Title

The archaeology of Cueva Santa Rita: A late Holocene rockshelter in the Sierra de la Giganta of Baja California Sur, Mexico

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The archaeology of Cueva Santa Rita: A late Holocene rockshelter in the Sierra de la Giganta of Baja California Sur, Mexico.

By

Celeste Nicole Henrickson

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Committee in Charge:

Professor Steven M. Shackley, Chair
Professor Margaret Conkey
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Abstract

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This dissertation is a contribution to the scientific study of prehistory in Baja California Sur, Mexico. In 2008, test excavations at Cueva Santa Rita resulted in the recovery of a rich and diverse artifact assemblage. The large, dry rockshelter is located in the southern Sierra de la Giganta of Baja California Sur, Mexico. The shelter formed in the volcanic breccias of the Comondú Group, part of a larger volcanic arc and forearc basin formed during the Oligocene to Middle Miocene. Drawing from geoarchaeological methods and ethnohistoric accounts, I combine analysis of the both the cultural and non-cultural to discuss regional prehistory. Artifact analysis includes an examination of *Olivella* shell bead and textiles recovered during excavations. The findings of the project indicate that the site has been occupied for at least the late Holocene.

To my family

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Chapter 1: Introduction

This dissertation is a contribution to the scientific study of ancient history in Baja California Sur, Mexico. In Baja California, cultural dynamics at multiple spatial scales are poorly understood. For example, the lack of deeply stratified, multi-component sites makes the fine-grained analysis of artifact variations within and between sites difficult and often unfeasible. Additionally, even at well-preserved rockshelter sites that do have sufficient sediment accumulation, the stratigraphy is often shallow and "severely mixed" (Hyland 1997:201). This project focuses on cultural contact at a variety of scales. At the broadest level, this research set out to investigate the nature and degree of contact between indigenous groups within the peninsula (Chapter 2). However, such an examination begins at the site level and my intent was to construct a research design and analytical methodologies that would highlight the production of crafts at the local level. This is why the study of *Olivella* shell beads (Chapter 4) and textile technologies (Chapter 5) at Cueva Santa Rita have been paired with a critical examination of regional cultural traits. Additionally, given that a clear understanding of rockshelter sediments was likely to be elusive, yet critical for inter- and intrasite correlation, field study of sediments was extensive and is presented here (Chapter 3).

In 2008, test excavations in the permanently dry conditions within Cueva Santa Rita resulted in the recovery a rich and diverse assemblage. There are few archaeological sites in the North American continent that have the capability to elucidate the cultural repertoire of everyday hunter-gatherer life without relying on the realms of stone tool or pottery analyses. It is an odd circumstance that only in cases of outstanding preservation do archaeologists find such detail of the ordinary, where the commonplace becomes a source of giddy excitement. Drawing from geoarchaeological methods and ethnohistoric accounts, I combine analysis of both the cultural and non-cultural to discuss the prehistory at the rockshelter, Cueva Santa Rita.

Conceptual Issues Baja California Ancient History

The concept of peninsular isolation is deeply rooted in the study of Baja California prehistory. The cultural geography of the Baja California peninsula is often described using analogies like "cul-de-sac" (Massey 1966), "population trap" (Tuohy 1978), or "refuge" (Gonzalez-Jose et al. 2003). These phrases imply a cultural core rooted near the northern base of the peninsula and an increasingly marginalized or isolated periphery moving toward the southern tip. This imagery can influence our interpretations of the past (Horning 2007) and lead to simplified concepts of peninsular history, including the manner with which peninsular geography constrains emigration and the consequent flow of peoples into and within the region. Indeed, the geographic ruggedness of Baja California, which hampers access to many areas today, has facilitated its characterization as culturally marginal in the past and within modern research frameworks of North America (e.g., Aschmann 1967; Dalton 2005; Gonzalez-Jose et al. 2003; Massey 1966; Rogers 1945). Much of the discussion about marginality was reinforced by geographic patterns of cultural traits in the south of the peninsula, for example, the retention of atlatls (Laylander 2007), distinctive cave burials (Massey 1955), and notable absence of indigenous pottery (Massey 1966). Imagery of Baja California Sur cultural isolation is also exacerbated by missionary accounts expressing considerable isolation, fear, and remoteness living so far from mainland Mexico and Europe (e.g., Baegert 1952). A superficial reading of these accounts could allow one to conflate missionary experiences of isolation with historic cultural relationships between indigenous groups. It is from these accounts that Massey (1949) established the peninsular tribal and linguistic groupings that characterize Baja California prehistory and began to discuss the linguistic stratification of the peninsula as a representation of a socially and geographically forced marginalization of groups in the south.

The traditional model of Baja California prehistory is known as the "layer cake" model of prehistory and is based on linguistic, ethnological, and archaeological evidence. It has been developed and refined since the late 1930s (Kirchoff 1942; Kowta 1984; Massey 1961,1966; Rogers 1939, 1945; Tuohy 1976). The model proposes a temporal series of at least 3 waves of migration of peoples into the peninsula, where each successive migration penetrates less distance into the peninsula. In other words, the uppermost cultural layer is the most recent migration (California Yuman) and the lowermost layers (Pericú) are the earliest. Important assumptions in the model include the intra-group homogeneity and inter-group heterogeneity, increasing isolation to the south, and limited migration at the northern base. There are some problems with this model including the focus on the macroscale, the homogeneity of groups, and unidirectional movement from the north to the south (Laylander 2012; Panich and Porcayo 2012). Much archaeological research along the peninsula has focused on understanding these different groups relative to the far southwest and upper California.

Archaeologists rarely employ the layer cake model when considering peninsular prehistory. The layer cake model is a useful conceptual tool that simplifies population movement into the peninsula and sets up a conceptual space to test hypotheses. As Don Laylander (2012) states: "Useful as such a model may be as a first approximation, the real stories of the past are almost certainly going to be much more complex, more multidimensional, more regionally variegated, and more interesting." Significantly, much of the intellectual discussion is rooted in the complex nature of the relationship between human lifeways and a peninsular landscape. A peninsula is a unique landform in that it is surrounded on three sides by water. It is part island and part continent. As Fitzpatrick et al. (2008) have emphasized in island studies, it is important to combine the archaeological record with other lines of evidence to explore the complex history of both isolation and interaction and how they might effect change on societies.

Southern Peninsula Early Explorers and Ethnohistories

Group Relations at Contact

From north to south along the southern peninsula, the linguistic groups identified by missionaries and primarily discussed here are the Cochimí, Guaycura, and Pericú (Figure 1). It is likely that, at least for the latest Holocene, the archaeological record is associated with these linguistic groups (Hyland 1997: 73). To date, archaeological sites and historic accounts indicate these groups were small-scale, mobile foragers who existed within diverse ecosystems traversing extreme gradients from coast to coast (Aschmann 1967; Hugo and Exequiel 2007; Hyland 1997; Ritter 2006). At the time of contact, Pericú territory included the peninsula's southern cape, as well as the four islands of Espíritu Santo, La Partida, San José, and Cerralvo. Directly to the north of the tropical cape are the Guaycura who inhabited the southern Sierra de la Giganta and Magdalena coastal plain. To the north of the Guaycura are the Cochimian groups. Additionally, the Seri are sometimes discussed here, a group located beyond the peninsula on the west coast of mainland Mexico, who refer to themselves today as the Comcáac (Bowen 2000). Kroeber (1931:49) was the first to suggest that the Seri migrated from Baja California at some point in the past, an idea supported by statistical analyses (Chapter 2) and other studies of cultural traits (Bowen 1973, 1976:101; Tuohy 1979). Oral histories (Bowen 1976, 2000) and archaeological research (Bowen 1976; Foster 1984) suggest the Seri/Comáac had cultural contact during the historic period with peoples from the Baja California Peninsula.

Figure 1. Distribution of southern Baja California languages (Massey 1949) and landscape features.

Cultural Setting-The Guaycura Peoples

Jesuit Missionary accounts during the late 17th century report that the Guaycura peoples inhabited a belt of land in south-central Baja California. Little is known archaeologically or otherwise about their antecedents. For an as yet undetermined amount of time, the Guaycura were "sandwiched" between at least two (Cochimí and Pericú), possibly three (Uchiti), cultural and/or linguistic groups (Figure 1). In the central peninsula, groups were loosely organized into bands of 50-200 individuals composed of families averaging 5 people (Ritter 1979; Aschmann 1959). The Guaycura had considerable within-group diversity as evidenced by numerous dialects and endemic warfare (Baegert 1952: 150-156; Taraval 1931; Aviles and Hoover 1997). In 1949 Massey published a detailed map of southern Baja dialects and languages (Figure 1) based on mission and explorer documents. Although Massey (1961) states there is no clear way to delineate the linguistic arrangement of the southern Peninsula, he combines the Guaycura, Huchiti, and Pericú as part of a larger Guaycurian-speaking Family. [1] He contrasts the Yuman tribal groups with Guaycurian, arguing that due to cultural and geographical isolation, the groups below Loreto had more in common with each other, including language, sociopolitical organization, and "simplistic" material traits than they did with those to the north. A common complaint of missionaries was the large number of not only dialects, but also the large number of languages encountered in a relatively small geographic region (Baegert 1772).

> We would require only half of the time to attend to the spiritual needs of our charges, if they did not speck [speak] so many and such different languages which one missionary could learn with great difficulty. My Guaycuro Indians alone make use of four different dialects. The same is also true of other missions. As a matter of fact, it not rarely happens that in one household the husband speaks one language and the wife another. Our older missionaries attribute this linguistic diversity to the fact that new groups of natives repeatedly descended from the north bringing with them these different languages [Burrus 1984 (Hostell 1750):251].

Aviles and Hooper (1997) suggest that the richer environments of the Sierra de la Giganta facilitated larger social groups, loosely controlled by headmen, rather than the more mobile Cochimí groups to the north with smaller populations and a drier, sparser environment. In direct contrast, Massey (1949:304) described the Guaycura region as waterless and marginal, especially compared to the fishing and gathering economy of the Cape region. He considered their location defensive. Regardless of where or how many language and dialect boundaries are drawn, there are clearly a variety cultural interfaces occurring during the colonial period. These disparities in opinion highlight the fact that the extent to which a region or people are marginal or isolated is an

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[1] Note that Guaycura and Callejue are two dialects of the Guaycura language and the Guaycura language is one of three *Guaycurian* languages. In other words Guaycura is a dialect, a language, and the plural form of Guaycura is a family. The terminology is repetitive.

academic matter that requires empirical testing and, undoubtedly, a reconfiguration of perceptions on marginality. An important first step towards positioning Baja California within a wider North American prehistory is to understand the relationships between peninsular groups with respect to themselves and to their neighbors. It is only recently that knowledge of Baja California prehistory is beginning to accumulate so that sites in relative close proximity along the length and width of the peninsula can be examined and compared. The well-preserved artifacts within shelters in the peninsular range are an opportunity to combine multiple classes of artifacts to refine our understanding of interactions between and within groups.

Missionary accounts and archaeological data suggest considerable cultural heterogeneity between immediate groups within Baja California Sur (Laylander 2000). Relative to other regions in North America, sociocultural interactions among historic, indigenous groups from Baja California Sur are not well understood despite the presence of a variety of ethnohistorical accounts of the region dated from the 16th century onward. Several factors contribute to this situation, including: 1) the absence of widespread, well-dated archaeological sites; 2) disagreement between ethnohistoric accounts on the number of linguistic groups present and their associated territories (e.g., Barco 1981; Massey 1949); and 3) ethnohistoric accounts that confound linguistic with group affiliation (Massey 1949). Also, like many regions in North America, it is difficult to articulate prehistoric sites with historic indigenous populations. These problems have been compounded by the effects of disease vectors (Aschmann 1967; Cook 1937), forced missionary relocation programs (Jackson 1983, 1984), and the possibility of historical demographic shifts and geographic displacement of indigenous populations due to indigenous agency (Mathes 1975) [although the latter has been placed into question (c.f. Laylander 1997:16)]. A final confound to interpreting relationships between historic BCS indigenous populations is related to whether one examines their linguistic or material culture attributes.

Physical Setting

The Cueva Santa Rita archaeological site is located in the southern Sierra de la Giganta (Figure 1). The site is located in a narrow canyon above a first-order stream bed that feeds into the ephemeral Arroyo La Presa, also known as Arroyo Santa Rita, just to the west of the peninsular divide. The western slopes of the Sierra de la Giganta formed during the westward migration of a volcanic arc that produced at least three facies, collectively named the Comondú Group (Umhoefer et al. 2001). The narrow eastern escarpment is an impressive large-scale tectonic transition between the Peninsular Ranges and the Gulf Extensional Province, the bulk of the latter located under the Gulf of California waters. Cueva Santa Rita is located not far to the west of this boundary within the boulders and breccias of the Comondú Group. The topographic disruption of the southern Main Gulf Escarpment created a weak link in communication for the Jesuit missionaries between La Paz and Loreto, playing an important role in the Pericú and Guaycura uprising that began in 1734. The landscape feature continues to prohibit transportation today, diverting northbound traffic to the western side of the peninsula. Fortunately for anthropologists, this region continues to be relatively isolated, maintaining a rich population of ranchero peoples, many of whom are direct descendants of Spanish men that stayed after the Jesuit expulsion of 1767 A.D. (Macfarlan 2012).

South-central Baja California can be divided into several ecoregions (Figure 1). On the Pacific side is the Magdalena Lagoon Complex at Bahía de la Magdalena, an extremely diverse and productive biological zone located at the transition between temperate and tropical regions (Bizzarro 2008). It is the largest coastal wetland in the peninsula (Zárate-Ovando 2006). To the east, the Magdalena Plains slope gently toward the Sierra de la Giganta, also known as the "Giganta corridor". Although often lumped with either the Sonoran Desert or Cape Region fauna, the Sierra de la Giganta is potentially its own separate ecoregion; a compositional mix of the lowland Cape Region, desert mountains of the central peninsula, and Sonoran desertscrub of mainland Mexico (Léon de la Luz et al. 2008). Additionally, the rockshelter has a relatively high number of distinct plant communites within 30 km or less including vernal pools, mangrove swamps, an ephemeral lake, freshwater marsh, and oases. On the eastern side of the Giganta an abrupt drop in elevation leads to a narrow and erratic strip of land stretching from La Paz to Bahía de Los Angeles, part of the Sarcocaulescent Desert, which incorporates the numerous gulf islands between these latitudes (Wiggins 1980).

Environmental Change at CSR

Although no local Holocene climate research has been done in the Sierra de la Giganta, some research has been done in the Cape Region and at Bahía Magdalena. So far, climatic trends in Baja California Sur are similar to those found in the western Mexico coastal plains (Sirkin 1985). At the onset of human occupation at CSR, important large-scale paleoclimatic shifts are indicated in pollen cores from Baja California Sur, Mexico. Sirkin et al. (2004) analyzed pollen core samples from mangroves, lagoons, and upland wetlands and found that they have several things in common. They suggest a warm, dry trend lasted from 7,000 until between 3,000 to 4,000 years ago followed by a shift to wetter, subtropical conditions. Furthermore, the last 2,000 years have been more dynamic than the early and middle Holocene, with more frequent fluctuations between cooling and warming. Currently, Baja California is in a cooler period that began approximately 1,000 years ago. On the opposite coast from CSR, studies of dune fields in the Magdalenian Bay have several implications for human prehistory (Murillo de Nava and Gorsline 2000; Murillo de Nava et al. 1999). Large dune emplacements appear to indicate especially dry periods (14,000-8,000 BP), although dunes have been active throughout the Holocene. The Magdalena Lagoon Complex was fully developed around 5-6K yr ago, after sea-level stabilized. Although they were used to date dune events, radiocarbon dates on prehistoric shell middens suggest that people occupied the coast during maximum sea-level, before sea-level stabilization.

Rockshelters of the Central Peninsula

Geographically, Cueva Santa Rita is located in the southernmost extent of the central peninsula. Everything south of the Sierra de la Giganta is considered the southern region of the peninsula. Prehistoric rockshelter sites closest to Cueva Santa Rita are found near the town of Comondú in the northern Sierra de la Giganta. This region is geologically similar, but environmentally and, at the time of contact, linguistically different from the Cueva Santa Rita region. In addition, despite being part of the same mountain range, this northern Comondú region is included in the limits of the Central Desert and in the southern California Yuman linguistic groups (Massey 1949; Ritter 1979). William Massey began test excavations here in 1949 and returned in 1953 and 1954 to excavate 4 rockshelters. The detailed reports of these four sites are presented in Tuohy's 1979 dissertation. Together, the work of Tuohy and Massey defined what is referred to as the Comondú Complex of central Baja California, named after the town of Comondú, a logistical gateway for travel to rockshelters during fieldwork. The Comondú culture is defined primarily by a shared set of artifact traits. This includes a preference for square knot netting; the use overhand knots in joining cords, tying the ends of cords and in sandals; non-interlocking stitch coiled basketry; and stone pipes (Hyland 1997; Tuohy 1979). Tuohy's dissertation is primarily a detailed description of artifacts recovered, which is fortuitous since all collections housed outside of the Phoebe A. Hearst Museum at the University of California, Berkeley are missing. Unfortunately, this means the majority of the collection is likely gone. A significant portion of his dissertation also critically reviews peninsular models of population dynamics.

The Sierra de la Giganta are part of a geologic segment of a larger spine of mountain that run the length of the peninsula. To the north is the Sierra de San Francisco and above that is the Sierra San Borja. Clement Meighan (1966) first published on the cave paintings and artifacts found in the narrow canyons of the Sierra San Borja, near Santa Rosalia. The indigenous in this central region are known as the Cochimí. In this region, the latest Holocene artifacts are typical of the Comondú culture defined by Massey (1947). Meighan attributes the cave paintings of this region to the Comondú people, although this wasn't scientifically tested for another 30 years (see Hyland 1997). The significance Meighan's work lies in that it identified an impressive regional rock art style that was unlike anything in North or South America.

A bit farther south, yet still north of Cueva Santa Rita, the rockshelters in the Sierra de San Francisco's are best known for their rock art style most notable for their large scale and high placement, indicating a large labor investment. Justin Hyland's dissertation study in 1997 discussed the position of mural sites and settlement patterns at a regional scale. The lack of fresh water and shell middens on the Pacific coast and at inland sites in general led Hyland to suggest that a single population of people lived in the mountains with short-term occupation along the Pacific coast. The high number of milling tools from coast to coast indicates additional short-term logistical camps. Artifacts recovered from shelters under the Great Murals are diagnostic of the late prehistoric Comondú culture and include an abundance of late-summer/early-fall floral species, lending more credibility to ethnohistoric accounts of ceremonial activities, including painting, during these seasons. The distribution of 81 radiocarbon dates peak around 1300 BP and again between 1600 and 1700 A.D. One of the earliest dates came from cordage at 6999±60 and 86% of the dates postdate 1800 BP. North of the Sierra de la Giganta, much of the rockshelter research in central Baja California has a strong focus on rock art.

Study Site

Wider than it is deep, Cueva Santa Rita is technically a rockshelter, rather than a cave (Goldberg and Macphail 2006; Waters 1992). Rockshelters in the Cueva Santa Rita region form as the poorly-sorted beds erode at different rates (Goldberg and Mandel 2008). The rockshelter is 50 meters in length along the drip line and extends to a maximum depth of about 21 meters in its central portion (Figure 2). In June 2004, there was a large pot-hunters-pit in the central portion of the cave that measured several meters in diameter. Located adjacent to the looters pit, the topmost facies of the excavation trench is partly derived from the looters back dirt pile. With the permission of the Instituto Nacional de Antropología e Historia (Appendix I), archaeological excavations took place at Cueva Santa Rita (CSR) during the summer of 2008. Three 2X2 meter units were excavated in a discontinuous trench pattern, spaced 1 meter apart, in a line perpendicular to the cave entrance (Figure 1). In addition, three 1X1 meter units were excavated. All excavations maintained a 10cm arbitrary-within-stratigraphic strategy. A site datum was used to build a site grid and serve as a reference point for the horizontal and vertical measurement of artifacts using a simple field transit. All sediment was screened using 1/8-inch mesh screen. Each excavator took detailed notes. Features were excavated separately and photographed.

Preliminary analysis of remains indicate that the rockshelter provided shelter for general purpose activities including the processing of desert and oases resources such as lithics, reeds, cactus fruits, and agave for consumption and production of various artifacts such as cordage, beads, arrows, and stone and wood tools.

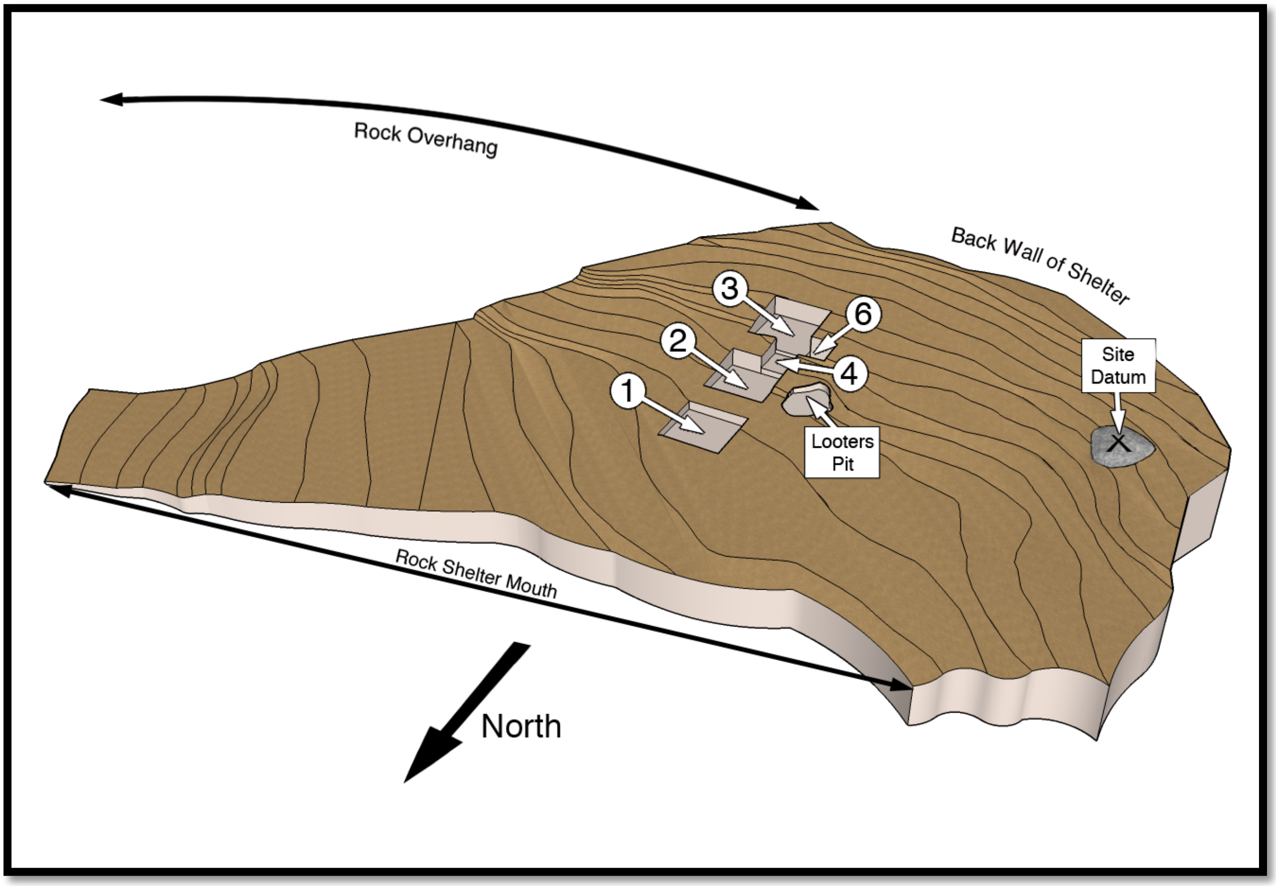

Figure 2. Topographic map of shelter floor. Unit 5 is under rock overhang, 50 meters east of the northeast corner of Unit 1. Contour interval is 5 cm. Units were aligned to magnetic north in 2008.

Organization of Study

This dissertation is organized into six chapters. This is a journal-format dissertation, consisting of four manuscripts designed to be published as journal articles. In Chapter Two, *Inferring Relationships Between Indigenous Baja California Sur and Seri/Comcáac Populations Through Cultural Traits*, I test assumptions about the relationships between groups in the southern peninsula and western Mexico through the examination of cultural traits gathered from historic documents. Two raters conducted a systematic analysis of content in ethnohistoric and early explorer accounts to derive presence/absence of traits that were then analyzed using inferential statistics. This research was carried out, presented at the *Society for American Archaeology* meetings, and published in the *Journal of California and Great Basin Anthropology*. I presented the paper as the first author for with my colleague, Shane Macfarlan. We switched positions for the publication and I became second author.

In Chapter Three, *Regional Landscape Geology, Raw Materials, and Site Stratigraphy at Cueva Santa Rita in South-Central Baja California Sur, Mexico*, I discuss peninsular tectonics and regional geology, highlighting their significance towards archaeological investigations. Research pertaining to the geology of central Baja California has been published in a wide range of literature. By integrating the research literature, I utilized it as a technique in the field for discovering different types of sites and understanding the depositional history at Cueva Santa Rita.

Chapter Four, Olivella *Shell Bead Production at Cueva Santa Rita in south-central Baja California Sur, Mexico: An Ethnohistoric and Archaeological Study of Manufacture and Significance*, is the first of two chapters that detail the results of artifact analyses. I describe and discuss *Olivella* shell bead artifacts recovered during excavations. I also discuss the shell bead manufacture process and previous bead research in the central peninsula.

In Chapter Five, *Prehistoric Textiles from Cueva Santa Rita, Baja California Sur, Mexico*, I describe the cordage technologies present at Cueva Santa Rita to develop a regional understanding of production style. I also discuss knots, netting, beaded cordage, plaiting, and matting.

In the final Chapter, *Conclusions*, I summarize the chapters and discuss their implications for future research.

References Cited

Aschmann, Homer

1959 The Central Desert of Baja California: demography and ecology. *Ibero-Americana* 42.

1967 *The Central Desert of Baja California: Demography and Ecology*. University of California Publications, Ibero-Americana No. 42.

Baegert, Johann J.

1952 [1772] *Observations in Lower California*. Translated from German by M.M. Brandenburg and C. L. Baumann. Berkeley: University of California Press.

Barco, Miguel del

1981 *Ethnology and Linguistics of Baja California*. Translated by F. Tiscareno. Baja California Travel Series 44. Los Angeles: Dawson's Book Shop.

Bowen, Thomas

1973 Seri basketry: A comparative view. The Kiva 38(3-4): 141-172.

1976 Seri Prehistory: The Archaeology of the Central Coast of Sonora, Mexico. *Anthropological Papers of the University of Arizona*, No. 27. Tuscon: University of Arizona.

2000 *Unknown Island: Seri Indians, Europeans, and San Esteban Island in the Gulf of California*. Albuquerque: University of New Mexico Press.

Dalton, R.

2005 Skeleton Keys. *Nature* 43:454-456.

Foster, J. W.

1984 A Late Period Seri Site from Bahía de los Angeles, Baja California. *Pacific Coast Archaeological Society Quarterly* 20(1): 61-68.

González-José, R., A. González-Martín, M. Hernández, H. M. Pucciarelli, M. Sardi, A. Rosales, and S. Van der Molen

2003 Craniometric Evidence for Palaeoamerican Survival in Baja California. *Nature* 425:62-65.

Hugo, Riemann, and Ezcurra Exequiel

2007 Endemic Regions of the Vascular Flora of the Peninsula of Baja California, Mexico. *Journal of Vegetative Science* 18: 327-336.

Hyland, Justin.R.

1997 *Image, Land, and Lineage: Hunter-Gatherer Archaeology in Central Baja California, Mexico*. Ph.D. dissertation. University of California, Berkeley.

Jackson, Robert H.

1983 Patterns of Demographic Change in the Missions of Southern Baja California. *Journal of California and Great Basin Anthropology* 5(1-2):131-139.

1984 Demographic Patterns in the Missions of Central Baja California. *Journal of California and Great Basin Anthropology.* 6(1):91-112.

Kroeber, Alfred L.

1931 The Seri. *Southwest Museum Papers 6.*

Laylander, Don

1997 The Linguistic Prehistory of Baja California. In *Contributions to the Linguistic Prehistory of Central and Baja California*, edited by G.S. Breschini and T. Haversat, pp. 1-94. Salinas, CA: Coyote Press.

2000 *Early Ethnography of the Californias, 1533-1825.* Salinas, CA: Coyote Press.

2007 Large Projectiles and the Cultural Distinction of Southern Baja California: A

Reexamination. *Pacific Coast Archaeological Society Quarterly* 39 (2&3):11-21.

2012 *Beyond the Layer Cake: Complexity in Baja California's Past.* Anthropologies: A collaborative online project. Accessed Feb. 4, 2013: http://www.anthropologiesproject.org/2012/11/beyond-layer-cake-complexity-in-baja.html

Macfarlan, Shane J.

2012 *Political Ecology of the Sierra de la Giganta Oases.* Anthropologies: A collaborative online project. Accessed Feb. 4, 2013: http://www.anthropologiesproject.org/2012/11/political-ecology-of-sierra-de-la.html

Massey, William C.

1947 Brief Report on Archaeological Investigations in Baja California. *Southwestern Journal of Anthropology* 3(4):344-359.

1949 Tribes and Languages of Baja California. *Southwestern Journal of Anthropology* 5(3):272-307.

1955 *Culture History in the Cape Region of Baja California, Mexico.* Ph.D. dissertation. University of California, Berkeley.

1961 The Survival of the Dart-Thrower on the Peninsula of Baja California. *Southwestern Journal of Anthropology* 17(1):81-93.

1966 Archaeology and Ethnohistory of Lower California. In *Ethnology of the Baja California Indians*, edited by M. Mathes, pp. 334-361. *Spanish Borderland Sourcebooks* 5. New York: Garland Publishing.

Mathes, Michael

1975 Some New Observations Relative to the Indigenous Inhabitants of La Paz, Baja California, Sur. *Journal of California Anthropology* 2(2):180-182.

Ritter, Eric W.

2006 South-Central Baja Caliornia. In *Prehistory of Baja California: Advances in the Archaeology of the Forgotten Peninsula* D. Laylander and J.D. Moore eds., pp. 24-41. Gainesville: University of Florida Press.

Rogers, Malcolm

1945 An Outline of Yuman Prehistory. *Southwestern Journal of Anthropology* 1: 167-198.

Tuohy, Donald

1970 The aboriginal containers of Baja California, Mexico: A search for origins. Tebiwa 13(2):41-51.

1978 *Cultural History in the Comondu Region, Baja California, Mexico: With Appendix on Metate Cave String and Twine Analysis by Carolyn M. Osborne*. Ph.D. dissertation. University of Nevada, Reno.

2. Inferring Relationships Between Indigenous Baja California Sur and Seri/Comcáac Populations Through Cultural Traits

> In general, simplicity and crudity of workmanship increases from north to south, attaining in Southern and Lower California the greatest degree of primitiveness, a condition which was undoubtedly due to the area being marginal to its ancestral hearth and farthest removed for many centuries from the points of ingress of foreign influence [Rogers 1945:168].

> If we are too quick to assume marginality from a reading of privileged documentary sources, or an emotional response to places which to us seem remote…we are in danger of destroying the history and lives of the people we purport to study [Horning 2007:374].

Missionary letters and reports are the most productive source of information for uncovering cultural relationships between Baja Californian groups (Aschmann 1986). These historic documents provide demographic, linguistic, and cultural trait information pertaining to specific indigenous groups. Of these, linguistic attributes overwhelming are preferred for reconstructing prehistoric relationships; however, multiple interpretations exist on the appropriate clustering of historic groups. Massey (1949, 1966) proposes the presence of two language families (Yuman and Guaicurian) decomposed into four linguistic groups (the Peninsular Group or Cochimí, Guaicura, Huchiti, and Pericú) (Figure 1). Gursky (1966) and Swadesh (1967) suggest Guaycura is best placed within the Hokan language stock, while Fernandez de Miranda (1967) and Campbell (1997) disagree. Kroeber (1931) considers Cochimí to be related to Yuman, but does not afford it full membership status, while Troike (1976) and Mixco (1978, 2006) suggest the Cochimí and Yuman were genetically related but should be considered two distinct families. Mixco (2006) advocates Guaycuran and Cochimian languages likely are not related. Regardless of how the linguistic relationships are characterized, a purely linguistic appraisal by no means provides definitive answers to the cultural relationships between populations, given that linguistically distinct groups are known to have considerable culture contact (e.g., northern California – Jordan and Shennan 2003; O'Neil 2008). The same documents used to construct linguistic relationships also can be used to construct cultural relationships between groups if one focuses analysis on cultural traits – that is, institutional structures that organize societies (e.g., marriage patterns, residence rules) or ethnic markers (arbitrary, visual expressions of group membership, thought to facilitate within-group social action) (Brown 2008). Following McElreath, Boyd, and Richerson (2003), ethnic markers such as adornments, dress, or hair-style allow people to indentify those individuals who share a common underlying normative framework for behavior and facilitates mutually beneficial interactions amongst themselves to the exclusion of others.

Treating historic documents as ethnologies can be problematic (Mathes 1981); however, these documents are the only firsthand accounts of historic groups from BCS. Missionaries and explorers lived amongst these indigenous groups from several days to upwards of 30 years. Combined, their reports represent over 250 years of direct evidence of past ecosystems, landscapes, and cultural behavior. The record, at times, describes in detail the cultural inventories of several distinct social and/or linguistic groups, such as the Pericú, Guaycura, Cora, and Cochimí (e.g., Baegert 1952; Barco 1981;

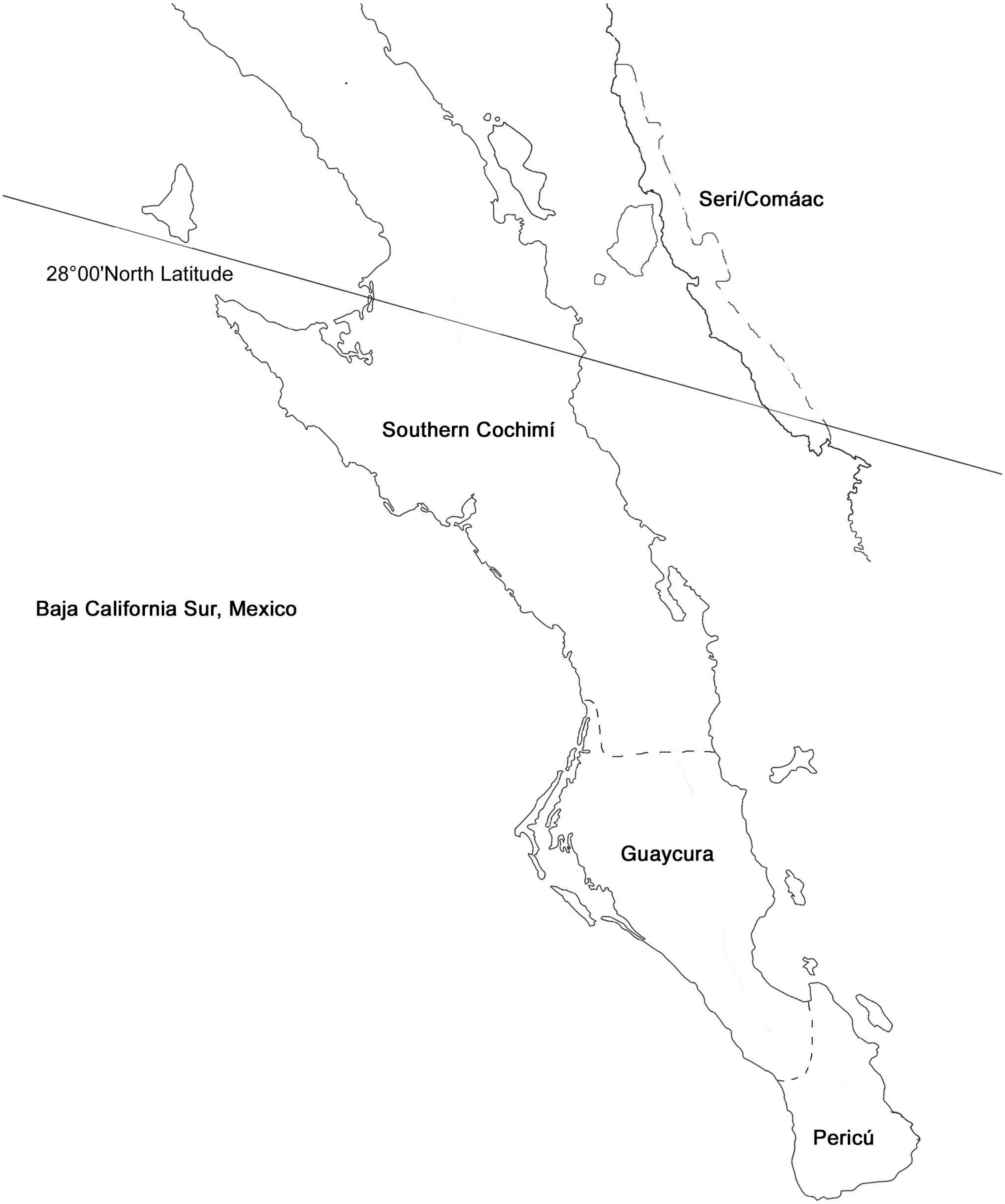

Figure 1. Cultural groups discussed in text.

Napolí 1970). Included in this inventory are ritual practices, watercraft technology, and the clothing styles and toolkits of men and women (for reviews see, Laylander 2000 or Mathes 2006). Archaeologists and ethnographers use this information to contextualize sites and case studies (e.g., Aschmann 1967, 1986; Bowen 1976, 2000; Kroeber 1931; Massey 1966). Recently, archaeologists (e.g., Laylander 1997, 2000) and historians (Mathes 2006) have compiled these cultural inventories into several fine works of scholarship (of which, the authors are indebted).

Although cultural traits have been used for reconstructing cultural relationships within Baja California (e.g., Massey 1947, 1966) and between Baja California to other cultural regions of North America (e.g., Kroeber 1931), none relied on the use of inferential statistics. For example, Massey (1947:346) suggested the Pericú and Cochimí were culturally dissimilar, while the Guaycura shared cultural features with both based on the distribution of a limited number of cultural elements, such as the presence/absence of reed boats, atlatls, fishing technology, and basketry. Although an expert on the ethnohistoric record and peoples of Baja California, Massey did not formally analyze the distribution of cultural trait data to test these relationships. As such, it can be taken at face value as the opinion of an expert and a proposition worthy of further empirical testing.

Kroeber (1931) constructed a distribution of cultural traits for the Guaycura, Cochimí, and to a lesser extent, the Pericú (as well as several other non-peninsular groups) based on the Jesuit missionary accounts of Johann Jacob Baegert, as well as research by Miguel Venegas and Francisco Xavier Clavijero (1789) to determine their relationship with the Seri/Comcáac. Kroeber tentatively suggested: 1) the Guaicura had greater cultural affinity to the Seri/Comcáac than did the Cochimí; and 2) the cultural groups of lower California as a whole were less culturally similar to Seri/Comcáac than the Gila Pima or Walapai-Havasupai. His analysis consisted of adding the number of traits each group shared with the Seri/Comcáac subtracted from the number of traits they did not share; however, he did not use the same cultural-trait distribution to measure all relationships. Instead, the number and kind of traits used to determine relationships differed for each pair-wise grouping with the Seri/Comcáac. As a result, there is no way to meaningfully interpret the nature and magnitude of the differences between groups as each was measured on a separate metric. When inferences of group similarity are based on the presence or absence of cultural traits and cultural traits are missing for some groups, both Type I (incorrectly identifying a difference exists between groups when none is present) and Type II (incorrectly identifying a similarity exists between groups when in fact they are different) errors are inflated, causing a distorted picture of relationships to emerge. Although a valiant first attempt, the paucity of data and the lack of statistical controls render any interpretation difficult. Bowen (1976:102) echoes similar concerns about the interpretation of Kroeber's data, but suggests the overall pattern is likely correct. Additionally, he suggested Kroeber's trait list be revised and expanded to discern relationships between BCS groups and the Seri/Comcáac. To our knowledge, no one has proceeded with this task.

Content analysis is a research methodology that can render the anecdotal nature of historical documents into systematic cultural trait distribution lists. Once constructed, cultural trait data allows hypotheses to be tested about macro-level social interactions between groups (Ryan and Bernard 2000). Reliability and hierarchical cluster analysis are then utilized to determine cultural relationships within BCS populations and between them to the Seri/Comcáac. Due to the dearth of theory and data for predicting relationships between cultural groups in southern BCS, our analysis largely is exploratory. Based on our analyses it appears: 1) the historic Guaycura and southern Cochimí were highly culturally similar; 2) the degree to which the Guaycura and southern Cochimí shared cultural traits was much greater than any other grouping; 3) the Seri/Comcáac form a distant but natural grouping with the Guaycura and southern Cochimí; and 4) the Pericú are culturally distinct.

Methods

This study applies classical content analysis (Ryan and Bernard 2000) to investigate relationships between three historical BCS cultural groups: the Pericú, Guaycura, and southern Cochimí; as well as the Seri/Comcáac of the Gulf of California and Sonora Mexico (Figure 1). Content analysis uses messages (e.g., texts), rather than behavior or artifacts, as the unit of study (Neuendorf 2002). Although content analysis consists of a range of techniques, the basic premise is the same; researchers convert qualitative texts into quantitative data, which can be used to test relational hypotheses (Ryan and Bernard 2000). Content analysis requires: 1) selecting texts for analysis; 2) defining the variables to be coded; 3) applying those codes systematically to a set of texts; 4) testing the reliability of coders when more than one is present; 5) creation of a unit-of-analysis-by-trait matrix from the texts and codes; and finally, 6) hypothesis testing using statistical methods (Bernard 2002). The traits examined include institutional structures and ethnic markers identified by historic explorers and Jesuit missionaries, as well as cultural anthropologists, archaeologists, and historians who have examined or translated these ethnohistoric documents.

There are multiple ways to derive lists of cultural traits. Archaeologists derive them from the material record; cultural anthropologists generally use ethnographies. Cross-cultural anthropologists commonly employ distribution lists of cultural traits to test relational hypothesis about the ecological, historical, or social correlates of human behavior (e.g., Barry and Schlegel 1980). There are drawbacks to this type research (also termed holocultural research). For example, culture trait lists generally are based on a few descriptive sentences about the presence or absence of a particular trait in a particular culture at one given time. Additionally, coding the presence or absence of a trait for a cultural group based on limited informants masks all of the variability that often exists *within* a culture (Hewlett and Macfarlan 2010), particularly age, gender, and status. Given these limitations, holocultural research can be useful for determining broad patterns between cultures.

Two reviewers derived a list of cultural traits based on four classes of source material: 1) translated historical documents related to explorations of Baja California spanning the period of A.D. 1539 – 1721 (Alarcón 1992; Atondo y Antillón and Kino 1992; Ascensión 1992; Cardona 1992; Cooke 1992; Lucenilla 1992; Nava 1992; Ortega 1992; Porter y Casanate 1992; Shevlocke 1992; Ulloa 1992a, 1992b; Vizcaíno 1992a, 1992b); 2) translated Jesuit missionary accounts of Baja California Sur groups spanning the period of A.D. 1683-1768 (Baegert 1952; Barco 1981; Burrus 1984; Nunis 1982); 3) Seri/Comáac ethnographic accounts (Bowen 2000; Felger and Moser 1991; Kroeber 1931; McGee 1898) and archaeological research (Bowen 1976); and 4) peer reviewed academic research pertaining to historic BCS (Aschmann 1967; Heizer and Massey 1953; Kroeber 1931; Laylander 2007; Massey 1947, 1949, 1961, 1966; Mathes 1992, 2006). As an initial exploration of a method with a time consuming research process, I chose not to include information from groups living north of the 28th parallel in the peninsula. The logic is this approximates the northern boundary of southern Cochimí language (Laylander 1997; Mixco 2006) and groups below this boundary had definite, documented contact with Europeans since A.D. 1539 (Mathes 1981). The Cora and Monqui are excluded because insufficient data existed for a separate trait analysis and their group and linguistic affiliation is ambiguous.

Assigning Traits to Groups

A list of 88 candidate cultural traits was derived from initial readings of Baegert (1952), Barco (1981), Burrus (1984), and Nunis (1982). These traits largely describe Guaycura and southern Cochimí culture, and to a lesser extent, the Pericú. Cultural traits pertaining to the Seri/Comcáac were easily derived as trained ethnographers and linguists have researched these groups since the pioneering work of McGee (1898). Pericú cultural traits were the most difficult to code due to a lack of data; however, historic explorer accounts spanning the period of A.D. 1537-1712 were vital for reconstruction. This process caused our final data set to be truncated to 51 cultural traits, grouped into five categories: 1) Male Headdress; 2) Female dress; 3) Religious practices/marriage; 4) Child Carrying Devices; and 5) Technology (Appendix II).

A presence/absence dichotomizing method was used to assign cultural traits to groups. To avoid sample bias, a trait was used only if sufficient information existed for all four groups. The rationale is, if an account identified a trait for one group with no information recorded concerning the other groups, marking an absence of this trait could inflate the similarity of the other groups when statistical analyses are run. Some traits were recorded as "not present" when an alternative version was present and the author made no claim about the trait's absence.

A two-tiered system was utilized to reconcile instances where accounts/reviewers differed on presence/absence of a trait. If a trait was suggested by one account to be absent, but another recorded its occurrence, the author who reported the presence was chosen. The rationale is it is easier to mistakenly attribute a trait's absence than its presence. Secondly, authority was deferred to accounts where the author spent a greater deal of time with a group than to authors who never visited the peninsula or visited briefly. The rationale is these authors should have greater cultural knowledge of the groups they discuss.

