Great Basin Ceramic Distribution Patterns in San Bernardino County

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Abstract

Ceramic evidence from San Bernardino County has often been neglected in both California and Great Basin archaeological research. Recent investigations have revealed that San Bernardino County contains ceramic wares and production techniques reflective of Great Basin, California, and even Southwestern traditions. The study region therefore presents unique and exciting challenges in ceramic analysis and typology. We have pursued one such research avenue relating to the Great Basin ceramic component within the county. The ceramic patterns known for the surrounding region are first explored, then a Geographic Information System-based distribution analysis of pottery sources, production, distribution, and use for San Bernardino County itself is offered. This may be the first attempt within California to derive prehistoric ceramic patterns from the state mandated computerization of archaeological site records. Using the computerized records, we consider how ceramic sites might be associated with natural clay sources, with specific vegetation communities, and with other archaeological attributes within San Bernardino County. Despite the present limitations of the database, we believe that such analysis holds much promise for future ceramic research.

Introduction

San Bernardino County, California's largest county, incorporates more surface area than many of the eastern states. More than 10,000 archaeological sites have been recorded within it. Prehistorically, the county was home to diverse cultures and incorporated no fewer than three different and distinctive culture areas. The county's southwest corner is within the California culture area, its easternmost tip, part of the Colorado Desert, was influenced by Southwest culture traditions, while the bulk of the county between these two elements lies within the Great Basin. Accordingly, most of our discussion relates to the Great Basin component of San Bernardino County.

Developments in chemical sourcing and residue analysis have brought important advances in understanding the introduction, source, production, distribution, and use of ceramics in California. Although Geographic Information System (GIS) analyses cannot provide firm answers for these crucial research questions, it provides a valuable toolset for identifying and interpreting patterns in existing data. Thousands of potsherds have been found in hundreds of individual sites and isolated occurrences throughout San Bernardino County. A geographic database is a logical means for storing and displaying all the data represented in these sites. Furthermore, GIS provides an ideal means for exploring possible associations between archaeological sites and different natural environments. GIS is also advantageous for dealing with large areas containing sites within different ownership and curatorial jurisdictions because it organizes information without requiring physical contact or destruction of artifacts, and it has but minimal cost scaling associated with increased sample size.

There have been a number of pottery studies in the southwestern Great Basin but relatively few within San Bernardino County. The most intensive studies within the county are from the Fort Irwin National Training Center and China Lake Naval Air Weapons Station (Gilreath et al. 1987; Lyneis 1988a, 1988b, 1989; Hildebrandt and Ruby 1999). Consequently, analysis of ceramics in San Bernardino County, and particularly in the northwest region of the county, must rely heavily on extrapolation from surrounding areas (cf. Eerkens 2001, 2003a, 2003b, 2004, 2005; Eerkens et al. 2002a). Figure 1 provides an overview of our study region, locating sites and areas where important pottery research has been conducted. One of the principle goals of our present work is to evaluate the extent to which models developed for the western Great Basin, principally the Owens Valley and adjoining areas, are applicable to San Bernardino County.

Regional Interpretations and Models

Most evidence suggests that utility brown wares were not traded over long distances (Lyneis 1988c; Eerkens 2001). Steward (1933) suggested that pottery production in the Owens Valley was localized, with a small number of potters producing and distributing locally made ceramics. Eerkens et al (2002a) challenged this

