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

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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. This article reports results of AMS ^{14}C dating of stratified sequences at the residential group Tzutziiy K'in, associated with the major Maya polity 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 by the Late Preclassic period (350–100 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 and 900. This study provides a framework for interpreting patterns of spatial, demographic, and sociopolitical change between households and the Cahal Pech site core.

Keywords: AMS ^{14}C dating, Bayesian analysis, ancient Maya, household archaeology.

INTRODUCTION

Understanding the development and growth of ancient communities into spatially, demographically, and sociopolitically 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; Inomata et al. 2013, 2014; Joyce 2013). 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; 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; Hoggarth et al. 2014; Overholtzer 2014; Lesure et al. 2014; Huster and Smith 2015).

This article reports the results of high-resolution AMS ^{14}C dating from Tzutziiy K'in, a large hinterland house group associated with the major ancient Maya polity of Cahal Pech, located outside the modern town of San Ignacio in the upper Belize Valley of west-central Belize (Figure 1). Cahal Pech provides a unique case study for understanding the development of sociopolitical complexity in the Maya lowlands because of its long occupational history from around 1200 cal BC to cal AD 900 (Figure 2; Awe 1992; Healy et al. 2004a, 2004b). 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

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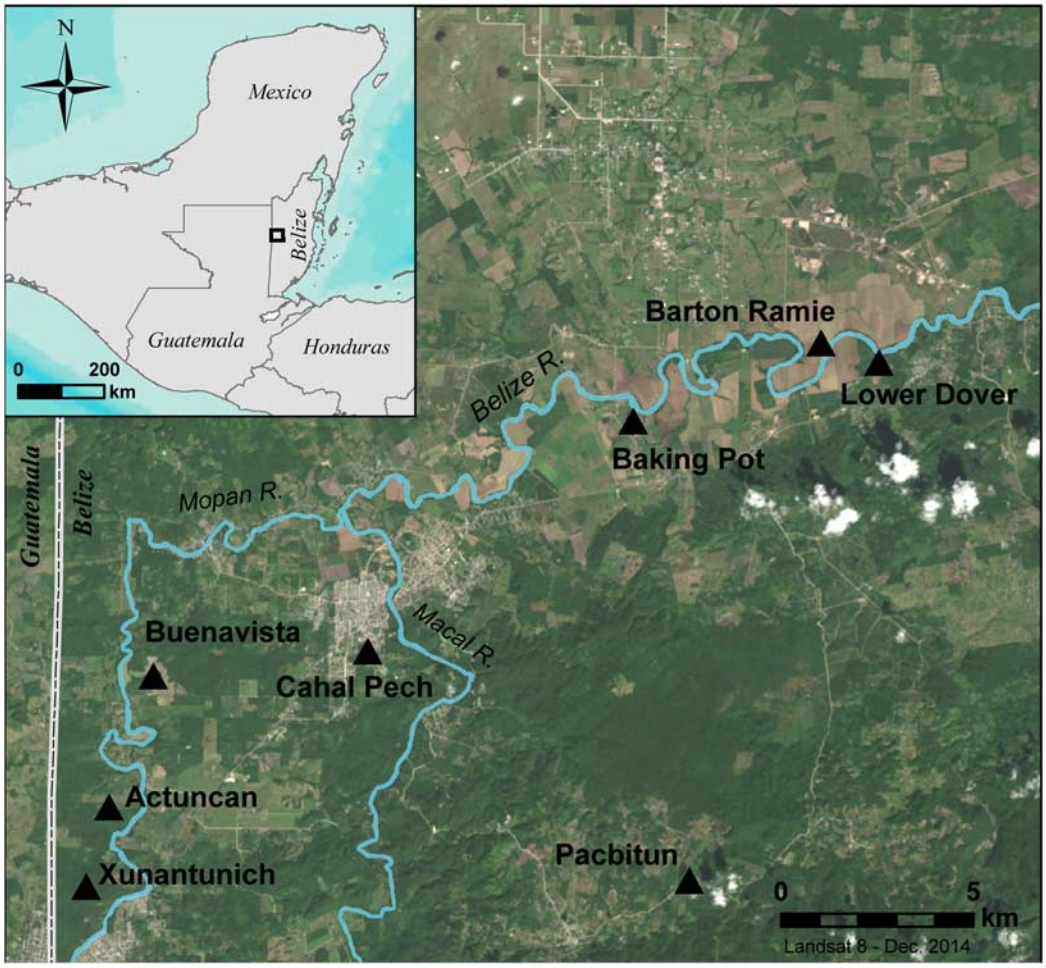

Figure 1 Map of the Belize Valley showing the location of Cahal Pech and other major sites mentioned in text. Location of Belize Valley is outlined on the inset map.