Results

Due to human error (e.g., incorrect reading of text or data coding), it is important to evaluate inter-coder agreement or reliability (Ryan and Bernard 2000). Reliability concerns whether a measuring procedure yields the same results on multiple trials (Carmine and Zeller 1982) and is evidence that a coded theme has some external validity (i.e., it is not a figment of the researchers imagination) (Ryan and Bernard 2000). As such, reliability analysis was used to determine accuracy between raters. Conventions in reliability analysis are varied; however, many authors agree coefficients greater than 0.7 are sufficient for exploratory research to perform subsequent analyses (Landis and Kosh 1977). High inter-rater agreement was achieved for traits assigned to the four cultural groups (Pericú: Cohen's $K=0.95$, $N=51$, $p<0.001$; Guaycura: Cohen's $K=0.8$, $N=51$, $p<0.001$; southern Cochimí: Cohen's $K=0.92$, $N=51$, $p<0.001$; Seri/Comcáac: Cohen's $K=0.92$, $N=51$, $p<0.001$). When disagreements occurred on a trait's proper coding, primary source material was reviewed and the appropriate scheme determined through consensus. Thus, the consensus building process eventually resulted in perfect agreement between raters for all traits for all four cultures.

Reliability and hierarchical cluster analyses were employed to determine data structure. Reliability analysis determines a set of items' internal consistency when measured with Cronbach's alpha (Vogt 2005). When items are cultural traits, reliability analysis determines the extent to which groups share a culture. High reliability coefficients (e.g., >0.7) indicate that groups share a common culture. Low reliability coefficients indicate groups are culturally distinct from one another. A low reliability coefficient was derived when all four cultural groups were examined simultaneously (Cronbach's $\alpha=0.40$; N=51). A second set of reliability analyses were run examining three cultures simultaneously, which revealed moderate to extremely low reliability coefficients (Guaycura-southern Cochimí-Seri: Cronbach's $\alpha=0.47$; N=51; Pericú-Guaycura-southern Cochimí: Cronbach's $\alpha=0.47$; N=51; Pericú-Guaycura-Seri: Cronbach's $\alpha=0.15$; N=51; Pericú-southern Cochimí-Seri: Cronbach's $\alpha=0.17$; N=51). A final set of reliability analyses examined pairs only. High internal reliability was reached for the Guaycura and southern Cochimí (Cronbach's $\alpha=0.77$; N=51); however, extremely low or negative reliability coefficients were derived for all other pair-wise groupings (Table 2). Negative reliability coefficients are indicative of small sample sizes or the evaluation of multiple constructs (Krus and Helmstadter 1993) – i.e. different cultures. Although the sample is moderately small, it appears multiple cultures were examined simultaneously. Given the high cultural trait agreement between southern Cochimí and Guaycura, the additional constructs being evaluated are the Pericú of the Cape Region and Seri/Comcáac cultures of mainland Mexico.

Table 2. Pair-wise reliability coefficients based on cultural traits

	Pericú	**Guaycura**	**Southern Cochimí**	**Seri**
Pericú	-	0.13	-0.09	0.24
Guaycura	-	-	0.77	-0.08
Cochimí	-	-	-	0.17
Seri	-	-	-	-

Due to the moderate reliability estimates for the Guaycura-southern Cochimí-Seri and Guaycura-southern Cochimí-Pericú groupings, further exploration is needed to determine whether deeper structures exist within the data. Researchers, including anthropologists (e.g., Maxwell et al. 2002), employ cluster analysis when a set of objects' natural classification is unknown and taxonomic order is desired (Aldenderfer and Blashfield 1984). Hierarchical cluster analysis is one clustering technique that places single entities into increasingly homogeneous groupings using an iterative process. Although standards vary, many agree hierarchical cluster analysis is a preferred clustering method for small sample sizes (e.g., <250 cases), with a minimum requirement of no less than 2^k cases (k=number of variables) (Dolnicar 2002). Hierarchical clustering requires a similarity metric to assess distances between groups and a link-function to hierarchically organize them. It is vital to have a justification for selecting one similarity metric and one link-function over others, as output is determined by these choices (Aldenderfer and Blashfield 1984). In this case a *Phi 4-point correlation* similarity metric and a *within-groups* link function were utilized. The *Phi 4-point correlation* procedure was selected over other binary data similarity measurements because of its ease of interpretability (it is equal to the Pearson product moment correlation coefficient for binary data) and it gives equal weight to the joint presence and absence of traits to calculate similarity. Because traits were selected where the joint absence of a trait was equally meaningful as their presence, this metric is more appropriate than those that exclude joint absences from computation (Aldenderfer and Blashfield 1984). The within-groups link function was selected because it was designed for the specific purpose of determining homogeneity within clusters by examining both inter- and intra-cluster pairs (Garson 2009). This resulted in two classifications: 1) the geographically adjacent southern Cochimí and Guaycura of the south-central peninsula form a distant yet single group with the Seri/Comcáac of mainland Mexico; while 2) the Pericú of the southern peninsular tip were isolated. Identical results were obtained using other similarity metrics (i.e., Lambda, Anderberg's D, and Yule's Q).

Discussion

The study was performed to systematize cultural trait information from ethnohistoric documents from BCS and to formally analyze cultural relationships between the Pericú, Guaycura, southern Cochimí and the Seri/Comcáac populations through inferential statistics. The former was accomplished through content analysis; the latter through reliability and hierarchical cluster analysis. Based on the traits identified, it appears: 1) the historic Guaycura and southern Cochimi share a similar culture; and 2) the Seri/Comcáac form a more natural grouping with the Guaycura and southern Cochimí than do the Pericú. Although largely exploratory in nature, the analyses confirm some assumptions about how certain historical BCS groups were culturally related to one another, while rejecting others. First, Massey's (1947) assumption that the Cochimi and the Pericú are culturally distinct from one another is confirmed. Secondly, the assumption that the Pericú are culturally distinct from nearly all groups is confirmed. On the other hand, Massey's (1947) assumption that the Guaycura are equally culturally similar to the Pericú as the Cochimi is rejected. In addition, Kroeber's (1931) interpretation that the Guaycura have greater cultural similarity to the Seri/Comcáac than the Pericú or Cochimi is also rejected. Results are discussed with reference to analytic limitations and historical processes.

Analytic Limitations

Several data-level and analysis related features require attention prior to a full consideration of the historical and cultural mechanisms affecting between group relationships. First, the intent was to create a sufficiently large cultural-trait list to test relationships between groups; however the list is not exhaustive. Documents that have not been translated were not analyzed, some historic documents are inaccessible because or their location (e.g., repositories), and archaeological investigations are ongoing. As such, it is likely additional traits will be identified in the future. When cluster analyses are run on small samples, like ours, cluster stability can become problematic. If new traits are identified and added to our list, it is possible the groupings uncovered will no longer be meaningful. Thus interpretations must proceed with caution.

Second, one may question the utility of the particular cultural traits identified. Many were based on observations from people with no ethnographic training. Additionally, sparse data exists for Pericú institutional elements (e.g., descent rules, marriage patterns); exactly those traits preferred for analysis by cross-cultural anthropologists (e.g., Barry and Schlegel 1980). However, many of the traits identified appear to be ethnic markers (e.g., style of hair and dress). These can be desirable data points because they are maximally arbitrary, thus when groups share these traits it represents some shared cultural schema for behavior (Brown 2008; Strauss and Quinn 1997).

Finally, the characterization of each cultural group is a composite picture formed by accounts spanning time, geographic locations, and levels of cultural contact with Europeans. As such, the trait list derived for each group is unique in some way. Traits identified for the Seri/Comcáac are derived from ethnographic source material spanning three locations (Isla Tiburon, Isla San Esteban, and Coastal Sonora) from the late 19th and early 20th centuries. Pericú and some Guaycuran traits were retrieved from historical accounts spanning early 16th to 18th centuries. For this paper, Jesuit missionary accounts provided many traits for the Guaycura and southern Cochimí, but proved more difficult for identifying traits for the Pericú (e.g., Napolí 1970). In general, these accounts are not as complete as those that exist north of the cape region. Consequently, one must ask whether the close associations found between the southern Cochimí and Guaycura, and their distances to the Pericú and Seri/Comcáac is simply a byproduct of the temporal period when traits were recorded. One can reasonably question, had Jesuit missionaries recorded as much cultural information for the Seri/Comcáac during the 17th-18th centuries A.D. as they did in the peninsula, would they appear more similar culturally to the Guaycura and southern Cochimí? Despite these limitations, this is the most complete picture derivable for these cultural groups at this time and the implications of these findings are directly assessed through several cultural processes, explained below.

Cultural Processes

This is the first study to formally evaluate the direction and magnitude of cultural similarities and differences within historical BCS cultures and between these groups to Seri/Comcáac populations through inferential statistics. The Guaycura and the southern Cochimí appear culturally homogeneous using a composite of cultural traits derived from historic accounts spanning the 16th through 18th centuries. They have more in common with themselves than they do the Pericú or the Seri/Commcáac. Although hierarchical cluster analysis suggests a natural grouping with the Seri/Comcáac, reliability coefficients suggest the Seri/comcáac and Pericú are virtually equidistant culturally from the southern Cochimí and Guaycura. This pattern could be the result of at least three processes: 1) the Guaycura and Cochimí descend from similar linguistic stock and shared historical trajectory, thus their cultures are more similar to each other than either to any other group; 2) their descent is ambiguous; however, the shared ecology and forager lifestyle has constrained cultural repertoires to occur in parallel without cultural contact; 3) their descent is ambiguous, but recent cultural diffusion has caused them to appear culturally homogenous.

The first candidate process seems unlikely given recent linguistic evidence suggesting Guaycura and Cochimi languages are not related genetically (Mixco 2006). Even if these groups shared a linguistic history, as suggested by Gursky (1966) and Swadesh (1967), it would likely be in the remote past as an extension of a larger Hokan language stock. This deep linguistic ancestry is unlikely to have produced the cultural similarities between the Guaycura and southern Cochimí during the historic period.

If the Guaycura and Cochimí do not share a common linguistic heritage, it is possible the shared desert environment and foraging economy caused their cultures to become similar through convergent mechanisms. This process has the additional benefit in that it explains why the Pericú and Seri/Comcáac are dissimilar to the Guaycura and southern Cochimí. The mixed marine/terrestrial foraging economy of the southern

Cochimí and Guaycura are distinct from the largely aquatic foraging economies and coastal habitat of the Seri/Comcáac (Bowen 2000) and Pericú. However, convergent processes are insufficient as they explain only ecologically salient traits.

The third process is plausible given the pattern of European and indigenous action on the Baja California peninsula during the historic period. Historic explorers prior to the missionary period were enlisted on several occasions by the Pericú to attack Guaycura peoples (Massey 1966; Ortega 1990). Indeed, many accounts explicitly state the Pericú and Guaycura were at war, possibly due to an incursion of Guaycuran peoples into the Cape Region of BCS for access to its preferential resource base (Massey 1966) at approximately A.D. 1670 (Mathes 1975) or earlier; however, Laylander (1997:16) disagrees with this interpretation. The low reliability coefficients derived for the Guaycura and Pericú indicate considerable cultural differentiation despite geographic proximity. Because ethnic markers signal in-group membership, warfare may have caused these groups to diversify along these dimensions. Guaycura peoples may have directed cultural contact with southern Cochimian groups in light of the Pericú's enlistment of European person- and fire-power to resist intrusion.

Interestingly, the Guaycura and southern Cochimí share all religious and female dress traits. This suggests females may have moved exogamously between groups, possibly sharing religious ideas and female attire. Three pieces of information provide tangential evidence to this phenomenon: 1) missionary reports suggest only Cochimí men could make basketry (Barco 1981); 2) there is no indication archaeologically (Massey 1966) or historically (Baegert 1952) the Guaycura made basketry; and 3) female shamans were present during the historic period for the Guaycura and possibly for the southern Cochimí (Baegert 1952; Massey 1966). Aschmann (1967) suggests the Cochimí were patrilocal. If males remain amongst natal kin throughout life, male traits are less likely to be shared between groups. As a consequence, male traits, such as Cochimian basketry construction, would not be shared with the Guaycura. Additionally, females are known to have performed religious functions for the Guaycura (Baegert 1952). If they moved exogamously between groups, one could expect the southern Cochimí and Guaycura to share religious elements and ethnic markers related to femininity. On face value this proposition is appealing; however, it will require archaeological data to bear out. It seems plausible convergent cultural evolution and diffusion processes could be working in tandem to produce these patterns.

Hierarchical cluster analysis revealed the Guaycura, southern Cochimí, and Seri/Comcáac form a more natural grouping with each other than any other hierarchical grouping with the Pericú. This suggests at least two processes: 1) the Guaycura, southern Cochimí, and Seri/Comcáac share a similar linguistic history, with the Seri/Comcáac very distantly related, while the Pericú are relatively culturally distinct; or 2) the southern Cochimí and Seri/Comcáac share a distant history, the Guaycura recently engaged in sustained contact with the southern Cochimí, while the Pericú are culturally distinct. The first process is unlikely given the limited linguistic evidence. Although evidence suggests the Cochimí, Seri/Comcáac, and Yuman groups share linguistic features distantly (Kroeber 1931; Mixco 1978, 2006), it is unlikely Guaycura is related (Mixco 2006). Even if Guaycura were related to Cochimí and Seri/Comcáac through a related Hokan language area, it would not explain the negative reliability coefficient between the Guaycura and Seri/Comcáac, unless selection pressures shaped cultural traditions in radically different, yet locally relevant ways.

The second process appears more useful. Some linguistic evidence supports Cochimí and Seri/Comcáac being distantly related (Kroeber 1931; Mixco 2006). Thus these groups might share an ancient history. Indeed, some interpretations of Seri/Comcáac oral history place their origins in central Baja California (Bowen 1976; Moser and White 1968). Additionally, Seri/Comcáac oral tradition (Bowen 2000:23-25) suggests contact with coastal, central Baja California peoples. Although our analysis suggests the Guaycura and Seri/Comcáac are culturally dissimilar, both share traits with the southern Cochimí. It seems possible the Seri/Comcáac share a distant history with southern Cochimí, but developed unique cultural features via innovation and/or drift mechanisms (Neiman 1995), while the Guaycura recently came into contact with the southern Cochimí.

Questions regarding relationships between Pericú and other Native American groups have been a part of archaeological discussion since the late 18th century (Massey 1947). The debate centers on whether the Pericú represent a remnant or separate population of early migrations into the New World (González-Jose et al. 2003) that remained isolated into historic times (Massey 1966) via a culturally marginalizing "peninsular effect". Our data suggests the Pericú were culturally distinct from the Guaycura and southern Cochimí during the period of historic contact. However, this does not speak to the antiquity of the Pericú, as cultural mechanisms can cause groups to diverge quickly, especially when population sizes are small (Neiman 1995). Contemporary academic use of the term marginality is relative and often used with no contextual reference to a core (cultural, political, economic, or geographic) (Turner and Young 2007). Our data does not address Pericú origins; however, if marginality is defined as distinct boundaries that exist between culture groups, it is likely a cultural boundary in conjunction with a phytogeographic boundary existed between Pericú and the Guaycura during the historic period that hampered contact, while a cultural boundary of such distinction did not exist for the Guaycura and southern Cochimí.

Conclusion

This paper builds on a program of research started by Kroeber (1931) and expanded upon by Massey (1947), Laylander (1997, 2000), and Mathes (2006), a program that involves deriving cultural traits from historic documents in order to infer group relationships both between cultures in historic BCS and with cultural groups outside the region. This paper's contribution lies in the fact that it has tested assumptions about cultural relationships between groups through inferential statistics rather than intuition alone. Cultural traits comprise an important set of evidence that can independently reinforce linguistic research in the investigation of inter-group contacts. Archaeologists and historians will play a vital role in creating larger, more meaningful cultural trait distributions for BCS indigenous populations. Articulating these datasets with information from cultural groups in the northern half of the peninsula, Southern Alta California, and mainland Mexico will be fundamental for reconstructing the prehistory of these regions. Constructing cultural trait distribution lists through written and material records, in conjunction with linguistic data, allows one to test hypotheses about cultural or ecological marginality and core/periphery relationships, rather than assuming their applicability to the Baja California peninsula.

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References Cited

Alarcón, F. de

1992 [1540] Relation of Fernando de Alarcón: May-September 1540 ([1600] 1904). Translated by R. Hakluyt. In *Ethnology of the Baja California Indians*, edited by M. Mathes, pp. 95-134. *Spanish Borderland Sourcebooks* 5. New York: Garland Publishing.

Aldenderfer, M. S., and R. K. Blashfield

1984 Cluster Analysis. *Quantitative Applications in the Social Sciences*, No 44. London: Sage Publications.

Atondo y Antillón, I. de, and E. F. Kino

1992 [1683] Accounts of Isidro de Atondo y Antillón and Eusebio Francisco Kino, S. J.: 1683 (1990). Translated by W.M. Mathes. In *Ethnology of the Baja California Indians*, edited by M. Mathes, pp. 273-277. *Spanish Borderland Sourcebooks* 5. New York: Garland Publishing.

Ascensión, A. de la

1992 [1602] Father Antonio de la Ascensión's Account of the Voyage of Sebastián Vizcaíno: 1602 (1929). Translated by H.R. Wagner. In *Ethnology of the Baja California Indians*, edited by M. Mathes, pp. 164-208. *Spanish Borderland Sourcebooks* 5. New York: Garland Publishing.

Aschmann, Homer

1967 *The Central Desert of Baja California: Demography and Ecology*. University of California Publications, Ibero-Americana No. 42.

1986 Learning about Baja California Indians. *Journal of California and Great Basin Anthropology* 8:238-245.

Baegert, Johann J.

1952 [1772] *Observations in Lower California*. Translated from German by M.M. Brandenburg and C. L. Baumann. Berkeley: University of California Press.

Barco, Miguel del

1981 *Ethnology and Linguistics of Baja California*. Translated by F. Tiscareno. Baja California Travel Series 44. Los Angeles: Dawson's Book Shop.

Barry, H. III, and A. Schlegel

1980 *Cross-Cultural Samples and Codes*. Pittsburgh: University of Pittsburgh Press.

Bernard, H. R.

2002 *Research Methods in Anthropology: Qualitative and Quantitative Approaches*. Walnut Creek: Altamira Press.

Bowen, T.

1976 Seri Prehistory: The Archaeology of the Central Coast of Sonora, Mexico. *Anthropological Papers of the University of Arizona*, No. 27. Tuscon: University of Arizona.

2000 *Unknown Island: Seri Indians, Europeans, and San Esteban Island in the Gulf of California*. Albuquerque: University of New Mexico Press.

Brown, M. J.

2008 When Culture Does Not Affect Behavior: The Structural Basis of Ethnic Identity. In *Explaining Culture Scientifically,* edited by M. J. Brown, pp. 162-183. Seattle: University of Washington Press.

Burrus, E. J.

1984 *Jesuit Relations, Baja California, 1716-1772*. Baja California Travel Series 47. Los Angeles: Dawson's Book Shop.

Campbell, L.
1997 *American Indian Languages: The Historical Linguistics of Native America*. New York: Oxford University Press.

Cardona, N. de
1992 [1615] Description of Nicolás de Cardona. Translated by W.M. Mathes. In *Ethnology of the Baja California Indians*, M. Mathes ed., pp. 209-220. *Spanish Borderland Sourcebooks* 5. New York: Garland Publishing.

Carmines, E.G., and R.A. Zeller
1982 *Reliability and Validity Assessment*. Beverly Hills: Sage.

Clavijero, F. J.
1789 *Storia della California*. Venice.

Cook, S. F.
1937 *The Extent and Significance of Disease among the Indians of Baja California from 1697 to 1773*. Berkeley: University of California.

Cooke, Edward
1992 [1712] Cabo San Lucas: November-December 1709 (1712). In *Ethnology of the Baja California Indians*, edited by M. Mathes, pp. 289-305. *Spanish Borderland Sourcebooks* 5. New York: Garland Publishing.

Dalton, R.
2005 Skeleton Keys. *Nature* 43:454-456.

DiPeso, C.C. and D.S.Matson
1965 The Seri Indian in 1692 as described by Adamo Gilg, S.J. *Arizona and the West* 7(1)33-56.

Dolnicar, S.
2002 A Review of Unquestioned Standards in Using Cluster Analysis for Data-Driven Market Segmentation. Paper read at the annual meeting of the Australian and New Zealand Marketing Academy. Deakin University, Melbourne.

Felger, R. S., and M. B. Moser
1991 *People of the Desert and Sea: Ethnobotany of the Seri Indians*. Tuscon: University of Arizona Press.

Fernandez, de M., M. Teresa
1967 Inventory of Classificatory Materials. In *Handbook of Middle Americans* 5, edited by R. Wauchope, pp. 63-78. Austin: University of Texas Press.

Foster, J. W.
1984 A Late Period Seri Site from Bahía de los Angeles, Baja California. *Pacific Coast Archaeological Society Quarterly* 20(1): 61-68.

Garson, G. D.
2009 *Cluster Analysis*. Electronic document, http://faculty.chass.ncsu.edu/garson/PA765/cluster.htm, accessed July 17, 2009.

González-José, R., A. González-Martín, M. Hernández, H. M. Pucciarelli, M. Sardi, A. Rosales, and S. Van der Molen.
2003 Craniometric Evidence for Palaeoamerican Survival in Baja California. *Nature* 425:62-65.

Gursky, K.-H.
1966 On the Historical Position of the Waikuri. *International Journal of American Linguistics* 32(1):41-45.

Hardy, L.R.W.H.

1977 (1829) *Travels in the Interior of Mexico in 1825, 1826, 1827, & 1828*. Facimile of the 1829 edition reprinted by The Rio Grand Press, Glorieta, New Mexico.

Heizer, R. F., and W. C. Massey

1953 Aboriginal Navigation off the Coasts of Upper and Baja California. *Bureau of American Ethnology Bulletin* 151:285-311.

Hewlett, B., and S. J. Macfarlan

2010 Fathers in Forager, Farmer, and Pastoral Cultures. In *The Role of the Father i Child Development*, 5th Edition, M.E. Lamb ed., Hoboken: John Wiley & Sons.

Horning, A.

2007 Materiality and Mutable Landscapes: Rethinking Seasonality and Marginality in Rural Ireland. *International Journal of Historical Archaeology* 11: 358-378.

Hugo, Riemann, and Ezcurra Exequiel

2007 Endemic Regions of the Vascular Flora of the Peninsula of Baja California, Mexico. *Journal of Vegetative Science* 18: 327-336.

Hyland, Justin.R.

1997 *Image, Land, and Lineage: Hunter-Gatherer Archaeology in Central Baja California, Mexico*. Ph.D. dissertation. University of California, Berkeley.

Jackson, Robert H.

1983 Patterns of Demographic Change in the Missions of Southern Baja California. *Journal of California and Great Basin Anthropology* 5(1-2):131-139.

1984 Demographic Patterns in the Missions of Central Baja California. *Journal of California and Great Basin Anthropology.* 6(1):91-112.

Jordan, P., and S. Shennan

2003 Cultural Transmission, Language, and Basketry Traditions amongst the California Indians. *Journal of Anthropological Archaeology* 22(1):42-74.

Kroeber, Alfred L.

1931 The Seri. *Southwest Museum Papers 6.*

Krus, D.J., and G.C. Helmstadter

1993 The Problem of Negative Reliabilities. *Educational and Psychological Measurement* 53: 643-650.

Landis, J. R., and G.G. Koch

1977 The Measurement of Observer Agreement for Categorical Data. *Biometrics* 33:159-174.

Laylander, Don

1997 The Linguistic Prehistory of Baja California. In *Contributions to the Linguistic Prehistory of Central and Baja California*, edited by G.S. Breschini and T. Haversat, pp. 1-94. Salinas, CA: Coyote Press.

2000 *Early Ethnography of the Californias, 1533-1825.* Salinas, CA: Coyote Press.

2007 Large Projectiles and the Cultural Distinction of Southern Baja California: A Reexamination. *Pacific Coast Archaeological Society Quarterly* 39 (2&3):11-21.

Lucenilla, de F.

1992 [1668] Relation of Francisco de Lucenilla: May-July 1668 (1966). Translated by W.M Mathes. In *Ethnology of the Baja California Indians*, edited by M. Mathes, pp. 254-272. *Spanish Borderland Sourcebooks* 5. New York: Garland Publishing.

Macfarlan, Shane J. and Celeste N. Henrickson

2010 Inferring Relationships Between Indigenous Baja California Sur and Seri/Comcáac Populations Through Cultural Traits. Journal of California and Great Basin Anthropology 30(1):51-67.

Massey, W.C.

1947 Brief Report on Archaeological Investigations in Baja California. *Southwestern Journal of Anthropology* 3(4):344-359.

1949 Tribes and Languages of Baja California. *Southwestern Journal of Anthropology* 5(3):272-307.

1955 *Culture History in the Cape Region of Baja California, Mexico.* Ph.D. dissertation. University of California, Berkeley.

1961 The Survival of the Dart-Thrower on the Peninsula of Baja California. *Southwestern Journal of Anthropology* 17(1):81-93.

1966 Archaeology and Ethnohistory of Lower California. In *Ethnology of the Baja California Indians*, edited by M. Mathes, pp. 334-361. *Spanish Borderland Sourcebooks* 5. New York: Garland Publishing.

Mathes, Michael

1974 *Californiana III: Documentos para la Historia de la Transormación Colonizadora de California, 1679-1686*. 3 vols. Colección Chimalistac 36-38. José Porrúa Turanzas, Madrid.

1975 Some New Observations Relative to the Indigenous Inhabitants of La Paz, Baja California, Sur. *Journal of California Anthropology* 2(2):180-182.

1981 Problems of Ethnohistorical Research in Baja California. *Journal of California and Great Basin Anthropology* 3(1):44-48.

1992 A Case of Idolatry Among the Cochimí (1974). In *Ethnology of the Baja California Indians*, edited by M. Mathes, pp. 278-288. *Spanish Borderland Sourcebooks* 5. New York: Garland Publishing.

2006 Ethnohistoric Evidence. In *Prehistory of Baja California: Advances in the Archaeology of the Forgotten Peninsula*, edited by D. Laylander and J.D. Moore, pp. 42-81. Gainesville: University of Florida Press

Maxwell, B. A., F.L. Pryor, and C. Smith

2002 Cluster Analysis in Cross-Cultural Research. *World Cultures* 13(1):22-38.

McGee, W.J.

1898 The Seri Indians. *Seventeenth Annual Report of the Bureau of American Ethnology*, Part I. Smithsonian Institution.

McElreath, R., R. Boyd, and J. Richerson

2003 Shared Norms and the Evolution of Ethnic Markers. *Current Anthropology* 44(1):122-129.

Mixco, M. J.

1978 Cochimí and Proto-Yuman: Lexical and Syntactic Evidence for a New Language Family in Lower California. *Anthropological Papers* No. 101: University of Utah.

2006 The Indigenous Languages. In *Prehistory of Baja California: Advances in the Archaeology of the Forgotten Peninsula*, edited by D. Laylander and J.D. Moore, pp. 24-41. Gainesville: University of Florida Press.

Moser, E., and R. S. White, Jr.

1968 Seri Clay Figurines. *The Kiva* 33(3):133-154.

Napolí, I.M.

1970 [1721] The Cora Indians of Baja California. Translated by J.R. Moriarty III and B.F. Smith. Los Angeles: Dawson's Book Shop.

Nava, D. de la

1992 [1632] Opinion Given by Licentiate Diego de al Nava: April-June 1632 (1975). Translated by W.M. Mathes. In *Ethnology of the Baja California Indians*, edited by M. Mathes, pp. 221-228. *Spanish Borderland Sourcebooks* 5. New York: Garland

Publishing.

Neiman, F. D.
1995 Stylistic Variation in Evolutionary Perspective: Inferences from Decorative Diversity and Interassemblage Distance in Illinois Woodland Ceramic Assemblages. *American Antiquity* 60(1):7-36.

Neuendorf, K.A.
2002 *The Content Analysis Guidebook*. Thousand Oaks: Sage Publications.

Nunis, D. B.
1982 *The Letters of Jacob Baegert 1749-1761: Jesuit Missionary in Baja California*. Translated by E. Schulz-Bischof. Los Angeles: Dawson's Book Shop.

O'Neil, S.
2008 *Cultural Contact and Linguistic Relativity Among the Indians of Northwest California*. Norman: University of Oklahoma Press.

Ortega, F. de
1992 [1634] Relations of Francisco de Ortega: 1633-1634 (1990). Translated by W.M. Mathes. In *Ethnology of the Baja California Indians*, edited by M. Mathes ed., pp. 229-244. *Spanish Borderland Sourcebooks* 5. New York: Garland Publishing.

Porter y Casanate, P.
1992 [1644] A Spanish Voyage to California in 1644: The Report of Pedro Porter y Casanate (1976). Translated by W. M. Mathes. In *Ethnology of the Baja California Indians*, edited by M. Mathes, pp. 245-272. *Spanish Borderland Sourcebooks* 5. New York: Garland Publishing.

Ritter, Eric W.
2006 South-Central Baja Caliornia. In *Prehistory of Baja California: Advances in the Archaeology of the Forgotten Peninsula* D. Laylander and J.D. Moore eds., pp. 24-41. Gainesville: University of Florida Press.

Ryan, G.W., and H.R. Bernard
2000 Data Management and Analysis Methods. In: *Handbook of Qualitative Research.* 2nd Edition N.K. Denzin and Y.S. Lincoln, eds., pp. 769-802. Thousand Oaks: Sage Publications.

Rogers, Malcolm
1945 An Outline of Yuman Prehistory. *Southwestern Journal of Anthropology* 1: 167-198.

Salvatierra, J.M.
1971 *Selected Letters about Lower California*. Translated by Ernest J. Burrus, S.J.

Strauss, C., and N. Quinn
1997 *A Cognitive Theory of Cultural Meaning*. Cambridge: Cambridge University Press.

Shelvocke, G.
1992 [1726] Cabo San Lucas: August 1721. In *Ethnology of the Baja California Indians*, edited by M. Mathes, pp. 306-333. *Spanish Borderland Sourcebooks* 5. New York: Garland Publishing.

Swadesh, M.
1967 Lexicostatistic Classification. In *Handbook of Middle American Indians* 5, edited by R. Wachope, pp. 79-115. Austin: University of Texas Press.

Troike, R. C.
1976 The Linguistic Classification of Cochimi. In *Hokan Studies*, edited by M. Langdon and S. Siulver, pp. 159-63. The Hague: Mouton.

Turner, S., and R. Young
2007 Concealed Communities: The People at the Margins. *International Journal of Historic Archaeology* 11:297-303.

Tuohy, D.

1978 *Cultural History in the Comondu Region, Baja California, Mexico: With Appendix on Metate Cave String and Twine Analysis by Carolyn M. Osborne*. Ph.D. dissertation. University of Nevada, Reno.

Ulloa, F. de

1992a [1600] Relation of Francisco de Ulloa: 1539([1600]1904). Translated by R. Hakluyt. In *Ethnology of the Baja California Indians*, edited by M. Mathes, pp. 2-74. *Spanish Borderland Sourcebooks* 5. New York: Garland Publishing.

1992b [1600] Voyage of Francisco de Ulloa: July 1539-May 1540 (1929). Translated by H.R. Wagner. In *Ethnology of the Baja California Indians*, edited by M. Mathes, pp. 75 94. *Spanish Borderland Sourcebooks* 5. New York: Garland Publishing.

Vizcaíno, S.

1992a [1596] Relation of Sebastián Vizcaíno: August-November 1596 (1990). Translated by M. Mathes. In *Ethnology of the Baja California Indians*, edited by M. Mathes, pp. 135-144. *Spanish Borderland Sourcebooks* 5. New York: Garland Publishing.

1992b [1602] Relation of Sebastián Vizcaíno: June-November 1602 (1990). Translated by M. Mathes. In *Ethnology of the Baja California Indians*, edited by M. Mathes, pp. 145-163. *Spanish Borderland Sourcebooks* 5. New York: Garland Publishing.

Vogt, W. P.

2005 *Dictionary of Statistics and Methodology: A Nontechnical Guide for the Social Sciences*. Thousand Oaks: Sage Publications.

Chapter 3: Regional Landscape Geology, Raw Materials, and Site Stratigraphy at Cueva Santa Rita in South-Central Baja California Sur, Mexico.

Introduction

This study frames local geology and tectonics in an archaeological context, presenting specific sites within these landscapes of archaeological significance. The objectives of fieldwork were to develop and establish protocols for excavation and sampling at rockshelter sites in the Sierra de la Giganta. This research is important for several reasons. First, regional geology is presented as a technique for locating specific kinds of archaeological sites, such as quarries and rockshelters. Second, test excavations outline a methodology for the stratigraphic excavation of rockshelters in Baja California Sur. Lastly, it significantly adds to the scanty research on rockshelters of the geographically extensive Comondú Group, particularly the nature of rockshelter stratigraphy.

Geologic Setting

Tectonics have played an active role in the evolution of large-scale features of the peninsular landscape. The complexity of geologic history in Northwest Mexico is related to its location at the intersection of larger plate tectonic systems including the North American and Pacific Plates, the East Pacific Rise, the San Andreas Fault System, and the Basin and Range Province. This chapter will focus on the geologic setting of Baja California Sur, Mexico. Landscape formation in Baja California is typically divided into stages (Hausback 1984; Umhoefer 2001). In sequential order, five stages are discussed here: 1) basement formation, 2) subduction, 3) proto-Gulf transform faulting, 4) rifting, and 5) post-subduction volcanism. Each stage will be briefly described below and their relevance to archaeological investigations is discussed in more detail.

1. Basement Formation: Cape Region

The oldest rocks in Baja California Sur are pre-Tertiary batholith basement rocks (Figure 1) (Gastil et al. 1979). They are sparsely located on islands and coastlines on both sides of the Peninsula (e.g. Magdalena Island), but dominate the Cape region. The granitic exposures are dated between 70 and 115 million years ago (Umhoefer et al. 2001). In contrast, in the northern state of Baja California, igneous intrusive bedrock is more common than all other types of bedrock (Davis 2006). When driving the northern peninsula, the Cataviña Boulder Field is a striking example of plutonic basement exposure (Figure 2). The difference in bedrock geology between northern and southern Baja California has important implications for archaeology, in particular, raw material availability and site formation processes (Davis 2006).

2. Subduction: Peninsular Ranges

Separated by a distinct unconformity, volcanogenic facies of the Comondú Group overly the basement rocks. Following Hausback (1984) and Umhoefer et al. (2001), during the Late Oligocene-Early Miocene, Baja California was still attached to mainland Mexico, resting in a shallow marine setting west of the dominantly peralkaline Sierra Madre Occidental. At this time, the Farallón plate was subducting under the North American continental crust producing calc-alkaline volcanism east of the Sierra Madre Occidental. This period of mountain building began ~34 million years ago and was

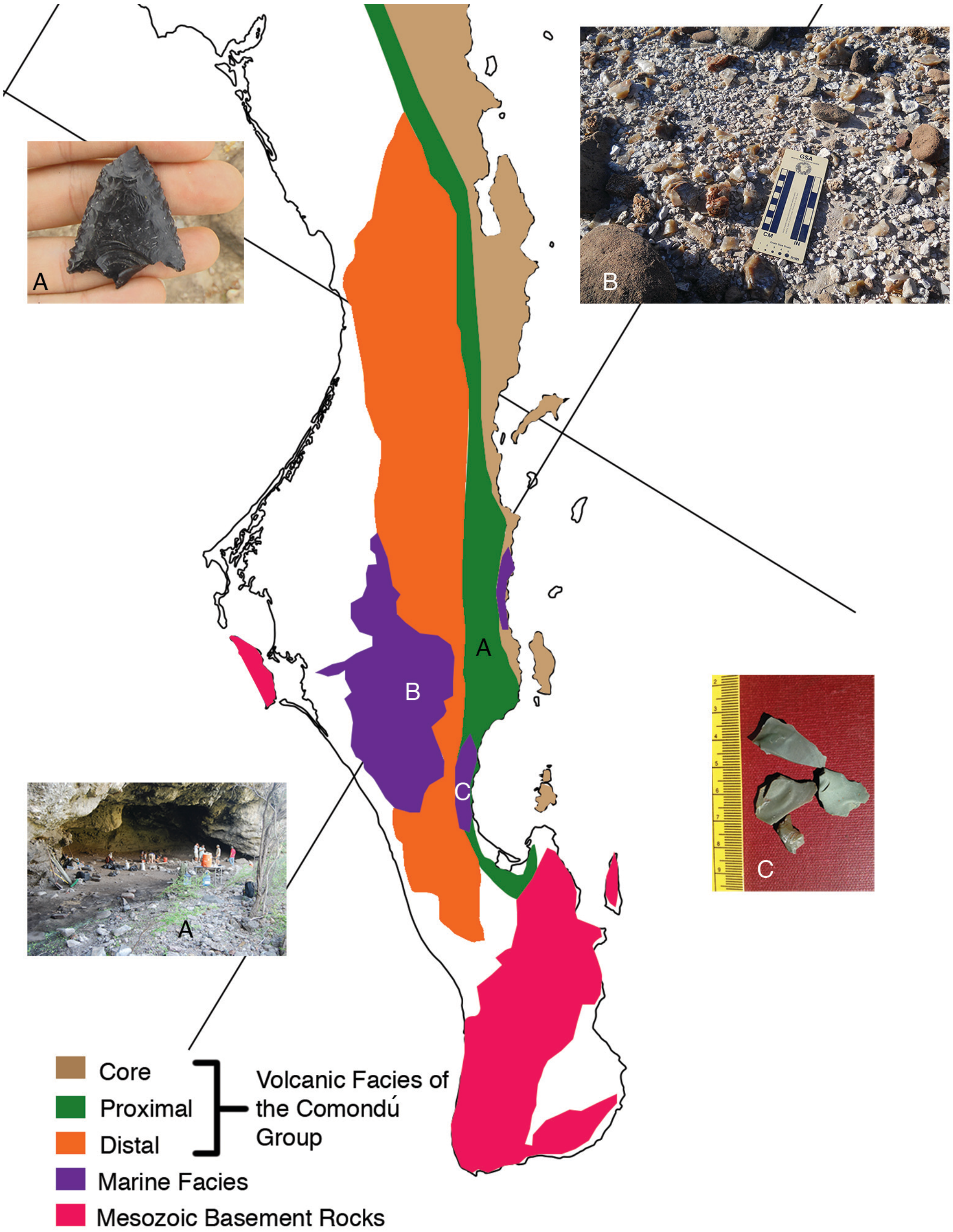

Figure 1. Location of rock units discussed in text. Letters on photographs correspond to locations of letters on map. (a) Lower picture shows the Cueva Santa Rita bedrock, upper picture is the obsidian projectile point found during field survey, tentatively sourced to Valle del Azufre; (b) Chert quarry site. Chert visible as the lighter-colored ground cover; (c) Lithics from a dominantly green chert quarry site near San Juan de la Costa.

Figure 2. Cataviña Boulder Field. Cataviña, Baja California, Mexico

mobile, migrating westward over time, first building the Sierra Madre Occidental then, as the Baja platform was uplifted, portions of the eastern peninsula (Atwater 1989; Lonsdale 1991; Stock and Lee 1994). Westward migration of the volcanic arc came to rest and ceased in the Loreto region around 12 million years ago (Umhoefer 2001). West of the volcanic front, when the peninsula rested underwater, until the peninsula was uplifted to its current position, more than 4,000 m of marine and volcanic sediments were deposited (Alatorre 1988). Today in the deserts of Baja California Sur, evidence for these events are recorded in the marine Formation such as Tepetate, El Cien, Monterrey, Isidro, and Salada and Formations of the Comondú Group. Both the marine and volcanogenic facies are important to archaeological research.

Marine Facies of the Peninsular Ranges

Marine facies typically crop out at lower elevations on the flanks of the Sierra de la Giganta (Figure 1). Unfortunately nomenclature for these Late Oligocene-Early Miocene units can be confusing (Dorsey and Umhoefer 2000; Umhoefer 2001). Some units have several names and others were at one time identified as the same units (Beal 1948), but have since been distinguished as different and sometimes concurrent marine deposition (Lozano-Romen 1975).

Several archaeologically relevant chert sources have formed in the marine facies of the peninsular ranges (Figure 1b and 1c). Following Luedtke (1992), chert is a sedimentary rock composed primarily of microcrystalline quartz, including flint, chert, chalcedony, and jasper. Several high-quality chert locations were found while surveying. Although they were found on both sides of the Sierra de la Giganta, all three are located in the marine outcrops described below. More research needs to be done to determine how many chert types exist. Due to the complexity and variability of chert formation, even within the same chert type, adequate characterization is necessary to be useful to provenance studies (Shackley 2008). The marine formations relevant to provenance studies are the Tepetate and El Cien, described below.

Heim (1922) was the first geologist to identify the Tepetate formation. It was deposited during a relatively long time period of fluctuating sea levels. In a well-defined section of the Tepetate Formation, Carreño et al. (2000) suggests that microfossils found at Arroyo Colorado (24°23'17.7"N; 111°07'53.2"W) survived in shallow marine environment between low tide and the continental shelf. At Arroyo Colorado, Carreño et al. (2000) dated the section as Late Eocene (51.2-48.4 million years ago) although others have found earlier dates of Early Eocene age from other localities (Knappe 1974). The formation crops up in various locations and unconformably underlies the El Cien Formation and the Comondú Group (Carreño et al. 2000). At least one prehistoric chert quarry has been located in the Tepetate formation (Figure 1b).

Following Applegate (1986), the El Cien (San Gregario) formation is purely marine and is characterized as shales, tuffs, limestones, sandstones, and conglomerate beds ranging in color from white to tan and green to brown. The formation is found around the town of El Cien and to the east. As is standard for a formation, it is bounded by unconformities: the Tepetate formation lies below and the Comondú Group above. From youngest to oldest the three members of this formation are: Cerro Colorado, San Hilario, and Cerro Tierra Blanca. The El Cien formation contains important strata for archaeological work in the Baja California peninsula. Applegate (1986) collected over 40 species of fossil shark teeth from two locations, one at the base of the Cerro Tierra Blanca member and the other from top of the phosphate layer in the San Hilario member. A single shark's tooth was found during excavations (Figure 3). Shark's teeth have been found associated with elevated status individuals in the Cape Region and at El Conchalito, east of La Paz. In the Cape Region they have been found inset into one end of elaborately crafted flat, wooden artifacts and are associated with secondary, red-ochre painted, bundle burials (Brown and Raab 2003; Massey 1947). At El Conchalito the shark's teeth were found as adornments on a cranium (Dahl and Barba 2003) and buried with an individual in an elaborate primary burial (Rosales-López et al. 2003). The El Cien Formation is one possible geologic source for fossil teeth. Fossil shark's teeth are also sometimes found at the mines in San Juan de la Costa near the north end of Bahía de La Paz (Romero, Pablo, personal communication 2008).

Figure 3. Fossil Shark's Tooth found at Cueva Santa Rita. Lingual and Labial view.

Volcanogenic Facies

The westward migration of the volcanic arc produced at least 3 facies in Baja California Sur. These have been informally described as the three Formations of the Comondú Group (Figure 1) (Umhoefer et al. 2001). Field studies of the Comondú Group have focused on the Loreto region and regions to the north (Hausback 1984; Umhoefer et al. 2001; Vessel and Davies 1981). The Cueva Santa Rita archaeological site is located in the Sierra de la Giganta, or the southernmost extent of the Comondú Group. Generalized maps of the facies belts place CSR in the *proximal volcanic belt* or *middle breccia and lava flow unit* deposited around 19 Ma (Umhoefer et al. 2001). Umhoefer et al. (2001:136) describe this unit:

> Volcanic breccia is the most common lithology in the Comondú Group in the Loreto area. The breccias are light gray, purple-gray, and tan, thick bedded to massive, poorly sorted, matrix-supported (~60% matrix, ~40% clasts), and contain clasts that range in size from mm to 2m. Rarely lcasts are up to 2-4m in diameter. Clasts include andesite, dacite, andesite porphyry, and minor rhyolite and sandstone. Clasts are generally subangular, although large clasts (>60cm) are typically subrounded. Matrix of the breccia is a fine- to coarse-grained mixture of ash and sand. The matrix is lithic-rich and contains abundant amphibole crystals and crystal fragments and less common quartz and plagioclase crystal fragments. Bedding in the breccia is thick to massive, typically ~1-5m, and commonly unstratified. Bedding is typically defined by uncommon thin to lenticular sandstone beds, by slight changes in color, and by crude alignment of large clasts.

3. Gulf Extensional Province: Proto-gulf Transform Faulting and 4. Sea-Floor Spreading

A major transformation in plate tectonics took place when subduction ceased and transform faulting began. This tectonic transition is visually apparent on the peninsular landscape. One of the most striking landscape features in the Santa Rita region is the hanging wall of the Main Gulf Escarpment, which marks the boundary between the western edge of the Gulf Extensional Province and the Sierra de la Giganta range. The drive to Los Burros from Cueva Santa Rita, straight down the Main Gulf Escarpment (Figure 4), exposes hundreds of meters of the Comondú Group. The detachment of the peninsula from mainland Mexico involved two extensional events, a protogulf extension followed by onset of sea-floor spreading. At this time, details of the extensional period of the peninsular geologic history are not clear-cut (Lee et al. 1996; Umhoefer 2001), but researchers generally agree that from ~12-6 million years ago, a period of proto-Gulf east to east-northeast extension ensued, creating the Gulf Extensional Province (Fletcher 2007; Gastil et al. 1979; Hausback 1984; Stock and Hodges 1989; Henry and Aranda-Gomez 2000). After 6 million years ago, transform rifting began and the modern Pacific-North American plate boundary developed (Lizarralde et al. 2007).

