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RADIOCARBON CHRONOLOGY OF THE TLATOANI SITE AT TLAYACAPAN, MORELOS, MEXICO

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ABSTRACT. The archaeological site of Tlatoani at Tlayacapan is located in the Mexican Highlands, in the present-day state of Morelos. The site is an extant settlement located at the top of the Tepoztlan mountain range, and has been occupied since the Late Preclassic period (AD 150–500). At the height of its occupation in the Epiclassic and Early Postclassic periods (AD 600–1150), Tlayacapan was situated on the top of the hill. The radiocarbon investigations reported herein revealed some further distinct findings, although no clear absolute chronology was demonstrated. A dog skull was found inside the oldest foundation stage, and dated between cal AD 646 and 765, the middle of the Epiclassic period. Human remains found in the first grave belonged to three individuals. A male skeleton was dated to AD 1158–1227. Fragments of an incomplete skeleton of a child and an incomplete skeleton of a second male were placed on top of the first male skeleton and were dated in the range AD 1030–1156. A fourth skeleton found nearby in the second grave gave a similar date of AD 1164–1253. These burials were in accordance with the Middle America cosmovisional system, where bodies were buried beneath the household space. It is evident from the ^{14}C dates of the skeletons that the burial sites beneath the household space had been reused by exhuming and reburying skeletons that had been previously buried there. A comparison of dates on fractions of collagen and bioapatite of the same bones was possible. Two of the samples were in good agreement between these fractions, whereas the other three samples are close but just outside the 2σ range.

INTRODUCTION

In the Early Postclassic period in Morelos, during the collapse of the Epiclassic hegemonic state of Xochicalco, currently dated to AD 1050 or 1100 (González et al. 2008), Xochicalco was looted, burned, destroyed, and abandoned. In this time, the large city Big Tula or Tula Mazapa (AD 900/1150) was successful in creating and maintaining the regional hegemony for 50 or 100 yr more (Mastache et al. 2002; Sterpone Canuto 2006).

Very few occupation sites dating to this period have been identified as such by the present Mexican state of Morelos (Smith 1992). The Tenecaxtle site in Santiago Tepetlapa, Tepoztlan, near Tlayacapan, which was excavated between 2009 and 2010, is one of the sites where a local relative chronology of primary contexts could be established.

Based on the ethnohistorical sources, the Xochimilca people arrived from the southern Mexico Basin in the 10th century, with a Toltec-Chichimeca cultural order (Anzures Carrillo 2008). There was a transformation that is reflected in the archaeological culture, adopting Aztec I ceramics from Xochimilco. The ceramic tradition apparently began in the 11th century fully from Culhuacan (Séjourné 1983). In the Tlatoani site ceramic collection, Azteca I ceramic type is present, not only the Black on Orange but also the Black on Red Engraved type.

The sources detail the possibility that the Xochimilcas would come, from the middle of the 12th century to the southern region of the lakes in the Basin of Mexico, when the supposed Toltec Empire came to an end. Their arrival reached Xochiquilazco, ancient toponym of Xochimilco. This meant the possibility of migration at least partially, to the valleys of the current state of Morelos, where in the eastern portion the Mixtec and/or Popoloca language transformed into the Nahuatl language between the 10th and 12th centuries (Smith 1983). This process has been inferred from studies of

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written sources using glottochronological analysis.

Xochimilco, the southernmost settlement of the lacustrine portion of the Mexico Basin, was the scene of the development termed the Lake Revolution. It describes a technological revolution that developed agricultural productivity exponentially from *chinampa* technology, with its beginnings likely dated to the Early Postclassic between AD 900 and 1150 (Avila López 1999, 2007). This technological development allowed to colonize the great freshwater lake of Xochimilco. This is perhaps a period of expansion and colonization of land by the inhabitants of Xochimilco. Among the ceramics present in the Tlatoani site, none have associated ceramics from Xochimilco like White or Polychrome ceramic types, although they exist in other parts in the lower section of the hill.

