl 1	LC	3MS	Ixtepeque	575	12312	85	19	9	118	178	20	177	10
CHP2029	Cahal Pech Str. G1, EU G1, Lvl 3	LC	3MS	Ixtepeque	499	11291	50	18	6	115	175	20	181	11
CHP2030	Cahal Pech Str. G1, EU G1, Lvl 3, Below Plaza Floor B	LC	CRF-bp	Ixtepeque	466	8564	35	17	6	91	133	18	149	7
CHP2031	Cahal Pech Str. G1, EU G1/G2 Alley, Lvl , BackFill	TC	CRF-bp	El Chayal	647	6687	50	18	8	138	141	19	107	8
CHP2032	Cahal Pech Str. G1, EU G1-3, Lvl 4, Below Plaza Floor B	EC	TMS	El Chayal	728	7103	65	18	9	156	158	22	115	10
CHP2033	Cahal Pech Plaza B, EU CHP-PB-PU-37, Lvl 1, Humus	LC	1DS	El Chayal	737	7039	47	18	9	151	150	23	112	11
CHP2034	Cahal Pech Plaza B, EU CHP-PB-PU-37, Lvl 1, Humus	LC	1PS-sf	Ixtepeque	523	9055	38	17	5	96	145	18	157	8
CHP2035	Cahal Pech Plaza B, EU CHP-PB-PU-33c, Lvl 9, Below Floor 10	MPC	3DS	Ixtepeque	546	10387	39	17	4	101	155	19	168	10
CHP2036	Cahal Pech Plaza B, EU CHP-PB-PU-35, Lvl 1, Humus	LC	3PS-sf	El Chayal	793	7668	49	18	10	158	161	23	123	12
CHP2037	Cahal Pech Plaza B, EU CHP-PB-PU-31, Lvl 12, Below Floor 14	MPC	3PS-sf	SMJ	599	7293	37	17	8	114	187	16	115	7
CHP2038	Cahal Pech Plaza B, EU CHP-PB-PU-31, Lvl 12, Below Floor 14	MPC	PSH	El Chayal	747	6716	50	18	10	144	140	20	112	9
CHP2039	Cahal Pech Plaza B, EU CHP-PB-PU-37, Lvl 8, Below Floor 9	LPC	TMS	Ixtepeque	419	9845	30	17	5	102	147	18	165	9
CHP2040	Cahal Pech Plaza B, EU CHP-PB-PU-36, Lvl 11, Below Feature 30	MPC	3PS-sf	SMJ	612	7118	32	17	10	114	191	17	113	8
CHP2041	Cahal Pech Plaza B, EU CHP-PB-PU-36, Lvl 11, Below Feature 30	MPC	3MS	SMJ	671	7957	49	18	8	120	199	19	119	7
CHP2042	Cahal Pech Plaza B, EU CHP-PB-PU-36, Lvl 11, Below Feature 30	MPC	DSH	SMJ	904	10921	73	19	13	150	242	20	133	10

Sample ID	Provenience	Time Period	Technology	Source Group	Mn	Fe	Zn	Ga	Th	Rb	Sr	Y	Zr	Nb
CHP2043	Cahal Pech Plaza B, EU CHP-PB-PU-36, Lvl 12, Below Floor 13	MPC	3MS	SMJ	624	7675	54	18	10	123	200	18	120	9
CHP2044	Cahal Pech Plaza B, EU CHP-PB-PU-35, Lvl 8, Below Floor 11-outside Feature 25	LPC	3MS	SMJ	594	7422	40	18	10	116	192	17	115	8
CHP2045	Cahal Pech Plaza B, EU CHP-PB-PU-35, Lvl 8, Below Floor 11-outside Feature 25	LPC	3MS	SMJ	565	7382	41	18	9	120	201	18	117	8
CHP2046	Cahal Pech Plaza B, EU CHP-PB-PU-37, Lvl 10, Below Floor 12-on top of Feature 27	MPC	3MS	SMJ	570	7631	43	18	8	120	193	16	116	9
CHP2047	Cahal Pech Plaza B, EU CHP-PB-PU-37, Lvl 10, Below Floor 12-on top of Feature 27	MPC	3MS	SMJ	650	7892	41	17	8	122	203	17	122	9
CHP2048	Cahal Pech Plaza B, EU CHP-PB-PU-37, Lvl 10, Below Floor 12-on top of Feature 27	MPC	3DS	SMJ	612	6680	43	17	7	110	174	17	107	9
CHP2049	Cahal Pech Plaza B, EU CHP-PB-PU-37, Lvl 11, Below Floor 12-outside Feature 27	MPC	3PS-sf	SMJ	672	8064	54	18	9	126	202	16	119	10
CHP2050	Cahal Pech Plaza B, EU CHP-PB-PU-35, Lvl 8, Below Floor 11-outside Feature 25	LPC	3MS	SMJ	683	8173	44	18	9	122	202	19	120	8
CHP2051	Cahal Pech Plaza B, EU CHP-PB-PU-35, Lvl 8, Below Floor 11-outside Feature 25	LPC	3MS	SMJ	601	7350	43	18	9	118	193	18	114	8
CHP2052	Cahal Pech Plaza B, EU CHP-PB-PU-35, Lvl 8, Below Floor 11-outside Feature 25	LPC	3MS	SMJ	695	8111	53	18	9	125	200	18	118	10
CHP2053	Cahal Pech Plaza B, EU CHP-PB-PU-35, Lvl 8, Below Floor 11-outside Feature 25	LPC	3PS-sf	SMJ	605	7481	44	18	10	115	191	20	117	8
CHP2054	Cahal Pech Plaza B, EU CHP-PB-PU-35, Lvl 8, Below Floor 11-outside Feature 25	LPC	3PS-sf	SMJ	566	7294	45	18	7	115	197	18	117	8
CHP2055	Cahal Pech Plaza B, EU CHP-PB-PU-35, Lvl 8, Below Floor 11-outside Feature 25	LPC	3PS-sf	SMJ	686	7677	49	18	8	119	198	18	119	8
CHP2056	Cahal Pech Plaza B, EU CHP-PB-PU-38, Lvl 5, Below Floor 7	LPC	3PS-sf	Ixtepeque	496	9577	27	17	5	95	145	16	157	9
CHP2057	Cahal Pech Plaza B, EU 1c-20, Lvl 1, Humus	LC	3RC-ds	El Chayal	834	7268	64	18	9	155	149	18	112	10
CHP2058	Cahal Pech Plaza B, EU 1c-20, Lvl 1, Humus	LC	CSF-ct	El Chayal	712	6850	55	18	9	149	144	21	111	7
CHP2059	Cahal Pech Plaza B, EU 1c-20, Lvl 1, Humus	LC	3PS-sf	El Chayal	679	6371	48	18	12	149	145	21	111	11
CHP2060	Cahal Pech Plaza B, EU 1c-20, Lvl 1, Humus	LC	3MS	El Chayal	765	6833	50	18	9	156	153	21	113	11
CHP2061	Cahal Pech Plaza B, EU 1b-4, Lvl 2, Sub-floor Construction Fill	LC	3MS	El Chayal	776	7572	71	19	13	166	164	22	120	11
CHP2062	Cahal Pech Plaza B, EU 1a-3, Lvl 2, Sub-floor Construction Fill	LC	3DS-pl	El Chayal	665	5779	53	18	8	129	127	19	104	8