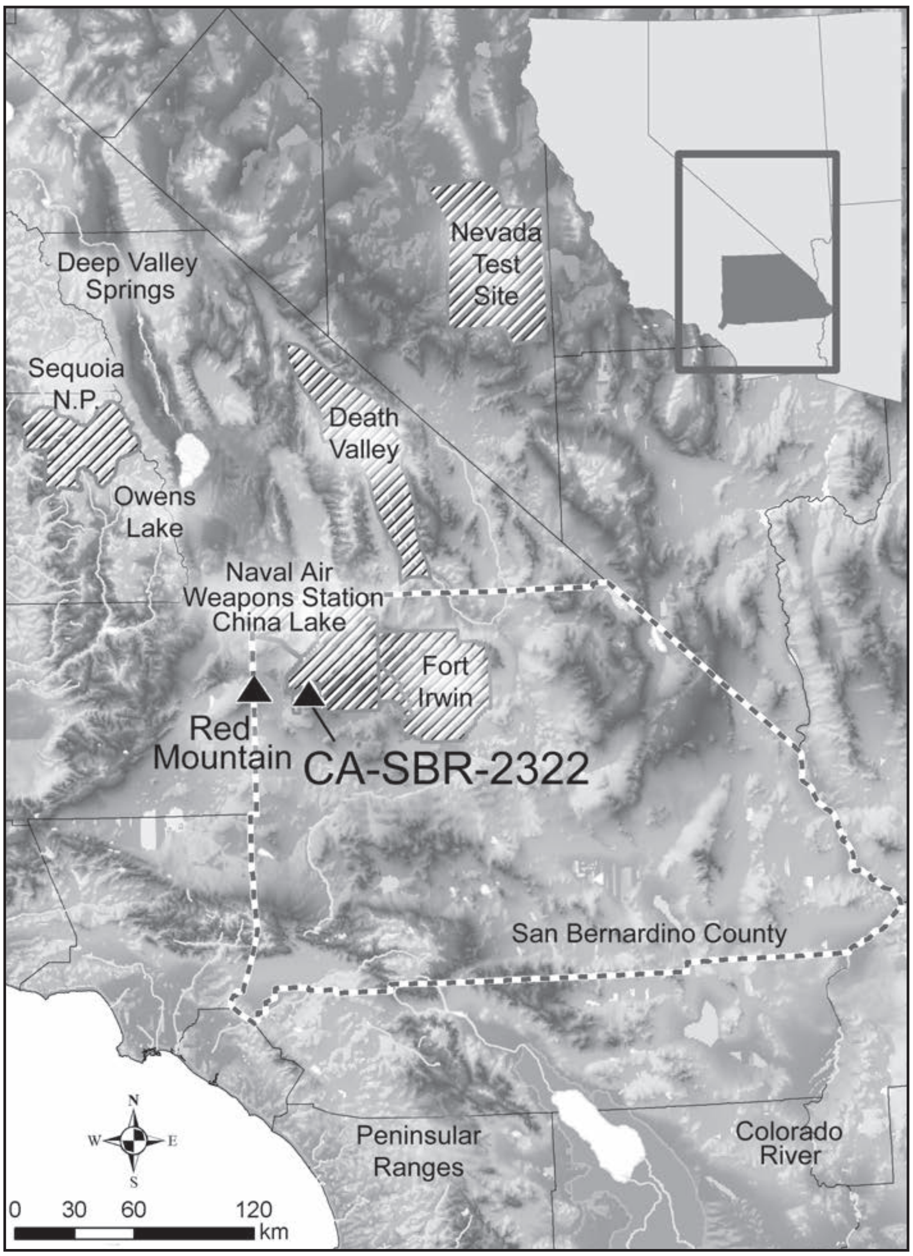

Figure 1. Southeastern California and adjacent states, showing San Bernardino County and archaeological locations mentioned in the text.

hypothesis within the Owens Valley after conducting INAA elemental composition analysis of sherds and clays. If Steward's hypothesis is correct farther south, then it should be possible to detect pottery clustering through GIS analysis of sources and distribution patterns. The individual elements of such clusters, if found, could then be tested by INAA to determine if they derived from a common source. There has been speculation that the Mohave used residual rather than sedimentary clays; this could also be testable through distribution analysis.

In Death Valley, prehistoric sites occur under a wide range of geographic and environmental conditions, but pottery is only common around salt pan margins (A. Hunt 1960). To some extent, Owens Valley appears to follow a similar pattern, with the richest pottery assemblages found near lakeshores and on valley bottoms (Eerkens 2001). With relatively little analysis completed outside of Fort Irwin, GIS research is the most logical tool for determining whether a similar pattern is present further south within San Bernardino County. Alternatively, pottery distribution can be viewed as a product of use patterns. It is logical to expect that regions with food resources most suited to processing with pottery should have the highest density of potsherds. Because of transportation losses incurred with heavy, fragile brown ware, pottery may be more abundant in areas where resources permitted foragers to remain in one place for an extended length of time. Pottery may have also been adaptive in this setting as a fuel conservation measure. Although dismissing this as a primary cause for the introduction of ceramics, Eerkens (2001) suggested that thin-walled pots associated with arid environments allowed food to be cooked using less fuel than older methods requiring the heating of boiling rocks for baskets. Fuel conservation is most important when the duration of residence leads to localized exhaustion and more time is required for fuel collection.

Although ethnographic references to pottery offer some clues regarding ceramic uses, clay sources, production technologies, and economics of conveyance, there is considerable danger in relying on these accounts. Due to the ubiquitous halt in ceramic production in the middle nineteenth century, pottery was less familiar to informants than other traditional technologies (Baldwin 1950). Eerkens (2001) found that most ethnographic descriptions of pottery in the Owens Valley could not be substantiated by archaeological evidence.

Great Basin Wares and Typology

San Bernardino's prehistoric pottery cannot be lumped into a single typological group, yet it also defies easy typological divisions based on readily observable attributes or upon chronological or geographical differences. Utilitarian brown ware dominates most San Bernardino ceramic assemblages within its Great Basin portion, and other wares differentiated by slip or decoration are uncommon. Slipped and decorated ceramics are generally found as products of trade in conjunction with utility wares rather than as distinct temporal or cultural phenomena. Contradicting this pattern are the Cronise Basin and Turquoise Mountain areas of the county, which may have hosted Patayan and even Anasazi peoples for at least several centuries. If so, they are best interpreted as outposts of Southwestern culture. We set these fascinating enclaves aside for the purpose of our present study, which concentrates on the Great Basin cultural province of San Bernardino County.

The three wares most commonly found within the Great Basin portion of the county are Owens Valley Brown Ware, Tizon Brown Ware, and Colorado Buff Ware (Dobyns and Euler 1958; Schroeder 1958; Bettinger 1986). The terms "Owens Valley Brown Ware" and "Tizon Brown Ware" may not be strictly appropriate for San Bernardino County, but in keeping with the literature of the region, they are used here as shorthand for local varieties of Great Basin Brown Ware and paddle-and-anvil utility ware, respectively.