The relationship between Big Tula and the Tlatoani site was not clear. Now we know, based on the radiocarbon dates, that they coexisted. Smith and Montiel (2001) have analyzed the concept of hegemonic rule for Teotihuacan, Tula, and Tenochtitlan. They made the assumption that it is feasible for the existence of the first and the last of these, while the evidence does not support the possibility of a Toltec Empire. Transforming an earlier model, Montiel and Smith argue that there are three elements that determine the existence of an empire: (a) a capital city sufficiently long and complex to control an empire with its respective ideology; (b) the domination of a territory determined by its widespread economic exchange and political control; and (c) imperial influences in economic, political, and cultural rights beyond its borders (Smith and Montiel 2001). These authors consider only size distinctions and not qualitative ones. Big Tula grew quickly without counterbalance as a regional hegemonic central site, which developed political and economic power. The question of whether Tula was an empire is highly relevant to our study. It is clear that when the other cities of the Epiclassic period collapsed, Big Tula continues to prosper. It remains to be clarified why such a disparity in prosperity occurred.

In the Tlatoani site at Tlayacapan, multiple ceramic types similar to those reported for Tula Grande occur, and although the material is not Toltec, it fits into some Toltec ceramic modes, differing only in terms of decoration motifs (Figure 3). However, the so-called Toltec Empire does not have many possibilities for existence, at least not as defined by Nigel Davies (1977). However, there is a time of centrality when the region leveled hegemonic power, which is related to the political system, and El Tlatoni could be a part of its periphery.

SITE DESCRIPTION

The excavated site is an extant settlement in the southeastern part of the Tepoztlan mountain range (Figure 1). The area is registered in the Catalogue of Archaeological Sites in Morelos State since February 1987, but its existence was for many generations thought to be part of the nearby Tlayacapan communities. The site is only a small area of a more extended settlement that existed since the Late and Terminal Preclassic (AD 500–150). At its maximum occupation, with workshops and small temples associated, Tlatoani reached the top of the hill in the Epiclassic and Early Postclassic period (AD 600–1150). At some point in the Middle and Late Postclassic (AD 1150–1521), a change occurred. The setting of a handmade hill with a strong symbolic meaning became a major architectural project with dozens of staggered terraces without any vegetation. This covered the workshops and small temples of the Early Postclassic; only the temple on the top of the hill with some architectural items added remained in use. By the time of this last occupation, the staggered terraces on the hill acquired a military defensive nature.

Access corridors (Figure 2) were architecturally integrated from three narrow ascending drain boards formed in the interstices of the rocks of the hill. Big stones were staggered there to give