5. Post-subduction Volcanism

The last stage in southern peninsular landscape formation discussed here is post-subduction volcanism. With the end of subduction came a progressive change in volcanic geochemistry (Bigioggero et al. 1995; Calmus et al. 2003; Castillo 2008). West of the Main Gulf Escarpment post-subduction is dominated by subalkaline magmas (Hausback 1984; Sawlan and Smith 1984; Sawlan 1991; Umhoefer 2001). East of the Main Gulf Escarpment is an entirely different suite of medium-K calc-alkaline volcanics, erupting in the Pliocene and Quaternary (Bigioggero 1995; Sawlan 1991). In Baja California Sur, there are three localities of these calc-alkaline volcanics: Tres Virgenes Volcanic Complex, Cerro Mencenares Volcanic Center, and Isla Coronado. Volcanics east of the Main Gulf Escarpment have produced the only known artifact quality obsidian sources in Baja California Sur. Within the Tres Virgenes Complex, the Valle del Azufre source is an exceptional prehistoric quarry, largely due to intensive exploitation, including an adit and subsurface trenches (Shackley 2013; Shackley et al. 1996). Two projectile points found at archaeological sites in Baja California Sur are tentatively sourced to Valle del Azufre using a portable, handheld Thermo Scientific Niton XL2 Series X-ray Fluorescence analyzer for elemental analysis of obsidian. The first is on display at the Museo Regional de Antropología e Historía in La Paz and was found in Baja California Sur. The other was found during survey work near Cueva Santa Rita (Figure 1a). Additionally, local informants pointed out an obsidian source near Toris de la Presa, eroding out of a volcanic breccia. Major oxide and trace element data from this source are published in Appendix III. Although this is a high-quality glass source, the marekanites recovered are small (<3cm) and projectile points made from the nodules are small (Figure 5).

Because more recent rhyolitic volcanism is limited to the eastern peninsula, immediately adjacent and along the Main Gulf Escarpment, the source locations of artifact-quality obsidian sources are most likely spatially limited to this narrow strip of land. Although, in northern Baja California, secondary geographic distribution of obsidian is extensive and the sources themselves are more numerous than originally thought (Panich et al. 2012). Further provenance studies in both the north and south would help make significant progress in our understanding of inter- and intra-group interactions (see Shackley and Henrickson 2009).

Figure 4. Photographer is standing on the top of the Main Gulf Escarpment (MGE) looking north into the Gulf of California. Isla Santa Cruz visible in the background right. The MGE marks the western edge of the Gulf Extensional Province along the eastern side of Baja California. A relatively flat exposure of the Gulf Extensional Province lies between the MGE and the Gulf and is seen here as a flat expanse adjacent to the shoreline. Picture taken from above the town of Los Burros.

Figure 5. Left: Possible obsidian projectile point made of Toris de la Presa marekanites. Note second picture of point in upper, left corner with pen for scale. Right: Obsidian Marekanites from Toris de la Presa, Baja California Sur, Mexico.

Rockshelter Formation and Cave Deposits

Wider than it is deep, Cueva Santa Rita is technically a rockshelter, rather than a cave (Goldberg and Macphail 2006; Waters 1996). The distinction is not important colloquially, but is important when discussing formation processes (Goldberg and Macphail 2006). The dominant lithology of the rockshelter bedrock is volcanic in origin. Using a 7-class scale developed by Clayton and Arnold (1942:7), the shelter walls were a

Class 4, weakly weathered bedrock. The rock cannot be broken by hand, produces a dull ring or no ring from a hammer blow, and may be weakly spalling. The shelter floor exposed after excavations was a Class 5, or moderately weathered bedrock. It broke into fragments (5-15 cm in diameter) with pressure from our bare hands.

Several observations indicate that the weathered bedrock is an important part of site formation and post-depositional processes (Wald et al. 2012). First, the impermeable bedrock holds standing water from chubascos and hurricanes and greatly effects organic preservation, particularly in sediments closer to the drip line. Second, a white chemical precipitate was visible on some of the organics, especially in Facies 1. A white precipitate was also visible at the high water mark of perched water after rainfall. (Appendix IV, Figure 1). In other words, conditions are favorable for liquid precipitation at sediment contact with bedrock and along the drip line. This is a source of potential chemical weathering. Third, physical weathering of bedrock is an important source of endogenic sediments from all sides of the rockshelter, including the floor. The éboulis ranges in size from boulder to sand-size grains and is subangular to rounded. Fourth, erosion of bedrock has created an irregular rockshelter floor and slope towards the rockshelter entrance.

Formation of rockshelters in igneous extrusive bedrock is far less common than limestone or sandstone (Goldberg and Sherwood 2006). Rockshelter formation is directly related to local bedrock geology. Rockshelters in the CSR region form as the poorly-sorted beds erode at different rates (Figure 6) (Goldberg and Mandel 2008). Regional field surveys in 2008 indicate that certain lithologies comprising the three main units are more strongly associated with rockshelter formation.

Figure 6. Cueva Kakiwi in the Sierra de la Giganta. Differential erosion rates of the poorly-sorted beds of the Comondú Group. The finer-grained bedrock is more prone to erosion, seen in Cueva Kakiwi as the lighter colored beds, as opposed to the darker stained ceiling. The suspended cobbles and boulders in the back wall are a good example of the poorly-sorted matrix.

Bedrock lithology is an important component of the endogenous sediments at the archaeological site. Accumulation of weathering detritus from the cave wall and ceiling range in size from sands to boulders. Several cobbles fell from the ceiling during excavations, indicating that deposition is active. Rockshelter sediments are described in more detail below.

Site Stratigraphy and Rockshelter sediments

This discussion of excavated sediments is a summary of field analysis and is primarily a presentation of macromorphological analyses. Aspects of sedimentary features and structures, such as boundaries and lateral relationships, which can only be performed in the field, are explained in detail (Farrand 2001). The aim of this study is to develop a robust excavation methodology for ongoing research in rockshelters of the Sierra de la Giganta and Baja California Sur.

Rockshelter sediments are typically discussed in terms of origin and genesis (Farrand 2001). Sediment input can come from outside the shelter (exogenic) or from within the shelter (endogenic). Sediment deposition in the shelter are from three possible sources: geogenic, biogenic, and anthropogenic (Goldberg and Sherwood 2006; White 1988). Clastic and chemical sediments likely include entrance talus, aeolian, organic debris, anthropogenic sediments, weathering detritus, entrance talus, biogenic debris, evaporates and guano. Typically, features or facies in caves and rockshelters are not derived exclusively from a single source. The sediments at CSR are primarily composed of different components of anthropogenic sediments and bedrock clasts.

Field Methods

Profiles descriptions include depth, color, structure, percentage estimate by volume (e.g. charcoal, FCR, gravels), and boundaries (distinctness and topography) (Birkeland 1999). In the profile descriptions (Appendix IV), each strata is given a number and described below. A Munsell® soil color chart was used to determine sediment color. A small sample of sediment was freshly exposed and held directly behind the aperture until the closest matching color was found. Structure, percentage estimate by volume of soil features, and boundaries all follow methods outlined by Birkeland (1999:347-357) and charts for estimating proportions of coarse fragments included in the Munsell® soil color chart (2000). The distinctness and topography of the lower boundary of each unit was described. The distinctness describes the boundary transition and was either abrupt (<2 cm) or clear (2-5 cm). The topography of the boundary was smooth (parallel to surface); wavy (undulating with pockets wider that deep); or irregular (pockets deeper than their width).

Profile Descriptions

As stated in the Introductory chapter, test excavations were placed in a discontinuous trench-like pattern (Figure 7). Units 1, 2, and 3 are 2 X 2 meter units. The remaining units were all 1X1 meter. Unit 4 (1X1 meter) was placed between Units 2 and 3 and excavated first so that excavations could proceed with some knowledge of upcoming stratigraphic units. Unit 5 (1X1 meter) was not part of the trench and was located under a rock overhang 21 m east of the trench to investigate the range of site use patterns and variability in depth to bedrock. Unit 6 (1X1 meter) was excavated last to recover the only example of textile matting found in 2008, which was exposed in the west wall of Unit 3. Standardized field descriptions were made in the field and are reported in Appendix IV. Grain size and bulk chemical analyses are not reported on here but are forthcoming.

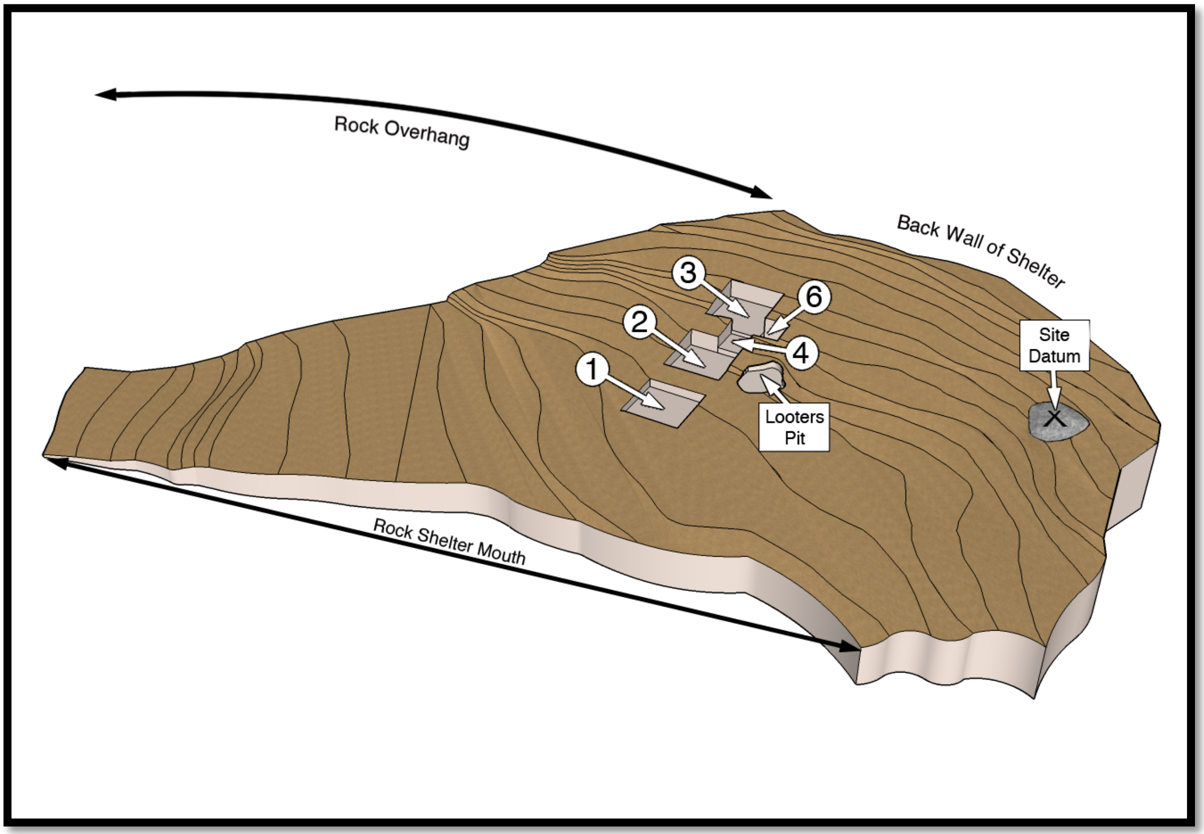

Figure 7. Plan view of excavation Trench A (Units 1, 2, 3, 4, and 6) at Cueva Santa Rita. Contour interval is 10 cm. Unit 5 is not pictured, but located 21 meters east of the northeast corner of Unit 1.

The stratigraphy at CSR is discussed using the term "facies". Facies are spatially restricted, laterally coexisting sedimentary deposits associated with specific subenvironments (Goldberg and Macphail 2009; Waters 1992). A facies approach emphasizes the deposition of penecontemporaneous sediments in adjacent areas of the cave, lateral relationships, and composition of strata. At CSR, facies are defined by composition, formation process, lithology, texture, structure, and radiocarbon dates. Some of these characteristics, such as radiocarbon dates, were later assessed in the lab. The most important facies characteristic in the field was relative organic and mineral composition. The abundance of one over another was visually apparent in the stratigraphic profile and during excavations.

Test Unit 1 (2X2 meter)

Unit 1 was placed closest to the shelter entrance. Compared to other units, Unit 1 had a high amount of fire-cracked rock (FCR), no features, and a low volume of organics, particularly macrobotanical remains. In total, the FCR from Unit 1 weighed 447lbs. Excavations progressed slowly due to the large amount of FCR and lithics that were mapped. This is the only unit that encountered roots, particularly in level 4. After excavating level 4, excavations were halted for several days to let the unit dry after rainfall from Tropical Storm Julio. Excavations on the north side of the unit were not completed due to flooding of unit, influx of sediment, and wall damage caused by rainfall, which hit the region on August 24th, 2008. No features were encountered in this unit. Unit 1 was excavated to depth of 20 centimeter before reaching bedrock in the southern half. The deposits exposed in the profile (Appendix IV, Table 1) are 10YR 4/2 (dark grayish brown) to 10YR 2/1 (black) and consist of subangular to angular, pebble to cobble-sized clasts of igneous extrusive bedrock of the Comondú Group. The poor sorting and subangular clasts are indicative of éboulis. The volume of organics in Unit was much smaller than all other units excavated at the site, suggesting that preservation, site use, or both was different at the front of the shelter than farther inside the shelter.

Test Unit 2 (2X2 meter)
Two profiles are described from Unit 2 (Appendix IV). The deposits in Unit 2 were the thickest at the site with a depth of 45 centimeter in the southeast quad. Sediment composition alternated between dominantly organic-rich and mineral-rich and facies terminated by thinning out at the edges in a lenticular pattern. Organic-rich facies are predominantly anthropogenic. Mapped artifacts in the organic rich matrix include quid, cordage, reed beads, beaded cordage, incised reed, bone, modified flakes, shell beads, hammerstone, projectile points, cores, manos, charcoal, and FCR. More features were found in Unit 2 than any other Unit (n=12). In the southern profile of Unit 2, there appears to be a series of lenticular, ashy-charcoal rich units that appear to represent intact hearths. Distinguishing features in this area of the unit was particularly difficult. There may be superimposed hearths. Additionally, ash and coals may have been spread between burning events.

Test Unit 3 (2X2 meter)
Unit 3 was located at the rear of the cave. Two profiles from Unit 3 are described in Appendix IV. Sediments were shallow (13 cm) at the rear of the shelter where the bedrock floor slopes upward to meet the back wall. To the north of the unit sediments were ~30 cm thick. Despite the shallow sediments, Unit 3 still retained a pattern of alternating organic-rich and mineral-rich facies that were lenticular in profile. The most extensive organic facies in Unit 3 includes mapped artifacts such as quid, leather sling or tumpline, leather and cordage, reed beads on cordage, cordage, quid, maize cobs, worked wood, manos, metates, cobble tool, FCR, biface fragments, and modified flakes. A piece of matting was found in the western profile, which prompted the excavation of a 50X50 meter unit (Unit 6) that was eventually expanded to a 1X1 meter. Seven features were excavated in Unit 3. Again, excavators expressed difficulty in identifying and isolating features.

Test Unit 4 (1X1 meter)
Test Unit 4 was placed between Units 1 and 2 to provide an advance vies of the site stratigraphy. It was excavated at an expedient pace to provide a window for the surrounding units. Except for features, there was less emphasis on in-situ recovery of items. Similar to units 1 and 2, an organic-rich matrix was found directly below the uppermost, disturbed facies. The organic layer measured between 1 and 6 cm thick across the unit and uncovered a wide variety of lithic and organic artifacts. A single hearth feature was excavated (Figure 7).

Test Unit 5 (1X1 meter)
This Unit was placed 21 m east of the northeast corner of Unit 1, beneath a low overhang of rock. Four levels were excavated before encountering bedrock. Relative to

Units 2, 3, 4, and 6, the sediments were low in organic matter and dominated by a silty matrix with common angular pebbles. Excavations uncovered a maize cob, a bifacial core, a strand of reed node beads, a tear-drop shaped biface, cordage, debitage, bone, and some macrobotanical fragments.

Test Unit 6 (1X1 meter)
Unit 6 began as a 50X50 centimeter unit, but due to difficulties excavating large pieces of organics in a small unit, it was expanded to 1X1 meter. The organic layer, level 3, included copious amounts of agave. This unit uncovered several unique items including fire-starters, decorated gourd, matting, and a feature that may be a padded sleeping depression for an infant or possibly the remnants of a bundled burial.

Cultural Features

A number of features were recovered during excavations including hearths, artifact clusters, a possible bedding feature or burial, and possible large roasting features. Features were designated using a dual number system separated by a dash. The first number is the unit. The second number represents the unique, consecutive feature number. Thus, the higher the feature number, the later it was encountered during excavations. The top and bottom elevations were also taken as well as feature dimensions. The letter "F" is often used to designate a feature number. Features were more concentrated in the central portion of the rockshelter. Features were excavated by mapping any artifacts larger than 1 cm^2. Field notebooks for features were kept separate from general field notes and photographs were taken for each feature.

Excavations at CSR separated 22 features. Features were defined as stratigraphically distinct from the surrounding matrix, containing clear boundaries, and often presented gradual lateral thinning to termination. They are also interpreted as geologic discontinuities younger than the layer or feature they cut. Their distinction as features, rather than archaeosediments or facies, was purely an excavation strategy. This approach was used to guide stratigraphic separation of visually bounded, distinct sedimentary units from the surrounding matrix. Currently, I have identified 4 kinds of features, but a detailed study of the features is incomplete.

It is important to note that there may be several large, well-preserved, rock-lined roasting pit features at the site. Several field observations indicate roasting pits may be present, but more geoarchaeological analyses should be conducted, particularly at the microscale, to determine and distinguish the diversity of combustion features that clearly exist at the site.

Radiocarbon Dates

Nine radiocarbon dates were submitted for analysis (Figure 8, Table 5, and Appendix V). Three were analyzed by the University of Arizona AMS laboratory. The remaining six were analyzed by the Center for Applied Isotope Studies at the University of Georgia. Calibration was done using the online version of Calib 7.0 (Steiner et al. 2005). Unless otherwise noted, all radiocarbon dates are discussed in uncalibrated radiocarbon years BP. A single early outlier is present at 3,772 ±39 BP from a dessicated cactus fruit recovered from the facies at contact with bedrock in Unit 3. For greater resolution, Figure 9 displays all the calibrated radiocarbon dates less than 2,000 BP. Eight dates occupy the period from 1156 AD to 1950 AD.

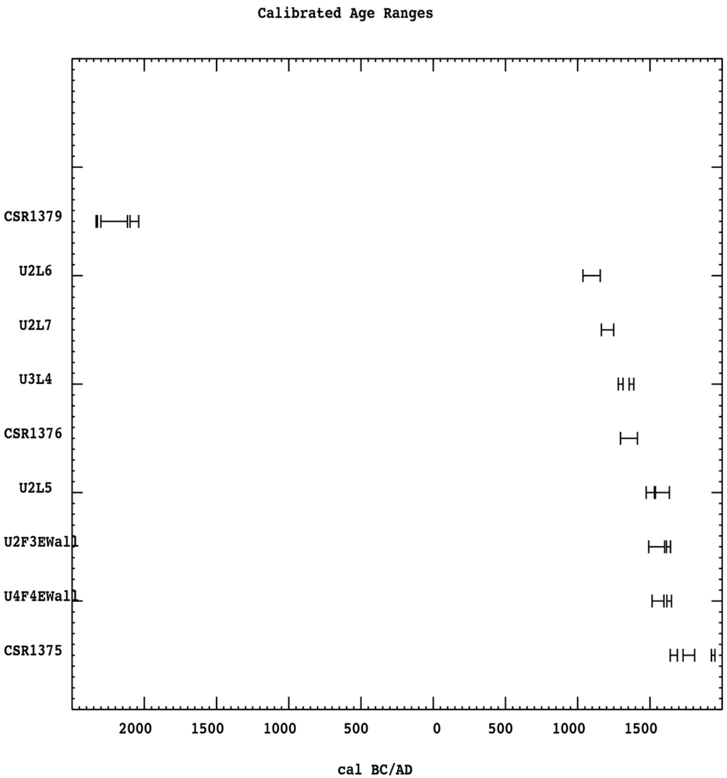

Figure 8. All calibrated radiocarbon dates.

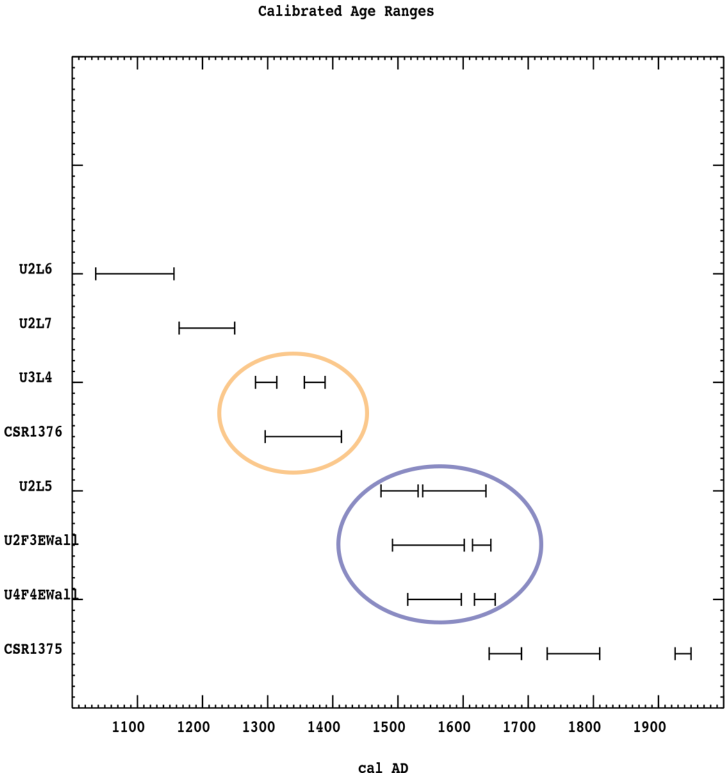

Figure 9. Calibrated radiocarbon dates less than 1200 A.D. Blue and yellow circles indicate overlapping dates (see Table 1).

Unit 2

The calibrated dates on Facies 3 (Figure 9, 11 and Table 1) overlap and are consistent with one hypothesis that they may be part of a large roasting event. The calibrated date range for this feature would be A.D. 1492-1635 (95.4% confidence). Two radiocarbon dates in Unit 2, excavation levels 6 and 7, are reversed. This may indicate some vertical or horizontal mixing of sediment. Alternatively, this may be the result of our field sampling techniques of those particular samples, which were selected from the

Figure 10. Unit 4, Level 4, Feature 1. Feature 1 is exposed on the surface of Level 4 and is clearly visible as a white, ashy matrix in the center and back of this unit.

~30 Liter paleoethnobotanical samples taken from the NE corner of each 2 X 2 meter unit at the beginning of each level. The samples were part of a larger blanket sampling strategy, whereby all units and features were sampled. Although we excavated using an arbitrary-within-stratigraphic strategy, I now suspect that the dominantly geogenic Facies 1 and 2 had a considerable slope (~30°), particularly noticeable in the northeast corner of Unit 2 (Figure 11) that were not visible while excavating. To take paleoethnobotanical samples, we used a composite sampling technique, where small amounts of sample were taken to represent undisturbed portions of each northeast quadrant (Pearsall 2009). It is entirely possible given the sampling technique, that in this case different, yet sequential time periods are represented. Because strata were not horizontal, I advise more frequent samples from small, precise locations, rather than large composite samples.

Table 1. Radiocarbon dates from Cueva Santa Rita. *Calib 7.0 Online (Steiner et al. 2005),** measured. Blue and yellow cells overlap with each other (see Figure 9).

Unit	Level	Facies	Feature	Material	Lab	Lab Number	^{14}C	*cal BC/AD, 2 sigma (95.4%) range	**δ^{13}C,‰
2			7	cactus fruit	UA	AA84828	216 ± 34	1640-1950 AD	-14.1
4		4		charcoal	UGa	14221	300± 20	1515-1649 AD	-22.0
2		3		charcoal	UGa	14216	320± 20	1492-1643 AD	-22.7
2	5			charcoal	UGa	14218	340± 20	1474-1635 AD	-23.9
2			7	cactus fruit	UA	AA84827	576 ± 34	1300-1422 AD	-15.0
3	4			charcoal	UGa	14220	660± 20	1281-1388 AD	-23.7
2	7			charcoal	UGa	14217	840± 20	1164-1249 AD	-24.5
2	6			charcoal	UGa	14219	930± 20	1036-1156 AD	-22.4
3	9			cactus fruit	UA	AA84829	3,772± 39	1752-1534 BC	-14.0

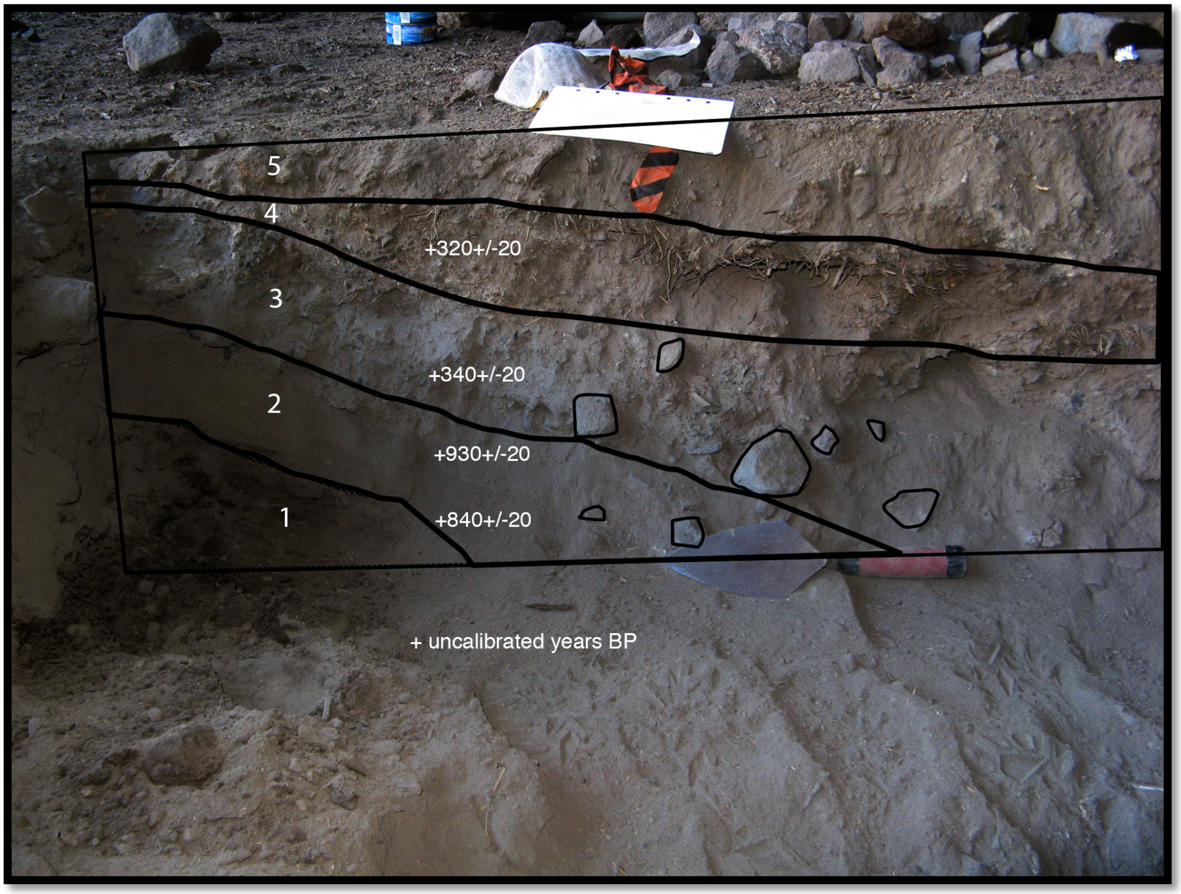

Figure 11. Unit 2, East wall, radiocarbon dates.

Two AMS dates on cactus fruit from Unit 2, Feature 7 are also problematic. They were selected from a feature described as ashy sediment with charcoal, containing botanical fragments, and reed bead cordage. It was 8 cm thick and rested on the surface of level 4, which was a much more compact matrix. It is not depicted on the stratigraphic profile because it did not intersect any walls. These dates are disregarded at this time until further analysis of Feature 7 is complete.

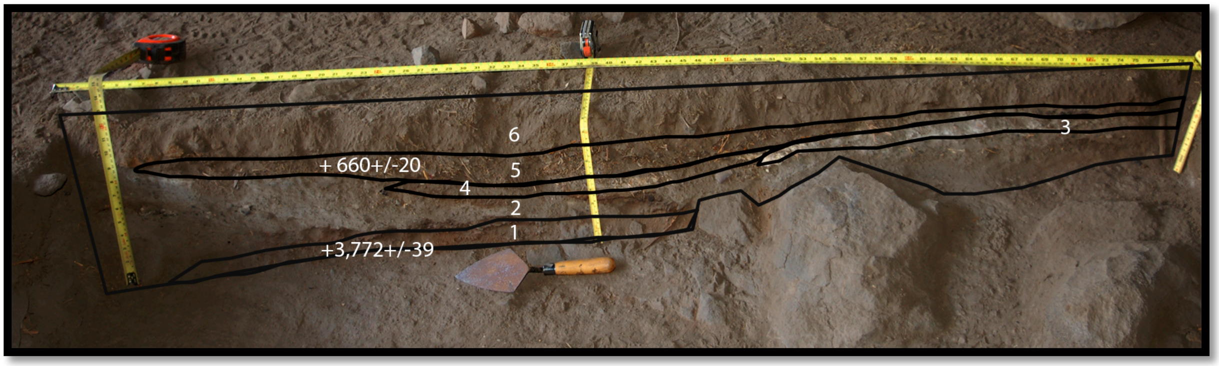

Figure 12. Unit 3, East wall, radiocarbon dates.

Unit 3

The oldest AMS date at CSR is 3,772 ± 39 (Figure 12). Facies 1 was an ephemeral unit found in Unit 3, 4, and the southern portion of Unit 2. The AMS date of 660 ± 20 comes from Facies 5, an organic-rich unit directly below Facies 6, a disturbed facies that was present across the site.

Unit 4

A single AMS date of 300 ± 20 on charcoal came from Unit 4, Facies 4. This is an organic unit that is the same as Unit 3, Facies 4 (Appendix IV, Figure 4 and Table 5). Facies 4 is a thick, organic-rich anthropogenic unit.

Summary

The landscape features that compose the peninsula are a product of a complex geologic history. Through time, irregular accretive geologic events have formed lineaments, running roughly parallel to the peninsula itself, fragmented and cross-cut at a large scale by structural provinces (e.g. Gulf Extensional Province) and at a smaller scale by recent faulting and geomorphic processes. Geologic history has important implications for archaeological research in Baja California. By narrowing down probable localities of lithic sources, survey time is more efficient and it is possible to use this knowledge to inform our choice of sourcing techniques. Understanding the bedrock lithology also helps to understand rockshelter formation and geogenic deposition.

The clasts from the volcanic breccias are by far the most common lithic material utilized. Currently, three different lithic raw material resources are identified in the study region: 1) moderate-quality clasts from volcanic breccias of the Comondú Formation 2) high-quality localized chert sources and 3) a high-quality distant obsidian source. There is suitable rhyolite material available everywhere locally, based on previous lithic studies in Baja California Sur, and there may be distinctive quarry and workshop sites (Harumi and Poyotas 2007; Harumi 2009). To date, local chert exposures in south-central Baja California have been found along the east and west flanks of the Sierra de la Giganta, where marine facies are exposed. The quantity of the high-quality, but distant obsidian from the Valle del Azufre source that has reached the southern peninsula is small and the form is limited to finished projectile points. Additionally, a local obsidian source has been found, but so far the nodules are small, limiting but clearly not prohibiting production of tools.

Sediments accumulating in the cave are primarily a mix of anthropogenic and geogenic deposits. Observations made at the macroscopic level indicate a diversity of features intercalated with facies. However, stratigraphic context is still tentative and many cultural materials remain to be studied. The saturation through precipitation of the front part of the shelter and the lower portion of sediments closest to the entrance is capable of producing significant chemical weathering. The saturation and movement of water through the sediments observed after tropical storm Julio provided insights into this process. The perched water, mineral precipitate it left behind (Appendix IV, Figure 1), lateral and horizontal capillary fringe (Appendix IV, Figure 2, Facies 1), and the in-situ weathering of the shelter bedrock floor suggest that hydration may contribute to a weathering zone that radiates out from the drip line.

The outcome of radiocarbon dating provided important chronological information (Table 1). Radiocarbon ages determined on 9 charcoal samples range from 216 ± 34 to 3,772 ± 39 BP. The earliest date comes from the lowest facies and indicates a Middle Holocene component. After 1,000 BP, the number of features, such as hearths and artifact clusters increases significantly, especially after 660 BP. Sediments in Unit 1 are saturated after rainfall and as a result, the preservation of fragile organic materials is greatly decreased. The number of features in the central area of the excavation trench is significantly higher than at the ends and is a foci of midden accumulation. There were no features found in Unit 5, most likely a reflection of the low ceiling and lack of headspace. Consideration of these dates indicates that there was significant occupation at CSR after ~1,000 years ago. The organic-rich facies date from 660 ± 20 to 300 ± 20 and based on artifacts, represent the remains from a range of activities. There appears to be a significant hiatus between the oldest facies and all other facies and features, the latter representing an overwhelming majority of rockshelter sediments. This does not necessarily represent the absence of people and could instead indicate sampling error, rockshelter floor maintenance, or postdepositional processes. The increase in plant processing activities could also be associated with the late Holocene cooling trend that began 1,000 years ago (see Chapter 1). Additionally, although occupation was relatively continuous in the central Sierra de San Francisco region after ~3,000 years BP, Justin Hyland (1997:278) noted a bimodal peak in radiocarbon dates at 1300 BP and 300 BP. Although the number of radiocarbon dates from Cueva Santa Rita is small, the archaeological significance of this is that the increase in organic facies after 1,000 BP coincides with increasing populations and/or changing subsistence strategies to the north.

The sediments at CSR are complex. Specific kinds of features were extremely difficult to identify and, therefore, stratigraphic excavations were difficult to accomplish. As the medium in which all artifacts are embedded, spatial and temporal information is impossible to interpret unless the stratigraphy is carefully analyzed. The consistent difficulties involved in excavating and identifying features make a more detailed study of stratigraphy significant; any data we can obtain pertaining to combustion features and appropriate excavation methodologies in volcanogenic rockshelters may have significant impacts on previous and future excavations in Baja California Sur. This is particularly important in the San Fransico de la Sierras, a region of active tourism dependent on archaeological research in rockshelters in the same geologic formation. Additionally, if there are roasting pits in shelters, this would greatly impact prevailing interpretations of rockshelter use and artifact context. If large roasting pits occur in other shelters, it will be much more difficult to interpret shelter stratigraphy. The digging and possible re-use of roasting features likely involved significant sediment and stone tool recycling. Geoarchaeological and archaeological evidence offers an excellent source for addressing these problems.

Although sediments at rockshelters are characteristically idiosyncratic (Farrand 2001), stratigraphic features at Cueva Santa Rita can shed light on central Baja California rockshelters, particularly those formed in similar volcanic outcrops. For example, stratigraphic descriptions indicate a relatively simple stratigraphic record for both Caguama and Metate Caves (Tuohy 1979). Sediments were removed by stripping three primary layers in succession. The layers were referred to from top to bottom as dung, grass, and dust. The grass layer was "lensatic in cross-section, thicker in the center, and thinning towards its areal limits…This layer is composed almost entirely of dried grass, and held most of the perishable artifacts recovered" (Tuohy 1979:70). This unit was assumed to be stratigraphically homogenous and the high amount of grasses indicated use as bedding, but was also part of a larger unit of living debris. At first glance, stratigraphically guided excavations at Cueva Santa Rita appeared to be identical. However, a more detailed geoarchaeological investigation at Cueva Santa Rita indicates that rather than continuous layers of grass and dust beneath a dung cap, it is likely that organic-rich deposits are composed of multiple, discrete organic features or facies, which may sometimes be associated with combustion, cooking or roasting features. So far, radiocarbon dates support this idea. It is possible that Tuohy was entirely correct in his stratigraphic intepretations, but the geoarchaeological investigations at Cueva Santa Rita suggest that it would be easy to mistake the irregular, discrete small-scale (1-2 m^2) organic facies for larger, continuous organic-rich units. These investigations indicate that, given the opportunity, it is entirely possible to construct an excavation protocol that would facilitate the ability of archaeologists in central and southern Baja California to excavate sites in their stratigraphic context.

References Cited

Alatorre, Armando A E

1988 Stratigraphy and depositional environments of the phosphorite-bearing Monterrey Formation in Baja California Sur. *Economic Geology and the Bulletin of the Society of Economic Geologists* 83(8):1918-1930.

Applegate, Shelton P.

1986 The El Cien Formation, Strata of Oligocene and Early Miocene age in Baja California Sur. *Revista del Instituto de Geología Universidad Nacional Autónoma de México* 6:145-162.

Atwater, Tanya, and Joann Stock

1998 Pacific–North America plate tectonics of the Neogene southwestern United States. *International Geology Review* 10:375–402.

Beal, Carl H.

1948 Reconnaisance of the geology and Oil Possibilities of Baja California, Mexico. *Geologic Society American Memoirs* 31.

Goldberg, Paul and Richard Macphail

2009 *Practical and Theoretical Geoarchaeology*. John Wiley & Sons.

Birkeland, Peter W.

1999 *Soils and Geomorphology*. Oxford University Press.

Bigioggero, Biagio, Sergio Chiesa, Andrea Zanchi, Attilio Montrasio, and Luigina Vezzoli

1995 The Cerro Mencenares volcanic center, Baja California Sur: Source and tectonic control on postsubduction magmatism within the Gulf Rift. Geological Society of America Bulletin 107(9):1108-1122.

Brown, Larae and Ann M. Raab

2007 Baja California Sur, Mexico: A Natural Laboratory for Forager Mortuary Archaeology. *Pacific Coast Archaeological Society Quarterly* 39(2&3):53-65.

Calmus, T., A. Aguillón-Robles, R.C. Maury, H. Bellon, M. Benoit, J. Cotten, J. Bourgois, F. Michaud

2003 Spatial and temporal evolution of basalts and magnesian andesites ("bajaites") from Baja California, Mexico: the role of slab melts. *Lithos* 66(1-2):77-105.

Carreño, Ana Luisa, Jorge Ladesma-Vázquez, and Rosalía Guerro-Arenas

2000 Biostratigraphy and Depositional History of the Tepetate Foramtion at Arroyo Colorado (Early-Middle Eocene), Baja California, Sur, Mexico. *Ciencias Marinas* 26(1):177-200.

Castillo, Paterno R.

2008 Origin of the adakite,Äìhigh-Nb basalt association and its implications for postsubduction magmatism in Baja California, Mexico. *Geological Society of America Bulletin* 120(3-4):451-462.

Reygadas Dahl, Fermîn and Gerardo Gonzalález Barba

2003 Ornamento elaborado con dientes de tiburón impregnado a un cráneo humano del sitio prehispánico El Conchalito, Baja California Sur, Mexico. In *Presencia de la Arqueoictiologia en México, Libro de Memorias de la 12a Reunión de Grupo de Trabaja en Restos de Peces del Consejo Internacional para la Arqueozoología*, edited by Ana Fabiola Guzmán, Oscar J. Polaco, and Felisa J Aguilar, pp. 145-149. CONACULTA and INAH, Guadalajara, Jalisco, Mexico.

Danzeglocke, U., Jöris, O., B. Weninger
2013 CalPal-2007 Electronic software, http://www.calpal-online.de/, accessed October 13, 2013.
Davis, Loren
2006 Baja California's Paleoenvironmental Context. In *The Prehistory of Baja California: Advance in the Archaeology of the Forgotten Peninsula*, edited by Don Laylander and Jerry D. Moore, pp.14-23. University Press of Florida.
Dorsey, R.J. and Paul J. Umhoefer
2000 Tectonic and Eustatic Controls on Sequence Stratigraphy of the Pliocene Loreto Basin, Mexico. *Geologic Society of America Bulletin* 112: 177-199.
Fletcher, John M., Marty Grove, David Kimbrough, Oscar Lovera, and George E. Gehrels
2007 Ridge-trench interactions and the Neogene tectonic evolution of the Magdalena Shelf and southern Gulf of California; insights from detrital zircon U-Pb ages from the Magdalena Fan and adjacent areas. *GSA Bulletin* 119:1313–1336.
Farrand, William R.
2001 Sediments and Stratigraphy in Rockshelters and Caves: A Personal Perspective on Principles and Pragmatics. *Geoarchaeology: An International Journal* 16(5): 537-557.
Gastil, Gordon R., Daniel Krummenacher, and John Minch
1979 The record of Cenozoic volcanism around the Gulf of California. *Geologic Society for American Bulletin.* 90 (839-857).
Goldberg, Paul, and Richard Macphail
2006 *Practical and Theoretical Geoarchaeology*. Wiley-Blackwell.
Goldberg, Paul, and Rolfe Mandel D.
2008 Caves and Rockshelters. *Encyclopedia of Archaeology* Vol. 2. Elsevier.
Goldberg, Paul and Sarah C. Sherwood
2006 Deciphering Human Prehistory Through the Geoarchaeological Study of Cave Sediments. *Evolutionary Anthropology* 15: 20-36.
Hausback, Brian P.
1984 Cenozoic volcanic and tectonic evolution of Baja California, Mexico. Geology of Baja California Peninsula, In *Pacific Section Society of Economic Paleontologists and Mineralogists*, edited by Virgil A. Frizzell Jr. Special Paper 39, 219-236.
Harumi, Fujita
2009 Rhyolite Bifacial Preform Production at El Puguero: A Prehistoric Quarry and Workshop Site in the Cape Region of Baja California. *SCA Proceedings* 22: 1-6.
Harumi, Fujita and Gema Poyatos de Paz
2007 Prehistoric Quarrying and Stone Tool Production at El Pulgero, Baja California Sur. *Pacific Coast Archaeological Society Quarterly* 39(2-3): 23-36.
Henry, Christopher D., and J. Jorge Aranda-Gomez
2000 Plate interactions control middle-late Miocene, proto-Gulf and Basin and Range extension in the southern Basin and Range. *Tectonophysics* 318(1-4):1-26.
Heim, Arnold Z.
1922 Notes on the Tertiary of Southern Lower California. *Geological Magazine* 59:529-547.
Huffman, Jim
1993 *Between River and Rim: A comparative View of Subsistence Systems in Grand Canyon, Arizona*. Master's thesis. Northern Arizona University, Flagstaff.
Kelly, Isabel

1976 Southern Pauite Ehtnography. In *Pauite Indians II*, edited by David Agee Horr, pp. 11-224. Garland American Indian Ethnohistory Series. Garland Publishing, Inc., New York/London.

Knappe, R. Jr.

1974 The micropaleontology of a section of the Tepetate Formation and a comparison with equivalent Foraminifera along the West Coast of the United States. Master's. thesis, University of Ohio.

Kwiatkowski, Scott and Robert E. Gasser

1993 Prehistoric Agave Cultuivation in the Phoenix Metropolitan Area. *Agave, Mescal, Maguey: Prehistoric Cultivation in North America*, edited by Susan K. Fish and Jeffery R. Parsons. University of Arizona Press, Tucson.

Lee, Jeffrey, M. Meghan Miller, Robert Crippen, Bradley Hacker and Jorge Ledesma Vazquez

1996 Middle Miocene extension in the Gulf Extensional Province, Baja California: Evidence from the southern Sierra Juarez. *Geological Society of America Bulletin* 108(5):505-525.

Lizarralde, D., G.J. Axen, H.E. Brown, J.M. Fletcher, A. González-Fernández, A.J. Harding, W.S. Holbrook, G.M. Kent, P. Paramo, F. Sutherland, and P.J. Umhoefer

2007 Variable styles of rifting in the Gulf of California: *Nature* 448:466–469.

Lonsdale, P.

1991 Structural patterns of the Pacific floor offshore of Peninsular California. In *The Gulf and Peninsula Province of the Californias: American Association of Petroleum Geologists Memoir 47*, edited by Dauphin, J.P., and B.R.T. Simoneit, pp. 87-126.

Mather, J. R.

1974 *Climatology: Fundamentals and Applications*. McGraw-Hill Co., New York.

Massey, William C.

1947 Brief Report on Archaeological Investigations in Baja California. Southwestern *Journal of Anthropology* 3(4):344-359.

Munsell Color

2000 *Munsell Soil Color Chart*. Gretag-Macbeth, New York.

Murillo de Nava, J. M., Donn S. Gorsline, Glenn A. Goodfriend,V.K. Vlasov, Rodolfo Cruz-Orozco

1999 Evidence of Holocene climatic changes from Aeolian deposits in Baja California Sur, Mexico. *Quaternary International* 56(1):141-154.

Panich, Lee, Antonio Michelini, and M. Shackley

2012 Obsidian Sources of Northern Baja California: The Known and the Unknown. *California Archaeology* 4(2):183-200.

Pearsall, Deborah

2009 *Paleoethnobotany: A Handbook of Procedures*. Left Coast Press.

Piper, D. Z.

1991 Geochemistry of a Tertiary sedimentary phosphate deposit: Baja California Sur, Mexico. *Chemical Geology* 92(4):283-316.

Rosales-López, Alfonso, J. Eldon Molto, and Leticia C. Sanchez Garcia

2003 The Dead at El Conchalito: Ancient Burial Practices on La Paz Bay, Baja California Sur, Mexico. *Pacific Coast Archaeological Society Quarterly* 39 (2&3): 67-80.

Sawlan, Michael G.

