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THE TEMPLE OF QUETZALCOATL, TEOTIHUACAN: NEW DATA ON THE ORIGINS OF THE SACRIFICIAL VICTIMS

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Abstract

Continuing isotopic investigation of the sacrificial burials and trophies beneath the Feathered Serpent Pyramid (Temple of Quetzalcoatl) in ancient Teotihuacan, Mexico, has produced new results. Isotopic proveniencing using bioapatite strontium and structural carbonate oxygen isotopes in tooth enamel was applied to 39 samples, 24 from the sacrificial victims and 15 from the trophy jaws. Both the strontium and oxygen isotope ratios suggest that most or all of the sacrificial victims came from the central highlands of Mexico, which includes the area of Teotihuacan. In this sense, we find somewhat less multiethnicity represented among the military at Teotihuacan than previously thought. Analysis of carbon isotope ratios in enamel structural carbonate indicated a childhood diet dominated by maize, relatively homogeneous among the victims at the pyramid, and typical for much of pre-Hispanic Mesoamerica.

INTRODUCTION

Some years ago, several papers were published on the origins of sacrificial victims in the Temple of Quetzalcoatl (Spence et al. 2004; White et al. 2002) and the Moon Pyramid (White et al. 2007) at the site of Teotihuacan in central Mexico. More recently, Nado (2017; Nado et al. 2017) measured a number of samples from Teotihuacan, including the Temple of Quetzalcoatl. In the present study, we add new isotopic data for the individuals found inside the Temple (Feathered Serpent Pyramid) and continue the discussion of possible places of origin. In addition, we consider the application of oxygen isotopes in human-proveniencing in Mesoamerica.

The ancient city of Teotihuacan lies about 45 kilometers from the center of modern Mexico City at an elevation of 2,370 m. The archaeological site covers some 20 km^2. The city thrived for almost eight centuries between 150 B.C. and A.D. 650 and was one of the largest cities in the world during its heyday with a population estimated at 125,000 or more (Millon 1981). The city was focused on a civic-ceremonial center with many large and magnificent structures surrounded by residential areas characterized by more than 2,000 large apartment complexes organized in *barrios*. These *barrios* show a great deal of variation and functioned as centers of labor and production for the city. In addition, a number of the *barrios* appear to have been foreign enclaves with inhabitants from distant locations involved in trade and the production of exotic goods (Price et al. 2000; Rattray 1993; Spence 1989; White et al. 2004a). In fact, much of the city was probably inhabited by immigrants, given its size and rapid growth (Cowgill 2015; Manzanilla 2012, 2015, 2017a; Price et al. 2000; Spence 1992).

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The city center was composed of broad avenues flanked by palaces, plazas, temples, and pyramids (Figure 1). The Temple of Quetzalcoatl (Feathered Serpent Pyramid) is the third largest pyramid in the city, after the Pyramids of the Sun and Moon, and was built between A.D. 200–250 in the Early Tlamimilolpa phase (Sugiyama 1998). The Feathered Serpent Pyramid was constructed inside an enormous rectangular enclosure known as the Ciudadela. The Pyramid of the Moon sits at the head of the Avenue of the Dead about two kilometers north of the Ciudadela. About one kilometer south of the Pyramid of the Sun and along the Avenue of the Dead, the Ciudadela is thought to have been the political and religious center of the city (Cowgill 1983; Millon 1981, 1988). On the north and south sides of the Feathered Serpent Pyramid are apartment compounds that may have been the residences of Teotihuacan's rulers (Armillas 1964; Cowgill 1983; Millon 1973; Taube 1992).

The Feathered Serpent Pyramid sits on the east side of the Ciudadela, oriented toward the Avenue of the Dead to the west. This structure (Figure 2) is a six-level, step pyramid built in a distinctive Teotihuacan style known as *talud-tablero*. There was originally a large temple on top of the structure. The outside edges of each level were decorated with feathered serpent heads alternating with another element, generally thought to be a headdress (Sugiyama 2005:57–58). There is a broad staircase facing the plaza of the Ciudadela that today is largely hidden behind another structure known as the Adosada platform.

In 2003, a long, deep tunnel was discovered and eventually determined to run a distance of some 100 meters from the plaza to a series of chambers 20 m beneath the floor of the pyramid. This tunnel was sealed in A.D. 200. In 2014, investigators reported large quantities of mercury in the area below the Pyramid, along

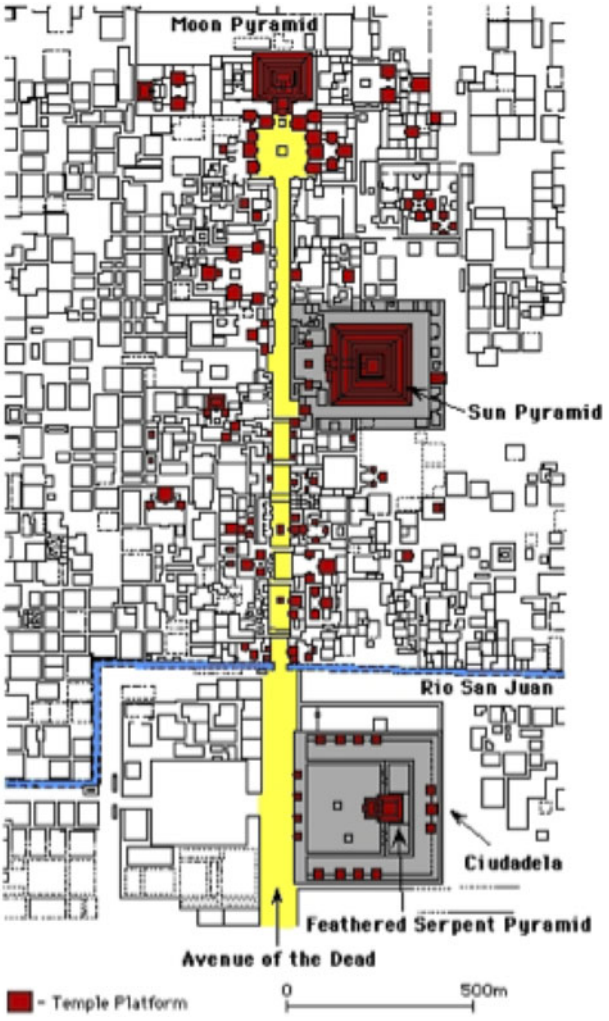

Figure 1. Map of the central core and Avenue of the Dead (yellow) at Teotihuacan. Drawing by Michael Ritchie and Saburo Sugiyama after Millon et al. (1973).

with jade statues, jaguar remains, a box filled with carved shells and rubber balls, and numerous metallic spheres.

Perhaps most dramatic are the finds of numerous human sacrifices associated with the construction of the pyramid (Cabrera Castro 1993; Sugiyama 1989). Pits containing more than 200 individuals in and around the pyramid's core were discovered in the late 1980s (Cabrera and Cabrera Cortés 1991; Cabrera and Serrano Sánchez 1999; Cabrera et al. 1991; Sugiyama 1991, 1992, 1995). Figure 3 shows the distribution of some of these burial pits at ground level beneath or beside the pyramid. Males outnumber females. The average age of those buried beneath the pyramid is somewhat higher than those buried around the periphery (Serrano Sánchez et al. 1991). There is probably a symmetrical arrangement of burials on all sides at ground level both inside and outside the pyramid, but many areas have not yet been exposed.

The burials included 72 males dressed in military fashion and accompanied by weapons. Their hands were tied behind their backs, and many had collars or necklaces of human jaws and teeth around their necks (Figure 3). Most of these were artificial, but four individuals wore actual human teeth and jaws. The equipment with which they were buried was clearly local, suggesting that these were members of the Teotihuacan military, often referred to as "soldiers." Cowgill (1997) argued that the elaborate and rich regalia that the "soldiers" wore indicated they came from an elite corps of professionals. There are, of course, alternative views that suggest that these males may have been civilians, i.e., commoners dressed in military outfits, rather than professional soldiers (Manzanilla 2001; Sugiyama 2005).

There were also separate burials of young females, again in symmetrical trenches, separate but associated with the male military burials. The females were buried in groups of eight, the military males in groups of 18. All were buried in mass graves at the periphery and inside the Feathered Serpent Pyramid during its construction.

Analysis of their nonmetric dental traits shows some variability within each mass grave, but also suggests that some of the soldiers may have had close genetic ties. For example, four of the nine men in grave 5 (5C, 5D, 5G, and 5H), and one of 5H's trophies retained their deciduous maxillary canines into adulthood (Spence 1997). These men, then, may have had close kin relationships and were either placed together in the grave because of those relationships or, more likely, had been members of a social unit that was designated for the sacrifice. In either event, it seems that the social composition of each grave was not entirely random. Isotopic results for the individuals with retained deciduous canines are discussed in a subsequent section of this study.

Another example is the presence of supernumerary permanent teeth in the area of the maxillary central incisors. These supernumerary teeth are not like any of the normal permanent teeth but are like each other. They have curved single roots and ovaloid crowns, sometimes with pointed tips. They are present in victims 190M, 190P, 204Ñ, and 204L (Figure 4). Unfortunately, the only information we have for these individuals are two bioapatite phosphate oxygen isotope compositions ($\delta^{18}O_{p\ (VSMOW)}$) in bone: 190M = +14.2‰; 190P = +14.6‰.