Sample ID	Provenience	Time Period	Technology	Source Group	Mn	Fe	Zn	Ga	Th	Rb	Sr	Y	Zr	Nb
CHP2063	Cahal Pech Plaza B, EU 1a-3, Lvl 2, Sub-floor Construction Fill	LC	3RC-sf	El Chayal	872	8297	66	18	11	176	165	21	124	13
CHP2064	Cahal Pech Plaza B, EU 1b-2, Lvl 1, Humus	LC	3PS-sf	El Chayal	827	7564	70	19	12	168	165	21	120	12
CHP2065	Cahal Pech Plaza B, EU 1b-2, Lvl 1, Humus	LC	3PS-sf	El Chayal	737	7210	66	18	11	158	153	22	118	11
CHP2066	Cahal Pech Plaza B, EU 1b-2, Lvl 1, Humus	LC	3DS	El Chayal	807	7051	65	18	7	149	150	20	111	10
CHP2067	Cahal Pech Plaza B, EU 1b-2, Lvl 1, Humus	LC	UNF	El Chayal	692	7071	59	18	9	161	153	19	120	11
CHP2068	Cahal Pech Plaza B, EU 1b-2, Lvl 1, Humus	LC	3MS	El Chayal	807	7736	66	19	13	159	159	22	116	11
CHP2069	Cahal Pech Plaza B, EU 1b-2, Lvl 1, Humus	LC	OA	El Chayal	757	6838	54	18	11	152	153	20	113	8
CHP2070	Cahal Pech Plaza B, EU 1a-1, Lvl 1, Humus	LC	3MS	El Chayal	1041	10140	91	20	13	198	190	22	129	14
CHP2071	Cahal Pech Plaza B, EU 1a-1, Lvl 1, Humus	LC	3MS	El Chayal	839	7646	59	18	11	170	169	25	122	11
CHP2072	Cahal Pech Plaza B, EU 1a-1, Lvl 1, Humus	LC	3MS	El Chayal	1075	9450	92	20	13	193	189	26	129	12
CHP2073	Cahal Pech Plaza B, EU 1a-1, Lvl 1, Humus	LC	3MS-nt	El Chayal	693	6474	47	18	10	144	142	20	111	9
CHP2074	Cahal Pech Plaza B, EU 1a-1, Lvl 1, Humus	LC	3PS-sf-bp	SMJ	658	7741	71	18	9	114	193	17	110	9
CHP2075	Cahal Pech Plaza B, EU 1b-9, Lvl 4, Sub-floor Construction Fill	LPC	3PS-sf-bp	El Chayal	742	7209	60	18	10	161	168	21	120	10
CHP2076	Cahal Pech Plaza B, EU 1a-5, Lvl 2, Sub-floor Construction Fill	LC	SH	El Chayal	937	8372	88	19	13	178	168	23	120	10
CHP2077	Cahal Pech Plaza B, EU 1b-4, Lvl 2, Sub-floor Construction Fill	LC	TPS-sf	El Chayal	709	7130	61	18	9	154	155	24	115	10
CHP2078	Cahal Pech Plaza B, EU 1b-4, Lvl 2, Sub-floor Construction Fill	LC	3CB-sf	El Chayal	845	7730	75	19	11	162	165	22	116	10
CHP2079	Cahal Pech Plaza B, EU 1b-4, Lvl 2, Sub-floor Construction Fill	LC	2PS-sf	Ixtepeque	492	9655	36	17	5	100	148	17	164	8
CHP2080	Cahal Pech Plaza B, EU 1b-4, Lvl 2, Sub-floor Construction Fill	LC	3MS	El Chayal	707	7002	59	18	13	159	151	20	116	9
CHP2081	Tolok Str. 14, EU 14W1/NW, Lvl 1	LC	3MS	SMJ	648	7776	55	18	9	128	206	19	120	8

Appendix E

LITHICH TECHNOLOGICAL ANALYSIS CODES

Pressure Blade Sequence Code	Description
1PS-sf	Proximal section with a single facet platform of a 1st series blade
1UCB-ms	Medial section of a crested blade made from a macroblade (i.e., lamacrete)
2CB-ms	Medial section of a 2nd series corner blade from half lunar core
2DS	Distal section of a 2nd series blade
2MS	Medial section of a 2nd series blade
2PS-sf	Proximal section with a single facet platform of a 2nd series blade
2TMS	Medial section of a second series triangular blade
2TPS	Proximal section of a second series triangular blade
3CB	3rd series corner blade (blade from a half lunar core)
3DS	Distal section of a 3rd series blade
3MS	Medial section of a 3rd series blade
3PS	Proximal section of a 3rd series blade
3RC	Proximal section on a rejuvenated core
3UCB-ps	Proximal section of a crested blade made from a 3rd series blade.
CRF	Core recycling flake
CS	Core section with whole diameter is present
CSF	Core section fragment with whole diameter is present
HLC	Half lunar core
LF3	Languette flake, 3rd series blade (chunk missing from ventral)
PDB	Primary decortication blade (blade exhibits >50% cortex)
PDF	Primary decortication flake (blade exhibits >50% cortex)
TDS	Distal section of a triangular blade
TPS-sf	Proximal section with a single facet platform on a triangular blade
TMS	Medial section of a triangular blade

Percussion Sequence Code	Description
BP-ch	Bipolar chunk
BF	Bipolar flake
BP-FC	Bipolar core
BP-sh	Bipolar shatter
BTF	Bow-tie flake; blade artifact from when a blade is snapped in half
DSH	Decortication shatter
DRS	Rejuvenation sequence
DSC3	Small obsidian disc, made from a third series blade
FF	Percussion flake fragment
FLK	Flake
IF	Interior percussion flake
NPB-sf	Narrow percussion blade with a single facet platform
NPB	Narrow prismatic blade removed with percussion
NTB	Narrow triangular blade removed with percussion
OA-perc	Overhang adjustment removed with percussion
PF	Percussion flake
PSH	Percussion shatter
PS-sf	Percussion sequence-single facet
SDF-sf-c	Secondary decortication flake, single facet platform
SDF-ds	Secondary decortication flake, distal section
SH	Percussion Shatter
UN/UNF	Unidentified percussion flake

