Postmarital Residence Patterns of Late Archaic Hunter-Gatherers from the Loma Sandia (41LK28) Mortuary Site, Live Oak County, Texas: An Analysis using $^{87}Sr/^{86}Sr$

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Introduction

Archaeologists researching hunter-gatherers in the Texas Coastal Plains (TCP) & Central Texas have noted differences between sexes in $\delta^{13}C$ and $\delta^{15}N$ studies. These differences maybe be due to patrilocality (Bousman & Quigg 2006; Mauldin et al 2013). This study utilizes strontium ratio isotopes (87Sr/86Sr) analysis to evaluate postmarital residence patterns in the TCP Late Archaic by comparing male and female 87Sr/86Sr from Loma Sandia (41LK28), a Late Archaic mortuary site in the TCP. If patrilocality is present, male Sr values will be similar to local Sr values, while female Sr values will be heterogenous by comparison.

Background

Increasing moisture and abundant resources during the Late Archaic (ca 4000-1200 BP) set the stage for population packing and circumscribed mobility in the TCP.

Exogamy may have served as a means to maintain social and trade networks during this time of increasing territoriality.

Ethnohistoric accounts by Álvar Núñez Cabeza de Vaca suggest that *patrilocal exogamy* and warfare were common practices during the Late Prehistoric II period (ca AD 1250-1700). These accounts suggest that exogamy was considered important to avoid incent and maintain and manipulate social interactions (de Vaca 1961).

This project utilizes $^{87}Sr/^{86}Sr$ analysis on a site dated to the later end of the Late Archaic, the period prior to the Late Prehistoric, to examine if the practice of patrilocal exogamy was also present during this period of increasing social complexity.

Study Site and TCP Geology

Loma Sandia (41LK28) is a large mortuary site dating from 2800 BP to 2600 BP located approximately 90 miles from the Gulf Coast in Live Oak County Texas.

Males and females of all age groups were buried at the site. Local and non-local grave goods were present with most non-local grave goods originating from the coast. Coastal goods were associated more with female burials (Taylor and Highley 1995).

The TCP is divided into three ecological zones: 1) the Coastal Zone; 2) the Riverine Zone; and 3) the Inland Zone **[Figure 1]**.

Hard and Katzenberg (2011) show that by 2500 BP, Coastal Zone inhabitants do not appear to have been exploiting Riverine Zone resources only 25km away suggesting an increase in circumscribed mobility in the TCP during the Late Archaic.

The TCP is geologically young but it is also very complex with geologic units that mix and overlap. The area around Loma Sandia is particularly mixed **[Figure 2]** but is primarily Oligocene. Pleistocene and Holocene deposits have the same $^{87}Sr/^{86}Sr$ distributions and are considered a single unit for this project.

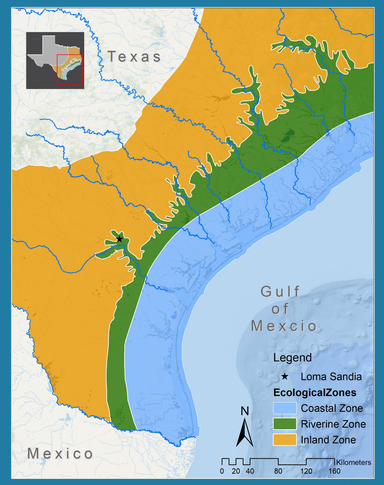


Figure 1: Ecological Zones of the Texas Coastal Plains and the location of Loma Sandia

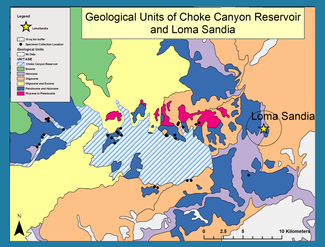


Figure 2: Mixed geological units of Loma Sandia and surrounding areas.

Analysis

Data was analyzed using IBM SPSS v.24.

Geologic groups were determined in a previous project. Outliers were determined by boxplots **[Figure 4]** and removed for this analysis. Human outliers are still important to identify and will discussed.

Not all data sample groups have normal distributions. Mann-Whitney-U tests were used to determine if $^{87}Sr/^{86}Sr$ distributions were the same across paired groups.

Middle Eocene and Paleocene/Eocene group values were not analyzed as they are distinctly different from all other groups.