In the center of the pyramid at ground level were several additional sets of burials in pits 12, 13, and 15 (Figure 5). Another set of skeletal remains was found in the area designated as 14. Looters from pre-Columbian times had tunneled into the pyramid and disturbed graves 12, 13, and 15, but evidence of high-status grave goods remained. The looters did not reach grave 14 in the precise center of the great structure. In that place, 20 people had been sacrificed, accompanied by thousands of lavish offerings. Those individuals were not buried but had simply been placed on the ground with their hands tied behind their backs. The pyramid was built over them.

The richness of burial goods generally increased toward the center of the pyramid. At least three degrees of status have been identified among the burials, although there is no evidence for a primate ruler or noble (Cowgill 2002, 2003). Those in the central interior may have been bureaucrats or royal household retainers. Analyses of dental modifications of the "soldiers" suggested that some of these sacrificed individuals may have been foreigners, perhaps from the Valley of Oaxaca or Maya regions (Serrano Sánchez et al. 1997).

A number of important questions arose from the finds of human remains in and around the Temple of Quetzalcoatl. Specifically, the local versus nonlocal origins of the sacrificial victims would shed light on the nature of ritual and ceremony in Classic Mesoamerica. Were these captives or prisoners of war who were put to death to commemorate the construction of the temple, or were they local individuals who volunteered for or were coerced

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Figure 2. The Feathered Serpent Pyramid at Teotihuacan. Photograph by Spence.

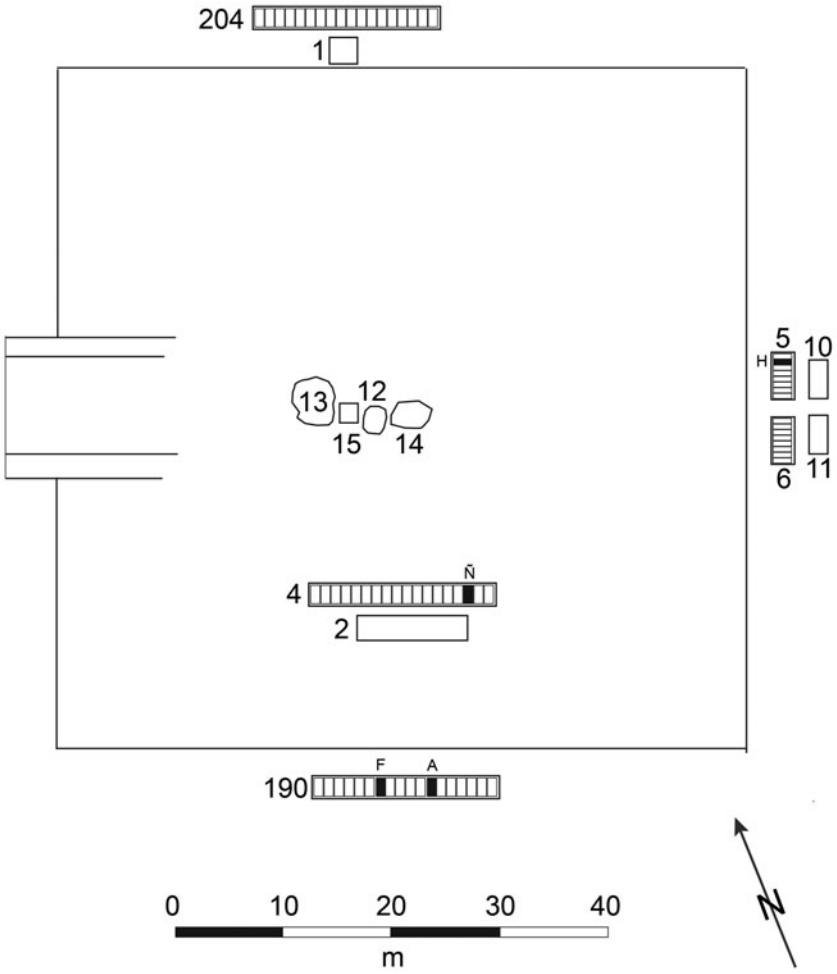

Figure 3. Burial areas in and around the Temple of Quetzalcoatl (White et al. 2002), location of the graves of "soldiers'" (small rectangles) in and around the Temple of Quetzalcoatl (Spence et al. 2004), and the location of the human trophy jaws (black).

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Figure 4. Photograph of sacrificial burials of "soldiers" with hands tied and collars of human jaws (shell copies). Photograph by Spence.

into being sacrificed? If these were buried soldiers who had been sacrificed, what was the makeup of the military? Were the individuals associated with different status items in burial 14 local or nonlocal? Were they the retainers of elite, or were they nonlocal individuals unfortunately incorporated in the commemoration ceremonies for this new structure?

PREVIOUS STUDIES

Published in 2002, a study by White et al. measured oxygen isotope ratios in the bones and teeth of 41 of the sacrificial victims from the Feathered Serpent Pyramid. The oxygen isotope composition of the phosphate component of bioapatite was obtained for these samples and reported relative to VSMOW ($\delta^{18}O_{p\ (VSMOW)}$). To correct for trophic effects caused by breastfeeding, the $\delta^{18}O_{p\ (VSMOW)}$ values of canine teeth were lowered by 0.7‰ and premolars by 0.35‰ from the measured ratios (White et al. 1998). Comparison of the $\delta^{18}O_{p\ (VSMOW)}$ values in both tooth and bone provided an index of movement from child- to adulthood and resulted in the identification of at least four different regions of origin for the sacrificial victims. Some of the "soldiers" were local individuals from the city and its environs and about 2/3 of them had moved to Teotihuacan after childhood from one of several foreign locations. All of the "soldiers" had been in Teotihuacan for some years and, in spite of the tooth modifications, there was no definite oxygen isotope evidence that they were originally from Oaxaca or the Maya area.

Some of the women had lived their entire lives in or around Teotihuacan, while others had moved to the city during their lifetime. Most of the 20 individuals in Unit 14 were not from Teotihuacan. The possible presence of a Maya foreigner in one of the looted pits (13) is suggested by a high-status (Maya-like) baton from the disturbed fill and $\delta^{18}O$ values consistent with highland Guatemala. The study concluded that the military at Teotihuacan included foreign-born individuals and a large multiethnic component.

Another aspect of the study of these remains involved the teeth in the trophy necklaces worn by some of the sacrificed "soldiers" (Spence et al. 2004). Figures 3 and 5 show the location of the "soldiers'" burial places in and around the Temple of Quetzalcoatl. Because of the symmetrical disposition of the graves that have been found, it seems likely that more complementary burials must be present in the unexplored areas of the pyramid. Most of the burials were equipped with necklaces of eight to 11 artificial jaws made of wood and stucco, with "teeth" of marine shells. Figure 3 shows which burials wore collars or necklaces with real, rather than artificial, human maxillae and teeth.

Specifically, human dentition was found with burial Ñ in Grave 4 (11 maxillae), H in Grave 5 (eight maxillae), and A (10 maxillae) and F (seven maxillae and three mandibles) in Grave 190. There was a total of 36 real maxillae and three mandibles with these four individuals. Several others wore maxillae from dogs or coyotes and imitations of canid teeth. The human teeth and jaws were almost exclusively from males from a wide range of ages. Oxygen isotope analysis was employed to investigate place of origin. In all, 15 teeth from 13 jaws were measured for $\delta^{18}O_{p\ (VSMOW)}$. Analysis of these teeth led to the conclusions that the "soldiers" collected these trophy jaws both in distant places and nearby localities. In sum, the study of oxygen isotope ratios in the sacrificial victims, and the trophy teeth indicated that many of these individuals came from several different places in Mesoamerica. Other studies have similarly concluded that rates of immigration from multiple sources at Teotihuacan were high (Cowgill 2015; Manzanilla 2015, 2017a; Millon 1973; Price et al. 2000; Spence 1992).

A study by Nado (2017) examined carbon, nitrogen, and oxygen isotopes in rib bone from 12 burials from the Feathered Serpent Pyramid and compared the results with individuals from two groups of burials from domestic contexts in Teotihuacan, of intermediate and low status, respectively. In that study, the oxygen isotope composition of the structural carbonate in the bioapatite has been reported relative to VPDB ($\delta^{18}O_{c\ (VPDB)}$). With the exception of one outlier (Individual 11A, $\delta^{18}O_{c\ [VPDB]} = -12.9‰$), the range of oxygen isotope compositions found within the rib samples of individuals interred in the Feathered Serpent Pyramid closely matched the individuals interred in the two residential contexts. The $\delta^{18}O_{c\ (VPDB)}$ values in bone carbonate from the sacrifices (minus outlier 11A) averaged $8.3 \pm 1.1‰$. These oxygen isotope ratio data from bone are not used in the present study.

