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## Residential Mobility and Pottery Use in the Western Great Basin<sup>1</sup>

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The intersection of settlement patterns and material technology has long been of interest to archaeologists. For example, there is a huge body of literature on the relationship between mobility strategies and flaked stone assemblages. Similarly, much has been written on houses and other structures as they relate to mobility patterns. Unfortunately, for a range of reasons, similar effort has rarely been extended to ceramic technologies (but see Arnold 1985, Sassaman 1993, Bright and Ugan 1999, and Simms, Bright, and Ugan 1997).

At a general level, it is clear that pottery making and

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settlement patterns are correlated, pots are commonplace in sedentary societies but uncommon in residentially mobile groups. On theoretical grounds, this finding makes sense. Pots are heavy and taxing to carry during the seasonal round and, because they are fragile, may be exposed to high rates of breakage during residential moves. Further, mobile groups may not stay in one place long enough to complete the production cycle, a process which can take up to several weeks (Arnold 1985). Related to this problem is that the most opportune time to produce pots, the dry season, is also the time when many seeds, berries, and greens ripen, creating time conflicts between gathering and pottery production. Moreover, the small population sizes typically encountered among mobile hunters and gatherers tend to limit the demand for pots, and this prevents people from taking advantage of economies of scale in pot production (e.g., Brown 1989). In sum, pottery technologies do not fit in well with a mobile lifestyle.

Despite these obstacles, the anthropological and archaeological record contains numerous examples of mobile groups that produce pots. Understanding how they accomplish this should be of concern to all ceramicists, for it is often from these extremes that we push the methodological and theoretical boundaries of our understanding of ceramic use in prehistory. This paper explores several related questions. How do mobile groups overcome these obstacles to make pottery production worthwhile? Does the degree of residential mobility restrict or inhibit pottery use? Does mobility affect the design of pots? These questions have important implications for many topics of interest in archaeology, such as the origin of pottery, which often takes place in mobile hunter-gatherer settings, and the adoption and modification of new technologies (e.g., Aikens 1995, Close 1995, Hoopes and Barnett 1995, Ikawa-Smith 1976, Reid 1984, Rice 1999).

Simms, Bright, and Ugan (1997; see also Bright and Ugan 1999) have recently been exploring some of these questions in the eastern Great Basin of North America. Building on their work but taking it in a different direction, I investigate these issues in the western Great Basin. I examine pottery from a single tradition at a spatial scale that is larger than that of their study, which is based on individual sites and covers two distinct traditions, but smaller than the scale examined by Arnold (1985), which is based on linguistic groups, covers the globe, and includes many different traditions. On the basis of ethnographic and other information, residential mobility practices from six distinct regions in the western Great Basin are reconstructed. Pottery from the same six regions is then compared with mobility practices. I first examine the distribution and density of pottery to assess whether residential mobility affects the degree to which people engage in the craft. A greater reliance on pottery should be reflected in the archaeological record by more pots and, consequently, potsherds. This part of the study is referred to as the distributional analysis. I go on to examine whether residential mobility affects *how* pots are made, measuring potsherds for several different at-

tributes and comparing trends in the data with the data on residential mobility. I conclude by examining how mobile hunters and gatherers in the western Great Basin were able to incorporate pottery into their toolkit despite a high degree of residential mobility and how such processes may operate among mobile hunters and gatherers worldwide.

#### BACKGROUND AND SAMPLE

Although widely known in anthropology for their high residential mobility and social “simplicity” (Steward 1938, Thomas 1981), the Paiute and Shoshone hunter-gatherers of the western Great Basin did engage in pottery making. To be sure, pottery is never a dominant part of the archaeological record, but late-prehistoric sites contain enough sherds to suggest that pots were an integral part of the toolkit.

Although there is variability, vessels are usually medium-sized (ca. 15–25 cm high and 18–25 cm wide at the mouth) and undecorated. Conical straight-sided pots are most common, though spherical bowls with recurved rims are also present (Bettinger 1986, Eerkens 2001, Hunt 1960, Lyneis 1988, Pippin 1986, Prince 1986, Touhy 1990, Touhy and Strawn 1986, Wallace 1986). Judging from ethnographic descriptions (Gayton 1929, Steward 1933) and archaeological analysis (Bettinger 1986, 1989; Hunt 1960), vessels seem to have been constructed mainly by stacking coils of clay on a circular disk base and scraping these together with the fingers or a small object. Most pots are tempered with sand, though fiber was occasionally added. Vessels were fired at relatively low temperatures (ca. 600° C) and appear brown-red in color, giving rise to the general category of “brownware” recognized in the region.

Pottery making is predominantly a late technology in the western Great Basin and is consistently associated with other artifacts that date after 700 B.P. (Pippin 1986, Rhode 1994). In the Owens Valley, people seem to have been experimenting with pottery around 1,200 years ago (Eerkens, Neff, and Glascock 1999), but associations with radiocarbon dates indicate that the craft did not become established and commonplace until 500–700 years ago (Delacorte 1999). Although they performed a range of functions, residue studies suggest that pots were primarily used to boil seeds (Eerkens 2001). Clay provenance data demonstrate that pots were rarely transported outside their region of manufacture; only 5–15% of pots in most regions are exotic (Eerkens, Neff, and Glascock 2002). However, the frequency of pot transport varies slightly by region, with more mobile groups transporting pots slightly more often. Overall, production seems to have been on a small scale, likely at the family or individual level, for local and domestic use (Eerkens, Neff, and Glascock 2002).

