SPATIAL, TECHNOLOGICAL, AND FUNCTIONAL VARIABILITY AMONG THE PREHISTORIC CERAMICS OF THE SOUTHERN CALIFORNIA COAST

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ABSTRACT

SPATIAL, TECHNOLOGICAL, AND FUNCTIONAL VARIABILITY AMONG THE PREHISTORIC CERAMICS OF THE SOUTHERN CALIFORNIA COAST

By

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Prehistoric pottery found across southern California has a remarkably discrete spatial distribution. While locally manufactured vessel ceramics are common to the south and southeast of the Los Angeles River, sherds are virtually absent in deposits located to the northwest and along the California Coast. Two primary possibilities exist to account for this pattern. First, it is possible that populations to the north may have had access to resources necessary for vessel alternatives and may have differed in their settlement patterns or subsistence practices. Alternatively, it is possible that ceramics are concomitant with distinct population histories and that the southern area of the coast was occupied with populations that are derived from the California desert where vessel ceramics are common, while the rest of the area was occupied by populations with no tradition of making pottery. In this thesis, I generate descriptions of ceramics including measurements of technological and functional variability of ceramic deposits across southern California. These measurements are designed to determine the degree of variation that exists in the use and production methods of vessel ceramics. I explore whether ceramic distributions are correlated with space and the structure of the environment. Based on my results, I conclude that ceramic variability is driven by utilitarian functions and, thus, their distribution is related to proximity to subsistence resources. The evidence supports the hypothesis that the presence of ceramics is explained by the functional roles pottery plays within the population and appears as a consequence of necessity for cooking and processing vital subsistence resources which are correlated to wetland regions.

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CHAPTER 1

INTRODUCTION

In comparison to other regions of North America, relatively little is known about the late prehistoric populations of southern California. Initial contact between the arrival of European populations resulted in substantial depopulation of native groups (Baker and Kealhoffer 1996). Depopulation occurred years before the area was systematically described. In addition, the region's rapid urbanization during the late nineteenth and early twentieth centuries resulted in substantial loss of the archaeological record. This loss occurred prior to the implementation of federal and state cultural resource laws. This legislation began in the late 1960s and early 1970s with the purpose of enforcing the protection of cultural resources prior to disturbance from construction activities (Sebastian and Lipe 2009). Since the emergence of cultural resource management, some progress has been made in generating comprehensive information about the archaeological record of the region. Over the past 30 years, southern California has witnessed an explosion of projects resulting in thousands of site records and reports across the region, often along with massive stored artifact collections. Despite the abundant documentation, a comprehensive understanding of the region's prehistory has yet to fully emerge. Archaeologists are only beginning to have a robust and comprehensive handle on the chronology of occupation, and currently only have a rough understanding of prehistoric subsistence and settlement patterns in the area over the course of the last 10,000 years.

In southern California, prehistoric vessel ceramics are a class of artifacts that remain only partially understood. While fired vessel ceramics are common across most of North America, the Pacific Coast of North America almost entirely lacks populations that produced ceramics during prehistory (Dillon and Boxt 2013). Yet, beginning in the region around Long Beach and areas to the south towards Baja, deposits with vessel ceramics are relatively common (Cameron 1999). The spatial distribution of ceramics is a bit of a puzzle: archaeologists do not yet understand why pottery is generally absent in coastal areas to the north despite the similarity of the environment, shared subsistence practices, common settlement patterns, and evidence that coastal populations interacted with inland populations and communities to the south, in which pottery is relatively common. Exploring this puzzling aspect of southern California prehistory demands detailed investigation and in-depth explanations.

Collections produced by cultural resource management firms provide a particularly potent opportunity to investigate the regional aspects of southern California pottery in the archaeological record. Existing collections offer access to extant material that is available for study rather than requiring further excavation and consequent diminishment of the finite archaeological record.

My research goals are to generate data from these collections that can be used to evaluate my hypotheses. To accomplish this goal, I systematically compiled known records and surveyed existing collections to characterize the range of deposits that have potential information pertaining to the prehistoric use of pottery. In this thesis, I built a comprehensive database of information for known prehistoric vessel ceramics that have thus far been found. Second, I used these collections to study formal and structural variability in ceramics that are linked to past functional variability and technology. This data gave me the opportunity to perform a systematic and theoretically informed analysis of prehistoric ceramics in the southern California region.

CHAPTER 2

BACKGROUND

Understanding the context in which past populations made and used ceramics requires a knowledge of the details of the local landscape. Given that southern California is environmentally, culturally, and archaeologically diverse, it is necessary to begin investigations with a review of the region's environmental and archaeological background.

2.1 Environment

The region under investigation in this study is southern California, more specifically Los Angeles and Orange Counties (Figures 1 through 3). These counties span an area known as the Peninsular Range, a range that includes the San Jacinto, Chino Hills, Palomar, Santa Rosa, Laguna, and Santa Ana Mountains. To the north, the region is bounded by the Transverse Ranges that include the Santa Monica, San Gabriel, San Bernardino, San Rafael, Sierra Madre, Sierra Pelona, Topatopa, Santa Susanna, Tehachapi, and Santa Ynez Mountains.

The region has three major rivers that include the San Gabriel, Los Angeles, and Santa Ana Rivers. Prior to urbanization of the area, much of the Los Angeles Basin was marshy grassland that spanned the large floodplains of these rivers (Schoenherr 1992). In the uplands, the vegetation was dominated by coastal sage scrub and chaparral. Overall, the climate of the region is considered both maritime and Mediterranean (Schoenherr 1992).

2.2 Previous Archaeological Research

Prehistoric ceramics are found in relative abundance across southern California including Orange, Riverside, and San Diego Counties (Figure 3). There are five regions in California that contain ceramic traditions (Figure 2). In the Central Valley, on the Cosumnes and Sacramento Rivers archaeologists discovered baked clay balls and small ceramic bowls (Johnson 1990). This ceramic tradition is known as Cosumnes Ware. Archaeologists have defined a second ceramic tradition called Siskiyou Utility Ware (Griset 1996). Siskiyou Utility Ware is found by the Klamath and Pit Rivers in northern California and southern Oregon (Griset 1996; Mack 1986, 1990). This ware includes low-fired and hand sculpted bowls (Mack 1986, 1988, 1990). The third ceramic tradition, known as Owens Valley Ware is found on the east and west of the Sierra Nevada Mountain Range. Owens Valley Ware is formed through the use of coil-and-scrape technique (Eerkens et al. 1999; Pippin 1986; Riddell 1951). Another ceramic tradition, Tulare Ware is found by Tulare County. The Tulare Ware vessels are similar to Owens Valley Ware and are made from modeling or coiling, and the use of paddle and anvil (Fenenga 1952; Moratto 1984).

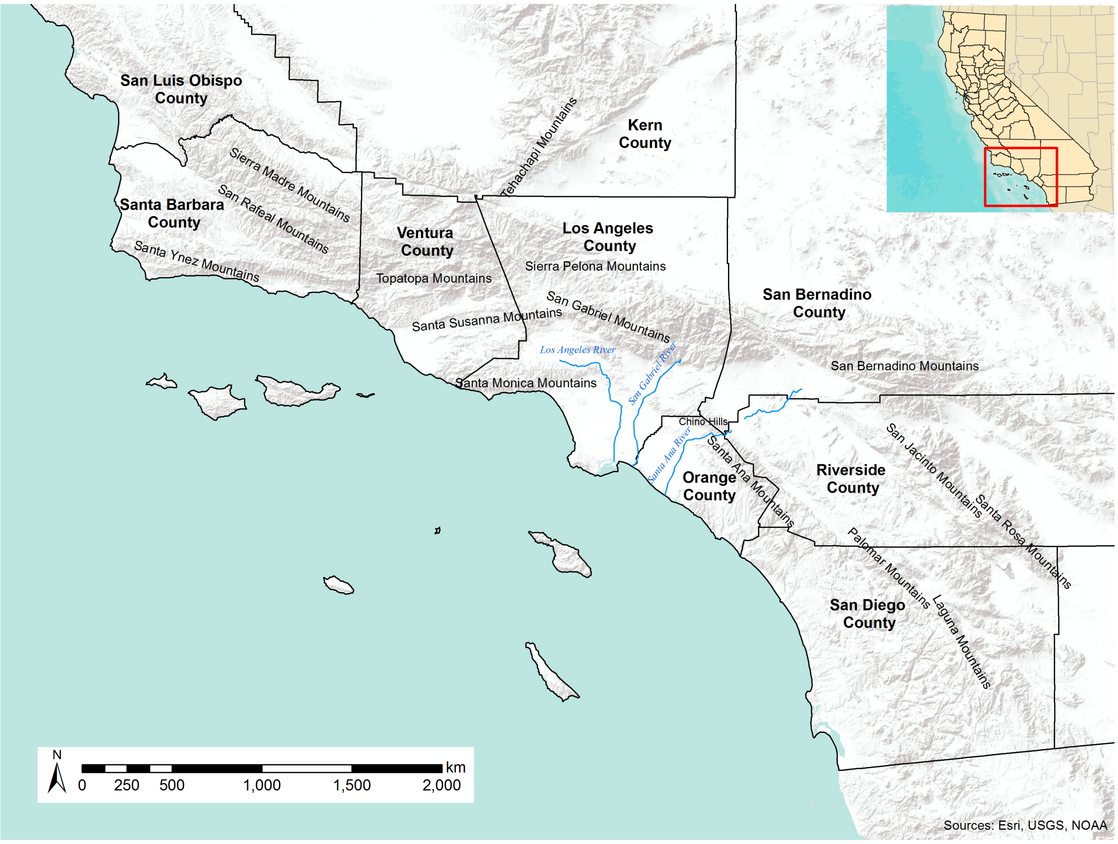

FIGURE 1. The mountain ranges and rivers of the study area.

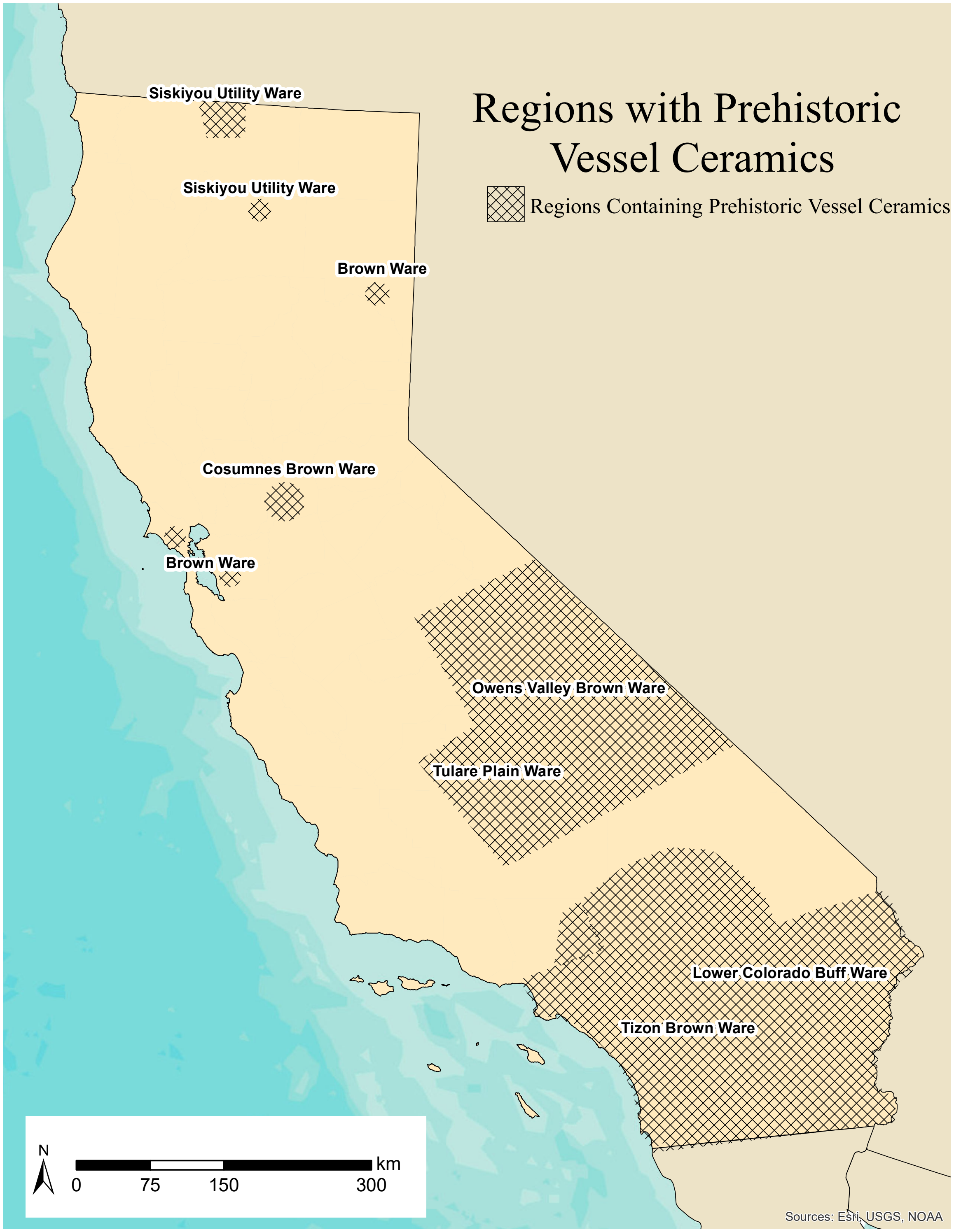

FIGURE 2. Approximate areas with known vessel ceramics in California. Sources: Eerkens et al. (1999), Griset (1996), Johnson (1990), Mack (1986), and Riddell and Riddell (1986).

The role that these ceramics served within populations is a bit controversial. Griset (1996), for example, argued that they are not complete pottery traditions because they did not fully replace the need for basketry. Griset (1996) elaborates that pottery in these regions was utilized at times with other containers, but pottery was not used as a main container type.

The ceramic vessels of southern California, however, are markedly different from these other traditions. Griset (1996:11) describes the southern California ceramics as "a true ceramic tradition" and this tradition contains the vast majority of ceramics in California. There are two subregions for ceramics in southern California: Tizon Brown Ware and Lower Colorado Buff Ware (Dobyns and Euler 1958; Griset 1996; Schroeder 1958). These two wares are distinguishable based on the clay type. Tizon Brown Ware is associated with granitic residual clays made from the Peninsular Mountain Ranges, which produce sherds ranging in color from red, orange, brown, grey, and black (Griset 1996). Colorado Buff Ware is produced from alluvial sedimentary clays from desert regions east of the Peninsular Mountain Ranges to the Colorado River, which produce sherds ranging in color from pink, buff, and grey (Griset 1996).

2.2.1 Locations of Vessel Ceramics in California

Overall, the distribution of pottery found in California is relatively spotty. This pattern suggests that relatively local conditions and historic effects of populations drive ceramic use in local environments.

In southern California, the distribution of vessel ceramics mirrors that of the patterns observed elsewhere across the state: pottery is limited to specific spatial locations. Pottery is common, for example, in areas to the south of the Los Angeles River. While pottery is commonly found southeast of the Los Angeles River, prehistoric sherds are relatively rare in deposits located to the northwest and nearly absent as one moves northward up the California coast. The rare examples of vessel ceramics that are known north of the Los Angeles River include few sherds found in a deposit in the Santa Monica Mountains, and sherds from northeastern and northwestern Los Angeles County (Boxt and Dillon 2013) (Figure 3).

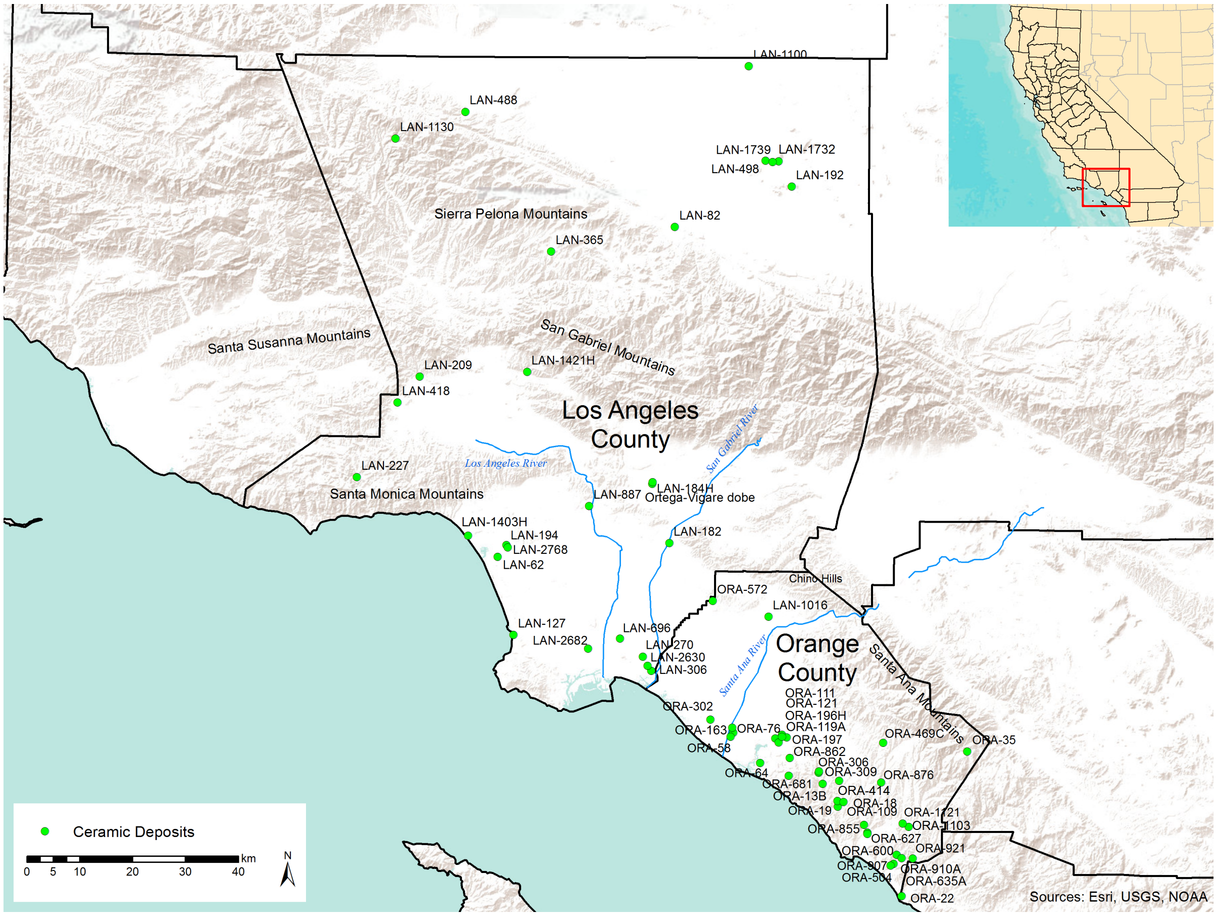

FIGURE 3. Locations of deposits with ceramics in Los Angeles and Orange Counties.

2.2.2 Explanations for the Patterns of Vessel Ceramics in Southern California

One explanation for the distinctive pattern of ceramic occurrence in southern California is that they appear as a consequence of diffusion from surrounding populations that had ceramics such as the Luiseño, Serrano, or Cahuilla (Koerper et al. 1978; McCawley 1996). This explanation suggests that the existence of ceramics in the Los Angeles and Orange County regions occurred only when other surrounding groups began using ceramics. Further, extensive trading led to the exchange of ideas and/or materials. There are two lines of evidence in favor of this explanation. First, the archaeological record suggests that trade networks existed between these regions which resulted in interactions amongst these groups (Bean 1972; Davis 1974; Hudson 1969; Koerper et al. 1978). Second, the large majority of deposits with ceramic assemblages in southern California are associated with late prehistoric and post-contact contexts (Boxt and Dillon 2013; Cameron 1999). These late dates for southern California ceramics suggests that ceramics occurred later in prehistory in this region and thus likely diffused from nearby populations. Unfortunately, in this explanation it remains unclear why ceramics appear when they do in the nearby groups and also fails to explain why nearby groups in southern California do not have ceramics, though they likely traded with inland groups that did.

A second explanation for why ceramics appear in some areas of southern California and not others is the "Shoshonean Wedge" model (Sutton 2009). In this model, Takic speakers immigrated into southern California from the northern deserts of the Great Basin and reached the Pacific Coast hundreds of years before contact (Koerper and Mason 2004). Kroeber (1925) was the first to argue for the Shoshonean Wedge hypothesis and estimated that the migration began about 1,500 years ago (Koerper 1979; Kroeber 1925). More recent studies suggest that the expansion of Takic populations began around 3,500 BP (Sutton 2009). One puzzling aspect of the Shoshonean Wedge model is that pottery in southern California is known early (e.g., CA-ORA-64) as well as late during prehistory. In the region, the oldest known ceramics are those from CA-ORA-64 (Drover et al. 1979), this will be discussed later in the chapter. Thus, the appearance of ceramics does not appear to be a single event that marks the arrival of Takic populations (Sutton 2009). However, it is a possibility that the long chronology of ceramics does not necessary contradict the model, as ceramics may be only the latest entry into the area that followed patterns of interaction set by earlier Takic speakers who were already exchanging pottery with local populations. According to Sutton (2009) Tizon Brown Ware dates to about after 1,300 BP throughout California. Sutton argues that "[ceramics] almost certainly diffused into southern California from the south and east late in time" (Sutton 2009:55). If a new population migrated into the region, we would expect to see drastic changes in the archaeological record, and the appearance of ceramics do not correlate to the "arrival" of Takic speakers. Further, the Shoshonean Wedge model does not account for why pottery did not move northward.

Another alternative explanation for the introduction of ceramics into southern California comes from Griset (1996). Griset argues that the origin of ceramics in the Riverside and San Diego County regions is the result of two diffusion scenarios in which the *idea* of pottery was passed from one local population to another. In the first scenario, ceramics diffused into the Colorado River and then into the coastal areas of southern California (Rogers 1936, 1945). In the second scenario, ceramics diffused from Baja California into San Diego but only as far north as the Los Angeles River. The difficulty with this model comes from the fact that while ceramics in Baja should date earlier than those to the north, northern examples of ceramics appear before those to the south (Griset 1996).

A fourth explanation for the patterning of vessel ceramics in southern California holds that the origin of ceramics in the region were the result of two events of introduction. The first event would have been an early ceramic tradition in California that may have simply been innovated within *in situ* indigenous traditions. The second event follows Griset's (1996) and

Rogers's (1936, 1945) explanation of the spread of ceramics through diffusion from the Great Basin and Colorado River (Drover et al. 1979; Rogers 1936, 1945). This hypothesis is based on observations of fired clay artifacts that have been found among early deposits, specifically: CA-ORA-64, CA-SCAI-17, CA-SJO-68, and the Coyote Cave Site (Drover 1975, 1978; Drover et al. 1979; Porcasi 1998). Evidence to support this model is based on the fired clay objects that are found throughout southern California and date well before influence from surrounding regions such as the southwest (Porcasi 1998). This explanation is different from other versions as it attempts to explain the early existence of fired clay objects and vessel ceramics in southern California. However, this explanation overlaps with the hypothesis that late prehistoric vessel ceramics are the result of diffusion from the southwest. In order for this explanation to be true, we must find evidence of the development of independent invention of ceramic traditions that are dependent on function. The problem with this explanation is that there is very limited evidence for an early ceramic tradition in southern California other than a few deposits in central and southern California. Further, only one of the deposits (CA-ORA-64) has any evidence of early vessel ceramics.

A final hypothesis, posed by McLean (2001) argues that all ceramics found in southern California date to historic and not prehistoric contexts. McLean (2001) states ceramics only appear in the region as a consequence of local populations responding to the needs of Europeans. Based on a summary of many archaeological sites in Orange County that contain ceramics, as well as linguistic and ethnographic descriptions, McLean (2001) concludes that the majority of ceramics are from post-contact populations. She points out that during pre-contact times, there were functional alternatives to vessel ceramics such as containers made from steatite and baskets. She also demonstrates that there is a larger association of vessel ceramics in the context of post-contact deposits rather than those at are only prehistoric in age (McLean 2001). Of course, the fact that many post-contact deposits were also occupied during prehistory is not surprising and the presence of pottery in these kinds of longer duration deposits does not mean that pottery *only* arrived with Europeans. A close look at the chronology of ceramics is required to evaluate the veracity of this hypothesis. Of course, this hypothesis fails to explain the spatial pattern of ceramics. Another possibility is that the surface ages of the deposits are different. But this can be ruled out because deposits date to prehistoric and historic times.

Given these five potential and conflicting accounts for the spatial and temporal distribution, it is clear that a consensus on the origin of ceramics has yet to emerge. Broadly speaking there are three categories of explanatory narratives: diffusion, migration and *in situ* development. The first holds that pottery comes from the consequence of diffusion from surrounding groups to the south and east. In a diffusionist model, it is argued that ideas of a technology are passed from group to group following patterns of cultural transmission (Storey and Jones 2011). While a defining feature of culture is that it is shared (Taylor 1967) detecting shared cultural traits works most effectively when studying stylistic traits since these are not shaped by the structure of the environment, but by simply the patterns of interaction (Eerkens and Lipo 2005). In the case of pottery, the fact that there is a functional component (i.e., the performance value of having a fired-clay vessel) means that the distribution cannot *only* be determined by sharing but by other aspects of behavior and the environment.

The alternative to the diffusion narrative is migration: the movement of people and their behaviors from one location to the other. The migration model is what underlies the Shoshonean Wedge model in which populations arrived in southern California carrying material culture from the desert. In the migration model, the new populations bring with them new traditions and technology that replaced the previous way of life. Thus, empirically one expects to see a relatively abrupt shift in the continuity of behavioral and cultural patterns as a consequence of these immigrants.

TABLE 1. Summary of Ceramic Narratives for Southern California

Model	*Chronological Pattern*	*Spatial Pattern*	*References*	*Data Needed for Evaluation*
Diffusion from surrounding groups	Ceramics appear in Los Angeles and Orange counties after arrival of ceramics in southern and/or eastern California	Diffusion to only those groups in contact with other areas	Koerper et al. 1978; McCawley 1996; Griset 1996; Rogers 1936, 1945	TL dates, typological similarities, evidence of interaction between groups
Shoshonean Wedge	Ceramics appear with the arrival of Takic speakers	Ceramics are related to the arrival and distribution of Takic speakers	Sutton 2009	TL dates of ceramics that correlate with the Takic speakers in southern CA
Trade and Exchange	Ceramics appear with the interaction of trade groups	Ceramics are distributed in relation to exchange/trade networks	Hurd et al. 1990; Hurd and Miller 2013	NAA data on clay sources from ceramics
In situ innovation and diffusion	Early ceramics in the region	Early ceramics have spotty spatial distributions dependent on function, later ceramics result of contact with other areas	Drover 1975; Drover 1978; Drover et al. 1979	TL dates and evidence that older ceramics differ functionally or stylistically from ceramics produced in late prehistory
Ceramics only after European arrival	Ceramics are produced after European contact, and not prehistorically or protohistorically	Ceramics only appear at post-contact and historic deposits.	McLean 2001	TL dates that date to post-contact only and Ceramics only found at post-contact deposits

These culture historical models have problems in terms of explaining the movement of ceramics. While both are relatively plausible scenarios, the Shoshonean Wedge model is particularly complicated by the vague dates for this “event” and the relatively early arrival of ceramics compared to the suspected arrival time of Takic speakers into the region. If one defines migration as being a specific event (rather than just general population exchange that occurs over long periods of time and over long distances), it is difficult to determine what empirical evidence exists for the singular event. The only evidence available is the presence of pottery and Takic speakers at the time in which anthropologists began recording linguistic patterns. If one then argues that the movement of Takic speaking people took significant time (from the 3,500 BP to late prehistory), it is difficult to argue that this was indeed a “migration” and more generally looks like simply the consequence of interacting populations and diffusion. For this reason, the diffusion model generally accounts for the distribution of ceramics with the least contradictions found in the archaeological record.

The alternative category of narrative relative to diffusion, on the other hand, focuses on the local needs for ceramics that are consistent with the conditions of southern California. While knowledge of ceramic technology may be common due to trade and interaction, this “diffusion” is not a causal mechanism since pottery is only used by populations where resources are available to produce it and there is a need for fired-clay vessels related to subsistence. Yet, there is no question that populations in southern California interacted extensively across the region and that information about technology must have been shared widely. The degree to which we can isolate the parts of the explanation requires us to explore the history of ceramics in the region. We need to understand the technological constraints of pottery that might be useful to distinguish sharing of features (in the case of diffusion and trade) versus finding equivalent solutions to shared problems (in the case of *in situ* development).

2.3 Ceramic Culture History in Southern California

Although some researchers (e.g., Kroeber 1925; McLean 2001) challenge whether pottery was produced in the region during prehistory, such an assertion can only be demonstrated with empirical evidence: we need to examine the archaeological record to show that there are no pre-contact vessel ceramics. Much of the support for this claim comes from ethnohistoric accounts but fundamentally, the archaeological record is the only empirical means of evaluating claims about whether ceramics were made before European contact. Ethnohistoric accounts certainly demonstrate that pottery was present at least by the time that Europeans began to settle in the region, however, we cannot use these observations to conclude that pottery was not present prior to Europeans. One important feature of ethnohistoric accounts is that they were typically made long after initial contact and after the region had undergone tremendous change as a consequence of disease and settlement changes (Baker and Kealhofer, ed. 1996). Thus, accounts made several hundred years after contact do little to shed light on the degree of ceramic production during prehistory. Yet, these accounts are often used in lieu of direct evidence. Reid and Heizer (1968), for example, use an account from 1852 in which Hugo Reid described Gabrielino populations and argued that the Spaniards had taught the local people to manufacture ceramics. Further, in 1769, Spanish Missionary Juan Crespí (2001), noted that the native people of southern California had pipes that were made from baked clay.

Around 1905, Harrington (1942) described the native populations of the region including the Chumash, Gabrielino, and Serrano. According to his observations and information he obtained from the Gabrielino, Harrington (1942) argued that populations had pre-European ceramics and that these vessels were made using coils, formed with paddle and a cobble anvil, and were fired in open bark fires. He (Harrington 1942:25) also described the presence of pottery vessels as having a spheroid shape and a maximum diameter of 8 inches. Given that Harrington's observations took place in the early 1900s, hundreds of years after European contact, it is unclear whether he described traditions rooted in pre-contact times or those altered by European arrival. Due to catastrophic population loss, resettlement, and the introduction of European technology we cannot simply use these observations as direct evidence of prehistoric practices.

2.3.1 The Presence of Ceramics as Homologous Versus Analogous Similarity

In explaining the distribution of southern California ceramics, archaeologists tend to emphasize mechanisms that focus on homologous similarity (i.e., similarity due to relatedness). This emphasis on homology comes from the roots of archaeological inquiry as dominated by culture history. In culture historical studies, similarity is assumed to be homologous similarity. Homologous similarity consists of shared attributes that are the result of shared ancestry (O'Brien and Lyman 2000). The attention of culture historians on studying shared ancestry results in explanations that emphasize the mechanisms of diffusion, migration, acculturation, trade, or invention (Dunnell 1978). While these kinds of explanations are consistent with descriptions of homology, they are inappropriate for explaining change that comes from analogous similarity. Analogous similarity consists of shared attributes that are the result of shared functional and environmental constraints (O'Brien and Lyman 2000). In cases of analogous similarity, the appearance of traits in common does not arise from sharing or communication, but from populations finding the same solutions.

The ability of culture historians of the early part of the twentieth century to construct chronology from descriptions of the archaeological record comes from their focus on homology.

Tracing homologous attributes allowed archaeologists to map the sequences of cultural traditions across space and time. To explain these sequences, culture historians focused on those explanations that fit this emphasis on homology. For the arrival of ceramics in California, for example, most early explanations focus on diffusion. Kroeber (1922, 1925), for example, argues that ceramics in California are the result of southwestern influence and were not produced prehistorically or locally in the region. Kroeber (1922) also suggests that vessel ceramics were only produced post-contact and were not a feature of prehistoric populations. He states "pottery had come into use by the end of the mission period. But it is stated positively that clay was not worked in aboriginal days. Archeology [sic] confirms: no pottery has been found in ancient remains in the Gabrielino habitat" (Kroeber 1925:628). Instead, Kroeber (1925) suggests that ceramics are the result of contact with Europeans.