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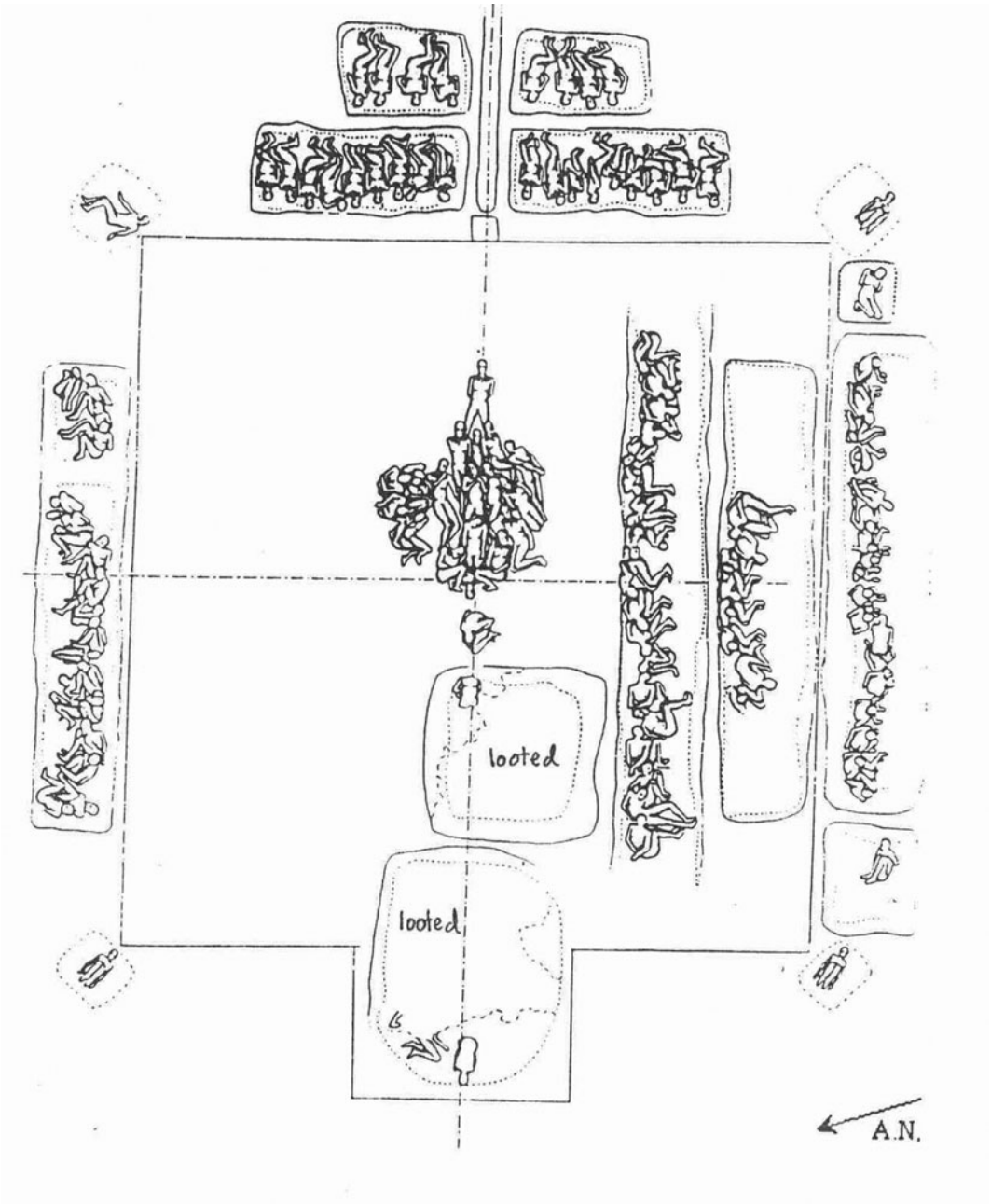

Figure 5. Sketch of body position for many of the sacrificed individuals at the Feathered Serpent Pyramid, Teotihuacan (from Sugiyama 1995).

Nado et al. (2017) interpreted the oxygen isotope data to indicate that these individuals lived within the local Teotihuacan area in the years immediately prior to their deaths. The trabecular bone in ribs should turnover within a period of a few years. These sacrificed individuals also had a diet different from other groups at Teotihuacan, as indicated by carbon and nitrogen isotope ratios, suggesting that the sacrificial victims had a social or economic identity distinct from the majority of the Teotihuacan population. It is the case, however, that trabecular bone is readily susceptible to diagenesis, which can change the original oxygen isotope composition of structural carbonate. Alternatively, perhaps the tested individuals were originally from rural areas in the Valley of Teotihuacan or the Valley of Mexico? Nado et al. (2017:129) also suggest that the dietary difference may have been due to the military status of the men if they were provided rations from state stores.

ISOTOPIC METHODS

It is important to reiterate that the present study is a follow-up to previous investigations of the human remains associated with sacrifices at the Feathered Serpent Pyramid. In this report, we focus on tooth enamel and its strontium, oxygen, and carbon isotope ratios. Carbon and oxygen isotope compositions in the enamel structural carbonate are reported relative to VPDB. The principles and methods for these

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analyses are described in the Supplementary Material, in which we also provide information on background levels of these isotopes as currently understood for Mesoamerica. With this background as context, we present here the results of the new analyses and an interpretation of their implications.

In sum, isotope methods involve the measurement of isotopic ratios in bone and tooth. Tooth enamel forms in early childhood and is composed of the elements and isotopes from local diet. Strontium and oxygen isotope compositions vary geographically, the former with geology and the latter with the elevation, latitude, and amount of rainfall. There is significant geographic variation in strontium and oxygen isotope ratios across Mesoamerica. Carbon isotopes vary according to diet. Enamel is largely unaltered after formation and generally resistant to diagenesis (Budd et al. 2000). Bone continuously turns over, and its chemical composition changes through life. Bone usually reflects an adult context; enamel records childhood conditions.

Strontium isotope ratios vary among geological deposits, depending on rock type and age. In very general terms, much of the central highlands of Mexico is volcanic and has low values of $^{87}Sr/^{86}Sr$ (0.704–0.706). In the area of Teotihuacan and the Basin of Mexico, $^{87}Sr/^{86}Sr$ values should be in the range of 0.704 to 0.705. In Teotihuacan itself, bone $^{87}Sr/^{86}Sr$ values are consistently in the 0.7045–0.7049 range (Nado 2017:Appendix B; Price et al. 2000:Table 1; Solís Pichardo et al. 2017:Table 6.1). Much of the Maya region rests on limestone and other marine deposits and has somewhat higher $^{87}Sr/^{86}Sr$ values (0.707–0.709). Still higher values of $^{87}Sr/^{86}Sr$ exist but are uncommon in Mesoamerica.

As Price (2015) and others (Lightfoot and O'Connell 2016) have noted, oxygen isotopes are quite variable in human remains, and the approach remains somewhat controversial. It is clear, however, that oxygen isotope compositions vary between the highlands and lowlands of Mesoamerica, and these ratios exhibit some useful variation within the Maya region as well. At Teotihuacan, $\delta^{18}O_{p\ (VSMOW)}$ values

Table 1. Sample information and isotopic measurements for the Feathered Serpent Pyramid. C, canine; L, lower; M, molar; P, premolar; T, trophy, U, upper.

Lab No.	Burial No.	Sex	Age	Tooth	$\delta^{18}O_{p\ VSMOW}$	$\delta^{13}C_{c\ VPDB}$	$\delta^{18}O_{c\ VPDB}$	$^{87}Sr/^{86}Sr$
Individuals								
F4742	2C (96.73)	F	14–16	LRC	+13.0	−0.40	−4.15	0.7059
F4766	2 G (96.74)	F	17–19	LLM2	+15.2	+0.45	−5.36	0.7057
F4757	2H (96.72)	F	22–28	LRC	+17.8	−1.70	−5.32	0.7043
F4763	4A (96.75)	M	35–39	LRC	+14.4	+0.31	−5.92	0.7046
F4752	4L (96.76)	M	18–20	LLC	+11.4	−3.11	−3.30	0.7060
F4767	4Ñ (96.42)	M	20–22	LLP1	+17.8	−0.93	−3.69	0.7046
F4768	4O (96.43)	M	25–29	URC	+17.2	+0.31	−4.65	0.7056
F4750	5C (96.81)	M	19–21	URP1	+18.2	−1.22	−4.21	0.7045
F4759	5D (96.82)	M	40–44	LLM2	+17.2	−0.95	−5.16	0.7057
F4751	5E (96.83)	M	25–29	ULC	+16.3	+0.06	−4.52	0.7051
F4764	5F (96.80)	M	35–39	ULP	+17.5	−2.31	−3.79	0.7075
F4749	5 G (96.84)	M	18–20	LLC	+17.4	−0.48	−4.87	0.7058
F4769	5H (96.44)	M	18–20	ULP1	+14.9	–	–	0.7053
F4761	6B (96.87)	M	20–24	LRC	+15.6	−1.29	−5.23	0.7052
F4743	6C (96.88)	M	20–24	URC	+16.4	−0.93	−4.84	0.7055
F4753	6D (96.85)	M	18–20	URC	+16.9	−2.04	−5.54	0.7056
F4756	6I (96.86)	M	40–44	URC	+15.0	−1.89	−5.60	0.7054
F4747	10A (96.89)	F	25–29	ULC	+15.8	–	–	0.7046
F4772	13E (96.100)	M	35–39	LRC	+16.5	+0.48	−4.47	0.7049
F4758	14A (96.94)	M	19–22	ULC	+14.9	−0.61	−4.42	0.7050
F4770	14C (96.99)	M	35–39	LLP2	+16.6	+0.40	−5.79	0.7049
F4771	14F (96.98)	M	22–24	LLC	+10.1	−1.96	−4.79	0.7074
F4748	14I (96.97)	M	35–39	URP1	+17.0	−0.14	−4.58	0.7047
F4754	190F (96.69)	M	17–19	ULC	+15.5	−1.29	−4.77	0.7046
Trophies								
F4776	T4Ñ:6 (96.56)	T	–	URC	+15.6	−0.13	−4.73	0.7046
F4777	T4Ñ:10 (96.51)	T	–	URM3	+17.5	−0.37	−4.51	0.7045
F4778	T4Ñ:5 (96.50)	T	–	ULM3	+15.9	+0.09	−5.72	0.7045
F4779	T4Ñ:O-1 (96.49)	T	–	ULM2	+15.8	−0.03	−6.05	0.7046
F4785	T4Ñ:3 (96.54)	T	–	ULP1	+17.4	+0.29	−4.08	0.7046
F4784	T4Ñ:6 (96.55)	T	–	URM3	+17.4	−0.24	−4.29	0.7046
F4780	T4Ñ:7 (96.53)	T	–	URC	+15.7	−1.15	−5.11	0.7046
F4786	T4Ñ:7 (96.52)	T	–	URM3	+16.9	−0.17	−4.84	0.7047
F4775	T5H:2 (96.45)	T	–	ULM3	+16.3	+0.48	−4.50	0.7046
F4781	T5H:8 (96.46)	T	–	ULM3	+16.3	−2.06	−5.03	0.7047
F4782	T5H:4 (96.47)	T	–	ULM3	+15.1	−0.79	−6.14	0.7045
F4783	T5H:6 (96.48)	T	–	ULM3	+15.4	−0.09	−6.81	0.7059
F4755	T190F:10 (96.68)	M,T	–	LLC	+14.9	−2.20	−4.19	0.7044
F4760	T190F:1 (96.92)	M,T	–	ULC	+14.9	−1.14	−6.14	0.7054
F4762	T190F:5 (96.70)	M,T	–	URC	+14.8	−0.37	−4.40	0.7065