Other Codes	Description
GBF	General biface fragment
GBT	General bifacial thinning fragment
NMB	Narrow macro blade
SP	Projectile point classification
UNIF-ES	Unifacially worked tool; end scraper

Code Extensions	**Description**
-bp	Artifact has been bipolared
-c	Complete flake or blade
-ct	Core top
-dof	Directional orientation flake; direction of force on ventral runs opposite to that on dorsal
-dx	Cortex present on distal end of the flake or blade
-em	End modified
-f	Fragment of the artifact, usually with a platform
-gd	Artifact shows example of grinding
-h	hinge on dorsal surface; error removal
-hb	Hinged blade, blade terminates prematurely
-hlc	Half lunar core; core that is half conical, flat on one side, usually not worked
-j	J flake; error removal
-ms	Medial section
-nt	Notched
-pa	Proximal section but platform is absent
-sh	Piece of shatter identified from the artifact (e.g., a 3MS blade)
-sm	Worked on side margin
-sn	Side notched
-xp	Cortical platform; cortex on platform

Appendix F

CERAMIC COMPOSITIONAL GROUPS IDENTIFIED THROUGH INAA

Sample ID	Context	Provenience	Time Period	Ceramic Complex	Ceramic Type	Compositional Group
CHP001	Site Core	Cahal Pech Str. B4, Unit 7, Lvl 8b	Middle Preclassic	EF Kanluk	Jocote/Chaccinic	Group B
CHP002	Site Core	Cahal Pech Str. B4, Unit 7, Lvl 8b	Middle Preclassic	EF Kanluk	Jocote/Chaccinic	Unassigned
CHP003	Site Core	Cahal Pech Str. B4, Unit 7, Lvl 8b	Middle Preclassic	EF Kanluk	Jocote/Chaccinic	Group D
CHP004	Site Core	Cahal Pech Str. B4, Unit 7, Lvl 8b	Middle Preclassic	EF Kanluk	Jocote Orange-Brown	Group D
CHP005	Site Core	Cahal Pech Str. B4, Unit 7, Lvl 8b	Middle Preclassic	EF Kanluk	Jocote Orange-Brown	Group D
CHP006	Site Core	Cahal Pech Str. B4, Unit 7, Lvl 8b	Middle Preclassic	EF Kanluk	Jocote Orange-Brown	Group B
CHP007	Site Core	Cahal Pech Str. B4, Unit 7, Lvl 8b	Middle Preclassic	EF Kanluk	Jocote Orange-Brown	Group D
CHP008	Site Core	Cahal Pech Str. B4, Unit 7, Lvl 8b	Middle Preclassic	EF Kanluk	Jocote Orange-Brown	Group D
CHP009	Site Core	Cahal Pech Str. B4, Unit 7, Lvl 8b	Middle Preclassic	EF Kanluk	Savana Orange (v. Rejolla)	Group D
CHP010	Site Core	Cahal Pech Str. B4, Unit 7, Lvl 8b	Middle Preclassic	EF Kanluk	Savana Orange (v. Rejolla)	Group D
CHP011	Site Core	Cahal Pech Str. B4, Unit 7, Lvl 8b	Middle Preclassic	EF Kanluk	Savana Orange (v. Savana)	Group B
CHP012	Site Core	Cahal Pech Str. B4, Unit 7, Lvl 8b	Middle Preclassic	EF Kanluk	Savana Orange (v. Savana)	Group C
CHP013	Site Core	Cahal Pech Str. B4, Unit 7, Lvl 8b	Middle Preclassic	Cunil	Uck Red	Group B
CHP014	Site Core	Cahal Pech Str. B4, Unit 7, Lvl 8b	Middle Preclassic	Cunil	Uck Red	Group B
CHP015	Site Core	Cahal Pech Str. B4, Unit 7, Lvl 9	Middle Preclassic	Cunil	Baki Red Incised (v. Baki)	Group B
CHP016	Site Core	Cahal Pech Str. B4, Unit 7, Lvl 9	Middle Preclassic	EF Kanluk	Jocote Orange-Brown	Group B
CHP017	Site Core	Cahal Pech Str. B4, Unit 7, Lvl 9	Middle Preclassic	EF Kanluk	Jocote Orange-Brown	Group D
CHP018	Site Core	Cahal Pech Str. B4, Unit 7, Lvl 9	Middle Preclassic	EF Kanluk	Jocote Orange-Brown	Group D
CHP019	Site Core	Cahal Pech Str. B4, Unit 7, Lvl 9	Middle Preclassic	EF Kanluk	Joventud Red	Group B
CHP020	Site Core	Cahal Pech Str. B4, Unit 7, Lvl 9	Middle Preclassic	EF Kanluk	Joventud Red	Group E
CHP021	Site Core	Cahal Pech Str. B4, Unit 7, Lvl 9	Middle Preclassic	EF Kanluk	Reforma Incised (v. Mucnal)	Group D
CHP022	Site Core	Cahal Pech Str. B4, Unit 7, Lvl 9	Middle Preclassic	EF Kanluk	Reforma Incised (v. Mucnal)	Group D
CHP023	Site Core	Cahal Pech Str. B4, Unit 7, Lvl 9	Middle Preclassic	EF Kanluk	Savana Orange (v. Rejolla)	Group D
CHP024	Site Core	Cahal Pech Str. B4, Unit 7, Lvl 9	Middle Preclassic	EF Kanluk	Savana Orange (v. Rejolla)	Group C
CHP025	Site Core	Cahal Pech Str. B4, Unit 7, Lvl 9	Middle Preclassic	EF Kanluk	Savana Orange (v. Savana)	Group D
CHP026	Site Core	Cahal Pech Str. B4, Unit 7, Lvl 9	Middle Preclassic	EF Kanluk	Savana Orange (v. Savana)	Unassigned