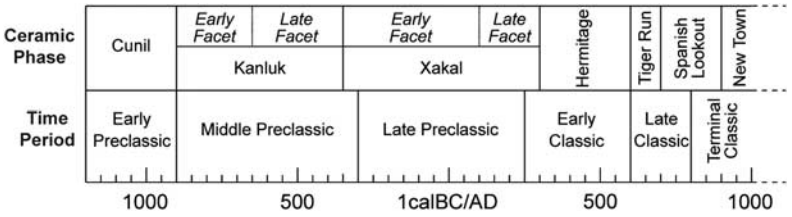

Figure 2 Chronological periods for Cahal Pech with associated ceramic phases

to estimate the timing of events including the settlement and growth of the site (Beramendi-Orosco et al. 2009; Bronk Ramsey et al. 2010; Kennett et al. 2011, 2014; Prufer et al. 2011; Culleton et al. 2012; Inomata et al. 2013, 2014; Jazwa et al. 2013; Lesure et al. 2014; Hoggarth et al. 2014; Smith et al. 2014; Bronk Ramsey 2015; Huster and Smith 2015).

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 conventional radiocarbon 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 ^{14}C 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 ^{14}C samples at the site for undated events, as well as generating comparable data sets from other house groups to reconstruct broader spatial, demographic, and sociopolitical 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). 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; Healy and Awe 1995; Clark and Cheetham 2002). A limited program of ^{14}C 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 periods (Awe 1992; Healy et al. 2004a; Awe and Helmke 2005). 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 small regional polity (Awe 1992, 2013; Healy et al. 2004a; Garber and Awe 2008). Other large, formally organized civic centers were also established during the Late Preclassic throughout the Belize Valley including Blackman Eddy, Xunantunich Group E, Pacbitun, Actuncan, and Barton Ramie (Awe 1992; Garber et al. 2004; Healy et al. 2004b; Brown et al. 2013). 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).

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 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). 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 × 3 m 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 identify chronologically secure contexts.