1991 Magmatic evolution of the Gulf of California rift. In *The Gulf and Peninsula Province of the Californias: American Association of Petroleum Geologists Memoir 47*, edited by Dauphin, J.P., and B.R.T. Simoneit, pp. 217–229.

Shackley, Michael S.
2008 Archaeological Petrology and the Archaeometry of Lithic Materials. Archaeometry 50(2): 194-215.
2013 Geoarchaeology XRF Lab. Electronic document, http://www.swxrflab.net/nomexico.htm, accessed November 16, 2013.
Shackley, Steven M., Justin R. Hyland, and Maria de La Luz Gutierrez
1996 Mass production and procurement at Valle del Azufre: A unique archaeological obsidian source in Baja California Sur. *American Antiquity* 61(4):718-731.
VonSleichter, Connie L.
1997 *A comparison of roasting pit complexes in southern Nevada*. Master's thesis. University of Nevada, Las Vegas.
Stewart, Omer C.
1942 *Culture Element Distribution xviii: Ute-Southern Pauite*. University of California Anthropological Records 6(4): 231-356.
Stock, J.M., and Hodges, K.V.
1989 Pre-Pliocene extension around the Gulf of California and the transfer of Baja California to the Pacific plate: *Tectonics* 8:99-115.
Stock, J.M. and Lee, J.
1994 Do microplates in subduction zones leave a geological record? *Tectonic*s 13:1472 1487.
Umhoefer, Paul J., Rebecca J. Dorsey, Shawn Willsey, Larry Mayer, and Paul Renne
2001 Stratigraphy and geochronology of the Comondú Group near Loreto, Baja California sur, Mexico. *Sedimentary Geology* 144:125-147.
Umhoefer, Paul J.
2011 Why did the Southern Gulf of California rupture so rapidly?-Oblique divergence across hot, weak lithosphere along a tectonically active margin. *GSA Today* 21(11): 4-10.
Vessel, R.G., Davies, D.K.
1981 Nonmarine sedimentation in active forearc basins. In *Recent and ancient nonmarine depositional environments: models for exploration*, edited by Frank G. Flores and Romeo M. Ethridge, pp. 31-45.
Wald, Jonathan A., Robert C. Graham, and Phillip J. Schoeneberger
2012 Distribution and properties of soft weathered bedrock at ≤ 1m depth in the contiguous United States. Electronic Document, http://digitalcommons.unl.edu/usdaarsfacpub/1131, accessed July 10, 2013.
Waters, Michael R.
1996 *Principles of Geoarchaeology: A North American Perspective.* The University of Arizona Press.
White, William B.
1988 Geomorphology and Hydrology of Karst Terrains. Oxford University Press, New York.

Chapter 4: *Olivella* Shell Bead Production at Cueva Santa Rita in south-central Baja California Sur, Mexico: An Ethnohistoric and Archaeological study of manufacture and significance.

Introduction

This paper discusses shell bead artifacts at Cueva Santa Rita, an inland rockshelter located in the eastern peninsular ranges of Baja California Sur, Mexico (Figure 1). *Olivella* beads are significant for several reasons. Found at many coastal and inland sites throughout Western North America, *Olivella* shells are important indicators of long distance trade networks in the Americas (Masucci 1995; Vellanoweth 2001) since the Early Holocene (Fitzgerald 2005; Vellanoweth 2003) and persisting through even the dramatic cultural changes brought by colonization (Dahdul 2008; Gamble and Zepeda 2002). In North America, the variability in *Olivella* species habitat range can distinguish oceanic sources, e.g Pacific, Gulf of California, or Gulf of Mexico (Kozuch 2002, McGuire and Howard 1987, Nelson 1991). Stable isotope studies can further refine provenance to spatially restricted source zones (Eerkens et al. 2005). Furthermore, the many contexts of shell use in the ethnographic and ethnohistoric literature is a rich resource for archaeological model building (Trubitt 2003). Numerous avenues of shell bead analysis provide significant information on the bead production system, particularly if research includes ethnographic, ethnohistoric, and archaeological data (Trubitt 2003). Marine shell is also an independent line of evidence when investigating group relationships at the inter-and intraregional level.

The genus *Olivella* (Swainson 1831) is member of the Olivellidae "Dwarf Olive" family. It is a carnivorous sea snail found worldwide in intertidal and subtidal sands. Two species of *Olivella* genus beads were found at the site including *Olivella biplicata* or "Purple Olive" (Sowerby 1825) and *Olivella dama* or "Dwarf Olive" (Wood 1828). *O. biplicata* has a wide geographic distribution from southern Alaska to Bahía Magdalena, Baja California Sur but it is restricted to the colder waters of the Pacific Ocean. Its habitat ranges from sandy bottoms to lagoons and bays in intertidal zones up to 50 m depth and can be found in large aggregations. *O. dama* is restricted to the warmer waters of the Gulf of California south to Sinaloa and is found in shallow waters on sandspits. Some of the most commonly found species of beads at archaeological sites in California and the Great Basin are *O. biplicata* and *O. dama*. Milliken and Schwitala (2012:14) report that although four species of *Olivella* are relevant to archaeological studies in western North America, the most important distinction is between the "bulging silhouette" group (*O. biplicata, O. baetica, O. pedroana*) of the eastern Pacific and the "torpedo silhouette" of *O. dama* from the Gulf of California. As long as these two groups are distinguished, prehistoric networks can be traced to the appropriate marine bodies.

Bead Manufacture

Compared to non-whole shell bead production, where small fragments of the original shell are made into beads, whole-shell beads produce very little to no manufacturing waste and involve fewer production stages. Yet, there is considerable variation in the stages of the bead production process drawn from ethnographic, archaeological, and experimental data. Bennyhoff and Hughes (1987:116) state that spires may be broken, ground, or naturally worn off. Describing the manufacture of whole-beads in more detail, Rosen (1995:89) outlines the production of spire-lopped beads as follows:

1) breaking the bead with punching or bipolar percussion
2) if necessary, the outer lip is chipped to enlarge opening
3) grinding or polishing to smooth the opening

For the production of barrel beads, Rosen (1995:94) adds that if slightly more force is added during bipolar percussion, it will remove the canal (distal) end in addition to the spire. Others variations in manufacture include heat treatment as a necessary first step that whitens, or "bleaches", the bead blanks, making them easier to cut (Hartzell 1991). Heat treatment is listed as an *optional* step based on ethnographic studies done by John P. Harrington (see Macko 1984:5-6 or Farmer and La Rose 2009:3).

Previous Bead Research in the Central Peninsula

Olivella shell beads have been reported from 3 different regions (six archaeological sites) in central Baja California (Figure 1). From the Sierra de San Franciscos, a single large (12 mm) spire-lopped *O. dama* bead was found at bedrock at Cueva Pintada (Hyland 1997). Closer to Cueva Santa Rita, from four caves excavated by William Massey and Donald Tuohy in the northern Sierra de la Giganta, or Comondú region, between 1949 and 1954, only two *Olivella* beads were recovered (Tuohy 1978). It is difficult to determine whether this reflects a lack of *Olivella* shell bead use or excavation methods. Massey and Tuohy did not use screens during excavations. At Metate Cave one *Olivella* bead was recovered. It was found as the terminal bead on a string of Carrizo node beads and is a "small" *Olivella* shell. One *Olivella* spire-lopped bead was also found at Caguama Cave.

North of the Sierra de la Giganta, in the Cochimí region, Eric Ritter excavated 72 *Olivella* shell beads, all of them *O. dama*, at Bahía Concepción. The beads came from 2 cave sites: Cueva Lupe Diaz (BS-D55) and Cueva Cola de Ballena (BS-D140). A radiocarbon date from a plaited mat resting on bedrock (45 cmbs) was 670±80 B.P. (A.D. 1280) (GaK-4363). He divides these beads into 5 types: large spire-lopped, small spire-lopped, side-perforated, side-perforated/spire-lopped, and spire. The large and small spire-lopped beads are separated based on a dichotomy of bead length at 8.0 mm. He attributes both caves to the Comondú Culture of the central peninsula.

My purpose in this chapter is to identify the species and types of *Olivella* beads recovered from Cueva Santa Rita; determine whether beads were manufactured at the site or elsewhere; examine the ethnohistoric literature to investigate the role of shell bead use in central Baja; compare the shell beads at CSR to other sites in the region; and to present a database of *Olivella* shell bead morphology and discuss the regional bead manufacture process, offering a way for archaeologists to explore regional relationships and interactions between Baja California groups.

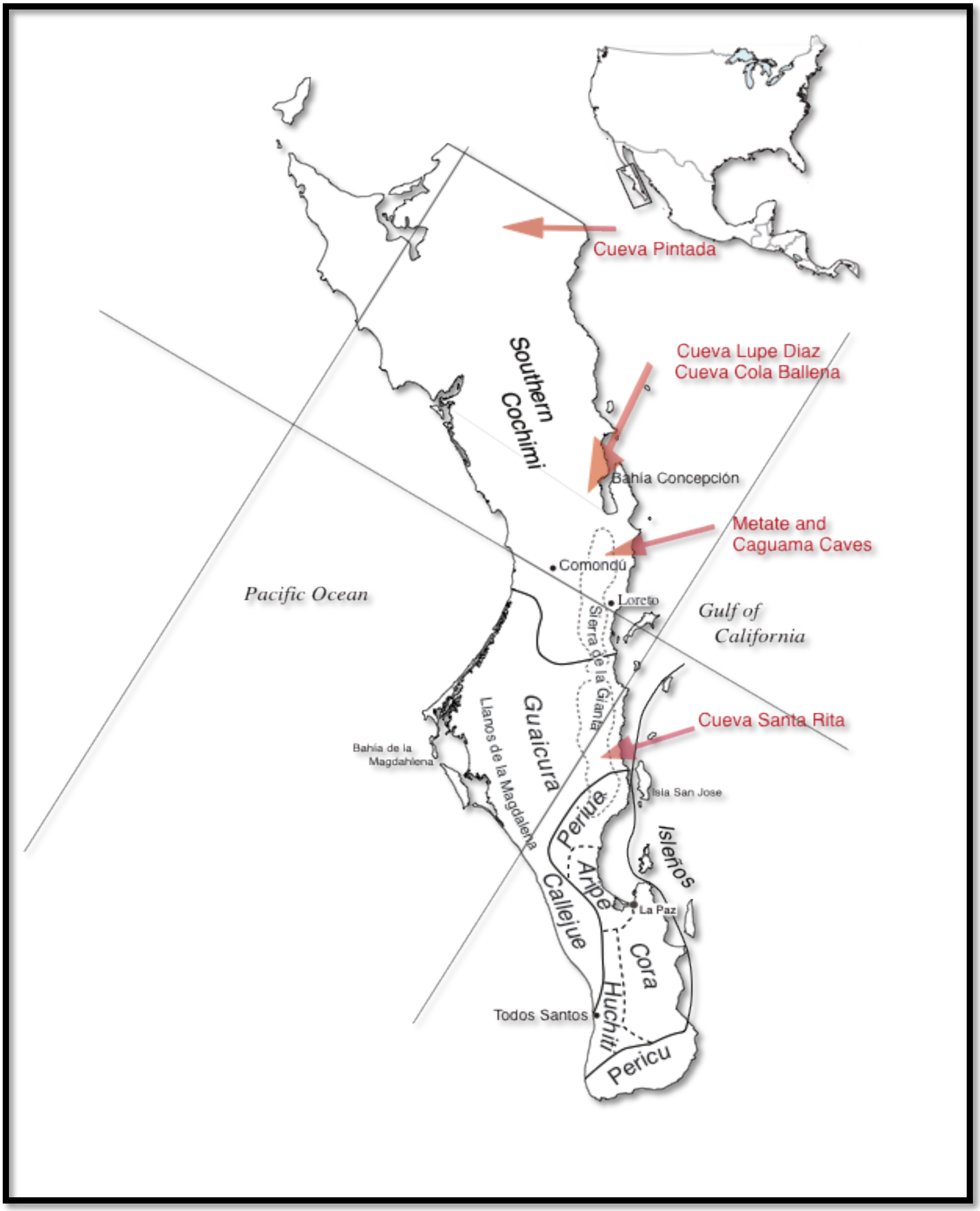

Figure 1. Map of Baja California and place names discussed in text. Linguistic groups from Massey (1949). Solid lines divide languages and dotted lines denote dialects. Archaeological sites are indicated with red text.

Methods

Shell beads were recovered during field excavations and from 30 liter bulk macrobotanical samples processed in the lab. The only cleaning performed was a light brushing of dirt using fingers or by blowing on the specimens. Identifications were made using a number of resources including literature on misidentification (Rosen 1995; Troost et al. 2012), archaeological reports (Rosen 1995), and reference guides (Burch and Burch 1963; Harasewych and Moertzsohn 2010; Olsson 1956). The cave's dry environment, frequency of unbleached shell, and bead type (whole-shell) facilitates species identification at CSR. These aspects tend to preserve the original coloring and markings of the shell in its natural form, making them easier to identify.

Francis (1989) defines two broad categories of shell beads. The first is when the final bead form preserves the majority of the shell body and the second involves blanks made from fragments of the shell body and shaped into beads. Only the former, "whole-shell" beads were recovered at CSR. I utilized the classification systems presented in shell bead guides developed by Bennyhoff and Hughes (1987) and Milliken and Schwitalla (2012). The bead chronologies in these guides are not considered because they are developed for California and the Great Basin and their applications along the peninsula are uncertain. In addition to bead blanks, or unmodified *Olivella* shell, 2 bead classes were excavated at CSR, Class A (Spire-lopped) and Class B (End-ground and Barrel beads). Bennyhoff and Hughes (1987) further divide Class A and B by angle of spire-removal and by diameter: small (3.0-6.5 mm), med (6.51-9.5 mm), and large (9.51-15.0 mm).

The majority of whole-shell beads at CSR are *Olivella biplicata* with the spire or both ends removed. As Milliken and Schwitalla (2012) emphasize, reporting the metrics and non-metrics of beads is critical due to the inevitable refinement and reorganization of bead typologies and temporal significance. This data is provided in Appendix VI.

Bead Production System

Reconstruction of shell bead manufacture is accomplished through the use of ethnographies (Trubitt 2003), ethnohistories, experimental studies (Francis 1989), microwear analysis (Velazquez-Castro2012), statistical methods (Arnold 1994) and examination of shell beads and bead detritus at production sites (Arnold 1994; Hartzell 1991; Rosen 1995, 1994; Yerkes 1993). To conceptualize the complexity of the entire bead production system Trubitt (2003) suggests adopting Costin's (2001) approach of breaking down the system into its component parts. In this chapter, I utilize a version of Costin's (2001) production components as a general framework, keeping in mind Trubitt's comment that "Because these different components may be separated in time and space, it is important to conceptualize craft production and exchange as an interrelated system (Trubitt 2003:245)." In the results section I will present the results of bead classification and spatial distribution of beads at CSR. Then I discuss other, non-metric aspects of the bead assemblage including detritus, heat treatment, and use-wear.

Results

In addition to bead blanks, the following bead types were identified: 1) A1: simple spire-lopped, 2) A2: oblique-spire lopped, 3) A4: punched spire-lopped, 4) B1: Side-Ground, 5) B2: End-Ground, 6) B3: Barrel, and 7) B6: Double-Oblique (Figure 2). The first three types are Class A , Spire-Removed (Figure 3) and the last four are Class B, End-Ground (Figure 4). Results of classification will be presented first, followed by the recorded non-metric attributes of the shell, including, but not limited to (see Appendix VI) distribution by facies, detritus, heat-treatment, and use-wear.

Blanks

An important component of shell bead production sites, the *Olivella sp.* bead blank to finished bead ratio was approximately 1:6. Blanks were found in facies 1, 2 and 4 and included *Olivella* sp., *Olivella biplicata*, and *Olivella dama* (Figure 5). Of the 22 blanks, 41% are bleached.

Class A1: Simple Spire-Lopped

The 26 beads of this type were found in facies 1, 2, and 4 and 73% were bleached (Figure 2a-b). As discussed later in this paper, this is the most common bead type in central Baja California.

Class A2: Oblique Spire-Lopped

These are whole-shell beads with the spire ground at an angle (Figure 2c). Of the 17 beads, three were unidentifiable beyond the species level, one was *O. dama*, and the rest were *O. biplicata*. Bleached beads comprised 41% of specimens.

Class A4: Punched Spire-Lopped

Only two beads were punched and spire-lopped. Milliken and Schwitalla (2012) note that most punched beads are perforated naturally. If this is the case, than these may not be separate class of beads and instead represent two additional simple spire-lopped beads. This is difficult to determine given that use-wear may erase traces of natural or human modification.

Class B1:Side-Ground

Side ground beads have the spire and distal end removed, but the aperture is ground diagonally. Only three beads of this type were recovered. All are *Olivella* sp. and two are bleached.

Class B2: End-Ground

A single bead had both the spire and distal end removed. It is *O. biplicata* and was found in Facies 1, a disturbed context.

Class B3: Barrel

Barrel beads have spires and distal ends removed, but the degree of end removal is higher, such that much of the aperture is gone (Figure 2d). These were the most frequently encountered bead at CSR. Most (41%) came from Facies 4 and another 20% came from a disturbed context. In southern California these beads begin to appear during the Early Period (King 1981).

Class B6: Double-Oblique

Two types of double-oblique barrel beads were found. In the first subtype the distal end was ground parallel to the proximal end (n=23) (Figure 2e) and the other in which the distal end was ground perpendicular to the proximal end (n=3). This difference in grinding angle would affect the way the bead hangs on cordage. Double-oblique barrel beads are uncommon in California and none have been found in the Great Basin (Milliken and Schwitalla 2012). Neither Bennyhoff and Hughes (1987) nor Milliken and

Schwitalla (2012) were able to examine these beads for their guidebooks. A single bead of this type from the Stege Mound in Richmond, CA came from a level dated to 2785 ± 200 B.P. (UCR-1156) (Bennyhoff and Hughes 1987: 122).

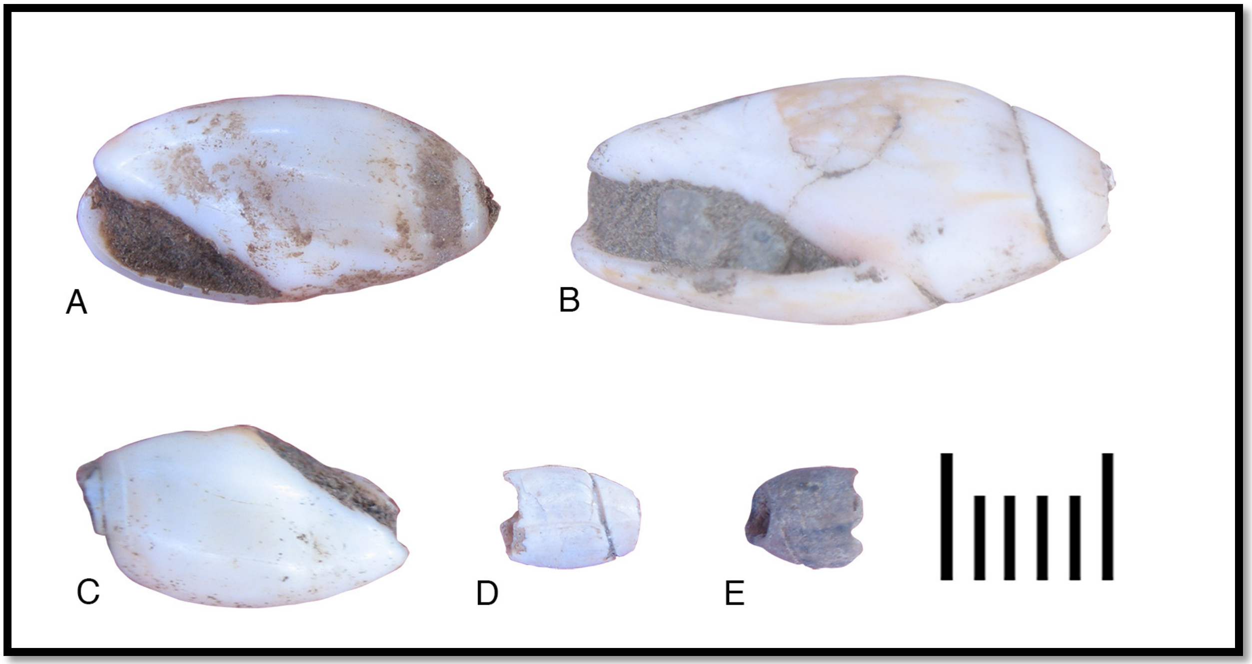

Figure 2. Various shell bead types from Cueva Santa Rita: (a) CSR#952 A1, Simple-spire lopped, natural color; (b) CSR#936 A1, Simple-spire lopped, natural color; (c) CSR#536 A2, Oblique spire-lopped, natural color; (d) CSR#534 B3 Barrel, bleached; (e) CSR#539 B6 Double-oblique, bleached.

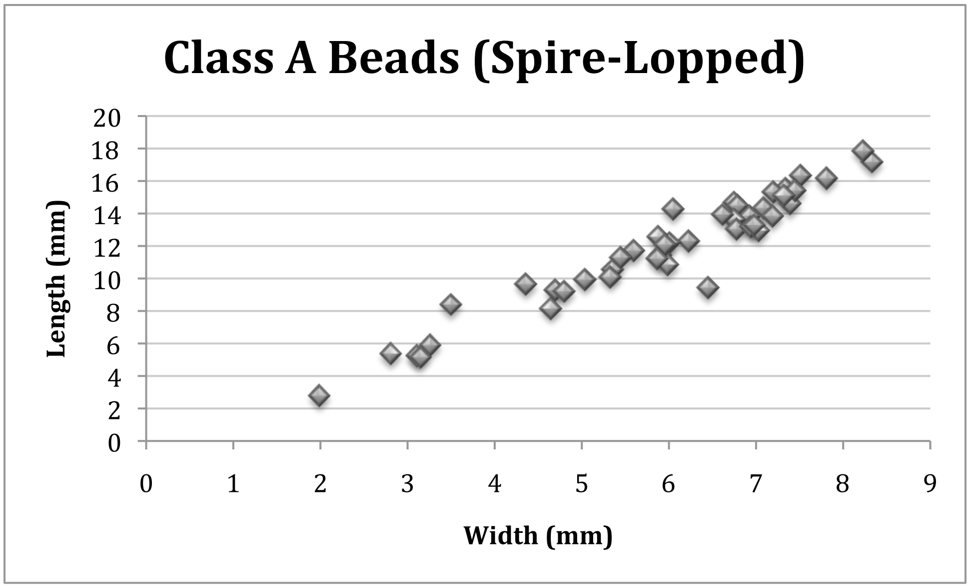

Figure 3. Class A (Spire-Lopped Beads). All species and types.

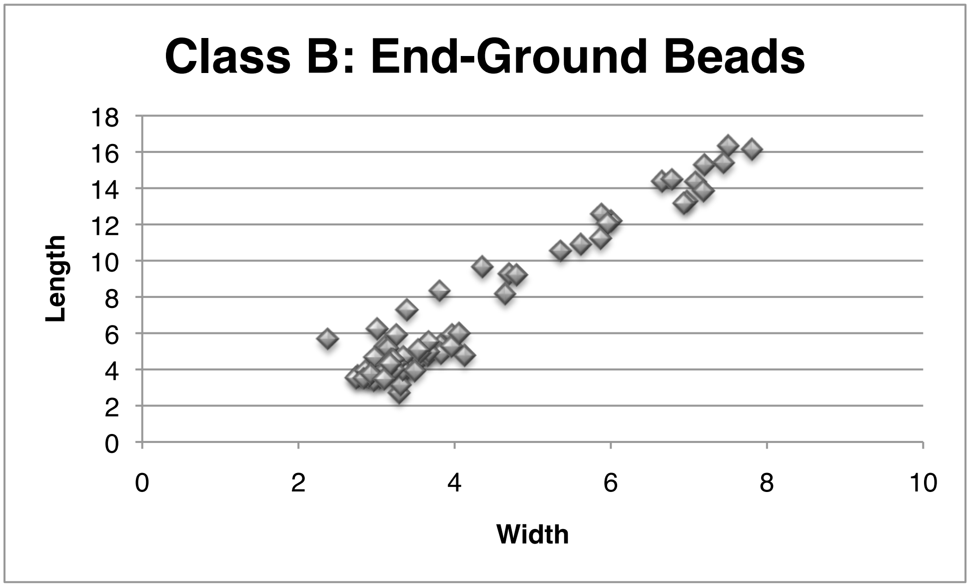

Figure 4. Class B, end-ground beads. All species and bead types.

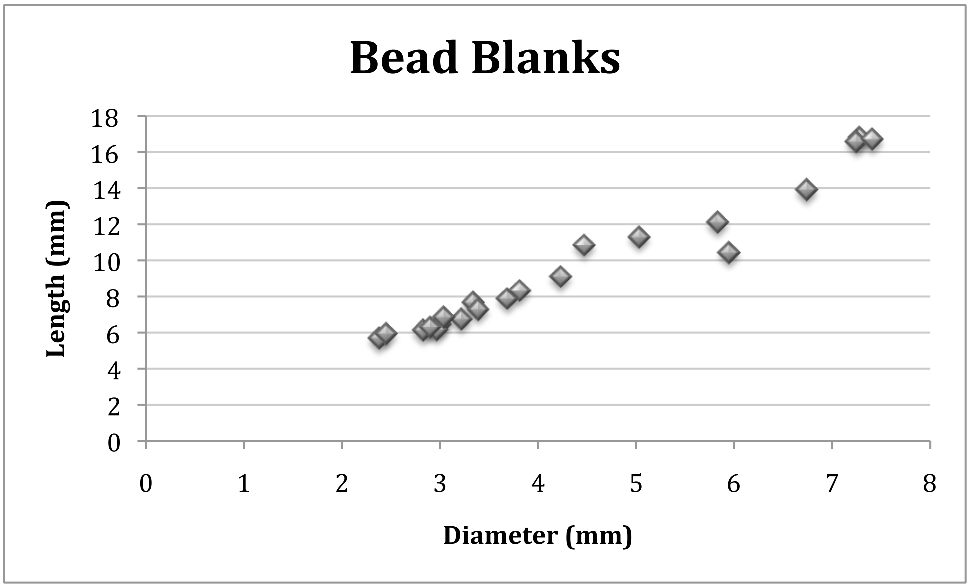

Figure 5. Bead blanks. All species.

Detritus

Analysis of bead manufacturing waste is a particularly useful approach for identifying production locales and understanding what bead types (Arnold 1994) and production techniques (Rosen 1995) were made and utilized. For Class A, spire-lopped beads, neither manufacture technique, grinding or lopping of the spire produces shell detritus (Rosen 1995:97). Grinding the spire off produces a powdered substance and lopping produces such a small piece that it is unlikely to be recovered. Class B, end-lopped beads, could be produced through grinding, bipolar percussion/spire-tapping, breaking, or a mixture of the above. In Rosen's (1995) study, the bipolar technique in the production of Class B beads was confirmed through the identification of battering on the canal end of *Olivella* detritus. To date, no bead detritus has been recovered from CSR. Bulk samples (30 liters) were taken from each level, each feature, and for geoarchaeological analyses. Various samples from all of these contexts have been examined and no bead detritus has been found. Two explanations are proposed. First, the beads requiring the most modification, therefore producing the most detritus, are barrel beads. The majority of barrel beads are less than 4.5 mm in diameter and 93% are between 3 mm and 4 mm in width. As the width generally represents the *Olivella* spp. largest diameter or close to it, this represents the intentional collection of very small *Olivella* shells. It is likely that the spire-tapping method of production of Class B *Olivella* beads of this size would produce very little detritus or detritus too small to see in bulk samples. Second, it may be more efficient to simply grind the ends of Class B beads of this size. As the width of these beads is 2/3 the size of a standard pencil eraser and some are quite delicate and thin-walled, it is difficult to imagine that grinding would not be more feasible than a bipolar or tapping technique (Figure 7). If a grinding technique was utilized on both ends of the bead, there would be no visible detritus produced, only powdered shell. Given that the majority of beads at CSR are spire-lopped, small barrel, and small double-oblique barrel beads, it is probable that grinding was the most commonly used technique in bead production. Grinding is an efficient technique if small portions of bead are being removed. For example, it took Francis (1982: 714) 1 min, 40 seconds to grind the apex off an *Olivella* shell using a basalt block as a grinding platform.

Heat treatment

Four variations in bead color were observed at CSR: natural or non-treated, white, brown, and gray-black (Figure 8). The term "bleached" is used here for any degree of bead heat-treatment. Based on ethnographic work and replications studies, Hartzell (1991) suggests that variations in color are the result of different stages of heating and that overheating results in the gray-black color. She specifically states that an *appropriate* degree of heat treatment is required: too much heat produces black beads with undesirable attributes such as surface spalling (Hartzell 1991:36). Harrington implies that a "white" color is desired, effectively agreeing with Hartzell. Numerous beads at CSR are unbleached, finished beads. Most of the beads Hartzell analyzed (80%) were M Class beads, or normal sequin beads, requiring that the beads be broken and cut into usable sections. Production of Class M beads relies on the natural breakage patterns of the beads along growth lines and most likely relied more on heat treatment to make them amenable to grinding or breaking in predictable ways. This is not necessarily the case at CSR, where beads can be made by simple grinding. Bead color, or heat treatment, could be interpreted in other ways.

Although Hartzig (1991) states that heat treatment is necessary for the production of non-whole beads, it is further hypothesized here that heat-treatment is not a necessary step in the production of whole-shell beads. I suggest that the archaeological evidence at CSR supports the idea that heat treatment is an optional technological process in the manufacture of spire-lopped and end-ground beads. This additional step involves labor and time costs, and risk of failure and loss of beads. This idea is supported by the fact that of the 22 unbleached *O. biplicata*, 44% are blanks and

Figure 7. *Olivella sp.* shell bead. Picture taken on a 1970 penny for scale. Photo taken with a ProScope HR high resolution handheld microscope at 50X.

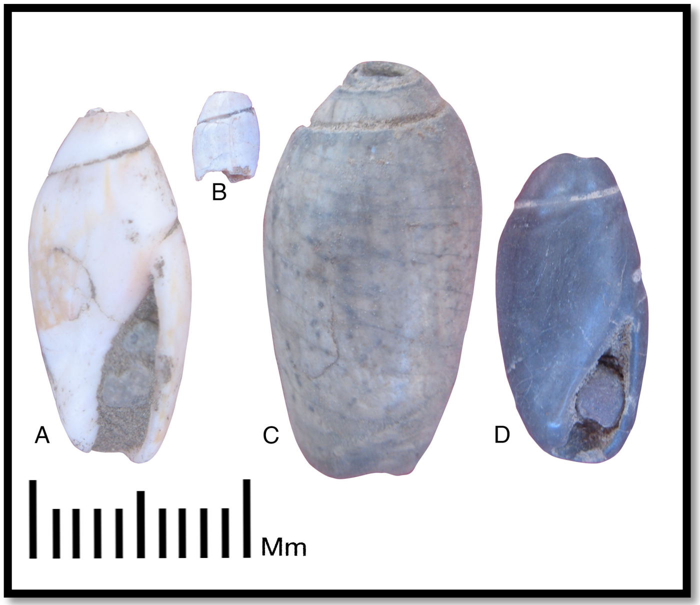

Figure 8. Degree of heat treatment: (a) Natural, unbleached spire-lopped bead; (b) Bleached (white) end-ground bead; (c) Bleached (brown) spire-lopped bead; (d) Bleached (Grey-Black) spire-lopped bead.

56% are beads. If heat treatment is a necessary first step for the production of whole shell beads, then naturally colored complete beads would not be present.

Use-Wear

One of the attributes recorded was the presence or absence of a canal groove. The canal groove is a u-shaped notch worn into the shell by the cordage sliding back and forth along the canal edge during the time the bead was strung. Dahdul (2002:51) also noted the presence of canal grooves and u-shaped curves on spire-lopped specimens, but did not discuss this attribute in her interpretations. The canal groove is only produced if the bead was strung for a significant period of time before discard. There was a significant negative relationship between heat treatment and whether or not it is grooved. In other words, although both beads with natural coloring and heat-treated beads were worn, the majority of beads with canal grooves were not heat-treated (59%). Also, although some shells were intentionally bleached, others may have been discarded or burned for ceremonial purposes. Ten beads were found in features, 60% of them bleached.

Conclusions

The majority (92%) of beads at CSR are of four types: A1, A2, B3, and B6. In general, beads at CSR were what Bennyhoff and Hughes (1987) define as "small" and "medium." Non-metrical attributes of beads are also informative, particularly when investigating the suite of behavioral variability involved in the bead making process. Analysis of heat- treated beads suggest that heat treatment is unnecessary, the degree of heat treatment is an optional step, and that all variations in heat treatment were worn, including untreated beads. The lack of bead detritus in various bulk soil samples combined with the nature of the finished bead assemblage indicates that the majority of beads were likely produced using a grinding technique. Bleaching seems to be an optional process in the bead manufacture sequence. If notching at the apex is an indicator of stringing, natural colored beads and bleached beads were both utilized on cordage. Preferences for variation in bead coloring produced by bleaching is not surprising given that there is color symbolism associated with shell (Trubitt 2003). These kinds of attributes could turn out to be key in identifying group relationships, bead function, or symbolism of shell usage. Additionally, just as bead types are often associated with different groups and time periods, variability in the production process may follow similar patterns.

Regional Patterns

The most commonly found beads in the southern peninsula are spire-lopped beads (Figure 9). The types of *Olivella* beads and species found at Bahía Concepción differ from those found at CSR. Additionally, at Bahía Concepción all *Olivella* sp. were Gulf species and at CSR a strong majority are from the Pacific. It is unknown at this point whether any of these bead types are chronologically sensitive, but the variation in bead type is potentially significant. The variability between the shell bead assemblages at these two sites coincides with linguistic, rock art style, and artifact assemblage divisions previously noted between the southern Cochimí and Guaycura (Hyland 1997).

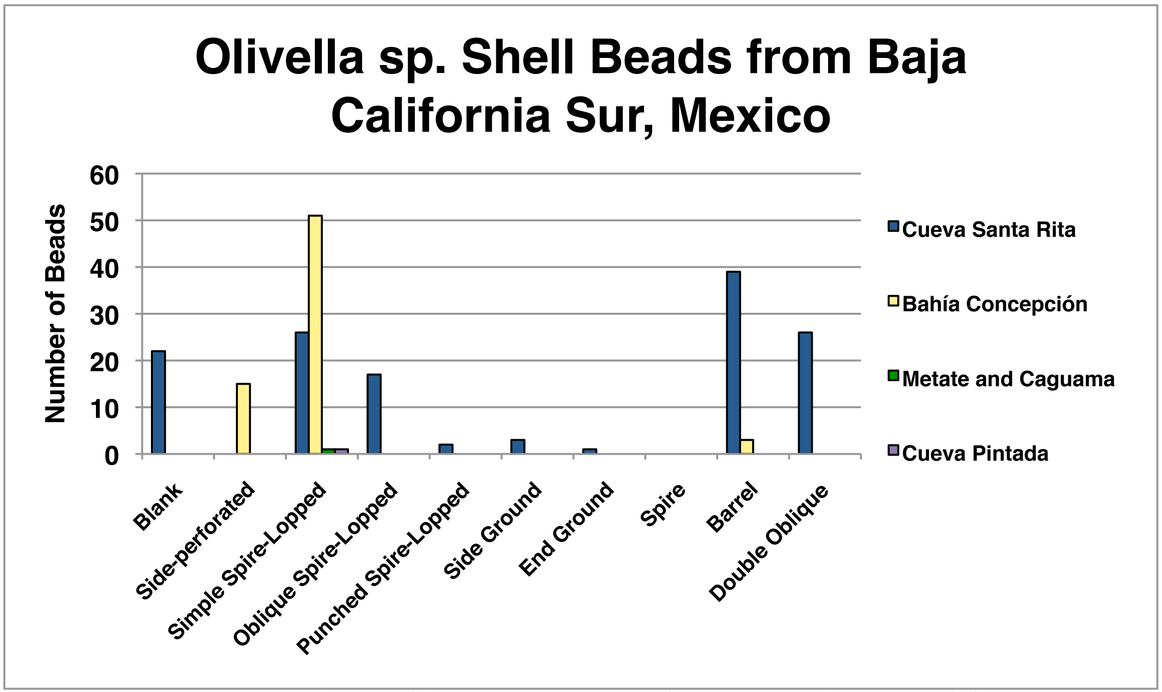

Figure 9. Types and numbers of beads recovered from central Baja California, Mexico.

Domestic Context of Olivella Shell Production

This study of shell beads suggests several things for production organization in terms of locale, techniques, and production sequence. First, shell working and bead manufacture appear to have taken place in the rockshelter. At CSR we have both completed beads and bead blanks, indicating that residents were both consumers and producers. In contrast, when comparing data on completed beads and activities associated with bead production on island Chumash to mainland Chumash consumer sites, Arnold and Munns (1994) found marked differences. It is typical for mainland sites to have thousands of completed beads and no bead detritus, while island sites had few completed beads and large quantities of bead waste. My interpretation based on available data suggests that the high numbers of bead blanks, relatively stable bead and bead blank counts across time periods, and production of bead types that produce low volume, very small, or no bead waste would generate the bead assemblage patterns seen at CSR. Given the context, shell bead manufacture at CSR occurred in the same spaces as other craft activities such as cordage and reed bead manufacture.

Resource Acquisition

Although CSR is located in close proximity to the Gulf coast, the majority of marine shell beads come from the Pacific. This suggests clear cultural, economic, and/or symbolic ties to the Pacific. The high number of *O. biplicata* relative to *O. dama* indicate either some form of trade from east to west or direct procurement of these resources by area residents. During the early mission period there are clear difficulties in east-west travel between males from different rancherías (groups of 3-5 families) between the Guaycura of the SG and Magdalena Plains. While passing from the foothills of the SG into the Magdalena Plains on their way to the Magdalena Bay (Figure 1), through continuous Guaycura territory, Father Clemente Guillen stated:

> Two of the men who accompanied us from Cuedené…refused to continue and took another trail…The cause for leaving us…was because they saw us determined to continue down the way on our trip, and they feared their neighbors of Santa Marîa Tacanopá, one of whose men they had killed a few days before as we later found of from the said people of Tacanopá [Mathes 1979 (Guillen):44-45].

This does not mean all SG Guaycura were prohibited travel to the west or that these boundaries were static through time. What is clear is that community organization, especially at the local and intermediate levels, is more complex and dynamic than the layer cake model currently relates (see Chapter 1).

At a larger scale it is very clear from even the earliest explorer and mission accounts that the Guaycura peoples and the Pericú, including the Isleño Pericú or Isleños, inhabiting Isla San José, ~25 km east of CSR, were bitter enemies (Figure 1).

> These wars that these Indians have are over some fisheries and a place where much tobacco and camote, a root like sweet potatoes of Spain, are fathered. On the 2nd day of December the prince Conichí, son of Bacarí, king of this land…left this camp, and having taken over 200 Indians to the said fishing and shellfish site, after eight days, while he and his companions were sleeping, the king of the Guaycuros surprised and attacked them. The said Conichí, his wife, and a son of two years who was baptized were killed, along with over 30 persons including women and children [Mathes 1992 (Ortega 1633-1634): 241].

The high number of *O. biplicata* (n=104), which can only be gathered from the Pacific Coast, throughout all levels and units, suggests long-term social networks moving in a lateral direction. The low number of *O. dama* shell beads (n=5), which can only be found along the Gulf coast, despite the sites much closer proximity to the Gulf coast (15 km to Gulf vs. 80 km Pacific), suggests either a strong preference for *O. biplicata* or an avoidance of the Gulf Coast for at least the past 4,000 years. If the latter is true, social networks would not necessarily be lateral to the peninsulas maximum extent of a coast to coast, but in a western direction, towards the Magdalena plains, indicating a West Coast-Eastern Mountain connection. A possible but less probable explanation is that the Guaycura had as much difficulty navigating the steep eastern slopes of the SG as the missionaries, making travel to the Gulf coast difficult. This idea is less likely do the fact that missionaries had to deal with unfamiliar territory, uncertain water sources, as well as carrying heavy equipment and traveling with pack animals.

Multiple roles of Shell Beads-Use and Consumption

Observations made by missionaries and explorers involving shells include accounts of gift-giving; display; personal adornment; possible source locations; and production, often directly associated with geographic locations. The multiple contexts of shell ornaments mentioned by missionaries raise interesting questions that would otherwise be difficult to discuss based on artifact provenience alone, for example the symbolic meaning of shell in social exchanges. Geographic location can also be important if there is shell bead production variability by social group.

Shell beads and pendants were likely an important expression of group membership. Not only the kind of shell, but the manner of adornment. Barco (1981:) noted that men were naked except for some diversity in adornments, which varied by nation. The following is an excerpt detailing the variability in male head adornments between the three southern groups:

> "Thus, the Pericúes of Cabo San Lucas used to adorn their head with pearls, knotting them and entangling them in their hair, which they kept long. They wove some small white feathers into their hair, which artificial adornment, together with the pears, seen from a distance, could easily give the impression of being a wig…Those of Loreto used to gird their waist with a finely woven belt, and their forehead with a peculiar little net. Some of them added a necklace to the net, with certain finely worked mother-of-pearl figures, and trimmed sometimes by some little round fruit, in the manner of beads…The Cochimíes of the north…did not use pearls, as did those of the south, but they did have an even more showy adornment, to wit: a small headdress made of mother-of-pearl with which they circled their heads, as if with a crown. In order to form it they first pared off the mother-of-pearl and they polished it until it was smooth and bright on both sides. Then, they used a flint to split the shells in strips of six or eight líneas [1 líneas=1.9mm] long, and two or three wide. Making holes in the ends, they joined them in such a way that they formed a circle, which they place on the head, with the strips of shell hanging down all over. The Pericús of the South also had, in ancient times, this custom of wearing a headdress. It was formed by some small snail shells, white and round, which resembled pearls."

The different shell species and adornment style between Cochimí, Guaycura, and Pericú head nets and headdresses are important to note. The tools and motor skills used are also notable. Two mother-of-pearl pendants fitting the description and measurements of the southern Cochimí shell bead headdress were found at Cueva Santa Rita (Figure 8). The "small snail shells" ascribed to the Pericú could be the predatory sea snail, *Olivella*.

The ethnohistoric record is sparse when it comes to *Olivella* shell beads specifically. In the two cases where "snail shell" in particular is mentioned, both were observations of

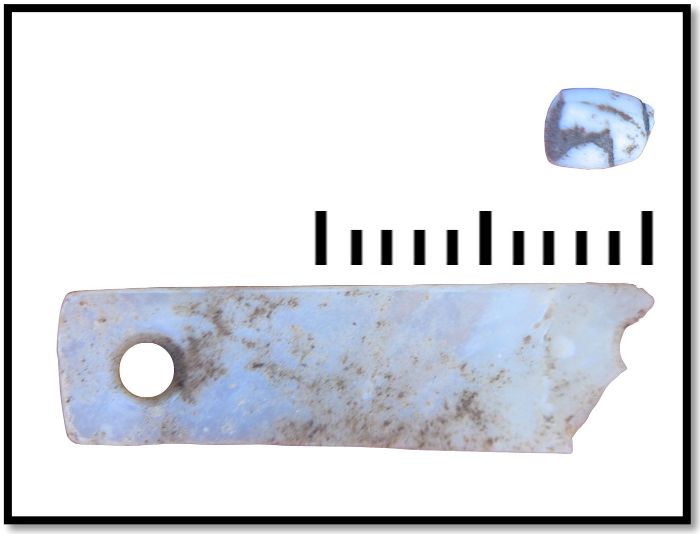

Figure 10. Top: Double-Oblique Barrel Bead (CSR 532). Bottom: Mother-of-pearl male headdress fragment (CSR 922). The split shell strips described above would be 11.4-15.2mm long and 3.8-5.7 mm wide. The fragment above is approximately 18.0 mm long and 4.5mm wide.

Pericú personal adornments: one was male, the other female. In contrast, mother-of-pearl shell is mentioned relatively frequently. In the Guaycura region, several instances of trade with a group of Guaycura men included a necklace of "mother-of-pear shell" and some "little shells of the kind in which pearls grow" were recorded during the voyage of Francisco de Ulloa when he spent several days at Magdalena Bay in 1539 (Wagner 1920 [Ulloa 1539]:33 and 35).

The functional interpretation of *Olivella* beads is most commonly for personal adornment, but archaeological and ethnohistoric records point to a need for archaeologists to look closer at shell bead assemblages, as the reality appears to be much more multidimensional. For example, given the nature of assemblage, such as high numbers and diversity in cordage production at the site and lack of strung shell beads, we cannot rule out a hypothesis suggested by Vellanoweth's et al. (2003) that perforated *Olivella* could also have been used as fishing implements. In trading with early explorers and missionaries, marine shell is one of the most frequently traded items. Shell was a such a commonly traded item for the Guaycura that shell itself was used as a symbol to begin trading with colonialists: "they went up a hill which was near us and again made a sign that they wished to resume trading as on the preceding day, which sign was to raise an arrow with a shell on it, of the kind they gave us…(Ulloa 1539:35)." Based on the number of accounts detailing mother-of-pearl shell trade, different marine shell artifacts may have different routes, frequency, and duration of circulation (Trubitt 2003). In the northern SG, at Metate Cave a single *Olivella* bead was recovered as the terminal bead on a string of Carrizo node beads (Tuohy 1979). Strings of carrizo node beads are typically fragments of women's skirts. This style may be indicative of variation at the household or intraregional level. A series of burials excavated on the Gulf coast at Bahía de Los Angeles in central Baja California, also known as the Palmer Collection, found *Olivella* beads used in a variety of contexts (Massey and Osborne 1961). In addition to four broken strings of *O. biplicata* beads, fragments of *O. biplicata* shells were found as inlay on a wooden artifact, possibly a bull-roarer, and a string of *Olivella* beads was tied in with a human hair cape.