Sample ID	Context	Provenience	Time Period	Ceramic Complex	Ceramic Type	Compositional Group
CHP027	Site Core	Cahal Pech Str. B4, Unit 7, Lvl 9	Middle Preclassic	EF Kanluk	Savana Orange (v. Savana)	Group B
CHP028	Site Core	Cahal Pech Str. B4, Unit 7, Lvl 9	Middle Preclassic	EF Kanluk	Savana Orange (v. Savana)	Unassigned
CHP029	Site Core	Cahal Pech Str. B4, Unit 7, Lvl 9	Middle Preclassic	EF Kanluk	Savana-Reforma	Group B
CHP030	Site Core	Cahal Pech Str. B4, Unit 7, Lvl 9	Middle Preclassic	Cunil	Uck Red (v. Uck)	Group B
CHP031	Site Core	Cahal Pech Str. B4, Unit 7, Lvl 9	Middle Preclassic	Cunil	Uck Red (v. Uck)	Group B
CHP032	Site Core	Cahal Pech Str. B4, Unit 7, Lvl 9	Middle Preclassic	Cunil	Uck Red (v. Uck)	Group B
CHP033	Site Core	Cahal Pech Str. B4, Unit 7, Lvl 10	Middle Preclassic	EF Kanluk	Jocote Orange-Brown	Group C
CHP034	Site Core	Cahal Pech Str. B4, Unit 7, Lvl 10	Middle Preclassic	EF Kanluk	Jocote Orange-Brown	Group D
CHP035	Site Core	Cahal Pech Str. B4, Unit 7, Lvl 10	Middle Preclassic	EF Kanluk	Jocote Orange-Brown	Group D
CHP036	Site Core	Cahal Pech Str. B4, Unit 7, Lvl 10	Middle Preclassic	Cunil	Mo Mottled (v. Mo)	Group B
CHP037	Site Core	Cahal Pech Str. B4, Unit 7, Lvl 10	Middle Preclassic	EF Kanluk	Savana Orange (v. Rejolla)	Unassigned
CHP038	Site Core	Cahal Pech Str. B4, Unit 7, Lvl 10	Middle Preclassic	EF Kanluk	Savana Orange (v. Rejolla)	Group B
CHP039	Site Core	Cahal Pech Str. B4, Unit 7, Lvl 10	Middle Preclassic	EF Kanluk	Savana Orange (v. Savana)	Group B
CHP040	Site Core	Cahal Pech Str. B4, Unit 7, Lvl 10	Middle Preclassic	Cunil	Sikiya Unslipped	Group D
CHP041	Site Core	Cahal Pech Str. B4, Unit 7, Lvl 10	Middle Preclassic	Cunil	Sikiya Unslipped	Group D
CHP042	Site Core	Cahal Pech Str. B4, Unit 7, Lvl 10	Middle Preclassic	EF Kanluk	Jocote Orange-Brown	Group B
CHP043	Site Core	Cahal Pech Str. B4, Unit 7, Lvl 10	Middle Preclassic	EF Kanluk	Jocote Orange-Brown	Group G
CHP044	Site Core	Cahal Pech Str. B4, Unit 7, Lvl 10	Middle Preclassic	Cunil	Uck Red	Group G
CHP045	Site Core	Cahal Pech Str. B4, Unit 7, Lvl 10	Middle Preclassic	Cunil	Uck Red	Group B
CHP046	Site Core	Cahal Pech Str. B4, Unit 7, Lvl 11	Early Preclassic	Cunil	Sikiya Unslipped	Group D
CHP047	Site Core	Cahal Pech Str. B4, Unit 7, Lvl 11	Early Preclassic	Cunil	Sikiya Unslipped	Group B
CHP048	Site Core	Cahal Pech Str. B4, Unit 7, Lvl 11	Early Preclassic	Cunil	Sikiya Unslipped	Group D
CHP049	Site Core	Cahal Pech Str. B4, Unit 7, Lvl 12	Early Preclassic	Cunil	Ardagh Orange-Brown (v. Ardagh)	Group D
CHP050	Site Core	Cahal Pech Str. B4, Unit 7, Lvl 12	Early Preclassic	Cunil	Ardagh Orange-Brown (v. Ardagh)	Group D
CHP051	Site Core	Cahal Pech Str. B4, Unit 7, Lvl 12	Early Preclassic	Cunil	Cocoyol Cream (v. Cocoyol)	Group B
CHP052	Site Core	Cahal Pech Str. B4, Unit 7, Lvl 12	Early Preclassic	Cunil	Sikiya Unslipped	Group D
CHP053	Site Core	Cahal Pech Str. B4, Unit 7, Lvl 12	Early Preclassic	Cunil	Sikiya Unslipped	Group D
CHP054	Site Core	Cahal Pech Str. B4, Unit 7, Lvl 12	Early Preclassic	Cunil	Sikiya Unslipped	Group D
CHP055	Site Core	Cahal Pech Str. B4, Unit 7, Lvl 12	Early Preclassic	Cunil	Uck Red (v. Uck)	Group B
CHP056	Site Core	Cahal Pech Str. B4, Unit 7, Lvl 13	Early Preclassic	Cunil	Ardagh Orange-Brown (v. Ardagh)	Group D

