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Distribution and Conveyance of Late Prehistoric Western Mojave Obsidian Artifacts

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DISTRIBUTION AND CONVEYANCE OF LATE PREHISTORIC WESTERN MOJAVE OBSIDIAN ARTIFACTS

A Thesis

Presented to the

Faculty of

California State University,

San Bernardino

In Partial Fulfillment

of the Requirements for the Degree

Master of Arts

in

Applied Archaeology

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by

Nicholas Shepetuk

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ABSTRACT

There is a significant lack of publication, synthesis, and analysis of existing Late Prehistoric obsidian artifact sourcing data in the western Mojave Desert. However, a wealth of such data exists, especially in non-published archaeological reports produced mainly by cultural resources management firms. The purpose of this study was to test the validity of two regions which are divided roughly by the Mojave River and which are based on Sutton's (1989) interaction sphere model. The Northwestern Region occupies the portion of the Mojave Desert to the north and west of the Mojave River, while the Eastern Region makes up the area to the south and east of the River. It was claimed that groups in these two regions relied on different obsidian sources. Sutton asserted that in the Northwestern Region, groups relied almost exclusively on Coso obsidian, which comes from the Coso Volcanic Fields located on the Naval Air Weapons Station, China Lake approximately 26 miles north of Ridgecrest. In the Eastern Region, Sutton claimed that the majority of culturally modified obsidian came from four sources (Bagdad, Umpire, Hole-in-the-wall, and Hackberry Mountains sources) which were located within that area.

Obsidian source data for the region was gathered via review and synthesis of the literature. This was used to learn what proportions of obsidian sources were utilized in the two regions. This data was then statistically analyzed using an independent samples *t* test to determine if any observed differences were significant rather than resulting from the vagaries of sampling.

The results indicated that the two regions were indeed statistically significantly different from one another. In the Northwestern Region a nearly exclusive reliance on Coso obsidian was identified and in the Eastern Region a nearly equal reliance on Eastern Source material and nonlocal source material was observed. Several implications of these results are discussed below.

A number of factors could have affected the frequencies of obsidian sources utilized. Cultural differences (i.e., differing linguistic affiliations) and historical factors (i.e., immigration of Takic people or diffusion of Takic language into the Eastern Region) may have led to political limitations having been placed on trade. Material quality and manufacturing needs may have affected preferences for certain sources. The abundance and availability of various obsidian sources may have influenced the observed frequencies. And the fact that the Coso obsidian trade network was long standing may have made it a more readily available and tradable option than others.

Finally, the material conveyance methods responsible for the observed distribution of obsidian are discussed. Groups inhabiting the Coso area within the Northwestern Region obtained Coso obsidian through direct access. The people of that region outside of the Coso area relied on trade and exchange. Those inhabiting the Eastern Region got Eastern Source material through direct access and/or embedded procurement and most nonlocal source material was obtained through trade and exchange.

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DEDICATION

To Christina. You are my love and my life.

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CHAPTER ONE

INTRODUCTION

The Mojave Desert contains some of the most archaeologically well-researched locations in the western portion of North America (Sutton et al. 2007). Numerous obsidian sourcing studies have been conducted throughout this desert, especially in military bases such as Fort Irwin and Edwards Air Force Base, by cultural resources management (CRM) firms and government agencies (e.g., Christensen et al. 2004). Although there have also been a number of published studies which sourced obsidian artifacts there (e.g., Sutton 1987; Sutton et al. 2000; Williams 2009), there has not been enough work done to synthesize this kind of available data to create meaningful interpretations about the movement of obsidian and its trade.