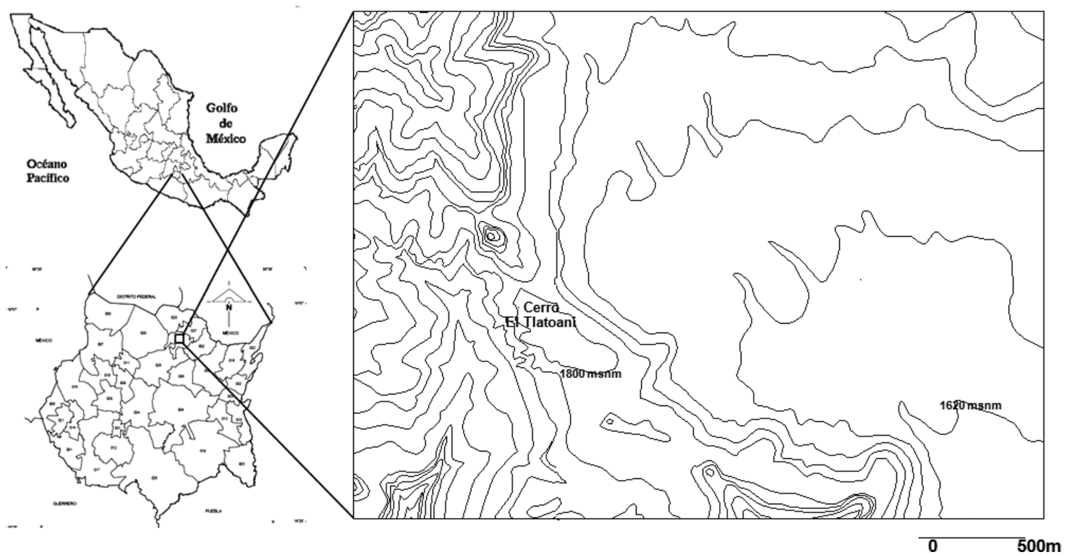

Figure 1 Map showing the State of Morelos within the Mexico Highlands and the Tlatoani site on top of a hill

access to the last drain, and allowing access to the terraced area. Such corridors restrict access to the higher section, and the narrow passages they create are one of the most notable elements that characterize the archaeological site.

The site could be easily differentiated into four sections: access corridors, terraces, engraved architecture, and Central Architectonic Ensemble (Figure 3). The excavations of the terraces and the Central Architectonic Ensemble allowed construction of a relative chronology based on identification of archaeological ceramics. However, this region did not have a clear absolute chronology.

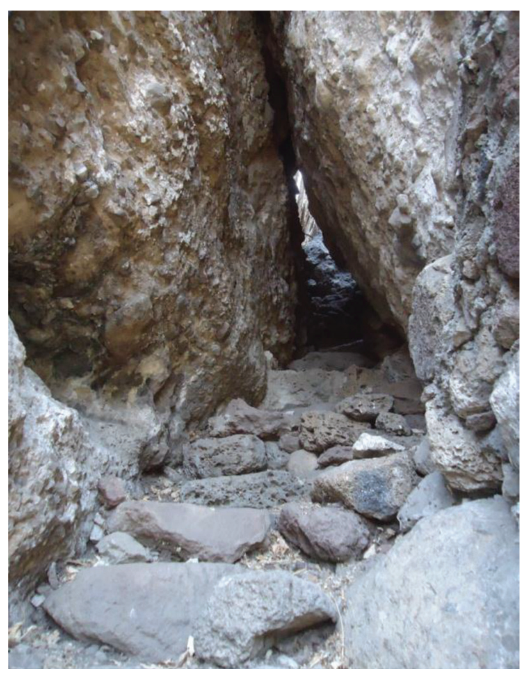
Figure 2 The first flight of stairs to climb the narrow interstices between the boulders stone leading to the summit of Tlatoani.