Sample ID	Context	Provenience	Time Period	Ceramic Complex	Ceramic Type	Compositional Group
CHP057	Site Core	Cahal Pech Str. B4, Unit 7, Lvl 13	Early Preclassic	Cunil	Ardagh Orange-Brown (v. Ardagh)	Group D
CHP058	Site Core	Cahal Pech Str. B4, Unit 7, Lvl 13	Early Preclassic	Cunil	Ardagh Orange-Brown (v. Ardagh)	Group D
CHP059	Site Core	Cahal Pech Str. B4, Unit 7, Lvl 13	Early Preclassic	Cunil	Baki Red Incised (v. Baki)	Group B
CHP060	Site Core	Cahal Pech Str. B4, Unit 7, Lvl 13	Early Preclassic	Cunil	Kitam Incised (v. Kitam)	Group B
CHP061	Site Core	Cahal Pech Str. B4, Unit 7, Lvl 13	Early Preclassic	Cunil	Mo Mottled (v. Mo)	Group B
CHP062	Site Core	Cahal Pech Str. B4, Unit 7, Lvl 13	Early Preclassic	Cunil	Mo Mottled (v. Mo)	Unassigned
CHP063	Site Core	Cahal Pech Str. B4, Unit 7, Lvl 13	Early Preclassic	Cunil	Sikiya Unslipped	Group D
CHP064	Site Core	Cahal Pech Str. B4, Unit 7, Lvl 13	Early Preclassic	Cunil	Sikiya Unslipped	Group D
CHP065	Site Core	Cahal Pech Str. B4, Unit 7, Lvl 13	Early Preclassic	Cunil	Sikiya Unslipped	Group D
CHP066	Site Core	Cahal Pech Str. B4, Unit 7, Lvl 13	Early Preclassic	Cunil	Sikiya Unslipped	Group D
CHP067	Site Core	Cahal Pech Str. B4, Unit 7, Lvl 13	Early Preclassic	Cunil	Sikiya Unslipped	Group D
CHP068	Site Core	Cahal Pech Str. B4, Unit 7, Lvl 13	Early Preclassic	Cunil	Uck Red (v. Uck)	Group B
CHP069	Site Core	Cahal Pech Str. B4, Unit 7, Lvl 13	Early Preclassic	Cunil	Uck Red (v. Uck)	Group B
CHP070	Site Core	Cahal Pech Str. B4, Unit 7, Lvl 13	Early Preclassic	Cunil	Unnamed brown slip	Group B
CHP071	Site Core	Cahal Pech Str. B4, Unit 7, Lvl 14	Early Preclassic	Cunil	Ardagh Orange-Brown (v. Ardagh)	Group D
CHP072	Site Core	Cahal Pech Str. B4, Unit 7, Lvl 14	Early Preclassic	Cunil	Ardagh Orange-Brown (v. Ardagh)	Group D
CHP073	Site Core	Cahal Pech Str. B4, Unit 7, Lvl 14	Early Preclassic	Cunil	Cocoyol Cream (v. Cocoyol)	Group B
CHP074	Site Core	Cahal Pech Str. B4, Unit 7, Lvl 14	Early Preclassic	Cunil	Sikiya Unslipped	Group D
CHP075	Site Core	Cahal Pech Str. B4, Unit 7, Lvl 14	Early Preclassic	Cunil	Sikiya Unslipped	Unassigned
CHP076	Site Core	Cahal Pech Str. B4, Unit 7, Lvl 14	Early Preclassic	Cunil	Uck Red (v. Uck)	Group B
CHP077	Site Core	Cahal Pech Str. B4, Unit 7, Lvl 14	Early Preclassic	Cunil	Unnamed Ash Temper	Group B
CHP078	Site Core	Cahal Pech Plaza B, PB-PU-38, Below Floor 8	Middle Preclassic	LF Kanluk	Jocote Orange-Brown	Group D
CHP079	Site Core	Cahal Pech Plaza B, PB-PU-38, Below Floor 8	Middle Preclassic	LF Kanluk	Jocote Orange-Brown	Group D
CHP080	Site Core	Cahal Pech Plaza B, PB-PU-38, Below Floor 8	Middle Preclassic	LF Kanluk	Jocote Orange-Brown	Group D
CHP081	Site Core	Cahal Pech Plaza B, PB-PU-38, Below Floor 8	Middle Preclassic	LF Kanluk	Jocote Orange-Brown	Group D
CHP082	Site Core	Cahal Pech Plaza B, PB-PU-38, Below Floor 8	Middle Preclassic	LF Kanluk	Jocote Orange-Brown	Group G
CHP083	Site Core	Cahal Pech Plaza B, PB-PU-38, Below Floor 8	Middle Preclassic	LF Kanluk	Jocote Orange-Brown	Group D
CHP084	Site Core	Cahal Pech Plaza B, PB-PU-38, Below Floor 8	Middle Preclassic	LF Kanluk	Reforma Incised (v. Reforma)	Group D
CHP085	Site Core	Cahal Pech Plaza B, PB-PU-38, Below Floor 8	Middle Preclassic	LF Kanluk	Reforma Incised (v. Reforma)	Unassigned
CHP086	Site Core	Cahal Pech Plaza B, PB-PU-38, Below Floor 8	Middle Preclassic	LF Kanluk	Savana Orange (v. Rejolla)	Group D

Sample ID	Context	Provenience	Time Period	Ceramic Complex	Ceramic Type	Compositional Group
CHP087	Site Core	Cahal Pech Plaza B, PB-PU-38, Below Floor 8	Middle Preclassic	LF Kanluk	Savana Orange (v. Rejolla)	Unassigned
CHP088	Site Core	Cahal Pech Plaza B, PB-PU-38, Below Floor 8	Middle Preclassic	LF Kanluk	Savana Orange (v. Rejolla)	Unassigned
CHP089	Site Core	Cahal Pech Plaza B, PB-PU-38, Below Floor 8	Middle Preclassic	LF Kanluk	Savana Orange (v. Rejolla)	Group C
CHP090	Site Core	Cahal Pech Plaza B, PB-PU-38, Below Floor 8	Middle Preclassic	LF Kanluk	Savana Orange (v. Savana)	Group D
CHP091	Site Core	Cahal Pech Plaza B, PB-PU-38, Below Floor 8	Middle Preclassic	LF Kanluk	Savana Orange (v. Savana)	Group D
CHP092	Site Core	Cahal Pech Plaza B, PB-PU-38, Below Floor 8	Middle Preclassic	LF Kanluk	Savana Orange (v. Savana)	Unassigned
CHP093	Site Core	Cahal Pech Plaza B, PB-PU-38, Below Floor 8	Middle Preclassic	LF Kanluk	Savana Orange (v. Savana)	Group D
CHP094	Site Core	Cahal Pech Plaza B, PB-PU-38, Below Floor 8	Middle Preclassic	LF Kanluk	Savana Orange (v. Savana)	Unassigned
CHP095	Site Core	Cahal Pech Plaza B, PB-PU-38, Below Floor 8	Middle Preclassic	LF Kanluk	Savana Orange (v. Savana)	Group B
CHP096	Site Core	Cahal Pech Plaza B, Unit PB-PU-19, Below Floor 11, Lot PLB-113	Early Preclassic	Cunil	Un-named Ash Temper (v. Unspecified)	Group A
CHP097	Site Core	Cahal Pech Plaza B, Unit PB-PU-19, Below Floor 11, Lot PLB-113	Early Preclassic	Cunil	Un-named Ash Temper (v. Unspecified)	Group A
CHP098	Site Core	Cahal Pech Plaza B, Unit PB-PU-19, Below Floor 11, Lot PLB-113	Early Preclassic	Cunil	Unknown Cream Slip	Group D
CHP099	Site Core	Cahal Pech Plaza B, Unit PB-PU-19, Below Floor 11, Lot PLB-113	Early Preclassic	Cunil	Unknown Cream Slip	Group D
CHP100	Site Core	Cahal Pech Plaza B, Unit PB-PU-19, Below Floor 11, Lot PLB-113	Middle Preclassic	LF Kanluk	Unknown Cream Slip	Group D
CHP101	Site Core	Cahal Pech Plaza B, Unit PB-PU-35, Below Floor 11, Lot PLB-353	Middle Preclassic	LF Kanluk	Jocote Orange-Brown	Group D
CHP102	Site Core	Cahal Pech Plaza B, Unit PB-PU-35, Below Floor 11, Lot PLB-353	Middle Preclassic	LF Kanluk	Jocote Orange-Brown	Group D
CHP103	Site Core	Cahal Pech Plaza B, Unit PB-PU-35, Below Floor 11, Lot PLB-353	Middle Preclassic	LF Kanluk	Jocote Orange-Brown	Group D
CHP104	Site Core	Cahal Pech Plaza B, Unit PB-PU-35, Below Floor 11, Lot PLB-353	Middle Preclassic	LF Kanluk	Joventud Red	Group F
CHP105	Site Core	Cahal Pech Plaza B, Unit PB-PU-35, Below Floor 11, Lot PLB-353	Middle Preclassic	LF Kanluk	Reforma Incised (v. Mucnal)	Unassigned
CHP106	Site Core	Cahal Pech Plaza B, Unit PB-PU-35, Below Floor 11, Lot PLB-353	Middle Preclassic	LF Kanluk	Reforma Incised (v. Mucnal)	Group C
CHP107	Site Core	Cahal Pech Plaza B, Unit PB-PU-35, Below Floor 11, Lot PLB-353	Middle Preclassic	LF Kanluk	Reforma Incised (v. Reforma)	Group C
CHP108	Site Core	Cahal Pech Plaza B, Unit PB-PU-35, Below Floor 11, Lot PLB-353	Middle Preclassic	LF Kanluk	Reforma Incised (v. Reforma)	Group C
CHP109	Site Core	Cahal Pech Plaza B, Unit PB-PU-35, Below Floor 11, Lot PLB-353	Middle Preclassic	LF Kanluk	Savana Orange (v. Rejolla)	Group D
CHP110	Site Core	Cahal Pech Plaza B, Unit PB-PU-35, Below Floor 11, Lot PLB-353	Middle Preclassic	LF Kanluk	Savana Orange (v. Rejolla)	Group D
CHP111	Site Core	Cahal Pech Plaza B, Unit PB-PU-35, Below Floor 11, Lot PLB-353	Middle Preclassic	LF Kanluk	Savana Orange (v. Savana)	Unassigned
CHP112	Site Core	Cahal Pech Plaza B, Unit PB-PU-35, Below Floor 11, Lot PLB-353	Middle Preclassic	LF Kanluk	Savana Orange (v. Savana)	Group D
CHP113	Site Core	Cahal Pech Plaza B , Unit PB-PU-26, Below Floor 13, Lot PLB-235	Middle Preclassic	LF Kanluk	Jocote Orange-Brown	Group D
CHP114	Site Core	Cahal Pech Plaza B , Unit PB-PU-26, Below Floor 13, Lot PLB-235	Middle Preclassic	LF Kanluk	Jocote Orange-Brown	Group D
CHP115	Site Core	Cahal Pech Plaza B , Unit PB-PU-26, Below Floor 13, Lot PLB-235	Middle Preclassic	LF Kanluk	Jocote Orange-Brown	Group D
CHP116	Site Core	Cahal Pech Plaza B , Unit PB-PU-26, Below Floor 13, Lot PLB-235	Middle Preclassic	LF Kanluk	Jocote Orange-Brown	Group D