For this paper, pottery from the following regions was analyzed: the Western Sierra Nevada (within and near Sequoia National Park), the Southern Owens Valley

(from Owens Lake to the Alabama Hills), the Northern Owens Valley (from just south of Big Pine to the Volcanic Tablelands just north of Bishop), Death Valley (mainly from Mesquite Flat and around the Salt Pan), Deep Springs Valley (mostly from around the playa), and the Northern Mojave Desert, including parts of China Lake Naval Weapons Center and Fort Irwin Army Base (fig. 1). The pottery examined came from distinct sites across the landscape in these areas, and it was impossible to control for logistically versus residentially occupied sites as Simms, Bright, and Ugan (1997) were able to do. For the distributional study, published data were consulted to determine where sherds were and were not found and their abundance (see Eerkens 2001 for a list of reports used). This part of the study focused on the sherd as the basic unit of analysis and included all sherds, whether bodies, rims, or bases. For the technological study, cur-

ated rim sherds from many of these same projects were analyzed for several attributes believed to be correlated with mobility strategies (e.g., Simms, Bright, and Ugan 1997).

#### ETHNOGRAPHIC MOBILITY

Those familiar with the ethnographic record of this region, particularly the work of Julian Steward (1933, 1938), will recognize a gradient of residential mobility strategies across the six different regions. Of course, residential mobility is a complex notion and can be measured across many different dimensions (Kelly 1995: 111–60). Thus, one group of people may on average make more residential movements per year while another may move less often but cover more territory (i.e., a larger average distance per move). Both groups may be de-

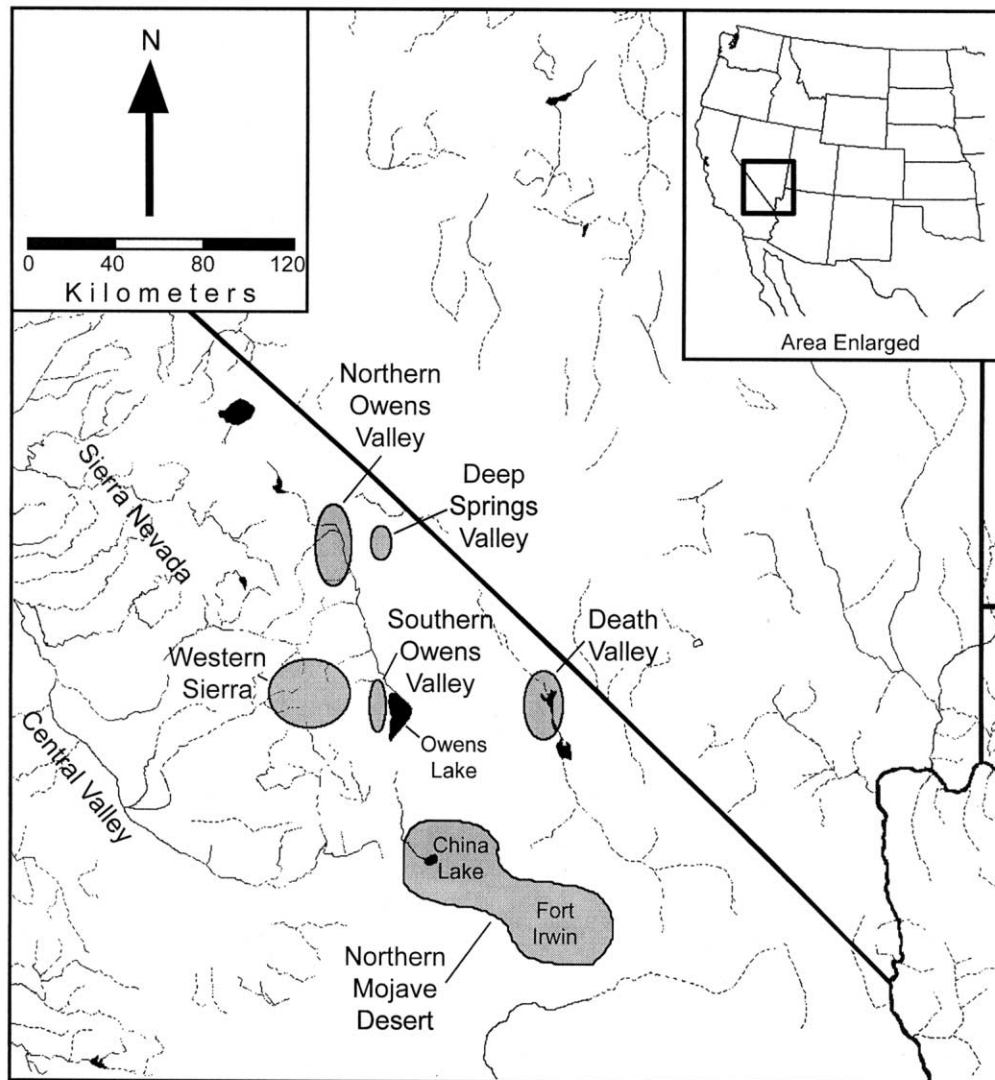


FIG. 1. Important geographic features and regions studied.

scribed as highly mobile, but ranking one over the other depends on which dimension is more heavily weighted.