Synthetical studies such as these, while rare, have been carried out in the Mojave. Sutton (1989) proposed a model of three distinct interaction spheres in the Late Prehistoric Mojave Desert which he based in part on obsidian artifacts in terms of their sources (see figure 1 above). The two interaction spheres that occupied the areas roughly to the north and west of the Mojave River (combined into one area by the current thesis, hereafter referred to as the Northwestern Region) were reported to have utilized almost exclusively Coso obsidian and some other more distant sources, hereafter referred to as nonlocal sources (these include: San Felipe, Baja California; Casa Diablo; Fletcher; Inyo Crater; Buck Mountain; Queen; Obsidian Butte), while the area south of the river (hereafter referred to as the Eastern Region) had very little obsidian artifacts, the vast majority of which came from “local sources” (hereafter referred to as Eastern Sources) where loose nodules could be gathered from the surface (see Figure 2 below). Other scholars have conducted studies that are similar in terms of their use of sourcing to learn about trade in the Mojave. For example, Scharlotta (2014) examined how lithic artifact raw material moved through Antelope Valley by doing geochemical analyses of rhyolite and obsidian artifacts. He suggested that west Sugarloaf subsource obsidian was traded from the Coso Volcanic Fields, through Antelope Valley, and on to more distant locales such as the

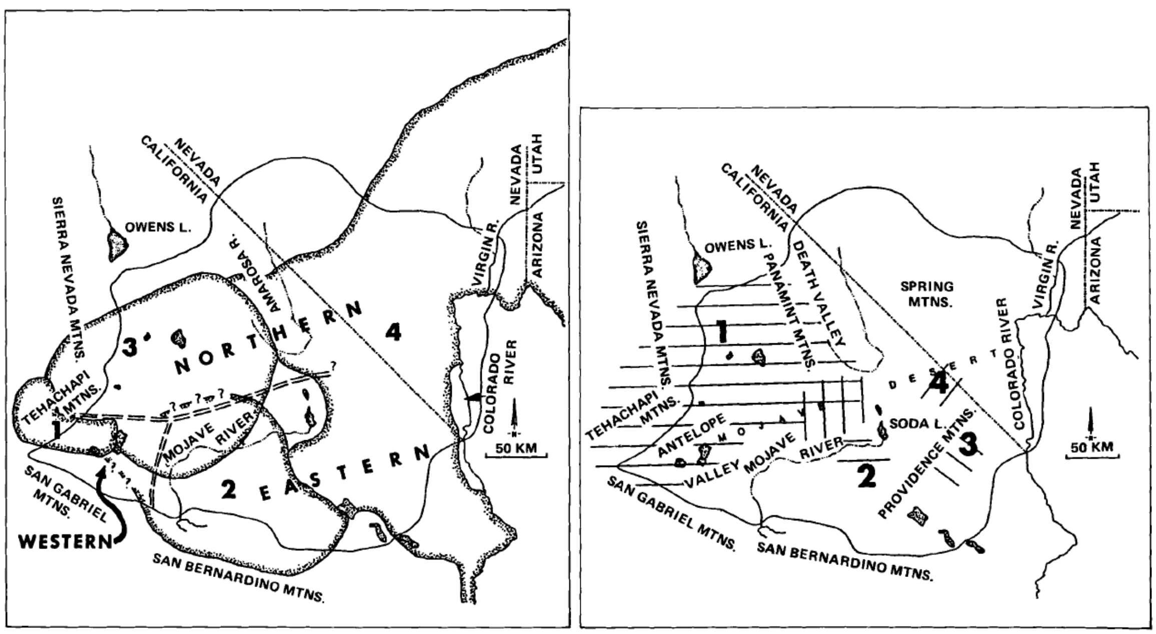

Figure 1: Maps of Western Mojave Desert Interaction Spheres:
Left image, “Interaction spheres (double lines) and ethnographically recorded territories in the Mojave Desert: 1) Kitanemuk (after Blackburn and Bean [1978:Fig. 1]); 2) Serrano (after Bean and Smith [1978:Fig. 1]); 3) Kawaiisu (after Zigmond [1986:Fig. 1]); and 4) Southern Paiute (after Kelly and Fowler [1986:Fig. 1]).” Right image, “Obsidian sources (numbers) and distributional patterns (screening) identified in the Mojave Desert and southern Sierra Nevada. 1) Coso volcanic field (horizontal lines) (includes east-central California and Nevada sources); 2) Bagdad and 3) Hackberry (left sloping lines); 4) Umpire (right sloping lines); and Obsidian Butte (vertical lines) (location off map to the south).” (Sutton 1989)

California coast. Sutton's model was created based on the data available in 1988, reported in an article published that year (Sutton 1988a). No statistical analyses were reported as having been done to support the model's claims.