In fact, most literature on ceramics in southern California tends to emphasize explanations that treat the presence of ceramics as homology. According to Koerper et al. (1978), independent invention is an unlikely source for pottery in the southern California region. Instead, it is suggested that the practice of making pottery comes from interaction with nearby groups: the Luiseño, Serrano, or Cahuilla groups (Koerper et al. 1978; McCawley 1996). Support for this argument comes from existing evidence that there were trading connections between southern California and the desert focused Serrano or Cahuilla.

The assumption that homology explains the presence of ceramics in populations has led to studies on the abundance of ceramics to determine the degree of interaction between populations. Cameron (1999), for example, studied the relative abundances of vessel ceramics in southern California as a means of mapping tribal boundaries during late prehistory. Her study treats the presence and absence of ceramics as homologous similarity, and thus is explicable in terms of the degree of interaction between communities. Cameron's (1999) study focuses on mapping the relative percentage of ceramics in the total artifact assemblages over space.

We know, however, that the presence of ceramics among populations is not necessarily only the product of homology: the presence of ceramics may be explained as analogous similarity. Analogous similarities are traits that are the result of shared constraints leading to similarity due to common solutions (O'Brien and Lyman 2000). Vessel ceramics, for example, are more likely to represent solutions with functional means of interacting with the environment rather than just interaction. Even if two groups intensely interact and one has no need for ceramic vessels, then it is unlikely that ceramics will be shared between the groups. The presence of vessel ceramics is much more likely to be driven by populations finding solutions to resource constraints in similar kinds of environments. In the case of vessel ceramics, this might be the need to process food through heating.

In the case of Cameron (1999) the assumption that ceramic vessel abundance equates to degree of interaction requires one to assume that ceramics are homologous. Lacking in this study is reliable information about the relative importance of ceramics within a community. We also lack information as to whether the total number of ceramic sherds relative to other artifact classes reflects social interaction or a mix of depositional processes, post-depositional processes, and the act of recovery. Lacking control of these variables, there is no reason to believe that the ceramic abundance can be explained as social interaction.

A few researchers have focused on building explanations of ceramics as analogous similarity and have emphasized differences in the environment that made ceramics more or less desirable for prehistoric people. Strong (1929), for example, argues that ceramic production was unnecessary in the region because of the close proximity to sources of steatite in the Channel

Islands. Further, he points out that the complexity of basketry in the region made the production of ceramics superfluous. Similarly, Johnston reasons that “undoubtedly the Gabrielino women knew something about the art of pottery but did not practice it where they could produce steatite, or soapstone, pots from Santa Catalina Island. These were superior articles” (Johnston 1962:31). Johnston (1962) asserts that the Gabrielino did not produce pottery until post-contact and those that occupied locations inland from the coast learned to produce pottery from the Serrano clans. Those areas that utilized ceramics did so because of the excessive distance to the ocean to obtain Catalina soapstone bowls.

In the case of southern California, it is likely that both kinds of similarity may be indicated by the presence of fired clay ceramics in the region. While pottery may be arriving from the movement of people or contact between groups via trade, the *presence* of ceramics reflects the local need for enclosed vessels for storage, food processing, cooking, transport, or some combination of these requirements. We can measure aspects of processes due to interaction by restricting observations to only those traits that are shaped by communication between populations. These are stylistic traits, those attributes that reflect equal cost alternatives and that do not directly affect performance. Stylistic attributes offer a way of studying the record in terms of homology. Classes built from stylistic dimensions dominate culture historical practice (Dunnell 1978). Studying processes that drive analogous similarity requires alternative kinds of classes and measurement dimensions. These dimensions reflect functional and technological variability that is driven by the performance of artifacts in local environmental conditions.

2.4 Culture Historical Units

Culture historical units are useful for tracing similarity in the composition and decoration of ceramics over time and space. These kinds of units formed the basis of chronology for across

North America. The construction of culture historical chronologies requires the establishment of units of measurement by which historical change can be sorted. In southern California, the first ceramic culture historical unit was Tizon Brown Ware, a class that was first described by Colton (1939:8) to characterize and sort sherds found in northwestern Arizona. Colton defines the class Tizon Brown Ware as:

> *Constructed*: by paddling.
> *Fired*: in oxidizing atmosphere.
> *Core*: gray, brown, red.
> *Temper*: water worn quartz plus other minerals.
> *Texture of core*: coarse to fine.
> *Surface finish*: smoothed or rough showing paddle marks.
> *Surface color*: buff, brown, red.
> *Forms*: bowls and jars.
> *Paint*: red and black when used [Colton 1939:8].

Dobyns and Euler revised this class as:

CORE:	Constructed: by coiling and paddle-and-anvil. Color: black, gray, brown, red. Fired: in poorly controlled oxidizing atmosphere.
TEMPER:	Sub-angular to rounded opaque quartz, feldspar, and occasional mica flakes. Texture: coarse to medium fine.
WALLS:	Fracture: crumbling.
SURFACE:	Color: brown, occasionally red, blackish or grayish in reduced areas. Finish: smooth, or occasionally exfoliated; anvil marks frequently visible on interior surfaces of large sherds and whole vessels.
FORMS:	Bowls and jars.
DECORATION:	Paint: rare; red and black when used [Dobyns and Euler 1958:72-73].

The vast majority of ceramics in southern California are identified as members of this class (Euler 1959). Two forms of vessel shapes are found in groups of sherds identified by this class: bowls and jars. Figure 4 and Table 2 show variability among shapes of Tizon Brown Ware found across southern California and surrounding regions (Rogers 1936). Tizon Brown Ware vessels are formed from coiling and paddle-and-anvil production techniques. As a consequence, anvil marks are visible on larger sherds. The color of sherds varies from black, gray, brown and

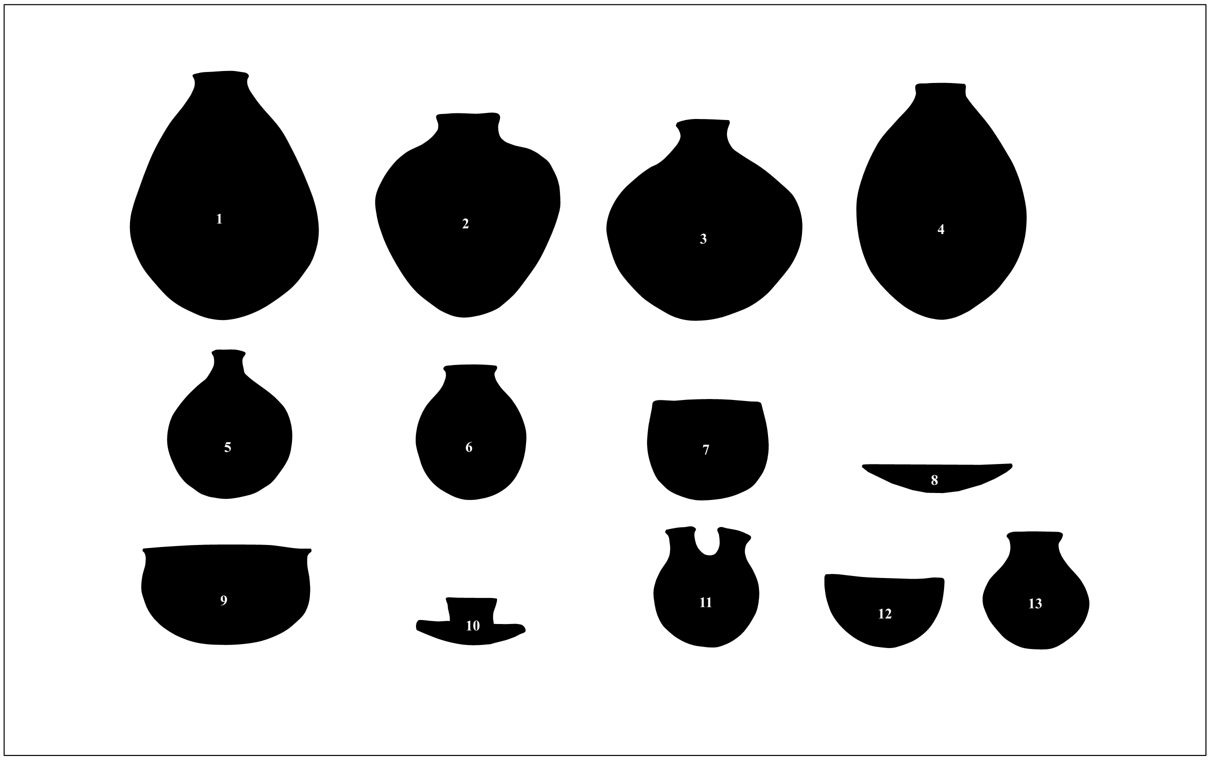

FIGURE 4. Rogers's western groups Yuman and Shoshonean pottery shapes. The vessel shapes are based on tribal boundaries. Source: Rogers (1936:52).

TABLE 2. Rogers's Western Groups Yuman and Shoshonean Pottery Shapes and Usage

Vessel Number	*Potential Usage*	*Western Groups Associated with Vessel Type*
1	Storage Olla	Cupeño, Northern Diegueño, and Southern Diegueño
2	Storage Olla	Northern Diegueño and Southern Diegueño
3	Storage Olla	Northern Diegueño and Southern Diegueño
4	Storage Olla	Luiseño, Cupeño, Kiliwa, Northern Diegueño, and Southern Diegueño
5	Water Olla	Cupeño, Kiliwa, Northern Diegueño, and Southern Diegueño
6	Cooking Vessel	Luiseño, Cupeño, Kiliwa, Northern Diegueño, and Southern Diegueño
7	Cooking Bowl	Luiseño, Cupeño, Seri, Kiliwa, Northern Diegueño, and Southern Diegueño
8	Plate	Northern Diegueño and Southern Diegueño
9	Food Bowl	Northern Diegueño and Southern Diegueño
10	Pottery Anvil	Northern Diegueño and Southern Diegueño
11	Canteen	Northern Diegueño and Southern Diegueño
12	Food Bowl	Luiseño, Cupeño, Seri, Kiliwa, Northern Diegueño, and Southern Diegueño
13	Jar	Luiseño, Kiliwa, Northern Diegueño, and Southern Diegueño

Note: Source: Rogers (1936:52).

red, which are the consequence of poorly regulated oxidizing atmospheres during firing, a property consistent with open pit firing (Griset 1990). The surface finish of sherds identified as Tizon Brown Ware are generally smooth, but at times exfoliated. Paint is rare but can be red or black (Dobyns and Euler 1958; Koerper and Flint 1978). Griset (1990) notes that the sherds are composed of residual granitic clays.

Tizon Brown Ware sherds dominate the assemblages from southern California and there is little known in terms of the temporal variability. One late variant of Tizon Brown Ware is so-called “Mountain Ware” (Treganza 1942:158). This class is also known as “Palomar Brown Type,” a variant of Tizon Brown Ware (Meighan 1959:36-38). According to Meighan (1959) and Euler (1959), examples of this class of ceramics are found associated with Diegueño and Luiseño groups known from post-contact accounts.

Overall and based on site records, examples of Tizon Brown Ware ceramics are found in association in prehistoric and historic contexts (Boxt and Dillon 2013; Cameron 1999) (Table 27 and Figure 5). Other than their association with European material, however, distinguishing pre-contact and post-contact contexts from sherds is difficult: ceramics identified in prehistoric and historic deposits as Tizon Brown Wares are indistinguishable by definition (Koerper and Flint 1978). May (2013) summarized examples of historic Tizon Brown Ware sherds from areas around Lake Cahuilla and described the specimens as having the same paste and temper characteristics as prehistoric Tizon Brown Ware sherds. Griset (1990) states that there are just a few empirical distinctions between sherds identified as Tizon Brown Ware in prehistoric and historic deposits. While sherds of prehistoric Tizon Brown Ware ceramics are found with smoothed surfaces, the historic ceramics are occasionally, but not always, found with polished surfaces. Further, sherds identified as Tizon Brown Ware that are found in post-contact contexts tend to exhibit more decoration than those from prehistoric contexts (Griset 1990). Griset (1990) argues that the historic examples often served as water jars and were manufactured without anvil-and-hammer, based on the lack of anvil impressions on the vessel interior and paddle marks on the exterior.

There has been some attempt to create alternative classes to Tizon Brown Ware that are more sensitive to temporal and spatial variability (e.g., Evans 1969). The addition of more criteria to the class, however, have not produced classes that have withstood the test of historical significance (Koerper and Flint 1978). Koerper and Flint (1978), for example, evaluated Evans's (1969) claim to have created a "Cerritos Brown" class that usefully identified ceramics found at La Casa de Rancho Los Cerritos. After consideration, Koerper and Flint (1978) determined that the material was the same that was identified as Palomar Brown Ware.

The inability to usefully create units with greater specificity than Tizon Brown Ware, however, does not mean that the ceramics lack chronological variability. Koerper et al. (1978) concluded that while Tizon Brown Ware is broadly useful, the ceramics identified as the ware in the La Casa de Rancho Los Cerritos deposit have properties that demonstrate homologous similarity between sherds found to the south and east. For example, they argue that similarity in vessel shape with Lower Colorado Buff Ware can be explained by the influence of interaction with populations from the Lower Colorado region (Koerper et al. 1978). They elaborate that it is difficult go far beyond claims about diffusion patterns in southern California due to small sample sizes, localized settlement patterns, and the plainness of the ceramics (Koerper et al. 1978).

FIGURE 5. Dates of ceramic deposits.

One alternative line of inquiry into the ceramics of southern California has focused on the late appearance of vessels in archaeological assemblages. McLean (2001), Hoover and Costello (1985), and May (1978) argue that ceramics were never manufactured in the southern California region prehistorically and that ceramic production only began post-contact with the arrival of European settlers to meet their utilitarian needs. Similarly, Hoover and Costello (1985) state that central and northern California populations did not produce ceramics prehistorically. Like Kroeber (1925) and McLean (2001), they (Hoover and Costello 1985) argue that ceramics found in southern California are the result of contact with the Spanish and missions. Costello and Wilcoxon (1978) state that the only exception known is a rim sherd found at the El Pueblo de Los Angeles, which they described as prehistoric Palomar Brown. Hoover and Costello (1985) account for the presence of this sherd by the hypothesis that the parent vessel was the result of migration or trade.

There is more evidence than this single sherd to suggest that prehistoric ceramics were somewhat common in the region during prehistory. Deposits such as CA-ORA-64, CA-LAN-270, and CA-LAN-2630 have vessel ceramics that are found among prehistoric deposits (Boxt and Dillon 2013; Drover et al. 1979). The vast majority of the deposits in which ceramics have been found, however, have not been dated. In many cases, however, sherds have been found in association with prehistoric artifacts and stratigraphy. These include the deposits at CA-ORA-119A, CA-ORA-302, CA-ORA-414A/B, CA-ORA-681, CA-ORA-855, amongst others (Table 27).

Regionally, the oldest known ceramics are those from CA-ORA-64, a deposit known as the Irvine Site that was located on an eastern bluff with a view of Newport Bay in Newport Beach (Drover 1975). Drover and colleagues (1979) generated two dates for CA-ORA-64 ceramics using thermoluminescence methods: 3238 ± 500 BP and 3692 ± 650 BP. The early nature of the dates points to the potential that fired ceramics have great antiquity in the region.[1] While these early dates are suggestive, they warrant reinvestigation. The CA-ORA-64 deposit opens the possibility that ceramic production was not necessarily late or post-contact and that it might not be the result of influence from the Great Basin and Colorado River area, since these ceramics were produced at a later time (Drover et al. 1979). Researchers at California State University, Fullerton utilized Inductively Coupled Plasma Mass Spectrometry (IC-PMS) on

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[1] These dates represent some of the earliest known fired ceramics in North America, though they were generated in the early days of luminescence dating and may need reevaluation.

the CA-ORA-64 ceramics to examine paste composition to determine if they were locally produced, but the results were never published.

In Long Beach, ceramics found at CA-LAN-270 and CA-LAN-2630, are well dated with large numbers of pre-contact radiocarbon dates (N=57). Although the ceramic assemblages from these locations have not been extensively studied, they have the potential to give insight into the technological and functional attributes of pottery in the region. Excavations at CA-LAN-2630 produced 642 pottery sherds (Boxt and Dillon 2013). Given the range of 55 radiocarbon dates that range from 800-250 BP uncal, the deposit's chronology supports the hypothesis that late prehistoric ceramic technology existed and was present in Los Angeles County (Boxt and Dillon 2013).

Overall, there appears to be five major hypotheses for the explanation of the spread of vessel ceramics into southern California. Based on the evidence, it appears that the diffusionist hypothesis is the most probable. Further, it is clear that vessel ceramics were in the region prehistorically and were not present as a result of post-contact interaction with Europeans. In order to gain a better understanding of ceramics, it is necessary to evaluate the technological, functional, and spatial distribution of vessel ceramics in the region. The research objectives for this thesis are the subject of the next chapter.

CHAPTER 3

RESEARCH OBJECTIVES

Based on the review of available evidence showing that fired ceramic vessels appear in pre-contact deposits, we can reasonably argue that vessel ceramics were a component of prehistoric artifact assemblages and thus, were not present only after European contact as has been claimed (e.g., McLean 2001). While it is possible that prehistoric southern California ceramics were imported from areas outside the region, they were certainly present and likely were integrated into the subsistence and settlement systems of the area. Table 27 presents a summary of prehistoric and historic deposits in which pottery is known. What remains striking about this distribution of these deposits is the fact that the locations in which pottery appears to be focused is on the area south and southeast of the Los Angeles River (Figure 3). While pottery is commonly found south of this location, lower densities of pottery has been found in areas to the north and northwest of the Los Angeles River.

3.1 Research Approach

Artifacts are defined as anything that have one or more attributes that are the consequence of human activity (Dunnell 1971). Ceramics are classes of artifacts that are formed of organic and inorganic materials and fired at high temperatures (Sutton and Yohe 2008). In California, ceramics can be divided into two groups: pottery (vessel ceramics) and non-vessel ceramic objects (figurines, pipes, net sinkers, etc.). The term pottery is used to describe vessel ceramics, which are defined as clay-fired artifacts that have an enclosed volume and opening. In California, ceramic objects and figurines preceded vessel ceramics (Dillon and Boxt 2013). The clay-fired figures found at CA-ORA-64 for example, demonstrate that the technology for firing clay was ancestral to the practices of firing class for vessel pottery.

The distribution of vessel ceramics is well suited to explanation by evolutionary theory. In an evolutionary framework, we treat individuals as inheriting cultural practices in pottery production and producing pottery with variability in cost and function. According to Braun (1983:108) "… pots are also tools. Their morphology and composition, and to a certain extent, their decoration as well, are in fact constrained by their intended contexts and conditions of use." As a consequence of their use, variability in composition, form, shape, and manufacturing effects the relative performance and thus change in vessels is explicable in accordance to natural selection. As Neff (1992:144) points out "… phenotypic characteristics that lead potters to transmit information more successfully tend to become more common, while characteristics that lead them to transmit information less successfully tend to become less common." Pottery is used by people in particular environmental settings with variability in success, and thus changes practices in pottery adoption, manufacturing, and use over time and space. While technology in the production of pots (e.g., improved firing, changes in temper, alterations to paste) may shape some of the change in vessels, southern California ceramics are relatively technologically homogeneous. Thus, we expect that the targets of selection in ceramics will be those that impact the functional dimensions of the pottery (Neff 1992). Aspects of ceramics that would impact performance potentially include: vessel form (costs, benefits to contents in terms of storage, access, protection of goods), toughness (ability to travel or withstand use), and heating (ability to transmit or withstand heat).

Following an evolutionary approach to explain pottery distributions in the archaeological record requires the measurement of functional and technological performance that is connected to the performance of ceramics. These are the properties that will result in having patterned consequences in varying environments of use.

3.2 Research Question

Previous hypotheses that account for the presence of ceramics in some areas of southern California tend to focus on treating ceramics as a homologous attribute. Homologous attributes are those that represent sharing as a consequence of relatedness. Focusing on homology allows researchers to trace patterns of historical connectedness through time and space and has been a major feature of culture historical research in Americanist archaeology since the early part of the twentieth century (Dunnell 1985; Lyman and O'Brien 1997). Under the premise that the presence of ceramics is homologous, we would account for some populations having pottery and others that do not, as a result of (or lack of) trade, exchange, diffusion and migration. The explanations of functional variability, ceramics as replacements for alternative containers, and raw material limitations are of this sort. In many ways, such ideas are plausible: the populations of the southern California area share many cultural attributes in common due to the degree of interaction that took place across the region. There is great similarity in artifacts such as groundstones, beads, drills, bifaces, pipes, basketry, and others (Moratto 1984; Shanks 2010). Overall, there is strong evidence that populations of the region traded amongst themselves, engaged in common foraging activities for subsistence, used common hunting technology, and shared general cultural traditions.

But why would ceramics be different from the other artifact classes that were known to be shared? Even if one group obtained ceramics (or the idea of ceramics were diffused) and continued to interact with other groups (as it appears occurred), it is puzzling that ceramics did not also spread to the other groups. In fact, if it was not for the difference in pottery, the northern and southern regions of the coast would be nearly archaeologically indistinguishable. Thus, we cannot simply conclude that populations to the north did not know about pottery and thus did not adopt it. If pottery was simply the outcome of sharing, we would expect it to quickly be found in all parts of the region.

The argument by Cameron (1999), that pottery was a cultural attribute takes the pottery-as-shared idea further. In her study, Cameron (1999) argues that pottery is connected with group identity and thus those groups who had significant pottery are culturally distinct from those that did not. The problem with this argument is that fired ceramic vessels, are not "symbols" in the typical sense, since as objects they are directly connected to subsistence activities. Thus their presence is quite unlikely to be "stylistic" (Dunnell 1978) and part of regional identities.

The presence of pottery is not a simple "equivalent cost alternative" to other vessel forms. It is a solution to a problem in which alternative containers do not provide sufficient functional advantages in comparison to pottery. In addition, given that other classes of artifacts are readily shared and exchanged, there is no reason to believe that pottery would be different in this way. While we might expect patterns of decoration on the surfaces of vessels to reflect variability in the way in which people interact the presence/absence/abundance of vessels is not the same kind of trait. Instead, the presence of pottery must be explained as a consequence of the way it impacts the fitness of the populations. Given that it has cost in manufacture, its presence must indicate some advantage for a subsistence/transport/storage issue that cannot be met by other forms of technology.

Rejecting pottery as a simple homologous attribute leaves us with exploring how the presence/absence of fired clay vessels might reflect either technological constraints or analogous similarity. In a technological constraint scenario, we might suppose that pottery is found in only those locations that have raw material that would allow one to make ceramic vessels, such as clay and wood material sufficient to fully fire clay into a ceramic state. As a consequence, pottery distributions might be easily explained based on the resources required to produce vessels. In a strictly technology driven model, we would find that the presence of pottery would most strongly correlate to the availability of resources needed for their manufacture. To explore this idea, we need to look to see whether populations to the north had access to resources necessary for constructing pottery vessel alternatives (e.g., baskets, steatite vessels) but were absent further to the south.

Third, it might be the case that the presence of pottery represents analogous similarity: that is, similarity due to common constraints. In a scenario in which the presence of pottery is analogous, we would expect to find fired clay vessels only in those locations where pottery vessels were low cost enough relative to alternative solutions and provided superior solutions for tasks associated with cooking, storage or transportation. In this scenario, we would expect to find pottery adapted to local environments and resources. Consequently, technological and functional variability of ceramics should co-vary with the use of vessel ceramics. Thus, if ceramic vessels serve a key subsistence related activity for some areas but not others, then their shapes and composition should illustrate similarity due to the way in which the vessels are used in the environments. If the presence of pottery is analogous, we might expect to see strong environmental differences that would result in significant differences in available resources. We need to look at the specific details of the areas in which pottery is found and not found to find out if there are particular items that might constrain pottery use in some areas, yet make it essential in others. This possibility also requires us to closely examine the details of the local environments related to food storage or processing as these features may be linked to the presence of vessel ceramics.

These three scenarios: homology, technology, and analogy, need not be mutually exclusive. It is possible that some combination of these attributes may be at work. For example, pottery may be homologous with external groups through trade and interaction, yet appear sporadically across the region depending on the local conditions in which each population lives or based on the available resources needed to make pottery. Similarly, ceramics might also be concomitant with distinct population histories and that the southern part of the coast has greater functional and cultural links to the California desert or another region. These populations may share pottery but also other kinds of resources. It is possible that successful populations were able to outcompete previous coastal dwellers by their use of inland resources, perhaps enabled through cooking with ceramic vessels. This explanation would account for the analogous and homologous aspects of ceramics.

Consequently, there are several hypotheses that we can evaluate to account for the puzzling pattern of pottery in southern California (Table 3). The first hypothesis that must be evaluated explains the differences in the presence of vessel ceramics as a consequence of differences in subsistence practices between the areas. In this scenario, if the two areas were distinct in terms of the availability of food material that required processing or storage in vessel ceramics, we would expect the presence of pottery to vary in proportion to the resources. Perhaps, the plant species that require pottery for processing, storage, or transport to the south are simply not available in the north. In this way, pottery is expected to map to the distribution of some vital subsistence resource. We would also expect pottery forms to relate to the particular function involved in subsistence, whether as storage vessels or processing through heating.

Second, we can consider whether the two areas shared subsistence practices but the function of pottery to the north was achieved by more easily produced basketry or some other kind of container. If northern areas had suitable materials for making baskets, it is possible that vessel functions related to baskets (e.g., storage, transportation) might have been more effectively accomplished with this lower-cost technology. Under this model, we expect that pottery will map to the absence of alternative materials used to construct similarly functioned containers. From the point of view of pottery technology related to their equivalent function in basketry, we would expect pottery shapes to be similar to those found in baskets since they come from this earlier tradition and would be fulfilling similar utilitarian needs. Further, they would be found in contexts similar to those in the north where baskets or groundstone bowls are utilized.

A third hypothesis, relates to differences in the raw materials required for producing pottery. Ceramic presence could be related to differences in the raw materials required for making pottery. When material for the manufacture of pottery is not available, there will be no pottery found in those regions.

If we falsify these hypotheses, then we are left with the only difference that accounts for the pattern being related to the history of the population and the patterns of relatedness resulting from how populations interacted. These would leave us a homology as the only reasonable alternative.

Table 3 lists a set of hypotheses as well as the empirical expectations based on them. Note that more than one hypotheses may be supported by the evidence. For example, ceramic vessels may be linked to subsistence practices and resources while also being tied to the lack of available material needed for alternative containers. Similarly, population history may include spatial patterns of groups that have subsistence practices tied to specific resources. This thesis explores these hypotheses. Overall, I measured physical characteristics of existing ceramic assemblages to assess whether there is evidence that links the technology of vessels to their

TABLE 3. Hypotheses and Expected Patterns

Hypotheses	*Expected Patterns*
Hypothesis #1 – Functional variability. Ceramics were used for a variety of functions and thus are variable in shape, form, and composition depending on resources in the local environment. When these resources are not available, there is no need to make pottery.	Sherds all differ in functional attributes. Consequently, we expect to see vessels that exhibit differing shapes, forms, volumes, tempers, physical and thermal properties. Spatial distribution of similarities in ceramics will be non-randomly distributed and will be distributed to some vital subsistence resource(s).
Hypothesis #2 – Ceramics as replacements for alternative containers. Ceramics are used as an alternative to other kinds of technology for the processing, storage, and transportation of resources. When alternative and less costly material is available for containers and vessels, those materials are used and no pottery will be found.	The presence of sherds in deposits will correlate with deposits in areas with no alternative sources of materials for containers. Further, ceramics will be found in similar contexts to where baskets/groundstone bowls are utilized in the north.
Hypothesis #3 – Raw material limitations. Ceramic use is linked to differences in the raw materials required for making pottery. When material for the manufacture of pottery is not available, there will be no pottery found in the archaeological record.	Spatial distribution of ceramics will be distributed to raw materials required for making pottery, such as water, clay, temper materials, and fuel.
Hypothesis #4 – Historical contingencies. The use of ceramic vessels is the product of distinct population histories that have equivalent subsistence practices or population interactions.	Ceramic sherds have spatial distributions that are randomly distributed with respect to environmental resources tied to subsistence, but are tied non-randomly to select cultural landscapes.

Note: These are not necessarily mutually exclusive explanations. More than one of them may explain the record at the same time. They each address different aspects of ceramic use by prehistoric populations that must be evaluated separately.

function and their use in the environment.

For a sample of assemblages distributed across the region, I took measurements designed to assess technological and functional variability in order to see if these properties shed light on the underlying reasons for the patterns of ceramics found in southern California. These measurements are the subject of the next chapter.

CHAPTER 4

CERAMIC DESCRIPTIONS

The sherds analyzed in this thesis are derived from ceramic collections known in southern California coastal deposits (Tables 4 and 8). I sampled collections from a variety of temporal contexts including late prehistoric, protohistoric, and historic pottery. One challenge in generating these measurements was locating the storage locations for the assemblages. California lacks a centralized database that tracks where materials are housed after their excavation. Between October 2015 and May 2016, I accessed ten assemblages housed at California State University Long Beach, the Blas Aguilar Adobe, the Pacific Coast Archaeological Society, and the John D. Cooper Archaeological and Paleontological Center. All samples described consist of sherds rather than whole vessels. The majority of sherds (98.6%) that are part of the study are smaller than 6cm in maximum diameter (N=498). The vast majority of sherds were body sherds (95.2%), only rarely (N=24) did I encounter rim portions of vessels.

4.1 Sample of Ceramic Sherds from Southern California Deposits

Figure 6 presents a summary of each deposit from which I sampled ceramic materials.

4.1.1 CA-LAN-270

CA-LAN-270 (“Los Altos”) is located in Long Beach about 3.7km west of the Los Angeles and Orange County boundary. In 1952, Ruth Simpson and members of the Archaeological Survey Association, an organization that promoted archaeological preservation and research excavated the deposit during salvage efforts associated with a housing construction project (Simpson 1953). During these initial excavations, Simpson (1953) uncovered several burials (N=21), leading her to argue that the deposit was a “burial ground.” Soon after the initial salvage work, Ethel Ewing continued the project and began a field school associated with

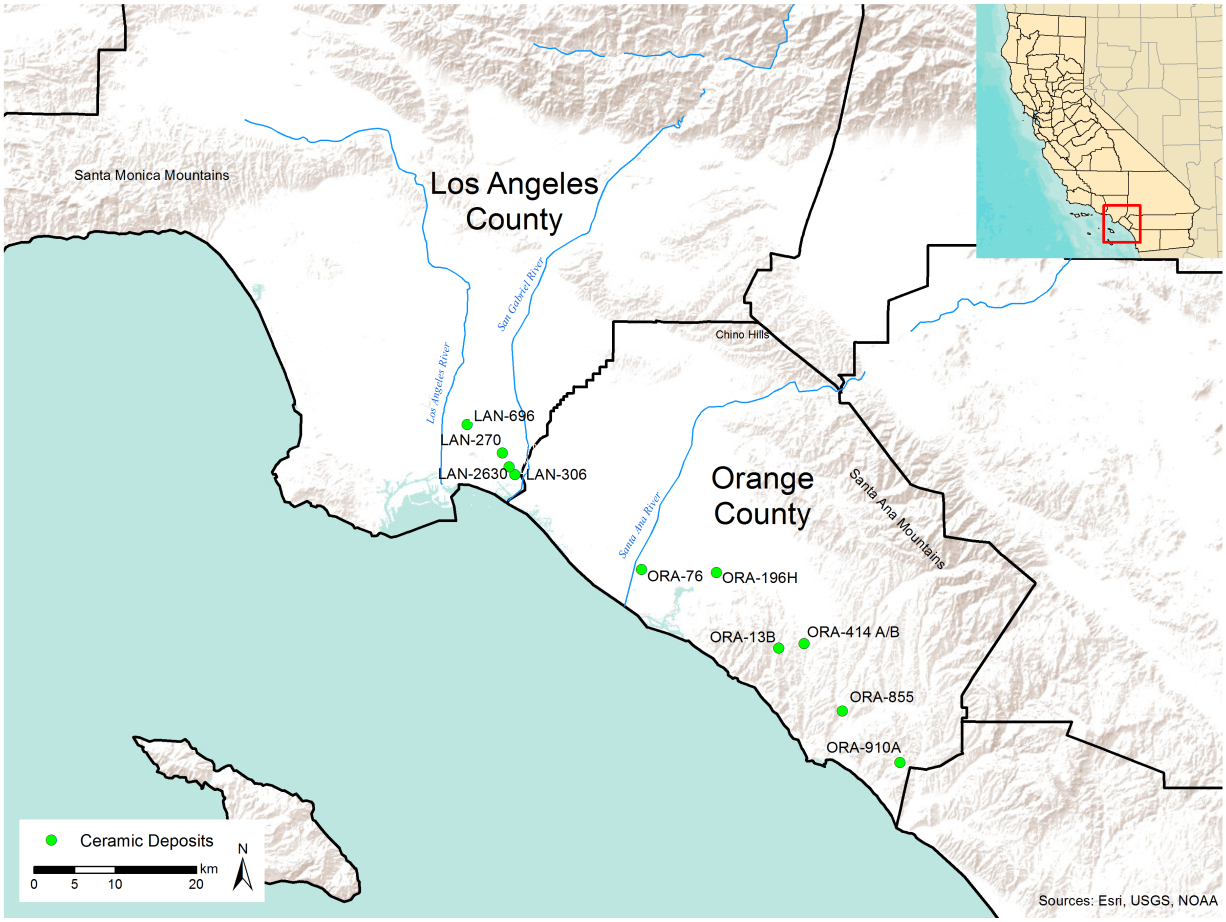


FIGURE 6. Locations of deposits in Los Angeles and Orange Counties, California that are included in this study.