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average + 15.3‰ in bone and + 15.7‰ in enamel. White et al. (2002) argue that the expected local range for bone phosphate (VSMOW) at Teotihuacan should be + 14 to + 16‰. We have little data from Teotihuacan, however, for carbonate $\delta^{18}O_{c\ (VPDB)}$ or $\delta^{13}C_{c\ (VPDB)}$ in tooth enamel. Webb et al. (2014) examined isotopic differences between structural carbonate in concurrently formed human enamel and bone and found large offsets for carbonate oxygen (1.4 ± 1.0‰) and carbon (4.3 ± 1.2‰), with enamel being consistently ^{18}O- and ^{13}C-enriched relative to bone. The oxygen isotope offset between concurrently formed human enamel and bone phosphate, by comparison, was much smaller and irregular in direction ($\pm 0.7 \pm 0.5$‰). Consequently, values of $\delta^{18}O_{p\ (VSMOW)}$ from paired enamel and bone are most suitable for investigations of residential history. Greater complexity is associated with comparisons of structural carbonate oxygen and carbon isotope compositions from enamel and bone bioapatite and therefore these data require more nuanced consideration.

From the *barrio* of Teopancazco at Teotihuacan, Morales Puente et al. (2012:Table XI:4) report a mean ± 1 *sd* $\delta^{18}O_{c\ (VPDB)}$ of -5.3 ± 1.5‰, with a range from −7.3 to −0.8‰ and $\delta^{13}C_{c\ (VPDB)}$ of -2.1 ± 1.5‰ with a range from −6.4 to −0.3‰ in enamel for 40 samples. Data from the human sacrifices at the Temple of the Moon (White et al. 2007) had a mean ± 1 *sd* for $^{87}Sr/^{86}Sr$ of 0.7055 ± 0.0009 for 69 samples, with a range from 0.7043 to 0.7075. The $\delta^{13}C_{c\ (VPDB)}$ in 22 samples of tooth enamel had an average value of -0.9 ± 1.0‰ with a range from −3.1 to 0.5‰. The $\delta^{18}O_{c\ (VPDB)}$ in the same 30 samples of tooth enamel had an average value -4.8 ± 0.7‰ with a range from −6.0 to −3.3‰ (Table 2).

Results of Isotopic Analysis

The details of the samples analyzed in this study, along with the results of the isotopic analyses, are provided in Table 1. We measured a total of 39 enamel samples: 24 from the sacrificial victims and 15 teeth from the trophy jaws around the soldiers' necks. The sacrificial victims came from several burial areas including 4, 5, 6, 10, 13, 14, and 190 at the Feathered Serpent Pyramid (Figure 3). There were four females in the sample of sacrificial victims from burials 2 and 10. The remaining males, with the exception of Units 13 and 14, were from the "soldiers" burials.

Table 2. Descriptive statistics for oxygen enamel phosphate and enamel carbonate, carbon, and strontium isotope ratios.

	$\delta^{18}O_p$ VSMOW	$\delta^{13}C_c$ VPDB	$\delta^{18}O_c$ VPDB	$^{87}Sr/^{86}Sr$
Sacrifice Victims				
Average	+15.8	−0.9	−4.8	0.7054
Standard deviation	2.0	1.0	0.7	0.0008
Minimum	+10.1	−3.1	−6.0	0.7043
Maximum	+18.2	+0.5	−3.3	0.7075
Count	24	22	22	24
Trophy Jaws				
Average	+16.0	−0.5	−5.1	0.7048
Standard deviation	0.9	0.8	0.9	0.0006
Minimum	+14.8	−2.2	−6.8	0.7044
Maximum	+17.5	+0.5	−4.1	0.7065
Count	15	15	15	15

Descriptive statistics for these isotope ratios in tooth enamel are presented in Table 2. The new $^{87}Sr/^{86}Sr$ analyses were performed on the same teeth used for the earlier phosphate oxygen isotope studies (Spence et al. 2004; White et al. 2002). The correction for breastfeeding fractionation was applied to the carbonate isotopic data in this study in the same way as for phosphate—the $\delta^{18}O_{c\ (VPDB)}$ values of canine teeth were lowered by 0.7‰ and premolars by 0.35‰ (Wright and Schwarcz 1998; White et al. 1998). The differences between the two groups—sacrificial victims and trophy teeth—were relatively minor. The average $^{87}Sr/^{86}Sr$ ratios and $\delta^{18}O_{c\ (VPDB)}$ were slightly higher for the victims, while average enamel $\delta^{18}O_{c\ (VPDB)}$ and $\delta^{13}C_{c\ (VPDB)}$ values were slightly lower.

The $\delta^{13}C_{c\ (VPDB)}$ values in tooth enamel from the victims of sacrifice at the Feathered Serpent Pyramid are generally higher (more positive) than expected for areas lacking C^4 plants and point to the importance of maize in the diet. Evidence in the form of plant remains and $\delta^{13}C$ values of both bone collagen and bioapatite carbonate emphasize the major contribution of maize (and perhaps amaranth) to the diet at Teotihuacan (Morales Puente et al. 2012; White et al. 2004b). Manzanilla (2017b) described the diet at Teotihuacan as primarily maize-based, involving the large-scale production of tortillas and perhaps other maize-based foods (*atoles* and *tamales*), together with protein derived primarily from domesticated animals such as dogs and turkeys (and perhaps rabbits), also fed with maize. There is convincing evidence that animal protein in the diet was a function of socioeconomic status within Teotihuacan society (Manzanilla 2017b).

The average values of $\delta^{13}C_{c\ (VPDB)}$ in tooth enamel for the sacrificial victims (−0.9‰) and for the trophy teeth (−0.5‰) can be compared with the values for Teopancazco (Morales Puente et al. 2012). Morales Puente et al. (2012) reported a mean ± 1 *sd* $\delta^{13}C_{c\ (VPDB)}$ in enamel carbonate of -2.1 ± 1.5‰, with a range from −6.4 to −0.3‰ for 40 samples. Teopancazco was described as a higher-status *barrio* with more C^3-fed meat in the diet. That meat component at Teopancazco could account for the differences in values from the sacrificial burial and trophy teeth at the Feathered Serpent Pyramid. Values for $\delta^{18}O_{c\ (VPDB)}$ of −4.8‰ and −5.1‰ for the sacrificial victims and the trophy teeth, respectively, compare closely with the value of -5.3 ± 1.5‰ with a range from −7.3 to −0.8‰ reported by Morales Puente et al. (2012) for Teopancazco.

Comparison with other $^{87}Sr/^{86}Sr$ values from Teotihuacan is informative. Figure 6 shows the distribution of values for archaeological rabbits at the site, locals from the barrio of Oztoyahualco, burials in the lava caves beneath the site, burials from the Oaxaca Barrio, and the individuals sacrificed at the Moon Pyramid and the Temple of Quetzalcoatl. These data are compiled from Price et al. (2000), White et al. (2007), and the present study. The values for the Temple of Quetzalcoatl also include the teeth from the trophy collars.