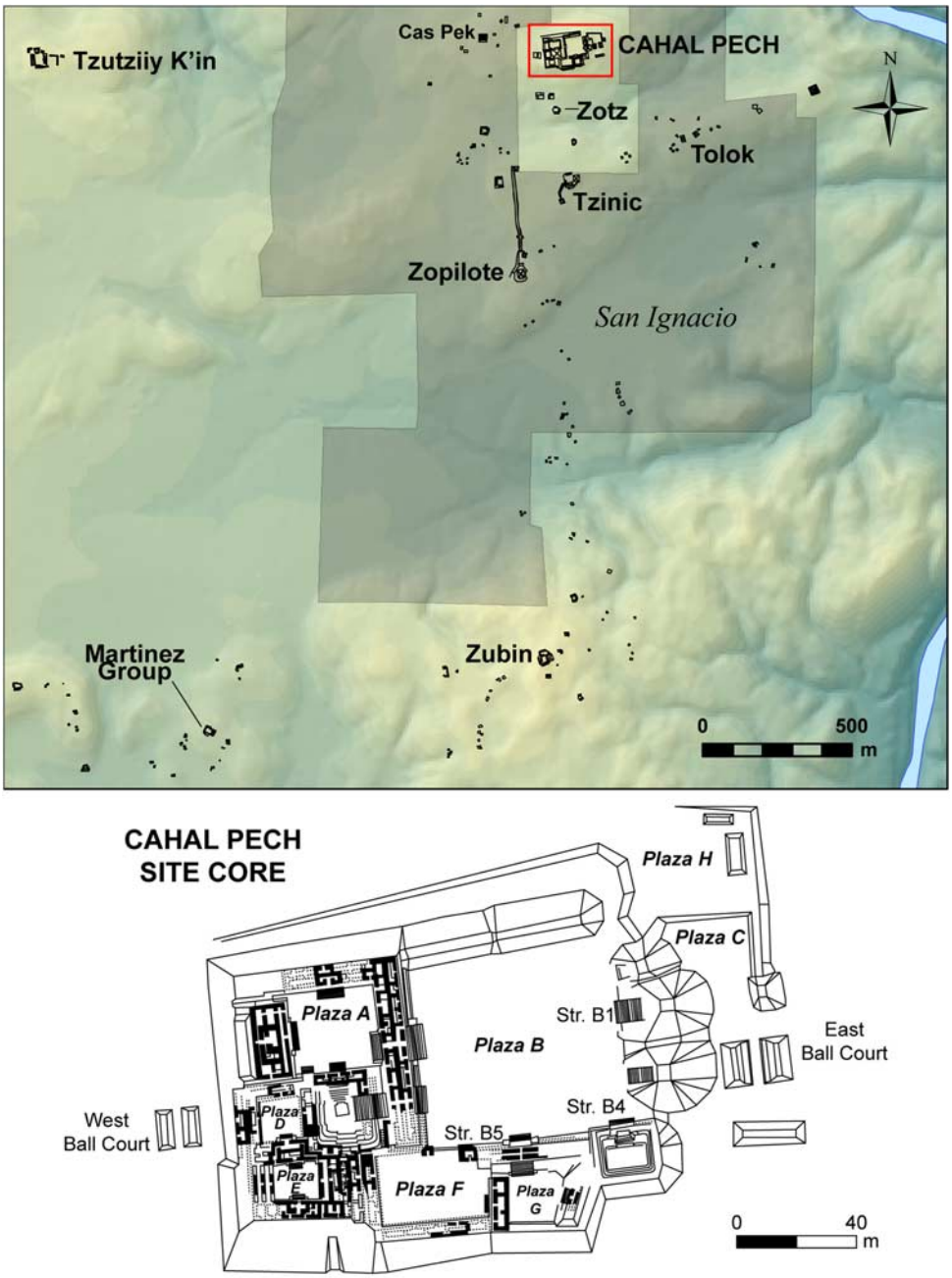

Figure 3 Map of Cahal Pech showing the relationship between the site core and known house groups (top), and detail of site core (bottom).

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

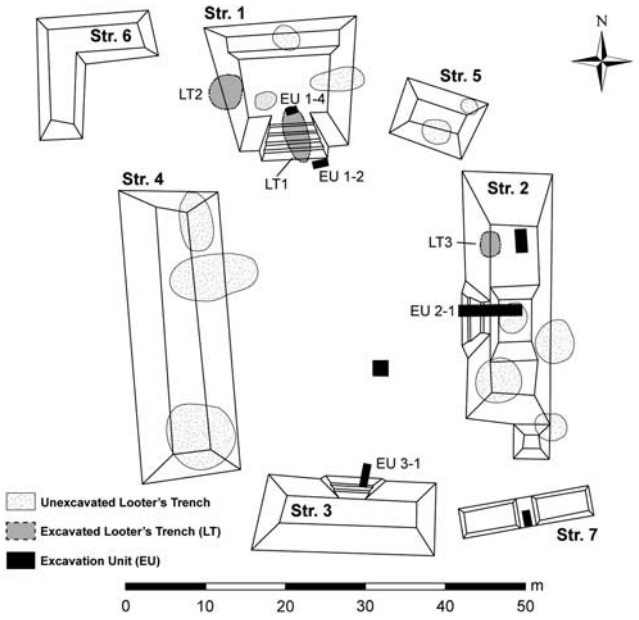

Figure 4 Map of Tzutziiy Ki'n showing locations of test excavations and excavated looter's trenches.

architecture and import exotic materials, including obsidian and jade, perhaps demonstrating elevated status based on connections to broader regional trade networks (Ebert and Dennehy 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 et al. (2014). Short-lived twig samples were selected for dating to reduce erroneous age assignments from the "old wood effect" (Schiffer 1986; Kennett et al. 2002). All ^{14}C ages reported in Table 1 are 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 2σ 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 (Buck et al. 1991; Bayliss and Bronk Ramsey 2004; Bronk Ramsey et al. 2010; Culleton et al. 2012; Inomata et al. 2013, 2014; Douka et al. 2014; Higham et al. 2014; Kennett et al. 2014; McClure et al. 2014; Bronk Ramsey 2015; Huster and Smith 2015).