California State College, Long Beach. Ultimately, Ewing recovered more than 2,787 artifacts from the excavations, including forty-five sherds (Bates 1972). Ewing and students excavated the sherds at a depth of 53 to 61cm from the surface of the deposit (Bates 1972).

Bates (1972) summarized the excavation and findings from CA-LAN-270. Radiocarbon analysis on marine shell suggest that the location was occupied 810-700 BP uncal (Boxt and Dillon 2013). This date is consistent with the material found during excavation that shows the location was occupied during late prehistory and is identifiable as a “Late Horizon” occupation. Bates (1972) suggests that the occupation also included post-contact activity, though no historic artifacts have been found at the site. In addition to pottery, the excavations uncovered many groundstone objects including: manos, mortars, bowls, pestles, and hammerstones. Based on the wide variety of materials, Bates (1972) concluded from the overall assemblage that the deposit was the remains of a “standard southern California village” that included a cemetery component.

In her discussion of ceramics found during the excavation, Bates (1972) argues that the sherds are identifiable as Tizon Brown Ware, more specifically Palomar Brown Type. Bates (1972) also assumed the pottery sherds were the result of trade and not local materials. Although some sherds may have come from the same vessel, this was difficult to determine, thus each sherd was measured independently. In my analysis of this deposit, I sampled fifty ceramic sherds (N=50).

4.1.2 CA-LAN-306

CA-LAN-306 is also known as Rancho Los Alamitos or Bixby Ranch. This deposit is located on a hill in east Long Beach that overlooks Bouton Creek to the north and the San Gabriel River Channel to the east. CA-LAN-306 is on the National Register of Historic Places due to its prehistoric component and its historic significance as the headquarters of a large Spanish ranch operation. Archaeologically, the deposit consists of a large shell midden. Artifacts found during investigations include a metate rim, lithics, china sherds, manos, pestles, stone bowls, bifaces, and thirteen Tizon Brown Ware sherds. From these materials, it appears that the location was occupied during pre-contact and post-contact time. I was only able to access one sherd from this deposit for my analyses (N=1).

4.1.3 CA-LAN-696

CA-LAN-696 is in Long Beach and is also known as La Casa de Rancho los Cerritos.

This site is on the National Register of Historic Properties and is also a National Historic Landmark. The historic Rancho los Cerritos was the headquarters of an ranching operation that began as the result of the Nieto Grant of 1784 (Evans 1969). Archaeologically, the deposit at CA-LAN-696 contains evidence of pre-contact and historic occupations. Artifacts associated with the deposit include manos, stone discs, cogstones, glass, china ceramics, fragments of nine Tizon Brown Ware vessels, clay pipes, scrapers, knives, and metal. Evans (1969) described the Brown Ware ceramics as being made of micaceous clay, with feldspar and/or quartz inclusions. The pottery shows evidence of coiling and smoothing using paddle and anvil techniques (Evans 1969). The ceramics are polished on the exterior and most of the rim sherds were recurved with flattened lips (Evans 1969). The shapes of the vessels included a spherical jar or olla, bowl, and a globular jar. For my analyses, I sampled eight ceramics from this collection (N=8).

4.1.4 CA-LAN-2630

CA-LAN-2630 is located on the banks of the prehistoric Bouton Creek and on California State University Long Beach campus. Construction workers discovered the deposit during the construction of a parking structure in May of 1994, Matthew Boxt excavated CA-LAN-2630 during a subsequent salvage project. During these excavations, archaeologists recovered a total of 642 (713g) pottery sherds from stratum 4, a layer that was approximately 70cm thick and consisted of sandy silts, loams, and marine shell (Boxt and Dillon 2013). The pottery sherds are associated with only definitively prehistoric artifacts (Boxt and Dillon 2013). These include groundstone items such as hammerstones. These artifacts are stratigraphically below historic artifacts that were found at depths of 0 to 50cm (Boxt and Dillon 2013). The large majority of the sherds are body fragments (N=240), and less than 1 percent of the sample contains rim sherds (N=7). The ceramics were formed from a variety of manufacturing techniques including molding, coiling, paddle-and-anvil, thinning, and scraping (Boxt and Dillon 2013). Fifty-five radiocarbon dates (N=55) demonstrates that the location was occupied between 800-250 BP uncal (Boxt and Dillon 2013). The site is significant because it definitively documents the fact that vessel ceramics were present in pre-contact Los Angeles County.

Hurd and Miller (2013) used neutron activation analysis (NAA) to measure the elemental composition of the CA-LAN-2630 ceramics to determine if the potsherds were the result of local production or exchange. The NAA analysis utilized samples of daub and sediment from CA-LAN-2630 excavation to compare chemical composition in order to evaluate whether the pottery was traded or represents local pottery production. Based on the results from the NAA, the daub samples have the same chemical elements as the pottery sherds. Thus, Hurd and Miller (2013) concluded that the CA-LAN-2630 sherds were produced locally. Hurd and Miller (2013) thus reject the hypothesis that the sherds were the result of exchange. Interestingly, the ceramic sherds from CA-LAN-270 and CA-LAN-2630 have similarities in terms of finish and firing (Boxt and Dillon 2013). I sampled two hundred and fifty-three pottery sherds from this collection (N=253).

4.1.5 CA-ORA-13B

CA-ORA-13B is located in Laguna Canyon in Orange County and is associated with Tischler Rock, a rock with a historic carving. The location of the deposit is also near two springs and during the late 1800s was used as a way station for stagecoaches. In 1935, John Romero initially described CA-ORA-13B. In 1949, it was then officially described and entered into the state files (Demcak and Allen 1994). In 1966 and 1974, members of the Pacific Coast Archaeological Society surveyed CA-ORA-13B and it was surveyed once more by Applied Conservation technology, Inc. (ACT) in 1986. In 1988, archaeologists from Archaeological Resource Management Corporation (ARMC) conducted test level investigations at CA-ORA-

13B and found a historic trash dump and a prehistoric shell midden (Demcak and Allen 1994). Artifacts from these excavations include bedrock mortars, a scraper, historic artifacts, bifaces, pestles, ceramics, and the remains of the Laguna Springs Adobe (Locus B). Archaeologists also uncovered a total of sixty-one Tizon Brown Ware ceramics (Cameron 1999). The ceramics appear to be associated with the Laguna Springs Adobe and were found in a historic dump (Demcak and Allen 1994; Demcak 1990). It is possible, therefore, that these ceramics are associated with the historic occupation of the site (Wade 1994). The ceramics from the deposit show attributes consistent with coiling and scraping during manufacture. Due to the lack of evidence for burning on the sherds, Wade (1994) suggests these ceramics were used primarily for storage. The majority of the sherds appear polished on the exterior (Wade 1994). I sampled forty-six sherds from this collection (N=46).

4.1.6 CA-ORA-76

CA-ORA-76 is also known as the Adams-Fairview Site or Griset Site and is located in Costa Mesa, Orange County. In 1935, the WPA excavated the deposit, but did not find ceramics (Winterbourne 1966). In 1957-1958, faculty from Long Beach State University excavated at the site. In 1965, members of the Pacific Coast Archaeological Society conducted a salvage excavation (Chace 1966). During the salvage excavation they discovered one Tizon Brown Ware sherd (Cameron 1999). This deposit consists of a shell midden that is located on a bluff east of the Santa Ana River. In post-contact times, inhabitants built an adobe over the pre-contact deposit (Cameron 1999). Artifacts from these excavations include cogstones, pottery, steatite pipes, hammerstones, manos, bowls, pestles, steatite effigies, charmstones, and bifaces. I sampled five sherds from this site (N=5).

4.1.7 CA-ORA-196

CA-ORA-196 is also known as Cienaga and is located in Newport Bay, Orange County. The nearest water sources are the San Diego Creek and Peters Canyon Washes. The area was a prehistoric deposit, but later was a mission outpost, then a rancho for the Sepulveda family (Cameron 1999). In 1968, members of the Pacific Coast Archaeological Society excavated the deposit to determine the location of the structure built in 1820 by the San Juan Capistrano Mission and to collect historic artifacts (Chace 1969). Artifacts found in the deposit include a metate, a hammerstone, manos, bone awl, lithic debitage, lithic bifaces, shell beads, scattered shell, seven Brown Ware ceramics, stone bowl fragments, two millingstones, and historic material (Chace 1969). Salvage excavations by members of the Pacific Coast Archaeological Society, salvaged 78 Brown Ware and 985 historic ceramics (Chace 1969). Chace (1969) described the Brown Ware ceramics as "sooted" from cooking on an open fire. In later test excavations, archaeologists excavated thirty-eight pottery sherds (Cottrell 1976). I sampled twenty-two ceramic sherds from this collection (N=22).

4.1.8 CA-ORA-414A/B

CA-ORA-414A/B is located in San Juan Capistrano, Orange County on a ridge above a creek. The deposit includes a millingstone scatter, shell midden material, bone artifacts, manos, metates, lithic flakes, hammerstones, cogstones, and ceramics (Demcak 1988). Excavations conducted by Demcak (1988) yielded a total of nineteen sherds (Demcak 1988). I gained access to thirteen sherds from this site (N=13).

4.1.9 CA-ORA-855

CA-ORA-855 is located in San Juan Capistrano, Orange County about ¼ mile west of Oso Creek and one mile north of the San Juan Capistrano Mission. The deposit is thought to be the location of a village site named Putuidem, which was occupied during the late pre-contact and early post-contact times (Koerper et al. 1988). Artifacts known from the deposit include groundstone, lithic debitage, Tizon Brown Ware ceramics, daub, hammers, fishhooks, and choppers. Koerper et al. (1988) also found three sets of human remains at the site. I sampled a total of sixty-one ceramics from this collection (N=61).

4.1.10 CA-ORA-910A

CA-ORA-910A is located in San Juan Capistrano, Orange County. Its closest water source is a tributary drainage to the Segunda Deshecha. Artifacts from this deposit include bifaces, cores, manos, hammerstones, scrapers, lithics, and Brown Ware sherds. I sampled forty-seven sherds from this collection (N=47).

TABLE 4. Summary of Ceramic Assemblages Sampled

Deposit	*Total Known Assemblage Size*	*Total Assemblage Size Available*	*Number of Ceramics Sampled*	*Location*	*References*
CA-LAN-270	50	50	50	Long Beach	Bates 1972 Simpson 1953
CA-LAN-306	-	1	1	Rancho los Alamitos, Long Beach	Zahniser 1974
CA-LAN-696	-	8	8	Rancho los Cerritos, Long Beach	Evans 1969
CA-LAN-2630	642	642	253	CSULB, Long Beach	Boxt and Dillon 2003 Hurd and Miller 2013
CA-ORA-13B	61	61	46	Laguna Canyon, Orange County	Demcak and Allen 1994 Wade 1994
CA-ORA-76	5	5	5	Costa Mesa, Orange County	Winterbourne 1966 Chace 1966
CA-ORA-196	78	22	22	Newport Bay, Orange County	Chace 1969 Cottrell 1976
CA-ORA-414A/B	20	13	13	San Juan Capistrano, Orange County	Demcak 1988
CA-ORA-855	-	61	61	San Juan Capistrano, Orange County	Koerper et al. 1988
CA-ORA-910A	-	46	46	San Juan Capistrano, Orange County	Mooney 1988

The ceramic deposits vary based on age, location, and previous documentation. All ceramic deposit locations utilized in this analysis are located in Los Angeles and Orange Counties. The majority of these deposits are the result of both prehistoric and historic occupation. The methods for analysis of these ceramic assemblages are subject of the next chapter.

CHAPTER 5

METHODS

To address the research questions raised in Chapter 3, I analyzed vessel ceramic fragments (sherds) from existing collections from across southern California. I define my study area based on the environmental boundaries of the local mountains and rivers and the known distribution of prehistoric ceramics. Thus, my study area spans from Los Angeles River on the north and northeast, to San Diego County on the south, and from the coast eastward to the Santa Ana Mountains. To have a statistically viable sample that represented ceramics from across the study area, I described as many sherds as possible from assemblages across the region. I described all sherds from smaller assemblages and at least fifty sherds from larger ones. I increased the sample size whenever I found a substantial degree of variation in my measurements.

In the end, I measured enough sherds to be able to reasonably characterize ten assemblages that span the region: CA-LAN-270, CA-LAN-306, CA-LAN-696, CA-LAN-2630, CA-ORA-13B, CA-ORA-76, CA-ORA-196, CA-ORA-414B, CA-ORA-855, and CA-ORA-910A (see Figure 6). All assemblages (N=10) come from deposits that demonstrate occupation during late prehistory, but assemblages containing ceramics from deposits with earlier and later dates were included in the sample. Importantly, my analyses included only non-destructive techniques (Tables 5 and 6).

For each sample with an intact interior and exterior surface that was at least 1cm in diameter, and for which the interior paste was visible, I took a scaled, visible-light digital photograph of the interior and exterior of the sherd. When possible, I oriented these sherds so that the horizontal curvature and vertical curvatures were oriented as though the sherd was

TABLE 5. Summary of Measurements

Formal Attributes	*Sherd Type*	*Measurement*
Dimensions	Rim	Orifice diameter Sherd Thickness
	Body	Sherd Thickness Vessel shape using the Two Curvature method (only on sherds >6cm)
Form	Rim	Rim form: recurved, incurved, or direct Lip shape: flat, round, or pointed Lip lateralization: interior, exterior, flat
Stylistic Traits	Rim/Body	Qualitative description of surface modifications: impressing, grooving, combing, finger-tipping, or stamping and surface applications: slip, added clay, glaze, polishing, or paint.
Cross-section	Rim/Body	Inclusion type Inclusion shape Inclusion abundance Munsell color
Firing Atmosphere	Rim/Body	Patterns of oxidization and reduction Munsell color
Thermal Properties	Rim/Body	Moh's Hardness

part of its original vessel. I used the photos to make quantitative descriptions such as shape, color, temper, texture, and finish. I also used the photographs as a reference for additional observations when I no longer had access to the collections.

In my model, I assumed that if ceramics were used for different functions, then my measurements would reveal significant differences in vessel form, wear pattern, paste and/or temper. If ceramics were limited to use in a single function such as food production, then we would expect that the ceramics would have strongly similar shape, form, and thermal properties. Following Eerkens (2001) who used a similar approach for studying the spatial distribution of ceramics in the California deserts and Griset (1996) who analyzed Tizon Brown Ware in Riverside and San Diego Counties, I described the physical attributes of sherds that are related to ceramic manufacture and use. According to Rice (1987:225) the "…four major use-related properties of ceramic containers are directly related to form or shape: capacity, stability, accessibility of contents, and transportability or ease of movement."

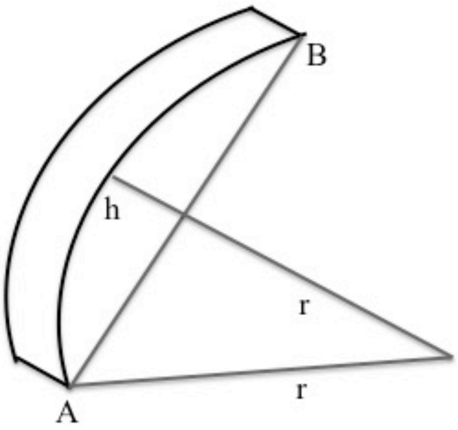
Consequently, I made a series of measurements to address these dimensions. First, I used a digital caliper to measure the thickness of each sherd to a resolution of 0.01mm. In this step, I took measurements across 25 positions on each sherd to produce a statistically sound estimate of thickness and to characterize variability in wall thickness within a single vessel. If calibrated by vessel size, the thickness of sherds can provide information about the use context of a vessel. Thick walls thermally isolate the contents better than thin walled vessels, and are more durable, making them more resistant to shock (Eerkens 2001). Thick walled vessels are heavier than vessels with thinner walls, meaning they would be less likely to be used for transportation when transport is primarily by human carriers (Eerkens 2001). Thickness also determines the amount of raw material needed to produce the vessel: thick vessels are costlier to produce than thin-walled vessels. Thinner-walled vessels are weaker but less affected by thermal stress and heat proficiently (Lawrence and West 1982). Thinner-walled vessels transmit heat to the contents more efficiently and are lighter for transport. Variability in the thickness of the vessel provides information on the relative importance of sherd thickness for providing consistent temperature.

Vessel shape and volume is somewhat (but not exclusively) related to the way in which ceramic vessels interact with the environment (i.e., "function"). Thus, in addition to thickness, I made measurements of the inverse of the radius of curvature (Hagstrum and Hildebrand 1983). To accomplish this task, I took measurements of profile and axial curvature using a caliper and carpenters contour gauge (Figure 7 and Figure 8) on sherds that were larger than 6cm in diameter. These measurements enabled me to make use of the Two Curvature Method (Hagstrum and Hildebrand 1983, 1990) for estimating parent vessel shape. The profile curvature of the sherd is proportional to the diameter of the parent vessel. Profile curvature is positive at inward curving portions of the vessel such as the body, and negative at outward curving areas such as the rim or neck sherds (Hagstrum and Hildebrand 1990). In order to calculate the profile curvature, I used the formula:

$$R=(c^2+h^2)/2*h$$

where R is the radius, c is half the chord length, and h is the height of the chord to the interior (Figure 7). To generate the data needed to estimate volume in this way, I oriented the sherds in a horizontally and vertically consistent fashion relative to the original vessel. In addition, I made all measurements on the interior of the sherd (Feathers 1985). Sherds from vessels that are small in diameter or ones with less curvature are more likely to have errors associated with the measurements taken (Feathers 1985), thus I used only sherds larger than 6cm. Using these measurements, I calculated the axial curvature, a value that is perpendicular to the profile curvature. While profile curvature is affected by vessel shape, axial curvature is affected by vessel volume (Hagstrum and Hildebrand 1990). To calculate the horizontal and vertical curvature of ceramics, I used a ruler and carpenters contour gauge to record axial curvature (Figure 7 and 8) and calculated the profile to axial curvature ratio. This step allowed me to characterize parent vessel shape as a single metric. Spherical pots have profile and axial curvatures equal to the radius (Hagstrum and Hildebrand 1990). A ratio of around 1.0 represents a spherical shape, while a ratio larger than 1.0 represents a flatter more elliptical shape (Hawsey 2015).

While these measurements are important in understanding overall vessel shape, there are large amounts of error associated with the measurements as a result of irregularities in handmade pottery (Feathers 1985). In a relative sense, larger vessel volumes are often related to storage. A larger ceramic diameter and globular shape results in a larger area of space to use, but makes transportation and heat dispersion challenging (Feathers 1985). Lower curvature in a vessel improves its mechanical strength (Braun 1983). Smaller vessel volumes, on the other hand, predominately are found in vessels used for serving, processing, and cooking (Eerkens 2001).



C=Chord Distance
h= Distance from arc to chord between A and B
r=radius
$r=(h^2+\frac{1}{4}(c^2))/2$

FIGURE 7. Measurements taken on sherds for the Two-Curvature Method.

For sherds that exhibited a finished edge between the interior and exterior surface, I measured the orifice diameter of rim sherds (to the nearest 5mm) by using a rim gauge chart. Because the ceramics are made through coiling and paddle-and-anvil techniques, there is some error associated with measuring the orifice diameter. Thus, they are not perfectly circular. Orifice

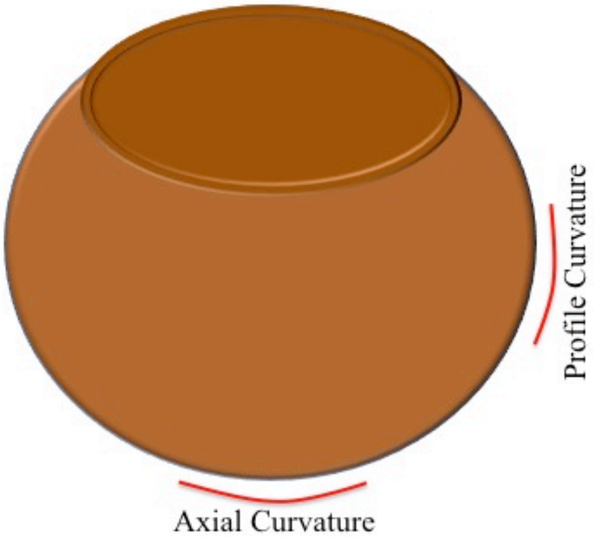


FIGURE 8. Profile and axial curvature for the Two-Curvature Method. Source: Hagstrum and Hildebrand (1990).

diameter is often an indicator of the use of the container. In general, storage containers have smaller orifice diameters to provide secure enclosures, while cooking and serving vessels have larger diameters to allow for access to the material being processed and eaten (Smith 1985).

In addition to the diameter of the opening, I also quantitatively described the shape of the rim form when present on sherd specimens. Rim forms for pottery can range from recurved, incurved, and direct (Figure 9). According to Eerkens (2001) storage containers generally have incurved or recurved rims as a result of narrow vessel necks/mouths, transport vessels have incurved and/or recurved rims, serving/processing vessels generally have direct rims, while cooking vessels can have all rim types. I recorded lip shape, which is the form of the finished surface where the interior of the vessel meets the exterior. Possible shapes included flat, round or pointed (Figure 10). Finally, I noted lip lateralization, an attribute that can be interior, exterior, or even (Figure 11) (Eerkens 2001).

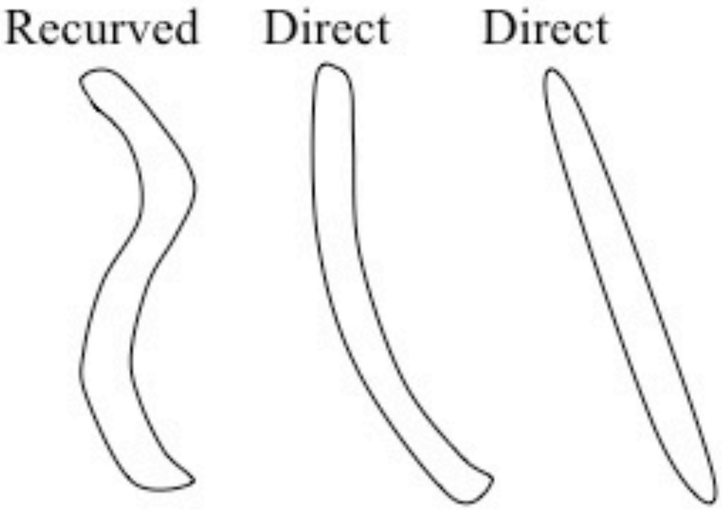


FIGURE 9. Rim Forms. Source: Eerkens (2001).

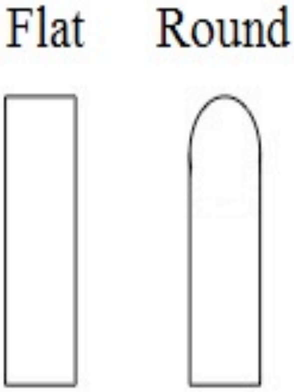


FIGURE 10. Lip Shape. Source: Eerkens (2001).

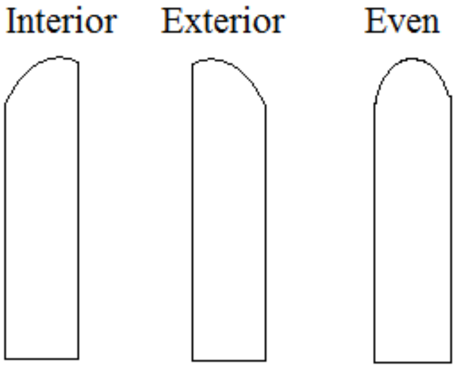


FIGURE 11. Lip lateralization. Source: Eerkens (2001).

Generally speaking, the prehistoric and early historic ceramics of southern California are undecorated (Griset 1996) though there are a few exceptions such as one sherd from CA-ORA-64 (Drover 1975). If surface finish or decorations were present, I photographed these features and described them in detail. In terms of decoration, I described the mode of application: surface applications or surface modifications. Surface applications consist of slip, added clay, glaze, polish, or paint (Orton and Hughes 2013). Surface modifications include impressing, grooving, combing, finger-tipping, stamping, polishing, and others (Orton and Hughes 2013). I measured, recorded the pattern, and recorded the extent of the surface treatment.

I described the inclusions/temper including the material, abundance, size, and shape. Temper helps deter pots from cracking and/or breaking during firing (Shepard 1968). Further, it helps to increase the heat transfer efficiency and quickens the clay drying process, but can make the pot weaker (Skibo et al. 1989; Skibo and Schiffer 1986). I also recorded the cross section for temper analysis using a low-power digital microscope, which allowed me to quantitatively describe temper shape variability. Following Eerkens (2001), the type of temper incorporated into the clay is important since it can impact firing, heating, and strength. Temper type also plays a role in balancing resistance to thermal stress and mechanical stress (Eerkens 2001).

In my research, I recorded information about the firing atmospheres in terms of patterns of oxidation and reduction (Orton and Hughes 2013). I also described color variations for each sherd by recording the dominant paste color of the exterior, interior, and the cross section plus any secondary coloration using the *Munsell Book of Color* (Munsell Color 2009). I utilized Orton and Hughes's (2013:154) thin-section diagram to describe the firing atmosphere of the vessels (Figure 12). The patterns of colors provide information on the degree to which firing was conducted in an oxidizing or reducing environment.

Thermal properties of vessels are related to paste hardness, density, composition, and thickness. Vessels fired at relatively low temperatures such as 550-650°C are weaker than those fired at higher temperatures (Skibo et al. 1989). One measure of the strength of a vessel paste is hardness. Hardness is the strength of a material usually determined through resistance to force or scratching (Orton and Hughes 2013). I measured the hardness of each sherd using the Mohs 10-point scale of hardness. Hardness of a vessel paste provides information on the temperature of firing (higher temperatures resulted in harder pottery) and the degree to which the vessel can withstand abrasion (Skibo et al. 1989). Hardness also provides information on the durability of a vessel that might be subject to mechanical stress, as well as its resistance to wear (Grimshaw

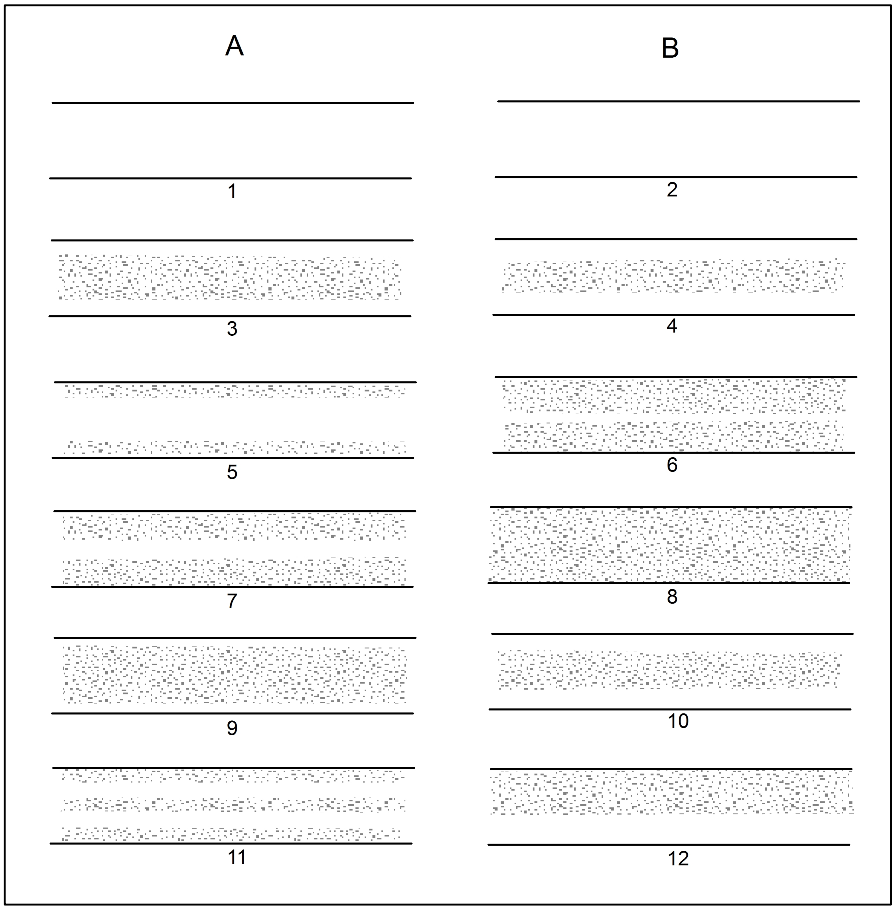


FIGURE 12. Thin-section diagram. Source: Orton and Hughes (2013:154).

1971). Cooking and transport vessels, on the other hand, need to be able to withstand stress caused by heating, handling, and transport and thus tend to be harder than vessels limited to storage purposes (Eerkens 2001).

The composition of ceramics also impacts the performance of a vessel in terms of overall weight, its heating abilities, capacity to withstand thermal and physical shock, as well as resistance to abrasion. Since acquiring and processing ceramic materials has cost, not all vessels are made with the same materials. Generally speaking, materials used are those that favor low cost and high return. This process leads to systematic variation in the composition of paste due to natural selection favoring the manufacture of the best vessel at the least cost. Consequently, I systematically described the contents of temper to learn if forms of ceramics vary based on their temper composition. To produce ceramics, clay, temper, water, and firing materials need to be accessible to potters.

TABLE 6. Purpose of Measurements Taken on the Ceramics

Measurement	*How contributes information to the study of ceramics*
Thickness of each pottery sherd	• Information about the use context of a vessel. • Thicker vessels more resistant to stress/shock. Thinner vessels are less durable. • Thick walls thermally isolate walls, but are more susceptible to thermal shock. Thinner walls transmit heat more efficiently and lighter for transport. • Thicker pots are heavier for transport, but are more durable.
Two Curvature Method: Measurements of chord depth, min/max diameters	• Shape and diameter can give information on use context of the vessel. • Smaller pots are more likely used for cooking/serving. • Larger vessels used for storage.
Orifice diameter	• Related to function. • Generally smaller diameter in storage vessels and a larger diameter in serving and cooking vessels.
Description of the shape of the rim form	• Storage vessels usually have incurved or recurved rims. • Serving containers normally have direct rims.
Description of surface finish and/or decorations	• Determine any stylistic attributes of the ceramics.
Descriptions of temper including the material, abundance, size, and shape	• Temper is important in cooking vessels. • Temper type determines heat efficiency. • Temper type can make pottery weaker and less resistant to stress.
Descriptions of color using a *Munsell Book of Color* (Munsell 2009)	• Determine firing temperature and atmosphere. • Lower firing temperature produces weaker pottery.
Hardness of each sherd using Mohs 10-point scale of hardness	• Hardness of a vessel paste provides information on the temperature of firing. • Higher temperatures result in harder pottery and the degree to which the vessel can withstand abrasion. • Cooking and transport vessels need to be able to withstand stress, more than storage containers.