Purpose and Research Questions

The purpose of this study was to determine if the Eastern Region was distinctly different from the Northwestern Region in terms of its obsidian source utilization, and to better understand the factors that influenced the distribution of the obsidian and the methods of its conveyance. To achieve this, a significant amount of new data was gathered via literature review to bolster and build upon Sutton's database. This data was then subjected to an independent samples *t* test to compare the Northwestern and Eastern Regions. The independent variable was the location (i.e., the two regions being compared). The dependent variable was the proportions of nonlocal to Eastern Source obsidian artifacts in each region.

The following four questions have guided research conducted as a part of the current study:

1. What are the proportions of nonlocal source obsidian artifacts and of Coso obsidian artifacts to the total number of obsidian specimens per site in the Northwestern Region and in the Eastern Region?
2. Is there a statistically significant difference between these proportions in the Eastern Region and in the Northwestern Region (i.e., are the two regions different in terms of their obsidian source utilization)?

3. If there is a significant difference, what factor(s) may have led to that being the case?
4. How was obsidian conveyed to both of these regions? Were different conveyance methods being utilized by them?

By utilizing existing data and building upon prior studies, the current thesis has created a more meaningful and well-backed model of obsidian distribution and conveyance in the Late Prehistoric western Mojave. Not only has this deepened the knowledge of behavior in terms of its economic, geographic, and political elements, but it can also serve as a steppingstone towards an increasingly detailed understanding of these aspects of life in that region and time period.

CHAPTER TWO

BACKGROUND

Late Prehistoric Archaeological Record

Published archaeological studies are relatively rare for the western Mojave Desert. However, the body of work that exists in the realm of non-published archaeological reports is vast by comparison. This is one of the primary reasons that the understanding of the history of this region is lacking (Sutton 1988b).

In broad terms, the western Mojave assemblage during the Late Prehistoric period has been characterized as containing Cottonwood and Desert Side-notched projectile points, buffware ceramics, and Lower Colorado Buff Ware ceramics (the latter being exclusive to the eastern portion of this region; Sutton 1996:237). However, Sutton's model (1989) broke this down into more specific assemblages for three interaction spheres. This model was based, in part, on obsidian source data synthesized a year earlier (Sutton 1988a). In this previous study, Sutton sought to demystify issues associated with and potential applications of obsidian hydration measurement and sourcing as they were used in the western Mojave Desert, but he focused on hydration. This technique can be used for relative and absolute dating, although the latter requires the development of rate models specific to the site in question and has numerous factors that can make results unreliable. He also synthesized all the hydration and source data that was available at the time for the region. This data was used to dispel the implicitly held belief that many archaeologists had that all the obsidian found in the western Mojave was Coso. He explained that the eastern Mojave was dominated by Eastern Sources (Bagdad, Umpire, Hole-in-the-wall, and Hackberry Mountains sources), but this could have been caused by sampling biases and/or an insufficient amount of data.

At no point did Sutton (1988b) clarify what he meant by “sourcing”. He did, however, state that many archaeologists still advocated for the use of visual assessment to establish obsidian source, which he criticized as inaccurate. Therefore, it remains unclear in many cases what sourcing technique(s) Sutton was referring to throughout the study. However, sourcing techniques for some of those sites have been determined during research conducted by the current study (see Appendix A). The sourcing results from the remaining sites he presented may be of variable reliability. They could have been obtained via XRF, INAA, visual analyses, or other unknown methods.

Sutton’s model (1989; furhter discussion in 'Interaction Sphere' section below) characterized the northern sphere’s assemblage as having Desert Side-notched and Cottonwood points, mainly Coso obsidian (limited amounts of it coming from Nevada, Owens Valley, and Obsidian Butte), and predominantly brownware ceramics and some buffware closer to the Mojave River. The western sphere’s assemblage was characterized as having mainly Cottonwood points, almost exclusive use of Coso obsidian (limited amounts of it coming from other northern sources), and almost no ceramics. Large villages and cemeteries were present in the western sphere and it was common to bury the dead, whereas cremations were the primary funerary technique in the other spheres. The eastern sphere's assemblage was characterized as having mainly Cottonwood points, only locally sourced obsidian, and a combination of brownware and buffware ceramics. Local obsidian sources in the eastern sphere were all surface concentrations of loose nodules known as marekanite. These sources included Bagdad, Umpire, Hackberry, and Hole-in-the-wall.