Numerous archaeologists have commented that archaeological investigation of shell beads has not reached its full potential (Trubitt 2003; Eerkens 2005). Similar to early archaeology and its treatment of lithic debitage, various aspects of shell have been erroneously viewed as having few implications for archaeological interpretation. This research is part of a long-term anthropological investigation in the southern SG. These data are preliminary and it is important to continue to assess the bead production system across the Guaycura and broader southern Peninsula as more sites are reanalyzed and excavated. My results highlight the interpretive significance of integrating multiple lines of evidence and data sets at the regional and local scale.

References Cited

Arnold, Jeanne E., and Anne Munns
1994 Independent or Attached Specialization: The Organization of Shell Bead Production in California. *Journal of Field Archaeology* 21:473-489.
Aviles, Brian A. and Robert L. Hoover
1997 Two Californias, Three Religious Orders, and Fifty Missions: A Comparison of the Missonary Systems of Baja and Alta California. *Pacfic Coast Archaeological Society Quarterly* 33 (3): 1-28.
Baegert, Johann J.
1952 [1772] *Observations in Lower California*. Translated from German by M.M. Brandenburg and C. L. Baumann. Berkeley: University of California Press.
1982 *The Letters of Jacob Baegert, 1749-1762: Jesuit Missionary in California*. Translated by E. Schulz-Bischof, edited by Doyce B. Nunis, Jr. Los Angeles: Dawson's Book Shop.
Bennyhoff, James A. and Richard E. Hughes
1987 *Shell Bead and Ornament Exchange Networks Between California and The Western Great Basin.* Anthropological Papers Vol. 64, Pt. 2. American Museum of Natural History, New York.
Bizzarro, Joseph J.
2008 A Review of the Physical and Biological Characteristics of the Bahía Magdalena Lagoon Complex Baja California Sur, Mexico. *Bulletin of the Southern California Academy of Sciences*. Vol. 107, Issue 1.
Costin, Cathy L.
2001 Craft production systems. In *Archaeology at the Millennium: A Sourcebook*, edited by G.M. Feinman and T.D. Price, pp. 273–327. Kluwer Academic/Plenum Publishers, New York.
Dahdul, Mariam
2002 *Beads and Ornaments from the Coachella Valley*. M.A. thesis. California State University, Fullerton.
Eerkens, Jelmer.W., Gregory S. Herbert, Jeffery S. Rosenthal, and Howard Spero, J.
2005. *Provenance analysis of Olivella biplicata shell beads from the California and Oregon Coast by stable isotope fingerprinting*. Academic Press.
Francis, P., Jr.,
1982 Experiments With Early Techniques for Making Whole Shells into Beads. *Current Anthropology* 23:713-714.
Francis, Peter Jr.
1989 The Manufacture of Beads from Shell, edited by C. Hayes and L. Ceci. *Proceedings of the 1986 Shell Bead Conference* 20: 25-36 Rochester, N.Y.
Fitzgerald, Richard T., Terry Jones, Adella Schroth
2005 Ancient long-distance trade in Western North America: new AMS radiocarbon dates from Southern California. *Journal of Archaeological Science* 32:423-434.
Gamble, Lynn H. and Irma C. Zepeda
2002 Social Differentiation and Exchange among the Kumeyaay Indians during the Historic Period in California. *Historical Archaeology* 36:71-91.
Harasewych, M.G. and Fabio Moretzsohn
2010 *The Book of Shells: A Life-Size Guide to Identifying and Classifying Six Hundred Seashells*. The University of Chicago Press. Chicago and London.
Hartzell, Leslie L.
1991 Archaeological Evidence for Stages of Manufacture of Olivella Shell Beads in

California. *Journal of California and Great Basin Anthropology* 13(1): 29-39.

Hyland, Justin R.
1997 *Image, Land, and Lineage: Hunter-Gatherer Archaeology in Central Baja California, Mexico*. Ph.D. dissertation. University of California, Berkeley.

King, Chester D.
1981 *The Evolution of Chumash Society: A Comparative Study of Artifacts used in Social System Maintenance in the Santa Barbara Channel Region before A.D. 1804*. Ph.D. dissertation. University of California, Davis.

Kozuch, Laura
2002 Olivella Beads from Spiro and the Plains. *American Antiquity* 67:697-709.

Laylander, Don
2006 Issues in Baja California Prehistory. In *The Prehistory of Baja California,* edited by D. Laylander and J. Moore, pp.1-13. University Press of Florida.

León de la Luz, José, Jon Rebman, Miguel Domínguez-León, Raymundo Domínguez-Cadena
2008 The Vascular Flora and Floristic Relationships of the Sierra de La Giganta in Baja California Sur, Mexico. *Revista Mexicana de Biodiversidad* 79: 29-65.

Macko, Michael E.
1984 *The Economics of* Olivella Biplicata *Shell Bead Production and Exchange in Southern California.* Paper presented at the Annual Meeting of the Society for American Archaeology.

Massey, William C.
1949 Tribes and Languages of Baja California. *Southwestern Journal of Anthropology* 5:272-307.

Massey, William C. and Carolyn Osborne
1961 *A Burial Cave in Baja California: The Palmer Collection, 1887*. Anthropological Records Vol. 16(8) University of California Press, Berkeley.

Masucci, Maria A.
1995. Marine Shell Bead Production and the Role of Domestic Craft Activities in the Economy of the Guangala Phase, Southwest Ecuador. *Latin American Antiquity* 6, 70-84.

McGuire, R.H and Howard A.V.
1987 The Structure and Organization of Hohokam Shell Exchange. *The Kiva* 52(2):113-146.

Milliken, Randall T., Al W. Schwitalla
2012 *California and Great Basin Shell Bead Guide*. Left Coast Press.

Nelson, Richard S.
1991 *Hohokam Marine Shell Exchange and Artifacts*. Arizona State Museum Archaeological Series 179. Arizona State Museum, Tuscon, AZ.

Olsson, Axel A.
1956 Studies on the Genus Olivella. *Proceedings of the Academy of Natural Sciences of Philadelphia* 108: 155-225.

Ritter, Eric William
1979 *An Archaeological Study of South-Central Baja California, Mexico*. Ph.D. dissertation. University of California, Davis.

Rosen, Martin E.
1995 IMP-6427, A Lake Cahuilla Shell Bead Manufacturing Site. *Proceeding of the Society for California Archaeology* 8: 87-104.

Sowerby, George B.

1825 *A Catalog of the Shells Contained in the Collection of the Late Earl Tankerville*. London, privately published. pp.VII-XXXIV.

Swainson, W.

1831 *Zoological Illustrations, or original figures and descriptions of new, rare, or interesting animals, selected chiefly from the classes or ornithology, entomology, and conchology* 2(2). London: Richard Taylor for W. Wood, London.

Trubitt, Mary Beth D.

2003. The Production and Exchange of Marine Shell Prestige Goods. *Journal of Archaeological Research* 11:243-277.

Troost, Alison I, Samantha D. Rupert, Ariel Z. Cyrus, Frank V. Paladino, Benjamin F. Dattilo, and Winfried S. Peters

2012 What can we learn from confusing *Olivella columellaris* and *O. semistriata* (Olivellidae, Gastropoda), two key species in panamic sandy beach ecosystems? Biota Neotropics 12(2):101-113.

Tuohy, Donald

1978 *Cultural history in the Comondu Region, Baja California, Mexico: with appendix on Metate Cave string and twine analysis by Carolyn M. Osborne*. Ph.D. dissertation. University of Nevada, Reno.

Velázquez-Castro, Adrián

2012 The Study of Shell Object Manufacturing Techniques from the Perspective of Experimental Archaeology and Work Traces. In *New Approaches in Theory and Techniques*, edited by Imma Ollich-Castanyer. Electric document, http://www.intechopen.com/books/archaeology-new-approaches-in-theory-and-techniques/the-study-of-shell-object-manufacturing-techniques-from-the-perspective-of-experimental-archaeology-, accessed November 15, 2013.

Vellanoweth, René L., Melissa R. Lambright, Jon M. Erlandson, Torben C. Rick

2003. Early New World maritime technologies: sea grass cordage, shell beads, and a bone tool from Cave of the Chimneys, San Miguel Island, California, USA. *Journal of Archaeological Science* 30:1161-1173.

Vellanoweth, René L.

2001 AMS Radiocarbon Dating and Shell Bead Chronologies: Middle Holocene Trade and Interaction in Western North America. *Journal of Archaeological Science* 28:941-950.

Wiggins, Ira L

1980 *Flora of Baja California*. Stanford University Press. Stanford, CA.

Wood, W.

1828. *Supplement to the Index Testaceologicus; or a catalogue of shells, British and Foreign*. London: Richard Taylor for W. Wood, London.

Yerkes, Richard W.

1993 Methods of Manufacturing Shell Beads at Prehistoric Mississippian Sites in southeastern North America. *Traces et fonction: les gestes retrouvés Colloque international de Liege Éditions ERAUL* Volume 50:235-232.

Zárate-Ovando, Bulmara, Eduardo Palacios, Héctor Reyes-Bonilla, Edgar Amador, Georgina Saad

2006. Waterbirds of the Lagoon Complex Magdalena Bay-Almejas, Baja California Sur, Mexico. *Waterbirds* 29:350-364.

Chapter 5: Prehistoric Textiles from Cueva Santa Rita, Baja California Sur, Mexico.

The initial research questions that drove this study are based largely on the idea that although there are numerous sites in Baja California Sur with well-preserved fiber industries, we do not have a strong understanding of either temporal or geographical textile technologies. The overall goal then is to describe the cordage technologies present at Cueva Santa Rita (CSR) to develop a regional understanding of this important prehistoric industry.

A seemingly inconspicuous character in the artifact assemblage, even at well-preserved sites, cordage is often one of the last materials subjected to detailed study, particularly in this relatively archaeologically unknown region. This is most evident in site reports that prioritize the analysis of other materials such as lithics, bone, basketry, ceramics, and fail to report on large quantities of cordage. It is easy to overlook the importance of cordage to humanity, both in the past and present. Karen Hardy poignantly states:

> String, cordage, or something that ties things together is such a fundamental part of everyday life that it is taken completely for granted. Such is the importance of string to humans that the knowledge and use of string or something that ties things together and makes interlaced materials is included in Brown's [1991] list of cultural universals [Hardy 2008:217].

Considering the above, it seems natural to build a more complete regional understanding of cordage, the foundation for so many cultural materials and often a shared attribute of composite artifacts. Informed and guided by ethnoarchaeological and ethnohistorical research as well as site reports of cordage attributes, this project is primarily a technical study that presents site-specific descriptive analysis. It also includes an intra-site comparison of cordage to determine the homogeneity of artifacts at Cueva Santa Rita.

Fiber Industry from Cueva Santa Rita

The textile assemblage at CSR consists of numerous lengths of cordage, sinew string, netting, matting, plaiting, quid, agave fiber masses, processed agave leaves, pointed sticks, sandstone slabs, metates, stone scrapers, and bone awls. Cordage was found un-knotted, knotted, strung with reed node beads, as elements in matting, knotted into nets, and made from at least two kinds of vegetal materials and spun hair. Although analysis is still ongoing, preliminary data demonstrate important observations about textiles in the southern Sierra de la Giganta. Cordage was the most common textile artifact recovered. Although the majority of cordage is 2-ply, S-spun and Z-twist, there are 11 different types represented in the collection.

Methods and Protocol

Analysis of textiles is guided by archaeological site reports in Baja California and western North America (Andrews et al. 1986; Andrews and Adovasio 1980; Tuohy

1978), reference books (Ashley 1944), and peer-reviewed publications (Haas 2001; Laughlin et al. 1954). None of the specimens were cleaned. Notes were made in the database when surface contaminants were visible, usually organic matter adhering to knots or beads. Identification was made macroscopically and microscopically with a Bodelin Proscope HR USB Microscope with a 50X lense. Microscopic analysis was particularly useful when knots were difficult to identify. The Proscope was also used to take pictures and videos of textiles, which are embedded into the digital cordage catalog. All specimens were measured using an electronic digital caliper and all units are reported in metric. Photos of specimens include a scale and often include shots taken from various angles to facilitate identification.

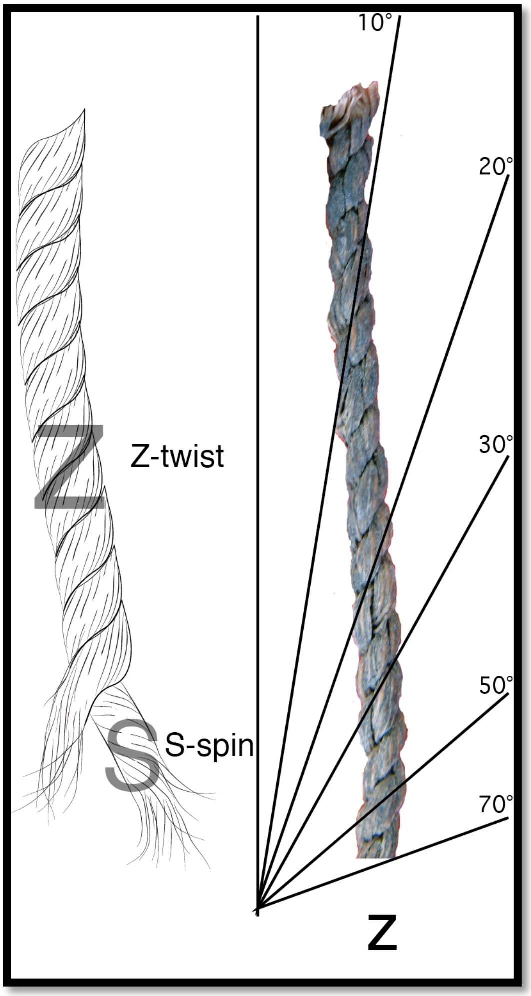

Figure 1. Illustrations of cordage: left, an illustration of cordage showing initial s-spin and final z-twist of a 2-ply or simple cord; right, illustration of how to measure angle of twist in cordage.

In this chapter, *cordage* is a very generalized term used to describe bundles of fibers that are spun and then twisted together, regardless of thickness. The initial bundle of processed fibers gathered and turned around its axis is referred to as the *spin* (Figure 1). The production of simple cordage occurs when two or more spun elements are *twisted* together to form a double helix around a central axis. Complex cordage is when two or more simple cordage pieces are twisted together. Each cordage artifact has an initial spin and a final twist and can only be in one of two states: "Z" or "S." There are four possible combinations of simple cordage: 1) S-spun, S-twist; 2) Z-spun, Z-twist; 3) S-spun, Z-twist; and 4) Z-spun, S-twist. When spun fibers are twisted together, the final twist is commonly in the opposite direction of the initial spin.

Results

Cordage Classification at CSR

Division of cordage into types is based on direction of spin, direction of twist, and number of plies (Andrews et al. 1986). Individual attributes are discussed in more detail under "Cordage Morphology." In total, 179 cordage artifacts from 6 excavation units were divided into 11 types (Table 1).

Table 1. Cordage Types by Excavation Unit. *Recovered from site during collection of surface artifacts.

	Single Ply		Simple Cordage				Complex Cordage				Braid	
	Type 1	Type 2	Type 3	Type 4	Type 5	Type 6	Type 7	Type 8	Type 9	Type 10	Type 11	**Total**
Surface*							1					**1**
Unit 1			3									**3**
Unit 2	2	2	46	10			5	1				**66**
Unit 3	3	2	38	5	2	2	2					**54**
Unit 4	2	1	12	7		1	6		1	1	2	**32**
Unit 6	1	1	21	2	1	1	2					**29**
Total	**8**	**6**	**120**	**24**	**3**	**4**	**16**	**1**	**1**	**1**	**2**	

Type 1, Single Ply, Z-Twist

Type 1 is a bundle of fiber that has been gathered and twisted around its own axis (Figure 2). Out of 14 single ply elements, 8 had a Z-twist. They range in diameter from .77 mm to 1.63 mm. Half appear to be made from animal hair and one is part of a large knot.

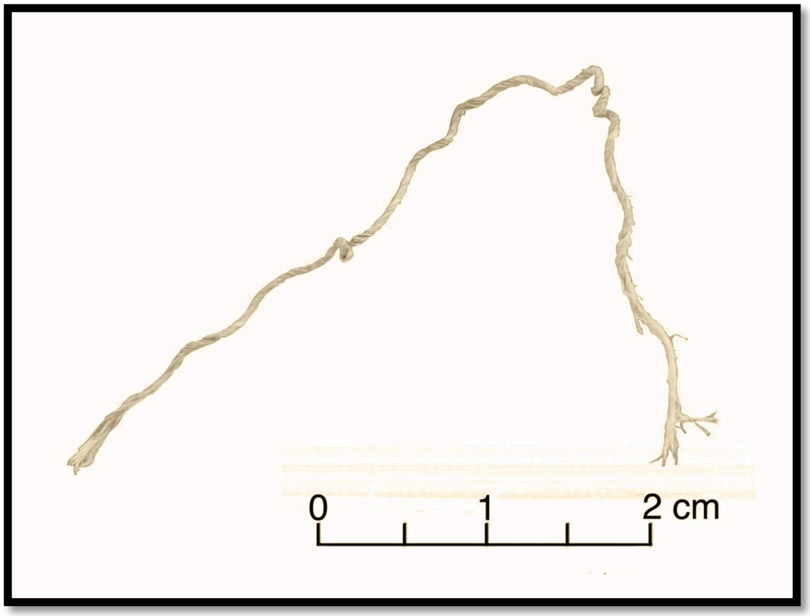

Figure 2. Type 1, Single Ply, CSR#2110.

Type 2, Single Ply, S-Twist

Type 2 is the same as Type 1, but twisted in an "S" direction. A total of 6 artifacts were single ply with an S-twist. One of these had a knot and one is made of animal fibers (Figure 3). The diameter ranges from .63 mm to 1.12 mm, the longest of which (CSR#2070) is a twisted bundle.

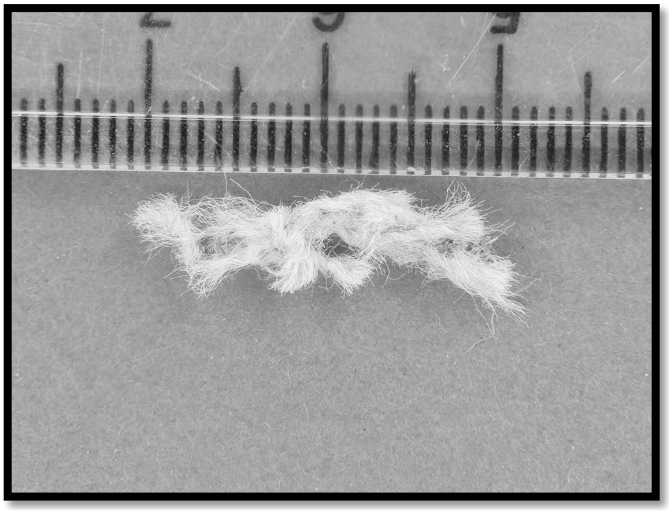

Figure 3. Type 2, Single Ply, CSR#2126. Animal hair.

Simple Cordage: Type 3, Two Ply, S- spun, Z-Twist

In this cordage type, two S-spun elements are twisted together to form a Z-twist (Figure 4a). Type 3 was the most common kind of cordage at Cueva Santa Rita. The maximum diameter is 6.48 mm and the finest cordage is .61 mm. Six specimens are rat-tailed. Of 18 charred specimens, 16 are charred at one or both ends. CSR#289 was threaded through leather. Fifty-five show clear evidence of use-wear, identified as organic coating, tearing of fibers from abrasion, or fraying fibers along the line of twist. Twist angle ranges from 20°-70°. Knots are present on 24 Type 3 artifacts, 19 have a single knot and 5 have two knots. Eighteen of these knots are Overhand and the others are unidentified. One knotted piece was tied into a large loop (50 cm long) of necklace length, one was tied into a loop of bracelet length (31.8 cm long), and three others were strung with reed node beads. One appeared to be looped around something that is now missing. Splicing was visible on 7 specimens. Only a single specimen was made of animal hair, the rest were made from plant raw materials.

Simple Cordage: Type 4, Two Ply, Z-spin, S-Twist
In the type 4 category, two Z-spun elements are twisted together to form an "S" pattern. Twenty-four or 13% of cordage artifacts fall into this category. One of the plies contains a Figure 8 knot and is coated in organic matter. Four are made of animal hair. One artifact has some organic staining, one is possibly coated in pigment, and one is connected to a large piece of leather or skin. The minimum diameter is .81 mm and the maximum is 4.96 mm.

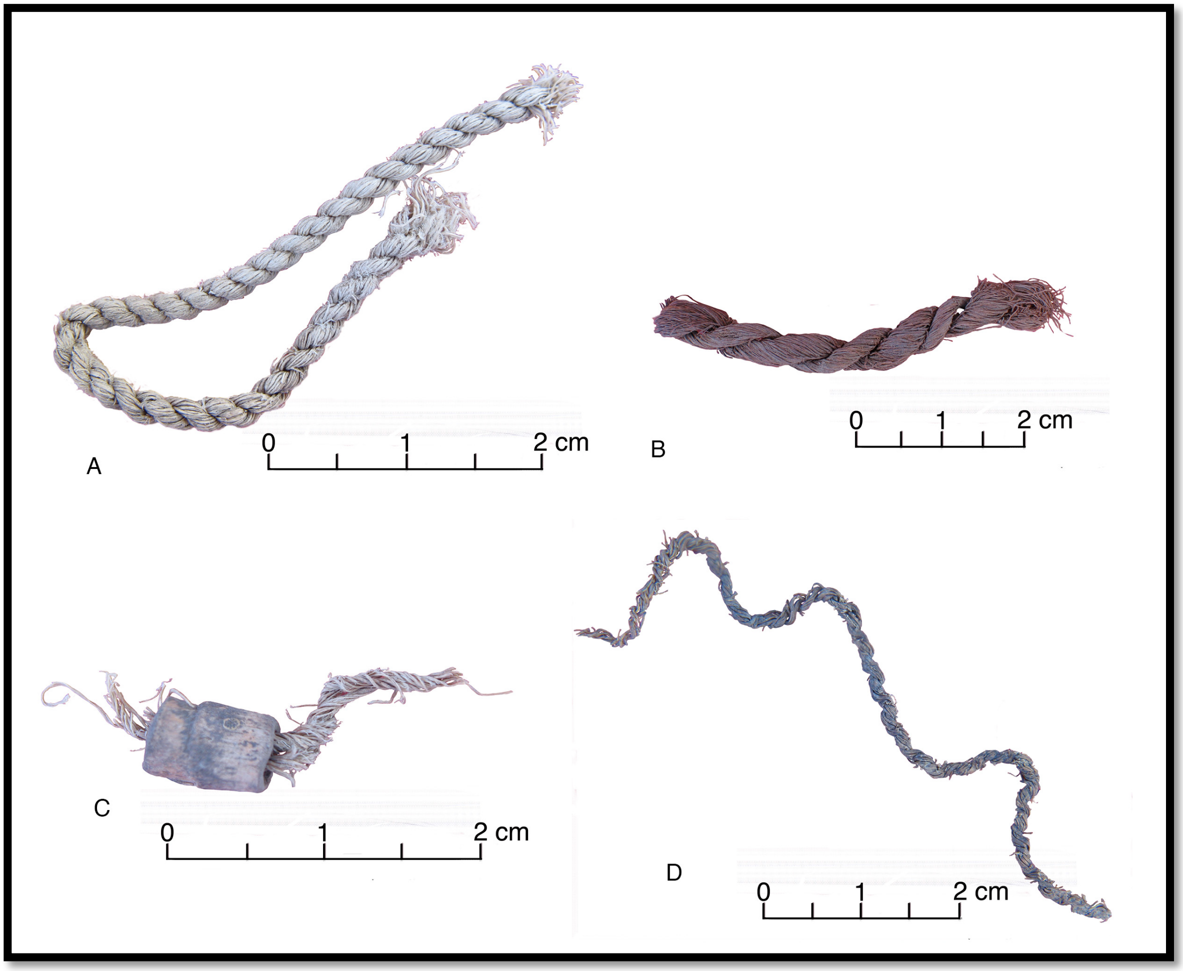

Figure 4. Simple Cordage. A) Type 3 Cordage, CSR#329; B) Type 4, CSR#2104; C) Type 5 Cordage, CSR#2064; D) Type 6, CSR#2106.

Simple Cordage: Type 5, Two Ply, Z-spin, Z-Twist
Type 5 simple cordage is constructed by spinning and twisting in a Z direction. There are 3 artifacts in the Type 5 category. One is strung with a reed node bead. The minimum diameter is .84 mm and maximum is 3.58 mm. The 3 specimens are quite different. One is .84 mm in diameter, with 50°angle of twist and 14 twists per cm. The second specimen was 1.67 mm in diameter, with 7 twists per cm and a 30°angle of twist. This specimen was unraveling at one end and was beaded with reed nodes. The last artifact was the longest (5 cm) and thickest (3.58 mm).

Simple Cordage: Type 6, Two Ply, S-spin, S-Twist
Type 6 is similar to Type 5, but with spin and twist in an S direction. Four artifacts fall under this type. Two are knotted with Overhand knots. One artifact is coated in cactus spines and the cactus "hair" that coats cactus fruit, suggesting that it may have been digested.

Complex Cordage: Type 7, Four Ply, Z-spun, Z-Twist
In this type, two Z-spun, S-twist plies are Z-twisted together. With 16 specimens, Type 7 is the most numerous of the complex cordage (Figure 5a). One specimen is coated in red ochre, two have knots and one of them is a Square knot. One is rat-tailed and all are made from plant materials. Nine show obvious signs of wear (fraying or rubbing) along the length of the cord, on beads, or at the ends. Three are unraveling, one is charred, and one is spliced.

Complex Cordage, Type 8, Four-ply, S-spun, S-Twist
A single specimen consists of two S-spun, Z-twist cords that are loosely twisted together in a final S-twist (Figure 5b). It has clear use-wear along the length. The diameter is relatively thick at 3.52 mm and length is 101.08 mm. One of the simple cords was measured at 2.21 mm in diameter.

Complex Cordage, Type 9, Four-ply, S-spun, Z-Twist
A single specimen of this type was found strung with reed node beads. It is 32.46 mm in length and .80 mm thick. Angle of twist is 40 degrees.

Complex Cordage, Type 10, Six-ply, Z-spun, Z-Twist
A single artifact of this type was found in Unit 4, Level 6. It is 15.62 mm long and 1.87 mm in diameter. Angle of twist is 40 degrees and it has 6 twists per cm.

Type 11, Braid
Two braided cordage artifacts were recovered (Figure 6). Both braids consist of untwisted bunches of fiber that are braided together. They have a flattened appearance and are coated in organic matter. Other braid types include braiding elements of Z-or S-twisted cord (Hyland 1997; Tuohy 1978) and the extensive use of two different kinds of braids to bundle bones in secondary burials in the Cape Region (Massey 1955). The latter is diagnostic of the Las Palmas culture.

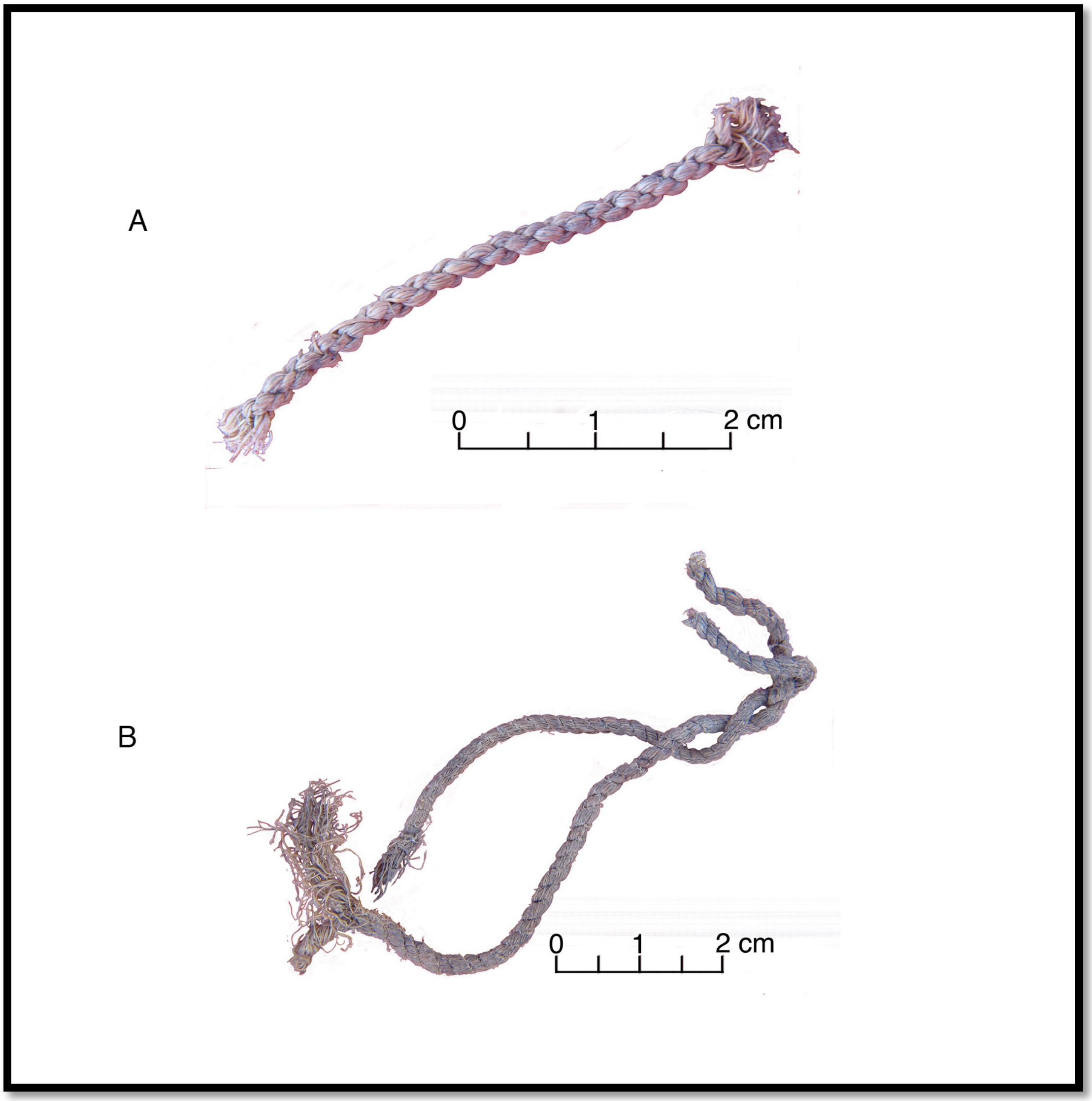

Figure 5. Complex Cordage. A) Type 7, CSR#1251; B) Type 8, CSR#122.

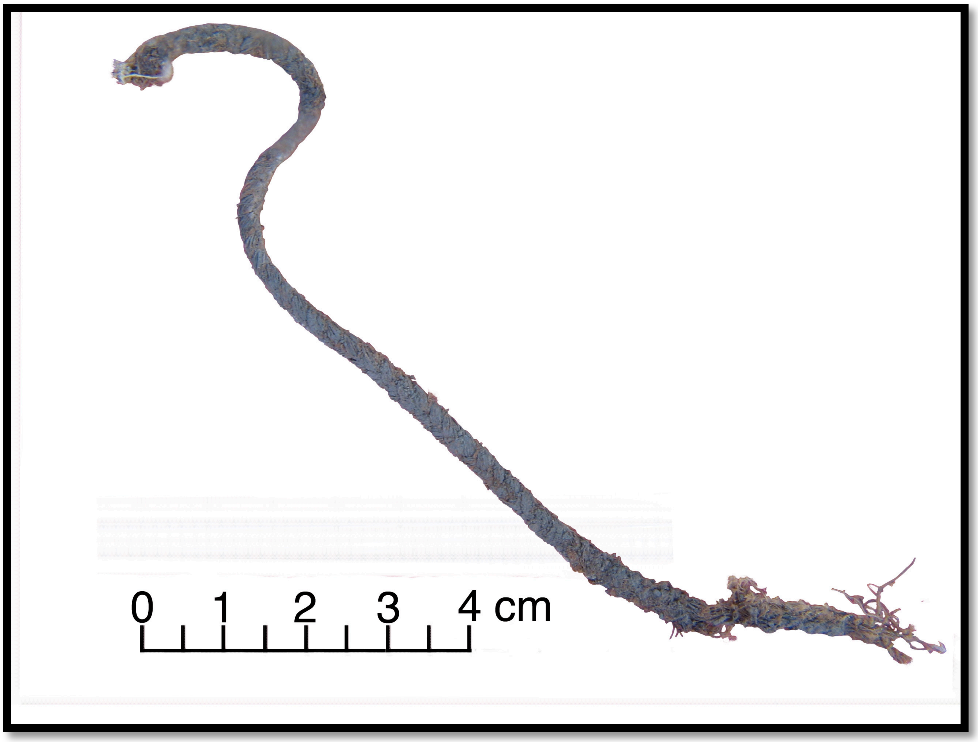

Figure 6. Type 11, Braid.

Cordage Morphology and Discussion

Although cordage types are described above, typologies based solely on spin, twist, and ply can mask considerable variability. For example, the cordage in Figure 7a-d are all type 3 cords, but are clearly different. To get a sense of the assemblage, additional description is necessary. The following attributes were recorded and measured from CSR cordage artifacts: raw material (vegetal or hair), length, diameter, number of knots, type of knot, direction of initial spin, final twist, number of plies, twist per cm, twist angle, range in twist angle, wear (absence/presence), location of wear, provenience, charring (absence/presence), and location of charring. Knots were identified using knot reference books (Ashley 1944) and archaeological site reports (Andrews and Adovasio 1980; Tuohy 1978). Microsoft® Excel® 2008 was used to organize the data and then statistical software StataCorp. 2007 was utilized to examine patterns in more detail. Type 1 and 2 specimens are not included because they are single plies, not technically cordage. An abbreviated catalog of cordage is included in Appendix VII.

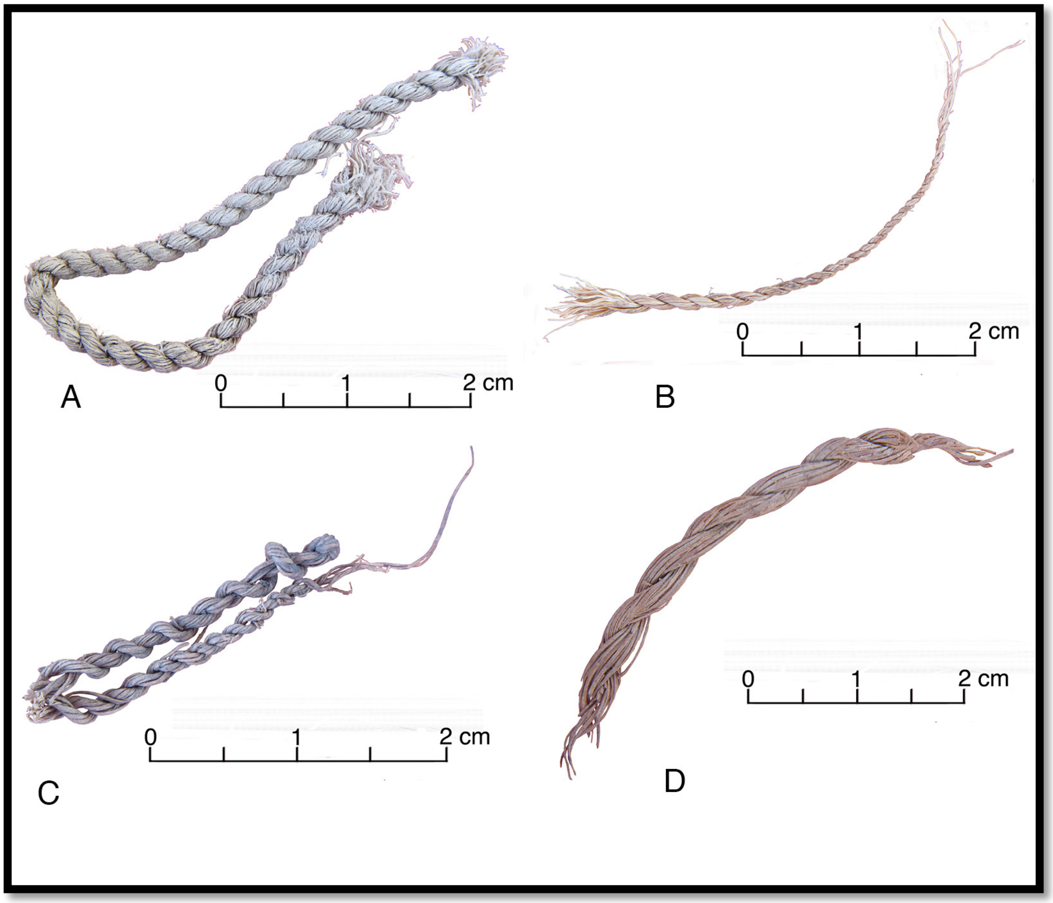

Figure 7. Variability in type 3 cordage: (a) CSR#329; (b) CSR#199, note rat-tail; (c) CSR#2059; (d) CSR#2093.

Raw Materials

While a full tabulation of raw materials is forthcoming, a general summary is presented here. Both animal and plant materials were used to make string at CSR. Sinew was found on several artifacts: a cane arrow fragment with remnants of three-feather fletching (CSR491), the base of a projectile point (CSR 1383), and a wood arrow foreshaft (CSR 1128) (Figure 8). From anthropological reports and mission accounts, potential plant materials used for cordage production includes Indian Hemp (Apocynum sp.), members of the Agavacea family, including Yucca and Agave genera; cotton; grass; mesquite; fibrous herbs; palm; and fibers from the rind of fruit (Burrus 1984 [Piccolo 1702], Burrus 1971:182 [Salvatierra 1699], Felger and Moser 1991:335, Hyland 1997, Laylander 2000, Massey and Osborne 1961, Mathes 1992:230 [Ortega 1633], Mathes 1975:224 [Diego de la Nava 1632], McGee 1898, Meighan 1966, Ritter 1979, Schulz 1977, Tuohy and Osborne 1979.

Diameter

Diameter is measured at the widest part of the cordage. In the construction of types, it is not standard to incorporate diameter. This masks considerable diversity within each cordage type. In Figure 9, Cordage type is plotted against diameter. The most obvious trend is that within the 3 types that are present in the highest quantity (types 3, 4, and 7) the majority of specimens are less than 3 mm in diameter. Figure 10 shows the diameter of type 3, in more detail and indicates the bulk of cordage is less than 2.5 mm. In fact, 57% of all cordage excavated is type 3 with a diameter under 2.5 mm. Within this subset of type 3, there is a preference for cordage with a diameter around 1.5 mm (Figure 10).

Figure 8. Sinew string artifacts: CSR#491 (top); CSR#1191 (bottom).

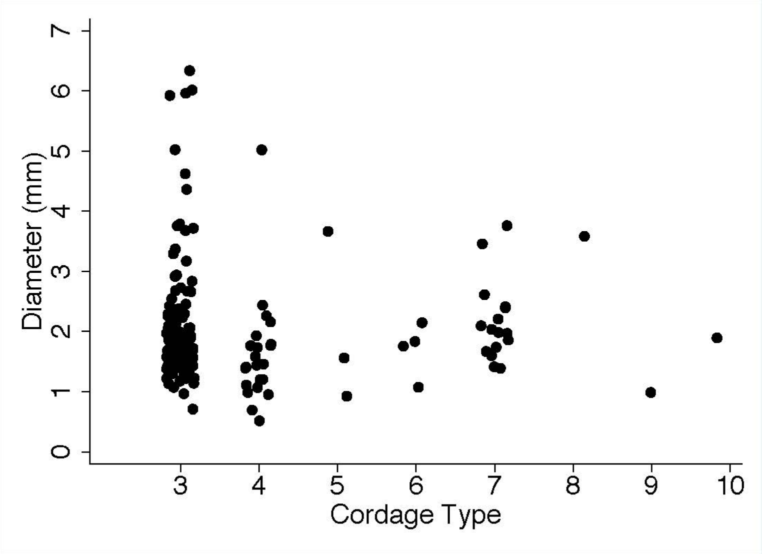

Figure 9. Cordage diameter by type. Dots are jittered.

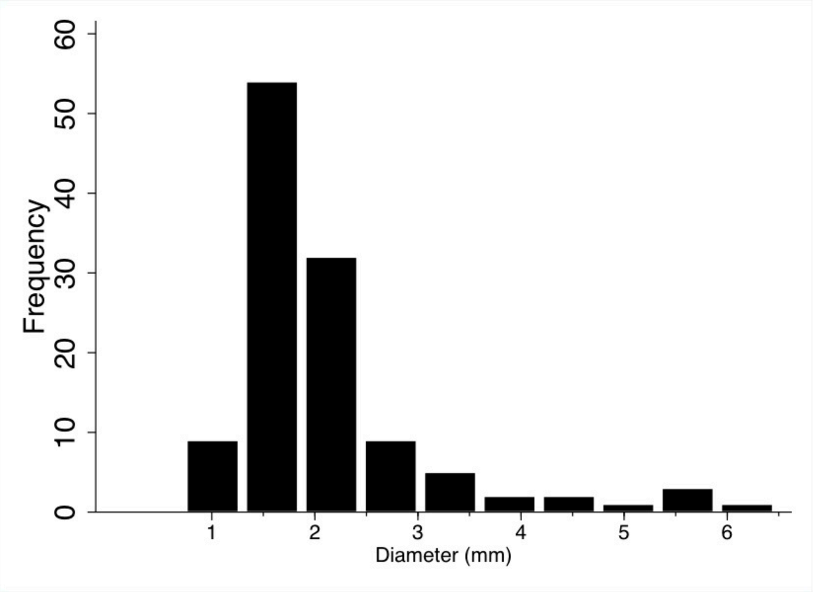

Figure 10. Type 3 Cordage frequency by diameter.

Length

Length is measured by laying the cordage flat and measuring the maximum length. To avoid damaging the artifact when the cordage was rolled or twisted, a non-organic string was laid parallel to the cordage and then measured. Cordage was recovered mostly as fragments, from a few mm to 50 cm long with a mean value of 7.06 cm. The majority of type 3 cordage was less than 5 cm in length (Figure 11). The combined length of all cordage, with and without knots, excluding netting, was 11.66 m.

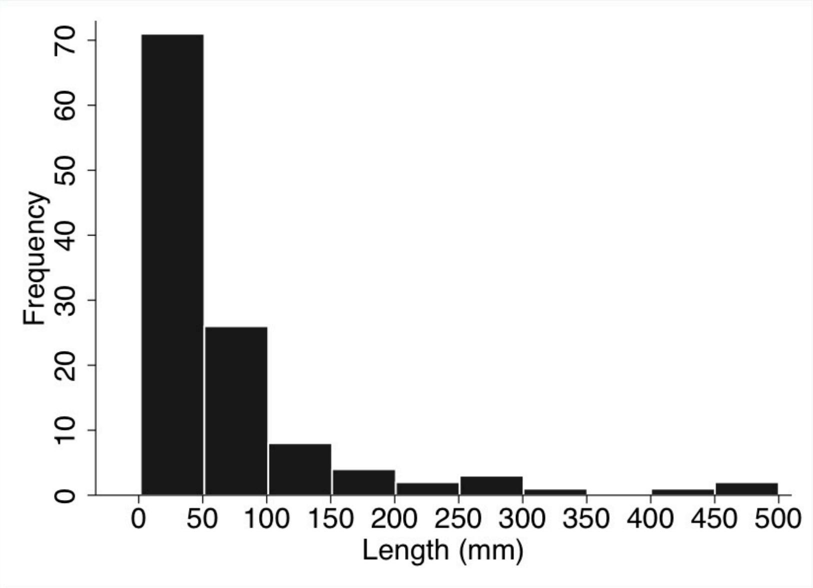

Figure 11. Length of Type 3 Cordage Specimens.

Angle of Twist or Tightness

The angle of twist is measured by laying the cordage flat and perpendicular to the base of a protractor. "Tightness" occurs during manufacture of cordage and relates to how much force is applied by the maker while twisting. Because the twist angle in a single specimen can vary (Haas 2001), the cordage twist was measured at various locations and a range of twist is reported along with maximum twist. Angle of twist in 2-Ply cordage ranged from 20-70°. I separated the angle of twist into tightness categories: medium (≤20°), hard (30°-60°), and crepe (≥70°). The majority of cordage (65%) measured between 40 and 50 degrees, a "hard" twist.

Twist per centimeter

Another way to examine "tightness" is to consider twist per centimeter (Table 2). Twist per cm was measured several times along the length of a cord and then averaged. Multiple regression analysis demonstrates that number of twists per cm mediates the relationship between number of knots and cordage diameter (R^2=.32; n=159; p<.001) (Figure 12).

Table 2. Descriptive statistics associated with cordage diameter and the number of twists per centimeter.

	Diameter	#Twist/cm
N	166	163
Mean (SD)	2.0 (1.0)	5.3 (2.2)
Median	1.8	5
Min/Max	0.5/6.5	0/16

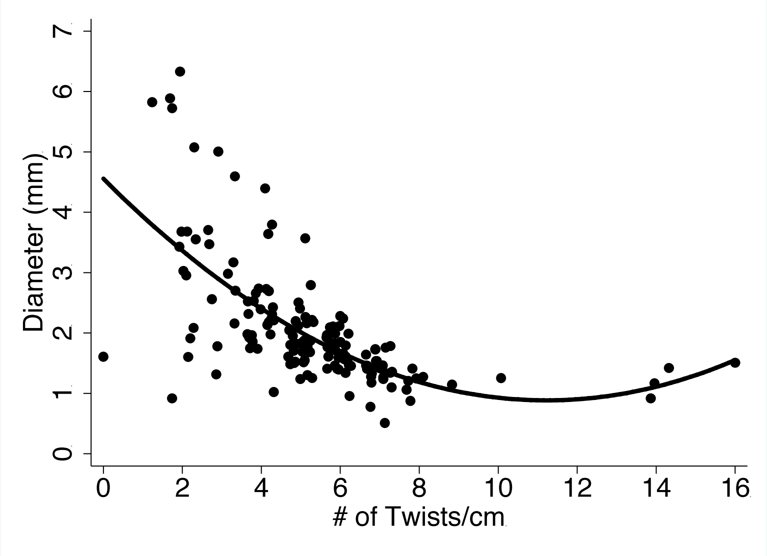

Figure 12. Scatterplot relationship between # of twists/cm and cordage diameter with best fit quadratic line (dots jittered).