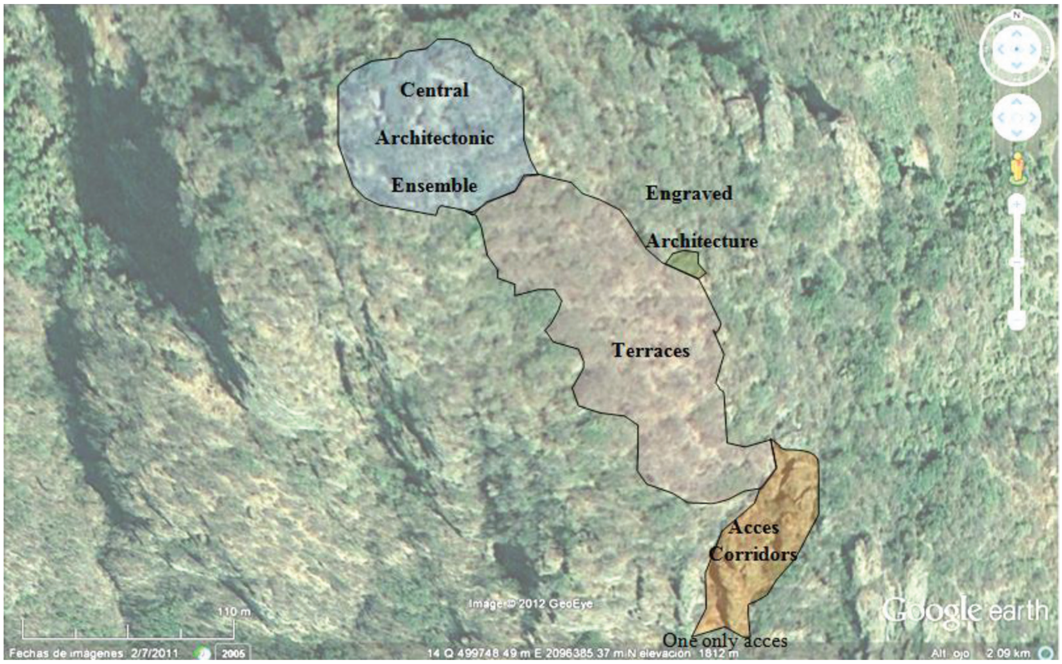

Figure 3 Map of the archaeological site viewed using Google Earth

The ^{14}C investigation led to some interesting discoveries. Human remains from two graves were found in the terraces. A dog skull was excavated from the oldest foundation stage of the Central Architectonic Ensemble, which was related to the middle of the Epiclassic period. The first grave was marked by plain flat stones that surrounded the burial site. The human remains found in this grave belonged to three individuals. Skeleton PICZAT1, discovered in anatomic display, belonged to a 45–49-yr-old male. Random fragments of an incomplete skeleton, PICZAT2, belonged to an 8-yr-old boy. Fragments of an incomplete skeleton, PICZAT3, with only the cranium and a few bones of the hand and feet present, came from a third male, 41–45 yr old. The skeletal fragments of PICZAT2 and PICZAT3 had been placed on top of the first skeleton PICZAT1.

The fourth skeleton, PICZAT4, was found in anatomic display (Figure 4). It was found in a different burial, which was located near the first burial. According to tradition in Middle America, the ancient people buried bodies beneath their household space. This burial could be used again in certain time intervals to bury other bodies. In such cases, the graves were excavated and previous remains of the skeletons would chaotically be placed on top of the newly buried body along with soil.

PICZAT6 is a skull belonging to a dog. This sample came from another excavation unit, which was the main pyramid of the Central Architectural Ensemble, right at the top of the hill. To better understand the architectonic history of the pyramid, three different constructive stages were found, and inside the oldest one we found the cranium of this dog. The first foundation of the architectonic project was made in the beginnings of the Epiclassic period (AD 600–850). Unfortunately, the sediments on this site did not contain any carbonates that could provide corroborating dates. The skull was discovered as an offering right on the bedrock, which is a kind of volcanic tuff.

Figure 4 One of the collective burials identified material regarding the Early Postclassic period (AD 900–1150)

RADIOCARBON DATING

Since the early days of ^{14}C dating, the analysis of bone material has been a problem due to the frequent discordance between the dates of the bone material and associated charcoal, and/or between different fractions isolated from a single bone. The most frequently used methods of bone preparation for ^{14}C dating are designed to extract and purify (with varying degrees of success) a fraction of the organic residue. In general, the goal of these methods is to isolate collagen or some individual compounds such as protein or amino acids of collagen. However, for badly preserved bones, the problem becomes acute, as the bones often do not content enough collagen even for accelerator mass spectrometry (AMS) dating, or the collagen fraction was strongly altered during the burial. The use of bioapatite for dating and paleodietary studies led to an active discussion of these issues. Schoeninger and DeNiro (1982) considered it impossible to use this kind of reconstruction for paleodiet. However, many others have proven that paleodiet reconstruction is possible (Bocherens 2000; Lee-Thorp 2000; Jim et al. 2004; Zazzo et al. 2004b).

The mineral fraction does not usually undergo microbiological decomposition, but may be exposed to isotopic exchange with environmental carbonates. It is possible, however, that a precipitation of secondary apatite occurs, either inorganic or under microbial mediation. If it happens, all treatments are ineffective as the carbonate is trapped in the crystals (Zazzo et al. 2004a,b, 2009).

The bone sample for analysis is first thoroughly washed in an ultrasonic bath, and wire brushed to remove external material. If secondary deposits or identification marks remain, the bone is physically scraped or sanded to remove such extraneous material. If the sample is large enough, the bone is split and the marrow cavity is stripped out.