Table 1 Calibrated AMS ^{14}C dates from Tzutziiy K'in. Depth below a datum point in cm is denoted by cmbd.

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

Eight AMS ^{14}C 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 ^{14}C 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 the beginning of the Late Preclassic period 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 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. 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

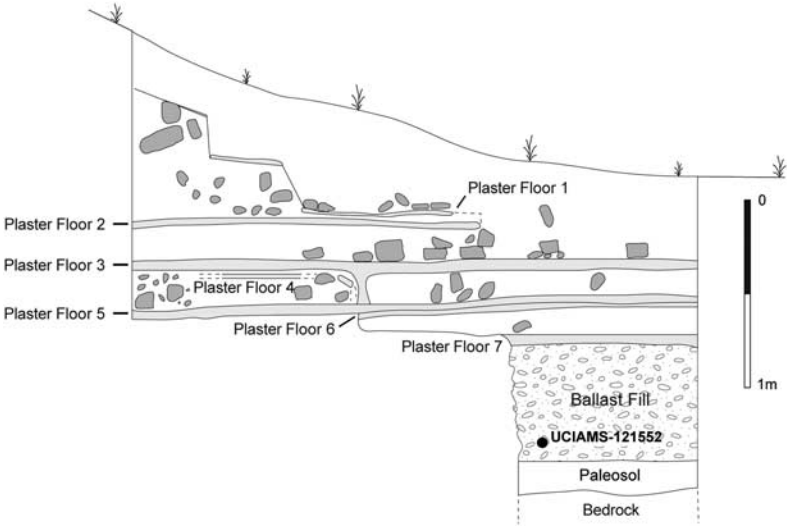

Figure 5 Profile of EU 3-1 at Tzutziiy K'in Structure 3, showing location of earliest ^{14}C sample for the site. Subsequent occupational surfaces are also depicted.

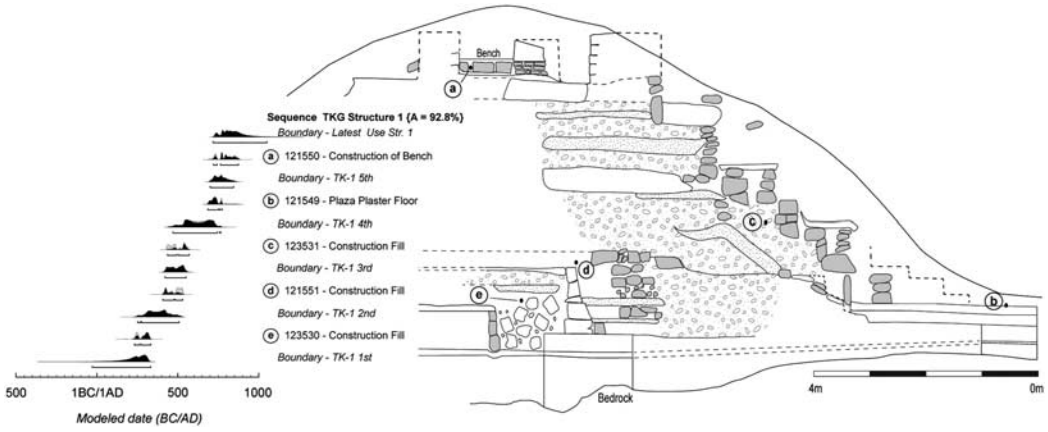

Figure 6 Profile of Tzutziiy K'in Structure 1 showing location of AMS ^{14}C samples and modeled calibrations

Classic (primarily Belize Red types) were recovered in strata above Floor 2. Late and Terminal Classic ceramics represent the final construction and use of Structure 3.

Structure 1 Sequence

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 6 and Table 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 and cal AD 330.

Table 2 Modeled radiocarbon sequence for Structure 1.

UCIAMS-#	Provenience	Conventional ^{14}C age (BP)	Modeled 2σ 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

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 2 m 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 cal AD 435–575 (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 ^{14}C 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 TK-1 4th. This may have occurred relatively quickly between 0 and 150 cal yr.