Knots

A total of 29 specimens contain knots. A Spearman's rank order test reveals that cordage diameter increases as the number of knots per cordage piece increases (Rho=.18; p=.02; n=165) (Figure 13). Although the sample number of specimens with 2 knots is small (n=6), this may indicate that they were intended for some similar purpose or function.

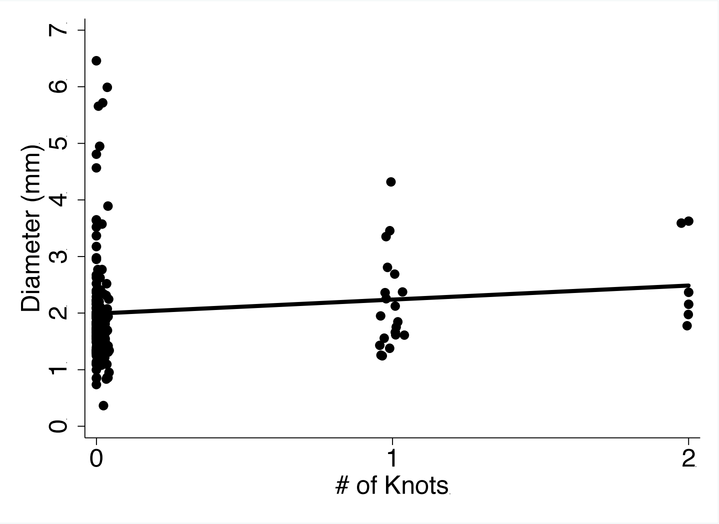

Figure 13. Scatterplot relationship between cordage number of knots and cordage diameter, with linear "best fit" (dots "jittered" to display data point density).

Netting

Five fragments of netting were found (CSR#'s 150, 570, 2067, 2080, 2115) (Figure 14). Three came from the first two levels excavated in Unit 3 and two came from Unit 2, Levels 3 and 4. Four were made using square knots and the fifth is a different, but undetermined knot. A single square knot netting fragment from Cueva Pintada in the Sierra de San Francisco was radiocarbon dated to 650+/-50 BP (Hyland 1996). To the north, net fragments from the Bahía Concepción region were unknotted Loop and Twist nets (n=511) (Ritter 1979) and to the south, nets from the Cape Region are made using exclusively Lark's Head knots (Massey 1966).

Beaded Cordage

Included in the cordage assemblage are cords strung with reed beads (Figure 15). All strung beads were nodes cut from reed. The number of node beads ranged from 1 to 38. Beaded artifacts were found throughout the central portion of the cave in Units 2, 3, 4, and 6. Three are strung on type 3 cordage and two are on type 5 (Figure 4c) 9 cordage. Many early reports refer in detail to regional variations in clothing of men, women, shamans, and sometimes children and infants (Laylander 2000: 142-143). It is generally reported that women and girls wore skirts that varied in length and material. Longinos (1792) specifically refers to aprons of cane joints in south-central Baja California. To the north, two pieces of cordage with node beads were found in two shelters in the Sierra de San Francisco (Hyland 1997). In contrast, even farther north strung beads found by Meighan (1966) in Gardner Cave at the southern end of the Sierra de San Borjas were tube beads. Considering ethnohistoric records and archaeological findings, the distribution, style, and manufacturing details of women's skirts clearly reflect important social and economic relationships of the past (Laylander 2000; Macfarlan and Henrickson 2010).

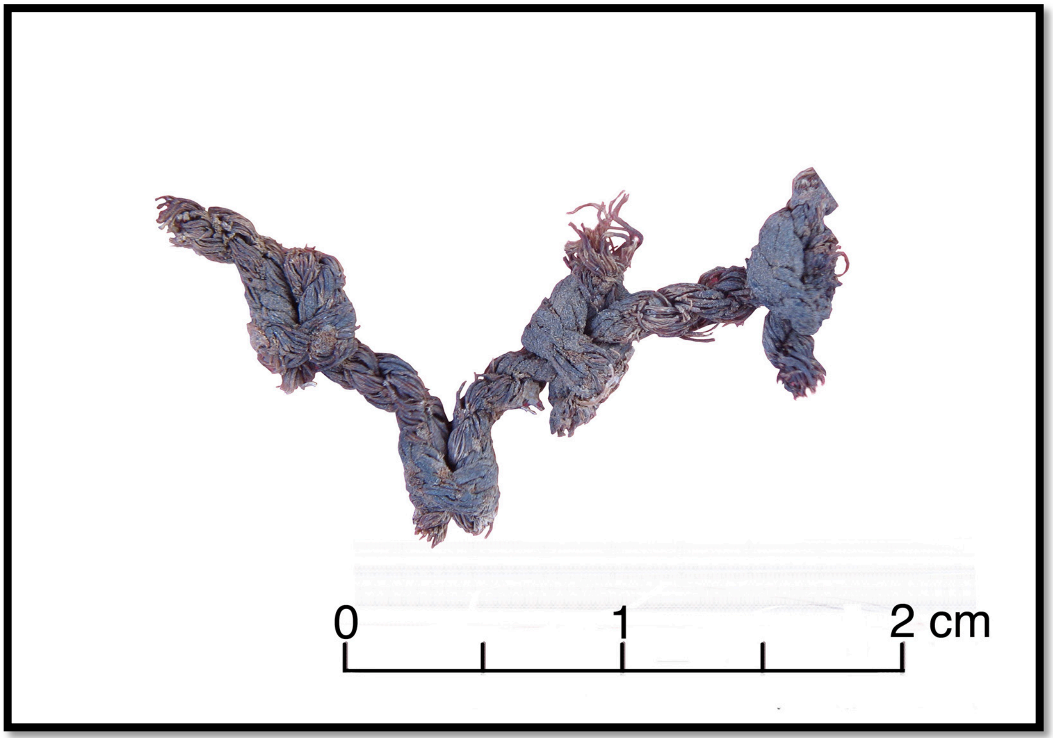

Figure 14. Netting with 4 square knots using Type 3 cordage. CSR#2115.

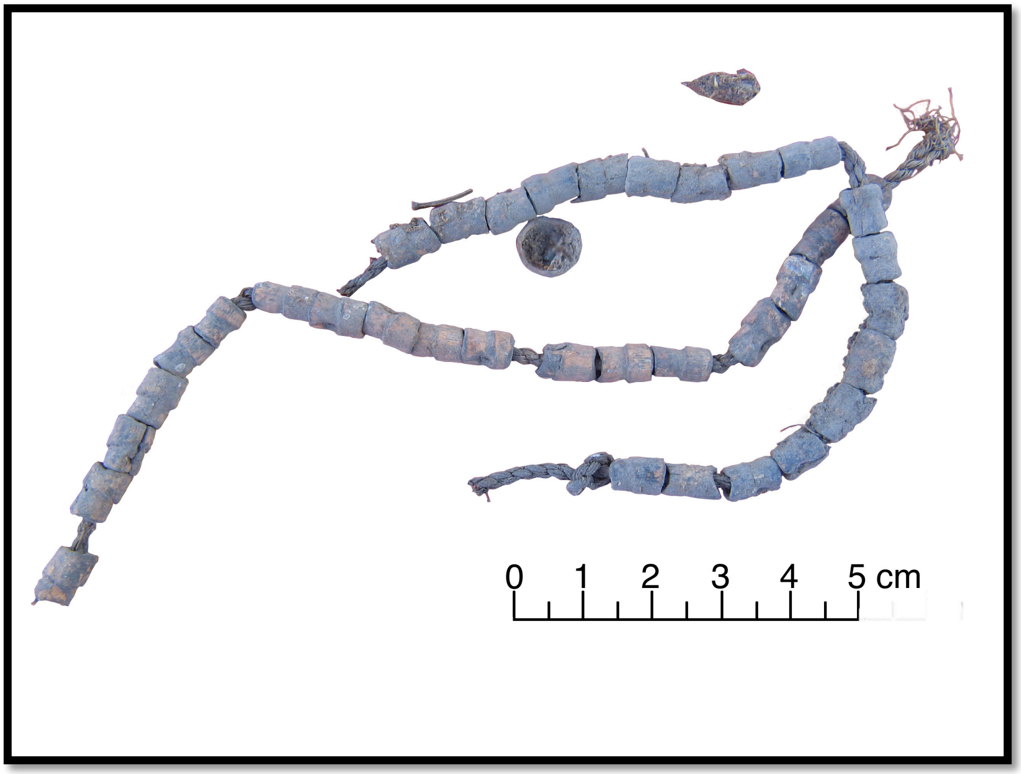

Figure 15. CSR#855. Cane node or joint beads on cordage. Individual bead in center shows the hole of the node, which is filled with dirt.

Plaiting
A single artifact (CSR 565) was plaited (Figure 16). This specimen exhibits single plaiting strips that pass over each other in a 2/2 interval. Single strips are possibly an Agave sp. and are nearly equal in size. The terminal elements were folded at 90 degrees and replaited into the body of the specimen. Splices were laid in and concealed. The fragment is charred on two sides. Size of fragment is 144.98 mm by 175.88 mm. Range in diameter is 5.17-8.42 mm. Range and mean angle of crossing of plaiting elements is 90°.

Matting
A single example of matting was found in the west wall of Unit 3 (Figure 17). A small 1 X 1 meter unit was opened to safely remove this artifact. It consists of bundles of unspun fibers gathered together using cordage as the weft. The cordage is S-spun, Z-twist. A simple Overhand knot is used to between loose agave fiber bundles to bind or hold them together. The fibers were not completely separated from the skin of the plant and are quite coarse. On one edge the matting cordage continues as if several bundles have fallen out of the piece. The matting is 50.80 mm in width, parallel to the cordage, and 254.26 mm in length or parallel with the fiber bundles. Another artifact consisting of several loops of cordage is most likely a fragment of matting missing the fiber bundles. The structure of this matting is identical to a matting fragment (139540) identified by Massey and Osborne (1961) in the Palmer collection from Bahía de los Angeles.

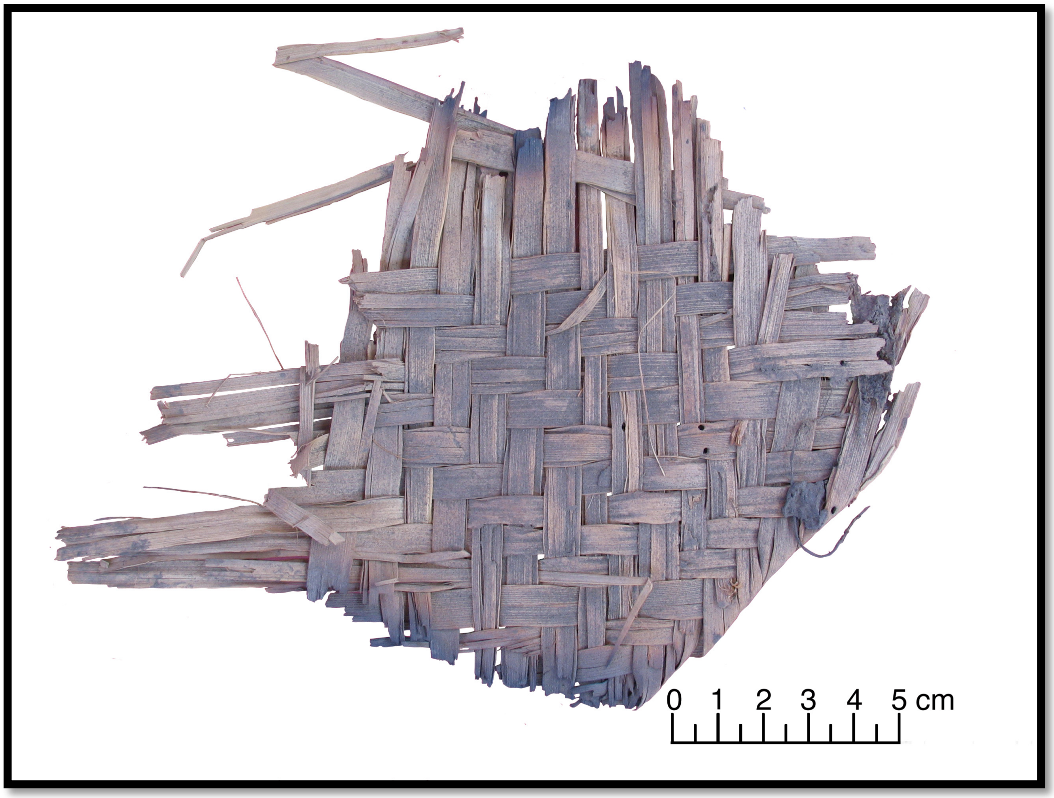

Figure 16. Plaiting. CSR#565

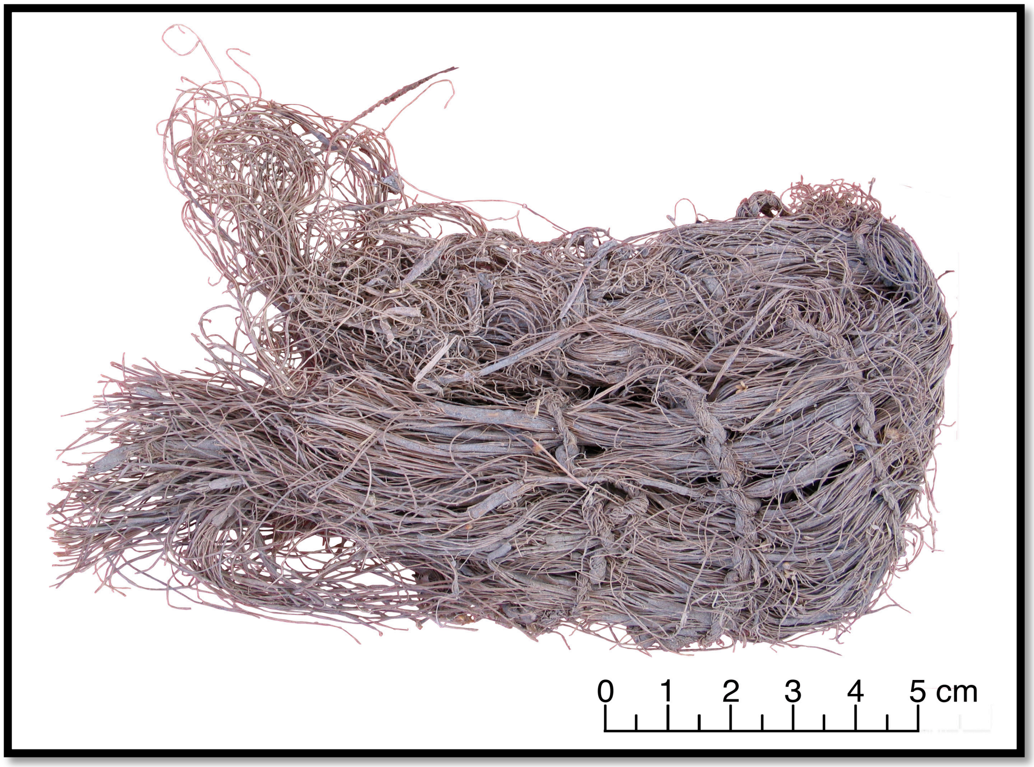

Figure 17. Matting. Warp bundles and cordage appear to be Agave spp.

Conclusions

Cordage specimens comprise a sizeable component of perishable artifacts recovered from Cueva Santa Rita. A total of 172 pieces were excavated from all the units. Overhand knots are the most common knot type. The 11 cordage structural types were established on the basis of number of plies, direction of initial spin, and final twist. Of these structural types, 14 are single-ply, 151 are simple cords, 19 are complex cords, and 2 are braided. The most common type of cord is Type 3 (63%), followed by Type 4 (13%) and Type 7 (8%).

Comparison of cordage type distribution by unit and level (Appendix VIII) indicates that diversity of types and quantity of cordage varies spatially. The organic-rich facies (see Chapter 2) consistently had the highest quantity of cordage in every unit. Cordage is present in every level in Unit 2 and 3 and in all units, the number of cordage gradually decreases in the last 2 or 3 levels. The earliest facies dates to 3,772 +/-39 BP and contained only two pieces of cordage. One was the type 3 and the other was the only 6 ply specimen (Type 10) recovered.

The overwhelming majority of cordage is made from plant fibers. Half of all animal hair recovered was from the collection of 14 single-ply artifacts (Figure 3). A total of 97 unique pieces are type 3 with a diameter of less than 2.5 mm, and collectively they consititute 57% of the total sample. Most of the cordage are fragments less than 5 cm long. There was a relationship between number of knots and diameter, with diameter increasing alongside number of knots. There is a negative relationship between the number of twists per centimeter and cordage diameter.

Netting from Cueva Santa Rita is represented by 5 fragments. Netting was made using Square knots, a characteristic shared with groups within central Baja California (Hyland 1997; Massey 1961, 1966). Five artifacts were cords strung with reed node beads. Node beads were also used by women in the Sierra de San Francisco's to make skirts. A single example of plaiting and matting were found.

Stratigraphically, the majority of cordage recovered dates to the last 1,000 years of the late Holocene epoch. Both directions of final twist are present during this period, with a preference for final Z-twist (84%). The argument for on-site production of cordage is based on several lines of evidence. Although not yet quantified, there are high quantities and a variety of kinds of fiber waste artifacts in all units except 1 and 5, where 97% of cordage was recovered.   This indicates that the central and back portion of the shelter were places utilized for cordage making. The association of cordage with production tools and plant production byproducts suggests that artisans produced and processed cordage on site.

References Cited

Adovasio, James M., Olga Soffer, and Jake Page
2007 *The Invisible Sex: Uncovering the True Role of Women in Prehistory.* New York: Smithsonian Books.

Andrews R.L., James M. Adovasio, and J.M. Carlisle
1986 *Perishable Industries from Dirty Shame Rockshelter, Malheur County, Oregon.* Ethnology Monographs Number 9. Department of Anthropology, University of Pittsburg, Pittsburg.

Andrews R.L. and James Adovasio, M.
1980 *Perishable Industries from Hinds Cave, Val Verde County, Texas.* Ethnology Monographs Number 5. Department of Anthropology, University of Pittsburg, Pittsburg.

Ascensión, Anontio de la
1992 [1602] Father Antonio de la Ascensión's Account of the Voyage of Sebastián Vizcaíno: 1602. Translated by H.R. Wagner. In *Ethnology of the Baja California Indians*, Spanish Borderland Sourcebooks No. 5, edited by Michael Mathes, pp. 164-208. New York: Garland Publishing.

Ashley, Clifford W.
1944 *The Ashley Book of Knots*. Doubleday & Company.

Brown, D.E.
1991. *Human Universals*. New York: McGraw Hill.

Burrus, Ernest J.
1984 *Jesuit Relations, Baja California, 1716-1772*. Baja California Travel Series 47. Los Angeles, Dawson's Book Shop.

Cameron, Catherine M.
2013 How People Moved among Ancient Societies. *American Anthropologist* 115(2): 218-227.

Custer, Jay F.
2004 Cultural Context and Cordage Twist Direction. *North American Archaeologist* 25(2): 139-152.

Felger, Richard S. and Mary Beck Moser
1991 *People of the Desert and Sea: Ethnobotany of the Seri Indians*. University of Arizona Press: Tuscon.

Gilligan, Shane P.
2005 *Identifying Communities of Practice Through Cord Impressed Ceramics at the Early Late Prehistoric Sites of Thomas/Luckey and Chenango Point in Central New York.* Master's thesis. Binghamton University, State University of New York.

Hayden, Anna
2009 *Ceramic Production in Middle Woodland Communities of Practice: A Cordage Twist Analysis in Tidewater Virginia*. Master's thesis. The College of William and Mary.

Hyland, Justin R.
1997 *Image, Land, and Lineage: Hunter-Gatherer Archaeology in Central Baja California, Mexico*. Ph.D. dissertation. University of California, Berkeley.

McBrinn, Maxine and Cristina Peterson Smith
2006 A New Spin on Cordage: The Effects of Material and Culture. *The Kiva* 71(3): 265-274.

Haas, William Randall
2006 The Social Implications of Basketmaker II Cordage Design Distribution. *The*

Kiva 71(3): 275-298.

Haas, William Randall
2001 The Basketmaker II Fiber Industry of Boomerang Shelter, Southeastern Utah: A Synthesis of Cordage Morphology Analysis and Experimentation. *The Kiva* 67(2):167-185.

Hardy, Karen
2008 Prehistoric string theory. How twisted fibres helped to shape the world. *Antiquity* 82(316):271-280.

Laughlin, William S., Douglas Osborne, and Carolyn Osborne
1954 Twines and Terminologies. *American Anthropologist* 56(6):1093-1101.

Laylander, Donald
2000 *Early Ethnography of the Californias, 1533-1825*. Coyote Press.

Longinos Martínez, José
1961 *Journal of José Longinos Martínez: Notes and Observations of the Naturalist of the Botanical Expedition in Old and New California and the South Coast, 1791-1792.* Edited by Lesley Byrd Simpson. J. Howell, San Francisco.

Macfarlan, Shane and Celeste Henrickson
2010 Inferring Relationships Between Indigenous Baja California Sur and Seri/Comcáac Populations Through Cultural Traits. *Journal of California and Great Basin Anthropology* 30(1): 51-67.

McGee, W.J.
1898 *The Seri Indians*. Seventeenth Annual Report of the Bureau of American Ethnology, Part I. Smithsonian Institution.

Massey, William C.
1947 Brief Report on Archaeological Investigations in Baja California. *Southwestern Journal of Anthropology* 3(4):344-359.
1949 Tribes and Languages of Baja California. *Southwestern Journal of Anthropology* 5(3):272-307.
1955 *Culture history in the Cape Region of Baja California, Mexico.* Ph.D. dissertation. University of California, Berkeley.
1961 The Survival of the Dart-Thrower on the Peninsula of Baja California. *Southwestern Journal of Anthropology* 17(1):81-93.
1966 Archaeology and Ethnohistory of Lower California. In *Ethnology of the Baja California Indians*, Spanish Borderland Sourcebooks No. 5, edited by Michael Mathes, pp. 334-361. New York: Garland Publishing.

Massey, William C. and Carolyn Osborne
1961 A Burial Cave in Baja California: The Palmer Collection, 1887. *Anthropological Records* 16(8):339-364.

Meighan, Clement W.
1966 Prehistoric Rock Painting in Baja California. *American Antiquity* 31(3):372-392.

Nava, Licentiate Diego de la
1992 [1632] Opinion Given by Licentiate Diego de al Nava: April-June 1632. Translated by W.M. Mathes. In *Ethnology of the Baja California Indians*, Spanish Borderland Sourcebooks No. 5, edited by Michael Mathes, pp. 221-228. New York: Garland Publishing.

Piccolo, Francisco María
1984 [1702] *Jesuit Relations, Baja California, 1716-1762*. Translated and annotated by E.J. Burrus, pp.79-83. Baja California Travel Series, 47. Los Angeles: Dawson's Book Shop.

Salvatierra, Juan Maria de, S.J.
1971 *Selected Letters About Lower California*. Translated and annotated by Ernest J. Burrus, S.J. Baja California Travel Series, 25. Los Angeles: Dawson's Book Shop. 104-113.

StataCorp.
2007 *Stata Statistical Software: Release 10*. College Station, TX: StataCorp LP.

Teague, Lynn
1992 Textiles and Identity in the Prehistoric Southwest. In *Textiles in Daily Life: Proceedings of the Third Biennial Symposium of the Textile Society of America* pp. 51-59. Textile Society of American, Inc. Earleville, Maryland.

Ritter, Eric William
1979 *An Archaeological Study of South-Central Baja California, Mexico*. Ph.D. dissertation. University of California, Davis.

Schulz, Jeannette K.
1977 Prehistoric textile remains from Bahía Coyote, Baja California Sur. *Pacific Coast Archaeological Society Quarterly* 13(1):28-34.

Tuohy, Donald
1978 *Cultural history in the Comondu Region, Baja California, Mexico: with appendix on Metate Cave string and twine analysis by Carolyn M. Osborne*. Ph.D. dissertation. University of Nevada, Reno.

Ortega, Francisco de
1992 [1634] Relations of Francisco de Ortega: 1633-1634. Translated by W.M. Mathes. In *Ethnology of the Baja California Indians*, edited by M. Mathes, pp. 229-244. Spanish Borderland Sourcebooks 5. New York: Garland Publishing.

Chapter 6: Conclusions

This dissertation project sought to uncover the ancient history and cultural dynamics of an under-explored area of the Baja California peninsula: the Sierra de La Giganta region of Baja California Sur, Mexico. It accomplished this goal primarily through the excavation of a single cave site (Cueva Santa Rita) that contained both stratified deposits and a variety of well-preserved, organic material remains. However, the project also employed cultural trait analysis derived from the ethnohistoric record to situate within-site archaeological findings within a regional framework, using contemporary statistical analysis. Although this dissertation project represents the first steps of artifact analysis at Cueva Santa Rita, sufficient evidence concerning the site and its contents exist to draw preliminary conclusions concerning within-site and cross-region cultural dynamics. These findings are summarized below through a review of each chapter's key findings.

In Chapter 2, inferential statistics are applied to a set of cultural traits derived from the ethnohistoric record to test cultural relationships between Baja California and mainland Mexico groups. Although anthropologists working in the Baja California peninsula have used the rich ethnohistoric record to build cultural trait lists to assess the relationships in the past, this dissertation did so in a more formal manner that over came problems associated with type-1 and type-2 errors that plagued previous analyses. Based on cultural traits gathered at the time of contact, the southern Cochimí and Guaycura appear to be culturally homogenous. Hierarchical cluster analysis suggests a natural grouping between the above two groups and the Seri/Comcáac, yet reliability coefficients suggest the Seri/Comcáac and Pericú were equidistant from the southern Cochimí and Guaycura. Of the four groups chosen for this analysis, the similarities between the southern Cochimí and Guaycura are most notable. Although cultural traits are an important set of evidence, it is important seek out other methods of investigating cultural histories and narratives. Chapters 4 and 5 discuss the results of the analysis of artifact attributes and the process of material culture production with the purpose of constructing a more varied approach to the interpretation of the past.

Chapter 3 placed the archaeological site into geological and temporal context. The rockshelter contains considerable deposits of sediment that were generated through human activity. It is likely that all sediments at CSR have been impacted in some way by human activities. In terms of volume, the primary mode of anthropogenic sedimentation was the accumulation of organic-rich waste in lenticular deposits. These organic facies are shallow units of biogenically rich matrices of primarily dessicated remains and likely indicate single or short-term occupations, where a range of activities took place. The accumulation of geogenic sedimentation coupled with human activities resulted in the deposition of alternating layers geogenic and anthropogenic facies. Observations made at the macroscopic level and radiocarbon dates indicate that some of these "layers" could potentially be stratified combustion features, such as agave or food roasting pits. In addition, there is a diversity of combustion features in general.

Chapter 4 analyzed the *Olivella* shell bead assemblage at CSR. Cultural groups in this region have produced shell beads obtained from the Pacific coast as early as the middle Holocene. Almost all the beads at CSR were of four types: simple and oblique spire-lopped, barrel, and double-oblique barrel. Bleaching, which changes the color and physical properties of shell, is an optional step in the bead manufacturing sequence and beads of all bleach-induced colors were utilized CSR. This conclusion is based on the presence of a u-shaped notch at the apex of the shell, assumed to be a byproduct of use-wear, specifically stringing the beads on cordage, because this attribute is not known occur naturally on *Olivella*. The number and ubiquity of bead blanks suggests that beads were produced at the site. The majority of *Olivella* shell species acquired for bead production came from the Pacific coast, rather than the Gulf of California, which is interesting given that the gulf is over 5 times closer. This may be due to long-term social networks, mobility to the west, or an avoidance of the Pericú Isleños to the east.

Chapter 5 analyzed the fibrous material remains at CSR. For at least the last 3,772 ± 39 years BP, people were using and producing cordage at CSR. The overwhelming majority of the 171 specimens were two-ply, made from plant materials, and dated to the last 1,000 years BP. Netting from this later period was made using square-knots, similar to prehistoric netting of similar time periods to the north. The high quantity and variety of cordage-related fiber waste artifacts and tools suggest that the central and back portion of the shelter were spaces used for making cordage. Five artifacts of strung reed node beads were found at CSR. At other sites in the central peninsula, these are interpreted as fragments from women's skirts.

Limitations

All studies have limitations and this is no different. For example, I employed cultural trait analysis to infer inter-group interactions and to assess the extent to which cultural groups were more or less different from each other. Cultural trait analysis has a long history in anthropological inquiry dating to at least Boas and Wissler and made prominent by Kroeber (Lyman and O'Brien 2003). However, a number of potential problems have been identified with cultural trait analysis: 1) it accentuates with-group similarities and downplays with-group heterogeneity; 2) it treats cultural as being comprised of number of atomized elements that can be isolated from the larger matrix in which behavior and thought is situated; 3) it treats culture as a static entity that does not change over time; 4) to the extent that cultural traits are real entities, cultural trait analysis treats each trait as equally important or salient for anchoring cultural identity (i.e. cultural traits have no weight relative to one another).

The goal of good science is not to be correct, rather it seeks to reduce error in the ways we conceive of the world. A primary method for achieving this goal is to employ a variety of methods and theoretical perspectives to problems that are as yet, unresolved. As an archaeologist who is seeking to uncover the ancient history of Baja California Sur, Mexico, I would like to leave no tool in my theoretical toolbox untouched; even a broken pair of glasses can be useful if employed in the correct manner. The goal of the cultural trait analysis was not to demonstrate that cultural trait analysis is correct as a method or that the inferences generated from the analysis are true in any universal sense. Instead, I simply attempted to apply a tool some branches of anthropology find useful to an existing problem.

Chronological Issues

Radiocarbon dates at CSR and the assemblage of radiocarbon dates from the southern peninsular range provide some indication of site occupation and, coupled with other evidence, yield important clues about population dynamics in a peninsular landscape. At CSR, a large chronological gap exists in the currently available data between the earliest date of ~3,700 years BP and the tail of the peak in radiocarbon dates at ~1,000 years BP. This is not surprising given that only a small portion of the shelter was excavated. Several scholars working in the central peninsula have noted peaks in radiocarbon date distributions (Figure 1). Hyland (1997:275) notes a bimodal peak in 81 radiocarbon dates in the Sierra de San Francisco around 1300 BP and 400 BP. Two dates from Caguama cave roughly coincide with these same peaks (Tuohy 1978). Dates from Cueva Santa Rita peak between 300 and 700 years BP, coinciding with the latest of the bimodal peaks in Figure 1. The increase in site use observed at these sites during the later Holocene could be the product of multiple factors. Following proposals by Hyland (1997) and Des Lauriers (2005) the peaks could be related to either population increase or changing settlement/subsistence patterns during the late Holocene. Careful consideration of the spatial and temporal dynamics of regional interaction systems and how we may study them archaeologically will be critical to advancing models for population dynamics in central Baja California. Fine-scale resolution

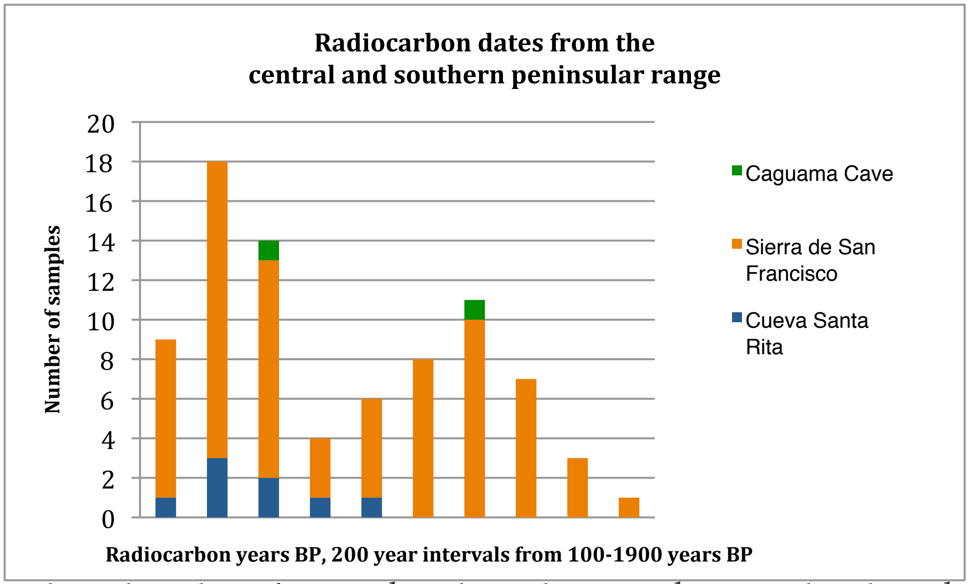

Figure 1. Radiocarbon dates from archaeological sites in the central and southern peninsular range from most recent (left) to early (right). Data gathered from Hyland (1997), Tuohy (1978), and the present project.

Significance and Future Directions

The investigation of how ancient history in this part of the peninsula changed and developed over time has implications that reach beyond the immediate region. The existence of regionally distinct cultural and linguistic expressions at the time of contact is an important factor that structured the development of conceptual issues of Baja California Sur prehistory. However, the data from CSR indicated that nature of prehistoric interactions is not well served by projecting ethnohistoric derived boundaries on to the past. In order to understand more dynamic issues of Baja California prehistory, we need to investigate the peninsula as a continuum of peoples and cultures, connected to each other through a laterally restricted terrestrial landscape. For example, data from Cueva Santa Rita, located geographically between central and southern Baja California, provides an opportunity to assess in what ways and to what degree geographically adjacent and disconnected groups participated in inter-regional social and economic networks. One of the most significant contributions to rockshelter research in central Baja California are the intact, stratified deposits at CSR. Further examination of combustion features at the microscopic level and additional radiocarbon dates and geochemistry would permit a high-resolution analysis and comparison of combustion-related activities at the site. The geoarchaeological approach and suggestions made in Chapter 3 should serve as an important guide for ongoing and future excavations of stratified rockshelter sites. The data at CSR indicate that if excavated appropriately, chronological control is possible to establish much needed data on paleoenvironments and subsistence activities.

References Cited

Hyland, Justin R.
1997 *Image, Land, and Lineage: Hunter-Gatherer Archaeology in Central Baja California, Mexico*. Ph.D. dissertation. University of California, Berkeley.

Lyman, R.L., O'Brien, M.J.,
2003 Cultural traits: units of analysis in early twentieth-century anthropology. *Journal of Anthropological Research* 5(2): 225-250.

Tuohy, Donald
1978 *Cultural history in the Comondu Region, Baja California, Mexico: with appendix on Metate Cave string and twine analysis by Carolyn M. Osborne*. Ph.D. dissertation. University of Nevada, Reno.

APPENDICES

APPENDIX I: EXCAVATION PERMIT

Berkeley California, 16 Abril de 2008

ARQLGO. ROBERTO GARCIA MOLL
PREIDENTE DEL CONSEJO DE ARQUEOLOGIA DEL INAH
CALLE ARGENTINA NU. 12 ESQ. CON DONCELES
COL. CENTRO
MEXIOC D.F., 06010

Por este conducto, le enviamos a Ud. La propuesta del proyecto “Investigación arqueológica en cuevas en el area del Rancho Santa Rita, Municipio de La Paz, B.C.S.”

Sin mas por el momento, aprovecho el momento para enviarle un cordial saludo.

ATENTAMENTE

Error! Contact not defined., PhD Candidate.
DEPARTMENT OF ANTHROPOLOGY
UNIVERSITY OF CALIFORNIA, BERKELEY
Campus address

Proyecto "Investigación arqueológica en cuevas en el área del Rancho Santa Rita, Municipio de La Paz, B.C.S."

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INTRODUCTION

In June 2003 and January 2008, a survey team lead by the author visited the Rancho Santa Rita region near San Pedro De La Presa in Baja California de Sur, Mexico (Figura 1A-B). Archaeological finds included: a minimum of 50 habitable rockshelters; lithic procurement sites; well-preserved and elaborate bone objects; rock art; an unusually high number of bifacial preforms and grinding tools; projectile points; and organic artifacts such as chewed plant remains, beads, shell, cordage and knot fragments (Figure 2B-J). One site in particular, Cueva Santa Rita (Figure 1C-D), will be the focus of this research. Cueva Santa Rita was chosen over other rockshelters for its potential to contain deep strata, large size, and vulnerability to destruction. Its large size and easy access has made it a popular place for shelter and shade for local goat and cattle. Additionally, between two field visits in 2004 and 2008, evidence of continued looting and vandalism was apparent (Figure 3). The sediments in Cueva Santa Rita appear to be at least 2 meters deep and may contain stratified cultural materials important to the study of Baja California archaeology as well as paleoenvironmental history. Clearly, in order to evaluate the importance of the cultural and paleoenvironmental record contained in the site, archaeological and geoarchaeological investigations are needed.

PROPOSED AREA OF INVESTIGATION

Cueva Santa Rita is located in southeastern Baja California, at 24º57'50.11"N latitude and 110º58'10.45"W longitude, approximately 16 km west of the Gulfo de California. The cave is 50 meters in length along the drip line and extends to a maximum depth of about 21 meters in its central portion. In June 2004, there was a large pot-hunters-pit in the central portion of the cave that measures several meters in diameter and extends to an unknown depth. A large number of manos, matates, debitage, and midden debris were observed on the surface of the cave floor next to the pit. The sediments at the exterior of the cave outside of the drip line are culturally rich soils (anthrosols) that contain rhyolite and chert lithic debitage, shell, mammal bone, and midden charcoal. In January 2008, several new pits were visible (Figura 3C) and artifacts had been vandalized and displayed on the cave wall (Figura 3B).

METHODOLOGY

Archaeological Research

The goal of archaeological investigations is to establish a general chronology of human occupation in the local region. In addition, a multidisciplinary team of archaeologists will study prehistoric technology, site activities, and dietary patterns to interpret hunter-gatherer lifeways and processes of cultural adaptation within inland riverine and cave environments. All research will be conducted only with full permission from the Instituto Nacional de Antropología e Historia (INAH). All artifacts recovered and excavated are Mexican national treasures protected by law and will be placed in an INAH approved repository. Post-excavation analysis will be conducted only with the appropriate permits and approval from INAH.

Landscape Survey

There will be two field components for this project. The first field component will investigate the long-term landscape socioecology of the region surrounding Cueva Santa Rita using a patch-based survey. A team researchers will walk 4-5 radiating transects from Cueva Santa Rita, collecting floral, faunal, geomorphologic, and archaeological data at 100 meter intervals. Patch-based surveys allow excavation sites to be contextualized in an ecological framework and emphasizes the dynamic relationship between natural and cultural systems at different times and scales. This strategy means that we do not limit our surveys to areas of high artifact concentrations, but seek to identify variation in artifact accumulations in different patches of the landscape, for example riverine vs. upland, and continue to collect landscape data from the places between sites. During this survey, surface artifacts and materials for dating will be mapped, labeled, and collected using standardized forms, plan view maps, and GPS.

Excavations at Cueva Santa Rita

The second field component will be site specific, focusing on intensive archaeological excavations at Cueva Santa Rita (Figure 4). Excavations will take place over a six-week field season, with mornings dedicated to excavations and late-afternoons used for field cataloging and other data processing. The placement of a 2 x 8 meter excavation trench will be perpendicular to the mouth of the cave, behind the drip line, to capture a range of spatial activity within the rockshelter. We will also open a 1 x 1 meter unit under a portion of the cave that is less disturbed due to a low ceiling. Excavations will employ simple arbitrary 10 cm levels and each level and feature will be photographed and drawn. A site datum will be used to build a site grid and serve as a reference point for the horizontal and vertical measurement of artifacts. All sediment will be screened using 1/8-inch mesh screen. Each level will have a form, photograph, bulk soil sample, and plan view and profile map. Standardized forms will be used to identify, classify, label, and record artifacts. Each excavator will take detailed notes. Features will be excavated separately and extensively photographed. All sediments will be described in the field and undergo a series of bulk chemistry analysis for major, minor, and trace elements; pH; phosphate; organic carbon; and particle-size analysis.

JUSTIFICATION

We propose to excavate at Cueva Santa Rita for several reasons. First, it is important that excavations take place before further looting destroys all archaeological context. It is disturbing how much damage has occurred in the cave between the two surveys in 2003 and 2008. If the cave continues to be looted at this rate, the artifacts from the central portion of the cave will be gone in the next 5 years. The looting of sites destroys the historical, cultural, religious and scientific information that is derived through the careful, systematic excavation of sites. Before excavations begin, we will stabilize the boundaries of the pot-hunters-pit through backfilling to prevent further wall collapse. We will also collect surface artifacts to protect them from further looting and damage.

A second reason to excavate is because very little is known archaeologically or otherwise about Guaycura, making this an exploratory research endeavor, with the goal of building fundamental regional knowledge. The geographic position, dominantly terrestrial ecosystem, stratified cave sediments, and high degree of preservation due to an arid climate, make this an ideal environment for investigation. The wide variety of geographic resources will elucidate an unknown set of prehistoric activities, particularly the relationship between inland alluvial environments and subsistence activities.

PROJECT MEMBERS

Celeste Henrickson is a PhD candidate in Anthrolopology at the University of California, Berkeley. Ms. Henrickson is an expert in archaeometry and geoarchaeology and has been working on archaeological projects in Baja California and Baja California Sur, Mexico with Loren Davis, Alan Bryan, and Ruth Gruhn since 1996. Miss Henrickson will direct and oversee all aspects of the archaeological and geoarchaeological investigations and analysis of this project.

Cara Monroe is a PhD candidate at the University of California, Santa Barbara. Miss Monroe has experience excavating and analyzing ancient DNA from the American southwest, southern California, and Baja California, Mexico. Miss Monroe is a volunteer and will help with excavation and analysis of ancient DNA.

Dr. Loren G. Davis es recientemente asignado como Profesor Asistente de Antropologia en la Universidad Estatal de Oregon, E.U. y ha llevado a cabo investigaciones arqueológico y geoarqueológicas en Baja California desde 1996. He is currently the director of the Pacific Slope Archaeological Laboratory at Oregon State University. Dr. Davis is a volunteer and will help with excavation and site logistics.

Shane Macfarlan is a PhD student at Washington State University and has an archaeology specialty in Museum Science and curation. Mr. Macfarlan is a volunteer and will help with excavation and curation of artifacts.

Samuel Willis es estudiante de la Maestría en Antropología en la Universidad Estatal de Oregon, especializando en el estudio de la tecnología de lítica en prehistoria. Sr. Willis tiene experiencia en el análisis e interpretación de la tecnología en el único sitio costero del periodo Pleistocene tardío en Oregon bajo la dirección del Dr. Loren Davis. Sr. Willis es voluntario y ayudará en las excavaciones y análisis de artefactos.

REPORTING OF RESULTS

The principal investigator is to provide the INAH with a full technical report that provides detailed discussion and summaries of the following aspects of the project: overall approach, detailed description of methods, results, and interpretation. Artifacts will be placed in an INAH approved repository. Additional papers in professional journals and presentations at academic meetings are expected to follow the report. Depending on the archaeological context and preservation of artifacts at Cueva Santa Rita, the results of these investigations will generate great interest in the scientific community. Credit will be given to INAH and the archaeologists of southern and central Baja California Sur.

WORK SCHEDULE

Julio 2008: Arrive in La Paz and begin landscape survey

Agosto-Septiembre 2008: Conduct archaeological test excavations. Give all artifacts to INAH before leaving Baja California Sur, Mexico.

Octubre-Noviembre 2008: Análisis de material en el laboratorio en La Paz. Elaborar catalogo de artefactos y entrega de material a la oficina de Centro INAH B.C.S.