Tizon Brown Ware and Colorado Buff Ware are both of paddle-and-anvil construction, while Owens Valley Brown Ware is characterized by coil-and-scrape construction. Tizon Brown Ware is found in southern San Bernardino County where it reaches the northern limit of its California distribution. Figure 2 compares ethnographic boundaries with the distributions of paddle-and-anvil pottery in the Mojave as proposed by Lyneis (1988c). Note that the distribution shown for Tizon Brown Ware represents the maximum estimated distribution of this ware, while the mapped distribution of Colorado Buff Ware only represents the region in which it is more common than Tizon Brown Ware. This distribution of Tizon Brown Ware extends farther north than accepted by many authorities. Eerkens (2005) acknowledged the use of paddle-and-anvil technique in southern California but categorically excluded its use in the Great Basin.

Owens Valley Brown Ware is more common in Mojave Desert sites south of the Owens Valley, thus representing the most common ware in northern San Bernardino County. Owens Valley Brown Ware sometimes exhibits a simple decoration of thumbnail impressions around the rim. This decoration remained consistent through time, although it is slightly more common toward the southern extreme of distribution in San Bernardino County than in the Owens Valley

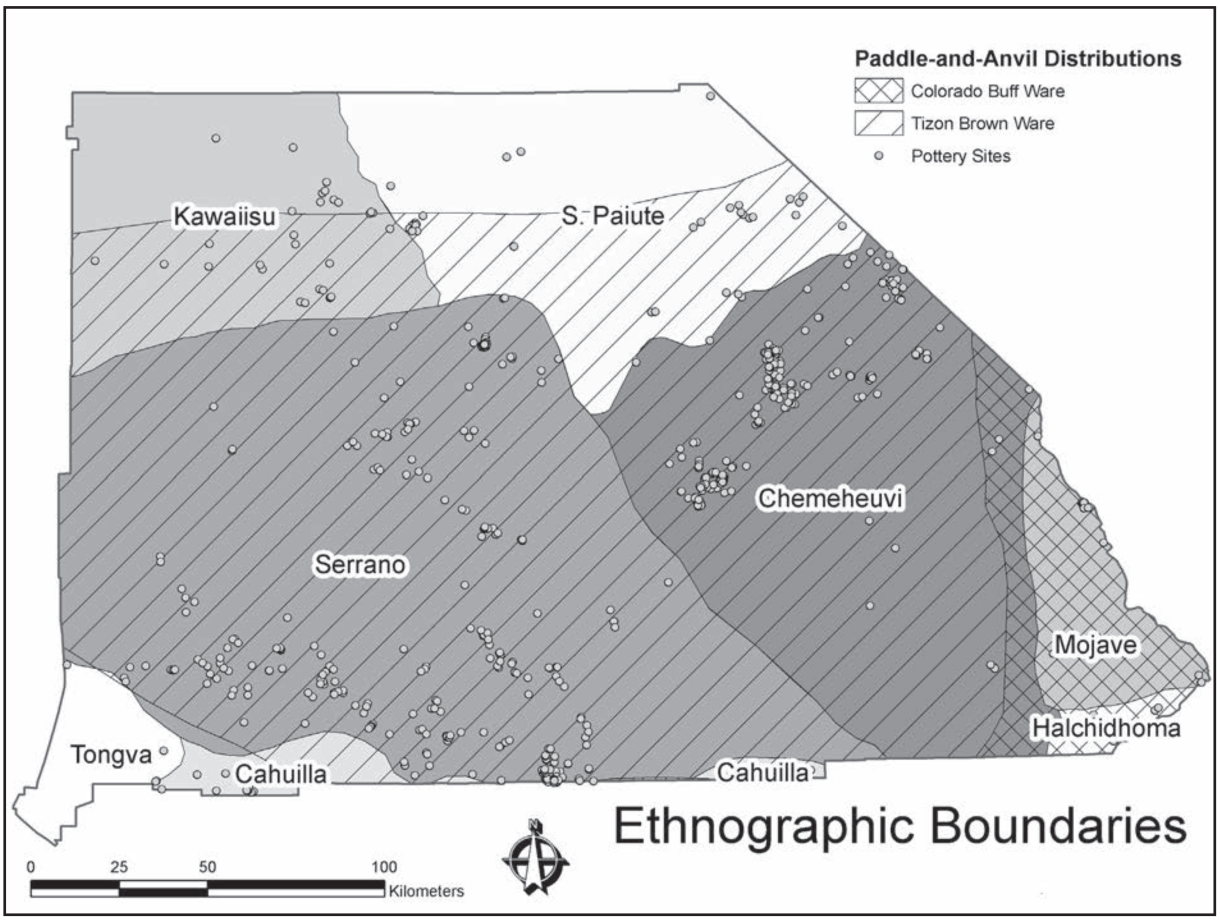

Figure 2. Distribution of ceramic technology and ethnographic boundaries in San Bernardino County, California. Archaeological pottery-producing sites (indicated as hollow circles) and ware distributions (diagonal line shading and cross-hatching) are superimposed on historically documented ethnographic territories.

(Eerkens 2001). The full distribution of each brown ware has not been adequately studied, and the extent to which coil-and-scrape and paddle-and-anvil methods were used concurrently in the region where the technologies overlap is unknown. Unfortunately, it is generally not possible to detect if pottery has been thinned through paddle-and-anvil or pinching techniques if it has also been scraped to join coils (Olson 2012).