Note: Based on methods of Eerkens (2001).

CHAPTER 6

CERAMIC ANALYSIS

Using a series of measurements derived from Eerkens (2001), I examined the design constraints that impacted the way in which prehistoric southern California populations made pottery. I used statistical analyses to examine the data for non-random associations of ceramic technological features and vessel forms. The statistical analyses that I utilized included multiple linear regression, Principal Components Analysis (PCA), and Detrended Correspondence Analysis (DCA). Multiple linear regression determines the relationship between independent and dependent variables (Drennan 2009). PCA reduces the variability along multiple dimensions to explore how there might be co-variation in values across dimensions (Drennan 2009). DCA is an ordination technique that takes into account the problems of Correspondence Analysis such as the arch effect and the compression of the end of the axis (Hill and Gauch 1980). DCA corrects the problems of Correspondence Analysis (Hill and Gauch 1980).

Using regression analysis, PCA, and DCA, I evaluated the degree to which the presence of sherds in the location of deposits correlates with local environments (and thus are related to resources) based on subsistence information that is known from the deposits. My data for these analyses included nominal, ordinal, interval, and ratio measures of thickness, shape, orifice diameter, rim sherd percent of vessel, rim form shape, lip shape, lip lateralization, surface finish, decorations, temper material type, temper density, temper size, temper shape, color, firing atmosphere, hardness, and temper sorting. I also generated data related to deposit location that varies due to the environment. The dimensions of measurement related to deposit location includes: distance to water resources, distance to potential clay sources, and distance to fuel sources. These statistical tests examined the frequency of pottery classes as a function of distance to a resource. An example of the use of regression analysis on pottery is comparing the pottery to the distance from a source (Orton 1980). For the data that I was unable to use regression analysis, I utilized DCA. This statistical analysis allows for the use of nominal data and data with values of zero.

To look at spatial patterns, I utilized Geographic Information Systems (GIS) to analyze the spatial distribution of the ceramic-bearing deposits in relation to the local environment. To produce prehistoric ceramics, populations needed access to water, clay, and fuel. Proximity to water is an important factor in the location of ceramic archaeological deposits. Water is necessary for not only subsistence but also in the production of ceramics. In terms of the production of ceramic vessels, sediments containing clay are vital, because ceramics are made from clay. Further, access to fuel resources is necessary in order to fire clay into a ceramic state. The environmental factors that I examined included elevation, sediment, historic vegetation, and historic hydrology. In order to calculate the proximity to these resources, I utilized the near tool to polygon in ArcGIS. This tool uses the site location as the point, and calculates the proximity to the nearest resources. In this method, the distance is calculated to the nearest polygon vertex.

I then developed a GIS predictive model to determine the areas containing all resources necessary for ceramic production. In this model, I assigned rankings to each environmental factor to create a weighted map to determine potential locations for ceramic production materials. First, I georeferenced historic maps from USGS (2017) and digitized historic waterways, including marshes, bays, streams, and rivers. The historic maps I utilized varied in scale, however based on availability, I employed maps with the smallest scale available, generally 1: 24,000. I treated locations with <1km of freshwater as “high,” distance of 1.1-2km as “medium,” and any distance >2km as “low.”

Previous research (Griset 1990; Rogers 1936) infers that pre-contact populations utilized oak bark as a fuel to fire ceramics. But, this may not be the case as harder woods, such as oak wood are more likely to burn slowly and create the higher temperatures needed for firing pottery (Shepard 1956). It is a possibility that pottery was fired using brush, as this can create low uncontrolled firing atmospheres for the ceramics (Eerkens 2001). To look for potential fuel, such as wood, I used historic vegetation data from LANDFIRE, a shared program with the U.S. Department of Agriculture Forest Service and U.S. Department of the Interior (2013). In this context, the term historic refers to vegetation data that is based on pre-European settlement (U.S. Department of Interior 2013). It was created based on current environmental factors and the estimation of historic disturbance (U.S. Department of Interior 2013). The LANDFIRE dataset is a raster with a 30m resolution. In my model, I used this data to rank areas that contained high quantities of fuel material as high, areas with limited access to potential fuel sources were ranked as medium, while areas without access to fuel resources I ranked as low. High areas included densely wooded and shrubland regions, while medium consisted of somewhat wooded and shrubland regions, and low consisted of regions barren of vegetation.

I obtained soil data from SSURGO (USDA 2014) to determine information about local sediment. I ranked sediments with clay content as high, sediments with lesser quantities of clay as medium, and sediments with no clay content as low. A major issue with the SSURGO dataset is that it does not have data for a large portion of Los Angeles County and a few other regions within my study area (Figure 29). While other data sources, such as STASGO were available, the scale of 1: 250,000 was too small for this type of analysis (USDA 2014). SSURGO has a scale of between 1:12,000 to 1: 63,360 (USDA 2014).

Finally, I acquired Digital Elevation Models (DEMs) of the southern California region. This dataset was created in 2013 and has a $^{1}/_{3}$ arc-second resolution. I used the mosaic tool to combine the DEMs and then calculated the percent slope. I ranked slopes of 20% or less as high, slopes of greater than 20% as medium, and slopes of 40% or greater as low. I used slopes of 20% or less as high because generally archaeological sites are less common on steeper slopes.

I then combined these rankings in GIS through applying the weighted sum tool. I equally weighted each dataset to create the predictive model. I chose to do an equal weighted sum because each dataset is significant in site location and ceramic production. By unequally weighing one dataset over another, potential bias could be created in the output results.

It is important to note that there may be errors associated with the datasets I utilized in my analysis. The digitized waterways may contain errors related to digitizing, scale, georeferencing, and the various production years of the historic maps. There is also error associated with the LANDFIRE vegetation dataset because it was created using a predictive landscape model, (U.S. Department of Interior 2013) however there is no way to fully identify the vegetation on the prehistoric landscape due to urbanization and land changes. Further, I also implemented subjective rankings to these datasets, which can cause errors and biases in the results. Although there are many potential errors associated with this predictive model, it has the ability to tell us about the relationship between ceramics and the environmental factors needed to produce pottery. Further, we can compare the results of this predictive model to known locations of ceramic deposits and determine if these environmental factors impact the spatial distribution of vessel ceramic deposits.

TABLE 7. Ceramic Production Resources Proximity Predictive Model Steps

Step	*Description*
1. DEM	Acquire and mosaic DEMs for Santa Barbara, Ventura, Los Angeles, and Orange Counties from USGS.
2. Soil Data	Acquire soil data from SSURGO (USDA 2014).
3. Hydrology Data	Acquire historic maps from USGS (USGS 2017) and digitize streams bays, and marshes.
4. Historic Vegetation Data	Acquire from USGS LANDFIRE (U.S. Department of Interior 2013).
5. Calculate Slope	Use the slope tool to calculate slope percentage, reclassify, and rank the slope.
6. Rank Soil	Reclassify and rank the soil based on clay content.
7. Rank Hydrology	Utilize Euclidean distance to reclassify and rank hydrology data.
8. Rank Vegetation	Convert vector to raster data. Rank and reclassify vegetation based on wood and shrub content.
9. Weighted Sum	Apply equal weighted sum to combine the rankings.

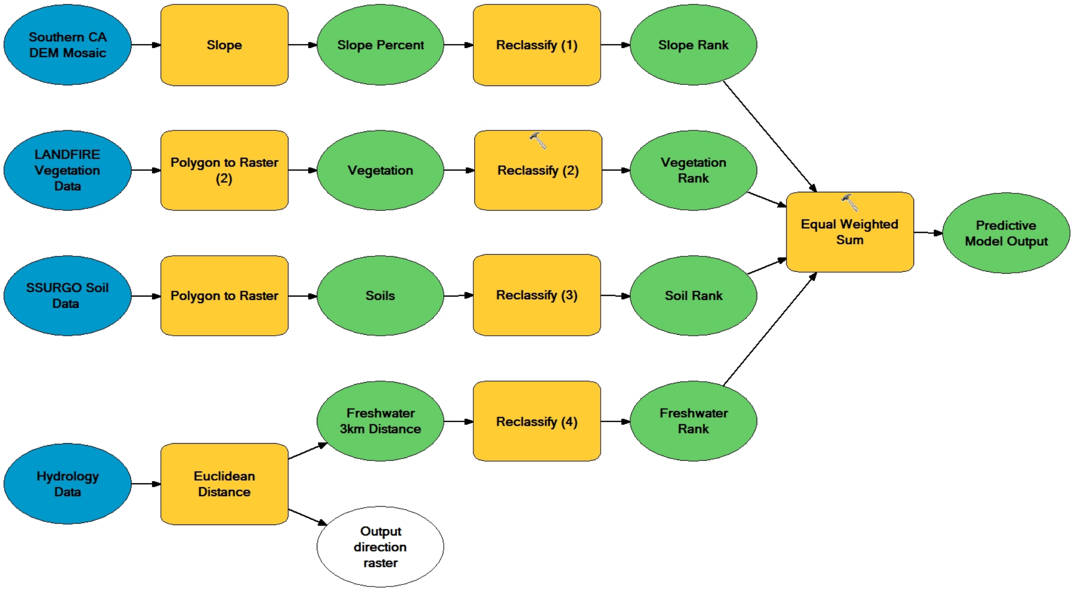


FIGURE 13. Spatial model of GIS steps for predictive model.

CHAPTER 7

RESULTS

Two major limitations exist for studying the ceramics of southern California: small sample size for assemblages and the relative plainness of the ware. The first limitation makes it difficult to statistically evaluate descriptions of assemblages. The second limitation restricts our studies to primarily analogous similarity. While the latter issue challenges our ability to creatively consider ways of describing ceramics in stylistic terms (*sensu* Dunnell 1978), the former issue can be somewhat mitigated by measuring whole assemblages whenever possible. As can be seen in Table 8, in my study I sampled a total of 505 sherds from ten archaeological deposits. Most of the sherds sampled are plain body sherds. I had access to only 24 rim sherds for analysis. Unfortunately, while body sherds provide information about the overall vessel shape and form, rim sherds provide the additional detail about the use of vessels since the opening is the means of access to the interior contents. In terms of future research, a larger sample size with greater numbers of rim sherds would greatly aid our understanding of vessel ceramics of southern California.

TABLE 8. Ceramics Sampled

Deposit	*Rim Sherds*	*Neck Sherds*	*Body Sherds*	*Total Sherds Sampled*
CA-LAN-270	3	5	42	50
CA-LAN-306	0	0	1	1
CA-LAN-696	0	0	8	8
CA-LAN-2630	7	6	240	253
CA-ORA-13B	5	2	39	46
CA-ORA-76	2	0	3	5
CA-ORA-196	1	2	19	22
CA-ORA-414B	0	0	13	13
CA-ORA-855	4	1	56	61
CA-ORA-910A	2	0	44	46
Total	24	16	465	505

The measurements I took include: thickness, shape, orifice diameter, rim sherd percent of vessel, rim form shape, lip shape, lip lateralization, surface finish, decorations, temper material type, temper density, temper size, temper shape, color, firing atmosphere, hardness, and temper sorting (Tables 5 and 6). The results of these analyses are below.

7.1 Thickness

Thickness is a property that directly impacts cost, durability, and function of pottery. Thick walls are more durable than thin walled vessels, making them more resistant to shock (Eerkens 2001). Thick walled vessels are heavier than vessels with thinner walls, which may reflect their potential functions. Thinner walled vessels are lighter for transportation, but thicker walled vessels can withstand mechanical strength, making them ideal for processing/serving (Eerkens 2001). Thinner walled vessels are generally weaker overall, but less affected by thermal stress and thinner walls transmit heat proficiently (Lawrence and West 1982). In my data sample, the majority of the sherds had a thickness of around 5mm. The thicknesses of pottery sherds range from 2mm to 11mm. Figure 14 suggests that the thickness of around 5mm is the modal thickness for pottery in this region and is a functional attribute. Figure 14 below shows the frequency of thickness for all pottery sherds and it has a slightly positive skew, meaning pottery thickness is skewed thicker. It is a possibility that there is a tendency to make vessels thicker, but these vessels may also have been larger pots. This is difficult to determine, as only seven sherds were large enough to calculate vessel shape (Table 10).

7.2 Morphology

The results for the morphology were limited since sherds in my sample deposits were relatively small in size. The smallest sherds in my sample were 1cm in size. Only seven sherds

TABLE 9. Mean, Median, and Mode of Thickness (mm) of Rim Sherds

Deposit	*Mean (mm)*	*Standard Deviation*	*Median (mm)*	*Mode (mm)*
LAN-270	5.96	0.84	5.9	4.86, 5.15, 5.90, 6.57, and 6.81
LAN-306	-	-	-	-
LAN-696	8.38	1.95	8.23	-
LAN-2630	5.65	1.34	5.45	5.45, 5.50, and 6.22
ORA-13B	5.65	1.35	5.29	5.13 and 5.58
ORA-76	6.65	1.29	7.03	-
ORA-196	5.72	1.22	5.34	6.26
ORA-414A/B	5.50	0.56	5.46	5.46
ORA-855	5.12	0.82	5.10	4.29
ORA-910A	5.06	0.79	4.95	4.55
Overall Sample	5.62	1.27	5.41	5.50

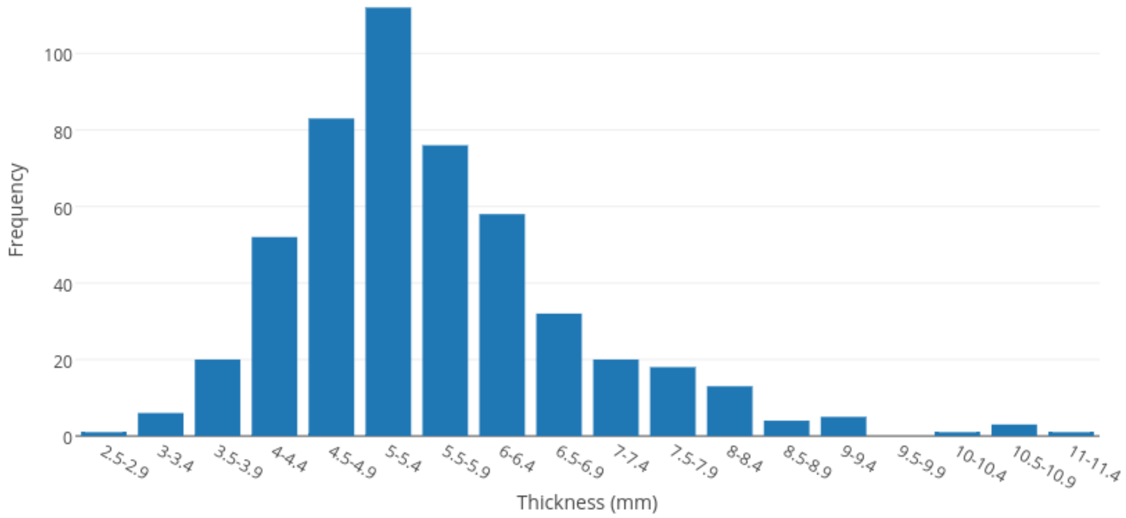


FIGURE 14. Histogram of thickness for southern California deposit sherds.

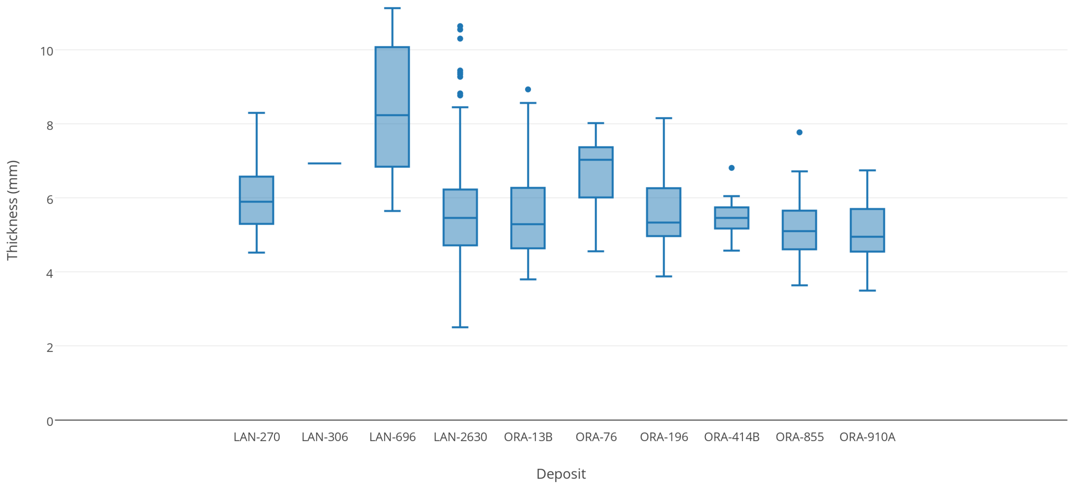


FIGURE 15. Box-and-whisker plot of thickness for southern California deposit sherds.

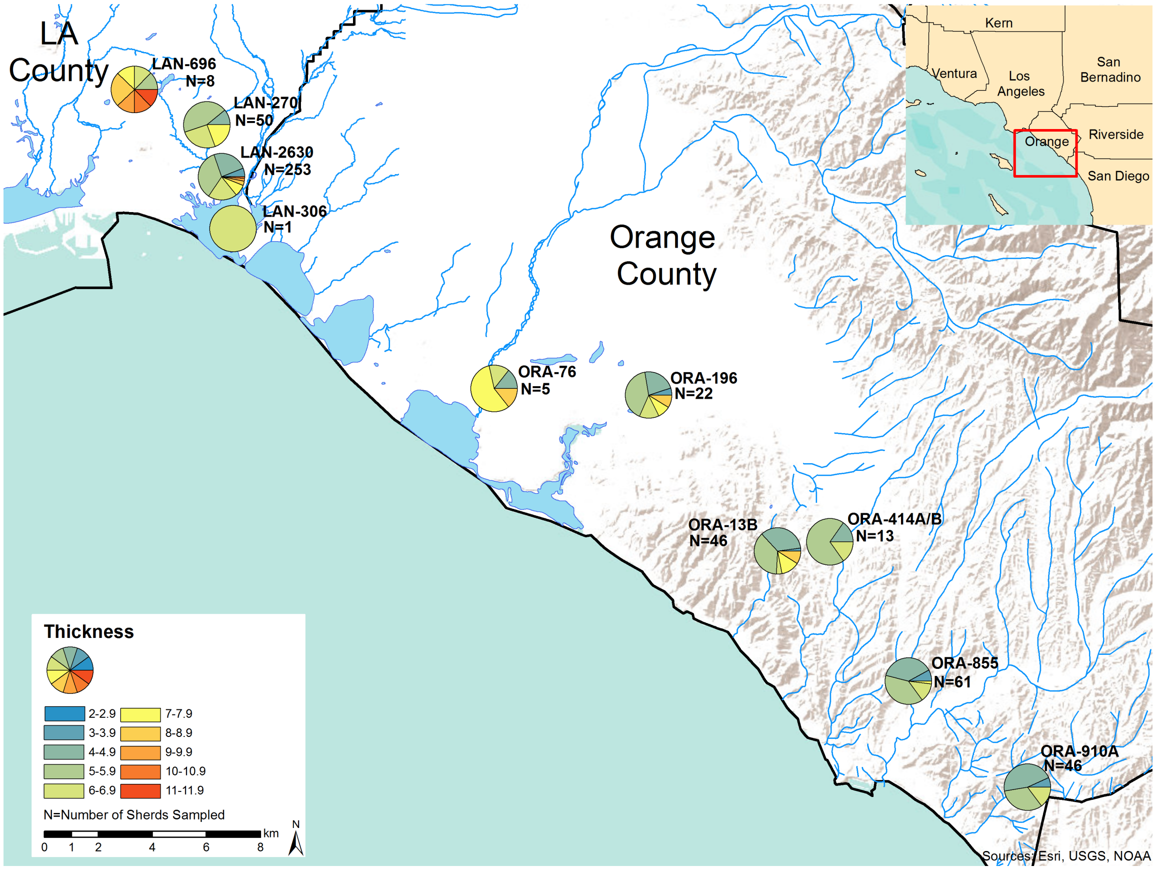


FIGURE 16. Spatial distribution of thickness for ceramic deposits.

(N=7) were large enough (greater than 6cm in size) to make the measurements necessary to calculate parent vessel shape using the Two-Curvature Method. Further, given the small sizes of the sherds there is error associated with these results as a result of the measurement of curvature. The majority of the sherds were globular in shape (Table 10).

TABLE 10. Parent Vessel Shape Calculated from the Two-Curvature Method

Deposit	*Mean Ratio*	*Estimated Parent Shape*	*Standard Deviation*	*Mode*
CA-LAN-270	0.45	Globular	0.08	0.39 and 0.42
CA-LAN-270	1.05	Globular/Ovaloid	0.21	1 and 1.15
CA-LAN-696	0.87	Globular	0.07	0.86 and 0.89
CA-ORA-13B	0.99	Globular/Ovaloid	0.10	0.89 and 1.03
CA-ORA-13B	1.00	Globular/Ovaloid	0.07	1.01
CA-ORA-13B	0.85	Globular	0.04	0.84
CA-ORA-910A	1.32	Ovaloid	0.17	1.21

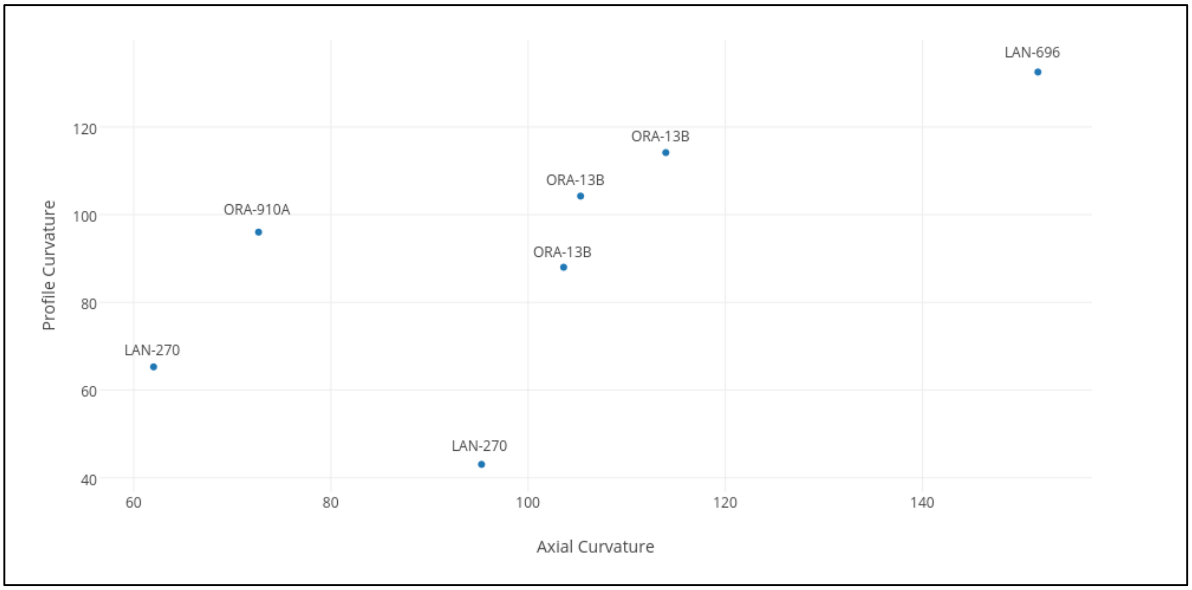


FIGURE 17. Graph of profile and axial curvature calculated from the Two-Curvature Method.

7.3 Rim Data

Descriptions of rim shape, form, and orifice diameter variability can be used to infer vessel function. Rim data for the 24 rim sherds that I described are shown in Tables 11 and 12.

Compared to the other sampled ceramic assemblages, CA-LAN-270 contains vessels with the smallest orifice diameter. In the deposits other than CA-LAN-270, orifice diameters range from small (i.e., 13cm) to large (i.e., 26cm). According to Griset (1996), one possible reason for this small orifice diameter is that the CA-LAN-270 ceramics served as mortuary urns, a distinct possibility given the presence of human remains and cremations within the deposit. However, small diameter openings are not necessarily connected to mortuary practices and none of the examples of ceramics were found in direct association with the human remains as burial artifacts.

In each deposit, the rim form shapes, lip shape, and lip lateralization (defined in figures 9, 10, and 11) were 100% homogeneous for sherds from the deposits CA-LAN-270, CA-ORA-76, and CA-ORA-910A. The rim form shapes, lip shape, and lip lateralization were 70% homogenous for CA-LAN-2630 and relatively homogenous for the deposits CA-ORA-13B and CA-ORA-855 (Table 11).

Per Griset (1996), direct and recurved rims are found on bowls, while recurved rims are associated with storage containers, cooking vessels, and water vessels. Eerkens (2001) states that storage and transport containers generally have incurved/recurved rims while serving containers such as bowls and cooking vessels have direct rims. The direct rim allows for easier use of the vessel in terms of serving and cooking because this rim type allows for easier access to the contents inside (Eerkens 2001). In general, smaller orifices are typically associated with storage vessels since the restriction of access increases the performance of this function (Rice 2015; Smith 1985). Similarly, larger diameter openings are often linked to cooking or serving vessels (Rice 2015; Smith 1985).

Overall, it appears that the orifice diameter and rim form vary in the different ceramic deposits sampled (Tables 11, 12, and Figure 19). Based on the inferred functions of the pottery,

TABLE 11. Summary of Rim Data from Southern California Deposit Sherds

Deposit	*Orifice Diameter (cm)*	*Sherd Percent of Vessel*	*Rim Form Shape*	*Lip Shape*	*Lip Lateralization*	*Inferred Function(s)*
CA-LAN-270	11	12%	Recurved	Rounded	Interior	Storage or Transport
CA-LAN-270	12	5%	Recurved	Rounded	Interior	Storage or Transport
CA-LAN-270	12	8%	Recurved	Rounded	Interior	Storage or Transport
CA-LAN-2630	20	1%	Direct	Rounded	Interior	Serving or Cooking
CA-LAN-2630	18	2%	Direct	Rounded to Flat	Interior	Serving or Cooking
CA-LAN-2630	21	3%	Direct	Rounded	Interior	Serving or Cooking
CA-LAN-2630	20	1.5%	Direct	Rounded	Interior	Serving or Cooking
CA-LAN-2630	23	1.5%	Direct	Rounded	Interior	Serving or Cooking
CA-LAN-2630	13	3%	Direct	Rounded to Flat	Even	Storage, Serving, or Cooking
CA-LAN-2630	23	2%	Direct	Rounded	Interior	Serving or Cooking
CA-ORA-13B	26	2.5%	Recurved	Rounded to Flat	Even	Storage, Transport, or Cooking
CA-ORA-13B	24	5.5%	Recurved	Flat	Exterior	Storage, Transport, or Cooking
CA-ORA-13B	24	5.5%	Recurved	Round	Even	Storage, Transport, or Cooking
CA-ORA-13B	20	6.5%	Recurved	Rounded to Flat	Even	Storage, Transport, or Cooking
CA-ORA-13B	20	11.5%	Recurved	Rounded to Flat	Even	Storage, Transport, or Cooking
CA-ORA-76	15	3%	Direct	Round	Interior	Serving or Cooking
CA-ORA-76	18	2%	Direct	Round	Interior	Serving or Cooking
CA-ORA-196	24	2%	Recurved	Rounded to Flat	Interior	Storage, Transport, or Cooking
CA-ORA-855	17	5%	Direct	Flat to Rounded	Interior	Serving or Cooking
CA-ORA-855	19	2.5%	Recurved	Flat	Interior	Storage, Transport, or Cooking
CA-ORA-855	19	3%	Direct	Rounded	Even	Serving or Cooking
CA-ORA-855	20	3.5%	Direct	Flat	Interior	Serving or Cooking
CA-ORA-910A	14	4%	Direct	Round	Interior	Serving or Cooking
CA-ORA-910A	17	5%	Direct	Round	Interior	Serving or Cooking

TABLE 12. Mean, Median, and Mode of Orifice Diameter of Rim Sherds

Deposit	*Mean (cm)*	*Median (cm)*	*Mode (cm)*
LAN-270	11.67	12	12
LAN-2630	19.71	20	20 and 23
ORA-13B	22.8	24	20 and 24
ORA-76	16.5	16.5	-
ORA-196	-	-	-
ORA-855	18.75	19	19
ORA-910A	15.5	15.5	-
Overall Sample	18.75	19.50	20

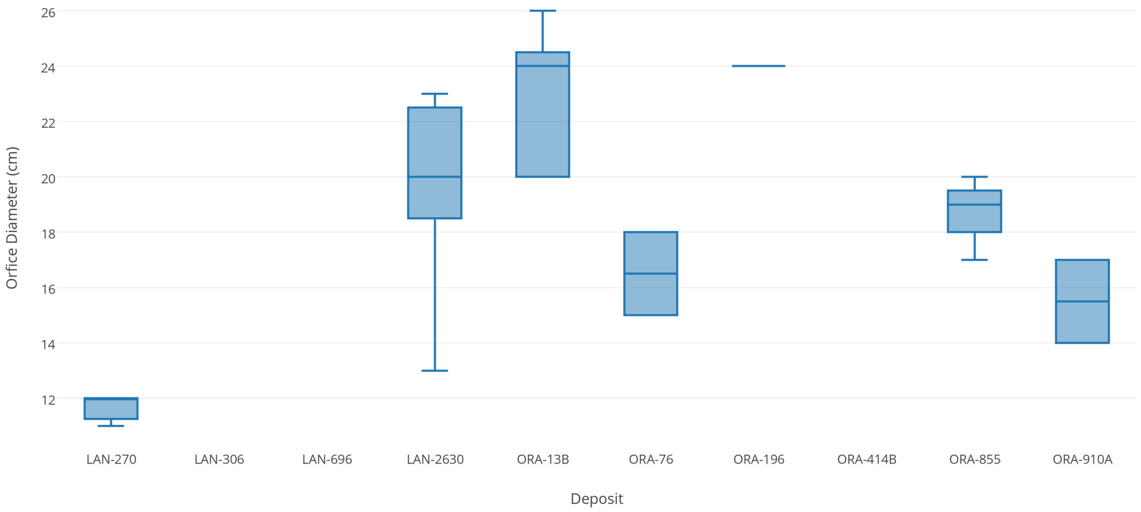


FIGURE 18. Box-and-whisker plot of orifice diameter from rim sherds.

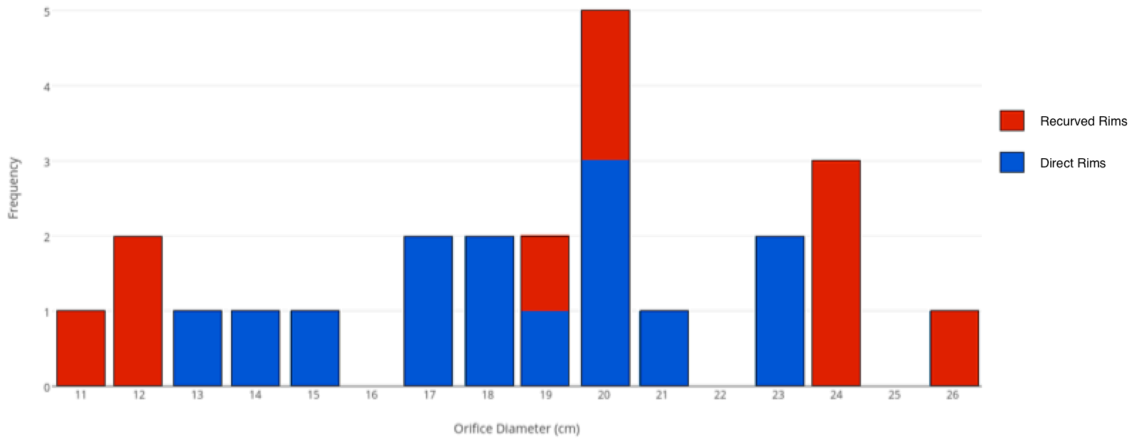


FIGURE 19. Histogram of orifice diameter and rim form shape for southern California deposit sherds.