Ethnographic and archaeological data support the notion that mobility practices varied greatly across the six regions. Following the original ethnographic work of Steward (1938), I focus in this study on the number or frequency of residential moves per year. Steward believed residential mobility to be inversely correlated with population density, which itself was correlated with precipitation and bioproductivity. Residential mobility was often necessary to take advantage of spatially variable and low-density food resources, especially piñon nuts, large game, and dryland seeds. Table 1 lists prehistoric population density estimates and precipitation levels for the six regions.

To reconstruct mobility, I begin with a study by Delacorte (1990), who compared mobility practices in four of the six regions under consideration, and add the remaining two regions to his analysis. Rather than any quantitative estimate of the frequency of residential moves, I provide only a relative and qualitative ranking between the different areas. Certainly this is a simplification, but for the purpose of comparing broad trends in mobility with pottery use I believe it is adequate. Delacorte (1990) suggested that the Paiutes living in the Owens Valley were less residentially mobile than those in Deep Springs Valley and the Deep Springs Paiute less mobile than the people of the Northern Mojave Desert (in particular, the China Lake region).

Extending his analysis, I interpret the Western Sierra Monache as less residentially mobile than the Owens Valley Paiute. These groups seem to have set up permanent camps that were rarely unoccupied. Staple resources including grass seeds, acorns, and manzanita berries were gathered from the surrounding landscape and carried back to the base village for processing, storage, and consumption (Gayton 1929, 1948; Gifford 1932). Northern Owens Valley groups practiced a similar settlement pattern and were mainly logistically mobile but seem to have moved their base camps into the piñon zone during some years. Seed irrigation tied domestic residences to particular tracts of land for much of the year. Groups in the Southern Owens Valley also had relatively permanent base camps on the valley bottom and relied mainly on logistical strategies to move foods to people. However, owing to the assumed absence of seed irrigation, these people were less tied to particular spots on the landscape and probably moved their base camps more frequently into higher-elevation areas or next to the lake to exploit seasonally abundant food resources (Steward 1933, 1938; Lawton et al. 1976). Thus, the Owens Valley groups are seen as more residentially mobile than their Western Sierra neighbors, with those in the northern end being slightly more sedentary than those in the southern end. Clearly, logistical mobility, whereby resources were brought to a main base camp from the surrounding landscape rather than moving the base camp to those resources, was an important aspect of settlement patterns in all three areas.

The remaining three areas all practiced residential mo-

TABLE 1  
*Population Levels, Average Precipitation, and Estimated Degree of Residential Stability*

Region	Population Estimate <sup>a</sup>	Average Annual Precipitation <sup>b</sup>	Mobility Rank
Western Sierra	0.5 <sup>c</sup>	57.7	1
Northern Owens	2.1	16.0	2
Southern Owens	2.1 <sup>d</sup>	14.5	3
Deep Springs	10.7	15.4	4
Death Valley	30.0	5.3	5
Northern Mojave	> 30 <sup>e</sup>	11.9	6

<sup>a</sup>In square miles per person; data from Steward (1938) unless otherwise noted.

<sup>b</sup>In centimeters per year.

<sup>c</sup>Data from Steward (1933).

<sup>d</sup>Steward (1933) gave this estimate for all of Owens Valley, but it probably applies more to the Northern Owens Valley, where he conducted his ethnographic work.

<sup>e</sup>Data from Delacorte (1990).

bility as a primary strategy to exploit available resources. Deep Springs Paiute moved less often than their Shoshone neighbors to the southeast in Death Valley (Steward 1938). Both groups set up base camps in either lowland or upland locations during the winter, moved across the valley bottom and mid-elevation areas during the early summer, used high-elevation (over 10,000 feet) areas in summer, and established upland piñon camps in the fall. However, the location of these piñon camps was not predictable from year to year. By contrast, most people using the Northern Mojave Desert were probably seasonal migrants from the surrounding region moving through in late spring and early summer with extremely high residential mobility (Zigmond 1981; for a summary see Eerkens 1999). On the basis of this information, Deep Springs Paiute are interpreted as less residentially mobile than Death Valley Shoshone and Death Valley Shoshone as less mobile than Northern Mojave groups.

Table 1 presents the final residential mobility rankings. I believe that most anthropologists familiar with the ethnographic record would generally concur on these rankings (i.e., would not significantly change them). An important assumption of this study is that mobility practices recorded by ethnographers in the early 20th century are related to late-prehistoric ones (ca. 700 B.P.–contact). I acknowledge that there is bias and misinformation in the ethnographic record and that there were changes in native lifeways due to disease and white contact prior to the commencement of ethnographic research (e.g., Blackhawk 1997). However, I believe that the patterns described are to a large extent still reflective of late-prehistoric ones, particularly with regard to more general issues such as settlement systems. Although there are minor differences, archaeological data are in general agreement with ethnographic ones with regard to mobility practices (i.e., Bettinger 1975, 1989; Delacorte 1990; Thomas 1971, 1983).