Colorado Buff Ware is generally distinguished by its lighter color and finer clay. These properties are associated with manufacture from sedimentary clay sources rather than residual products of rock decay which are coarser and darker (Waters 1982). Within San Bernardino County it is common only along the Colorado River, but it appears in limited quantities throughout the county. Lyneis (1988c) suggested that the relative scarcity of Buff Ware in the Mojave Desert can best be explained by considering the dichotomy between Tizon Brown Ware and Colorado Buff Ware as primarily one of clay source, with inadequate sedimentary sources available in the Mojave Desert for the local production of Buff Ware. Although this discounts the presence of clay deposits associated with Mojave Desert playas, which possess the texture and chemical composition to produce buff and gray ceramics similar in appearance to Colorado Buff Ware, evidence suggests that without additional processing these clays produce ceramics that are considerably less durable (Eerkens et al. 1999; Eerkens 2001). It is reasonable to speculate that Colorado Buff Ware distribution in the northwest portion of San Bernardino County is a result of trade with production areas to the east.

An additional kind of pottery occurs which has not been satisfactorily determined to be either an import from long-distance trade or relatively local production. These sherds have a red-orange slip on both their interior and exterior surfaces, finer clay, probably from sedimentary sources, and sand temper. This red ware has been found at Red Mountain, Blackwater Well (CA-SBR-2322), and other locations (Kaldenberg 1978; Olson 2012). Kaldenberg (1978) suggested that this ware could be associated with a local form produced in the Owens Valley. This is consistent with descriptions by Steward (1933) of pottery producers in the Owens Valley using reddish clay collected near Fish Springs and coated with mallow syrup to provide a red slip. Alternatively, this form may be a trade ware introduced by the Patayan trade and originating in the eastern Mojave Desert (Alexander Rogers, personal communication 2007).

There have been several attempts to refine typologies for these wares. In general, attempts to further subdivide utilitarian ware classifications have failed because the pottery is too diverse within overly small samples yet too homogenous across time and region. Malcolm Rogers (1929) recognized a number of divisions within Tizon Brown Ware, but his typology is not typically followed. Using sherds from Death Valley, Alice Hunt (1960) attempted to divide Owens Valley Brown Ware into types, but within the same report there is recognition that these macroscopic observations were inconsistent with thin-section analysis (C. Hunt 1960). Work by Bettinger (1986) and Griset (1988) have not been any more successful. More recently, Eerkens et al. (2002a, 2002b) used INAA to identify groupings of Owens Valley Brown Ware sherds from common source areas. Eerkens (2003a) also demonstrated that changes in some attributes vary through time when statistical averages for entire assemblages are compared. While these studies were effective in answering research questions regarding the introduction, distribution, and use of Owens Valley Brown Ware, they provide little assistance for typical site ceramics analysis. Furthermore, sherds included in these studies from Fort Irwin and China Lake did not form consistent patterns, making the applicability of these studies questionable for San Bernardino County (Eerkens et al. 2002a).

Although no chronology comparable to that available for the Southwest exists for Great Basin pottery, it is still a valuable temporal marker for sites in San Bernardino County. Whether through migration, technological transfer, or independent development, ceramic technology made a late introduction to eastern California and the western Mojave Desert. The precise date of pottery introduction remains uncertain but is generally held to fall between 700 BP and 500 BP, with the latter date representing a point after which pottery appears to become a common element in the local toolkit (Gilreath et al. 1987; Basgall and McGuire 1988; Rhode 1994; Eerkins 2003a). The small number of sherds found in sites firmly dated before 700 BP are clearly distinct from Great Basin ceramics types, with most positively identified as Southwestern wares introduced through trade (A. Hunt 1960; Gilreath et al. 1987; Eerkens et al. 1999). The introduction of metal cans, discards from Euro-Americans, beginning around AD 1850, rapidly replaced pottery as the preferred cooking vessel. Metal cans were cheaper to acquire, lighter, more durable, and more efficient for heat transfer than ceramic pots. Before AD 1850, pottery is a common site constituent, but it is entirely absent in later contexts. Most site components with pottery present can be expected to fall within the 400 year period between 500 BP and 100 BP.

Research Methods

The computer database of site attributes maintained by the San Bernardino County Information Center provided the raw site data for this analysis. This data set includes coded information for most of the attributes recorded on California Department of Parks and Recreation primary and archaeological site forms. For sites recorded before modern standards were developed, many of these fields have been left blank, thus limiting the ability for comparison. However, the Universal Transverse Mercator (UTM) locations and California Historic Resource Information System (CHRIS) attribute codes for each site, including those recorded before current forms were introduced, are included. From this data set, we extracted all sites with a prehistoric component and processed the resulting list to remove duplicate entries and sites recorded under multiple trinomials. Examination of the data set suggested that some ranges of site numbers lacked full CHRIS attribute code information. For these ranges the paper site records stored at the information center were examined, and resource attributes were updated for sites found to include pottery. We separated sites with the CHRIS code for prehistoric ceramics (AP3) from all other sites. Both data sets were converted to GIS data sets according to the ArcGIS Desktop 9.2 program. A small percentage of the sites in each set plotted outside of San Bernardino County due to errors on site forms or errors made during data entry. Some errors could be corrected by inspection (e.g., switched easting and northing), and they were corrected immediately. Other UTM errors for sites containing ceramics were corrected by reviewing the original site records and composite maps at the data center. There were too many incorrectly plotted sites (nearly 300) without ceramics to perform a similar check of each site but too few to have an impact on the analysis, and so these sites were discarded from the data set.