Explanations for the observed distribution of obsidian in the western Mojave Desert were also offered by Sutton (Sutton 1989:112). He speculated that trade between the Eastern and Northwestern Regions may have been "curtailed" by something. To explain this, Sutton pointed out that the boundary between the western portion of the northern and eastern spheres roughly matched the ethnographically described territorial boundary between Numic speaking people on the north side and Takic speaking people on the south side. One caveat was that the Chemehuevi were recorded as having resided in a large portion of the eastern sphere. However, Sutton suggested that the Chemehuevi replaced the Yuman speaking Mohave people in that area around 250 years ago.

Moratto (1984) had previously identified some slightly differing patterns, such as characterizing the southern Mojave Desert as having both Cottonwood and Desert Side-notched points with no distinction as to their relative proportions. Sutton (1996) and Moratto both point out the inferred presence of Anasazi settlements, or evidence of a trade network connecting these areas to Anasazi groups, in places like the Halloran Springs Turquoise mines and Cronise Lakes first described and identified as Puebloan by Rogers (1929). Moratto claims that this Anasazi presence in the Mojave is gone by A.D. 1150. Sutton (1989, 1996) also argues that the Chemehuevi, a Numic speaking group, replaced the Takic speaking Mohave people in the majority of his eastern sphere around the time of contact. This claim is supported by oral traditions and ceramic type changes.

By the beginning of the Late Prehistoric period the Medieval Climatic Anomaly was in full swing, a technological shift occurred, and populations shrank (Sutton et al. 2007). The nature of these shifts are disputed but they may be characterized by the abandonment of long occupied large villages, the establishment of villages along the Mojave River, the concentration of population into more dense settlements, or any combination of these (Gardner 2006; Sutton 2017; Sutton et al. 2007). Sutton (2017) alternatively proposed a settlement pattern for the Mojave desert that is characterized by camps set up by groups that typically dwelled in the peripheries of the desert (e.g., Beals and Hester 1971). In this model, the desert serves as a common pool resource zone that multiple groups exploit on a seasonal and temporary basis.

Other than the Antelope Valley area (e.g., KER-733) , the Mojave River was likely the only place in the western Mojave Desert that villages were occupied year round in the Late Prehistoric (Sutton 1996; Sutton and Earle 2017). The Desert Serrano occupied these settlements in the ethnographic period (and likely in the Late Prehistoric period). This river constituted part of an important trade route that was used to transport goods including obsidian, shell beads, and other items to and from the California coast and the Colorado River area (Earle 2005). Ethnographic and ethnohistoric accounts paint the Desert Serrano along the river as particularly small in population and poor (Bean and

Smith 1978; Kroeber 1925). However, Sutton and Earle suggest that they instead enjoyed considerable wealth and influence because of their control of the Mojave River and, in turn, its important function as a trade corridor.

Interaction Spheres

Processual archaeology was introduced in the 1960s when scholars such as L. Binford began urging for a switch to focusing on cultural evolution rather than on chronology and approaching this with a perspective that saw culture as a system (Binford 1962). In 1962 J. Caldwell introduced the concept of interaction spheres in an unpublished paper presented at the Annual Meeting of the American Association for the Advancement of Science in Philadelphia (Binford 1965). Caldwell's main concern was making generalizations about how "civilization" could emerge (Caldwell 1964). The assertion made was that multiple groups having contact and exchanging ideas and material with each other could be said to make up an interaction sphere. These disparate groups, through their interactions, could develop some common cultural traits, tying them together in that way. Caldwell also claimed that interactions between groups within an interaction sphere promoted innovation which he believed was the primary way that "civilization" (what would be more aptly referred to as increased cultural complexity) was brought about. However, Caldwell did point out that the modern conception of "civilization" was a misnomer, that the interaction sphere approach could apply to almost any set of groups that had prolonged interaction, and that this could lead to more cultural complexity without necessarily becoming the western idea of what a civilization was.