Sample ID	Context	Provenience	Time Period	Ceramic Complex	Ceramic Type	Compositional Group
CHP117	Site Core	Cahal Pech Plaza B , Unit PB-PU-26, Below Floor 13, Lot PLB-235	Middle Preclassic	LF Kanluk	Joventud Red	Group F
CHP118	Site Core	Cahal Pech Plaza B , Unit PB-PU-26, Below Floor 13, Lot PLB-235	Middle Preclassic	LF Kanluk	Joventud Red	Unassigned
CHP119	Site Core	Cahal Pech Plaza B , Unit PB-PU-26, Below Floor 13, Lot PLB-235	Middle Preclassic	LF Kanluk	Joventud Red	Group F
CHP120	Site Core	Cahal Pech Plaza B , Unit PB-PU-26, Below Floor 13, Lot PLB-235	Middle Preclassic	LF Kanluk	Reforma Incised (v. Reforma)	Group D
CHP121	Site Core	Cahal Pech Plaza B , Unit PB-PU-26, Below Floor 13, Lot PLB-235	Middle Preclassic	LF Kanluk	Reforma Incised (v. Reforma)	Group C
CHP122	Site Core	Cahal Pech Plaza B , Unit PB-PU-26, Below Floor 13, Lot PLB-235	Middle Preclassic	LF Kanluk	Reforma Incised (v. Reforma)	Unassigned
CHP123	Site Core	Cahal Pech Plaza B , Unit PB-PU-26, Below Floor 13, Lot PLB-235	Middle Preclassic	LF Kanluk	Savana Orange (v. Savana)	Group D
CHP124	Site Core	Cahal Pech Plaza B , Unit PB-PU-26, Below Floor 13, Lot PLB-235	Middle Preclassic	LF Kanluk	Savana Orange (v. Savana)	Group D
CHP125	Site Core	Cahal Pech Plaza B , Unit PB-PU-26, Below Floor 13, Lot PLB-235	Middle Preclassic	LF Kanluk	Savana Orange (v. Savana)	Group D
TKG001	Settlement	Tzutziiy K'in Str. 2, Unit 2-3A, Lvl 7, Below Floor 5, Lot TK-2-3-9	Late Preclassic	LF Xakal	Joventud Red	Group G
TKG002	Settlement	Tzutziiy K'in Str. 2, Unit 2-3A, Lvl 7, Below Floor 5, Lot TK-2-3-9	Late Preclassic	LF Xakal	Joventud Red	Group G
TKG003	Settlement	Tzutziiy K'in Str. 2, Unit 2-3A, Lvl 7, Below Floor 5, Lot TK-2-3-9	Late Preclassic	LF Xakal	Savana Orange (v. Savana)	Group D
TKG004	Settlement	Tzutziiy K'in Str. 2, Unit 2-3A, Lvl 7, Below Floor 5, Lot TK-2-3-9	Late Preclassic	LF Xakal	Sierra Red (v. Unspecified)	Group G
TKG005	Settlement	Tzutziiy K'in Str. 2, Unit 2-3A, Lvl 9, Below Floor 7, Lot TK-2-3-11	Late Preclassic	LF Xakal	Joventud Red	Group G
TKG006	Settlement	Tzutziiy K'in Str. 2, Unit 2-3A, Lvl 9, Below Floor 7, Lot TK-2-3-11	Late Preclassic	LF Xakal	Joventud Red	Group G
TKG007	Settlement	Tzutziiy K'in Str. 2, Unit 2-3A, Lvl 9, Below Floor 7, Lot TK-2-3-11	Late Preclassic	LF Xakal	Reforma Incised (v. Reforma)	Group D
TKG008	Settlement	Tzutziiy K'in Str. 2, Unit 2-3A, Lvl 9, Below Floor 7, Lot TK-2-3-11	Late Preclassic	LF Xakal	Reforma Incised (v. Reforma)	Group D
TKG009	Settlement	Tzutziiy K'in Str. 2, Unit 2-3A, Lvl 9, Below Floor 7, Lot TK-2-3-11	Late Preclassic	LF Xakal	Sampopero Red (v. Sampopero)	Group G
TKG010	Settlement	Tzutziiy K'in Str. 2, Unit 2-3A, Lvl 9, Below Floor 7, Lot TK-2-3-11	Late Preclassic	LF Xakal	Sampopero Red (v. Sampopero)	Group G
TKG011	Settlement	Tzutziiy K'in Str. 2, Unit 2-3A, Lvl 9, Below Floor 7, Lot TK-2-3-11	Late Preclassic	LF Xakal	Savana Orange (v. Savana)	Group C
TKG012	Settlement	Tzutziiy K'in Str. 2, Unit 2-3A, Lvl 9, Below Floor 7, Lot TK-2-3-11	Late Preclassic	LF Xakal	Savana Orange (v. Savana)	Group C
TKG013	Settlement	Tzutziiy K'in Str. 2, Unit 2-3A, Lvl 9, Below Floor 7, Lot TK-2-3-11	Late Preclassic	LF Xakal	Savana Orange (v. Savana)	Group D
TKG014	Settlement	Tzutziiy K'in Str. 2, Unit 2-3A, Lvl 9, Below Floor 7, Lot TK-2-3-11	Late Preclassic	LF Xakal	Sierra Red (v. Unspecified - Maroon)	Group G
TKG015	Settlement	Tzutziiy K'in Str. 2, Unit 2-3A, Lvl 9, Below Floor 7, Lot TK-2-3-11	Late Preclassic	LF Xakal	Sierra Red/Polvero Black	Group G
TKG016	Settlement	Tzutziiy K'in Str. 2, Unit 2-3A, Lvl 9, Below Floor 7, Lot TK-2-3-11	Late Preclassic	LF Xakal	Jocote Orange-Brown	Group G
TKG017	Settlement	Tzutziiy K'in Str. 3, Unit 3-2, Lvl 4, Below Floor 2, Lot TK-3-2-4	Late Preclassic	EF Xakal	Jocote Orange-Brown	Group G
TKG018	Settlement	Tzutziiy K'in Str. 3, Unit 3-2, Lvl 4, Below Floor 2, Lot TK-3-2-4	Late Preclassic	EF Xakal	Reforma Incised (v. Reforma)	Group C
TKG019	Settlement	Tzutziiy K'in Str. 3, Unit 3-2, Lvl 4, Below Floor 2, Lot TK-3-2-4	Late Preclassic	EF Xakal	Reforma Incised (v. Reforma)	Group D
TKG020	Settlement	Tzutziiy K'in Str. 3, Unit 3-2, Lvl 4, Below Floor 2, Lot TK-3-2-4	Late Preclassic	EF Xakal	Savana Orange (v. Savana)	Group D
TKG021	Settlement	Tzutziiy K'in Str. 3, Unit 3-2, Lvl 4, Below Floor 2, Lot TK-3-2-4	Late Preclassic	EF Xakal	Savana Orange (v. Savana)	Unassigned