Due to the limitations of the data used in this study and the inconsistency of typology as recorded by hundreds of different archaeologists on the site record forms, studying the distributional patterns of specific wares or types is not possible at present. To the extent that individual site records and project reports were examined to supplement holes in the CHRIS database, we found that ceramic variety was either not specified or was inadequately justified. The terms “Tizon Brown Ware” and “Owens Valley Brown Ware” were occasionally used in site records, but they appeared more closely correlated with arbitrary geography or experience of the recording archaeologist than physical attributes of the ceramics. Consequently, the ceramic distributions evaluated in our study must, at the present time, be considered as no more specific than utilitarian brown ware.

In order to determine possible sources of sedimentary clays, we created a GIS model to predict areas of likely alluvial deposition. By locating local sinks through calculation of flow direction based on a digital elevation model and by combining these areas with regions charted by the Mojave Desert Ecosystem Program (2001a) of clay that may have formed before current base-levels were established, the model incorporates as many sedimentary clay sources as possible. Euclidean distance from these alluvial deposits was calculated for all sites. This model also provides a reasonable estimation of the salt pans, playas, and valley bottoms that most closely match the environment in Owens Valley and Death Valley where pottery is most abundant. To test correlation between pottery distribution and environmental resources, we utilized a GIS layer dividing the study area into basic vegetation communities based on data available through the Mojave Desert Ecosystems Program (2001b). We extracted the vegetation community for each site point and calculated the number of sites falling into each community.

Results

Distance Between Sites and Clay Sources

Nearly 44 percent of sites with pottery are within 5 km of the sinks predicted by the GIS model. Before we were able to compare this with distribution of all sites, this was taken as support for either a sedimentary clay based production source or a use pattern consistent with those found in Death Valley and Owens Valley (Olson and Burns 2007). Figure 3 shows the area generated by the model, and it also shows distance zones into which sites were grouped for analysis. When all sites are considered, 59 percent lie within the same zone. These numbers are high due to the large overall area of the county's land surface that is included or within 5 km of the lakes, playas, salt pans, and other lowlands represented by sinks in the model, over 47 percent. Figure 4 compares the site percentage in each distance zone normalized by area within the zone. It should be noted that the spike in the distribution line for pottery sites in the 40–45 km zone is an artifact of sampling bias; only five sites occur within this zone. Overall, when compared to the distribution of all sites and area, we find that pottery is less abundant within 10 km of the area generated by the model. This is true even though pottery sites along the Colorado River, where sedimentary clay use was anticipated, are all included within the modeled area. Our findings are in contrast with Arnold (1985) who suggested that a much higher percentage of prehistoric potters worldwide obtain their clay from a distance less than 5 km from their residences. Future research on this issue may illuminate just how unusual our data may be and may answer whether it is the product of uniquely Californian cultural patterns or hunter-gatherer practice as opposed to sedentism.

Associations with Vegetation Communities

Analysis of vegetation zones further refined the findings based on sink proximity and provided additional insights. Figure 5 shows the results of the analysis. Results have been normalized by the area each plant community occupies; the x-axis is drawn at 1, rather than zero, so that bars falling below the axis indicate that fewer sites occur within this plant community than would be expected with random distribution. The desert scrub community, which occupies 77 percent of the county's land surface, has values slightly below 1.0, as might be expected for the most typical environment. Alkali desert scrub, the community associated with salt pan and playa margins, has a positive correlation with prehistoric sites but a negative correlation with pottery sites. This is consistent with the results of the sink proximity analysis. However, valley bottoms with external drainage, represented here by the desert riparian community, have a much higher density of pottery sites than expected based on density of all prehistoric sites. Not all communities showing high pottery presence in Figure 5 represent