Binford explained interaction spheres as “ the areal matrices of regular and institutionally maintained intersocietal articulation” (Binford 1965:208). He suggested that interaction spheres were definable in a given area by looking at the spatial distribution of socio-technic items. These were defined as items whose primary functions were social (e.g., status items such as a king’s crown; Binford 1962). Separate societies which had shared symbols, institutions, and/or socio-technic assemblages gained these similarities through “complex articulation” with other societies which had differing ethnicities, degrees of complexity of culture, and “social types” (Binford 1965:208). He made a distinction between socio-technic items, which could be used to define interaction spheres, stylistic variability in items, which denoted ideas of how items should be manufactured, and technomic items, which revealed ways in which a group coped with its environment and could be used to define adaptive spheres.

Sutton (1989) wanted to understand interactions between the archaeological groups of the Late Prehistoric period (defined as AD 1,000 to contact) western Mojave Desert and to make connections between them and ethnographic groups. He opted to look for archaeological interaction spheres rather than ethnic groups because he argued that the former were more easily defined with archaeological data because traits that members of a group used to identify social group affiliation may not have been archaeologically visible. Sutton, however, interpreted the concept of interaction spheres differently than was explained originally by Caldwell and Binford. Whereas Caldwell referred to the entire grouping of distinct cultural entities which interacted with each other as an interaction sphere, Sutton defined it as “relationships within or between ethnic groups and/or social units, such as exchange patterns, [which] might be defined by single traits” (Sutton 1989:100). This definition is not necessarily incongruent with Caldwell's, but it does emphasize ethnic groups (something touched on by Binford 1965), single traits, and does not mention the cultural complexity aspect of the theory. Sutton separated his interaction spheres based on differences in their signature artifactual complexes. There is no explicit mention by Sutton of anything related to stylistic (traditions) versus socio-technic (interaction spheres) versus technomic (adaptive spheres) items. In fact, Sutton defines his interaction spheres mainly with items which are more readily categorized as having stylistic attributes (e.g., ceramics, projectile points, rock art styles) rather than those which Binford relates directly to interaction spheres.

Rather than using an expressly direct historical approach, Sutton first identified archaeological assemblages and then attempted to associate them with known ethnographic groups. Drawing upon ethnographically described territories (Bean and Smith 1978:570; Blackburn and Bean 1978:564; Kroeber 1925; Zigmond 1986:398–399, 564), Sutton made the following associations: the northern sphere and the Kawaiisu; the western sphere and the Kitanemuk; the eastern sphere and the Serrano as well as the Mohave. Sutton concluded that the evidence supported ethnographic groups having been in the same areas during the Late Prehistoric period as they were in early ethnographic accounts.

The exception to this was noted as the Mohave who are suggested to have inhabited the majority of the eastern sphere until the ethnographic period when the Chemehuevi replaced them there (see also Bettinger and Baumhoff 1982; Byrd et al. 2011:64; Kroeber 1925).

Sutton (1989) pointed out that groups in his eastern interaction sphere were not obtaining Coso obsidian in significant quantities, while groups in the other two spheres were. He speculated that this may have been due to the exclusion of eastern sphere groups from the far reaching Coso obsidian trade network. Furthermore, he suggested that this may have resulted from the development of disparate ethnic groups representing the various spheres, which may have been fostered by competition for insufficient resources. He did, however, admit that the archaeological identification of ethnic groups was difficult (see above). Even so, one of the main focuses of the paper was "tying archaeological cultures with ethnographic ones." While he does avoid excessive focus on identifying ethnicity by opting instead for the use of his own conception of the term "interaction sphere," he still went as far as to suggest that his spheres may have represented separate ethnic groups and that this ethnic division may have led to the eastern sphere's exclusion from the Coso obsidian trade, ultimately resulting in its lower reliance on Coso material. Furthermore, Sutton used settlement patterns (i.e., the western sphere was unique in its use of large villages) to support his sphere boundaries. However, Hughes (Hughes 1992, 1994, 2011:8) pointed out that settlement patterns have been erroneously used to infer the separation of ethnic and linguistic groups. Other than these issues, Sutton's model provided a rare consideration of the potential processes that led to the observed distribution of obsidian in the western Mojave Desert.