The local range of values at Teotihuacan, as recorded in the rabbit and local inhabitants, lies between 0.7045 and 0.7055, with a tighter concentration in this and other series of 0.7045–0.7049, probably representing Teotihuacan itself and its immediate vicinity (see also Nado 2017:Appendix B; Solís Pichardo et al. 2017: Table 6.1). Each of the other sets of human burials contains a number of individuals who are nonlocal, i.e., with $^{87}Sr/^{86}Sr$ values above 0.706. The proportion of nonlocal individuals in the Moon Pyramid (White et al. 2007) is much higher than in the Feathered Serpent Pyramid. In fact, with three exceptions, all of the individuals from the Feathered Serpent Pyramid have

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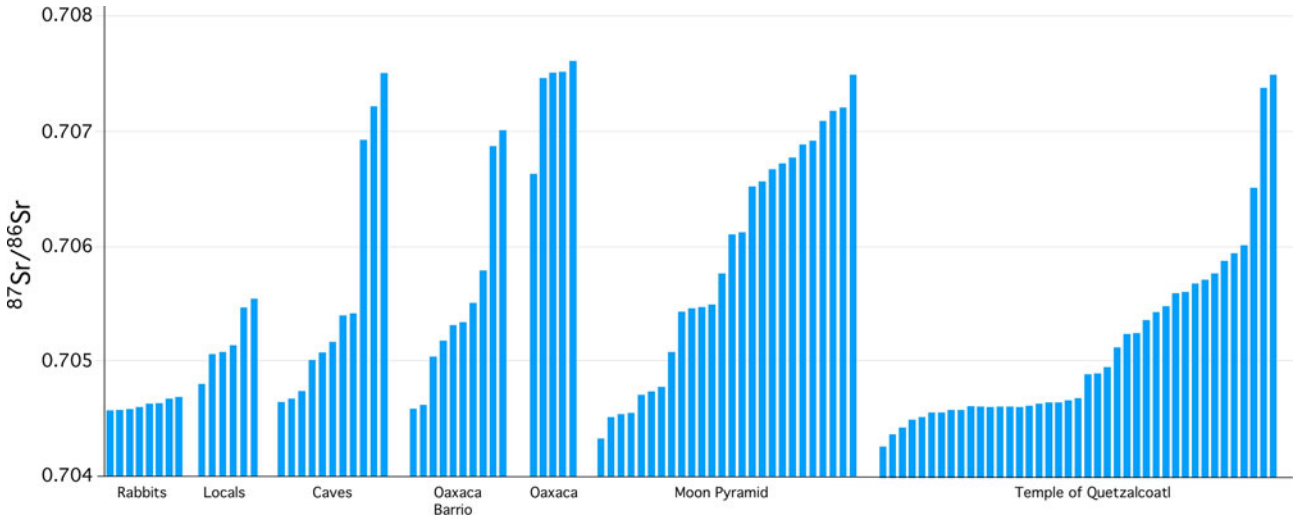

Figure 6. Bar graphs of ranked $^{87}Sr/^{86}Sr$ values for various samples at Teotihuacan. Image by Price.

$^{87}Sr/^{86}Sr$ values below 0.706. These three exceptions are all males, two "soldiers" and one individual from area 14.

The scale of the differences between the sacrificial victims and the trophy jaws can be seen in Figure 7, which provides a bar graph of ranked $^{87}Sr/^{86}Sr$ values for each of the two groups. Females among the sacrificial victims were in burials 2 and 10; the remainder were males. While the sacrificial victims show a range of values between 0.704 and 0.706 along with two clearly higher values, the trophy teeth are generally very homogeneous with a series of values around 0.7045 plus three distinctly higher values. The fact that the trophy teeth have a very homogenous range of $^{87}Sr/^{86}Sr$ between 0.704 and 0.705 strongly suggests that these individuals were from Teotihuacan itself or nearby. The mean $\delta^{18}O_{c\ (VPDB)}$ for the trophy teeth (−5.1‰) is close to the value for the barrio of Teopancazco at Teotihuacan (−5.3‰), reported by Morales Puente et al. (2012). The $\delta^{18}O_{p\ (VSMOW)}$ values for the trophy teeth are more diverse, but the majority (nine of 15) again fall in the Teotihuacan range (Spence et al. 2004:Table 4).

Many of the sacrificial victims themselves could be from throughout the central highlands (0.705–0.706), and at least two individuals could be from some distance, as $^{87}Sr/^{86}Sr$ values of 0.706 or greater are known from various areas in both highland and lowland Mesoamerica. A histogram shows this multimodal distribution clearly (Figure 8). There is one outlier at greater than 0.707. It is intriguing to suggest that the two lower modes represent respectively the trophy jaws, almost exclusively from Teotihuacan or nearby, and the sacrificial victims (largely military males) from both Teotihuacan (<0.705) and the surrounding central highlands (0.705–0.706). This scenario does not differ greatly from the argument presented in the oxygen isotope investigations of White et al. (2002) and Spence et al. (2004).

As can be seen in the scatterplots in Figure 9, the two groups of victims and trophy teeth largely overlap in their distributions of isotopic compositions. Although $^{87}Sr/^{86}Sr$ values are somewhat higher for the sacrificial victims, the carbon isotope ratios show the same distribution. This plot clearly shows the two lines of $^{87}Sr/^{86}Sr$ values that run parallel among the sacrificial victims. In addition to these two sets of values, there are three high $^{87}Sr/^{86}Sr$ values, one of which also has a very low enamel $\delta^{13}C_{c\ (VPDB)}$ value. There appear to be several distinct groups among the sacrificial victims in terms of strontium isotopes and place of origin. In the plot of oxygen isotope ratios, the sacrificial victims exhibit a few higher values and the parallel lines of $^{87}Sr/^{86}Sr$ values are less clear. In sum, the isotope ratios for the sacrificial victims are more scattered, suggesting more diverse origins than the trophy

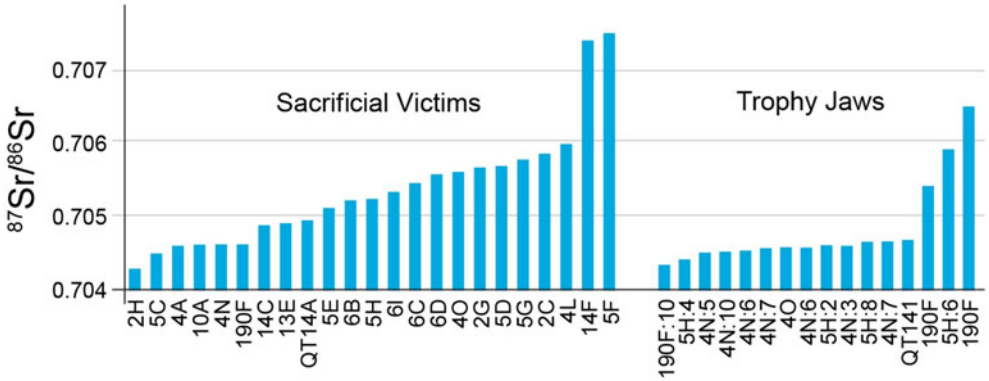

Figure 7. Bar graphs of ranked $^{87}Sr/^{86}Sr$ values for sacrificial victims and trophy jaws from the Feathered Serpent Pyramid. Image by Price.

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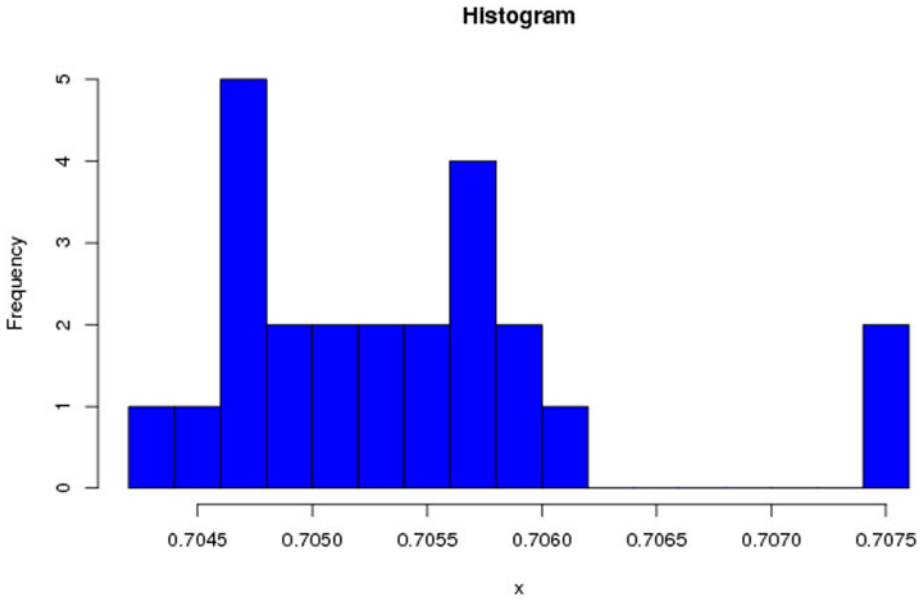

Figure 8. Histogram of $^{87}Sr/^{86}Sr$ values for 24 sacrificial victims at the Feathered Serpent Pyramid. Image by Price.

teeth. This generally confirms the pattern of variance seen in the standard deviations for these ratios.

There are several individuals that appear to be outliers in $^{87}Sr/^{86}Sr$, $\delta^{18}O$, or both among the samples from the Feathered Serpent Pyramid (Table 3). Individual 5C has a local Teotihuacan $^{87}Sr/^{86}Sr$ value, but the highest phosphate oxygen isotope composition measured for this suite of samples. Burial 5F has both high $\delta^{18}O_{p\ (VSMOW)}$ and the highest $^{87}Sr/^{86}Sr$ as well as generally low $\delta^{13}C_{c\ (VPDB)}$ in enamel. Individual 14F has the lowest $\delta^{18}O_{p\ (VSMOW)}$ and one of the highest values for $^{87}Sr/^{86}Sr$ and generally low $\delta^{13}C_{c\ (VPDB)}$. Trophy 5H:6 had the third highest $^{87}Sr/^{86}Sr$ value. Two teeth from Trophy 190F jaws were measured. Both teeth have higher $^{87}Sr/^{86}Sr$ values; the upper canine left has the second lowest $\delta^{18}O_{c\ (VPDB)}$. It is highly probable that all of these individuals were born outside of Teotihuacan and the Basin of Mexico. It is likely that several of these individuals came from substantial distances to an eventual burial place in the Feathered Serpent Pyramid. Ratios of $^{87}Sr/^{86}Sr$ above 0.706 are found outside the Mexican Volcanic Range. Higher oxygen isotope ratios generally mean lower elevations in this region.