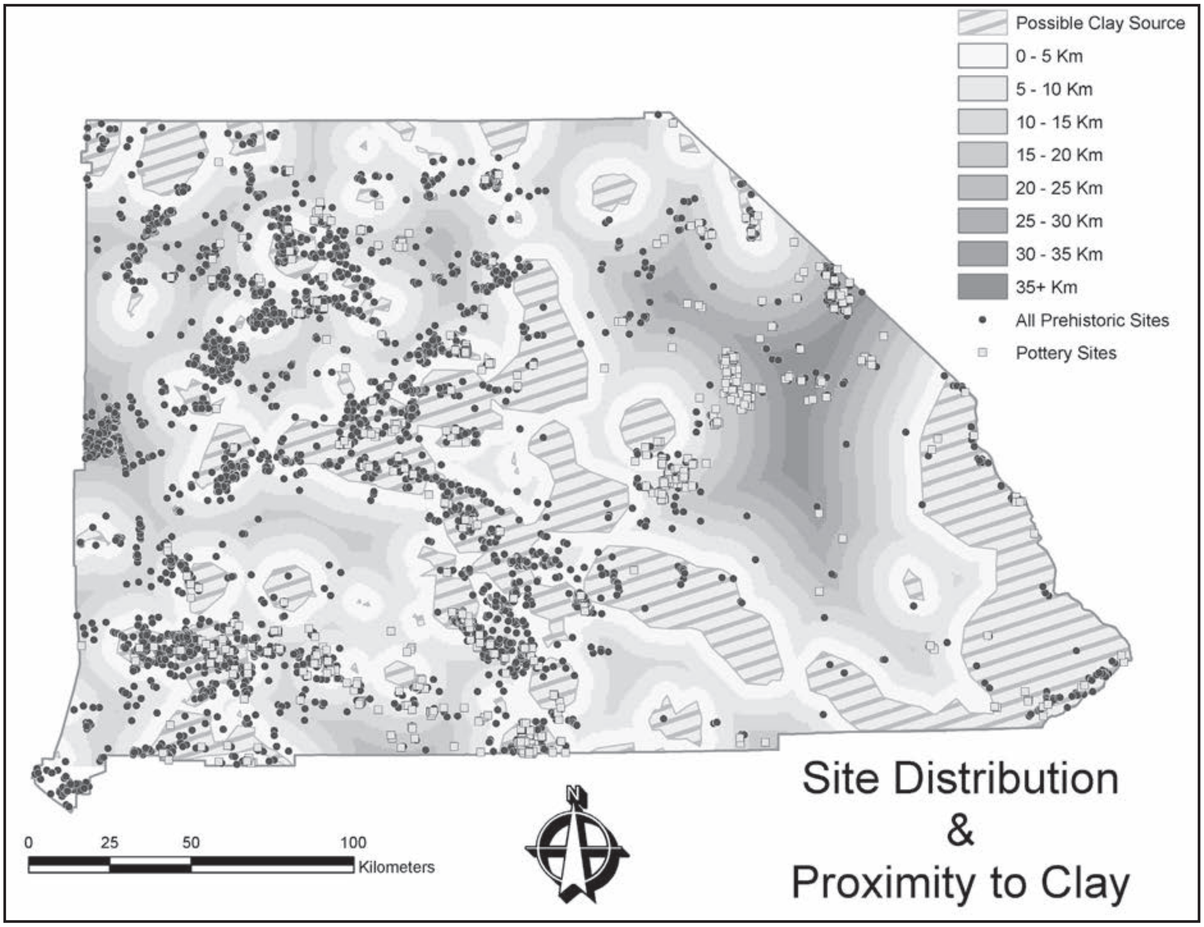

Figure 3. San Bernardino County, California, showing the distribution of pottery-bearing archaeological sites and potential sources of clay. Site shading from light to dark indicates increasing distance from sedimentary clay sources to archaeological sites.

statistically significant distribution patterns, but three communities indicated by arrows (desert riparian, piñon-juniper, and sagebrush) all contain a sufficient number of sites to provide significance at p = .005 or better. Pottery distribution in the Jeffrey pine community appears significant relative to area (p = .08), but the sample size is not adequate to demonstrate significance relative to distribution of all sites. Figure 5 reveals that within the Great Basin portion of San Bernardino County, archaeological ceramics are most commonly found at sites within the desert riparian community, then much less frequently within three more vegetation communities: desert succulent scrub, montane riparian, and sagebrush.

Ceramic Associations with Archaeological Attributes

Earlier analysis of the spatial distribution of sites containing pottery, which evaluated the attributes listed in the CHRIS system (Olson and Burns 2007), suggested that domestic attributes were clustered. By contrast, sites with features usually associated with ceremonial activity were randomly distributed. A review of the associations between individual attributes present at sites containing pottery, as presented in Table 1, may provide answers to questions about the introduction and function of ceramics at specific sites and may even reveal patterns common throughout larger regions of prehistoric San Bernardino County.

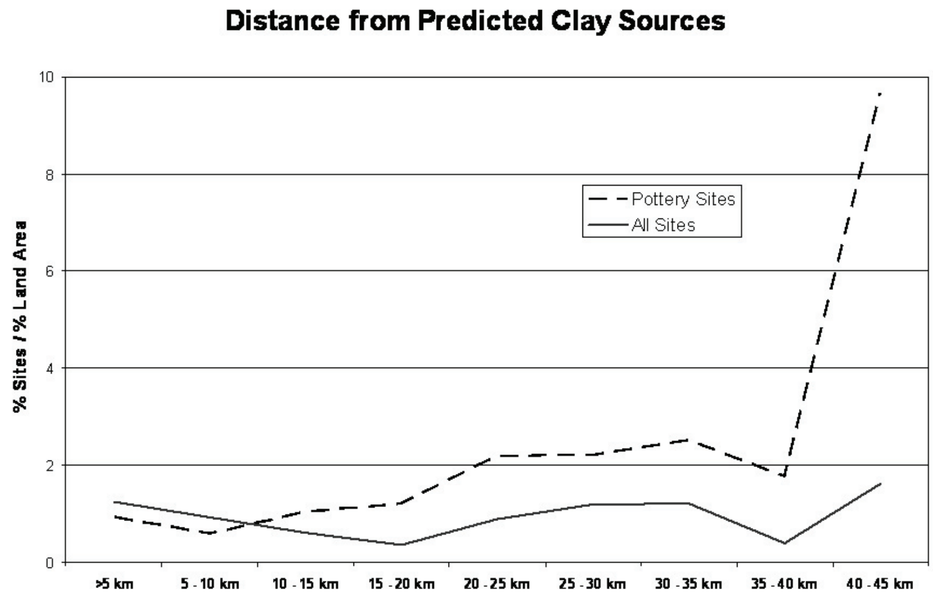

Figure 4. Graph comparing the distance from potential clay sources for recorded archaeological sites within San Bernardino County known to contain pottery and all recorded prehistoric sites.