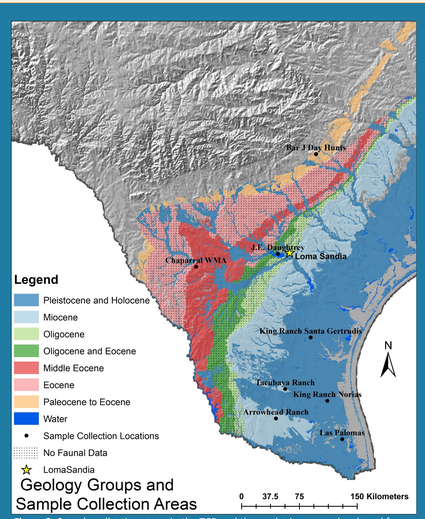


Figure 3: Sample collection areas in the TCP and the geologic groups developed from bioavailable $^{87}Sr/^{86}Sr$ data. J.E. Daughtrey is a mix of several zones that includes Pleistocene/ Holocene, Oligocene, & Oligocene and Eocene. These make up the 'local' $^{87}Sr/^{86}Sr$ data.

Acknowledgements: I would like to acknowledge the Texas Parks and Wildlife Department biologists and the private ranch owners for taking time out of their schedules to collecting sample for this project. I would also like to thank Raymond Mauldin at the Center for Archaeological Research, University of Texas at San Antonio and Ryan Mills at the University of North Carolina-Chapel Hill for their guidance in all lab preparation and processing. In addition, I would like to acknowledge Robert J. Hard and Raymond Mauldin for their support and guidance during this project. Finally, this project supported and funded by the National Science Foundation.

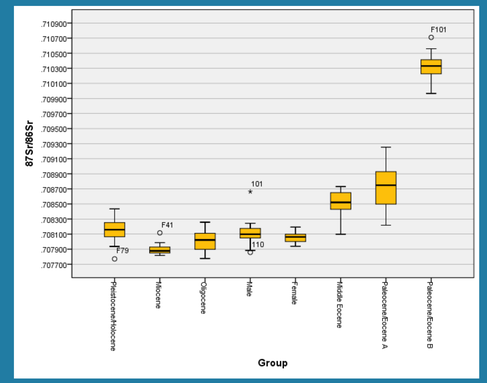


Figure 4 *(above):* Boxplot illustrating distribution of geologic groups and male/female data. Outliers were also determined by the boxplot and removed for Mann-Whitney U tests.

Table 1 *(below):* Results of Independent samples Mann-Whiney U tests. Middle Eocene and Paleocene/Eocene groups were not included as differences in distribution were apparent from the box plots.

Independent Samples Mann-Whitney U Test

H_0: The distribution of $^{87}Sr/^{86}Sr$ is the same across categories.

Group 1	Group 2	U	*p* (sig)	Decision
Male	Female	160	0.036	Reject H_0. It is fairly unlikely that the Sr distribution between males and females is the same.
Male	Pleistocene/Holocene (Coastal)	229	0.050	Retain H_0? It is slightly likely that the Sr distribution between males and Pleistocene/Holocene values is the same.
Male	Miocene (Riverine)	330	0.000	Reject H_0. It is extremly unlikely that the Sr distribution between males and Miocene values is the same.
Male	Oligocene (Local)	509.5	0.004	Reject H_0. It is very unlikely that the Sr distribution between males and Miocene values is the same.
Female	Pleistocene/Holocene (Coastal)	135	0.001	Reject H_0. It is extremly unlikely that the Sr distribution between females and Pleistocene/Holocene values is the same.
Female	Miocene (Riverine)	291	0.000	Reject H_0. It is extremly unlikely that the Sr distribution between females and Miocene values is the same.
Female	Oligocene (Local)	379	0.143	Retain H_0. It is likely that the Sr distribution between females and Oligocene values is the same.

The significance level is 0.050.

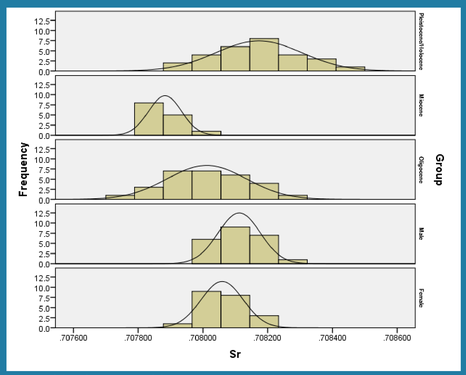
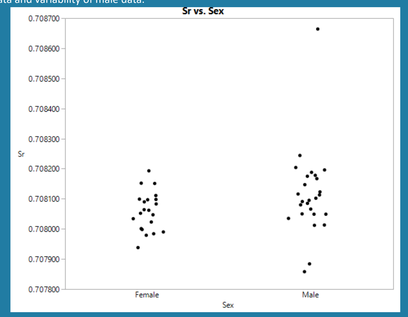


Figure 5 *(above):* Histogram of the groups analyzed (outliers removed).