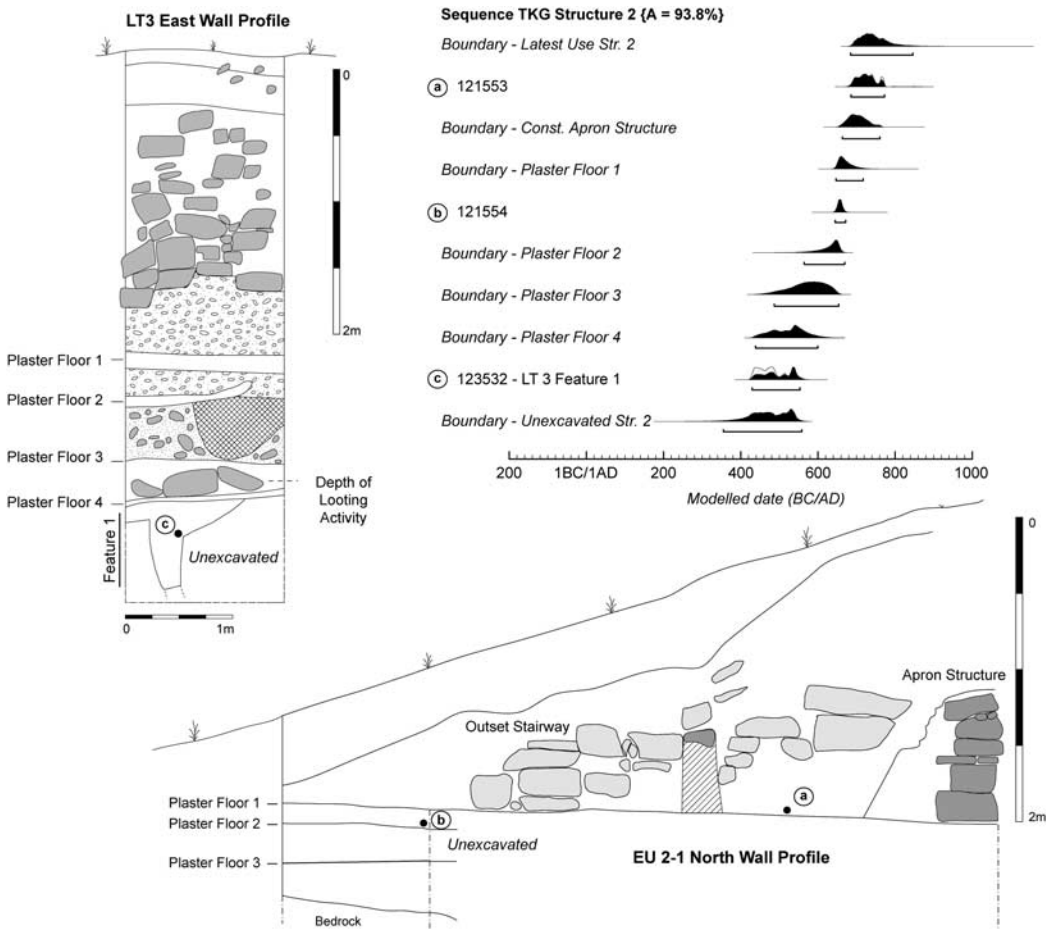

Figure 7 Profiles of EU 2-1 and LT3 at Tzutziiy K'in Structure 2, showing locations of ^{14}C samples and modeled calibrations.

The superstructure contained a plastered bench running east-to-west across the back of the room. A ^{14}C sample recovered from deposits that postdate the construction of the superstructure produced a 2σ 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.

Structure 2 Sequence

The sequence for Structure 2 includes several construction events dating from the Early to Terminal Classic periods (Figure 7 and Table 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).

Table 3 Modeled radiocarbon sequence for Structure 2.

UCIAMS-#	Provenience	Conventional ^{14}C age (BP)	Modeled 2σ 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

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.