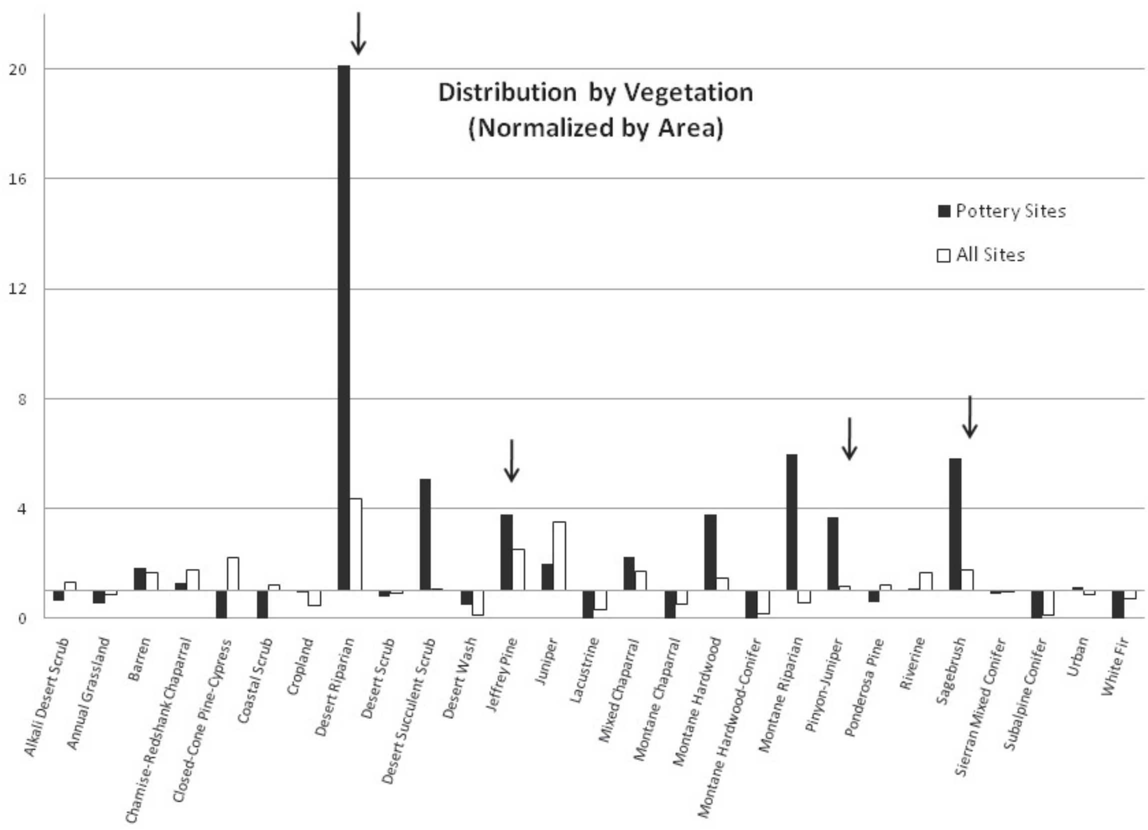

Figure 5 Distribution comparison of San Bernardino County archaeological sites containing ceramics versus all prehistoric sites in association with modern plant communities.

Eerkens (2001) believed that the co-occurrence of pottery and milling stones, specifically manos and metates, indicates that pottery introduction reflects an increased reliance on small seeds in the Owens Valley. This association cannot at present be pursued by our study as, unfortunately, no CHRIS attribute code is offered for portable milling equipment. The AP4 code for bedrock milling features can include both mortars and milling slicks, and thus it is as applicable to small seed processing as to acorns and piñon nuts. As pottery is expected in areas of resource processing and domestic activity and is typically associated with complex sites, it is not surprising that pottery frequently occurs in combination with bedrock milling features. Nevertheless, the extent to which pottery and bedrock milling features co-occur is impressive. Over 51 percent of pottery sites also listed attribute AP4, compared to about 23 percent of all sites. This 28 percent difference is nearly twice the difference for any other category.

Analysis

Unfortunately, available data were not sufficient to determine if production was by specialists or family groups. Some clustering occurs within the observed distribution, most notably in the mountainous portions of the Mojave National Preserve and on the north slope of ranges along the southern boundary of the county. Clustering in mountainous regions with exposed, eroding granitic geology may be connected with utilization of residual clay sources, but this clustering cannot presently be separated from sample bias inherent in heavily surveyed areas, including the Mojave National Preserve, San Bernardino National Forest, and Joshua Tree National Park. Clustering may also occur in areas dependent on pottery for resource intensification. It is unlikely that a GIS analysis of an area as large and diverse as San Bernardino County will be able to address this issue with meaningful results.