Precisely identifying the origins of these outliers is difficult, however, despite the presence of multiple lines of evidence. One major problem is that similar isotope compositions, whether oxygen or strontium, can be found in widely separated regions. Another is our still limited knowledge of the distribution of isotopic compositions throughout Mesoamerica (Supplementary Figure S4; White et al. 2007:Figure 2). Only a few areas of origin can be tentatively suggested. For example, the phosphate oxygen (+18.2‰) and strontium (0.7045) isotope compositions for soldier 5C might co-occur somewhere in the southern highlands, although we cannot suggest a more precise location (White et al. 2007: Figure 6). Soldier 5F has phosphate oxygen (+17.5‰) and strontium (0.7075) isotope compositions that are very similar to those of Moon Pyramid sacrifices 4A (+17.6‰, 0.7072) and 4E (+17.6‰, 0.7075) and so may have come from the same area, perhaps the Gulf Coast or some part of the Metamorphic Province (White et al. 2002:168, Table 1, Figure 6). The isotope compositions of trophies 5H:6 and 190F:1 are similar and suggest an origin in the central highlands but outside the Basin of Mexico, perhaps somewhere in Tlaxcala or Puebla.

Some of the soldiers' morphological traits suggest that genetically related individuals ended up in the same grave. One example, mentioned earlier, involves the retention of deciduous canine teeth in the maxilla. These teeth appear in six individuals: 5C, 5D, 5G, 5H, T5H:7, and T190A:1. Five of these cases are found in Unit 5. Table 4 provides information on the tooth analyzed and isotopic measurements for four of these individuals. There are no data on the trophy teeth. The similarity of most of these individuals in terms of isotopic compositions also supports an argument for similar origins. For example, soldiers 5D and 5 G have very similar phosphate oxygen and strontium isotope compositions (+17.2‰, 0.7057 and + 17.4‰, 0.7058, respectively), and are also similar to Moon Pyramid sacrifice 4D (+16.8‰, 0.7061), but no birth location can be suggested at present.

The trophy enamel isotope compositions can be plotted in terms of the individual burials in which they occurred: burials 4Ñ, 5H, and 190F (Figure 10). Both the oxygen and strontium isotope compositions show a major clustering in their respective Teotihuacan ranges, albeit not always of the same burial units. Both also show minor spreads beyond those ranges, presumably representing victims taken from more distant areas, but again not involving the same burial units. In particular, the strontium isotope compositions show a tight concentration of 4Ñ's trophies in the Teotihuacan range while the oxygen isotope compositions show a much wider spread. The opposite is true for the 190F trophies. As discussed above, these discrepancies are probably due to our limited understanding of isotope composition distributions in Mesoamerica.

DISCUSSION

Additional isotopic information from tooth enamel, specifically strontium and carbon isotope ratios, has provided new perspectives on the human remains from the Feathered Serpent Pyramid at

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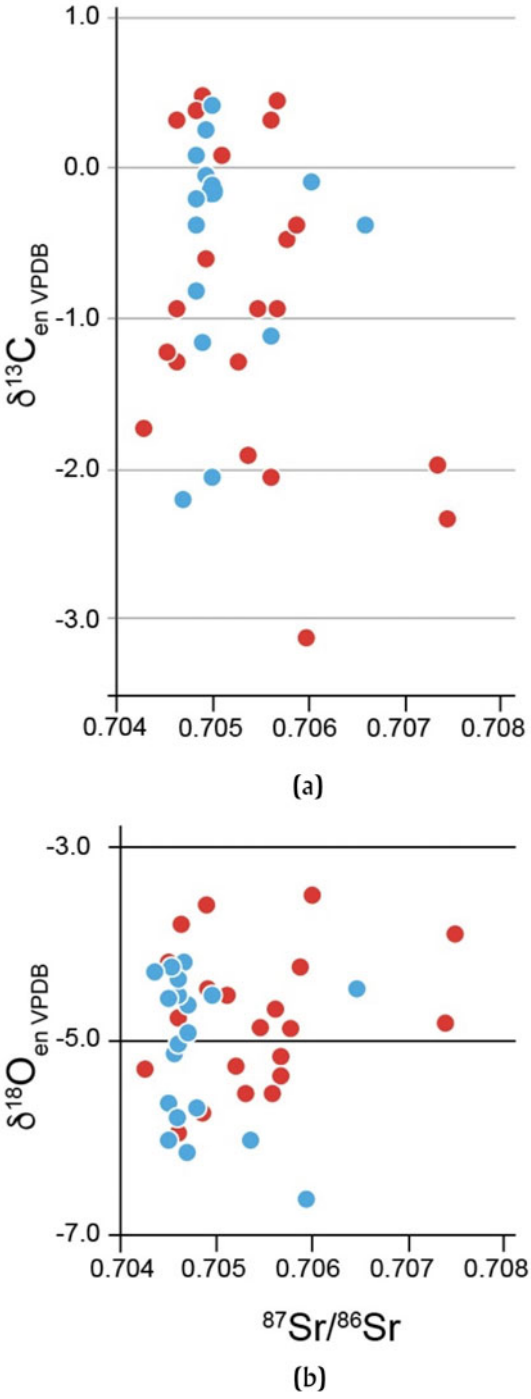

Figure 9. Scatterplots of (a) $\delta^{13}C_{c\ (VPDB)}$ versus $^{87}Sr/^{86}Sr$ and (b) $\delta^{18}O_{c\ (VPDB)}$ for enamel samples from the Feathered Serpent Pyramid. Red, sacrificial victims; blue, trophy teeth. Image by Price.

Teotihuacan. In concert with earlier interpretations (White et al. 2002), it seems that there is indeed "multiethnicity" present among the "soldiers" buried at the Feathered Serpent Pyramid. There are a number of individuals among the "soldiers" (perhaps 14 of the 24 sacrificial victims) who may have come to Teotihuacan from some distance. Most of the individuals represented by the teeth and jaws in the trophy collars, however, appear to have been local, perhaps even from Teotihuacan itself.

There are two major issues with this interpretation that need to be considered here: (1) what does local mean and (2) what are the limitations of oxygen isotopes in providing provenience information?

The Meaning of Local

It is important to remember that isotope ratios of strontium and oxygen occur across the landscape as a range of values. Many of the large and important archaeological sites in the central highlands of Mexico lie in the Mexican Volcanic Belt where geological $^{87}Sr/^{86}Sr$ values average 0.7040 (Torres-Alvarado et al. 2000). This area stretches across south-central Mexico from the Pacific Ocean to the Gulf of Mexico between 18°30′ and 21°30′N. This recent, active volcanic zone is approximately 1,000 kilometers long and 90–230 km wide, covering an area of approximately 160,000 km^2 (Ferrari et al. 2011). The area includes the states (from the west) of Colima and Jalisco, northern Michoacán, southern Guanajuato, southern Querétaro, the state of México, southern Hidalgo, the Distrito Federal, northern Morelos, Puebla, Tlaxcala, and central Veracruz. Strontium isotope ratios in geology and baseline bioavailable from this area range from 0.704 to 0.706 (Price et al. 2008). Because this large area is relatively homogeneous in terms of $^{87}Sr/^{86}Sr$ values, it is difficult to be more specific when defining local on the basis of strontium isotope values alone. This homogeneity can be seen in the baseline data reported by Schaaf et al. (2012) or in the map of baseline data for this area compiled by the Laboratory for Archaeological Chemistry at the University of Wisconsin-Madison (see Supplementary Figure 1).

Politically, the Mexican Volcanic Belt is heterogeneous and includes both areas that would have been part of the Teotihuacan heartland—the Basin of Mexico, southern Hidalgo, parts of Michoacan and Tlaxcala, among others—as well as regions that would have been independent and perhaps hostile to Teotihuacan—Jalisco, central Veracruz, perhaps parts of Puebla, and others. The isotope data from bone samples reported by White et al. (2002) and Nado (2017), however, indicate that nearly all of the soldiers spent some years in Teotihuacan before their sacrifice. It is not likely, then, that they were taken from elsewhere and brought to Teotihuacan for the event. Although both oxygen and strontium enamel isotope compositions indicate that a number of the soldiers passed their childhoods elsewhere, they may simply have been among the numerous people who emigrated from their homelands to Teotihuacan as it grew, eventually entering the military.

In the central highlands, oxygen isotopes, unfortunately, do not help much in determining human origins. As noted by White et al. (2002), similar values for $\delta^{18}O_{p\ (VSMOW)}$ in enamel occur across the region, especially at higher elevations. Values overlapping with the range from Teotihuacan are known from Cholula, Kaminaljuyu in Guatemala, and elsewhere. As Spence et al. (2004:12) noted: "the 14–16‰ range defined for Teotihuacan, and more generally for the Basin of Mexico, may overlap to a considerable degree with the ranges of neighboring regions that share similar geographic and climatic conditions—for example southern Hidalgo, Tlaxcala, and perhaps parts of Puebla and the Valley of Toluca … It is likely that there are other regions, as yet untested, with a similar range of $\delta^{18}O$ values." If similar $\delta^{18}O_{p\ (VSMOW)}$ (or $\delta^{18}O_{c\ (VPDB)}$) values do occur across this large region, and it seems that they do, then the "soldiers" from the Feathered Serpent Pyramid may well represent a multiethnic force, given the variation in the $^{87}Sr/^{86}Sr$ enamel values.

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Table 3. The six outliers in enamel samples from the Feathered Serpent Pyramid. C, canine; L, lower; M, molar; P, premolar; T, trophy, U, upper.