Septiembre 2009: Submit final report of findings

APPENDIX II: CULTURAL TRAIT LIST (1= Present; 0=Absent)

Category	Cultural Trait	Pericú	Source	Guaycura	Source	Southern Cochimí	Source	Seri	Source
Male Headdress	Pearl Knotted in Hair	1	Barco 1981:37	0	Barco 1981:37	0	Barco 1981:38	0	McGee 1898:101
	Long Hair	1	Cooke 1992:295; Porter y Casante 1992:249; Atondo and Kino 1992:167; Barco 1981:37	1	Ulloa 1992:79; Kroeber 1931:43; Baegert 1982:139, photos; Baegert 1952:88	0	Barco 1981:38	1	Kroeber 1931:43; McGee 1898:photos
	Hair Top Knotted	1	Porter y Casante 1992:249; Antonio de la Ascensión 1992:167; Mathes 2006:51	0	Barco 1981:37	0	Barco 1981:38-39	0	McGee 1898:101; Kroeber 1931:44
	Crown	1	Barco 1981:39	1	Ulloa 1992:82	1	Barco 1981:38	1	Felger and Moser 1991:146; McGee 1898:101 disagrees
	Net Worn on Head	0	Mathes 2006:52	1	Barco 1981:37; Ulloa 1992:82	0	Barco 1981:38-39	0	Kroeber 1931:44
	Mother-of-Pearl in Hair	1	Mathes 2006:51; Shelvocke 1992:320	1	Barco 1981:37	1	Barco 1981:38-39; Antondo and Kino 1992:33	0	*
Female Dress	Palm Skirt	1	Barco 1981:40	0	Barco 1981:43-44; Baegert 1952:62	0	Barco 1981:43	0	*
	Mammal Leather Use for Skirt	1	Cooke 1992:294	1	Baegert 1952:62	1	Barco 1981:69	1	Cardona 1992:102(island), 216; Felger and Moser 1991:45; Hardy 1829:298; McGee 1898:86, 92
	Bird Hide Skirt	1	Cooke 1992:294	0	*	0	*	1	McGee 1898:92; Kroeber 1931:22
	Agave Fiber Skirt	0	* Barco 1981:40	1	Barco 1981:43-44; Baegert 1982:138	1	Barco 1981:42	0	*
	Two Part Skirt	1	Barco 1981:40	1	Baegert 1952:62; Kroeber 1931:43; Barco 1981:43 disagrees; Baegert 1982:138	1	Barco 1981:42	0	Kroeber 1931:43
	Reed Beads Skirts	0	*	1	Salvatierra 1971:107; Barco:1981:43; Baegert 1952:61	1	Barco 1981:42	0	Kroeber 1931:43

	Leather Skirt on Back Only	0	*	1	Baegert 1952: 62; Baegert 1982: 138	1	Kroeber 1931:43	0	Kroeber 1931:43
	Long Hair	1	Barco 1981:41	0	Baegert 1982:140-141, photos; Baegert 1952:88	0	Ulloa 1992; Mathes 2006:52	1	McGee 1898:139; Kroeber 1931:43
	Bird Hide used in Clothing	1	Shelvocke 1992:323	0	Baegert 1952:62; Baegert 1982:138	0	Barco 1981:41-42	1	McGee 1898:86; Felger and Moser 1991:149
	Cape/shirt, everyday wear	1	Shelvocke 1992:323; Antonio de la Ascensión 1992: 168; Barco 1981:40	0	Baegert 1952: 61-62	0	Barco 1981:41-42	0	McGee 1898:86, 92; Kroeber 1931
Religious Practices/ Marriage	Polygynous	1	Barco 1981:49; Mathes 2006:58	1	Antondo and Kino 1992: 275; Baegert 1952:73; Barco 1981:49; Mathes 2006:58	1	Barco 1981:49	1	McGee 1898:279; Bowen 2000:21, 471; Kroeber 1931: 8,24, 43 disagrees
	Shaman Human Hair Cape	1	Kroeber 1931:44	1	Kroeber 1931:43; Baegert 1952:88	1	Aschmann 1967:114; Kroeber 1931:44	0	Kroeber 1931:43, 44
	Shaman Sucking Implement	0	*	1	Kroeber 1931:43; Baegert 1952:78	1	Aschmann 1967:113	0	Kroeber 1931:43
	Face/Body Painting	1	Antonio de la Ascensión 1992:168; Mathes 2006:51; Porter y Casante 1992:249	1	Ulloa 1992:83; Baegert 1952:62	1	Mathes 1974:103, 105	1	Kroeber 1931:40
	Face paint is non-Ritual	1	Mathes 2006:51; Shelvocke 1992:323	0	Baegert 1952:62	0	*	1	DiPeso and Matson 1965:51-52; Felger and Moser 1991:144,152; Kroeber 1931:27
	Shamans Tablas	0	*	1	Mathes 2006:65	1	Aschmann 1967:115-116	0	Kroeber 1931:44
	Shamans Use Caves	1	Kroeber 1931:42	1	Kroeber 1931:42; Mathes 2006:65	1	Kroeber 1931:42	1	Kroeber 1931:42, 43
	Hair Cut in Mourning	1	Ortega 1992:243	1	Kroeber 1931:43; Baegert 1952:88	1	Mathes 1974:105	1	Kroeber 1931:43
Child Carrying Device	Net/Bag	0	Kroeber 1931:44	1	Baegert 1982:142; Barco 1981:71-72	1	Kroeber 1931:44; Barco 1981:71-72	1	Felger and Moser 1991: 139
	Tray/Turtle Shell	1	Barco 1981:72	1	Kroeber 1931:41; Baegert 1952:63,74; Baegert 1982:142	0	*	0	Kroeber 1931:41, 42
	Stick Cradle	0	*	0	*	0	*	1	Kroeber 1931:40; McGee 1898:226

	Attached to Forehead	1	Barco 1981:72	1	Baegert 1982:142	1	Barco 1981:71-72	0	Kroeber 1931:44
	Attached to Pole/Yoke	0	*	0	*	1	Mathes 2006:55, 59	1	Felger and Moser 1991: 190
Technology	Fire Hardened Poles	1	Laylander 2007:15-17	1	Laylander 2007:15-17	0	*	1	McGee 1898: 190
	Lances/Javelins	1	Ortega 1992:230; Laylander 2007:15-17	1	Ulloa 1992:79: Laylander 2007:15-17	1	Laylander 2007:15-17	0	*
	Harpoons	1	Ortega 1992:230; Laylander 2007:15-17	0	*	0	*	1	Kroeber 1931: 43
	Fishing Spear	1	Laylander 2007:15-17	1	Laylander 2007:15-17; Baegert 1952: 176	0	*	1	Felger and Moser 1991:128; Kroeber 1931: 19, 40; McGee 1898: 193
	Fishing Nets/Traps	1	Ortega 1992:230	1	Aschmann 1967:73; Mathes 2006:55; Laylander 2000: 127	1	Kroeber 1931:44; Massey 1966:54; Laylander 2000: 128	0	Kroeber 1931:19, 44; McGee 1898:194
	Atlatl	1	Massey 1961	0	Massey 1961	0	Massey 1961	0	*
	Bow and Arrow	1	Cooke 1992:295; Porter y Casante 1992:249; Ortega 1992:230	1	Salvatierra 1971:120; Baegert 1952: 63	1	Aschmann 1967:66	1	Felger and Moser 1991:126
	Arrow foreshaft is cane reed	1	Cooke 1992:296	1	Kroeber 1931:43; Baegert 1952:64; Ulloa 1992:78; Mathes 2006:55	1	Mathes 2006:56	1	Kroeber 1931:40
	Long bows	1	Cooke 1992:295	1	Kroeber 1931:43; Baegert 1952:64; Baegert 1982:139; Ulloa 1992:78	1	Mathes 2006:50	1	Kroeber 1931:40; McGee 1898:200
	Non-Ritual Roofed Housing	1	Cooke 1992:294; Cardona 1992: 224; Barco 1981:45	0	Barco 1981:46; Baegert 1952:59; Baegert 1982:142	1	Laylander 2000: 154	1	Felger and Moser 1991:118-120; Kroeber 1931:43; Bowen 1976:45; McGee 1898:221-224
	Unroofed Rock Windbreak	0	*	1	Kroeber 1931:42	1	Aschmann 1967:108-110	1	Felger and Moser 1991:119-120; Kroeber 1931:40
	Basketry	1	Ortega 1992:230	0	Massey 1966:56	1	Massey 1966:54	1	Felger and Moser 1991:180; Kroeber 1931:40; McGee 1898:208
	Coiled Basketry	0	*	0	*	1	Aschmann 1967:62; Massey 1966:54	1	Kroeber 1931:40; McGee 1898:208
	Pottery	0	*	0	Massey 1966; Aschmann 1967: 38	0	Massey 1966: Aschmann 1967: 38	1	Felger and Moser 1991:9; Kroeber 1931:40

	Agriculture	0	*	0	*	0	*	0	Kroeber 1931: 47
	Female Head Carrying	0	Kroeber 1931:40	0	Kroeber 1931:40; Baegert 1952:88	0	Kroeber 1931:40	1	Felger and Moser 1991:139; McGee 1898:149; Kroeber 1931:16
	Agave Fiber Nets	1	Mathes 2006: 54	1	Kroeber 1931: 41; Baegert 1952: 68	1	Aschmann 1967: 73	1	Kroeber 1931:40
	Second Harvest of Pitahaya	1	Barco 1981:77	1	Baegert 1982:144	1	Barco 1981:77	1	Kroeber 1931:40; McGee 1898:209
	Shell for Adornment	1	Shelvocke 1992; Mathes 2006:52	1	Barco 1981:37	1	Barco 1981:38-39	1	McGee 1898:173
	Reed Balsa Boat	1	Heizer and Massey 1953	1	Baegert 1952:82; Kroeber 1931:42; Massey 1947	1	Heizer and Massey 1953; Massey 1947	1	Felger and Moser 1991:131; Kroeber 1931:40; McGee 1898:216-219; Ulloa 1992:78
	Log Boats	1	Cooke 1992:295; Ortega 1992:229; Massey 1947	0	Heizer and Massey 1953:290	0	Heizer and Massey 1953:290	0	Heizer and Massey 1953:290
	Double Bladed Paddle	1	Cooke 1992:295; Heizer and Massey 1953; Massey 1947	1	Heizer and Massey 1953; Massey 1947	1	Heizer and Massey 1953; Massey 1947	1	Kroeber 1931:40; McGee 1898:219

*Trait recorded as “not present” because an alternative version was present and no author made a claim about the trait’s absence.

APPENDIX III: MAJOR OXIDE AND TRACE ELEMENT ANALYSIS OF ARCHAEOLOGICAL OBSIDIAN FROM RANCHO EL CIRUELO AND MARIA SILVIA DE TORIS, BAJA CALIFORNIA SUR

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MAJOR OXIDE AND TRACE ELEMENT ANALYSIS OF ARCHAEOLOGICAL OBSIDIAN FROM RANCHO EL CIRUELO AND MARIA SILVIA DE TORIS, BAJA CALIFORNIA SUR

by

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9 February 2011

INTRODUCTION

The analysis here of source standard obsidian from two localities in southern Baja California indicates a high silica rhyolite glass, likely from a single magma source. The signature may be similar to an unlocated source present in small proportions in archaeological assemblages in central and southern Baja California (Shackley and Henrickson 2009).

ANALYSIS AND INSTRUMENTATION

All rock samples are analyzed whole. The trace element results presented here are quantitative in that they are derived from "filtered" intensity values ratioed to the appropriate x-ray continuum regions through a least squares fitting formula rather than plotting the proportions of the net intensities in a ternary system (McCarthy and Schamber 1981; Schamber 1977). Or more essentially, these data through the analysis of international rock standards, allow for inter-instrument comparison with a predictable degree of certainty (Hampel 1984).

The analyses were performed in the Archeological XRF Laboratory, El Cerrito, California, using a Thermo Scientific *Quant'X* energy dispersive x-ray fluorescence spectrometer. The spectrometer is equipped with a ultra-high flux peltier air cooled Rh x-ray target with a 125 micron beryllium (Be) window, an x-ray generator that operates from 4-50 kV/0.02-1.0 mA at 0.02 increments, using an IBM PC based microprocessor and WinTrace™ 4.1 reduction software. The spectrometer is equipped with a 2001 min^{-1} Edwards vacuum pump for the analysis of elements below titanium (Ti). Data is acquired through a pulse processor and analog to digital converter. For samples over 10 mm in minimum diameter, a 8.8 mm tube collimator is fitted. For samples under 10 mm in minimum diameter or extreme angular character (Toris samples 7, 9-13, 18) a 3.5 mm tube collimator is used to concentrate energy in a smaller diameter.

For Ti-Nb, Pb, Th elements the mid-Zb condition is used operating the x-ray tube at 30 kV, using a 0.05 mm (medium) Pd primary beam filter in an air path at 200 seconds livetime to generate x-ray intensity $K\alpha_1$-line data for elements titanium (Ti), manganese (Mn), iron (as Fe^T), cobalt (Co), nickel (Ni), copper, (Cu), zinc, (Zn), gallium (Ga), rubidium (Rb), strontium (Sr), yttrium (Y), zirconium (Zr), niobium (Nb), lead (Pb), and thorium (Th). Not all these elements are reported since their values in many volcanic rocks is very low. Trace element intensities were converted to concentration estimates by employing a least-squares calibration line ratioed to the Compton scatter established for each element from the analysis of international rock standards certified by the National Institute of Standards and Technology (NIST), the US. Geological Survey (USGS), Canadian Centre for Mineral and Energy Technology, and the Centre de Recherches Pétrographiques et Géochimiques in France (Govindaraju 1994). Line fitting is linear (XML) for all elements but Fe where a derivative fitting is used to improve the fit for iron and thus for all the other elements. When barium (Ba) is acquired, the Rh tube is operated at 50 kV and 0.5 mA in an air path at 200 seconds livetime to generate x-ray intensity $K\alpha_1$-line data, through a 0.630 mm Cu (thick) filter ratioed to the bremsstrahlung region (see Davis et al. 2011). Further details concerning the petrological choice of these elements in North American obsidians is available in Shackley (1988, 1990, 1995, 2005; also Mahood and Stimac 1991; and Hughes and Smith 1993). A suite of 17 specific standards used for the best fit regression calibration for elements Ti-Nb, Pb, and Th, include G-2 (basalt), AGV-2 (andesite), GSP-2 (granodiorite), SY-2 (syenite), BHVO-2 (hawaiite), STM-1 (syenite), QLO-1 (quartz latite), RGM-1 (obsidian), W-2 (diabase), BIR-1 (basalt), SDC-1 (mica schist), BCR-2 (basalt), TLM-1 (tonalite), SCO-1 (shale), all US Geological Survey standards, NBS-278 (obsidian) from the National Institute of Standards and Technology, BR-1 (basalt) from the Centre de Recherches Pétrographiques et Géochimiques in France, and JR-1 and JR-2 (obsidian) from the Geological Survey of Japan (Govindaraju 1994).

For the analysis of light elements (Na-Ca) a fundamental parameter (theoretical) method is employed using two separate conditions depending on atomic weight (Z). For the Low Za condition (Na, Mg, Al, Si) the tube is operated at 6 kV, auto current, with no tube filter in vacuum for 100 live seconds. For the Mid Zb condition (K, Ca, Ti, Mn, Fe) the tube is operated at 32 kV, auto current, with a thin (0.06 mm) Pd filter in vacuum at 100 live seconds. Five

USGS and Japanese standards (described above) are used in the theoretical calibration; RGM-1, JR-1, AGV-2, BHVO-2, BIR-1, and one Corning Glass standard D. Multiple conditions are designed to ameliorate peak overlap identified with digital filter background removal, least squares empirical peak deconvolution, gross peak intensities and net peak intensities above background.

The data from the WinTrace software were translated directly into Excel for Windows and into SPSS for statistical manipulation (Tables 1 and 2). In order to evaluate these quantitative determinations, machine data were compared to measurements of known standards during each run (Table 1). RGM-1 is analyzed during each sample run for obsidian artifacts to check machine calibration (Table 1). Bivariate plots of the trace element data indicate the similar magmatic relationship between the two localities (Figures 1-4). Field structural geological survey will confirm the analytical hypothesis.

REFERENCES CITED

Davis, M.K., T.L. Jackson, M.S. Shackley, T. Teague, and J. Hampel
2011 Factors Affecting the Energy-Dispersive X-Ray Fluorescence (EDXRF) Analysis of Archaeological Obsidian. In *X-ray Fluorescence Spectrometry (XRF) in Geoarchaeology*, edited by M.S. Shackley, pp. 45-64. Springer, New York.

Govindaraju, K.
1994 1994 Compilation of Working Values and Sample Description for 383 Geostandards. *Geostandards Newsletter* 18 (special issue).

Hampel, Joachim H.
1984 Technical Considerations in X-ray Fluorescence Analysis of Obsidian. In *Obsidian Studies in the Great Basin*, edited by R.E. Hughes, pp. 21-25. Contributions of the University of California Archaeological Research Facility 45. Berkeley.

Hildreth, W.
1981 Gradients in Silicic Magma Chambers: Implications for Lithospheric Magmatism. *Journal of Geophysical Research* 86:10153-10192.

Hughes, Richard E., and Robert L. Smith
1993 Archaeology, Geology, and Geochemistry in Obsidian Provenance Studies. *In Scale on Archaeological and Geoscientific Perspectives*, edited by J.K. Stein and A.R. Linse, pp. 79-91. Geological Society of America Special Paper 283.

Mahood, Gail A., and James A. Stimac
1990 Trace-Element Partitioning in Pantellerites and Trachytes. *Geochemica et Cosmochimica Acta* 54:2257-2276.

McCarthy, J.J., and F.H. Schamber
1981 Least-Squares Fit with Digital Filter: A Status Report. In *Energy Dispersive X-ray Spectrometry*, edited by K.F.J. Heinrich, D.E. Newbury, R.L. Myklebust, and C.E. Fiori, pp. 273-296. National Bureau of Standards Special Publication 604, Washington, D.C.

Schamber, F.H.
1977 A Modification of the Linear Least-Squares Fitting Method which Provides Continuum Suppression. In *X-ray Fluorescence Analysis of Environmental Samples*, edited by T.G. Dzubay, pp. 241-257. Ann Arbor Science Publishers.

Shackley, M. Steven
1988 Sources of Archaeological Obsidian in the Southwest: An Archaeological, Petrological, and Geochemical Study. *American Antiquity* 53(4):752-772.

1990 *Early Hunter-Gatherer Procurement Ranges in the Southwest: Evidence from Obsidian Geochemistry and Lithic Technology*. Ph.D. dissertation, Arizona State University, Tempe.

1995 Sources of Archaeological Obsidian in the Greater American Southwest: An Update and Quantitative Analysis. *American Antiquity* 60(3):531-551.

2005 *Obsidian: Geology and Archaeology in the North American Southwest*. University of Arizona Press, Tucson.

Shackley, M.S. and C. Henrickson
2009 From the Unknown to Known: the State of Obsidian Source Provenance Studies in Baja California. Paper presented at the Annual Meeting of the Society for American Archaeology, Atlanta, Georgia.

Table 1. Major oxides for one sample from Ciruelo and one from Toris.

Sample	SiO_2	Al_2O_3	CaO	Fe_2O_3	K_2O	MgO	MnO	Na_2O	TiO_2
CIRUELO-4	77.173	11.637	0.719	0.955	5.412	<.001	0.107	3.851	0.009
TORIS-1	77.156	11.877	0.704	0.925	5.276	<.001	0.092	3.814	0.016
RGM1-S4	74.589	12.466	1.302	1.483	5.159	<.001	0.044	3.5	0.294

Table 2. Elemental concentrations for Ciruelo and Toris sources, southern Baja California. All measurements in parts per million (ppm).

Sample	Source	Ti	Mn	Fe	Rb	Sr	Y	Zr	Nb	Ba	Pb	Th
EL CIRUELO-1	Rancho El Ciruelo	827	480	9037	242	41	26	67	11	340	77	22
2	Rancho El Ciruelo	896	489	9229	245	40	28	60	13	296	69	27

3	Rancho El Ciruelo	889	464	8915	237	41	24	59	7	305	59	33
4	Rancho El Ciruelo	819	401	7898	217	38	27	60	14	341	53	15
5	Rancho El Ciruelo	843	416	8367	225	39	29	58	11	310	62	21
6	Rancho El Ciruelo	827	475	8817	237	42	29	64	11	296	67	17
7	Rancho El Ciruelo	855	437	8438	222	38	24	59	12	309	62	21
8	Rancho El Ciruelo	987	474	9693	235	43	24	56	12	326	70	26
9	Rancho El Ciruelo	914	454	9016	230	41	23	56	11	292	75	19
10	Rancho El Ciruelo	888	407	8576	229	40	25	58	9	306	62	18
11	Rancho El Ciruelo	861	455	8410	223	38	22	57	11	288	60	23
12	Rancho El Ciruelo	950	436	9188	230	38	27	66	10	321	69	21
TORIS-1	Maria Silvia de Toris	783	417	7875	221	39	25	61	10	313	55	22
-2	Maria Silvia de Toris	837	452	8508	229	42	24	60	13	334	59	23
-3	Maria Silvia de Toris	900	395	9010	228	42	22	59	11	318	58	24
-4	Maria Silvia de Toris	808	431	8296	227	38	25	59	9	324	58	29
-5	Maria Silvia de Toris	979	443	9712	230	45	28	59	12	343	58	24
-6	Maria Silvia de Toris	834	467	8499	233	38	28	62	12	313	63	22
-7	Maria Silvia de Toris	791	354	7626	212	40	22	58	13	383	47	23
8	Maria Silvia de Toris	815	454	8622	230	40	24	57	15	312	61	24
9	Maria Silvia de Toris	912	593	9840	266	47	24	69	13	288	77	25
10	Maria Silvia de Toris	815	448	8513	240	43	28	61	13	306	60	20
11	Maria Silvia de Toris	890	492	9069	251	44	27	59	14	342	66	30
12	Maria Silvia de Toris	926	506	9156	253	43	27	62	12	347	70	27
13	Maria Silvia de Toris	938	488	9004	245	41	26	58	14	296	64	23
14	Maria Silvia de Toris	948	429	8918	217	39	26	58	11	293	55	18
15	Maria Silvia de Toris	847	435	8329	223	41	28	55	9	256	58	24
16	Maria Silvia de Toris	919	455	8707	229	39	24	59	12	274	58	21
17	Maria Silvia de Toris	843	415	8414	216	40	27	56	11	326	55	14
TORIS-18	Maria Silvia de Toris	844	450	8778	253	43	25	57	12	279	68	28

TORIS-SILVIA	Maria Silvia de Toris	857	464	8899	239	44	28	62	12	340	66	23
RGM1-S4	USGS standard	1579	272	12782	149	107	27	220	10	877	21	18
RGM1-S4	USGS standard	1557	274	13160	147	109	25	217	10	881	24	12

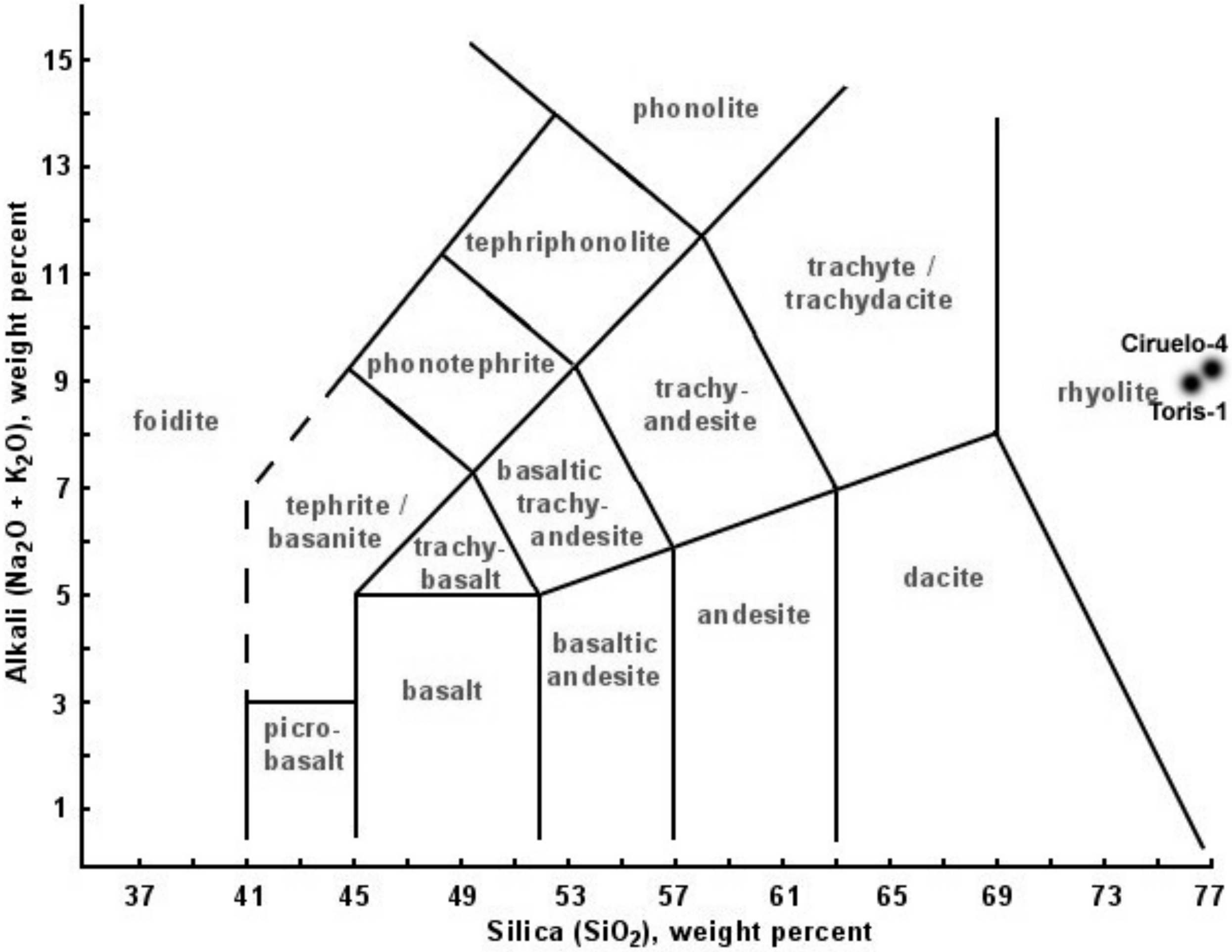


Figure 1. Alkali-silica plot of two samples from the two localities.

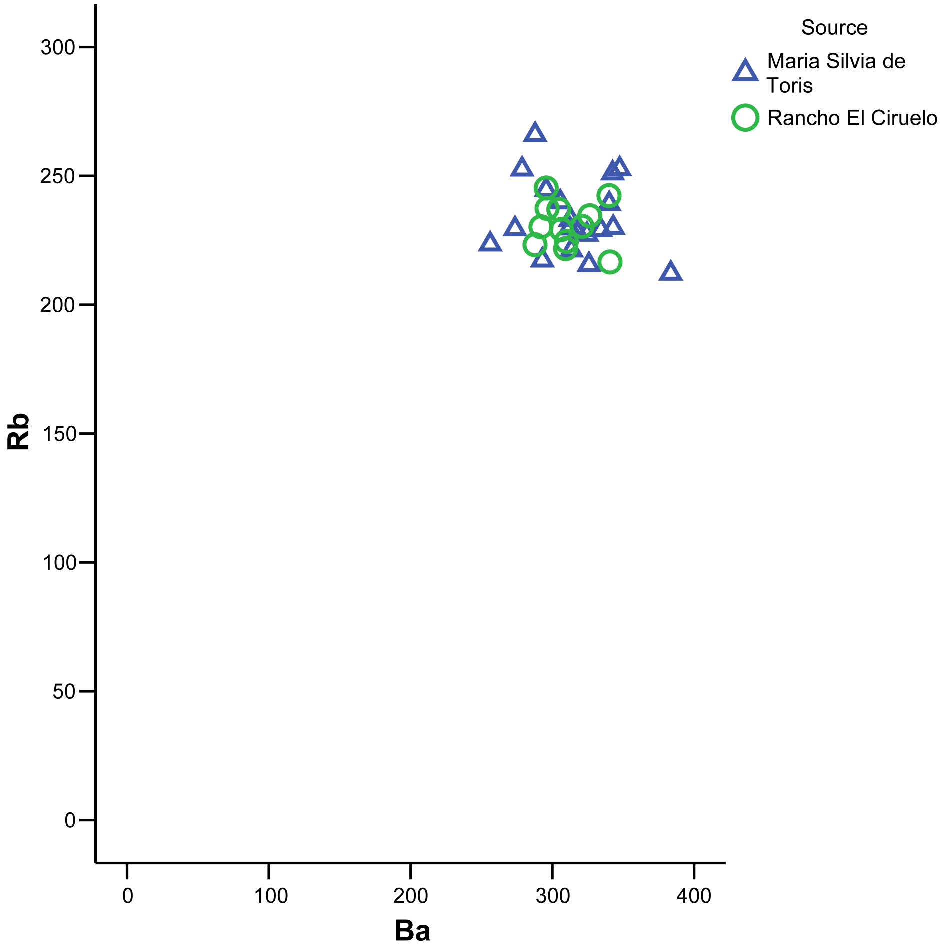


Figure 2. Ba versus Rb biplot of the source standards.

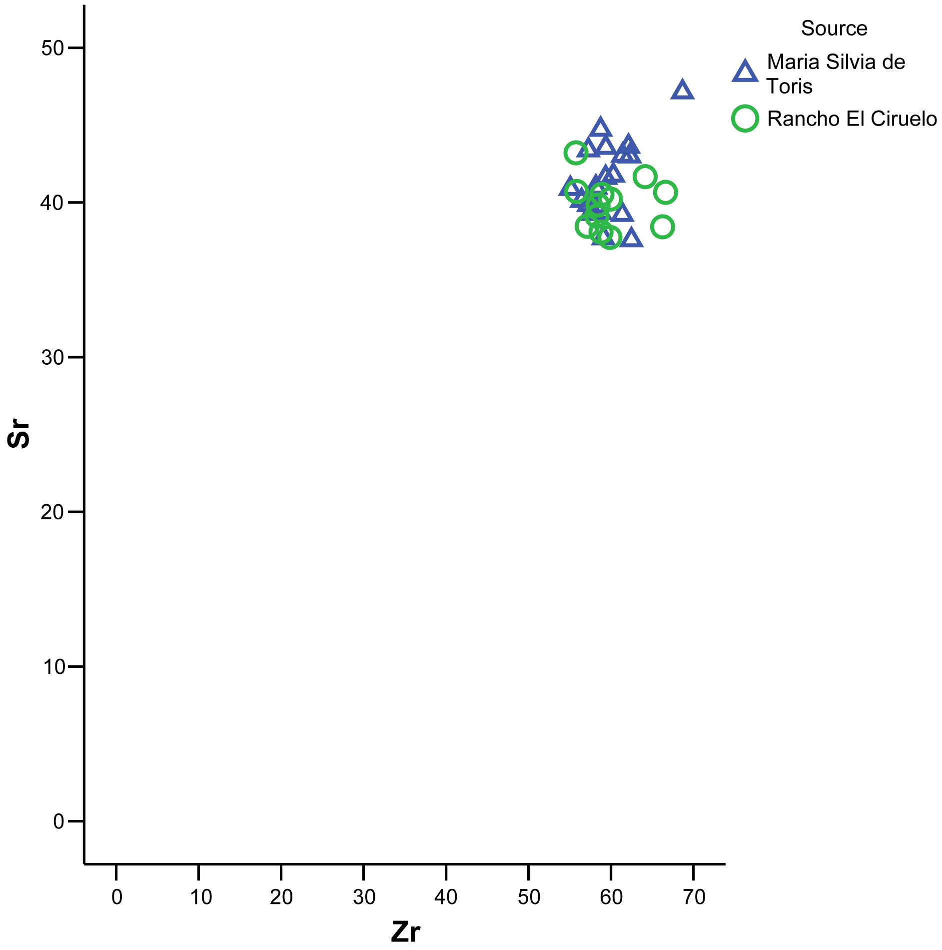


Figure 3. Zr versus Sr bivariate plot of the source standards.

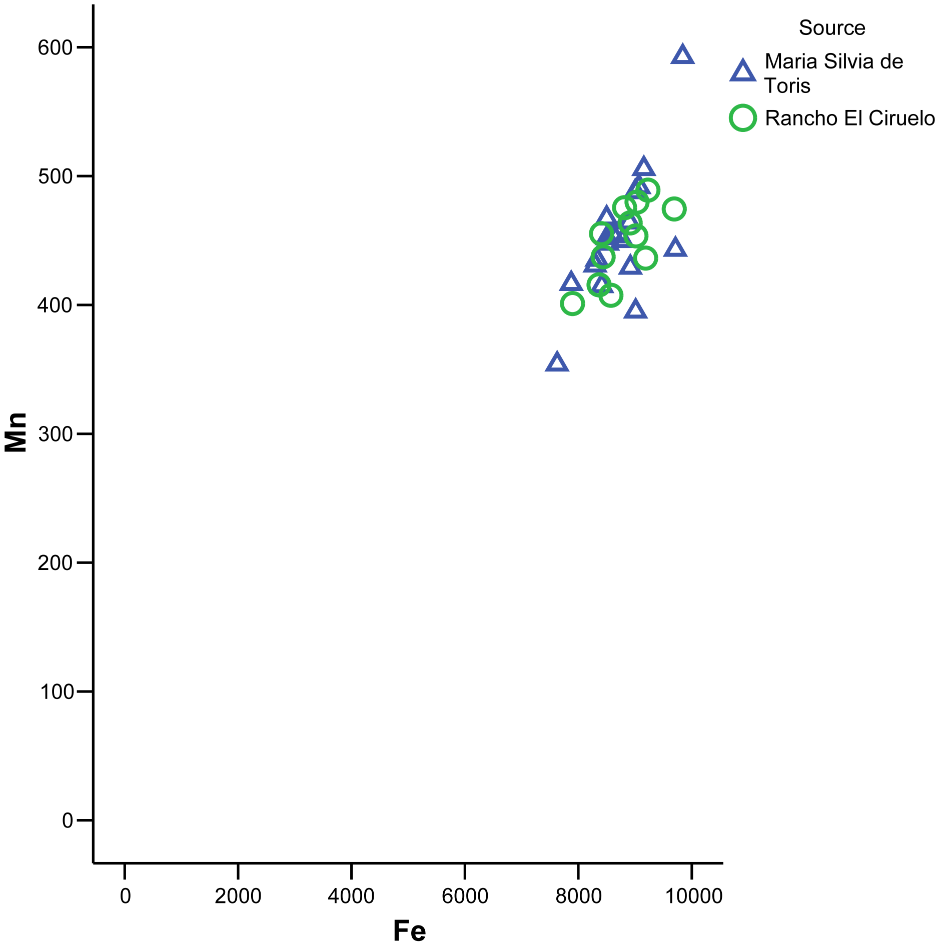


Figure 4. Fe versus Mn bivariate plot of the source standards.

APPENDIX IV: CUEVA SANTA RITA PROFILE DESCRIPTIONS

Figure 1 and Table 1. Trench A, Unit 1, east wall profile description

Figure 1. Photograph of Unit 1, south wall. *

Facies	Properties*
6	10YR 4/2 (Dark grayish brown) fresh, dry. Poorly sorted, loose matrix. Crushed by livestock. No pedogenic development. Heavily bioturbated. Clear, wavy to irregular boundary >1cm.
5	10YR 4/2 (Dark grayish brown) fresh, dry. Single grain structure. <10% organics.
4	10YR 4/6 (Dark yellowish brown)
3	10YR 2/1 (Black) fresh, dry. Clear, wavy boundary.
2	10YR 2/1 (Black) Subangular and subrounded pebbles-cobble sized clasts.
1	10YR 2/1(Black). Clast supported matrix. 10% charcoal. Subangular and subrounded pebbles-cobble sized clasts.

*Profile destroyed during tropical storm Julio. Unable to clean profile. A white line is visible along the walls of Unit 1. This line shows the highest level of perched water, leaving precipitates behind after it evaporated.

Figure 2 and Table 2. Trench A, Unit 2, east wall

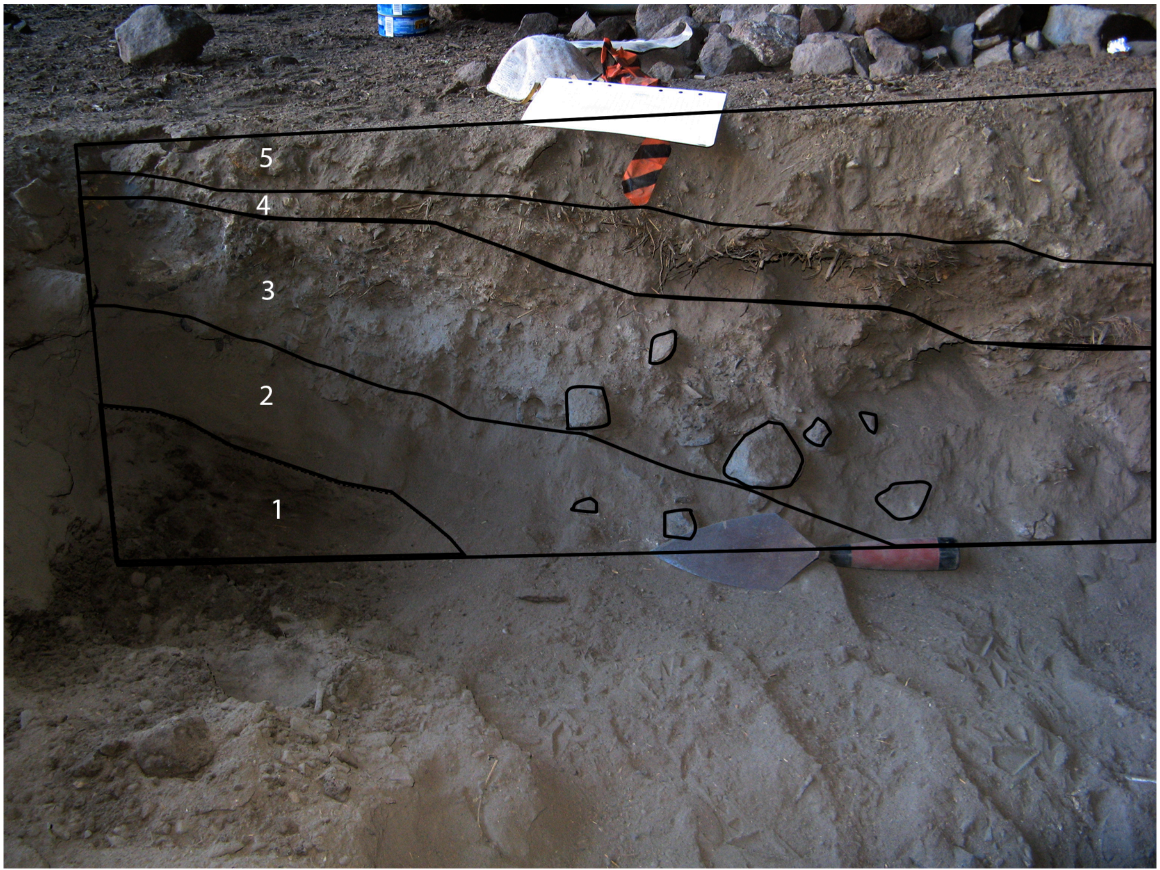


Figure 2. Northern half of east 2X2 meter wall profile.

Facies	Properties
5	10YR 4/2 (Dark grayish brown) fresh, dry. Poorly sorted, loose matrix. Trampled by livestock. No pedogenic development. Heavily bioturbated. Clear, wavy to irregular boundary >1cm.
4	10YR 4/2 (Gray) fresh, dry. Organic, poorly-sorted matrix. Abrupt, very irregular boundary.
3	10YR4/2 (Dark grayish brown) fresh, dry. Massive structure. 25% charcoal, <10% gravel and FCR. Gradual, smooth to wavy boundary. Conformable boundary between 2 and 3 suggests slow shift in depositional processes.
2	10YR 4/1 (Dark Gray) fresh, dry. Massive structure. Gravels 25%-75%. Abrupt, irregular boundary. Increasing concentration of éboulis and FCR from south to north, towards the rockshelter entrance. Increasing subangular clasts with depth, indicating a fining upward.
1	Same as Facies 2. Sediment staining is from the movement of water along the bedrock floor due to capillary action. The water entered the cave along the dripline after tropical storm Julio. As the sediments above the bedrock become saturated, capillary action draws the water laterally outward from the dripline.

Figure 3 and Table 3. Trench A, Unit 2, south wall

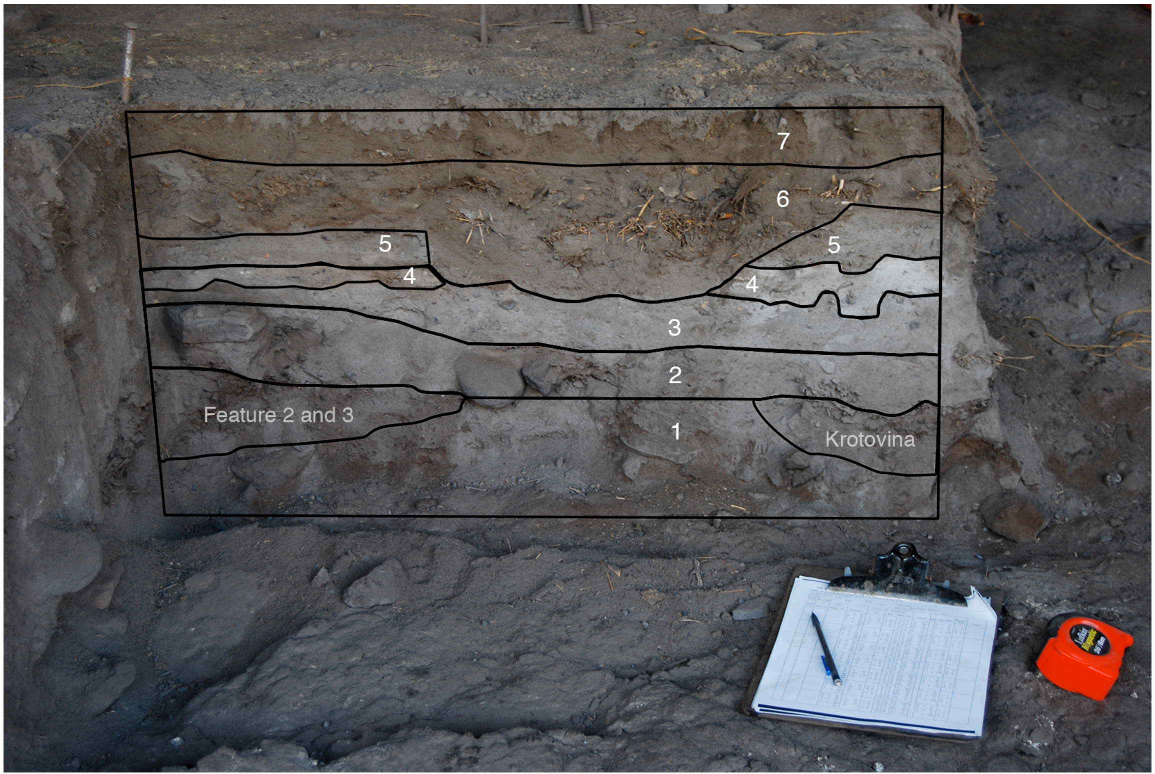


Figure 3. Photograph of south wall.

Facies	Feature	Properties
7		10YR4/2 (Dark grayish brown)-10YR3/2 (Very dark grayish brown) moist, Poorly sorted, loose matrix. Crushed by livestock. No pedogenic development. Heavily bioturbated. Clear, wavy to irregular boundary. Referred to as "polvo" in field notes and during excavations.
6		10YR 4/2 (Dark grayish brown) fresh, dry. Single grain structure. Organic-rich, poorly-sorted matrix. Abrupt, very irregular boundary. Compositionally high in organics.
5		10YR 4/2-10YR 5/3 (Dark grayish brown-Brown). Single grain. Abrupt, irregular boundary. Charcoal <10%. Cross-cut by Facies 6.
4		10YR 6/1 (Gray) Single grain. Ashy matrix. Looks like a hearth feature. Abrupt, irregular boundary. Cross-cut by Facies 6.
3		10YR 5/2 (Grayish brown) Single grain structure. Abrupt, wavy boundary. Charcoal <10%, 1-2cm dm.
2		10YR 5/1 (Gray) fresh, dry; Single grain structure, wavy, clear boundary. Possibly lined with grinding tools.

1	10YR 3/2 (Very dark grayish brown) fresh, dry. Massive, ephemeral unit <1cm-4cm thick. Organic rich. Sediments rest on bedrock in southern portion of unit.

Table 4. Trench A, Unit 4, east wall

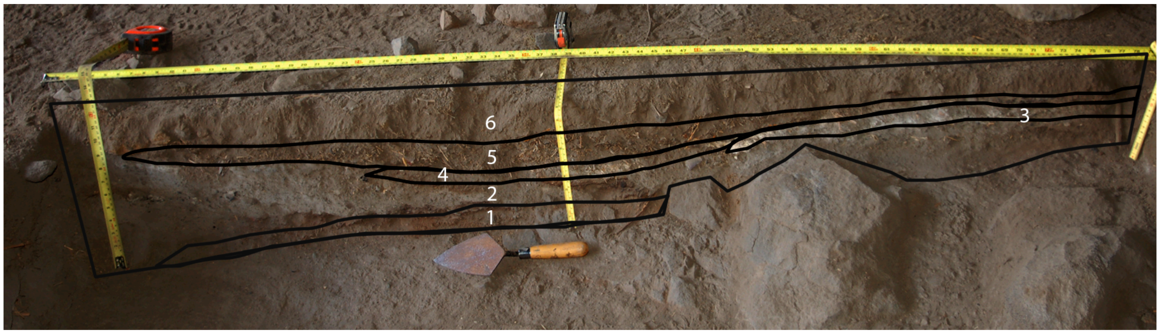
Facies	Properties
4	10YR4/2 (Dark grayish brown)-10YR3/2 (Very dark grayish brown) moist, Poorly sorted, loose matrix. Crushed by livestock. No pedogenic development. Heavily bioturbated. Clear, wavy to irregular boundary.
3	10YR 4/2 (Gray) fresh, dry. Organic, poorly-sorted matrix. Single grain structure. Abrupt, very irregular boundary. Unit cuts into a hearth feature.
2	10YR 4/2 (Dark grayish brown). Charcoal 15% (<1cm-2cm diameter). Ash lenses 3-7cm in width and 1-2cm deep.
1	10YR 4/4 (Dark Yellowish Brown) fresh, dry. Massive, ephemeral unit (1cm-3cm thick). Organic rich. Few FCR or rockfall. Sediments rest on bedrock in southern portion of unit.

Figure 4 and Table 5. Trench A, Unit 3, north wall.

Figure 4. North wall, Unit 3. Circles indicate rocks.