TABLE 2  
*Summary of Distributional Study and Density of Pottery in Regions*

Region	Mobility Rank	Sample Size	Sherds/Acre	Sherds/Points	% Sites with Sherds	Average Surface Area <sup>a</sup>	Pottery Rank
Western Sierra	1	1,657	n.a.	11.9	n.a.	1,295	3
Northern Owens	2	1,210	.02	5.2	7	1,702	6
Southern Owens	3	7,886	.14	33.9	54	1,907	1
Deep Springs	4	222	.06	7.9	38	n.a.	4
Death Valley	5	7,293	.09	17.7	48	1,529	2
Northern Mojave	6	2,130	.05	7.7	14	1,453	5

<sup>a</sup>In square centimeters.

#### DISTRIBUTIONAL STUDY

For the distributional study I chose to examine the presence and density of potsherds in lower-elevation areas (below the piñon-juniper zone) in the six different regions. Restricting the comparison to these areas helps to standardize the study in several ways. First, it facilitates comparison of pottery from similar environmental, settlement, and functional contexts. Second, because pottery is most common in these areas, it maximizes the sample size of sherds included in the study.

I assume that larger numbers of sherds left behind reflect a greater reliance on pottery in everyday life. Holding population size constant for the moment, people more dependent on pots should leave behind more broken pots and consequently more sherds than people less dependent on them. The reliance on pottery is then compared with residential mobility strategies. Over 20,000 sherds were included in this part of the study, the majority (over 14,000) coming from two regions, Death Valley and the Southern Owens Valley.

The presence and density of pottery were measured in three different ways from excavation and survey reports. First, I estimated the density of pottery by calculating the number of sherds per acre surveyed (surface survey data only). The main disadvantage of this measurement is that it fails to control for population density. More people will leave behind more sherds, even if they make less use of pottery on an individual basis. Thus, this measure is appropriate only when comparing areas that have approximately equal population densities, which is clearly not the case here. To correct for this problem the second measure standardizes the number of sherds in an area by another artifact category dating to the same time period, in this case Cottonwood Triangular and Desert Side-Notched projectile points. This measure assumes that the number of projectile points produced per person is approximately the same in different areas and that changes in the sherd-to-point ratio primarily reflect differences in the rate of pottery manufacture. It also mixes survey and excavation data. The third measure, following Weaver (1986), examines the presence of pottery in an area by tabulating the percentage of recorded sites containing potsherds (surface survey data only). Although they measure pottery use in slightly different ways, the three measures are highly correlated.

I recognize that data from the second measure, which mixes survey and excavation data, could be biased by postdepositional processes. Since surface sherds are more likely to break into smaller fragments than buried ones, regions containing primarily survey data may have more sherds per point than regions with mostly excavation data. cursory visual inspection of the difference between survey and excavation tends to support this conclusion. The average sherd-to-point ratio for 12 surveys is 21.3, while for 25 excavations it is 13.7. A large part of this difference is due to the influence of a few extensive surveys in pottery-rich areas. If we hold the region constant, the differences are less pronounced. For example, in the northern Owens Valley the ratio is 5.7 for surveys and 4.8 for excavations, and in Death Valley the ratios are 18.0 and 13.5 respectively. Although combining survey and excavation data into a single analysis is not ideal, the nature of survey and excavation work in different areas precluded the systematic elimination of one of these data sets. Doing so would have seriously reduced the size of the data set, subjecting statistical analyses to potential biases resulting from the inclusion of outliers such as pot drops or projectile-point caches.

Pot size may also play a biasing role here in that larger pots break into more pieces than smaller ones. At the same time, larger pots take more raw materials and effort to construct and in some sense imply a greater reliance on pots in the first place. Differences in pot size between the regions of interest are moderate rather than extreme. The average surface area of 44 whole or reconstructed pots that have been recovered in the six regions ranges from about 1,300 cm<sup>2</sup> in Sequoia to 1,900 cm<sup>2</sup> in the Southern Owens Valley (see table 2).

Although collection strategy and average pot size may potentially introduce bias, I do not believe it to be severe and/or systematic on a regional basis. Two of the three measures use survey data only, thereby standardizing collection strategy, and one (percentage of sites with sherds) is unaffected by pot size. Moreover the three pottery density measures are correlated although they rely on very different kinds of data. Thus, I argue that together the three pottery measures record, in a general sense, the overall late-prehistoric dependence on pottery.