Burial	Sex	Age	Tooth	$\delta^{13}C_{c\ VPDB}$	$\delta^{18}O_{p\ VSMOW}$	$\delta^{18}O_{cVPDB}$	$^{87}Sr/^{86}Sr$
5C	M	19–21	URP1	−1.22	+18.2	−4.22	0.7045
5F	M	35–39	ULP	−2.31	+17.5	−3.80	0.7075
14F	M	22–24	LLC	−1.96	+10.1	−4.82	0.7074
T5H:6	T	–	ULM3	−0.09	+15.4	−6.81	0.7059
T190F:1	T	–	ULC	−1.14	+14.9	−6.18	0.7054
T190F:5	T	–	URC	−4.43	+14.8	−0.37	0.7065

Table 4. Bone and enamel oxygen and strontium isotope ratios for individuals from Burial Unit 5 with retained deciduous canine teeth. C, canine; M, molar; P, premolar.

Individual	$\delta^{18}O_p$ ‰ Bone	Tooth	$\delta^{18}O_p$ ‰Enamel	$\delta^{18}O_c$ ‰Enamel	$^{87}Sr/^{86}Sr$
5C	+14.4	P	+18.2	−3.67	0.7045
5D	+15.2	M2	+17.2	−5.16	0.7057
5G	+14.5	C	+17.4	−4.83	0.7058
5H	+14.2	P	+14.9	–	0.7053

Oxygen Isotopes and Proveniencing

A second question involves the application of oxygen isotopes in the investigation of past human provenience. There are various concerns with contamination particularly in structural carbonate studies (Hedges et al. 1995; Lightfoot and O'Connell 2016; Sullivan and Krueger 1981). White et al. (2002) and Spence et al. (2004) have focused on phosphate oxygen isotope measurements to avoid the risk of isotopic alteration associated with structural carbonate. They also used a Crystallinity Index (CI; Shemesh 1990) as a test for *postmortem* recrystallization that might modify original $\delta^{18}O_{p\ (VSMOW)}$; the lack of correlation between $\delta^{18}O_p$ and CI suggested that such processes had not affected either teeth or bone from the Feathered Serpent Pyramid.

Comparison of $\delta^{18}O_{p\ (VSMOW)}$ and $\delta^{18}O_{c\ (VPDB)}$ in enamel bioapatite may provide some useful insights. Here we compare the oxygen isotope data for both sacrificial victims and trophy teeth (n = 37; Figure 11). The means and 1-σ for these two measures of oxygen isotope composition are + 15.9 ± 1.7‰ ($\delta^{18}O_{p\ (VSMOW)}$) and −4.9 ± 0.8‰ ($\delta^{18}O_{c\ (VPDB)}$), respectively. The distribution of phosphate compositions indicates at least two outliers.

Outliers are also apparent in a scatterplot of $\delta^{18}O_{c\ (VPDB)}$ versus $\delta^{18}O_{p\ (VSMOW)}$ (Figure 12). The three outliers to the left in the plot are distinguished by their lower $\delta^{18}O_{p\ (VSMOW)}$ values. All three of

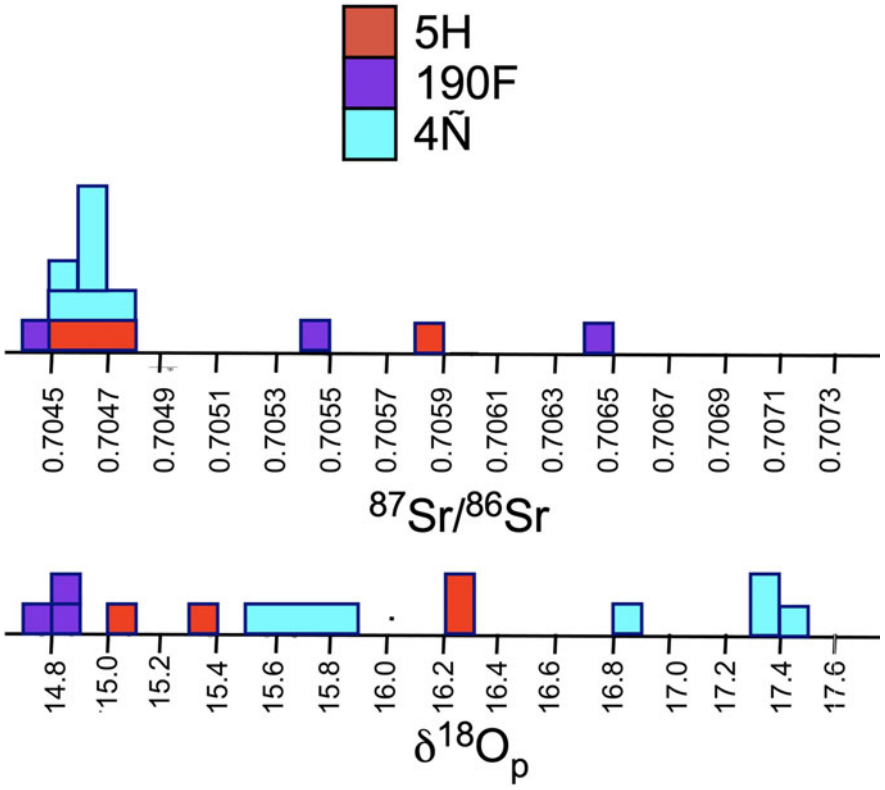

Figure 10. Histograms of $^{87}Sr/^{86}Sr$ and $\delta^{18}O_{p\ (VSMOW)}$ in trophy teeth by sacrificed individual. Image by Price.

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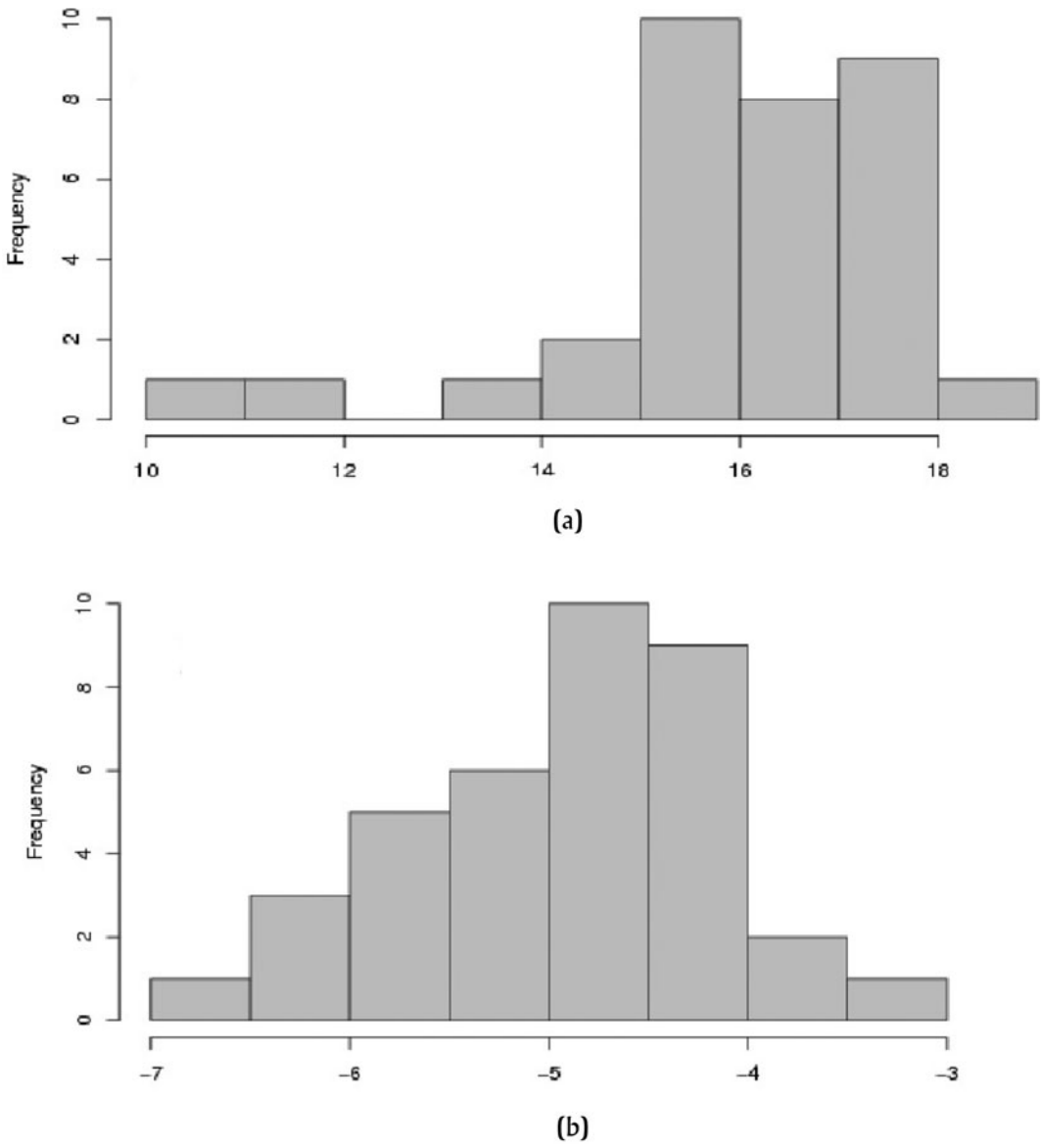

Figure 11. Histograms of $\delta^{18}O$ for (a) phosphate and (b) carbonate in tooth enamel from human remains at the Feathered Serpent Pyramid. Image by Price.

these individuals are sacrificial victims, two young soldiers and one young female. A Pearson's correlation coefficient for the two sets of values shows essentially no significant correlation among the values ($r = .0305$). Putting aside for the moment the $\delta^{18}O_{p\ (VSMOW)}$ values, the individual with the higher $\delta^{18}O_c$ might be considered to have grown up at some distance from Teotihuacan. Values of $\delta^{18}O_{c\ (VPDB)}$ for the other two outliers fall within the range of many of the individuals in the "local" cluster. Hence both of these individuals might have grown up in the "local" central highlands and moved to a lower elevation after early childhood.