The carbonates in fossil bone may be contaminated by secondary carbonates, precipitated in the process of burial as pore-filling cements. To remove these diagenetic carbon compounds, a bone sample of 1–3 g is selected for further preparation. The bone is gently crushed to small fragments less than 1 mm, but not to a fine powder, for further cleaning. The powdering of the poorly preserved bone leads to complete dissolution of collagen and destruction of structural bioapatite. The bone fragments are then treated with 1N acetic acid in a 250-mL Erlenmeyer flask. The flask is periodically evacuated to remove air and/or CO_2 from the micropores, after which the flask is returned to atmospheric pressure to force fresh acid into the microspaces of the sample. The first evacuation may be fairly violent since both absorbed air and carbon dioxide from the external diagenetic carbonates will be removed. The nature of this reaction is a qualitative indication of $CaCO_3$ contamination.

This process of evacuation and repressuring is continued at ~20-min intervals until no substantial release of gas as fine foamy bubbles occurs. This process should be repeated at least 4–5 times, the last reaction being overnight (20+ hr) under atmospheric pressure. If after overnight reaction the sample observed under vacuum has only the large bubbles, then we assume there are no more diagenetic carbonates present. The completely cleaned bone sample is then washed free of acetic acid by repeated soaking and decantation with demineralized water and dried at 60°C.

For analysis of carbon isotopes in bioapatite, approximately 300–400 mg of the cleaned bone powder is transferred to the reaction vessel. The bone is then reacted under vacuum with 1.5 mL of 100% H_3PO_4 at 65°C for 30 min. The released CO_2 is purified by cryogenic separation and collected in sealing tubes for AMS and stable isotope analyses. Bioapatite content is about 0.4–0.6% in archaeological samples.

The crushed bone was treated with 1N HCl at 4°C for 24 hr. The residue was filtered, rinsed with deionized water, and treated with 0.1N NaON to remove contamination from humic acids. Then, collagen was rinsed with deionized water, diluted HCl, and deionized water again and under slightly acid condition (pH = 5) heated at 80°C for 16 hr to dissolve collagen, leaving only humic substances in the precipitate. The collagen solution is then filtered to isolate pure collagen and dried out. The dried collagen was combusted at 575°C in evacuated/sealed Pyrex® ampoules in the presence of CuO. The carbon dioxide and nitrogen have been cryogenically separated for further analyses. The yield of collagen for the human remains did not exceed 2–3%. In the case of the dog skull, the yield was 1.5%. There was also a dated wood sample from an artifact found in the same burial, PICZAT09. These samples underwent the standard acid-base-acid pretreatment.

For AMS analysis, the cleaned carbon dioxide was catalytically converted to graphite as described in Cherkinsky et al. (2010). The graphite $^{14}C/^{13}C$ ratio was measured using a 0.5MV Pelletron AMS instrument. The sample ratios were compared to the ratio measured from the oxalic acid standard OXI (NBS-4990) to calculate ^{14}C.

The sample $\delta^{13}C$ and $\delta^{15}N$ were measured separately, using a Delta V elemental analyzer mass spectrometer and expressed as $\delta^{13}C$ with respect to PDB, with an error of less than 0.1‰. $\delta^{15}N$ had an error of less than 0.2‰ with respect to atmospheric air nitrogen. The obtained ^{14}C ages were converted to calendar dates using the calibration program CALIB 6.0 (Stuiver and Reimer 1993) with the IntCal09 calibration curve for soil and bone collagen samples and mixed marine and atmosphere curve for shell samples (Reimer et al. 2009).