Using the data in table 2, a ranking for the degree of reliance on pottery was generated. The lack of systematic

TABLE 3  
Results of Technological Study, Regions Listed in Order of Increasing Mobility

Region	No.	Diameter (mm)		Thickness (mm)		Exterior (%)			Interior (%)			Temper Size (%)		
		Avg.	C.V.	Avg.	C.V.	Smth	Scrp	Rgh	Smth	Scrp	Rgh	Fine	Med	Crs
Western Sierra	34	237	.36	5.15	0.23	39	58	3	64	30	6	15	44	41
Northern Owens	30	274	.35	6.64	0.17	7	83	10	17	60	23	18	53	30
Southern Owens	117	248	.31	5.97	0.22	19	54	27	12	74	14	34	50	17
Deep Springs	15	237	.11	5.55	0.11	22	49	29	27	73	0	22	46	32
Death Valley	73	251	.25	5.57	0.18	10	76	16	11	86	3	19	58	23
Northern Mojave	19	215	.25	5.80	0.19	11	44	44	5	68	27	33	47	20

NOTE: Each sherd represents a unique pot. No., number of rim sherds measured; C.V., coefficient of variation; Smth, smoothed; Scrp, scraped; Rgh, rough; Med, medium; Crs, coarse. Twelve of the 19 sherds from the Northern Mojave are from the China Lake region, 7 from Fort Irwin.

survey in the Western Sierras precluded calculation of two of the three measures, requiring a focus on the sherd-to-point ratio in this region. Pottery in the Southern Owens Valley is clearly most dense and widespread. Over half of the sites in the region have sherds, the number of sherds per acre surveyed is over twice as high as in other regions (except Death Valley), and, relative to late-period projectile points, sherds are most numerous. That the Southern Owens Valley has a high density of pottery has already been noted by others (e.g., Basgall and McGuire 1988, Delacorte 1999, Weaver 1986). Pottery in Death Valley seems to be second most common, followed in decreasing order by the Western Sierras, Deep Springs Valley, the Northern Mojave, and the Northern Owens Valley.

If increasing residential mobility had a restricting effect on the degree to which Paiute and Shoshone engaged in pottery making, the results in table 2 are *not* what we would expect. A Spearman's rank-order correlation coefficient of 0.03 is obtained when residential mobility rank and pottery rank are regressed (two-tailed significance of 0.96), indicating that there is no correlation. Residentially mobile groups seem to make just as much pottery as more sedentary groups and in many cases more. Clearly, Western Great Basin people were using some set of strategies to counteract the restrictions imposed by a mobile lifestyle to make pottery a worthwhile technology. These strategies are investigated below.

#### TECHNOLOGICAL STUDY

To provide some degree of standardization to the technological study, only rim sherds were measured. Rim sherds offer estimates for many attributes, such as size and shape of vessel, that body sherds cannot provide. Measuring only rim sherds also facilitated comparison of wall thickness between different assemblages. Since wall thickness varies with location on the vessel (i.e., rim versus middle of vessel versus base), limiting the sample to rim sherds controls for this potential bias. Moreover, the goal was to have each rim sherd represent a unique pot. Thus, if two rim sherds from the same site

appeared similar in outward appearance or were found in close proximity, only one was included in the analysis. This strategy certainly tends to minimize the sample size available, which makes statistical comparisons less robust. At same time, it ensures that each sample is derived from an independent pot (or sample), a requisite for most statistical tests. Thus, rather than being based on broken sherds, this part of the study focuses on individual pots. A total of 288 pots are included in this part of the study. The majority of these samples have also been analyzed by instrumental neutron activation analysis (Eerkens, Neff, and Glascock 2002), facilitating comparison between region of production (versus deposition) and pot size and shape.

For each rim sherd, thickness was measured to the nearest tenth of a millimeter at a location 1 cm below the lip using digital calipers. Occasionally pot thickness appeared to be variable across the piece. In these cases several thickness measurements were taken and averaged. Exterior and interior surface treatment was classified using the categories "rough," "scraped," and "smooth." To examine temper constituents, a fresh or recent break was examined on each sherd under low-power magnification (10–30×). The apparent average size of mineral temper within each sample was measured using calipers. Average particle size below 0.25 mm in diameter was considered "fine," between 0.25 and 0.5 mm "medium," and larger than 0.5 mm "coarse." The presence and density of organic temper were also noted.

The various regions exhibited pronounced technological differences (table 3). Most divergent are the sherds from the Western Sierras, which are significantly thinner and more often smoothed and have larger temper size on average than those from any other region. Clearly, these pots were made with different intended functions in mind than pots in the rest of the western Great Basin and could arguably be considered part of a separate ceramic tradition. Sherds from the Northern Owens Valley also stand out, being thicker than others and rarely smoothed and containing medium-sized temper. The other regions are more similar to one another, with the Southern Owens Valley displaying the finest temper of

any region. Paired *t*-test comparisons between regions (assuming unequal variance) are significant at the .05 level for the majority of the thickness and nearly half of the diameter measurements.

To relate these differences to mobility and understand trends in the data, I have calculated regression coefficients (Pearson's *R*) between the technological variables and the mobility and pottery density ranks. Although the use of an ordinal independent variable in regression analysis is not statistically sound, it can be used to reveal trends in data, particularly when the number of ranking categories is greater than five (e.g., Berry 1993:47). For a more robust statistical treatment, I have also converted the technological attributes (e.g., average thickness, mouth diameter) into a ranked ordinal scale from smallest (1) to largest (6) and compared them with mobility and pottery density rankings. Pearson's *R* and Spearman's  $\rho$  statistics for these tests are presented in table 4.