Facies	Properties
5	10YR 4/2 (Dark grayish brown) fresh, dry. Poorly sorted, loose matrix. Crushed by livestock. No pedogenic development. Heavily bioturbated. Clear, wavy to irregular boundary >1cm.
4	10YR 4/2 (Gray) to 10YR 4/3 (Brown) fresh, dry. Organic, poorly-sorted matrix. Single grain structure. Abrupt, irregular boundary.
3	10YR 5/1 (Gray). Organic-rich matrix. 10YR 8/1 (White) concretions (2cm in dm). Charcoal 10%.
2	10YR 4/2 (Dark grayish brown). Fine roots <1mm dm; <10% charcoal; and <10% gravels. Abrupt, smooth boundary.
1	10YR 4/4 (Dark Yellowish Brown) fresh, dry. Massive, ephemeral unit <1cm-4cm thick. Organic rich.

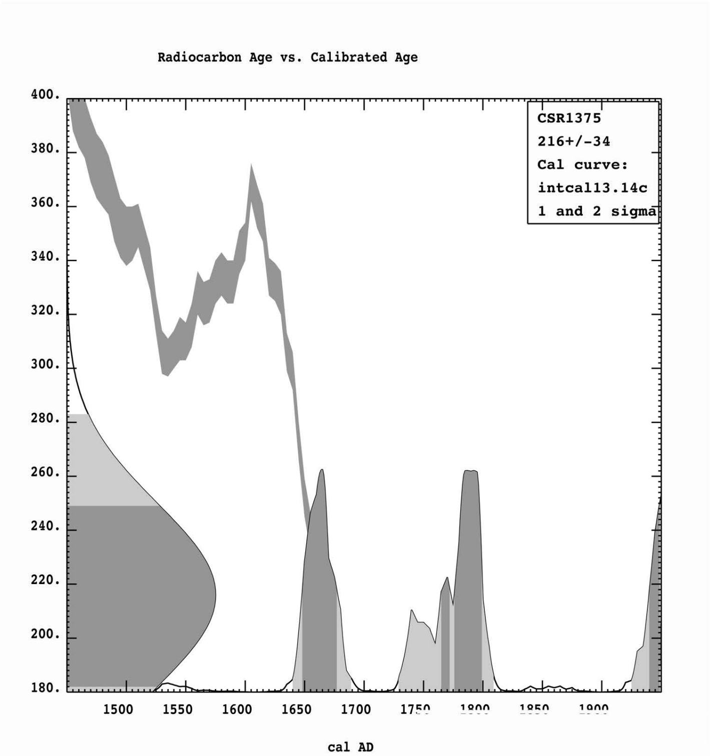
Figure 5 and Table 6. Trench A, Unit 3, Photograph of east wall.

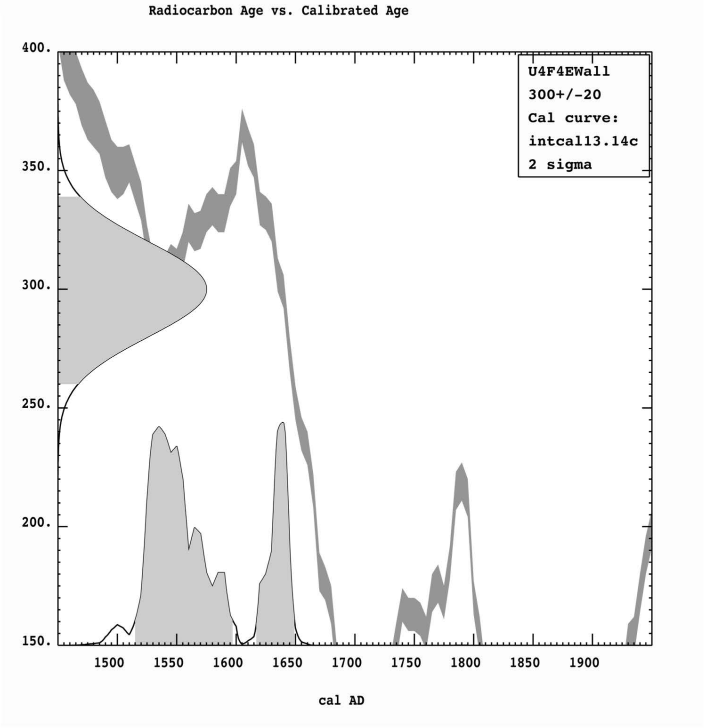


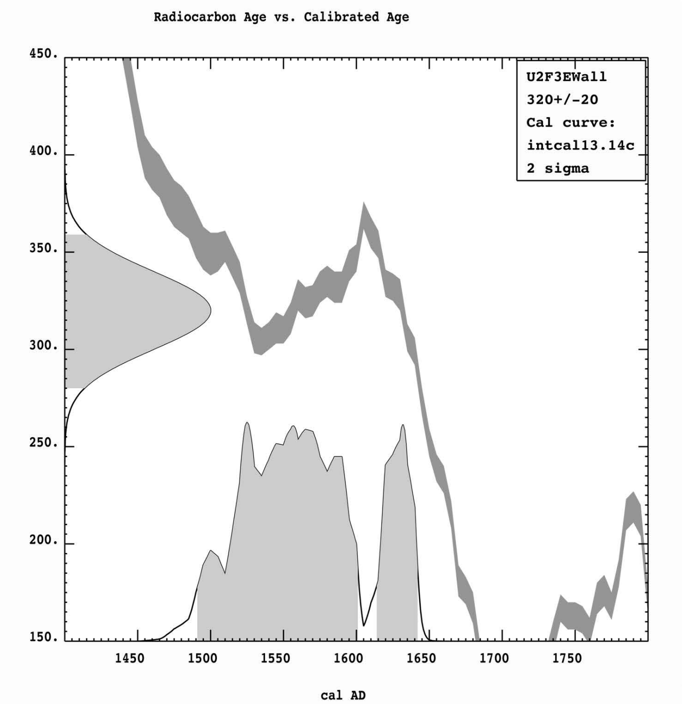
Facies	Properties
6	10YR 4/2 (dark grayish brown) fresh, dry. Poorly sorted, loose matrix. Crushed by livestock. No pedogenic development. Heavily bioturbated. Clear, wavy to irregular boundary >1cm.
5	10YR 4/2 (gray) fresh, dry. Organic, poorly-sorted matrix. Single grain structure. Clear, wavy boundary.
4	10YR 3/4 (dark yellowish brown). 1-2cm thick, 45cm wide. Charcoal and organics increase in southern portion half of unit. Abrupt, smooth boundary.
3	10YR 7/1 (light gray) with 10YR 8/3 (very pale brown) ash concretions. Single grain structure. Gradually fades toward southern portion of unit. Abrupt, smooth boundary. Subangular, blocky, firm ash concretions 2cm dm. Ashy, mineral rich matrix.
2	10YR 4/2 (dark grayish brown). Fine roots <1mm dm, <10% charcoal, <10% gravels. Abrupt, smooth boundary.

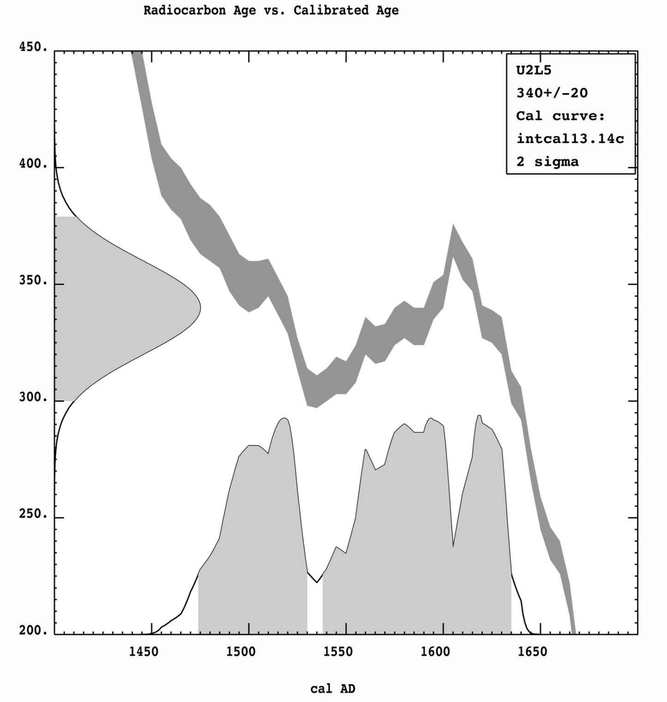
1	10YR 4/4 (dark yellowish brown) fresh, dry. Ephemeral unit <1cm-4cm thick. Organic rich. Poorly preserved in Unit 3 relative to Unit 2 and Unit 4 and appears only in the northern side of unit.

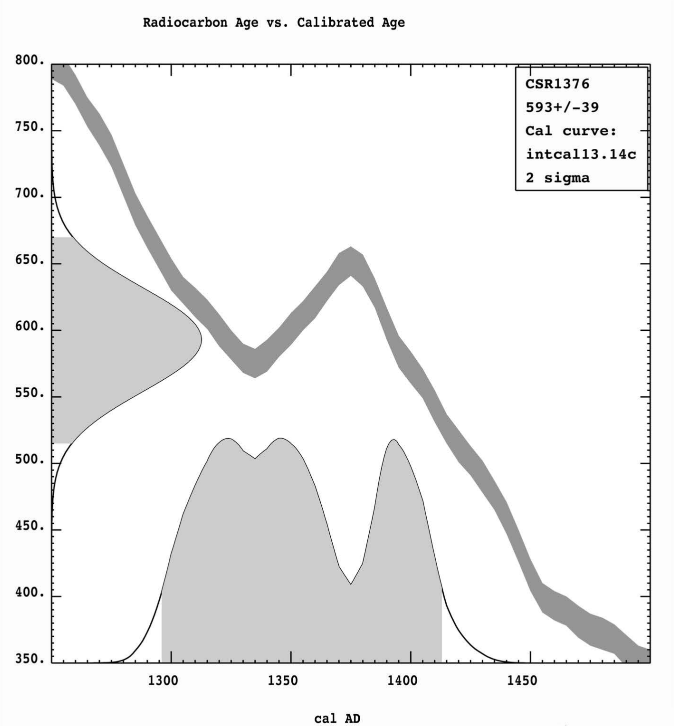
APPENDIX V: CALIBRATED RADIOCARBON DATES

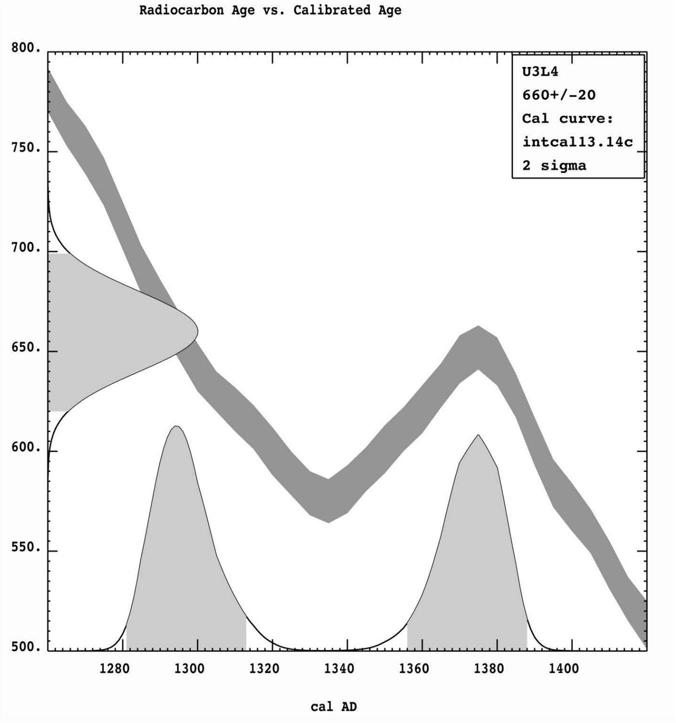


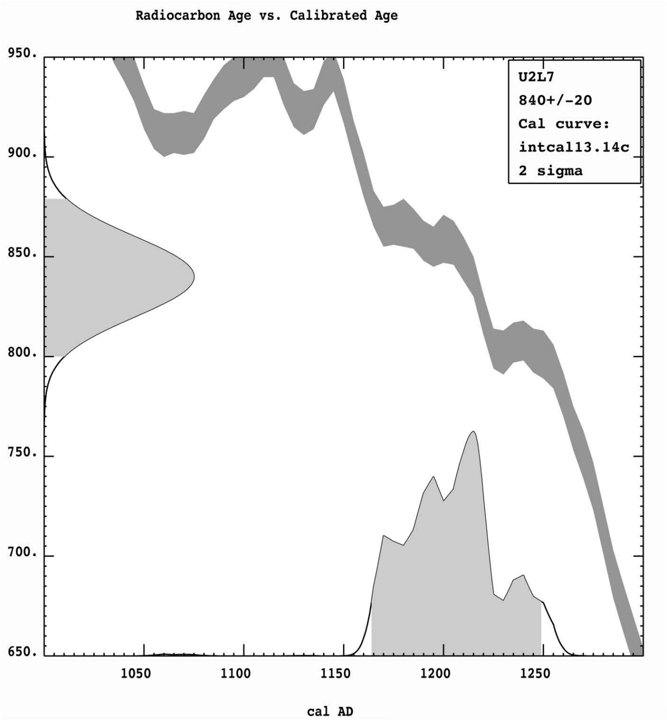


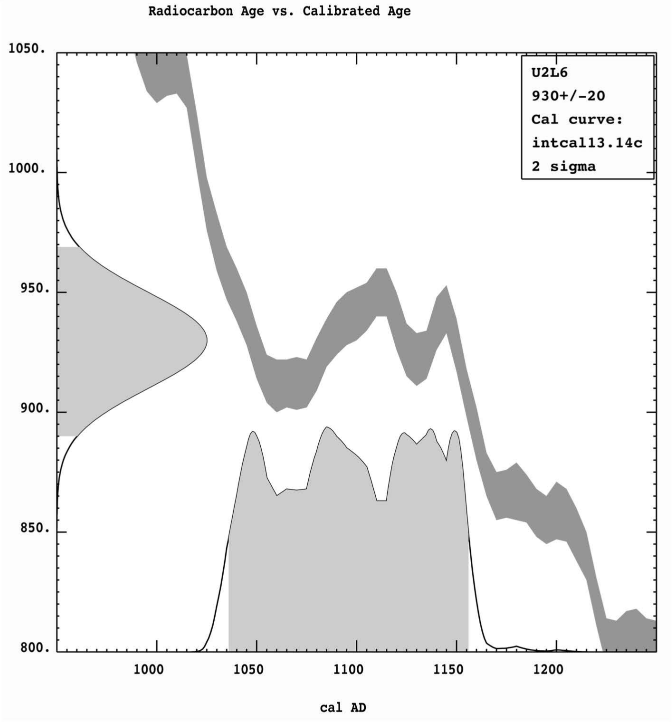

Radiocarbon Age vs. Calibrated Age
U2F3EWall
320+/-20
Cal curve:
intcal13.14c
2 sigma
450.
400.
350.
300.
250.
200.
150.
1450
1500
1550
1600
1650
1700
1750
cal AD

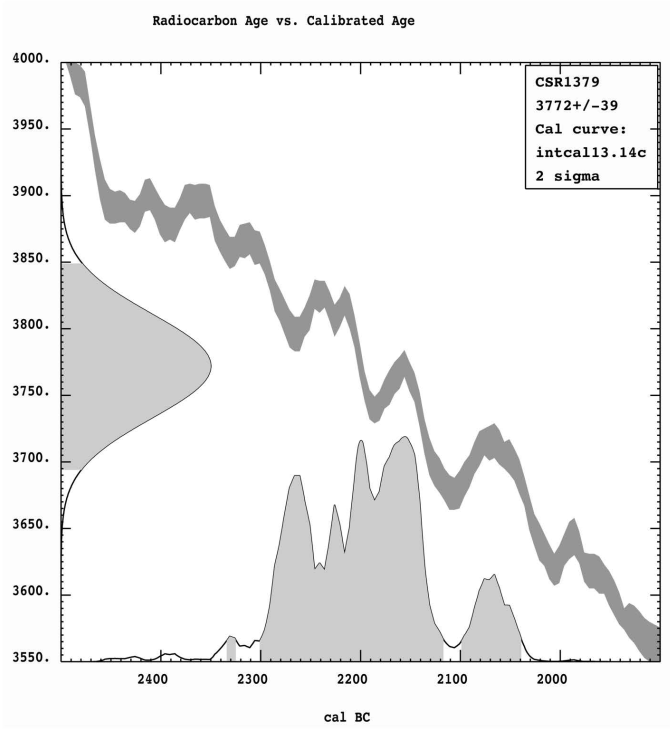

Radiocarbon Age vs. Calibrated Age
U2L5
340+/-20
Cal curve:
intcal13.14c
2 sigma
450.
400.
350.
300.
250.
200.
1450
1500
1550
1600
1650
cal AD


Radiocarbon Age vs. Calibrated Age
CSR1376
593+/-39
Cal curve:
intcal13.14c
2 sigma
800.
750.
700.
650.
600.
550.
500.
450.
400.
350.
1300
1350
1400
1450
cal AD


Radiocarbon Age vs. Calibrated Age
U3L4
660+/-20
Cal curve:
intcal13.14c
2 sigma
800.
750.
700.
650.
600.
550.
500.
1280
1300
1320
1340
1360
1380
1400
cal AD


Radiocarbon Age vs. Calibrated Age
950.
900.
850.
800.
750.
700.
650.
1050
1100
1150
1200
1250
cal AD
U2L7
840+/-20
Cal curve:
intcal13.14c
2 sigma


Radiocarbon Age vs. Calibrated Age
1050.
1000.
950.
900.
850.
800.
1000
1050
1100
1150
1200
cal AD
U2L6
930+/-20
Cal curve:
intcal13.14c
2 sigma


Radiocarbon Age vs. Calibrated Age
4000.
3950.
3900.
3850.
3800.
3750.
3700.
3650.
3600.
3550.
CSR1379
3772+/-39
Cal curve:
intcal13.14c
2 sigma
2400
2300
2200
2100
2000
cal BC

APPENDIX VI: CUEVA SANTA RITA SHELL BEADS AND BLANKS

Catalog #	Unit	Level	Feature	**Shell sp:** 0=*Olivella*; 1=*O.biplicata*; 2=other *Olivella*; 3=*Erato*	Shell Type (Bennyhoff 1987)	Circum-ference (mm)	Height (mm)	**Color:** 1=natural 2=white 3=browned 4=black
44	2	2		3	A1	9.76	11.79	4
61	2	2		1	Drilled	6.48	14.2	2
72	2	2		1	A1a	6.01	12.19	3
94	2	1		1		14.11	7.26	1
119	2	4		3	A1	8.69	11.8	1
146	2	4		2	A1a	5.96	12.05	1
149	2	4		1	A2a	5.87	11.21	1
203	2	3		1	B3a	2.76	3.63	4
236	2	6		1	A2b	7.81	16.15	4
278	2	7		1	B3a	2.93	3.74	1
401	2		7	1	A2a	5.33	10.08	3
456	2		12	2	A1a	12.98	7.1	1
496	2		14	1	A2a	5.45	11.26	2
529	3	1		0	A1a	5.6	11.7	1
532	3	1		0	B6a	2.47	2.83	2
533	3	1		0	A1a	6.05	14.26	1
534	3	1		0	B3a	3.15	4.11	2
536	3	1		0	A2a	5.04	9.93	1
563	3	1		1	Preform	2.45	5.91	1
577	3	2		1	Preform	7.25	16.55	1
581	3	2		2	Preform	4.47	10.82	1
648	3	3		1	Preform	3.22	6.75	1
649	3	3		0	B1a	5.27	11.8	1
653	3	3		0	A1a	5.91	11.41	2
654	3	3		0	1b	6.89	15.28	4
757	3	7		1	B3a	3.31	3.14	2
760	3	7		0	A1b	6.79	14.47	4
761	3	7		3	A2	9.77	16.53	3
846	4	2				6.21	7.32	
848	4	2		1	A2b	6.62	13.92	3
859	4	3		1	B6a	2.95	3.58	3
889	4	4		1	B6a	3.56	4.89	4
890	4	4		1	A1b	7.09	14.33	3
905	3	4		0	Preform	5.03	11.28	3
922	3	4				1.14	18.23	1
923	3	4		0	B1b	6.66	14.34	3
936	3	5		0	A1b	7.51	16.31	1
937	3	5		2	A?a	5.81	12.2	1
952	3	6		0	A1a	5.88	12.55	1
987	1	2		1	A1	6.45	9.41	4

1020	1	3		1	B6a	2.98	4.03	3
1062	1	6						
2198	1	2		0	A2b	6.78	13.04	2
2199	1	2		0	A1a	7.34	15.52	2
2200	1	1		1	B6a	3.3	4.59	3
2201	1	2		1	Preform	5.95	10.41	1
2202	1	2		1	B3a	3.61	4.51	3
2203	1	3		1	A4b	7.32	15.07	2
2204	1	3		0	B3a	3.17	3.55	3
2205	1	3		0	B3a	3.14	3.69	1
2206	1	3		1	B6a	3.15	3.33	1
2207	1	3		0	A1a	1.99	2.77	2
2208	1	3		1	B3a	2.99	4.37	4
2209	1	3		1	B3a	3.02	4.12	2
2211	2	4		1	A1b-drilled	7.19	13.83	4
2212	2	4		1	B6a	2.9	3.61	2
2213	2	4		1	B6a	3.97	5.88	4
2214	2	4		1	B3a	3.04	3.51	4
2215	2	4		1	B6a	3.96	5.24	4
2216	2	4		1	B3a	3.64	5.35	4
2217	2	4		1	B3a	3.35	4.66	4
2218	2	4		1	B3a	3.66	4.74	4
2219	2	4		1	B6a	2.98	4.65	4
2220	2	4		1	B3a	3.83	5.34	4
2221	2	4		1	B3a	3.83	4.88	4
2222	2	4		1	B6a	3.67	5.52	4
2223	2	4		1	B3a	3.34	3.95	4
2224	2	4		1	B3a	3.07	3.99	2
2225	2	4		1	A2a	4.8	9.19	1
2227	2		7	1	A1a	5.99	10.81	1
2228	2	2		1	Preform	5.83	12.09	2
2229	2	2		1	B3a	3.21	4.26	3
2230	2	2		1	B6a	2.9	4.1	1
2231	2	2		1	B3a	3.18	4.14	4
2232	2	2		1	B3a	3.32	3.88	4
2233	2	2		1	A1b	7.2	15.28	3
2234	2	6		2	A2b	6.98	13.27	1
2235	2	6		1	Broken preform			
2236	2	6		1	B6a	3.14	4.22	4
2237	2	6		1	B6a	4.06	5.96	4
2238	2	3		1	B6a	3.19	3.87	2
2253	2	1		1	A1b	8.33	17.14	4
2254	2	1		1	B3a	3.13	3.83	1
2255	2	1		1	A1b	6.93	13.82	4
2256	2	5		1	B3a	3.56	4.58	1
2257	2	5		1	B3a	3.67	4.96	4
2258	2	5		1	B6a	3.21	4.53	2

2259	2	5		1	B3a	2.97	3.35	4
2260	2	7		1	B3a	3.1	3.45	1
2261	4	4		1	A2a	4.65	8.14	4
2263	4	4		1	B3a	3.25	4.32	4
2263	4	4		1	B6a	3.23	4.01	4
2265	4	4		1	B3a	3.49	3.92	4
2266	4	4		1	A2a	3.11	5.25	1
2267	4	4		1	Preform	3.39	7.28	1
2268	4	4		1	A2a	3.15	5.14	2
2269	4	4		1	B3a	4.13	4.78	4
2270	4	2		1	B2a	3.5	4.85	4
2271	4	4		1	A1b	7.45	15.39	4
2273	3	1		1	B3a	3.32	3.47	1
2274	3	1		0	B3a	2.84	3.62	1
2275	3	1		1	A2a	2.81	5.35	2
2276	3	2		1	B6a	2.96	3.95	2
2277	3	7		1	B6a	3.13	3.99	4
2278	3	4		1	Preform	3.04	6.85	4
2279	3	4		0	A1a	6.23	12.28	2
2280	3	4		0	A1b	7.03	12.93	1
2281	3	4		1	Ba	3.26	4.62	2
2282	3	4		1	B3a	3.29	2.71	2
2283	3	4		3	A1	8.5	13.81	4
2284	3	7		1	B6a	2.87	3.9	4
2285	3	7		0	A2a	4.7	9.26	1
2345	4	2		0	B3a	3.28	3.52	4
2347	4	2		0	preform	4.23	9.08	1
2348	4	2		1	B7b	6.7	13.38	4
2349	4	2		1	B7b	6.69	14.55	4
2350	3	5		0	Preform	2.38	5.66	1
2351	3	5		1	A1a	5.36	10.53	4
2352	3	5		0	B1a	3.35	3.86	4
2353	3	5		0	B7a	5.62	10.89	1
2354	3	4		2	A4a	3.5	8.38	1
2355	3	4		1	preform	3.34	7.66	1
2356	1	4		1	Preform	2.83	6.1	3
2357	3	6		1	B3a	3.19	4.53	3
2358	1	4		1	preform	2.9	6.28	3
2359	1	4		1	B3a	3.41	4.44	2
2360	1	4		1	B3a	3.04	3.66	3
2361	1	3		3	preform	9.35	14.32	2
2362	1	3		1	FRAG		11.74	2
2363	1	3		1	Preform	7.41	16.71	4
2364	1	3		1	Preform	3.69	7.87	1
2365	1	4		1	B3a	3.08	4.65	4
2366	1	3		2	A1b-drilled	6.75	13.64	1
2367	1	7		0	B3a	3.01	6.23	2

2368	1	7		1	A2a	4.36	9.64	1
2369	1	7		1	A2a	6.94	13.16	4
2370	3	7		1	A2a	3.26	5.88	1
2371	3	7		1	Preform	3.81	8.31	3
2372	3		5	1	A1b	7.39	14.58	4
2373	3		3	1	Preform	6.74	13.89	4
2374	4	2		0	A1b	6.75	14.63	1
2375	4	4		3	A4	11.19	14.89	4
2376	4	5		1	B6a	3.54	5.06	4
2377	4	5		1	B6a	3.18	4.3	4
2378	4	5		1	B6a	2.84	3.5	2
2379	2		4	1	Preform	3	6.45	1
2380	2		4	1	Preform	2.97	6.17	1
2381	2		4	1	B3a	3.41	3.63	2
2382	2		4	1	Preform	7.28	16.82	4
2384	2	3		3	A1	7.64	10	2
2405	4	2		1	A1	8.23	17.82	4
2406	2	5		0	B3a	2.74	3.52	3

APPENDIX VII: CUEVA SANTA RITA CORDAGE

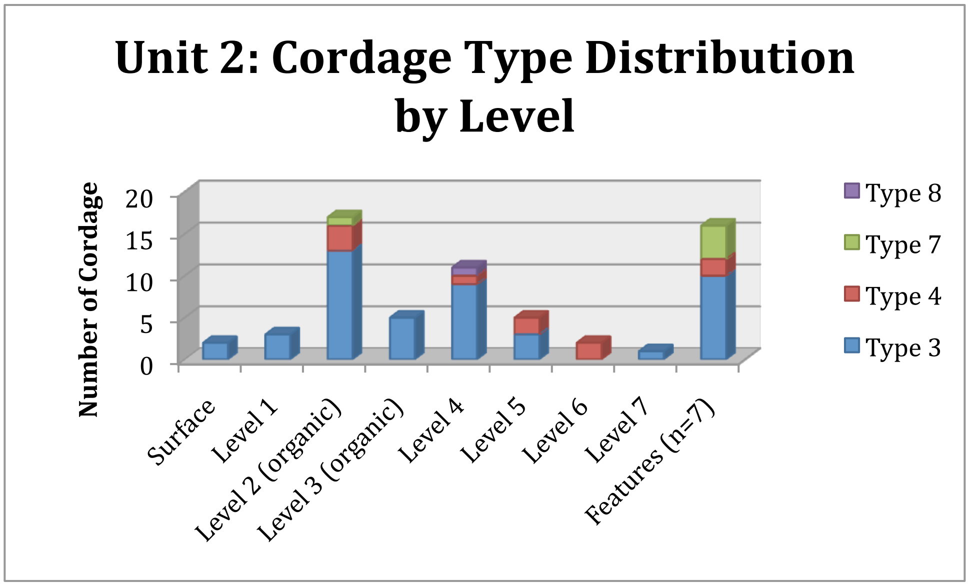
Catalog#	Type	Diameter (mm)	Length (mm)	Spin (Z=0, S=1)	Twist (Z=0, S=1)	Twist/ cm	Twist°	Unit	Level (0=surf;20=feature)
5	3	1.38	81.89	1	0	7	50	2	0
42	4	1.01	29.37	0	1	9	70	2	2
43	3	1.81	42.58	1	0	5	30	2	2
46	4	1.59	20.38	0	1	5	60	2	2
48	3	1.68	54.18	1	0	5	50	2	2
50	3	1.41	38.99	1	0	7	50	2	2
76	9	0.80	32.46	1	0		40	4	2
83	3	2.01	38.34	1	0	5	40	2	2
91	3	1.94	25.97	1	0	5	40	2	1
93	3	5.90	174.40	1	0	2	30	2	1
122	8	3.52	101.08	1	1	5	60	2	4
159	3	1.31	41.12	1	0	3	40	2	4
199	3	1.19	44.67	1	0	5	40	2	3
228	3	4.61	29.18	1	0	3	50	2	5
245	4	1.33	20.42	0	1	7	50	2	6
289	3	2.02	24.65	1	0	2	40	2	7
298	3	4.28	21.27	1	0	4	30	2	20
329	3	2.19	77.02	1	0	5	40	2	20
338	3	1.99	226.00	1	0	5	50	2	20
363	7	1.89	14.91	0	0	2	40	2	20
392	7	1.91	47.48	0	0	6	60	2	20
400	7	2.12	323.28	0	0	4	40	2	20
406	3	1.83	11.89	1	0	6	30	2	20
419	3	2.26	49.14	1	0	4	30	2	20
520	3	1.85	88.82	1	0	5	40	3	0
539	3	3.73	22.18	1	0	3	50	3	1
566	4	2.07	80.57	0	1	5	60	3	2
571	7	1.87	43.75	0	0	6	50	3	2
573	3	1.89	318.00	1	0	6	40	3	2
650	3	2.03	46.08	1	0	6	50	3	3
705	6	1.99	122.00	1	1	5	50	3	20
719	4	2.10	29.12	0	1	3	30	3	20
756	3	1.90	23.07	1	0	7	60	3	7
795	3	6.48	55.19	1	0	2	30	3	9
809	3	2.50	111.00	1	0	4	50	4	0
850	7	2.36		0	0	4	40	4	2
851	3	2.00	71.83	1	0	5	50	4	2
855	3	2.12	294.57	1	0	4	40	4	3
856	3	1.46	41.30	1	0	6	50	4	3
893	3	1.21	265.50	1	0	7	50	4	4
907	3	1.72	63.30	1	0	5	30	3	4
909	3	2.02	446.10	1	0	4	40	3	4
916	3	2.11	140.00	1	0	5	40	3	4
925	3	1.39	173.00	1	0	6	50	3	4
961	4	0.87	84.54	0	1	7	60	3	6
988	3	1.93	35.70	1	0	4	60	1	2
1106	10	1.87	15.62	0	0	6	40	4	6
1131	3	0.72	34.52	1	0	7	40	1	1
1136	3	2.82	50.00	1	0	5	70	6	20
1175	7	3.67	350.16	0	0	2	60	6	2

1181	3	2.97	100.00	1	0	2	50	6	2
1182	3	1.98	172.00	1	0	4	50	6	2
1188	3	3.47	30.00	1	0	3	40	6	2
1190	3	5.81	90.00	1	0	2	50	6	2
1212	3	3.60	65.50	1	0	2	20	6	4
1213	3	2.90	34.80	1	0	3	60	6	4
1251	7	2.22	46.02	0	0	5	50		0
1297	3	2.00	40.72	1	0	6	50	6	3
1304	5	0.84	18.61	0	0	14	50	6	3
2057	3	1.47	235.60	1	0	6	40	3	4
2058	3	2.39	80.05	1	0	4	50	3	4
2059	3	1.60	48.00	1	0	5	40	3	4
2060	3	3.08	63.41	1	0	3	40	3	4
2061	3	2.47	82.29	1	0	5	50	3	4
2062	3	1.37	18.26	1	0	5	50	3	4
2063	3	4.96	85.56	1	0	3	50	3	4
2064	5	1.67	23.82	0	0	7	30	3	4
2065	3	2.20	46.74	1	0	5	40	3	1
2066	3	1.89	46.78	1	0	5	40	3	1
2068	7	1.69	35.59	0	0	3	40	2	2
2069	3	2.04	17.88	1	0	6	50	2	2
2071	3	1.45	14.00	1	0	6	30	2	2
2072	4	1.41	62.81	0	1	14	70	2	2
2073	3	1.45	36.17	1	0	6	50	2	2
2074	3	1.33	488.70	1	0	10	30	2	2
2075	3	1.74	17.33	1	0	6	40	2	2
2076	3	5.88	60.90	1	0	1	30	2	2
2077	3	1.38	13.22	1	0	7	50	2	3
2078	3	2.38	1.49	1	0	4	60	2	3
2079	3	1.00	49.47	1	0	8	40	2	3
2081	3	1.91	72.65	1	0	4	40	2	3
2082	7	1.64	20.17	0	0	5	50	2	20
2083	4	1.02	15.28	0	1	8	60	2	20
2084	4	1.80	21.90	0	1		60	2	20
2086	3	1.66	42.76	1	0	7	50	2	4
2087	3	1.54	29.84	1	0	7	50	2	4
2088	3	1.41	104.00	1	0	5	50	2	4
2089	3	1.37	31.90	1	0	7	50	2	4
2090	3	1.64	10.47	1	0	6	50	2	4
2091	3	1.58	26.38	1	0	6	50	2	4
2093	3	3.16	50.93	1	0	2	30	2	4
2094	3	1.99	23.70	1	0	4	50	2	4
2095	4	1.81	19.71	0	1	5	60	2	4
2096	3	1.68	45.72	1	0	7	40	3	4
2097	3	1.59	65.86	1	0	7	50	3	7
2098	5	3.58	50.30	0	0	2	30	3	7
2100	3	1.49	15.23	1	0	7	50	3	7
2101	3	1.43	58.72	1	0	7	40	3	7
2102	3	1.51	24.72	1	0	6	50	3	7
2103	6	2.05	20.90	1	1		50	3	7
2104	4	4.96	50.23	0	1	2	60	2	6
2105	3	1.63	42.55	1	0	6	40	3	0
2107	3	1.93	43.20	1	0	6	50	1	2
2108	3	2.06	51.34	1	0	6	60	2	0
2111	3	1.04	44.23	1	0	2	40	2	1
2113	3	2.41	9.92	1	0		30	3	2

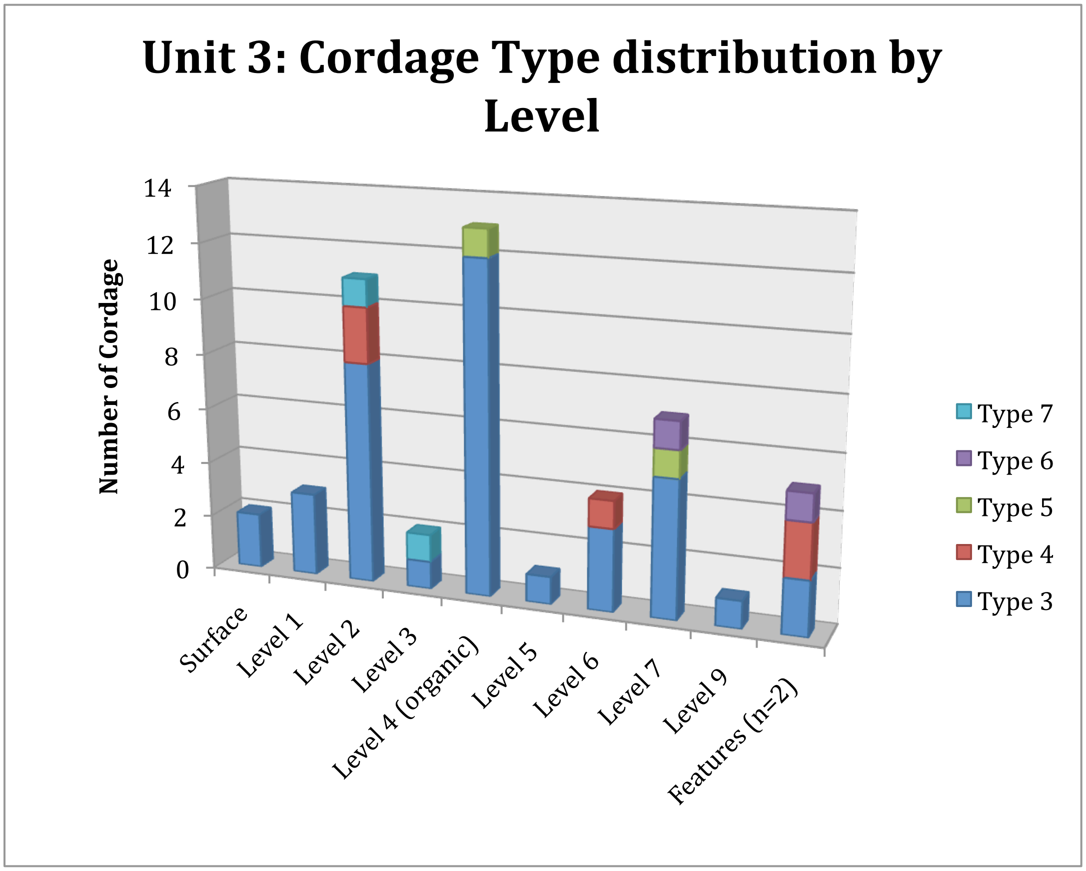
2114	3	2.13	13.64	1	0	6	40	3	2
2116	7	2.65	75.02	0	0	4	40	3	3
2117	3	1.41	51.39	1	0	7	40	3	6
2118	3	1.44	13.55	1	0	7	60	3	6
2119	3	1.68	44.80	1	0	6	40	3	6
2122	3	3.80	11.92	1	0	4	40	3	5
2124	3	1.39	60.62	1	0	7	50	3	2
2125	3	1.46	6.30	1	0	16	60	3	2
2126	4	1.46	46.95	0	1		30	3	2
2127	4	0.81	64.29	0	1	6	30	3	20
2128	3	2.40	90.37	1	0	6	50	3	20
2129	3	1.85	26.09	1	0	4	40	3	20
2131	3	1.33	500.00	1	0	5	40	2	5
2132	4	1.03	41.16	0	1	7	60	2	5
2133	3	1.91	120.00	1	0	7	50	2	5
2134	3	1.63	15.00	1	0	4	40	2	20
2135	3	1.70	259.00	1	0	5	40	2	20
2136	3	1.68	102.17	1	0	2	50	2	20
2137	3	2.73	115.97	1	0	3	30	2	20
2138	3	1.68	14.06	1	0	6	40	2	20
2141	4	0.51	50.00	0	0			2	5
2142	3	2.00	27.65	1	0	6	50	4	2
2143	4	1.88	42.89	0	1	4	50	4	4
2144	4	1.80	51.35	0	1	5	50	4	4
2146	6	1.68	64.50	1	1	5	30	4	3
2147	3	1.43	47.20	1	0	5	50	4	3
2150	4	1.75	29.40	0	1	5	40	4	3
2151	4	1.43	18.64	0	1	5	40	4	3
2153	6	1.29	31.10	1	1	8	50	6	3
2154	4	2.59	42.00	0	1	4	50	6	3
2155	3	1.43	87.11	1	0	5	60	6	3
2156	3	1.66	42.00	1	0	7	60	6	2
2171	3	1.25	36.90	1	0	8	60	4	3
2172	7	1.53	27.82	0	0	8	60	4	3
2173	3	1.77	40.00	1	0	4	40	4	3
2174	7	2.52	63.60	0	0	4	20	4	3
2175	4	1.37	54.00	0	1	5	70	4	3
2176	7	2.18	64.00	0	0	6	50	4	3
2177	3	1.73	41.06	1	0	6	40	4	3
2178	7	3.49	37.93	0	0	2	40	4	1
2179	3	1.78	128.00	1	0	6	60	4	1
2180	3	1.13	23.80	1	0	14	70	4	1
2182	3	2.51	74.90	1	0	4	60	6	2
2183	3	2.00	16.40	1	0	5	40	6	2
2184	3	1.33	34.90	1	0	7	40	6	2
2185	3	1.87	64.50	1	0	6	60	6	2
2187	3	2.67	122.00	1	0	3	40	2	2
2188	7	1.53	190.00	0	0	5	60	6	2
2189	3	1.74	53.00	1	0	6	60	6	2
2190	3	1.60	38.41	1	0	6	60	6	2
2191	3	1.71	20.50	1	0	6	50	6	2
2192	3	2.84	66.70	1	0	4	40	6	2
2193	4	1.03	211.08	1	1	4	40	6	2
2226	3	1.63	11.37	1	0	6	50	6	20
2294	3	1.26	32.52	1	0	7	50	3	2
2332	3	1.18	33.39	1	0	8	30	3	2

2343	7	1.46	36.22	0	0	6	50	4	2
2133a	3	1.61	7.26	1	0	0	40	3	2
2186A	3	2.41	190.00	1	0	4	60	6	2
2186B	3	3.47	33.97	1	0	4	60	6	2
47a	3			1	0	6		2	2
47b	3			1	0	4		2	2
833a	4			0	1	5	30	4	2
833b	4			0	1		40	4	2

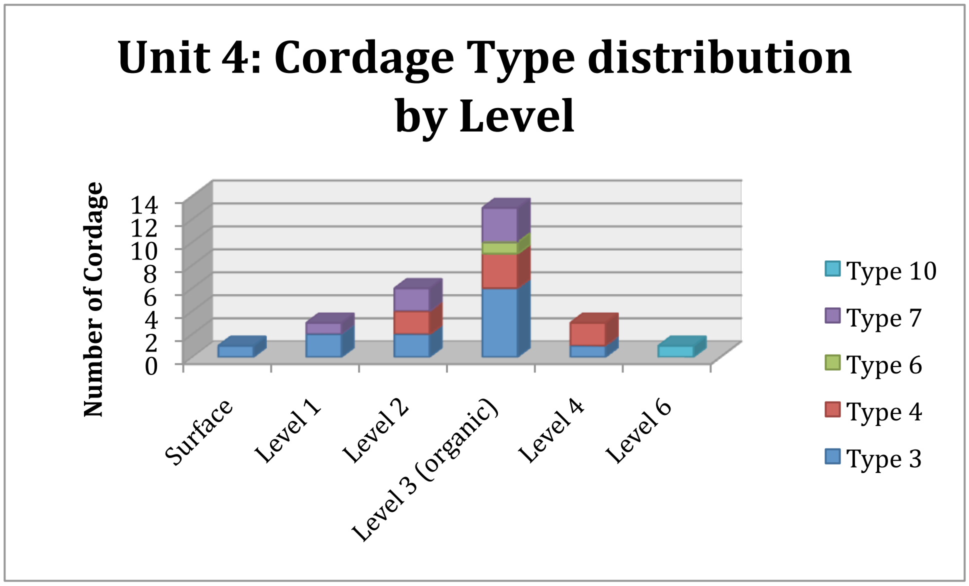
APPENDIX VIII: CORDAGE TYPE BY UNIT AND LEVEL



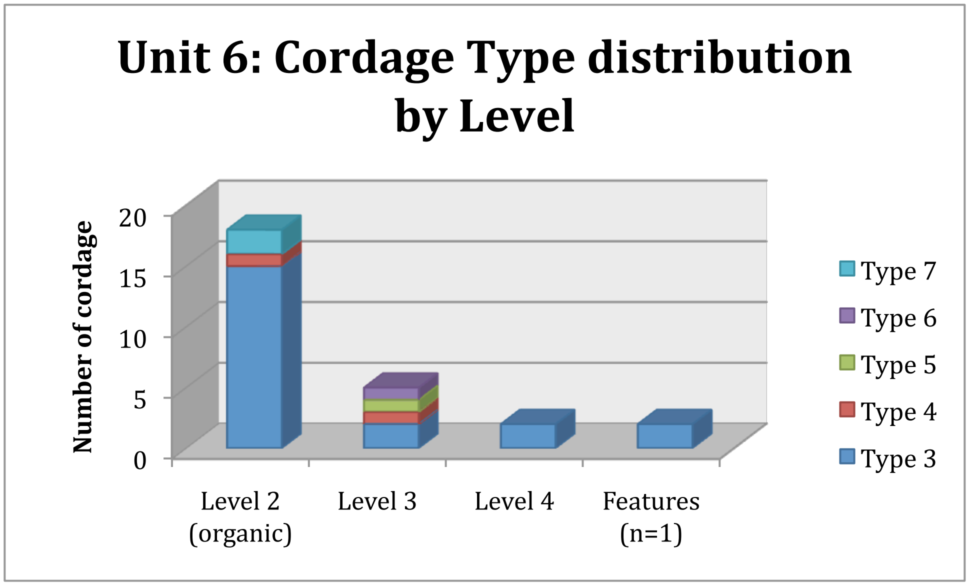
Unit 2
Cordage is more concentrated in the organic units, but is present in every level. Type 3 is the most common cordage. Level 4 has the greatest diversity of cordage and the only level that has cordage type 8. After level 4, the number of cordage declines with depth.



Unit 3
Cordage is present in every excavation level. Level 4 has the highest quantity of cordage, but is not as diverse as several other levels. Similar to unit 2, the number of cordage tapers off with depth.



Unit 4
Again, the organic unit has the highest number of cordage artifacts and the number of cordage artifacts gradually decreases with depth to bedrock.



Unit 6
The organic unit has the largest number of cordage. Despite having one third the quantity of cordage, level 3 has more diversity of cordage types. The number of cordage decreases with depth below the organic unit.