RESULTS AND DISCUSSION

Table 1 demonstrates that for all but one sample, the ^{14}C dates of the bioapatite and collagen fractions exhibit a difference of 130 yr or even less. This difference could be the result of two factors:

(1) a high-carbohydrate diet would mostly affect the mineral isotope composition of bone and a high-protein diet would mostly affect the organic fraction of collagen; and (2) the isotopic exchange with the soil solutions carrying dissolved inorganic carbon during the burial. Sample PICZAT2, from fragments of the incomplete skeleton of a young boy, was the only sample showing a discrepancy between the collagen and bioapatite dates, 920 ± 25 and 700 ± 25 BP, respectively, which resulted in a difference of more than 200 calendar years. We thus used only ages of the collagen fraction for the interpretation of ^{14}C dates.

The dates for three bone samples from different skeletons in one grave provided a general picture of the burial processes. The first and youngest of the three skeletons was buried between AD 1158 and 1227 (PICZAT1). It was the most complete skeleton, with much of the body presented in anatomic display. On top of this body were found two other secondary burials. The bodies of a young boy (PICZAT2) and a middle-aged man (PICZAT3) consisted of fragmented, incomplete skeletons. The bone fragments from these two incomplete skeletons were found to be significantly older than the complete skeleton PICZAT1 and were both dated between AD 1029 and 1172.

In Middle America, the traditional belief system associated with death required burying the dead beneath the household space. This excavation demonstrates that a grave site was reused to bury the skeleton PICZAT1. Thus, the grave was excavated, the older skeletal remains exhumed, and after placing the body of skeleton PICZAT1, the bones of PICZAT2 and PICZAT3 were placed on top of PICZAT1 along with soil.

The ^{14}C date determined for skeleton PICZAT4 from the second gravesite indicates that it was buried at the same time as skeleton PICZAT1. Also here, the difference between collagen/gelatin fraction and bioapatite is higher (Table 1). Moreover, it is also apparent from the resulting stable isotope data that all of the humans excavated had similar diets based on the C_4 plants, most likely maize.

We also excavated the main pyramid of the Central Architectural Ensemble, at the top of the hill, with the purpose of understanding the architectonic history of the pyramid. Three different constructive stages of the pyramid were found. The cranium of the dog, sample PICZAT6, was found buried in the oldest stage, the foundation of the pyramid, and dated to AD 560–646. Thus, the first foundation of the architectonic project was found to be built in the very beginning of the Epiclassic period (AD 600–900).

Wood fragment PICZAT9 from a billet artifact excavated at the site dated to 403–231 BC. The pottery recovered (Figure 5) in association with the billet is from the Early Postclassic period (AD 900–1175), indicating that it may have been some kind of relic. Possibly it is part of an artifact relevant for the cosmovisional values of these ancient people, one that was passed down through generations from the 4th century BC. This time of the Late Preclassic period is hundreds of years before the development of Teotihuacan, the first city-state with a large-scale hegemony in Middle America.

The date for the dog skull excavated from the foundation of the oldest stage of the Central Architectural Ensemble construction was found to be AD 560–760. When we consider the ^{14}C ages of both fractions, the difference between collagen/gelatin and bioapatite is again greater than 2σ. This date confirmed that the pyramid was erected in the beginning of the Epiclassic period, a few hundred years before the human burials.

The date for the wood fragment taken from an artifact was found to be significantly older than the household burials dated at the site, suggesting that the artifact may have been used by many generations and passed down through the centuries as a cult fetish.

Table 1 Radiocarbon and calendar age of collagen and bioapatite fractions of bone from Tlayacapan site, Morelos, Mexico.

UGAMS #	Sample ID	Source	Collagen $\delta^{13}C$ (‰)	Collagen $\delta^{15}N$ (‰)	Collagen ^{14}C age, yr BP	Collagen Calendar age AD, 2σ	Bioapatite $\delta^{13}C$ (‰)	Bioapatite ^{14}C age, yr BP	Bioapatite Calendar age AD, 2σ
12670	PICZAT1	Man	−7.9	6.6	850 ± 20	1158–1227 (0.961)	−2.9	910 ± 25	1035–1186 (0.987)
12671	PICZAT2	Boy	−9.4	n/a	920 ± 25	1030–1172 (1.000)	−3.9	700 ± 25	1265–1383 (1.000)
12672	PICZAT3	Man	−8.0	7.3	940 ± 25	1029–1156 (1.000)	−3.6	910 ± 25	1035–1186 (0.987)
12673	PICZAT4	Man	−7.9	n/a	840 ± 20	1164–1253 (1.000)	−3.3	970 ± 25	1017–1154 (1.000)
12674	PICZAT6	Dog	−18.9	7.6	1340 ± 25	646–765 (1.000)	−11.9	1460 ± 25	560–646 (1.000)
12676	PICZAT9	Wood	−16.0	n/a	2270 ± 50	403–231 BC (0.986)			