The data suggest that there is a tendency for pots to be narrower at their mouths, slightly thinner, more often rough on their exterior surfaces, and more finely tempered in areas where people were more residentially mobile. The strength of this relationship varies among the different attributes. For example, interior and exterior surface treatment are most strongly correlated with residential mobility, while thickness is only marginally correlated (though the correlation with thickness increases greatly if the Western Sierra pots are removed from the analysis). These differences likely relate to alternative intended functions and design constraints on pots in the different regions. In addition, there are relationships between mobility and variability in thickness and diameter as measured by the coefficient of variation. Pots in regions where people are more mobile are less variable, suggesting that they make a more limited range of pot sizes and shapes.

#### POTTERY USE IN THE WESTERN GREAT BASIN: DISCUSSION

Overall, the results demonstrate that residential mobility does not limit the quantity of earthenware vessels

produced in the western Great Basin. As indicated by all three measures of pottery density, highly mobile groups, including those using quite marginal environments such as the Northern Mojave Desert and Death Valley, made and used significant numbers of earthenware pots.

How did people in the western Great Basin organize pottery production and use within the constraints of a mobile lifestyle? A major factor may have been the ability to cache pots at particular locations in the landscape. In particular, if pots were used to process only a subset of the range of resources consumed in a single year and these resources were located at fixed spots in the landscape, places people knew they would be returning to, it may have been possible to store pots at these locations and avoid having to carry them around during the seasonal round. Indeed, an examination of the spatial distribution of pottery reveals some interesting trends. Several surveys in the region demonstrate that potsherds are much more common in valley-bottom locations, next to rivers and lakes, than in other parts of the landscape. For example, table 5 presents the results of five such surveys, three from the areas discussed above and two from the central Great Basin, showing that potsherds are between two and eight times more numerous in lowland areas and in the Reese River Valley come exclusively from this setting.

Besides the fact that they have all the resources necessary to make pots (e.g., clay, sand, water, firewood), a major advantage of riverside and lakeside locations is that they are fixed in the landscape and have predictable sources of water. As a result, the food resources in these locations are spatially and temporally predictable, particularly when compared with other Great Basin resources such as piñon nuts and dryland seeds (Thomas 1972). If pots were involved in processing wetland seed resources, a position supported by residue analyses (Eerkens 2001), caching may have been an important strategy for making the technology worthwhile. By leaving their heavy pots on the shores of rivers and lakes, people could avoid carrying them around as often and as far, and this also reduced rates of breakage. In addition, the higher density of foods in wetland areas may have allowed peo-

TABLE 4  
*Correlation Statistics for Technological Study*

Independent Variable and Statistic	Diameter		Thickness		Rough Exterior	Smooth Interior	Fine Temper
	Avg.	C.V.	Avg.	C.V.			
Mobility rank							
Pearson's <i>R</i>	-0.52	-0.61	-0.04	-0.35	0.81	-0.74	0.54
<i>R</i> signif.	.29	.20	.94	.50	.05	.09	.27
Spearman's $\rho$	-.43	-.83	.09	-.31	.83	-.83	.60
Spearman's signif.	.40	.04	.87	.54	.04	.04	.21
Density rank							
Pearson's <i>R</i>	0.06	-0.03	0.47	-0.42	0.10	-0.10	-0.20
<i>R</i> signif.	.91	.96	.35	.40	.87	.89	.70
Spearman's $\rho$	-.09	-.09	.26	-.49	.09	.03	-.31
Spearman's signif.	.87	.87	.62	.40	.87	.96	.54

TABLE 5  
*Distribution of Pottery (%) by Environmental Zone (Adjusted by Area Surveyed)*

	Valley Bottom	Piñon/Juniper	Above Piñon	Reference
Northern Owens	86	12	4	Bettinger (1975)
Deep Springs	64	36	0	Delacorte (1990)
Northern Mojave	63	37	n.a.	Gilreath and Hildebrandt (1997), Hildebrandt and Ruby (1999)
Reese River	100	0	0	Thomas (1971)
Monitor Valley	76	15	9	Thomas (1983)

ple to remain in one location long enough to see the pottery production cycle through. In this respect, they may have been able to avoid the inconsistencies discussed in the opening paragraphs between mobility and pottery production and use. Thus, the spatial predictability, relative patchiness, and seasonal abundance of lowland food resources in the western Great Basin may have afforded Paiute and Shoshone people the opportunity to engage in pottery making despite their mobile lifestyles. Indeed, caches of pots have been recorded in various rock shelters and caves (e.g., Bayman et al. 1996, Campbell 1931, King 1976, Wallace 1965). Thus, the degree of dependence on spatially predictable seed resources may have been more important than the overall degree of residential mobility in the decision to make pots (or not). Greater reliance on these resources resulted in a greater number of pots' being made.

While residential mobility did not affect the degree of dependence on pots, it does seem to have affected the way they were made. Pots in regions where people were more mobile are smaller at their mouth and in surface area, thinner, and more often rough on their exterior surface and contain finer temper. They are also more standardized in size and shape. As Simms, Bright, and Ugan (1997) suggest, extensive surface modification (including roughening or smoothing), addition of finer temper, and the creation of thinner walls represent an increase in investment of time and labor. Thus, it appears that increased residential mobility in the western Great Basin prompted an increased investment in pots.