Sample preparation techniques are sometimes indicted as responsible for introducing variation in the oxygen isotope composition of bioapatite, particularly structural carbonate (Grimes and Pelligrini 2013; Koch et al. 1997; Metcalfe et al. 2009; Pelligrini and Snoeck 2016). Breastfeeding practices, water sources and storage, and food preparation have also been suggested as causes of variation. In the present case, outlying $\delta^{18}O_{c\ (VPDB)}$ values could also have been affected by diagenesis. Carbonate is more vulnerable to diagenesis than phosphate, particularly in bone, but because of its tight crystalline structure, enamel is undoubtedly more resistant to alteration in both fractions (Hoppe et al. 2003; Lee-Thorp and Sponheimer 2003; Lee-Thorp and van der Merwe 1991; Sponheimer and Lee-Thorp 1999). In this case, however, it is three particularly low $\delta^{18}O_{p\ (VSMOW)}$ values that appear to be the greatest outliers.

Lightfoot and O'Connell (2016) caution against the indiscriminate use of oxygen isotopes for establishing provenience because of the large variation within a population. They argue that "identifying individuals' homelands on the basis of oxygen isotope analysis alone is not possible for the regions analyzed to date" and suggest that "in most cases pinpointing a specific homeland should not be attempted" (Lightfoot and O'Connell 2016:8). That said, foreigners can often be identified even if their actual homeland cannot be uniquely determined.

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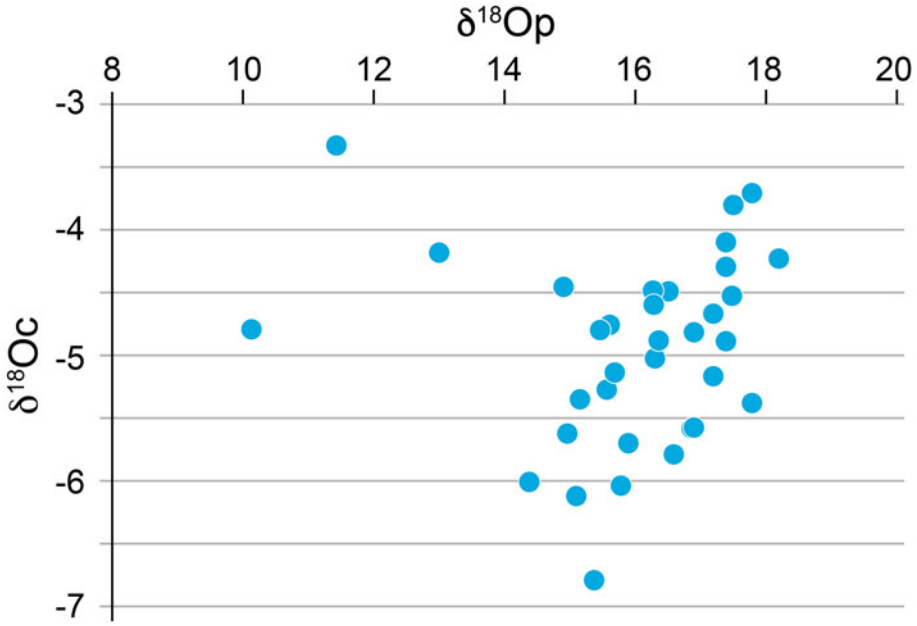

Figure 12. Scatterplot of $\delta^{18}O$ for structural carbonate versus phosphate in tooth enamel from human remains at the Feathered Serpent Pyramid. Image by Price.

There are certain areas of the world where $\delta^{18}O$ does provide much better geographic resolution. Those areas include regions with substantial variation in elevation such as the Himalayas, the Andes Mountains in South America, and parts of Mesoamerica. Specifically, Supplementary Figure 2, for example, provides convincing evidence that $\delta^{18}O_{c\ (VPDB)}$ varies across Mesoamerica among at least three different zones and can be used to distinguish individuals from those regions. Prerequisite to such applications, of course, is demonstrable evidence that primary bioapatite structural carbonate oxygen isotope compositions have been preserved.

CONCLUSIONS

The use of other isotopic indices in the investigation of the burials from the Feathered Serpent Pyramid at Teotihuacan has generally confirmed the results of the oxygen isotope study from some years ago, concluding that the individuals buried as "soldiers" came from a wide range of places, both near and far, and that, if these individuals were members of the military, then the group was of multiethnic origin. Bone values for both oxygen and strontium isotopes from other studies (Nado 2017; White et al. 2002) also indicate that most of the soldiers resided in Teotihuacan for years before their deaths, and so they were not foreign captives brought to Teotihuacan for the sacrifice. The Moon Pyramid sacrifices offer a clearer example of captives taken for sacrifice from other communities (White et al. 2007).

As González Sabrino (2017:95, Gráfica 1) points out, the age profile of the soldiers is markedly younger, as would be expected of soldiers, than that of an unbiased sample of Teotihuacan men. Also, the military nature of the soldiers is indicated by their costumes and accompaniments, which are typical of slightly later illustrations of the Teotihuacan military (Carballo 2007; Sugiyama 2005). Carballo (2007:189, 2011:49) notes that the mass production of weaponry under the auspices of the state in the Moon Pyramid precinct can be traced back to the Early Tlamimilolpa phase. Rubel (2009), in an analysis of musculoskeletal markers (MSMs) in 18 soldiers (burials 5 and 6), found only limited evidence for the use of spears or atlatl darts, the major elements of Teotihuacan weaponry. The MSMs for their use, however, were verified for six of the 18 soldiers, and those six tended to be older than the rest. It may simply be that the younger individuals (in their teens and early 20s) were more recent conscripts and had not been using the weapons long enough to develop notable MSMs.

González Sobrino (2017:126–128), Rubel (2009), and Spence (Michael W. Spence, personal observation) have all noted the scarcity of healed trauma among the Feathered Serpent Pyramid soldiers. Visible healed trauma, however, is the result of blunt force and the weaponry of the Teotihuacan military, and probably of other military forces in the central highlands, consisted of edged weapons (Carballo 2007). Sharp force trauma, once healed, leaves no trace. It thus seems likely that the soldiers of the Feathered Serpent Pyramid sacrifices were indeed members of the Teotihuacan military. The sacrifice of so many individuals and their apparent unwillingness suggest an additional possibility. They may have been rebels or from a rival faction in the military that the authorities wanted to suppress (Sugiyama 2005:226).

If the soldiers were members of the Teotihuacan military, then the trophy jaws were probably trophies taken in military campaigns. The age distribution of the trophies is broader and older than that of the soldiers, suggesting that they were not themselves soldiers but rather an unbiased harvest of adult civilians from their communities (Spence et al. 2004). The isotope data indicate that most had passed their childhood in the Teotihuacan region or nearby areas. There are no isotope measurements from bone to tell us where they lived in the years just before death.

With only four enamel samples from the females (burials 2 and 10) and from the "bureaucrats" (burial 14), conclusions about their origins are limited. About half have foreign strontium isotope values (Table 1). Oxygen isotope compositions from bone, indicating their residence in their last years, suggest that about half of the females,

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but none of the seven bureaucrats sampled, were Teotihuacan residents (White et al. 2002:Table 1).

In a broader view, as Spence and White (2009) and others (e.g., Knudson and Price 2007) have suggested, the use of several isotopic methods provides complementary information. White et al. (2007) employed strontium and oxygen in an examination of human and animal sacrifice in the Moon Pyramid at Teotihuacan. Knudson and Price (2007) and Lafoon et al. (2017) documented the utility of using multi-isotope approaches in the Andes and Caribbean, respectively. In the end, however, it is important to realize that there are large areas in Mesoamerica and many other places in the world that may have the same or similar isotopic signatures. We need a great deal more information before we can begin to detail fully human movement in the past. In this sense, Lightfoot and O'Connell (2016) are correct, in that defining a specific place of origin using oxygen isotopes or, for that matter, any single isotopic tracer is fraught with difficulties. That said, while isotopic proveniencing is still in its early days, the ability it offers to identify nonlocal individuals is a giant step in the study of the past.

RESUMEN

La investigación isotópica de los entierros de sacrificados y los trofeos debajo de la Pirámide de la Serpiente Emplumada (también conocido como el Templo de Quetzalcoatl) está continuando y actualmente ha producido nuevos resultados. Empleando el estroncio y el oxígeno en los carbonatos de esmalte dental, intentamos investigar el origen geográfico de los individuos con 39 muestras dentales, 23 de las víctimas sacrificadas y 16 de los trofeos maxilares. Las proporciones de los isótopos del estroncio y del oxígeno sugieren que la mayoría o todos de las víctimas sacrificadas procedieron del altiplano central de México, incluyendo el área de Teotihuacán. En este sentido hubo un poco menos multietnicidad en el ejercito teotihuacano que lo que pensábamos anteriormente. El análisis de las proporciones de los isótopos de carbono en los carbonatos de esmalte indica una dieta en la niñez dominada por maíz. Esta dieta fue más o menos homogénea entre las víctimas, y era típica de mucho de Mesoamérica prehispánica.

SUPPLEMENTARY MATERIAL

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