Obsidian Sources

Obsidian originating in Obsidian Butte, the Owens Valley, western Nevada, and from other California sources was somewhat present in the Late Prehistoric archaeological record of the western Mojave, but was generally overshadowed by the dominant presence of Coso material (Jackson and Ericson 1994:398–399; Sutton 1989).

Coso Obsidian

The Coso Volcanic Field is an expansive obsidian quarry which was the main source for the western Mojave Desert, coastal California, and many adjacent regions. Obsidian from this source was harvested and moved significant distances to the surrounding regions as long ago as 11,000 B.C. based on fluted points made of obsidian identified at China Lake (Ericson and Meighan 1984; Jackson and Ericson 1994; Sutton and Wilke 1984). Trade between south coastal groups and those in the Mojave Desert was apparent during the Middle Archaic (3500 – 1275 BP) because of obsidian originating at the Coso quarry being found along the coast (Gilreath and Hildebrandt 2011; Jackson and Ericson 1994:394).

Eastern Sources

Sutton (1988b, 1989) identified four Eastern Sources of obsidian (Bagdad, Umpire, Hackberry, and Hole-in-the-wall) that appeared to represent the dominant source of Late Prehistoric obsidian artifacts in the Eastern Region. These sources all consist of areas in which small nodules of obsidian, sometimes referred to as marekanite, could be readily found on the surface both in situ and loose. The Bagdad source is in the Bristol Mountains and raw material from it has also be found as far away as Lavic Lake and Bristol Lake (Shackley 1994). The Umpire source is located on the west side of the southern end of the Spring Mountains on the border of California and Nevada. Nodules from this source have also been found in the Mesquite Lake area. The Hackberry source is located in the Hackberry Mountains in the Mojave National Preserve.

The Study of Material Conveyance in Archaeology

The distribution of obsidian in the Late Prehistoric western Mojave Desert is the subject of the current thesis. While understanding this distribution better is a main goal here, it does not directly provide much insight into behavior. Therefore, the distribution information will be used as a basis for making more behaviorally oriented inferences about how that obsidian was transported to the locations from which it was collected. This section and the following one cover the study of material conveyance. First, a brief chronology of the general subject is provided. The following section reviews models of material conveyance that are most readily applicable to the subject region and time period.

A multitude of different approaches to the study of material conveyance and intergroup interactions in archaeological contexts have been developed throughout the history of archaeology. Early North American archaeologists such as Rau (1873) were interested in trade among early indigenous populations but focused mainly on simple descriptive accounts of it. Beginning in the culture historical era of the late nineteenth century, scholars such as Montelius (1885, 1899) harnessed the concept of trade, in part, in an attempt to explain the diffusion of cultural complexity throughout Europe (Bauer and Agbe-Davies 2010; Trigger 2006). Trade became a key area of study in the 1960s with the introduction of processual archaeology which approached trade and exchange mainly in terms of culture change and economics (e.g., Renfrew 1969), and utilized newly developed geochemical sourcing techniques which allowed for the reliable assessment of the geographical origin of raw materials (e.g., XRF, NAA). This was followed by post-processual approaches such as World Systems Theory (e.g., Schneider 1974, 1977), and Actor Network Theory (e.g., Olsen 2003) which engaged with trade in aspects such as agency and practice.

Early forays into trade studies in California and Great Basin archaeology often took geographic distance between an artifact and its inferred origin as evidence of it having been traded or exchanged down the line to reach the location at which it entered the archaeological record (e.g., Heizer 1951:94; Kroeber 1925:935; Uhle 1907:63). It is now well accepted that material was also often procured via direct access (i.e., acquiring things by travelling directly to them rather than trading for them) over long distances and as an embedded activity within the seasonal rounds that highly mobile populations often practiced (Basgall 1989:111; Binford 1979:259; Hughes 2011; Meighan 1992). The Mohave, for example, were noted in ethnohistoric accounts as having acquired both Puebloan and California coast goods via direct access by traveling an extensive network of trails which traversed the Mojave Desert (Sample 1950). They were known to travel distances of up to 100 miles on foot in a single day (Stewart 1983:60).