Why might we expect an increase in investment with increased mobility? I suggest that the conflicts of integrating a fired-clay technology with a mobile lifestyle in an arid environment prompted certain fuel-conservation modifications to pottery technologies. In particular, reduced availability of firewood in areas such as Deep Springs Valley, Death Valley, and especially the Northern Mojave Desert encouraged potters to thin the walls and roughen the exterior surfaces of their pots to increase heating efficiency. Although they are not as strong and resistant to impact stress, thinner pots will transfer heat more quickly, minimizing cooking time and the amount of fuel needed (Bettinger, Madsen, and Elsten 1994:95; Braun 1983; Smith 1985). Indeed, finer temper may reflect an attempt to increase tensile strength in these thinner pots (Eerkens 2001), though the relation between temper size and shock resistance is complicated (e.g., Bronitsky and Hamer 1986, Rye 1976). Further, rough-

ening the exterior increases the surface area that is exposed to an external flame, thereby increasing the amount of heat absorbed and transferred to the contents (Juhl 1995). More heating-efficient pots are a clear advantage in areas where firewood is scarce (Bettinger, Madsen, and Elsten 1994:95). In addition to maximizing fuel efficiency, smaller and thinner pots with rough exteriors dry more quickly, take less time to make, are light in weight, and present fewer problems during firing. Reduced weight, particularly in the Northern Mojave Desert, may have been advantageous, as proportionally more of these pots appear to have been carried into the region from outside it (Eerkens 1999, Eerkens, Neff, and Glascock 2002). A reduction in manufacturing time would have also been advantageous for residentially mobile groups, who might not otherwise have had the time to produce pots. These factors must have played an important role in the development of fired-clay technologies in the western Great Basin. As a result, residentially mobile groups had to invest more time and labor in their pottery than more logistically mobile people.

While these results may seem to run counter those reached by Simms, Bright, and Ugan (1997), who find decreasing investment with increasing mobility, a closer examination shows this not to be the case. While the pottery examined here is from a single "tradition" (Western Sierra sherds excluded) in which all groups have relatively mobile settlement patterns, their sample compares ceramics from distinct traditions including nomadic foragers and sedentary farmers. In addition, their study takes the site rather than the region as the basis of analysis, allowing them to control for site type (e.g., temporary versus base camp). When we restrict mobility strategies to more mobile peoples and examine regions rather than sites (averaging site types), a different picture emerges. In fact, a comparison with the work of Simms and colleagues may explain why Western Sierran pots appear so different from other western Great Basin pots. As we have seen, the Western Sierran pots show the most technological investment, and people there were least mobile. A nearly sedentary settlement pattern may have fostered a different set of social and environmental factors that required or allowed for greater investment in ceramic technology.

The restrictions imposed by a mobile lifestyle in the western Great Basin may also account for the low variation (as measured by the coefficient of variation) witnessed in mouth diameter and pot thickness in regions



where people were more mobile. The need for a reliable technology in marginal environments probably led to less experimentation and strict adherence to a proven system. Indeed, the long time between initial experimentation (ca. 1,200 B.P.) and eventual adoption (ca. 600 B.P.) may be explained by this factor, that is, a conservative approach to incorporating new technologies.

#### POTTERY USE AMONG MOBILE HUNTER-GATHERERS

While the discussion above relates to the specific case of pottery in the western Great Basin, aspects of it can be applied to mobile hunting and gathering groups in general. I would argue that the degree of occupational redundancy or tethering to certain locations, that is, the degree to which people make consistent and predictable use of specific areas, rather than overall residential mobility, should be a better predictor of pottery use (see also Arnold 1985:120; Hoopes and Barnett 1995:4; Simms, Bright, and Ugan 1997:789). Arnold (1985:120) used the term “temporary” or “partial” sedentariness to refer to this concept. In particular, he found that fully nomadic groups rarely make pots but 75% of semisedentary (transhumant) and nearly all (91%) of fully sedentary societies do. While his “partial sedentariness” captures the notion that people stay put in one place long enough to produce pots, it does not give the sense that people come back to these spots, where they may cache their tools (although he certainly recognizes that this could be part of the process). Simms, Bright, and Ugan (1997:789), in contrast, use the term “occupational redundancy,” which I believe better captures this notion.

In particular, I would argue that the degree of occupational redundancy in areas with resources suited to mass collecting and boiling, especially small seeds, should be better correlated with pottery use. While occupational redundancy may promote decreased mobility and/or sedentism in the long run (see Kelly 1995), quite mobile peoples can still be tethered to certain locations by making consistent and repeated use of them. By caching, such groups may be able to take full advantage of technologies that are normally reserved for more sedentary groups, including heavy and/or fragile tools such as milling stones and earthenware cooking pots. The success of a caching strategy will be highly dependent on the spatial predictability of the resources for which the tools are needed and the ability to leave objects without risk of theft and/or breakage.

If this is the case, it is not surprising that pottery is often associated with incipient agricultural strategies worldwide. Agricultural societies are clearly tethered to certain locations and make predictable and consistent use of them. Moreover, small seeds are often a major product grown in such societies and are easily and efficiently boiled in pots. This suggests that pottery may often develop in intensive hunting-and-gathering settings prior to the development of agriculture.