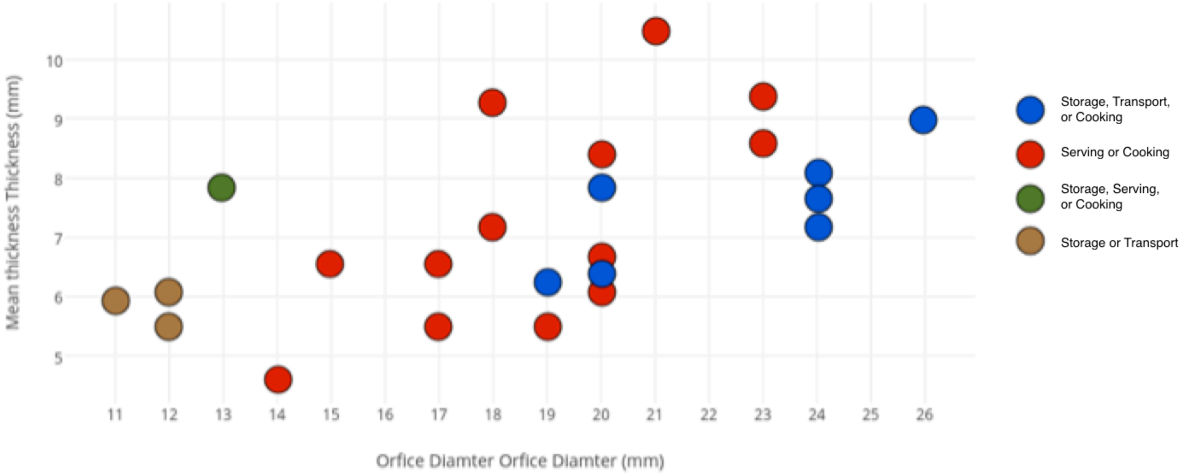


FIGURE 20. Scatterplot of thickness, orifice diameter, and inferred function(s) for southern California deposit sherds.

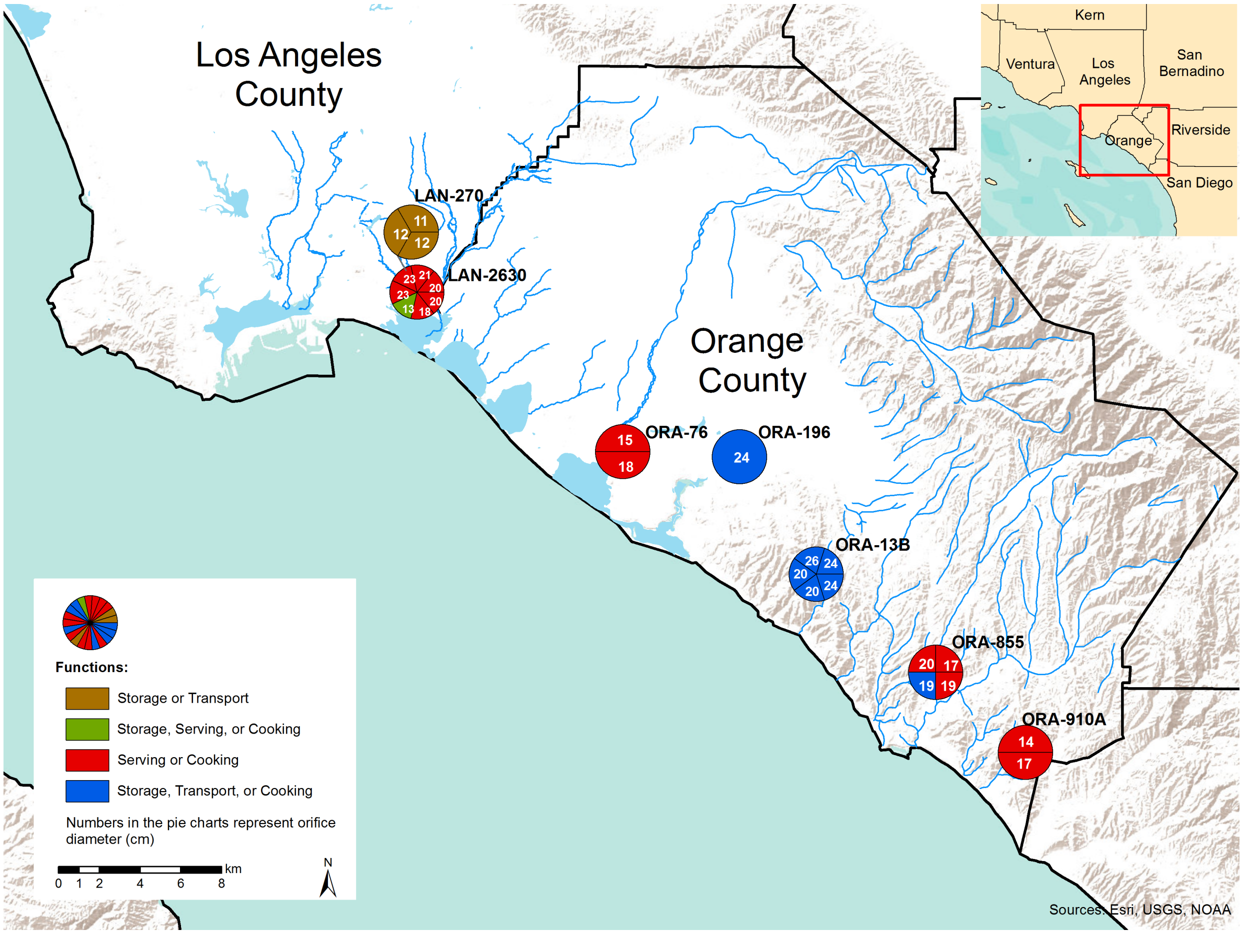


FIGURE 21. Spatial distribution of orifice diameters and inferred vessel function(s).

the majority of vessels were inferred to be serving or cooking vessels. Storage and transport vessels were also found in the assemblages. For a percentage of the rim sherds (>33%), it was difficult to infer functions because they had multiple attributes that could correlate to a variety of functions such as small orifice diameter with a direct rim form or large orifice diameter and a recurved rim form.

7.4 Decoration, Modifications, and Production

Based on the patterns of breakage and the surface impressions, most (>90%) of ceramic sherds in the sample appear to have been produced using paddle-and-anvil technique. As can be seen in Table 13, ceramic sherds from the deposit of CA-ORA-13B appear to have been polished on the exterior, this is an attribute of post-contact ceramics. Few sherds have incisions on their exterior/interior as well as fingerprints. It is unclear if the incisions and fingerprints are decorations or occurred unintentionally during pottery production.

Prehistorically we know that asphaltum was used to repair cracks or weaknesses of ceramic vessels (Griset 1996; Rice 2015). Asphaltum appears on twenty-nine (5.7%) of sherds found in the deposits CA-LAN-270, CA-ORA-855, and CA-ORA-910A (Table 14).

Soot is present on some sherds found in nine out of the ten assemblages analyzed. Soot appears mainly on the exterior of vessels, but was also found on the inside of vessels. Thirty-eight (7.5%) of sherds contain soot on the exterior of the vessels, while twenty-two (4.4%) contain soot in the interior. In terms of function, it is reasonable to assume that soot on the exterior is the result of cooking on a fire (Table 14).

7.5 Temper/Inclusions

I noted four major types of inclusions used for temper: quartz/sand, mica, feldspar, and micaceous hematite (Table 15). The CA-LAN-2630 deposit contained nine sherds (3.6% of the LAN-2630 assemblage) that appeared to have fiber temper based on the observation of voids in the paste. It is unclear as to whether the organic fibers were purposefully added to the clay during production or were just accidental. It is possible that organics were added to the clay since vegetable temper can create voids that serve to make ceramics more resistant to cracking and make the overall vessel lighter (Rice 2015). Organic material, however, can also be found naturally in clays in the southern California region since most of the clay comes from alluvial deposits.

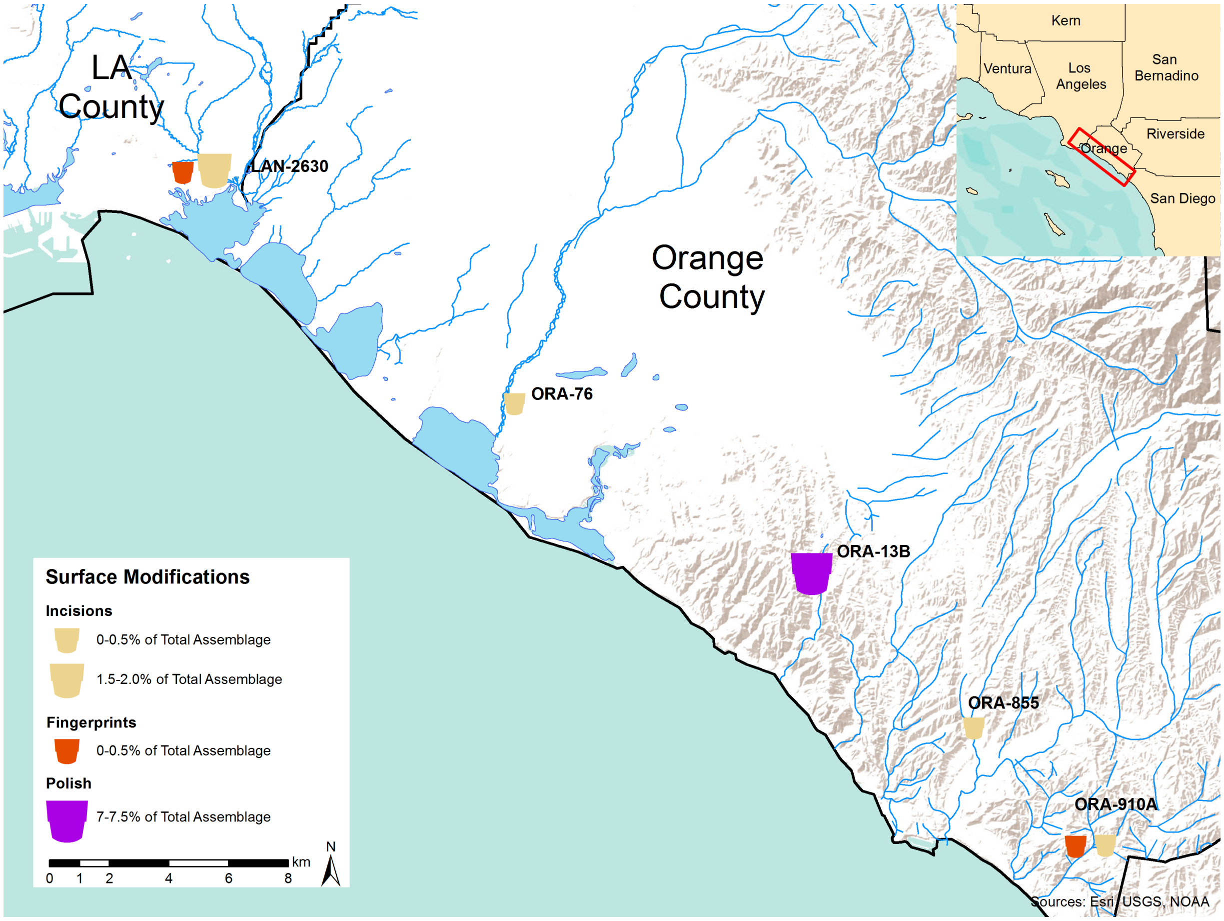
Most (>97%) of the mineral inclusions in the pottery are sub-angular to sub-rounded and are poorly sorted. Inclusion grain size varied from $^{1}/_{16}$ mm to 8mm in each ceramic assemblage

TABLE 13. Summary of Possible Decorations and Surface Modifications from Southern California Deposit Sherds

Deposit	*Incision(s) on Exterior*	*% Incisions on Exterior*	*Incision(s) on Interior*	*% Incisions on Interior*	*Fingerprint on Exterior*	*% Fingerprint on Exterior*	*Fingerprint on Interior*	*% Fingerprint on Interior*	*Polish on Exterior*	*% Polish on Exterior*	*Polish on Interior*	*% Polish on Interior*
LAN-270	0	0%	0	0%	0	0%	0	0%	0	0%	0	0%
LAN-306	0	0%	0	0%	0	0%	0	0%	0	0%	0	0%
LAN-696	0	0%	0	0%	0	0%	0	0%	0	0%	0	0%
LAN-2630	6	2.4%	6	2.4%	0	0%	1 (on rim)	0.4%	0	0%	0	0%
ORA-13B	0	0%	0	0%	0	0%	0	0%	37	80.4%	34	73.9%
ORA-76	1	20%	0	0%	0	0%	0	0%	0	0%	0	0%
ORA-196	0	0%	0	0%	0	0%	0	0%	0	0%	0	0%
ORA-414B	0	0%	0	0%	0	0%	0	0%	0	0%	0	0%
ORA-855	2	3.3%	0	0%	0	0%	0	0%	0	0%	0	0%
ORA-910A	1	2.1%	0	0%	0	0%	1	2.1%	0	0%	0	0%
Total	10	1.98%	6	1.19%	0	0%	2	0.4%	37	7.33%	34	6.73%

TABLE 14. Summary of Presence of Asphaltum and Soot on Sherds from Southern California Deposit Sherds

Deposit	*Asphaltum Present on Exterior*	*% of Asphaltum Present on Exterior*	*Asphaltum Present on Interior*	*% of Asphaltum Present on Interior*	*Soot Present on Exterior*	*% of Soot Present on Exterior*	*Soot Present on Interior*	*% of Soot Present on Interior*
CA-LAN-270	11	22%	7	14%	1	2%	1	2%
CA-LAN-306	0	0%	0	0%	0	0%	0	0%
CA-LAN-696	0	0%	0	0%	3	37.5%	2	25%
CA-LAN-2630	0	0%	0	0%	4	1.58%	1	0.4%
CA-ORA-13B	0	0%	0	0%	15	32.61%	0	0%
CA-ORA-76	0	0%	0	0%	1	20%	1	20%
CA-ORA-196	0	0%	0	0%	2	9.09%	1	4.55%
CA-ORA-414B	0	0%	0	0%	0	0%	4	30.77%
CA-ORA-855	6	9.84%	2	3.28%	3	4.92%	1	1.64%
CA-ORA-910A	2	4.35%	1	2.17%	9	19.57%	11	23.91%
Total	19	3.76%	10	1.98%	38	7.52%	22	4.37%



Sources: Esri, USGS, NOAA

FIGURE 22. Spatial distribution of surface modifications on ceramic deposits.

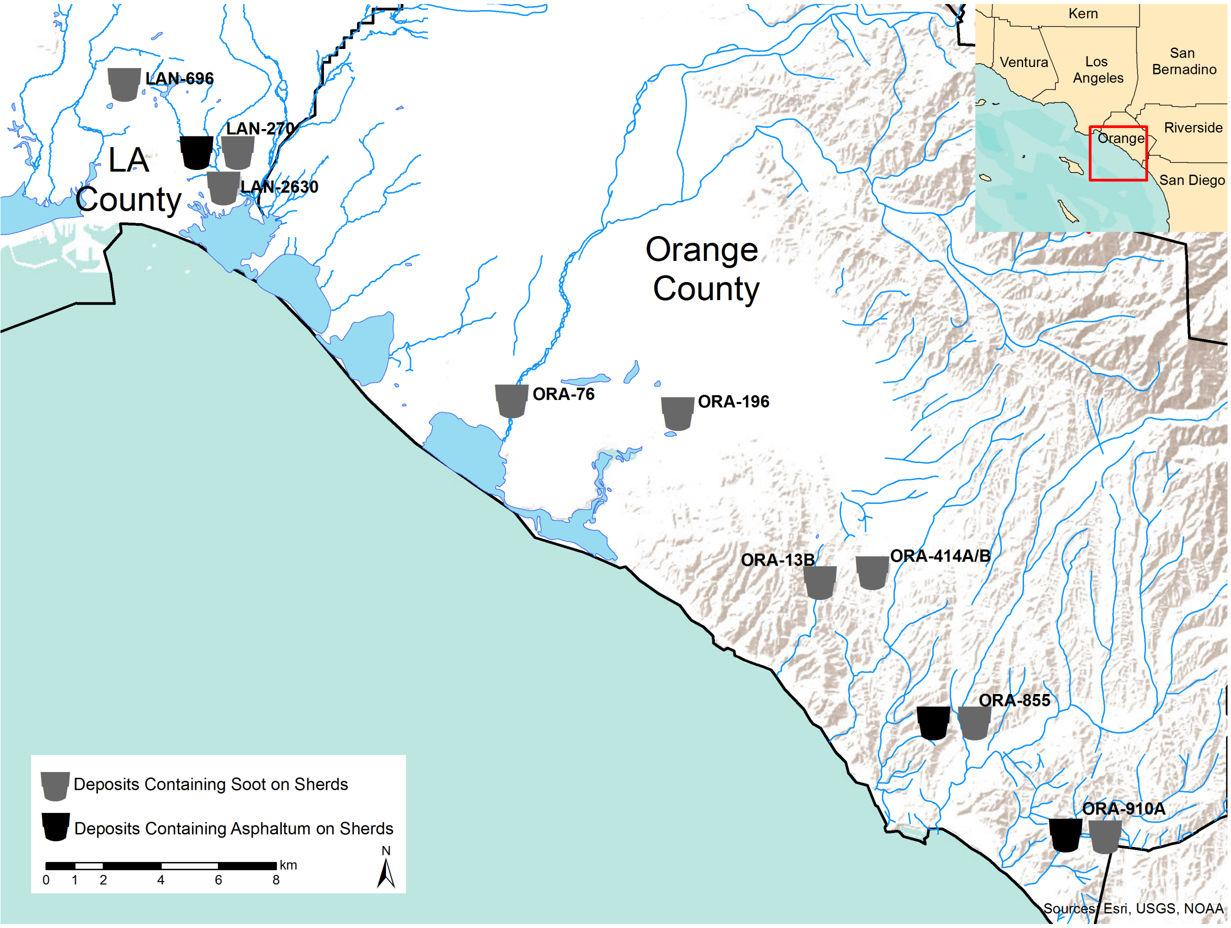


FIGURE 23. Spatial distribution of soot and asphaltum on ceramic deposits.

(Table 16). It is unclear as to whether the inclusions in the pottery were added to the clay or found naturally. Based on my observations, quartz, mica, feldspar, and hematite were found as a temper at nearly every deposit (Table 15). It does appear that select sherds have denser and larger inclusions compared to others. According to Rice (2015), mica inclusions are found commonly in pottery. The presence of mica in pottery could had been the result of utilizing micaceous clay or using temper made from micaceous rocks (Rice 2015; Shepard 1976). Quartz and sand can also be found naturally in clay deposits (Rice 2015). Further, feldspar is commonly found in ceramics both naturally or as added temper (Rice 2015). According to Rice (2015), a means of improving thermal stress resistance is through having inclusions that thermally expand similarly to the clay, one example of a temper type that does this is quartz.

TABLE 15. Summary of Inclusions in Sherds from Southern California Deposits

Deposit	*Quartz*	*Sand*	*Mica*	*Feldspar*	*Micaceous Hematite*	*Fiber*	*Unidentifiable Red Inclusions*
CA-LAN-270	X	X	X	-	-	-	-
CA-LAN-306	X	X	X	X	-	-	-
CA-LAN-696	X	X	X	X	X	-	-
CA-LAN-2630	X	X	X	X	X	X	-
CA-ORA-13B	X	X	X	X	X	-	-
CA-ORA-76	X	X	X	X	X	-	-
CA-ORA-196	X	X	X	X	X	-	-
CA-ORA-414B	X	X	X	X	-	-	-
CA-ORA-855	X	X	X	X	X	-	X
CA-ORA-910A	X	X	X	X	X	-	-

7.6 Patterns of Oxidation/Reduction

Based on my observations of 505 total sherds, 367 (72.7%) of the sherds from the ceramic deposits had firing conditions that led to the interiors of the vessels to be reduced. These sherds have interior colors that are gray and black. Interestingly, the sherds that come from vessels that were fired in a reduced atmosphere are generally harder than those from oxidizing environments (Tables 17, 18, and 19) and thus stronger. 126 (25%) of the sherds were in firing conditions that led to the interiors of the vessels to be oxidized. Overall, the exteriors of the sherds were oxidized (254 sherds, 50.3%) though some were reduced (224 sherds, 44.4%). The colors of the exteriors of the sherds are primarily reds and browns, indicating that the vessels from which the sherds are derived were exposed to oxygen. Since the interiors were deprived of oxygen, it is likely that the vessels were fired upside down or covered (Boxt and Dillon 2013). The core cross sections from the deposits vary in oxidation and reduction patterns from oxidized with no core, reduced with no core, half oxidized and half reduced, oxidized core, and reduced core. This pattern of coloration could be the result of different firing stages that influenced how the firing heat permeated the vessel wall (Orton and Hughes 2013). Overall, the majority of the ceramics from these deposits appear to have been fired in relatively low temperature environments that were poorly controlled.

TABLE 16. Summary of Inclusions Sizes in Sherds from Southern California Deposits

Deposit	*Very Fine Sand (1/16-1/8 mm)*	*Fine Sand (1/8-1/4 mm)*	*Medium Sand (1/4-1/2 mm)*	*Coarse Sand (1/2-1 mm)*	*Very Coarse Sand (1-2 mm)*	*Fine Pebble (2-4 mm)*	*Medium Pebble (4-8 mm)*
CA-LAN-270	X	X	X	X	X	-	-
CA-LAN-306	X	X	X	X	-	-	-
CA-LAN-696	X	X	X	X	X	X	X
CA-LAN-2630	X	X	X	X	X	X	X
CA-ORA-13B	X	X	X	X	X	X	-
CA-ORA-76	X	X	X	X	X	-	-
CA-ORA-196	X	X	X	X	X	X	-
CA-ORA-414B	X	X	X	X	X	-	-
CA-ORA-855	X	X	X	X	X	X	X
CA-ORA-910A	X	X	X	X	X	X	-

7.7 Thermal Properties (Hardness)

The hardness of sherds measured on the Moh’s hardness scale, ranges from 1 to 4. Eleven (2.2% of total assemblage) sherds from the CA-LAN-2630, CA-ORA-855, and CA-ORA-910A have a hardness of 1. Hardness values of 2 and 3 were most common (97.4%). The only deposit to have ceramics with a hardness of 4 was CA-ORA-696, a post-contact deposit (0.4%).

TABLE 17. Summary of Exterior Color on Sherds from Southern California Deposits

Color Hue	*Exterior Color*	*LAN-270*	*LAN-306*	*LAN-696*	*LAN-2630*	*ORA-13B*	*ORA-76*	*ORA-196*	*ORA-414B*	*ORA-855*	*ORA-910A*
Gray	Gray				X					X	X
	Reddish Gray				X	X					
	Pinkish Gray										
	Dark Reddish Gray				X	X				X	X
	Dark Gray	X		X	X	X		X	X	X	X
	Very Dark Gray				X		X	X	X	X	X
	Black		X		X					X	X
	Reddish Black									X	
Brown	Brown	X			X	X	X	X	X	X	X
	Light Brown					X	X				
	Grayish Brown	X							X		X
	Dark Grayish Brown										X
	Reddish Brown	X		X	X	X	X	X		X	X
	Dark Reddish Brown									X	
	Yellowish Brown				X						
Red	Red			X							
	Yellowish Red	X									X
	Weak Red				X						

TABLE 18. Summary of Interior Color on Sherds from Southern California Deposits

Color Hue	*Interior Color*	*LAN-270*	*LAN-306*	*LAN-696*	*LAN-2630*	*ORA-13B*	*ORA-76*	*ORA-196*	*ORA-414B*	*ORA-855*	*ORA-910A*
Gray	Gray	X			X					X	X
	Reddish Gray	X			X					X	
	Pinkish Gray										
	Dark Reddish Gray				X	X				X	
	Dark Gray	X		X	X	X	X	X	X	X	X
	Very Dark Gray				X	X	X		X	X	X
	Black		X		X			X		X	X
	Reddish Black										
Brown	Brown				X	X	X	X	X	X	
	Light Brown										
	Grayish Brown	X									
	Dark Grayish Brown							X			X
	Light Reddish Brown						X				
	Reddish Brown	X		X	X	X		X		X	X
	Dark Reddish Brown										
	Yellowish Brown										
Red	Red			X						X	X
	Yellowish Red	X			X						X
	Weak Red									X	

TABLE 19. Summary of Hardness on Sherds from Southern California Deposits

Deposit	*Raw Count with 1*	*Percent of Sherds with Moh's Hardness of 1*	*Raw Count with 2*	*Percent of Sherds with Moh's Hardness of 2*	*Raw Count with 3*	*Percent of Sherds with Moh's Hardness of 3*	*Raw Count with 4*	*Percent of Sherds with Moh's Hardness of 4*
CA-LAN-270	0	0%	46	92%	4	8%	0	0%
CA-LAN-306	0	0%	0	0%	1	100%	0	0%
CA-LAN-696	0	0%	5	62.5%	1	12.5%	2	25%
CA-LAN-2630	7	2.77%	158	62.45%	88	34.78%	0	0%
CA-ORA-13B	0	0%	4	8.7%	42	91.3%	0	0%
CA-ORA-76	0	0%	4	80%	1	20%	0	0%
CA-ORA-196	0	0%	20	90.9%	2	9.1%	0	0%
CA-ORA-414B	0	0%	13	100%	0	0%	0	0%
CA-ORA-855	3	4.92%	38	62.3%	20	32.79%	0	0%
CA-ORA-910A	1	2.17%	21	45.65%	24	52.17%	0	0%
Total	11	2.18%	309	61.19%	183	36.24%	2	0.4%

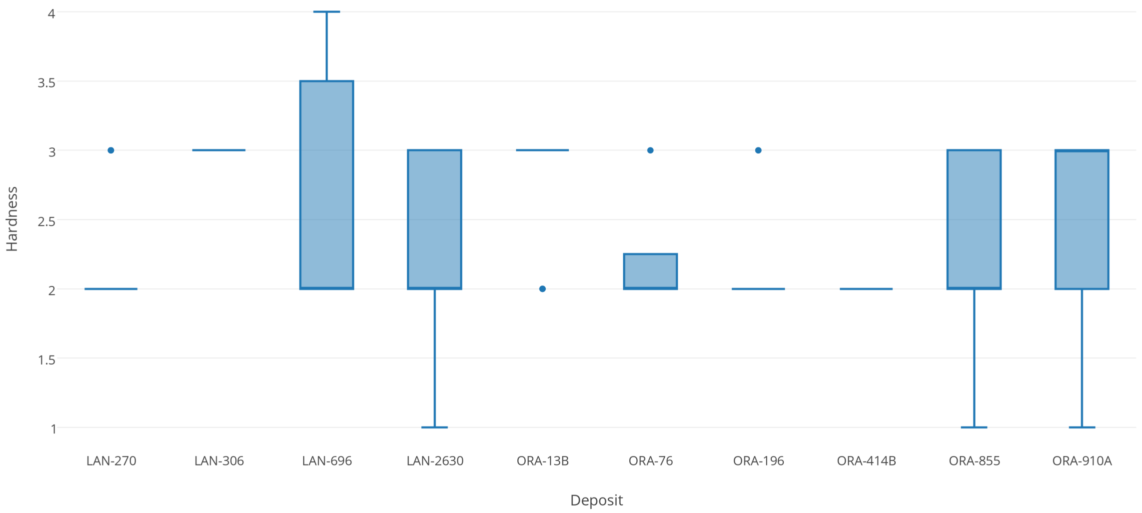


FIGURE 24. Box-and-whisker plot of hardness.

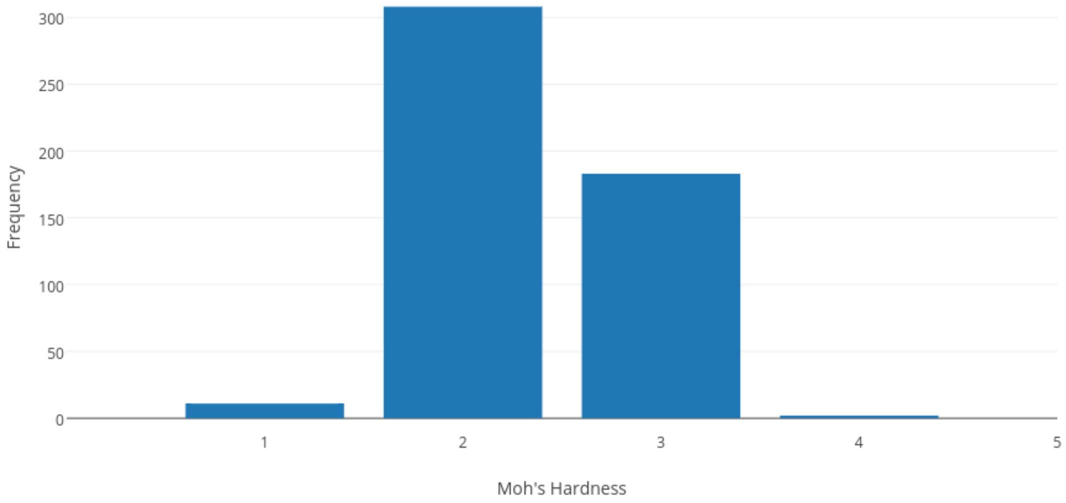


FIGURE 25. Frequency of hardness.

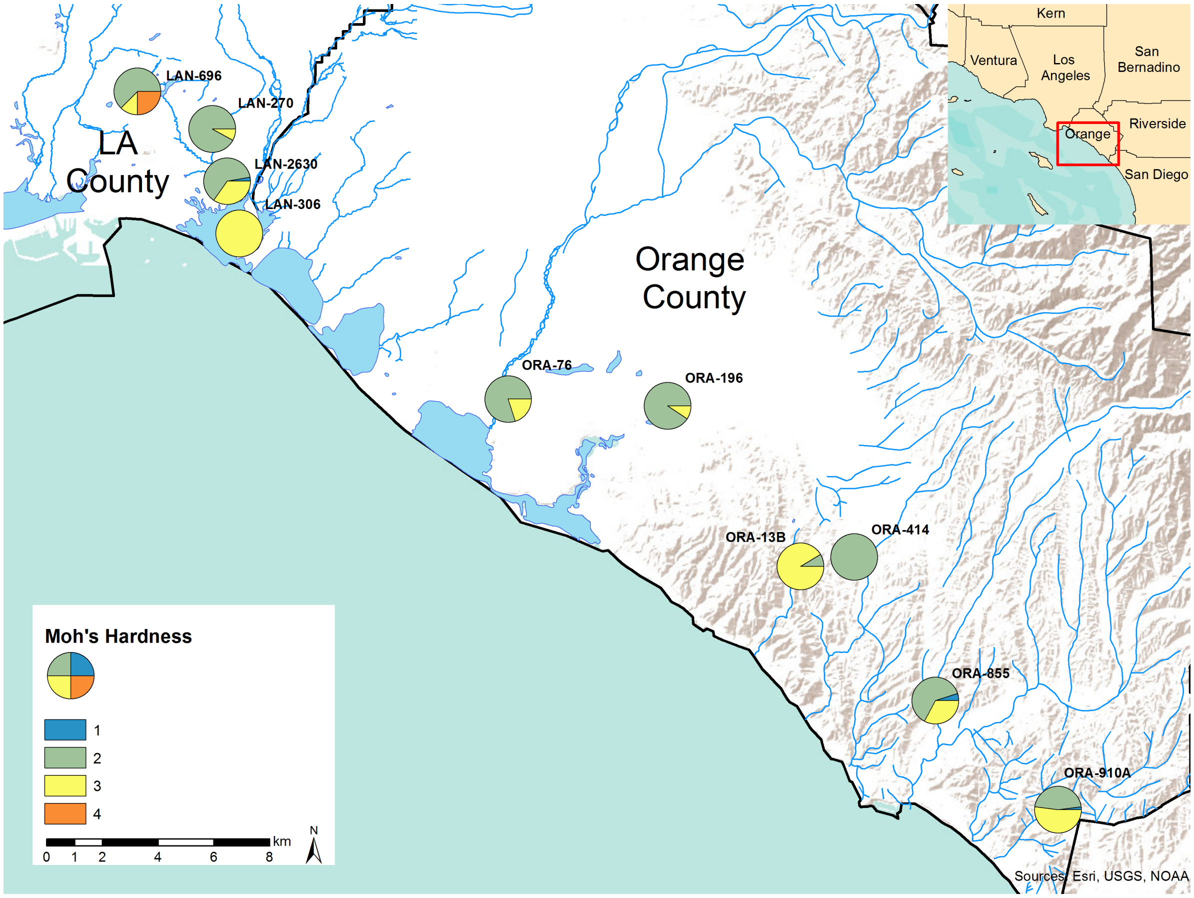


FIGURE 26. Spatial distribution of hardness on ceramic deposits.