Sample ID	Context	Provenience	Time Period	Ceramic Complex	Ceramic Type	Compositional Group
TKG022	Settlement	Tzutziiy K'in Str. 3, Unit 3-2, Lvl 4, Below Floor 2, Lot TK-3-2-4	Late Preclassic	EF Xakal	Sayab Daub Str.iated	Group G
TKG023	Settlement	Tzutziiy K'in Str. 3, Unit 3-2, Lvl 4, Below Floor 2, Lot TK-3-2-4	Late Preclassic	EF Xakal	Sayab Daub Str.iated	Group G
TKG024	Settlement	Tzutziiy K'in Str. 3, Unit 3-2, Lvl 4, Below Floor 2, Lot TK-3-2-4	Late Preclassic	EF Xakal	Sierra Red (v. Unspecified)	Group G
TKG025	Settlement	Tzutziiy K'in Str. 3, Unit 3-2, Lvl 4, Below Floor 2, Lot TK-3-2-4	Late Preclassic	EF Xakal	Sierra Red (v. Unspecified)	Group G
TKG026	Settlement	Tzutziiy K'in Str. 3, Unit 3-2, Lvl 5, Below Floor 3, Lot TK-3-2-5	Late Preclassic	EF Xakal	Sierra Red (v. Unspecified)	Group G
TKG027	Settlement	Tzutziiy K'in Str. 3, Unit 3-2, Lvl 5, Below Floor 3, Lot TK-3-2-5	Late Preclassic	EF Xakal	Sierra Red/Polvero Black	Group G
TKG028	Settlement	Tzutziiy K'in Str. 3, Unit 3-2, Lvl 6, Below Floor 4, Lot TK-3-2-6	Late Preclassic	EF Xakal	Joventud Red	Group G
TKG029	Settlement	Tzutziiy K'in Str. 3, Unit 3-2, Lvl 7, Below Floor 5, Lot TK-3-2-7	Late Preclassic	EF Xakal	Jocote Orange-Brown	Group G
TKG030	Settlement	Tzutziiy K'in Str. 3, Unit 3-2, Lvl 7, Below Floor 5, Lot TK-3-2-7	Late Preclassic	EF Xakal	Jocote Orange-Brown	Group G
TKG031	Settlement	Tzutziiy K'in Str. 3, Unit 3-2, Lvl 7, Below Floor 5, Lot TK-3-2-7	Late Preclassic	EF Xakal	Joventud Red	Group G
TKG032	Settlement	Tzutziiy K'in Str. 3, Unit 3-2, Lvl 7, Below Floor 5, Lot TK-3-2-7	Late Preclassic	EF Xakal	Joventud Red	Group G
TKG033	Settlement	Tzutziiy K'in Str. 3, Unit 3-2, Lvl 7, Below Floor 5, Lot TK-3-2-7	Late Preclassic	EF Xakal	Savana Orange (v. Savana)	Group D
TKG034	Settlement	Tzutziiy K'in Str. 3, Unit 3-2, Lvl 7, Below Floor 5, Lot TK-3-2-7	Late Preclassic	EF Xakal	Sayab Daub Str.iated	Unassigned
TKG035	Settlement	Tzutziiy K'in Str. 3, Unit 3-2, Lvl 7, Below Floor 5, Lot TK-3-2-7	Late Preclassic	EF Xakal	Sayab Daub Str.iated	Group G
TKG036	Settlement	Tzutziiy K'in Str. 3, Unit 3-2, Lvl 7, Below Floor 5, Lot TK-3-2-7	Late Preclassic	EF Xakal	Sayab Daub Str.iated	Group G
TKG037	Settlement	Tzutziiy K'in Str. 3, Unit 3-2, Lvl 7, Below Floor 5, Lot TK-3-2-7	Late Preclassic	EF Xakal	Sierra Red (v. Society Hall)	Unassigned
TKG038	Settlement	Tzutziiy K'in Str. 3, Unit 3-2, Lvl 7, Below Floor 5, Lot TK-3-2-7	Late Preclassic	EF Xakal	Sierra Red (v. Unspecified)	Group G
TKG039	Settlement	Tzutziiy K'in Str. 3, Unit 3-2, Lvl 7, Below Floor 5, Lot TK-3-2-7	Late Preclassic	EF Xakal	Unknown Tan Slip	Group G
TKG040	Settlement	Tzutziiy K'in Str. 3, Unit 3-2, Lvl 7, Below Floor 5, Lot TK-3-2-7	Late Preclassic	EF Xakal	Unknown Tan Slip	Group G
ZPL001	Settlement	Zopilote Group Str. 1, Unit 2015-1, Lvl 5, Below Floor 6, Lot ZPL-1-6-5	Late Preclassic	EF Xakal	Hillbank Red (v. Unspecified)	Group G
ZPL002	Settlement	Zopilote Group Str. 1, Unit 2015-1, Lvl 5, Below Floor 6, Lot ZPL-1-6-5	Late Preclassic	EF Xakal	Sayab Daub Str.iated	Group G
ZPL003	Settlement	Zopilote Group Str. 1, Unit 2015-1, Lvl 5, Below Floor 6, Lot ZPL-1-6-5	Late Preclassic	EF Xakal	Sayab Daub Str.iated	Group E
ZPL004	Settlement	Zopilote Group Str. 1, Unit 2015-1, Lvl 5, Below Floor 6, Lot ZPL-1-6-5	Late Preclassic	EF Xakal	Polvero Black	Group G
ZPL005	Settlement	Zopilote Group Str. 1, Unit 2015-1, Lvl 5, Below Floor 6, Lot ZPL-1-6-5	Late Preclassic	EF Xakal	Sierra Red	Group D
ZPL006	Settlement	Zopilote Group Str. 1, Unit 2015-1, Lvl 5, Below Floor 6, Lot ZPL-1-6-5	Late Preclassic	EF Xakal	Sierra Red	Group G
ZPL007	Settlement	Zopilote Group Str. 1, Unit 2015-1, Lvl 5, Below Floor 6, Lot ZPL-1-6-5	Late Preclassic	EF Xakal	Sierra Red/Polvero Black	Group G
ZPL008	Settlement	Zopilote Group Str. 1, Unit 2015-1, Lvl 5, Below Floor 6, Lot ZPL-1-6-5	Late Preclassic	EF Xakal	Sierra Red/Polvero Black	Unassigned
ZPL009	Settlement	Zopilote Group Str. 1, Unit 2015-1, Lvl 5, Below Floor 6, Lot ZPL-1-6-5	Late Preclassic	EF Xakal	Jocote Orange-Brown	Group G
ZPL010	Settlement	Zopilote Group Str. 1, Unit 2015-1, Lvl 5, Below Floor 6, Lot ZPL-1-6-5	Late Preclassic	EF Xakal	Jocote Orange-Brown	Group G
ZPL011	Settlement	Zopilote Group Str. 1, Unit 2015-1, Lvl 5, Below Floor 6, Lot ZPL-1-6-5	Late Preclassic	EF Xakal	Jocote Orange-Brown	Group G