Figure 6 *(below):* Comparison of female and male data illustrating tight clustering of female data and variability of male data.



Methods

Molar samples (N=103) were collected from a combination of deer, javelina, feral hog, and nilgai. Specimens were collected from Wildlife Management areas and private ranches. The $^{87}Sr/^{86}Sr$ data from these specimens was analyzed as part of a previous study and formed 5 main geologic bioavailable $^{87}Sr/^{86}Sr$ groups **[Figure 3]**.

Human tooth samples (N=54) from Loma Sandia were selected for destructive analysis with permission from the Texas Historical Commission and the Center for Archaeological Research (CAR), University of Texas at San Antonio. Seven of these samples were from children and not included in this study, leaving 26 male samples and 21 female samples. Bone preservation was too poor to compare with enamel samples, however Sr from teeth can be used to evaluate natal origins.

All samples were pre-processed at CAR in order to eliminate organic components and isolate the enamel apatite using a combination of procedures described by Garvie-Lok et al. (2004) and Price et al. (2000).

Ion chromatography and Thermal Ionization Mass Spectrometry was preformed at the University of North Carolina at Chapel Hill Isotope Geochemistry Laboratory, Department of Geosciences, under supervision of Dr. Ryan Mills and laboratory staff.

Disclaimers:
No animals were harmed for the purposes of this research. All faunal specimens were donated by hunters as part of their regular hunting activity or died of natural causes. All specimens were collected by TPWD wildlife biologists or on a private ranch by the researcher with permission of ranch owners.

This NSF funded project was completed with permission from the Texas Historical Commission and the Center for Archaeological Research, University of Texas at San Antonio, for destructive analysis of 54 enamel samples from 41LK28. At the time of this study, the remains of Loma Sandia were classified as unaffiliated according to the Native American Graves Protection and Repatriation Act.

Results

There is overlap between the groups examined **[Figures 4 & 5]**. However further analysis does show significant patterns.

The results of the Mann-Whitney U tests **[Table 1]** illustrate several points:

1. Males and females have slightly different $^{87}Sr/^{86}Sr$ distributions
2. Female $^{87}Sr/^{86}Sr$ values are similar to the Oligocene values.
3. A comparison of Male and Pleistocene/Holocene samples produced a *p* of exactly 0.050. This can be interpreted as slight evidence that Male values are somewhat similar in distribution to the Pleistocene/Holocene samples.
4. Neither male nor female samples had $^{87}Sr/^{86}Sr$ distributions similar to Miocene values.

Discussion

Human $^{87}Sr/^{86}Sr$ data overlaps with three geologic groups. Despite overlapping data, the distributions of the data between geologic groups is significantly different.

Human data was separated by sex and male/female distributions were compared with the three geologic groups they overlapped with.

Female data distribution were similar to the Oligocene data distributions. Since the Oligocene data is local, this suggests that most females were interred in the same region as their natal origins.

Male data distribution was most similar to the Pleistocene/ Holocene data distribution. The Pleistocene/Holocene data is within the Coastal Zone suggesting that at least some males originated from the Coastal Zone and were later interred at Loma Sandia.

A comparison of male and female data distributions **[Figure 6]** illustrates that the female data is tightly clustered and homogenous. The male data distribution shows more variability. The male data samples, unlike the female samples, also contained outliers.

Two of the male outlier samples have $^{87}Sr/^{86}Sr$ values that are lower than any of the female values. These two values are closer to Coastal Zone data.

One male sample is an extreme outlier. This outlier appears to be from one of the Inland Zone areas (Middle Eocene or Paleocene/Eocene 'A') **[Figure 4]**.

CONCLUSIONS

The data analysis strongly suggests that patrilocality was **not** practiced during the Late Archaic.

Instead, the data suggests that matrilocality was more likely. Due to the overlap of sample groups, ambilocality should also be considered a possibility.

If patrilocality was practiced in the later Late Prehistoric period, the shift in exogamy patterns between the two periods is further evidence of a socio-economical shift occurring shortly after the Late Archaic.

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