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 yr. 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 8 and Table 4). At least three periods of settlement and growth at Tzutziiy K'in

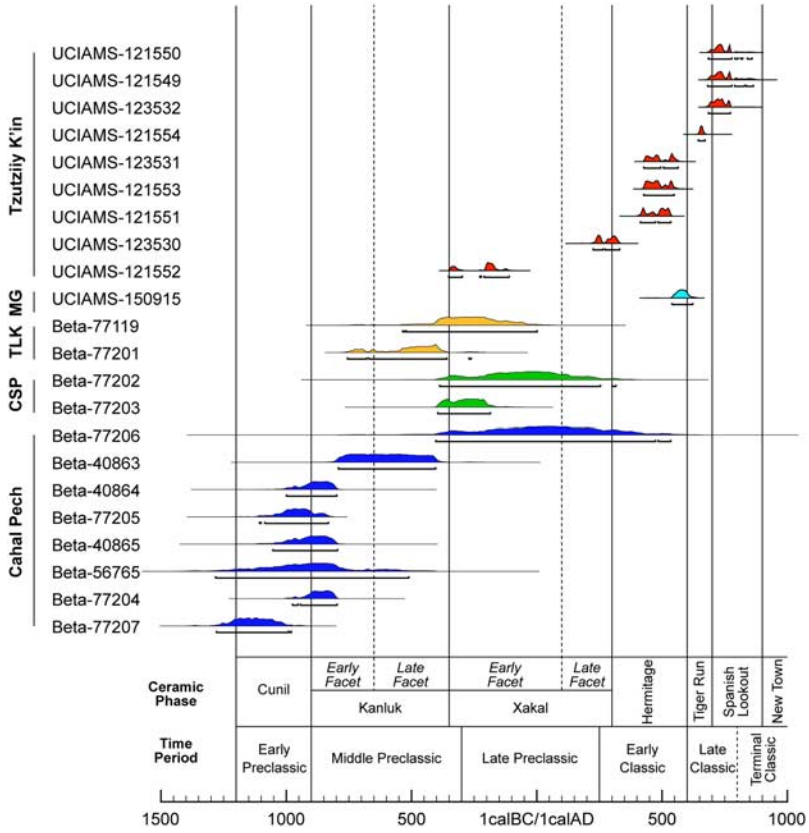

Figure 8 Calibrated ^{14}C date distributions from the Cahal Pech site core and hinterland house groups listed in Table 4 (CSP – Cas Pek; TLK – Tolok; MG – Martinez Group).

are represented by modeled ^{14}C dates, including (1) Late Preclassic period settlement, (2) increased construction activity and expansion of the site in the Early Classic period, and (3) Late to Terminal Classic period remodeling and termination of site occupation.

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 Structure A-1 1-Sub reached a height of almost 15 m. Plaza B was raised and enlarged during the Late Preclassic period, and Structure B-4 underwent several modifications (B-4 7-sub –B-4 10-sub) beginning with the construction of a specialized round structure dating to 795–405 BC (Beta-40863; Healy and Awe 1995) likely used for public ceremonies (Aimers et al. 2000), and terminating with a large, 4-m-high pyramid that supported a pole and thatch super structure (Awe 1992).

Table 4 Previous ^{14}C age determinations 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 2σ level.

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

[a]Denotes radiometric measurement.
[b]Denotes AMS ^{14}C measurement.

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 (Willey and Bullard 1956; Awe 1992:207; Cheetham et al. 1993; Iannone 1996; Powis 1996). Four ^{14}C 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 nonresidential 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 events at 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), Buenavista (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 (Santasilia 2012; Awe 2013; Ishihara-Brito et al. 2013). The Early Classic period also saw 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 as 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 nondomestic 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 and single residential mounds 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 and Awe 2014; Ebert 2015a). 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 multicomponent construction episodes at Tzutziiy K'in Structures 1 and 2 indicate that between cal AD 500 and 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 erection 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). 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 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 sociopolitical 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 interpolity warfare, and the collapse of elite socioeconomic 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 Rojling 2012; Iannone et al. 2014). In the Belize Valley, some large polities (e.g. Cahal Pech, Awe 1992, 2006; Buenavista, Ball and Taschek 2004; and Pacbitun, Healey et al. 2004b) may have been abandoned as early as AD 800 (Awe and Helmke 2007). Archaeological and epigraphic evidence from dated stone monuments indicate that the sites 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 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 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 sociopolitical and demographic change during the Terminal Classic period.

CONCLUSION

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 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), suggesting that a politically and economically important lineage resided at this location. Limited evidence for occupation of the group during the Terminal Classic period, 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 a precise and accurate chronology for the sociopolitical development and decline of this important Maya center.

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