7.8 Presence of Groundstone/Basketry

One set of hypotheses for the emergence of ceramics during pre-contact times suggests that vessel ceramics replaced basketry or groundstone containers. Griset (1996) argues that select ceramic types replaced basketry for activities such as cooking, water storage/carrying, and large storage. From my examination of the archaeological evidence, however, vessel ceramics did not completely replace basketry and groundstone industries. Each of the ten deposits that I analyzed contained groundstone artifacts (Table 20).

Based on ethnographic and historic accounts, we know that basketry was widely utilized in both the north and south (Moser 1993; Shanks 2010). Based on these accounts, basketry was utilized for subsistence, food processing, serving, and ceremonial uses (Moser 1993). In northern regions, the Chumash would utilize the plant materials of juncus (specifically *Juncus textilis*, *J. balticas*, and *J. acutus*), tule, sumac, bulrush, and rarely willow to produce basketry (Merrill 1918; Moser 1993; Shanks 2010). According to Moser (1993), in the southern regions, groups such as the Gabrielino, were known as great basket makers. Gabrielino basketry shared similarities with both the Chumash and Luiseño (Moser 1993; Shanks 2010). The Gabrielino would utilize the plant materials of juncus, sumac, deergrass, yucca, hemp, milkweed, and nettle materials (Moser 1992; Shanks 2010). The Luiseño and Juaneño used juncus, sumac, deergrass, and yucca fiber for twined and coiled basketry (Moser 1992; Shanks 2010). Thus, southern prehistoric populations concurrently utilized some form of vessel ceramics, groundstone, and basketry.

7.9 Proximity to Resources

Each ceramic deposit analyzed is within a relatively close distance to freshwater resources, fuel resources, and clay resources. 90% of sites analyzed are within 1km of

TABLE 20. Summary of Presence of Groundstone Materials from Southern California Ceramic Deposits

Groundstone	*Bowls*	*Metates*	*Hammerstones or Manos*	*Pestles*	*Mortars*	*Grinding Slicks/Millingstones*	*Other*
CA-LAN-270	X	-	X	-	X	-	-
CA-LAN-306	X	X	X	X	-	-	-
CA-LAN-696	-	-	X	-	-	-	-
CA-LAN-2630	-	-	X	-	-	-	X
CA-ORA-13B	X	-	X	X	X	-	X
CA-ORA-76	X	-	X	X	-	-	-
CA-ORA-196	X	-	X	-	-	X	-
CA-ORA-414B	X	X	X	X	X	-	-
CA-ORA-855	X	X	X	X	X	-	X
CA-ORA-910A	-	-	X	-	-	-	-

freshwater, fuel resources, and clay resources. Proximity to water is vital in the production of ceramics, food, and living. Both freshwater and saltwater give access to subsistence resources. According to evidence from surrounding regions, its suggested that oak bark was utilized as fuel in the firing of ceramics (Griset 1990; Rogers 1936), but it is possible they utilized hard woods and brush. Certain deposits such as CA-LAN-270 and CA-LAN-2630 used local clays near the deposits to produce pottery.

TABLE 21. Approximate Summary of Distance to Environmental Resources from Ceramic Deposits

Deposit	*Distance to Water (km)*	*Distance to Ocean (km)*	*Distance to Fuel (km)*	*Distance to High Clay Content (km)*
CA-LAN-270	0.2	5.1	0.3	0
CA-LAN-306	0.2	3.7	2.3	0
CA-LAN-696	0.2	8.4	0.1	8.0
CA-LAN-2630	0.1	4.2	0.5	0
CA-ORA-13B	0.2	4.9	0.1	0.9
CA-ORA-76	0.8	4.7	0.2	0
CA-ORA-196	2.7	3.7	0.6	0
CA-ORA-414B	1.0	8.1	0.1	0.2
CA-ORA-855	0.1	6.4	0.2	0.6
CA-ORA-910A	0.2	4.9	0	0

Note: Distance calculated using near tool in GIS.

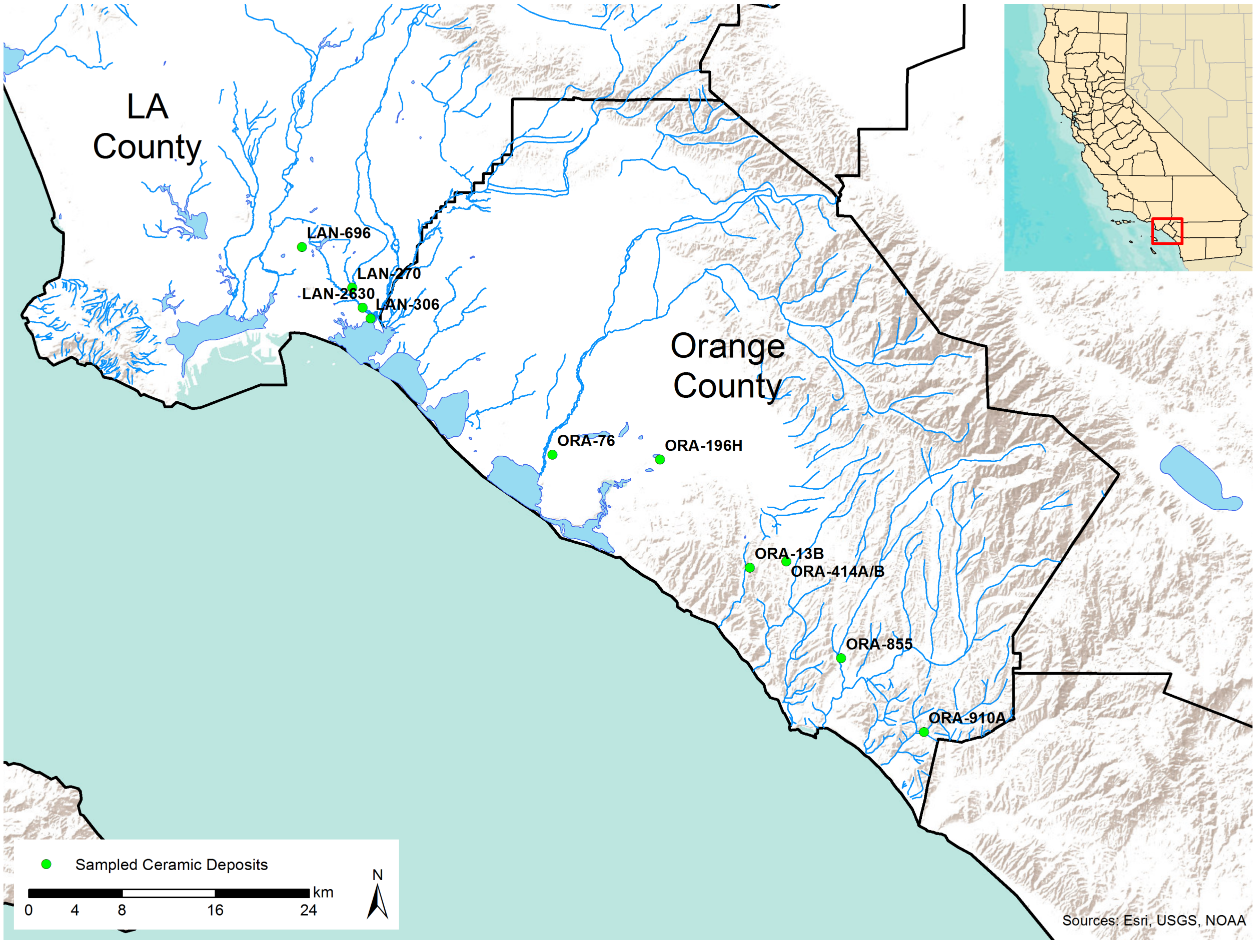


FIGURE 27. Map of water resources and sampled ceramic deposits.

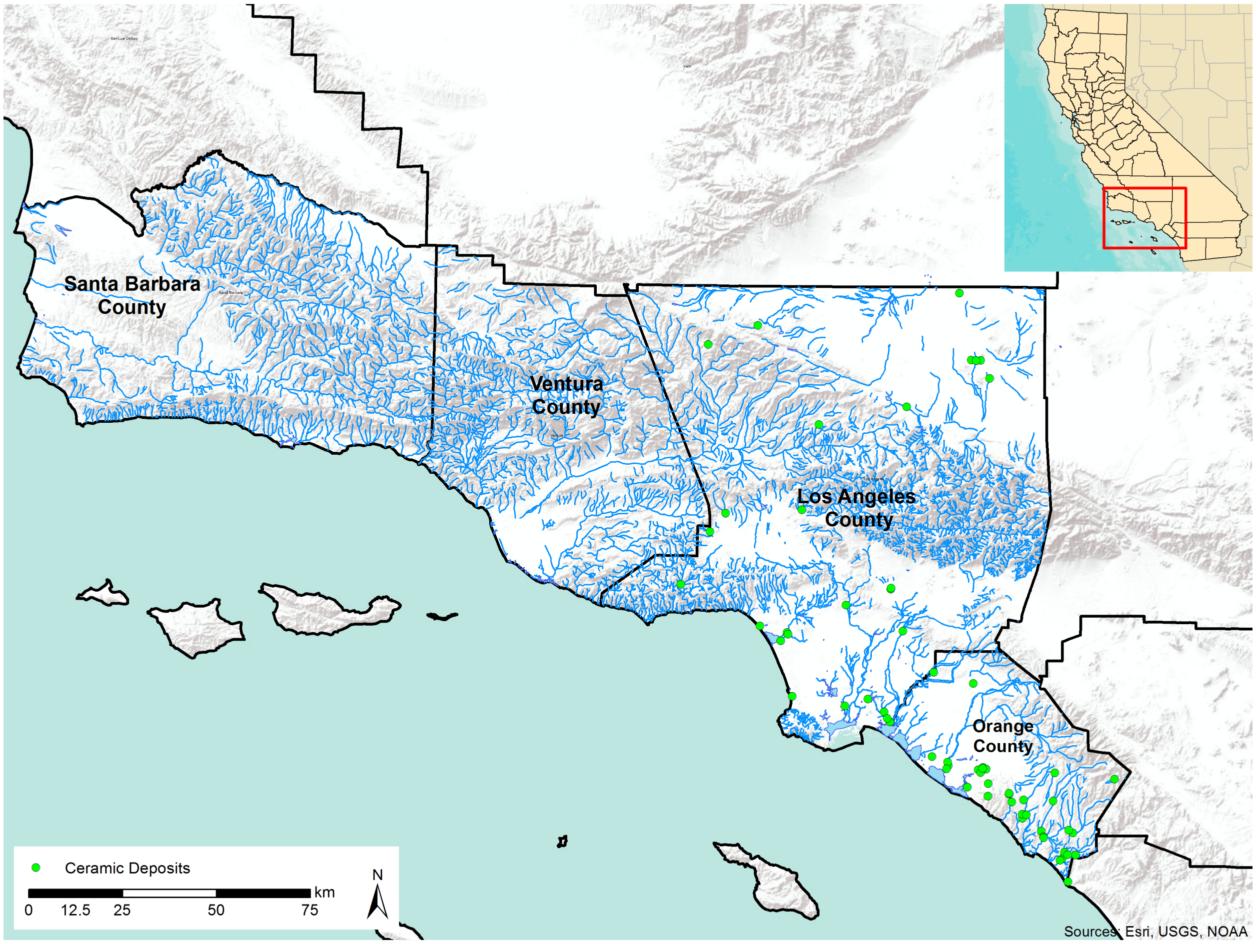


FIGURE 28. Map of historic water resources and ceramic deposits.

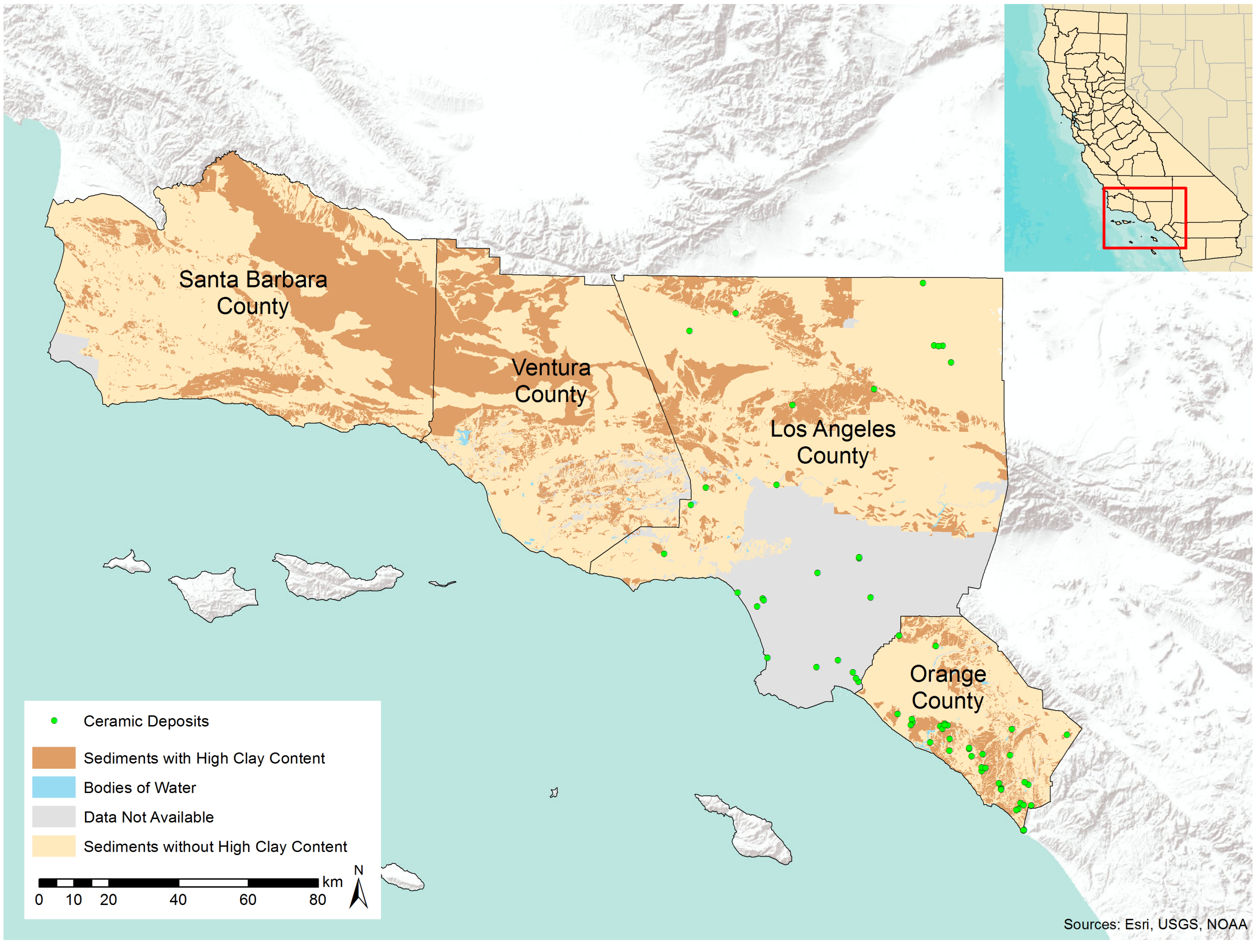


FIGURE 29. Map of sediments and sampled ceramic deposits.

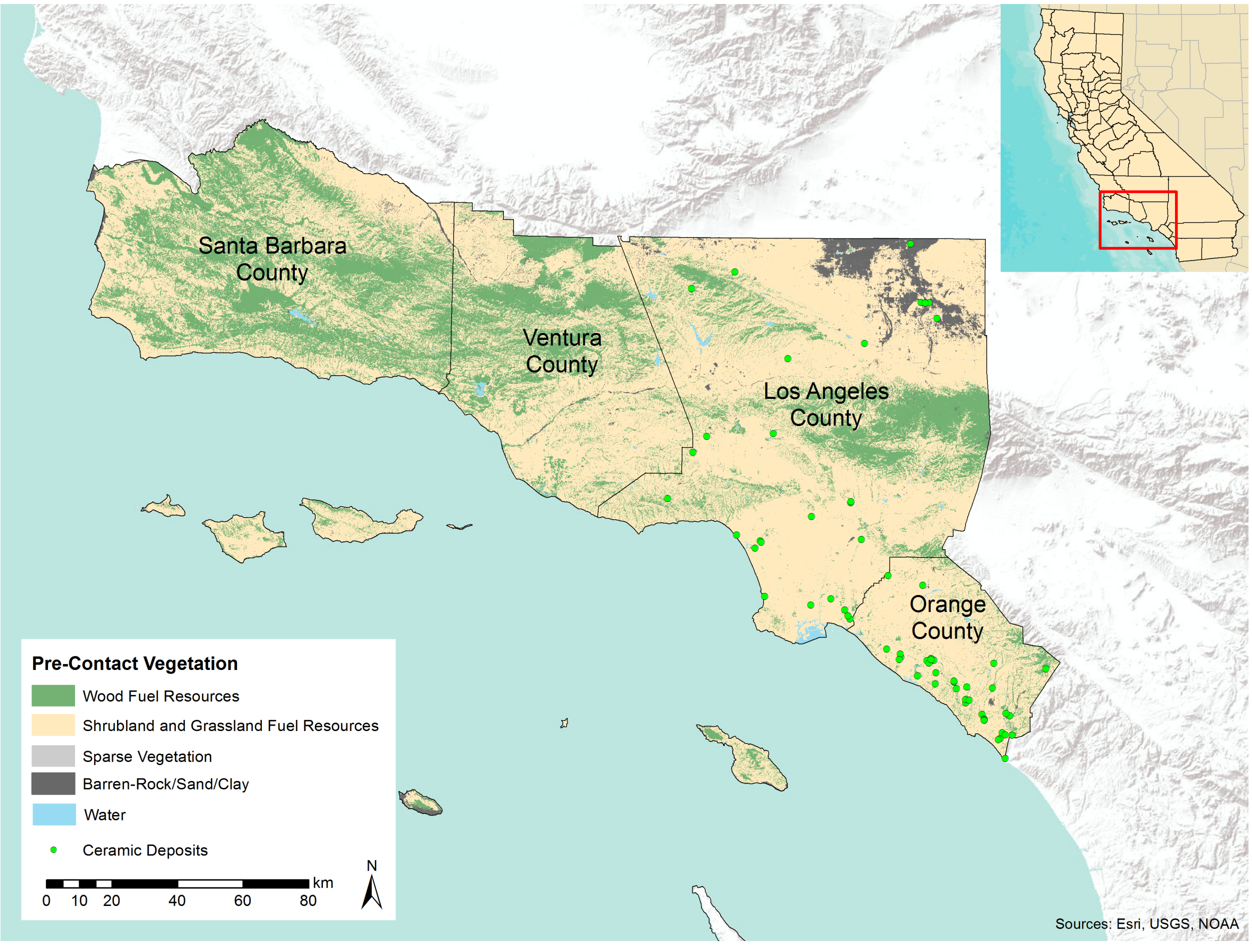


FIGURE 30. Map of pre-European vegetation and sampled ceramic deposits.

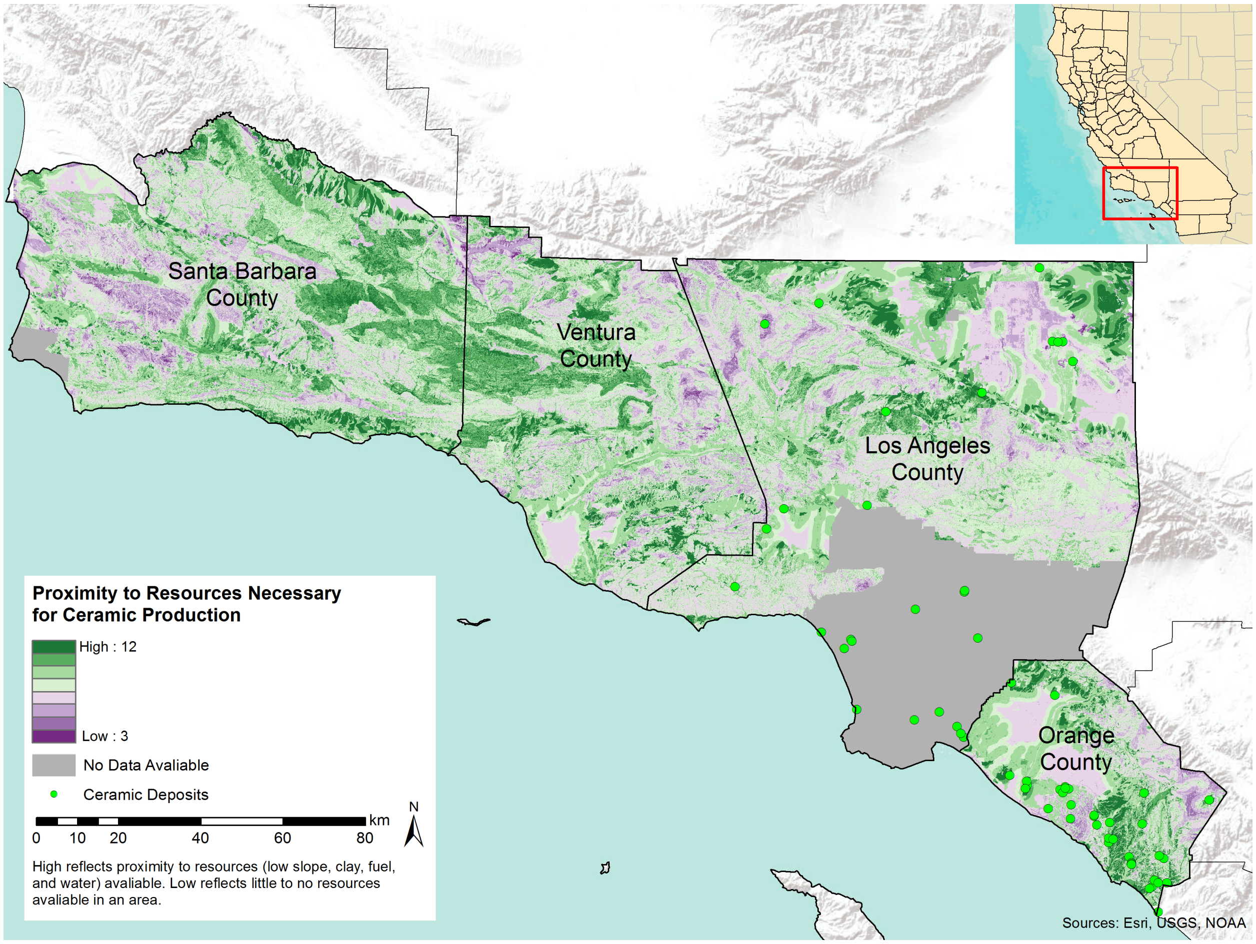


FIGURE 31. Predictive model of proximity to resources necessary for ceramic production. Areas in green are in proximity to resources (flatter elevation, fuel, clay, water) necessary for subsistence and pottery production. Areas in purple are further from those resources.

TABLE 22. Variables Used to Create the Predictive Model

Data Type	*Criteria*	*Rank*
DEM	0-20% Slope	3
	21-40% Slope	2
	>40% Slope	1
Vegetation	Wooded Environments	3
	Grassland/Shrubland	2
	Sparse/Barren	1
Soils	Sediment with High Clay Content	3
	Sediment with some Clay Content	2
	No Soil or Barren/Rock	1
Water	0-1km distance	3
	1.1-2km distance	2
	>2km distance	1

Note: Each variable was weighted equally using weighted sum.

The results of the predictive model for ceramic production resources are based on slope, distance to water resources, distance to fuel resources, and distance to clay resources (Figure 31). The predictive model shows that a majority of ceramic deposits are located near areas closest to resources needed for subsistence and the production of ceramics. Areas in green are ranked high in proximity to flatter elevation, fuel, clay, and water resources. This map demonstrates that the resources needed to produce ceramics are found in all regions, and not just in ceramic producing regions.

A major environmental difference between the north (Santa Barbara County and Ventura County) and the regions to the south (Los Angeles County, Orange County, and San Diego County), is the greater presence of estuaries. Estuaries are transition zones between the ocean and rivers. Given the nutrients available in these bodies of water, estuaries are home to highly productive ecosystems that include a wide array of plants, invertebrates, and vertebrates spread between the coastal area, the inland rivers, and the surrounding wetlands. Consequently, estuaries and their associated wetlands have long served as an important source of human subsistence resources and have supported large prehistoric populations. With modern development in southern California, it is difficult to appreciate the degree to which wetlands used to dominate the landscape. California's contemporary coastal wetlands are just a fraction of their previous extent. Wetlands have drastically decreased in size from an estimated historic 53,000 acres to a present 13,100 acres (Dennis and Marcus 1984; Wigand 2014). When we compare the wetlands of the northern parts of southern California with those of the south, we can see some distinct differences. Los Angeles, Orange, and San Diego Counties had more vegetated wetlands, more subtidal wetlands, more intertidal flats, open water, and salt flats than Santa Barbara and Ventura Counties (Steain et al. 2014). Based on wetland studies, wetlands to the north are not as extensive than those to the south. (Rundel and Gustafson 2005; Steain et al. 2014).

The physiography of estuaries in southern California is quite variable. The bay estuaries are home to some of the largest salt marshes in the region. These include: Morro Bay, Bolsa Chica, Upper Newport Bay, Mission Bay, San Diego Bay, and the Tijuana Slough. Due to the coastal uplift in the Santa Monica Mountains in Los Angeles County, Ventura County, and Santa Barbara County, large estuaries are common in the south but are relatively rare in the north. To the north, estuaries tend to be small and salt marshes are less extensive than those to the south. Further, in Ventura County, there are river mouth estuaries, which are brackish and do not form mudflats. (Rundel and Gustafson 2005).

One important consequence of varying estuary composition is the distribution of plants. Plant distributions within the salt marshes vary based on tidal flow (Rundel and Gustafson 2005; Zedler 1982) since the variety of plants in the marshes is related to levels of salinity in the sediment. Common salt marsh plants include: pickleweed (*Salicornia virginica, S.*

subterminalis), marsh jaumea (*Jaumea carnosa*), saltwort (*Batis maritima*), salt grass (*Distichlis spicata*), cord grass (*Spartina foliosa*), sea lavender (*Limonium californicum*), alkaki heath (*Frankenina salina*). Freshwater marshes are not as common in southern California as saltwater marshes. Common freshwater marsh plants include: cattails (*Typha latifoila* and *T. domingensis*), bulrushes (*Scirpus acutys* and *S. californicus*), true sedges (*Carex*), nut sedges (*Cyperus*), spike rushes (*Eleocharis*), smartweed (*Polygonum amphibian*), and yerba mansa (*Anemopsis californica*). (Rundel and Gustafson 2005).

Botanical remains found in archaeological deposits provide evidence as to how prehistoric populations used plants for subsistence. According to McCawley (1996), a vast majority of the local plant species were utilized by prehistoric populations at Ballona Wetlands. At the Ballona Wetlands, the use of acorns and small seeds was consistent during the Millingstone and Intermediate Periods but increased during the Late Period. Populations utilized a wide variety of seed species (Wigand 2014). Further, grasses were being increasingly utilized in greater quantities during the Late, Protohistoric, and Mission periods. The grasses utilized included: *Phalaris* (canarygrasses) and *Hordeum* (native barleys) (Lightfoot and Parish 2009; Reddy et al. 2016). Based on Statistical Research, Inc.'s (SRI) research at Ballona Wetlands, a total of 94 vessel ceramic sherds were found in the Ballona Wetlands. Although some of the sherds may be historic, it does appear they were produced locally and without European influence (Garraty 2016).

Bolsa Chica and Newport Bay provide useful contrast to the environment and resources found at the Ballona Wetlands. Bolsa Chica, located in northern Orange County encompasses a saltwater and freshwater marsh (Van Bueren et al. 1989). As a result, this area was particularly productive for prehistoric populations who exploited the area for subsistence resources. Plants found in in this area include pickleweed, cord grass, saltbrush, salt grass, cattail, tule, sedge, nettle, and others (Van Bueren et al. 1989). Similarly, sediment cores taken at the Huntington Beach Wetlands document the presence of salt grass, cordgrass, juncus, alkali bulrush, cattail, saltwort, California bulrush, marsh jaumea, and others (Maezumi 2010). Many of these plants were utilized by prehistoric populations for subsistence, medicinal, and utilitarian functions. Further discussion on the relationship between wetlands and vessel ceramics is subject of the next chapter.

7.10 Statistical Analyses

To statistically analyze technological and functional attributes of ceramics and the environment, I used backwards multiple linear regression analysis (Drennan 2009). First, I included only technological and functional attributes into the multiple linear regression analysis. I selected separate variables as the dependent variable and the other variables were selected for as independent (Table 23).

I utilized multiple linear regression to predict thickness based on the independent variables of temper abundance, temper size, lip shape, orifice diameter, and the hardness of the ceramics. I learned, that there is a statistically significant slight positive association between these variables ($p < .000$) with a R^2 of 0.165. Based on the R^2 16.5% of the variability of thickness can be explained by the independent variables. This means that pot thickness can be impacted by orifice diameter, lip shape, temper abundance, temper size, and hardness. Certain orifice diameters and lip shapes are correlated to thicker pottery. The larger the temper size and temper abundance, the thicker the vessel. The inverse relationship between hardness and thickness demonstrates that thinner pottery tends to be harder and thicker pottery tends to be less hard.

I found a significant relationship between the dependent variable hardness and the independent variables of thickness and lip shape. The results of this regression analysis were ($p = .001$) with a R^2 of 0.029. Based on the R^2 2.9% of the variability of hardness can be explained by the independent variables. The lip shape and thickness were significant in predicting hardness. Again, thinner sherds were generally harder. Also, certain lip shapes are correlated to being harder than other lip shapes.

I determined that there is a significant correlation between the dependent variable temper type and the independent variables temper abundance and temper size. I found that the results of the regression analysis for these variables were ($p < .000$) with a R^2 of 0.094. Based on the R^2 9.4% of the variability of temper type can be explained by the independent variables. The temper abundance and temper size were significant in predicting temper type. Temper abundance and temper size have an inverse relationship with temper type. This means that certain temper types or combinations of temper types were associated with larger temper sizes and/or abundances, while others were associated with smaller temper sizes and abundances.

Next temper size was used as the dependent variable. I determined that there was a significant association between temper size and the independent variables thickness and temper material. The output was ($p < .000$) with a R^2 of 0.047. Based on the R^2 4.7% of the variability of temper size can be explained by the independent variables. The thickness and temper abundance were significant in predicting temper size. Pots with larger temper size are thicker, while pots with smaller temper size are thinner. Temper size is inversely related to temper material, thus certain temper types are associated with smaller and larger temper sizes. Further, I considered aspects of the environment such as distance to water, sediment with high clay content, distance to ocean resources, distance to marshes/bays, and distance to fuel resources as the independent

TABLE 23. Summary of Multiple Linear Regression and Ceramic Attributes

Dependent Variable	*Independent Variables*	*P-value*	*R^2 Value*
Thickness	Temper Abundance Temper Size Lip Shape Orifice Diameter Hardness	$p <.000$	0.165
Hardness	Thickness Lip Shape	$p=.001$	0.029
Temper Type	Temper Abundance Temper Size	$p <.000$	0.094
Temper Size	Thickness Temper Abundance	$p <.000$	0.047

variables, while ceramic attributes were the dependent variables (Table 24). Based on the regression analysis, I calculated a significant relationship between the dependent variable of thickness and the independent variables of distance to water and distance to sediments with high clay content. The results for these variables were ($p < .000$) with a R^2 of 0.105. Based on the R^2 10.5% of the variability of thickness can be explained by the independent variables. The distance to water and distance to sediments with high clay content were significant in predicting thickness. According to the regression analysis, thicker pottery has an inverse relationship to water resources. This relationship demonstrates that thicker pottery may be found further away from water resources. Thicker pottery has a positive association with distance to clay resources, meaning thicker pottery may be found closer to sediment with high clay content.