Restrictions on technology imposed by a residentially mobile lifestyle may force such groups to modify their technologies in predictable ways (Simms, Bright, and

Ugan 1997, Bright and Ugan 1999). For example, we may expect to see more standardization in certain attributes, especially size, shape, and weight. A mobile lifestyle may not allow for a range of shapes to be made and used, and experimentation with new designs may not be possible, particularly in marginal environments where the cost of failure is high. Only after people become more sedentary and the craft becomes established will we see elaboration in shapes, sizes, and styles, particularly as the technology is employed for other purposes (see also Hoopes and Barnett 1995; Simms, Bright, and Ugan 1997:783). For heavier technologies that are cached, we may not see much in the way of decoration or other modifications. While potters may add decoration for their own artistic enjoyment, if the goal is to transmit social information such as status or faction membership such effort may not be worth the time because the pots will be out of view for much of the year.

In sum, it is true that nearly all sedentary societies make pots, a high percentage of transhumant societies do, and most nomadic societies do not. At this general level there is a strong correlation between pottery production and residential mobility. However, as Arnold (1985:109–25) has shown, the relationship between mobility strategies and pottery production is much more nuanced. A conservative approach to incorporating and experimenting with new technologies in marginal environments, as well as lower population densities, may explain why mobile groups often take longer to engage in pottery making (or never do). This may partly explain the observed correlation between pottery making and mobility strategies. However, once mobile groups have modified the technology to suit their particular needs and begun to produce pots, the degree of residential mobility does not affect *how much* they make. Instead, the degree of occupational redundancy at fixed spots on the landscape may be more of a factor in the decision to make and use pots and how much pottery is made.

There is also a strong correlation between mobility and the way pots are made. What we witness in the western Great Basin is the inventiveness, albeit conservative, of Paiute and Shoshone people in modifying the size, shape, and technological features of an existing technology to suit their particular situation. Only through the study and comparison of these “aberrant” or marginal cases at both small and large spatial scales will we learn more about the factors contributing to the introduction and origins of pottery making worldwide.

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## The Oldest Hominid Habit? Experimental Evidence for Toothpicking with Grass Stalks<sup>1</sup>

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It has long been appreciated that integrating biological and cultural data sets represents one of the most productive approaches in paleoanthropology. The earliest evidence of material culture from the hominid paleontological record consists of stone tools embedded in sediments more than 2.5 million years old (Semaw et al. 1997). Behavioral insights into the butchery of large

mammals by hominids have been generated by zooarchaeological analysis of modified animal bones of equivalent antiquity. Building on this record, the remains of early hominids themselves have often been used in attempts to understand early hominid behaviors.

Early in the last century, some fossil hominid teeth were observed to bear grooves between adjacent post-canine teeth. A recent review of these interproximal wear grooves demonstrates how behaviors can be inferred from skeletal evidence (Ungar et al. 2001). These grooves appear mostly on the root, their axis often paralleling the cervicoenamel junction of some premolars and molars from members of the genus *Homo*, including *H. erectus*, *H. neanderthalensis*, and *H. sapiens*. These grooves are semicircular in mesiodistal cross section and 1.5 mm to 2.6 mm in width and typically appear as elongated ovals on the mesial and/or distal aspects of the teeth.

Interproximal wear grooves have been recognized for almost a century, and different ideas have been put forth to explain them. Ungar et al. (2001), summarizing this literature, conclude that toothpicking is the only hypothesis consistent with the known distribution, micro-anatomical morphology, and anatomical placement of these grooves in early hominid premolars and molars.

Next to the use of lithics, the use of toothpicks by hominids is potentially one of the most persistent behaviors visible in the archaeological record. As Turner (1988) puts it, interproximal wear grooves represent the earliest evidence of any hominid habit. Toothpick grooves provide evidence for paleodiet, oral health, and possibly, because they sometimes occur at higher frequencies in males than females in modern human populations, even gender roles (Berryman, Owsley, and Henderson 1979, Turner and Cacciatori 1998).

One of the primary criticisms of the toothpicking hypothesis is, as Ungar et al. (2001) and others (Brown and Molnar 1990) note, that these grooves have never actually been documented in the molars or premolars of modern industrialized populations, even among heavy toothpick users. Additionally, for early hominids, the regular shape of these grooves and their wide distribution in time and geography would appear to require toothpicks of a regularity of manufacture beyond what is seen even in the latest Paleolithic, and yet they are present in the Oldowan.

The most viable alternative theory is the preparation of strands of sinew (Brown and Molnar 1990). Ethnographic films from Swanport, South Australia, show sinew-stripping activities that might result in interproximal wear grooves. However, the morphology of the grooves themselves is not always consistent with such activities, since not all of the grooves are worn completely across the cervicoenamel junction from buccal to lingual and not all are uniform in shape, some being more conical. Both the toothpick and sinew explanations are plausible and not necessarily mutually exclusive. Experimentation has been called for from both sides of the debate (Eckhardt and Piermarini 1988, Frayer 1991, Formicola 1991).

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