Table 1. Comparative Inventory of CHRIS Archaeological Attributes for San Bernardino County, California, Associated with Sites Containing Ceramics.

	Occurrence in SBR	Percent of Total	Association with Pottery	Percent of Pottery Sites	Δ Percent
AP2 (Lithic scatter)	5448	81.72	522	83.65	1.94
AP3 (Ceramic scatter)	Not Applicable				
AP4 (Bedrock milling feature)	1552	23.28	320	51.28	28.00
AP5 (Petroglyph)	322	4.83	52	8.33	3.50
AP6 (Pictograph)	100	1.50	41	6.57	5.07
AP7 (Architectural feature)	11	0.16	5	0.80	0.64
AP8 (Cairns/rock feature)	476	7.14	55	8.81	1.67
AP9 (Burial)	28	0.42	10	1.60	1.18
AP10 (Cache)	12	0.18	6	0.96	0.78
AP11 (Hearth/pit)	338	5.07	98	15.7	10.64
AP12 (Quarry)	393	5.89	13	2.08	3.81
AP13 (Trails/linear earthwork)	140	2.10	15	2.40	0.30
AP14 (Rock shelter/cave)	339	5.08	117	18.75	13.67
AP15 (Habitation debris)	269	4.03	124	19.87	15.84
AP16 (Other)	599	8.98	92	14.74	5.76

Analysis of distribution based on our sink prediction model offers better critique of the established paradigm for Great Basin pottery. Sites with pottery are not found in conjunction with large-scale sedimentary clay deposits, suggesting that ethnographic descriptions of use of residual clays are well founded, as is speculation based on brown ware composition. However, this analysis also suggests a difference between pottery distribution in the western Mojave Desert in San Bernardino County and Owens Valley and Death Valley in Inyo County; pottery is probably not concentrated along salt pan or playa margins as is the case to the north. Pottery site density within the saltbush scrub community is low compared to overall site density within the same community, providing additional confirmation that the connection between pottery use and these environments further north does not exist in San Bernardino County. It is possible that, although fewer in number, the sites within this zone have greater individual pottery density, but this cannot be determined because of the paucity of intensively studied pottery collections in the central portion of the county where these conditions are most prevalent.

A more plausible scenario is that in late prehistoric times the region around Owens Lake and the Death Valley salt pan supported important resources that were processed with pottery (brine shrimp and/or halophylic, small-seed bearing plants) and that such resources were not present in similar conditions farther south. Hotter temperatures in the Mojave Desert may also explain the dichotomy. The lower latitude and overall lower elevation of the Mojave Desert makes low elevation basins unsuitable for subsistence for most of the year. Fewer sites in these areas are associated with seasonal sedentary activity and thus less likely to require pottery. In addition to durability factors, brown wares made from residual clay sources may be a logical consequence of pottery production and use in higher altitude sites.

Comparison of distribution with modern plant communities suggests that resource processing or storage was the primary factor determining where pottery was used. Strong positive correlation between pottery presence and specific resource zones suggests that occurrence of pottery in site assemblages is best explained by intensification of specific resources. However, there may be more resources involved than small seeds. In addition to desert riparian and sagebrush communities where small seed intensification is a logical subsistence strategy, pottery is also associated with piñon-juniper woodland and Jeffrey pine forest. Once established, pottery may have been applied to multiple tasks where it was adaptive for new resources in different ecological zones. Processing of pine resin and pandora moth larvae are among the activities that have been documented elsewhere that could explain the intensive use of ceramics in areas without small seed resources (Weaver 1986; Eerkens 2005). Vegetation analysis also shows that pottery occurs in high density in areas where adequate resources might be available for prolonged utilization. However, except for the desert riparian community, most of these areas would be unlikely to be the focus of labor-intensive fuel gathering. It would be intriguing to learn whether the Owens Valley pattern of thinner pottery in fuel-poor areas also holds for San Bernardino County.

Future Research

Our research identified significant gaps in the CHRIS database (Burns and Olson 2008). This was most significant on federal lands where many more sites have been recorded and presumably reported to the information center than are actually present in the database. While this condition may never be fully remedied, an analysis similar to the one presented here, but limited in scope to smaller areas maintaining independent databases of intensively surveyed land, could provide more reliable conclusions. Detailed GIS analysis for Fort Irwin and China Lake would be a useful supplement to work already completed, while significant opportunities for new research exist in Mojave National Preserve and San Bernardino National Forest. A similar analysis applied to Inyo County would also be useful for verifying the results presented here and ensuring that models tested through other means are supported by GIS analysis.

Clearly, more studies requiring physical analysis of pottery are also in order. Collection studies to determine the extent of distribution of paddle-and-anvil wares and Owens Valley Brown Ware and the degree to which they co-occur or hybridize would provide significant clarification that is entirely absent from the present literature. Extension of INAA studies south to see if similar source groups exist is probably essential to understanding manufacture and production. If possible, residue analysis of pottery sherds selected based on surrounding vegetation communities should also be attempted.

Acknowledgments

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