I determined a significant correlation with the dependent variable temper material and the independent variables distance to marshes/bays, distance to ocean resources, and distance to sediments with high clay content. The output for these variables was ($p < .000$) with a R^2 of 0.086. Based on the R^2 8.6% of the variability of temper material can be explained by the independent variables. The distance to water, distance to ocean, and distance to sediments with high clay content were significant in predicting temper material. Temper material type is positively correlated to distance to bays/marshes and distance to sediment with high clay content. It has an inverse relationship to distance to the ocean.

The temper abundance had a relationship with distances to rivers, marshes/bays, ocean resources, fuel resources, and sediments with high clay content. I calculated the results to be ($p < .000$) with a R^2 of 0.203. Based on the R^2 20.3% of the variability of temper abundance can be explained by the independent variables. The distance to rivers, distance to marshes/bays, distance to ocean resources, distance to fuel resources, and distance to sediments with high clay content were significant in predicting temper abundance. Temper abundance has a positive relationship with distance to rivers and distance to ocean resources. Meaning sherds with higher abundances of temper are closer to river and ocean resources. Temper abundance has an inverse relationship with distance to bays/marshes, distance to fuel resources, and distance to sediments with high clay content, meaning sherds with higher temper abundances are further from these resources.

The temper size has a relationship with distance to fuel resources. I determined the results for these variables as ($p < .000$) with a R^2 of 0.075. Based on the R^2 7.5% of the variability of temper size can be explained by the independent variables. According to the regression analysis, the temper size has a relationship with distance to fuel resources. Larger temper sizes appear to be closer to fuel resources.

The Moh's Hardness of the ceramics had a significant relationship to distance to rivers, ocean resources, fuel resources, and sediments with high clay content. Based on the analysis, I calculated the results for these variables as ($p < .000$) with a R^2 of 0.081. Based on the R^2 8.1% of the variability of hardness can be explained by the independent variables. Harder sherds are found in relation to closer distances to sediments with high clay content. Hardness has a negative correlation with distance to rivers, distance to ocean resources, and distance to fuel resources. Meaning softer sherds were found closer to freshwater, saltwater, and fuel resources.

The orifice diameter of ceramics did not have a significant correlation to any of the environmental resources. This may be the result of small sample sizes of rim sherds. I then used PCA to determine the degree to which attributes are related to each other.

TABLE 24. Summary of Multiple Linear Regression and Ceramic Attributes Compared to Environmental Aspects

Dependent Variable	*Independent Variables*	*P-value*	R^2 *Value*
Thickness	Distance to Rivers Distance to Sediments with High Clay Content	p <.000	0.105
Temper Material	Distance to Marches/Bays Distance to Ocean Distance to Sediments with High Clay Content	p <.000	0.086
Temper Abundance	Distance to Rivers Distance to Marches/Bays Distance to Ocean Distance to Fuel Resources Distance to Sediments with High Clay Content	p <.000	0.203
Temper Size	Distance to Fuel Resources	p <.000	0.075
Moh’s Hardness	Distance to Rivers Distance to Ocean Distance to Fuel Resources Distance to Sediments with High Clay Content	p <.000	0.081

First, I ran PCA with only the technological and functional data attributes. By excluding the environmental factors, PCA only analyzed the relationship between ceramic attributes. I only included select variables that met the criteria to be included in a PCA. These include thickness, temper material, temper abundance, temper size, and hardness. This PCA produced two components (Table 25). On component one the high positive loader is temper abundance and the high negative loader is temper material. This is showing an inverse relationship between temper material and abundance. The high positive loaders on component two are thickness and temper size. The high negative loader is hardness. There is a relationship between thickness and temper size, and an inverse relationship between these two attributes and hardness.

TABLE 25. Results of the Rotated Component Matrix from Principal Components Analysis on Ceramic Attributes

Variables	*Component 1*	*Component 2*
Thickness	0.194	**0.668**
Temper Material	**-0.765**	-0.049
Temper Abundance	**0.782**	0.091
Temper Size	0.143	**0.616**
Hardness	0.251	**-0.626**

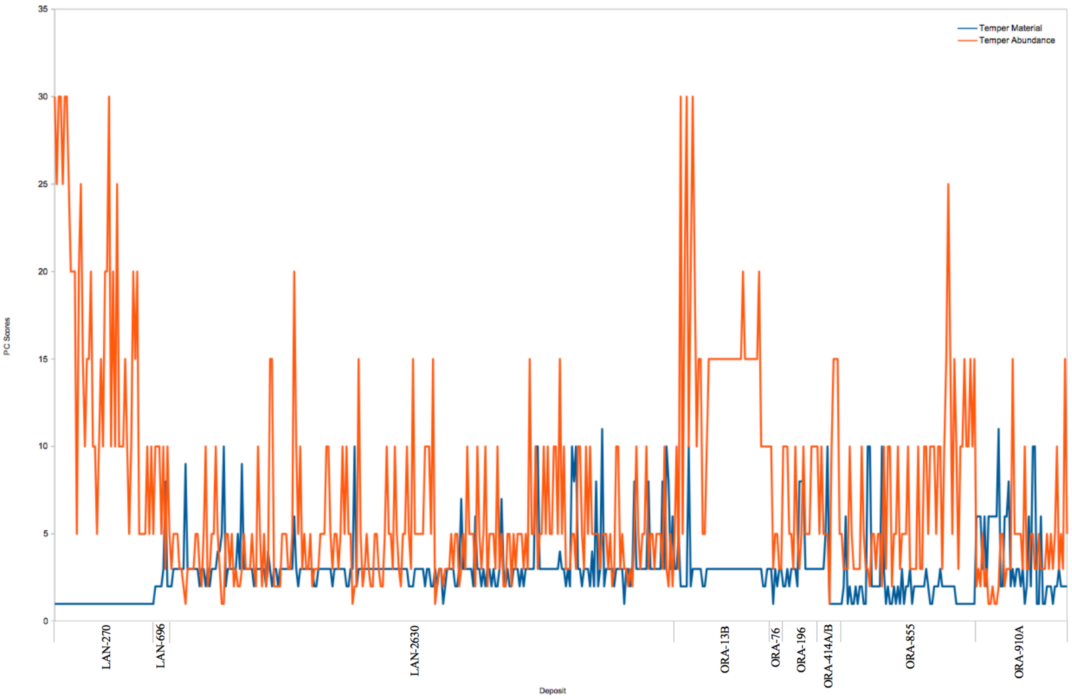


FIGURE 32. High loaders on PC1 for ceramic attributes.

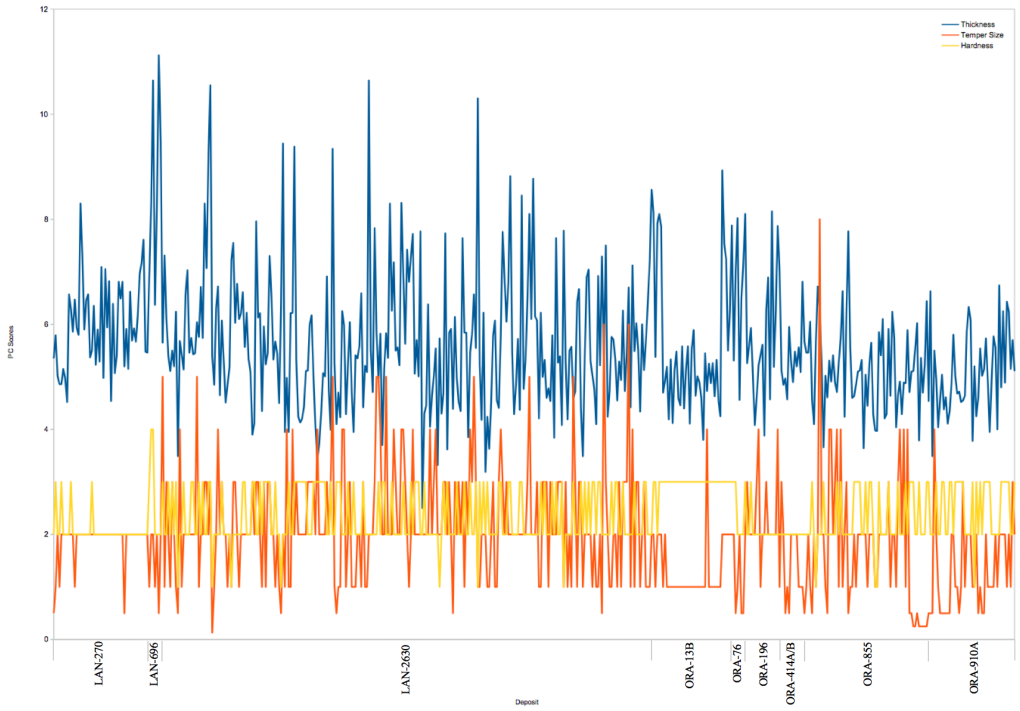


FIGURE 33. High loaders on PC2 for ceramic attributes.

I then used PCA to determine the degree to which ceramic attributes and environmental attributes are related to each other. The rotated component matrix created four components (Table 26). In component one, the high positive loaders include distance to marshes/bays and distance to ocean resources. The high negative loaders are distance to fuel resources and temper size. Like the multiple linear regression, there is a relationship between fuel resources and temper size. In component two, the high positive loaders were the distance to sediments with high clay content and thickness. There were no high negative loaders in this component. The third component had the high positive loader of temper density. The high negative loader was temper material type. This suggests an inverse relationship between temper densities to temper material. The high positive loader in component four is distance to rivers. The high negative loader is hardness. This shows an inverse relationship between hardness and distance to rivers. Overall, it appears component one is primarily picking up on distances to resources. Component two appears to be picking up on select clay attributes. Component three focuses on temper attributes, while component four deals with hardness of sherds, which have an inverse relationship to river resources.

TABLE 26. Results of the Rotated Component Matrix from Principal Components Analysis on Ceramic and Environmental Attributes

Variables	*Component 1*	*Component 2*	*Component 3*	*Component 4*
Distance to Rivers	-0.072	0.042	-0.139	**0.663**
Distance to Marshes/Bays	**0.840**	-0.207	-0.043	0.060
Distance to Ocean	**0.759**	0.408	0.225	0.007
Distance to Fuel	**-0.852**	-0.108	-0.167	0.170
Distance to High Clay Content	0.313	**.819**	-0.016	-0.169
Thickness	-0.266	**0.711**	0.151	0.164
Temper Material	-0.052	0.077	**-0.814**	0.030
Temper Abundance	0.019	0.173	**0.715**	-0.015
Temper Size	**-0.475**	0.090	0.323	0.020
Hardness	0.022	0.045	-0.110	**-0.799**

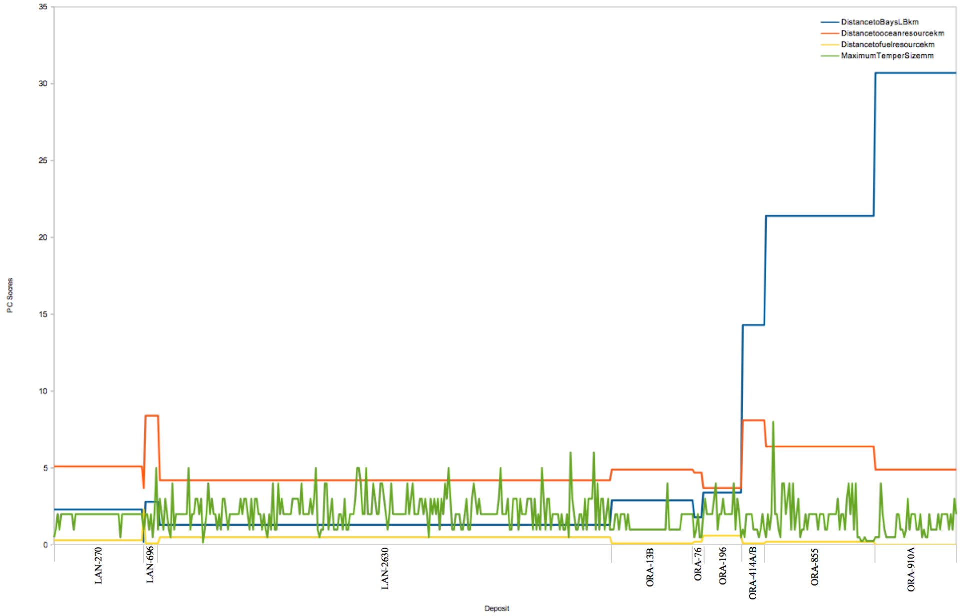


FIGURE 34. High loaders on PC1 for ceramic and environmental attributes.

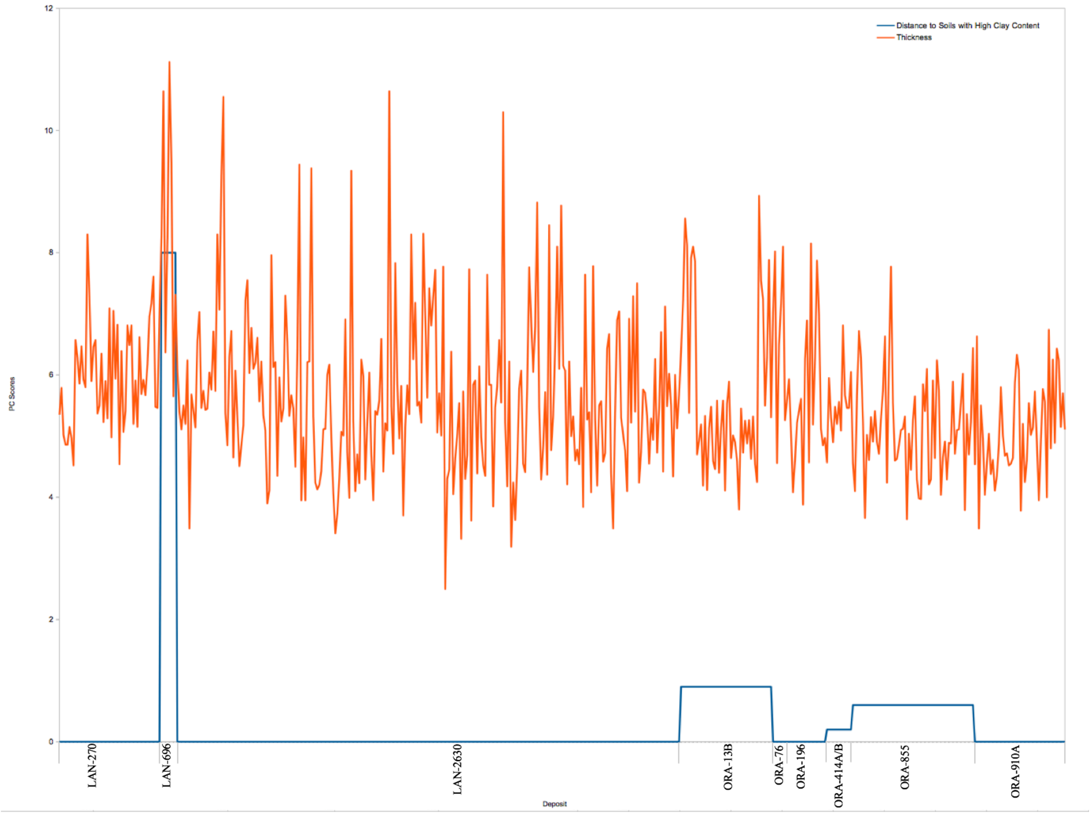


FIGURE 35. High loaders on PC2 for ceramic and environmental attributes.

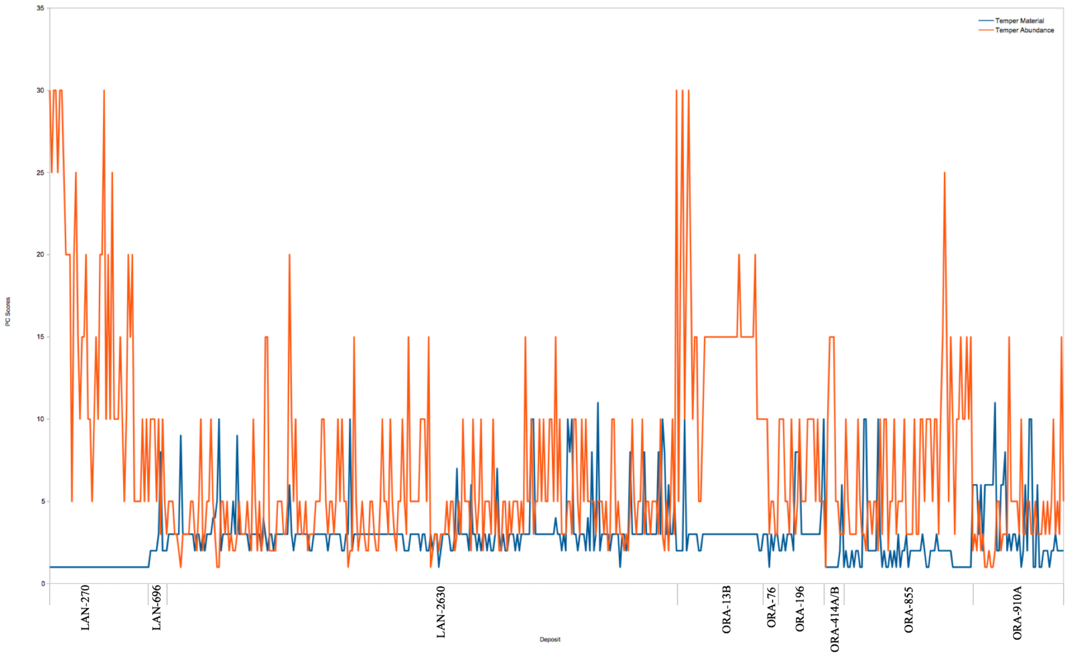


FIGURE 36. High loaders on PC3 for ceramic and environmental attributes.

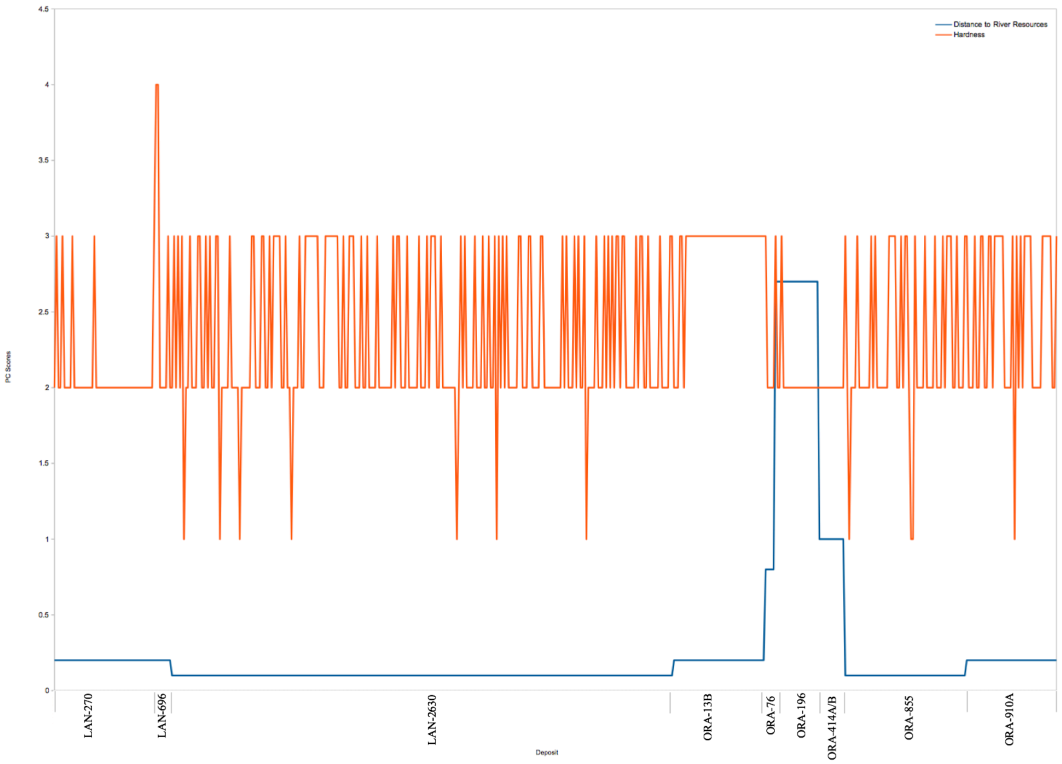


FIGURE 37. High loaders on PC4 for ceramic and environmental attributes.

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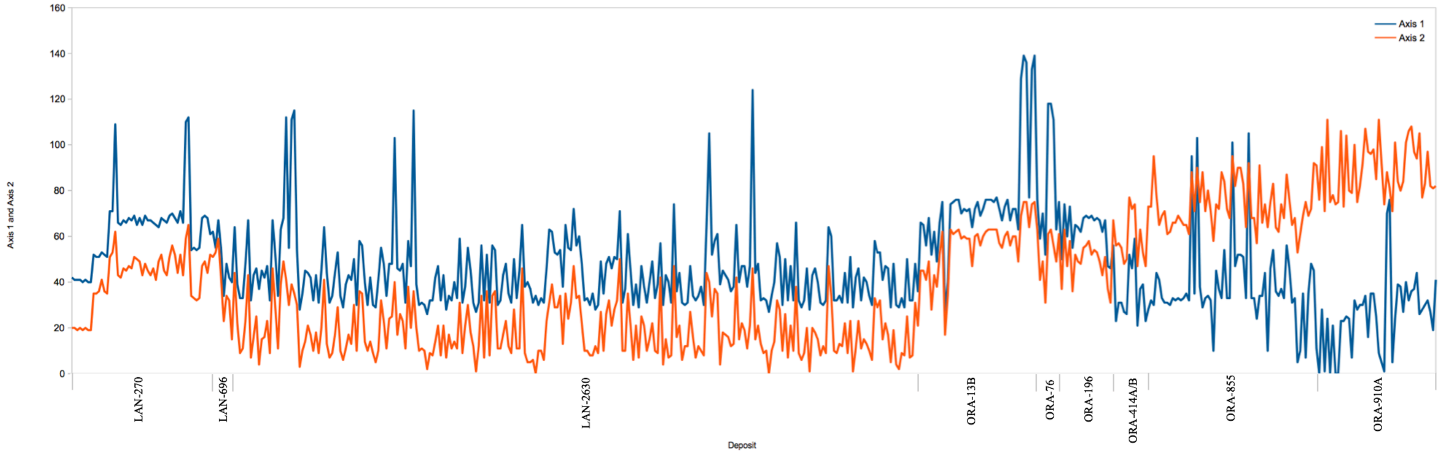

FIGURE 38. Results of detrended correspondence analysis.

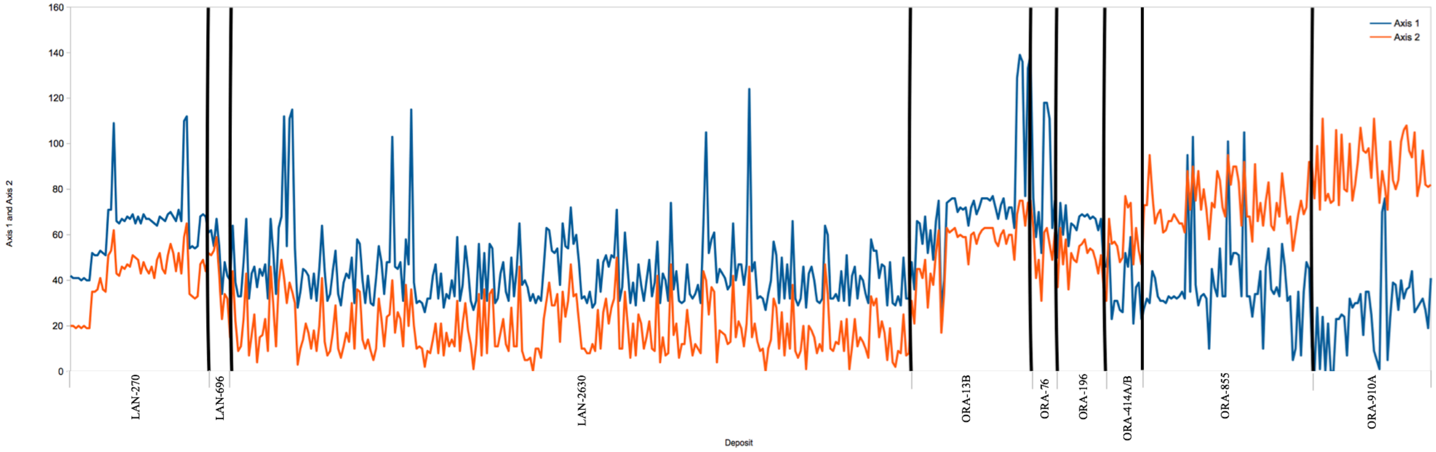

FIGURE 39. Results of detrended correspondence analysis with trend line divisions based on deposit.

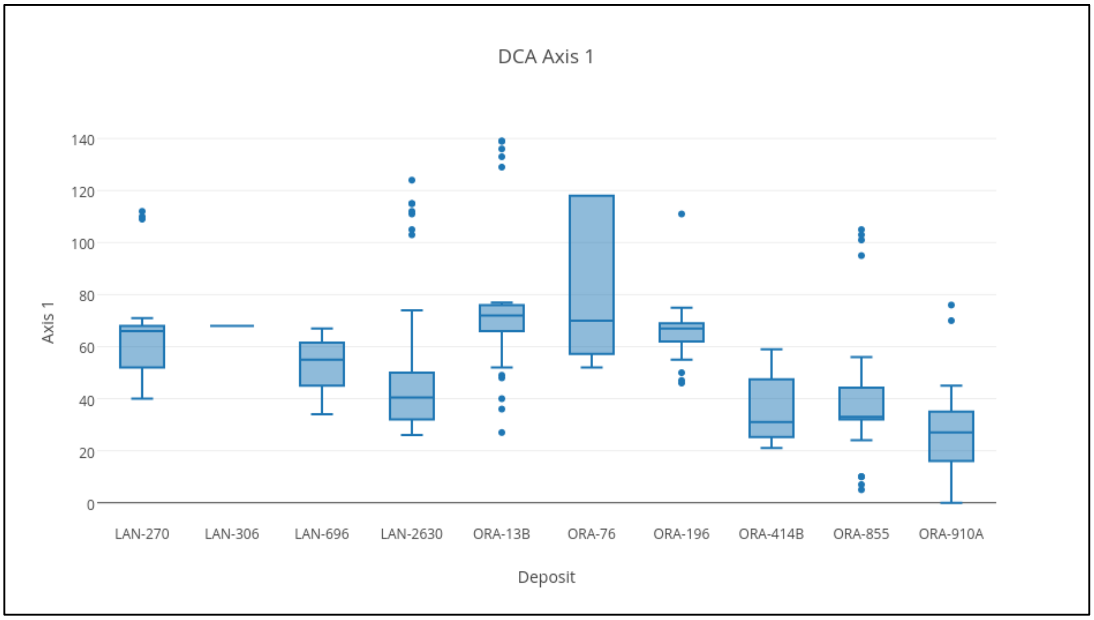

FIGURE 40. Results of DCA Axis 1. Demonstrates that attributes of ceramics differed at each deposit. Ceramics in southern California were not uniform, rather ceramics are spatially discrete and form varies based on deposit location.

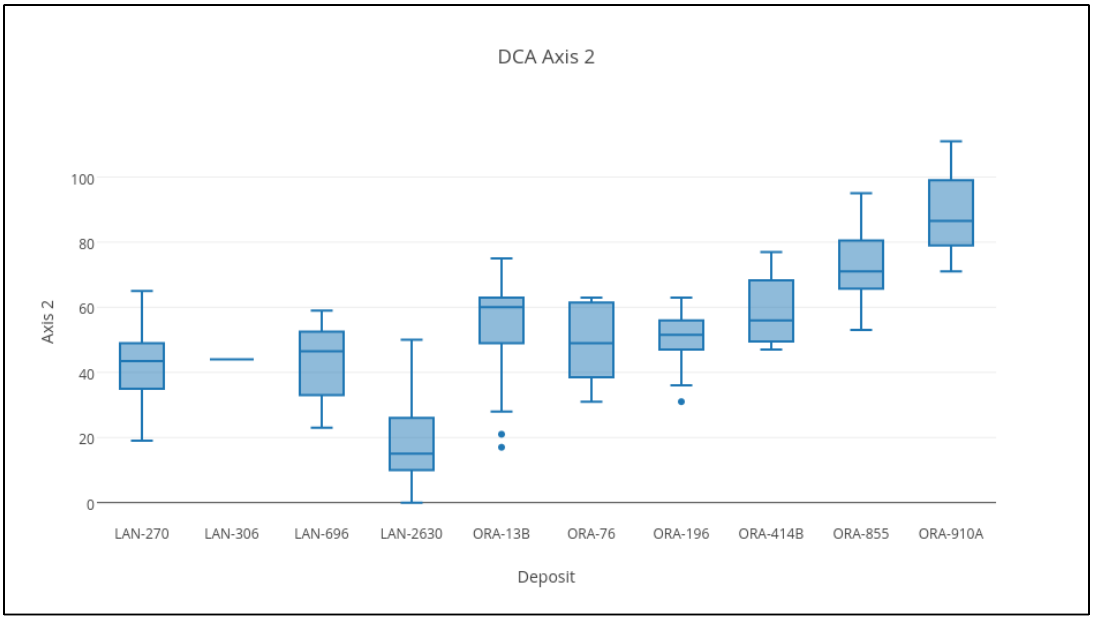

FIGURE 41. Results of DCA Axis 2. Demonstrates that attributes of ceramics differed at each deposit. Ceramics in southern California were not uniform, rather ceramics are spatially discrete and form varies based on deposit location.

The measurements I took ranged in data types. They included nominal, ordinal, interval and ratio data types. Because of the variety of data types and large quantity of zeros, DCA was useful in analyzing all the data together in one statistical technique. The results produced three axes and generally, the third axis is not utilized. Figure 38 and 39 are the results of the DCA.

In the line chart, there is a trend that changes at each deposit location. The DCA scores can be separated based on changing trends (Figures 39, 40, 41). The separations appear at every deposit location. Although there does appear to be a large amount of variability in CA-LAN-2630 ceramics, there is still distinct trend changes from the CA-LAN-270 deposit to CA-LAN-696 to CA-LAN-2630 and to CA-ORA-13B. It is more difficult to examine the changes between deposits with smaller sample sizes such as CA-LAN-696, CA-ORA-76, and CA-ORA-196, CA-ORA-414A/B. These figures demonstrate that each ceramic deposit is discrete and that ceramics differed at each deposit. Ceramics in southern California were not uniform, rather ceramics are spatially discrete and form varies based on deposit location. This chapter presented the results of my analyses. The next chapter will discuss these results and conclude this thesis.

CHAPTER 8

DISCUSSION AND CONCLUSION

8.1 Discussion

The goals of this research were to analyze the spatial, technological, and functional attributes of ceramics in southern California. My key research questions were: Can we explain the distribution of ceramics across southern California based on the resources needed in producing vessels? Further, can measurements of technological and functional variability of ceramic assemblages explain the use and production of vessel ceramics? With these questions in mind, it is important to remember that the analysis of pottery sherds can be difficult because one sherd does not represent an entire vessel. The breakage of a pottery sherd is the result of many factors including size, morphology, use, strength of the pot, disposal means, deposition, post-depositional factors, and recovery methods (Egloff 1973; Feathers 1985; Solheim 1960). Other factors such as sample size and errors associated with the variety of measurements taken on the sherds also impacted this study.

This thesis evaluated four main sets of hypotheses regarding vessel function and spatial distribution (Table 3). My first hypothesis evaluated the functional variability of ceramics and their relation to subsistence resources. The second hypothesis examined ceramics as replacements for alternative containers. My third hypothesis examined raw material limitations for the production of ceramics. My final and alternative hypothesis evaluated ceramic production and use as a result of different population histories.