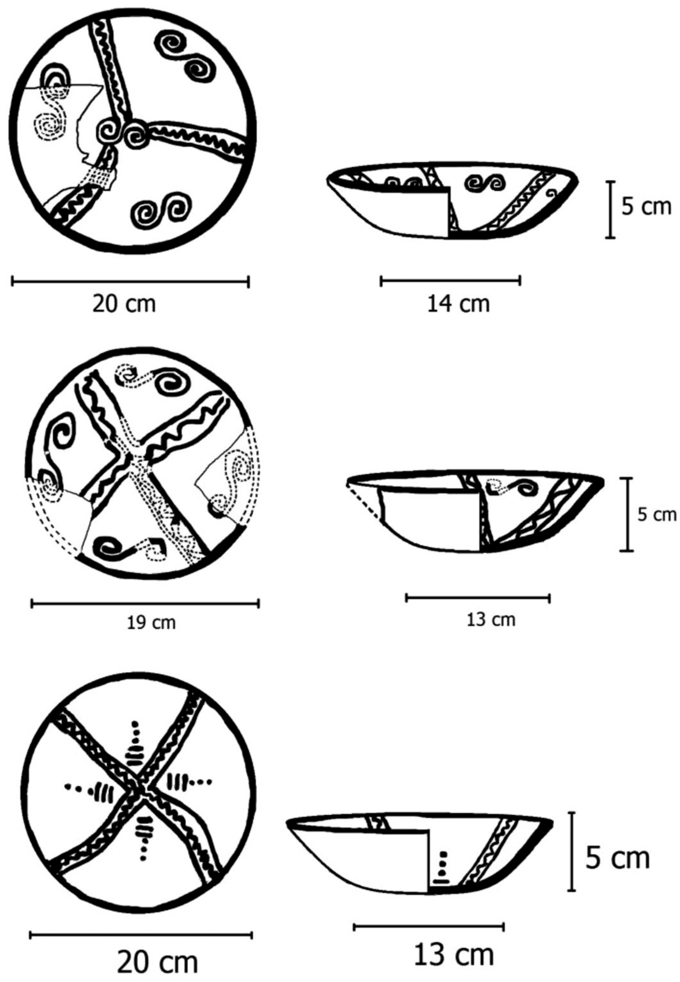

Figure 5 Ceramic specimens associated with the burials dated to the Early Post-classic (Red on Cream ceramic type).

CONCLUSION

The ^{14}C dates obtained for bone samples excavated from the Tlatoani site in Morelos, Mexico, have confirmed an Early Postclassic period of occupation. Dates were determined on both the collagen and bioapatite fractions of the bone samples. However, due to the uncertainty in the environmental conditions and diet of analyzed remains, a majority of the bioapatite dates were older than the collagen dates, except those for the bones of the buried boy, where the bioapatite dates appear to be outliers. The displaced bones of older, partial skeletons were found buried on top of a full skeleton that was almost 100 yr younger. ^{14}C dating thus confirmed the historic use of former household burial sites for exhumation and reburial.

A dog skull excavated from the foundation of the oldest stage of the Central Architectural Ensemble construction dated to AD 560–760. This date confirmed that the pyramid was erected in the beginning of the Epiclassic period, a few hundred years before the human burials. The date for a fragment taken from a wooden artifact was found to be significantly older than the household burials dated at the site, suggesting that the artifact may have been used by many generations and passed down through the centuries as a cult fetish.

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