Sample ID	Context	Provenience	Time Period	Ceramic Complex	Ceramic Type	Compositional Group
ZPL012	Settlement	Zopilote Group Str. 1, Unit 2015-1, Lvl 5, Below Floor 6, Lot ZPL-1-6-5	Late Preclassic	EF Xakal	Jocote Orange-Brown	Unassigned
ZPL013	Settlement	Zopilote Group Str. 1, Unit 2015-1, Lvl 5, Below Floor 6, Lot ZPL-1-6-5	Late Preclassic	EF Xakal	Jocote Orange-Brown	Group G
ZPL014	Settlement	Zopilote Group Str. 1, Unit 2015-1, Lvl 6, Below Floor 7 Lot ZPL-1-6-6	Middle Preclassic	LF Kanluk	Savana Orange (v. Rejolla)	Group D
ZPL015	Settlement	Zopilote Group Str. 1, Unit 2015-1, Lvl 6, Below Floor 7 Lot ZPL-1-6-6	Middle Preclassic	LF Kanluk	Savana Orange (v. Rejolla)	Group G
ZPL016	Settlement	Zopilote Group Str. 1, Unit 2015-1, Lvl 6, Below Floor 7 Lot ZPL-1-6-6	Middle Preclassic	LF Kanluk	Savana Orange (v. Rejolla)	Group C
ZPL017	Settlement	Zopilote Group Str. 1, Unit 2015-1, Lvl 6, Below Floor 7 Lot ZPL-1-6-6	Middle Preclassic	LF Kanluk	Savana Orange (v. Savana)	Unassigned
ZPL018	Settlement	Zopilote Group Str. 1, Unit 2015-1, Lvl 6, Below Floor 7 Lot ZPL-1-6-6	Middle Preclassic	LF Kanluk	Savana Orange (v. Savana)	Group C
ZPL019	Settlement	Zopilote Group Str. 1, Unit 2015-1, Lvl 6, Below Floor 7 Lot ZPL-1-6-6	Middle Preclassic	LF Kanluk	Unknown Tan Slip	Group G
ZPL020	Settlement	Zopilote Group Str. 1, Unit 2015-1, Lvl 6, Below Floor 7 Lot ZPL-1-6-6	Middle Preclassic	LF Kanluk	Sayab Daub Str.iated	Group G
ZPL021	Settlement	Zopilote Group Str. 1, Unit 2015-1, Lvl 6, Below Floor 7 Lot ZPL-1-6-6	Middle Preclassic	LF Kanluk	Sayab Daub Str.iated	Group G
ZPL022	Settlement	Zopilote Group Str. 1, Unit 2015-1, Lvl 6, Below Floor 7 Lot ZPL-1-6-6	Middle Preclassic	LF Kanluk	Sayab Daub Str.iated	Group G
ZPL023	Settlement	Zopilote Group Str. 1, Unit 2015-1, Lvl 7, Below Floor 8, Lot ZPL-1-6-7	Middle Preclassic	EF Kanluk	Cocoyol Cream (v. Cocoyol)	Group B
ZPL024	Settlement	Zopilote Group Str. 1, Unit 2015-1, Lvl 7, Below Floor 8, Lot ZPL-1-6-7	Middle Preclassic	EF Kanluk	Savana (v. Unspecified Ash Temper)	Group B
ZPL025	Settlement	Zopilote Group Str. 1, Unit 2015-1, Lvl 7, Below Floor 8, Lot ZPL-1-6-7	Middle Preclassic	EF Kanluk	Savana (v. Unspecified Ash Temper)	Group B
ZPL026	Settlement	Zopilote Group Str. 1, Unit 2015-1, Lvl 7, Below Floor 8, Lot ZPL-1-6-7	Middle Preclassic	EF Kanluk	Jocote Orange-Brown	Group G
ZPL027	Settlement	Zopilote Group Str. 1, Unit 2015-1, Lvl 7, Below Floor 8, Lot ZPL-1-6-7	Middle Preclassic	EF Kanluk	Jocote Orange-Brown	Unassigned

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SELECTED PUBLICATIONS

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