Thickness plays a role in the overall function of a vessel. As can be seen in Table 9, the mean thickness of the total sample size was 5.62mm. The thickness of sherds was generally skewed thicker than 5mm (Figure 14). Around 5mm may have been an ideal thickness for the use of vessels. Based on the statistical analyses of linear regression and PCA, thickness and hardness had a significant relationship. Generally thinner pots were harder, while thicker pots were softer. Further, thickness had a significant direct relationship to temper abundance and size in the linear regression and a relationship to temper size in PCA. Based on this, thicker pots had larger and denser temper. Larger temper can make pots less resistance to stress. The thinner vessels probably functioned as transport or cooking vessels due to lighter weight, because of the ability to withstand thermal stress, the ability to transmit heat more efficiently, and being more shock resistant. The thicker vessels were most likely used for processing or serving, as they would have been heavier and less resistant to thermal stress. In terms of a relationship to resources, there was a statistical relationship in linear regression between thickness and distance to water and sediment with high clay content. There was also a relationship in PCA between thickness and distance to sediment with high clay content. Potters would have utilized both water and clay in the production of ceramics, making proximity to these resources necessary.

Calculating the estimated morphologies of the ceramic vessels encompassed errors in measurement as a result of measuring the chord distance and the distance from the arc to the cord (Figure 7). As can be seen in Table 10, the majority of pottery shapes calculated were globular or ovaloid. These shapes are consistent with other studies done on southern California ceramics. For example, these shapes match with Rogers's (1936) Yuman and Shoshonean pottery shapes (Figure 4). Globular and ovaloid shapes would have been ideal for storage, processing, serving, cooking, or water jars.

Data collected on rim attributes reflects the potential vessel function. Based on my analyses the rim sherds fall into four major potential categories of function. The first is storage or transport, the second is serving or cooking, the third is storage, serving, or cooking, and the fourth is storage, transport, or cooking. Based on rim attributes, the most common functions were serving or cooking, and storage, transport, or cooking. Orifice diameter did have a significant positive relationship to thickness; meaning thicker pots had larger orifice diameters. There was no correlation between orifice diameter and environmental resources.

Overall decorations and surface modifications were relatively limited on the ceramic assemblages. Although incisions and fingerprints are present on select sherds, it is likely they were probably not stylistic decoration, but rather were caused during ceramic production. All polished ceramics are from one of the historic deposits, CA-ORA-13B. The polished texture is produced on the dried pot through abrading a stone on the exterior surface of the vessel (Griset 1990).

I described five main types of temper in the ceramic sherds. These include quartz, sand, mica, feldspar, and hematite. Larger temper sizes and higher densities of temper were probably purposefully added to the clays, while smaller temper could have occurred in the clays naturally. According to linear regression temper type has a significant relationship to temper abundance and size, while temper size is related to thickness and temper abundance. In terms of relationship to resources, temper type has a significant relationship to distance to marshes/bays, distance to the ocean, and distance to sediment with high clay content. Temper abundance has a significant relationship to distance to rivers, distance to marshes/bays, distance to ocean resources, distance to fuel resources, and distance to clay resources. Temper size has a relationship to fuel resources. PCA reflects similar relationships between temper attributes. Temper abundance and temper material have an inverse relationship, meaning more abundant temper correlates to select temper material. Temper size and thickness are high positive loaders, while hardness is a high negative loader. But unlike the linear regression results, there was no statistical relationship between temper and resources.

Overall, oxidization and reduction occurred on both the exterior and interior of a majority of sherds. Colors of sherds, based on the *Munsell Book of Color* (Munsell 2009) came in a diverse array of browns, reds, and grays (Tables 17 and 18). The sherd cores also varied in patterns such as oxidized with no core, reduced with no core, half oxidized and half reduced, oxidized core, and reduced core. A predominant core that occurred with a high frequency was reduced with no core. Ceramics were likely fired on open fires and may have been covered.

The most frequent hardness in the overall assemblage is a 2. The second most frequent hardness is a 3. Based on firing conditions it was probably difficult to produce higher temperature fires to create harder ceramics. The only deposit to have a hardness greater than 3, is a historic ceramic deposit, CA-LAN-696. According to the linear regression, hardness has a significant relationship to thickness and lip shape. Overall, it appeared that thinner sherds were harder, while thicker sherds were softer. Similar to the linear regression, PCA showed high positive and negative loaders on component 4 (Table 25), for an inverse relationship between hardness and thickness. Table 25 also showed an inverse relationship between hardness and temper size, meaning smaller temper can be associated with harder sherds. Linear regression and PCA both show an inverse relationship between hardness and distance to rivers. Linear regression shows a relationship between hardness and distance to oceans, distance to fuel resources, and distance to sediment with high clay content.

The DCA allowed for insight into ceramic variability based on deposit location. Figure 39 demonstrates that my sampled ceramic deposits appear discrete and that ceramics differed at each deposit. Ceramics in southern California were not uniform, rather ceramics are spatially discrete and form varies based on deposit location. This analysis along with research conducted by Boxt and Dillon (2013), Hurd and Miller (2013), and Koerper et al. (1978), supports the idea that ceramics were not being traded in from a location and further, it also supports that pottery was produced locally because they are spatially unique from one another.

In terms of spatial analysis, proximity to resources is a key aspect of subsistence and settlement of a region. More specifically, proximity to freshwater resources, fuel resources, and clay resources are critical in the production of ceramics. Based on my predictive model (Figure 31), nearly all mapped ceramic deposits fall within a medium to high proximity of closeness to water resources, fuel resources, and sediments with high clay content. Each of these environmental factors is important for living, subsistence, settlement, and the production of ceramics. The predictive model shows that a majority of ceramic deposits are located near areas closest to resources needed for subsistence and the production of ceramics. However, this map demonstrates that the resources needed to produce ceramics are found in all regions, not just ceramic producing regions. Thus, it is clear that ceramics were not being produced to the north as a result of a lack of resources.

8.2 Hypotheses Evaluation

Based on my analyses of the ceramic deposits and proximity to resources, I will discuss the results of my research.

8.2.1 Hypothesis One

From my hypotheses in Table 3, it is clear that my first hypothesis, functional variability can be accepted. Ceramics are being used for different utilitarian functions. Based on my analytical results, sherds differ in functional attributes. Vessel ceramics differed in shape, form, temper, physical and thermal properties. If sherds were utilized for one function, vessel attributes would be homogenous. Rather, vessel attributes varied at both the depositional and regional scale. Further, it seems that ceramic vessels appear at deposits in proximity to marsh and estuarine resources (Figures 27 and 28). These results parallel studies conducted by Eerkens (2001, 2004, 2005), Dean and Heath (1990), and Touhy (1990). In Eerkens's (2001) dissertation, he examined Brown Ware from the Great Basin region. These sherds contain similar attributes to Tizon Brown Ware, in that they are a plain brown ware with utilitarian functions and lack stylistic attributes (Eerkens 2001). Eerkens's (2001) findings are based on residue analysis and spatial distribution. He determined that ceramics were associated functionally with lowland/marshland areas to process estuarine resources, such as small seeds and nuts. As a result of using Gas Chromatography-Mass Spectrometry (GC-MS) for the residue analysis on sherds, Eerkens (2001, 2004, 2005) could not determine the genera or species of the residue, but he could determine the general food class (e.g. meat, berry, seed, nut, etc.) (Eerkens 2001, 2004, 2005). Based on the findings, about half of the analyzed sherds were utilized to cook/process seeds and nuts (Eerkens 2001). Another study conducted by Dean and Heath (1990) shows similar results to Eerkens's (2001, 2004, 2005) research. In this study, pot sherds from the Great Basin region predominately had a residue of seeds and plants. Specific species were: *Chenopodium* sp. (goosefoots), *Poa* sp. (grasses), juniper, ricegrass, and pickleweed (Dean and Heath 1990). Further, Touhy (1990) examined pollen and phytoliths in the residues on cooking pots from the Great Basin. Based on his analysis he found the pots were utilized to prepare plants such as pine nuts and grass seeds (Eerkens 2001; Touhy 1990).

It is possible that populations in southern California were using pottery to process plants similar to those found in the Great Basin region such as pickleweed, grasses, and other seed producing plants. Other studies show similar trends in the adoption of vessel ceramics by hunter-gatherers (Goodyear 1988). In addition to residue analysis, there are other similarities between Great Basin and southern California vessel ceramics. Pottery in these two regions are generally thinner, have larger orifice diameters, and were probably used for cooking (Eerkens 2001). Further, vessel ceramics occurred later in prehistory in both regions along with larger population sizes. The presence of sherds in deposits are spatially distinct and correlated to subsistence resources, specifically bays, marshes, and estuarine areas. It appears that plant differences in southern California are driving the need for pottery and these plants are connected to the massive wetland salt marshes that dominate the southern part of the region, which differ from those to the north.

8.2.2 Hypothesis Two

In terms of my second hypothesis, which examined ceramics as replacements for alternative containers, I evaluated groundstone and basketry. This hypothesis is rejected because ceramic use cannot be linked to the lack of available resources for alternative and less costly technology for processing, storage, and transportation of resources. At the ten ceramic deposits I analyzed, 70% of deposits had groundstone bowls present (Table 20). Further every deposit had some form of groundstone present at the ceramic deposits. Steatite and groundstone were readily available container materials that were accessible to both the north and south. It is difficult to determine the presence/absence of basketry at these deposits, as it does not preserve well in the archaeological record. Based on ethnographic accounts, the southern California regions did have basketry (Kroeber 1925). Further, groups such as the Chumash, Gabrielino, and Luiseño shared commonalities in the production and stylistic aspects of their basketry (Moser 1993; Shanks 2010). Further, the vegetation necessary to produce basketry such as sumac and juncus was available in both the northern and southern regions. Thus, there were available resources for alternative vessels, but groups to the south still chose to produce ceramic vessels.

8.2.3 Hypothesis Three

The third hypothesis that I evaluate is if the distribution of vessel ceramics is related to raw material limitations. I examined if ceramic use was linked to differences in the raw materials required for making pottery. Thus, if the resources necessary for the manufacture of pottery are not available, there will be no pottery found in the archaeological record. This hypothesis is rejected because all the materials necessary to produce vessel ceramics are found in both the northern and southern regions. Water resources including streams and rivers are found commonly throughout the northern and southern regions (Figure 28). Sediments with high clay content are also found consistently in both the ceramic producing and non-ceramic producing regions (Figure 29). Finally, fuel resources necessary for firing clay into ceramics are found in all regions (Figure 30). In the non-ceramic producing regions of the north, there are more hard wood fuel resources available, while in the south there are more brush/shrub fuel resources available. Because all the necessary raw materials needed to produce ceramics are widely available, I conclude that ceramics were not produced as a result of access to these resources.

8.2.4 Hypothesis Four

Based on my data and observed patterns, my final hypothesis, the presence of ceramics is based on historical contingencies and distinct population histories is rejected. Ceramics are not distributed in relation to different factors of cultural landscapes such as language. It is important to remember that artifacts are not language, and that artifacts can map to resources and geographic proximity independent of the languages present (*sensu* Welsch et al. 1992; Welsch and Terrell 1994). Further, it is likely that the region of southern California consisted of mixed populations from different regions.

8.3 Conclusion

This research contributes to the knowledge of southern California prehistory and it sheds light on potential reasons prehistoric ceramics for the area have such a marked distribution. This thesis examined the spatial, technological, and functional attributes of vessel ceramics for the southern California region. In this thesis, I evaluated measurements of sherds, spatial distributions, and statistical analyses. I conclude this thesis that ceramics were utilized for a variety of utilitarian functions in southern California. Further, ceramic distribution appears to be driven by plant differences that are connected to the massive wetland salt marshes that are present in the southern portion of the region. Based on this, southern populations may have been functionally similar to the inland desert groups because they were taking advantage of the same kinds of resources that require pottery.

Ideally, my study will lead to more extensive analyses on the chronological, spatial, technological, and functional attributes of ceramics. Also, I hope that this thesis will allow for further analyses on larger sample sizes of ceramics. Overall, this endeavor had the ability to provide insight into the functional, technological, temporal, and spatial patterns of prehistoric ceramics in southern California.

8.3.1 Future Directions

Although the time and funding was not available for this research, it would be useful to continue this research through additional analyses including luminescence dating and residue analysis. Luminescence dating is a means of generating an age associated with the last firing of a ceramic vessel (Wintle 2008). Firing temperatures that allow a ceramic sample to be dated are at least 500° C, but firings for 300° C over a longer period of time can also be dated (Feathers 2003). Luminescence dating relies on quartz and feldspar grains in ceramics being zeroed of luminescence energy during firing and then accumulating a luminescence signal due to a sample's exposure to radiation. The luminescence signal accumulates due to the decay of the radioactive isotopes in the local environment (Wintle 2008). To determine the amount of time that has lapsed since the last firing of the ceramic, the stored luminescence is released and measured. In addition, samples are exposed to known amounts of radiation so that the rate of luminescence signal accumulation can be estimated. Unfortunately, this process is partially destructive in that it requires that portions of sherds be crushed for the test.

Residue analyses have potential to determine the substances that were placed inside a vessel during its use-life. Similar to Eerkens's (2001) ceramics from the Great Basin region, southern California ceramics are good artifacts for residue analysis because they are unglazed, unpainted, and were produced late in prehistory, thus they are better preserved than earlier ceramics (Eerkens 2001; Evershed et al. 1997). Ceramics can be tested for plant products including wax, oil, and resin, but lipids are found on a large majority of sherds that are most often tested (Evershed et al. 1997). Residues can be extracted by GC-MS which analyzes the lipid profile in the sherds (Eerkens 2001). Like luminescence dating, this analysis is destructive. A 1cm^2 area of the sherd is broken and smashed using a mortar and pestle. A solvent is added to the crushed sherd to remove the clay and temper, but leaves behind organics. The sample is then placed in a vacuum to remove the solvent in which the lipids are left behind. The next step is to derivatize the sample. The sample is then analyzed in the GC-MS (Eerkens 2001). Eerkens (2001:100) explains "... organic compounds [are] identified by their relative retention time within the GC column, as well as by their mass spectra." In order to determine what residues were found in the vessel, scientists distinguish biomarkers that are indicative of different plant and animal species (Eerkens 2001). This type of analysis has the potential to determine if vessel ceramics were produced for specific plants related to the wetlands of the southern California region. Further, this data may contribute additional information regarding the previous use of these ceramics.

TABLE 27. Los Angeles, Orange, and Ventura Counties Deposits with Known Ceramic Collections

Site	*Location*	*Ownership*	*Count*	*Description*	*Dates*	*Reference*
CA-LAN-62	Playa del Rey	UCLA	1 sherd	-	Prehistoric	Site Record Form
CA-LAN-82	Barrel Spring Site	-	-	Southwestern, Colorado, Brown Ware	-	Moore 1990
LAN-127	Redondo Beach	-	-	-	-	Bucknam 1974
CA-LAN-182	Pio Pico Rancho Adobe	-	-	Tizon Brown Ware	Historic	Hurd and Miller 2013
CA-LAN-184H	San Gabriel Mission	-	-	Brown Ware	Historic	Site Record Form
CA-LAN-192	Lovejoy Springs	-	Dozens of sherds	Assorted	Late Prehistoric or Historic	Toney 1968 Griset 2009
LAN-194	Near Santa Monica Mountains	-	-	-	Historic	Bucknam 1974
CA-LAN-209	Chatsworth	UCLA	27 sherds	Red Clay Pot Sherds	Possible Prehistoric	Site Record Form
CA-LAN-211	Playa Vista	-	93 sherds	Tizon Brown Ware	Possible Historic	Garraty 2016
CA-LAN-227	Santa Monica Mountains	-	-	Tizon Brown Ware and Cibola White Ware	A.D. 1000	King, Blackburn, and Chandonet 1968
CA-LAN-270	Long Beach	CSU Long Beach	50 sherds	Brown Ware	A.D. 1250	Bates 1972 Simpson 1953
CA-LAN-306	Rancho Los Alamitos	Rancho Los Alamitos	1 sherd	Brown Ware	Historic	Zahniser 1974
CA-LAN-365	Vazquez Rocks	-	1 sherd	-	Possible Prehistoric	Boxt and Dillion 2013
CA-LAN-418	Antelope Valley	-	-	Brown Ware	-	Boxt and Dillion 2013
CA-LAN-488	Antelope Valley	-	-	Brown Ware	-	Boxt and Dillion 2013
CA-LAN-498	Rocky Butte	-	2 fragmented pots	Red-on-Brown and Brown Ware	-	Site Record Form
CA-LAN-696	Rancho Los Cerritos	Los Cerritos Rancho	8 sherds	Brown Ware	Historic	Evans 1969
CA-LAN-887	El Pueblo de Los Angeles	-	1 sherd	Palomar Brown Ware	Prehistoric or Historic	Costello and Wilcoxon 1978

TABLE 27. Continued

Site	*Location*	*Ownership*	*Count*	*Description*	*Dates*	*Reference*
CA-LAN-1016	Ontiveros Adobe	-	-	Tizon Brown Ware	Historic	Hurd and Miller 2013
CA-LAN-1100	Edwards Air Force Base, Lancaster	-	1 sherd	-	-	Site Record Form
CA-LAN-1130	Castaic, Transverse Range	-	1 sherd	Tizon Brown Ware	Prehistoric	Site Record Form
CA-LAN-1403H	Santa Monica	UCLA	-	Earthenware	Historic	Site Record From
CA-LAN-1421H	Tujunga	-	Several sherds	-	Historic	Site Record Form
CA-LAN-1732	Piute Butte	-	-	Brown Ware	Possible Prehistoric	Site Record Form
CA-LAN-1739	Antelope Valley	-	25 sherds	Brown Ware, Red-on-Brown painted, and Stucco-Ware sherd	Prehistoric or Protohistoric	Site Record Form
CA-LAN-2630	Long Beach	CSU Long Beach	642 sherds	Brown Ware	A.D. 1195 to A.D. 1717	Boxt and Dillon 2013 Hurd and Miller 2013
CA-LAN-2676	Playa Vista	-	1 sherd	Tizon Brown Ware	-	Garaty 2016
CA-LAN-2682	-	-	1 sherd	Tizon Brown Ware	Late Prehistoric and Protohistoric	Frazier 2000
CA-LAN-2768	Playa Vista	UCLA	-	-	Historic	Site Record Form
Ortega Vigare Adobe	San Gabriel (200 m south of Mission San Gabriel)	-	1448 sherds	Tizon Brown Ware	Probable Historic	Marshall 1982
Verrano Camp Site, Edwards Place Site	Near Mission San Gabriel	-	A few sherds	-	Historic	Winterbourne 1937
CA-ORA-13B	Laguna Canyon	PCAS	61 sherds	-	Historic	Demcak and Allen 1994 Wade 1994
CA-ORA-18	Aliso Creek	-	10 sherds	Brown Ware	-	Lytton 1963
CA-ORA-19	San Juan Capistrano	Cooper Center	-	Tizon Brown Ware	A.D. 150- post 1800	

TABLE 27. Continued

Site	*Location*	*Ownership*	*Count*	*Description*	*Dates*	*Reference*
CA-ORA-22	-	-	120 sherds	Brown Ware	Prehistoric and Protohistoric, possible Historic	Cameron 1999
CA-ORA-35	Cleveland National Forest	-	7 sherds	-	Probable Historic	Cameron 2000 Cameron 1999 Fritz 1971
CA-ORA-58	-	-	2 sherds	-	Probable Historic	Koerper et al. 1996
CA-ORA-64	East Newport Bay	CSU Fullerton	3 sherds	Untypical Brown Ware	3238 ± 500 and 3692 ± 650 BP	Drover 1975 Drover et al. 1979
CA-ORA-76	Costa Mesa	-	5 sherds	Brown Ware	Possible Prehistoric or Historic	Winterbourne 1966 Chace 1966
CA-ORA-109	Morro Canyon	-	4 or more sherds	Possible Mojave type or mission types	Possible Prehistoric and Historic	Winterbourne 1939
CA-ORA-111	Upper Newport Bay	-	2 sherds	-	Prehistoric and Historic	Bingham 1975 Winterborne 1938 Bean 1975
CA-ORA-119A	Upper Newport Bay	Blas Aguilar Adobe?	200 sherds	Brown Ware	Prehistoric	Koerper et al. 1978 Koerper 1981 Koerper and Drover 1983 Hurd et al. 1990
CA-ORA-121	Upper Newport Bay	-	2 sherds	Brown Ware	Prehistoric or Historic	Clevenger 1986 Cottrell 1978
CA-ORA-163	Costa Mesa	-	6 sherds	Pink semi-glaze and possible other ceramics	Historic	Bucknam 1974 Winterbourne 1968
CA-ORA-196H	Upper Newport Bay	PCAS	116 sherds	Brown Ware	Prehistoric and Historic	Chace 1969 Cottrell 1976
CA-ORA-197 II	Upper Newport Bay	-	26 sherds	Brown Ware	Historic	Cottrell 1976 Craib 1982
CA-ORA-302	Huntington Beach	CSU Los Angeles	1 sherd	Palomar Brown Type	Prehistoric	Lauter 1977
CA-ORA-306	Laguna Canyon	-	-	-	-	Irwin 1974
CA-ORA-309	Laguna Canyon	-	7 or 9 sherds	Tizon Brown Ware	-	Wlodarski et al. 1985

TABLE 27. Continued

Site	*Location*	*Ownership*	*Count*	*Description*	*Dates*	*Reference*
CA-ORA-414A/B	Laguna Hills	Cooper Center	20 sherds	-	Late Prehistoric	Demcak 1988
CA-ORA-469C	Plano Trabuco	UCLA?	86 sherds	Miscellaneous plain ware, painted sherds, red-on-red, Trincheras Pottery	Possible Historic and Late Prehistoric	Demcak and Cottrell 1985 Cottrell 1991
CA-ORA-504	Along the Segunda Deshecha in Rancho San Clemente	Cooper Center	25 sherds	Brown Ware and Buff Ware	Late Prehistoric	Cameron 1989 Cameron 1999
CA-ORA-572	Fullerton	CSU Fullerton	12 sherds	Painted pot sherds, similar to Sacaton-Red-on-Buff Ware	A.D. 900 to A.D. 1200	Bissell 1983
CA-ORA-600	Near the San Juan Capistrano Mission	-	4801.6 grams	Brown Ware and Buff Ware	Historic 1780-1820 A.D.	Brock et al. 1992
CA-ORA-627	Tomas Burruel Adobe Historic Old Town Site	-	1077 grams	Brown Ware and Buff Ware	Historic	Padon et al. 1990
CA-ORA-635A	Along the Segunda Deshecha	-	1 sherd	-	-	Cameron 1989 Cameron 1999
CA-ORA-681	Los Trancos Canyon	-	7 sherds	Tizon Brown Ware	-	Taylor and Douglas 1982
CA-ORA-855	1 mile north of San Juan Capistrano Mission	Blas Aguilar Adobe Museum in SJC	61 sherds	Tizon Brown Ware	Late Prehistoric	Koerper et al. 1988
CA-ORA-862	Arroyo Trabuco	-	52 sherds	-	-	Cottrell 1991
CA-ORA-876	Near Trabuco Adobe	-	-	-	Prehistoric and Historic	Cottrell 1991
CA-ORA-907	San Clemente	Cooper Center	47 sherds	Tizon Brown Ware	Possible before A.D. 1000	-
CA-ORA-910A	San Clemente	Cooper Center	47 sherds	Tizon Brown Ware	Late Prehistoric	Mooney 1988
CA-ORA-921	-	-	13 sherds	Brown Ware and Spanish	1720 ± 90 BP	Jones 1991
CA-ORA-1103	Southwest of Ortega Hwy	-	5 sherds	Brown Ware	Prehistoric and Protohistoric	Wlodarski et al. 1989

TABLE 27. Continued

Site	*Location*	*Ownership*	*Count*	*Description*	*Dates*	*Reference*
CA-ORA-1121	San Juan Creek	-	1 sherd	Brown Ware	Historic	Demcak and Del Chario 1989
CA-ORA-1247	Juan Avila Adobe	-	3019 sherds	Tizon Brown Ware, Buff Ware, and Earthenware	Historic	Brock et al. 1996
CA-ORA-1671	Anaheim	UCLA	11 sherds	-	Historic	Site Record Form
Santiago Cave Site	-	-	3 sherds	-	-	Winterbourne 1937
CA-VEN-11	Point Mugu	-	18 sherds	Mission Pottery/Tizon Brown Ware Lower Colorado Buff Majolica	290±60 U.C.R 400±140 U.C.R 500±130 U.C. R	Love and Resnick 1983
CA-VEN-87	Near Mission San Buenaventura	-	736 sherds	Tizon Brown Ware Majolica	Historic	May 1976

Note: Based on the sources of Boxt and Dillon (2013), Cameron (1999), and McLean (2001).

APPENDIX

CERAMIC SHERD IMAGES

The appendix contains a sample of images taken of vessel ceramic sherds from this research. Because I sampled 505 ceramic sherds, not all images could be included. Ceramics from CA-LAN-270 are not pictured due to cultural sensitivity.

FIGURE 42. Exterior and interior view of sherd from CA-LAN-306.

FIGURE 43. Exterior and interior view of sherd from CA-LAN-696.

FIGURE 44. Exterior and interior view of sherd from CA-LAN-696.

FIGURE 45. Exterior and interior view of sherd from CA-LAN-696.

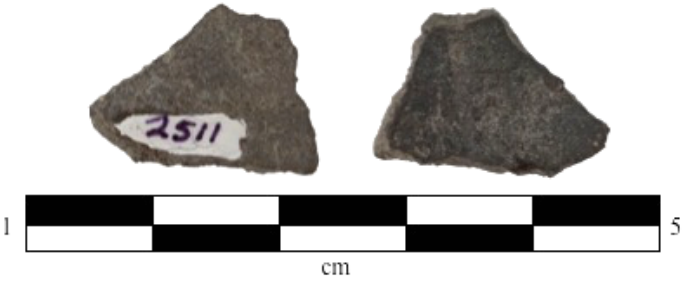

FIGURE 46. Exterior and interior view of sherd from CA-LAN-2630.

FIGURE 47. Exterior and interior view of rim sherd from CA-LAN-2630.

FIGURE 48. Exterior and interior view of sherd from CA-LAN-2630.

FIGURE 49. Exterior and interior view of rim sherd from CA-LAN-2630.

FIGURE 50. Exterior and interior view of sherd from CA-LAN-2630.

FIGURE 51. Exterior and interior view of sherd from CA-LAN-2630.

FIGURE 52. Exterior and interior view of sherd from CA-LAN-2630.

FIGURE 53. Exterior and interior view of sherd from CA-LAN-2630.

FIGURE 54. Exterior and interior view of sherd from CA-LAN-2630. Note incisions on interior.

FIGURE 55. Exterior and interior view of rim sherd from CA-LAN-2630.

FIGURE 56. Exterior and interior view of rim sherd from CA-LAN-2630.

FIGURE 57. Exterior and interior view of rim sherd from CA-LAN-2630.

FIGURE 58. Exterior and interior view of sherd from CA-LAN-2630. Note drill holes are the result of NAA sampling.

FIGURE 59. Exterior and interior view of sherd from CA-LAN-2630. Note incisions on interior.

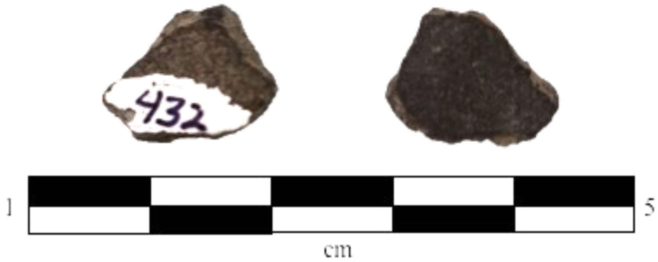

FIGURE 60. Exterior and interior view of sherd from CA-LAN-2630.

FIGURE 61. Exterior and interior view of rim sherd from CA-LAN-2630.

FIGURE 62. Exterior and interior view of sherd from CA-LAN-2630.

FIGURE 63. Exterior and interior view of sherd from CA-ORA-13B.

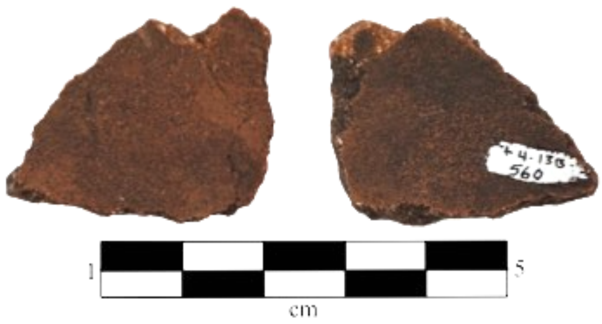

FIGURE 64. Exterior and interior view of sherd from CA-ORA-13B.

FIGURE 65. Exterior and interior view of sherd from CA-ORA-13B.

FIGURE 66. Exterior and interior view of sherd from CA-ORA-13B.

FIGURE 67. Exterior and interior view of sherd from CA-ORA-13B.

FIGURE 68. Exterior and interior view of sherd from CA-ORA-13B.

FIGURE 69. Exterior and interior view of rim sherd from CA-ORA-13B.

FIGURE 70. Exterior and interior view of rim sherd from CA-ORA-13B.

FIGURE 71. Exterior and interior view of rim sherd from CA-ORA-13B.

FIGURE 72. Exterior and interior view of rim sherd from CA-ORA-13B.

FIGURE 73. Exterior and interior view of rim sherd from CA-ORA-13B.

FIGURE 74. Exterior and interior view of rim sherd from CA-ORA-76.

FIGURE 75. Exterior and interior view of rim sherd from CA-ORA-76.

FIGURE 76. Exterior and interior view of sherd from CA-ORA-76.

FIGURE 77. Exterior and interior view of sherd from CA-ORA-76.

FIGURE 78. Exterior and interior view of sherd from CA-ORA-76.

FIGURE 79. Exterior and interior view of rim sherd from CA-ORA-196.

FIGURE 80. Exterior and interior view of sherd from CA-ORA-196.

FIGURE 81. Exterior and interior view of sherd from CA-ORA-196.

FIGURE 82. Exterior and interior view of sherd from CA-ORA-196.

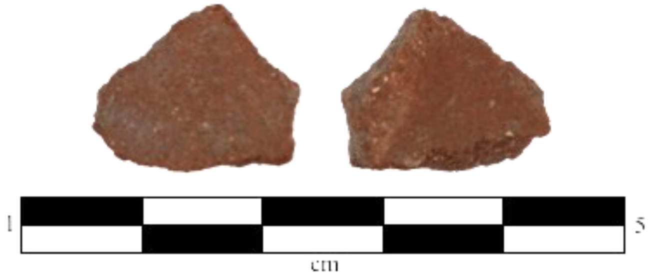

FIGURE 83. Exterior and interior view of sherd from CA-ORA-196.

FIGURE 84. Exterior and interior view of sherd from CA-ORA-196.

FIGURE 85. Exterior and interior view of sherd from CA-ORA-414A/B.

FIGURE 86. Exterior and interior view of sherd from CA-ORA-414A/B.

FIGURE 87. Exterior and interior view of sherd from CA-ORA-414A/B.

FIGURE 88. Exterior and interior view of sherd from CA-ORA-414A/B.

FIGURE 89. Exterior and interior view of sherd from CA-ORA-855.

FIGURE 90. Exterior and interior view of sherd from CA-ORA-855.

FIGURE 91. Exterior and interior view of rim sherd from CA-ORA-855.

FIGURE 92. Exterior and interior view of sherd from CA-ORA-855.

FIGURE 93. Exterior and interior view of sherd from CA-ORA-855.

FIGURE 94. Exterior and interior view of sherd from CA-ORA-855.

FIGURE 95. Exterior and interior view of sherd from CA-ORA-855.

FIGURE 96. Exterior and interior view of sherd from CA-ORA-855.

FIGURE 97. Exterior and interior view of sherd from CA-ORA-910A.

FIGURE 98. Exterior and interior view of sherd from CA-ORA-910A.

FIGURE 99. Exterior and interior view of rim sherd from CA-ORA-910A.

FIGURE 100. Exterior and interior view of sherd from CA-ORA-910A.

FIGURE 101. Exterior and interior view of rim sherd from CA-ORA-910A.

FIGURE 102. Exterior and interior view of sherd from CA-ORA-910A.

FIGURE 103. Exterior and interior view of sherd from CA-ORA-910A.

FIGURE 104. Exterior and interior view of sherd from CA-ORA-910A.

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