Obsidian Conveyance Models in the Southwest Great Basin

The following discussion of theoretical approaches to material conveyance will focus on the study of the distribution and movement of obsidian in indigenous southern California and the southwest Great Basin. Obsidian movement throughout the western Mojave Desert has not yet received the same extensive and thorough attention that it has in the nearby eastern Sierras and Owens Valley regions. Therefore, not all the models discussed pertain to the precise region nor time period that the current thesis was concerned with. However, they all had approaches that would be useful in constructing interpretations for the current study and many of them dealt partially or at least indirectly with the Mojave. There are three main types of material conveyance considered below, which include: embedded procurement, direct access, and trade and exchange.

Embedded Procurement

Some scholars have suggested that during the Middle Archaic obsidian east of the Sierras was most frequently acquired by mobile groups which would exploit obsidian sources as they moved through their seasonal round (e.g., Bamforth 1986; Basgall 1989; Kelly 1988; Meighan 1992; Parry and Kelly 1987). This approach to acquiring raw material was originally referred to as an “embedded procurement strategy” by Binford (1979:259), who developed the concept through ethnoarchaeological observations. Bettinger and Baumhoff (1982) argued that Middle Archaic populations predated the spread of Numic speaking people into the area, and that they were extremely mobile “travelers” who followed highly ranked resources. These people were later replaced by Numic speaking peoples (referred to as “processors”) who focused more on collecting readily available and lower-ranking resources locally. This would suggest that Middle Archaic populations may have been mobile enough to have a heavy reliance on embedded procurement for obsidian, while Late Archaic populations likely did not.

King et al. (2011) outlined a model of archaeological predictions of evidence for this type of conveyance. He argued that most of the material found at a given site would come from sources that were located within the seasonal range of the group. Furthermore, there would be higher frequencies of materials that came from sources which were more recently visited during the seasonal migration pattern than from sources that would have been visited earlier on in the year. Basgall (1989) suggested that higher diversity in the obsidian sources represented at a site would indicate that groups were practicing an embedded procurement strategy as well. He also argued that settlement patterns became more restricted following the Middle Archaic and groups began relying more on raw material located close to their core areas, rather than relying on an embedded procurement approach. However, these local materials were also under increased territorial control, so acquisition occurred mainly through more formalized exchange relationships.

Direct Access

An alternative to the embedded procurement model suggests that direct access was the primary mode of obsidian conveyance in the area. Eerkens et al. (2008) argued that, during the Newberry period (ca. 3500 – 1500 BP), direct access in the southern Owens Valley was carried out by logistical parties (coming from more residentially stable populations) which moved long distances quickly to reach far off hunting grounds rather than by groups moving more slowly as part of a seasonal round (see also McGuire and Hildebrandt 2005).

Expected archaeological evidence of such material conveyance consists of a limited variance in the size of flakes regardless of the distance of the source from which they came (Eerkens et al. 2008). The correlation between distance to source and falloff in the amount of material from that source would be very gradual (i.e., not a large difference in frequencies of materials coming from sources of varying distances). Sutton and Des Lauriers (2002) found that frequencies of obsidian sources represented at a given site was more affected by the distance between the site and source along a navigable route rather than Euclidean distance between the two. This should be considered when applying the model proposed above by Eerkens et al. (2008). Following this, the Haiwee period (ca. 1500 – 650 BP) was less well understood but was argued to have been the beginning of an increasingly sedentary settlement pattern that continued on that trajectory well into the Marana (ca. 650 BP – contact; Eerkens 2003).

Trade and Exchange

Others have suggested that densely populated groups living in the southern Sierras and in coastal southern California had a high demand for obsidian from the Great Basin and this fueled the exploitation of it for trade by local groups (e.g., Ericson 1982; Gilreath and Hildebrandt 1997). It has been argued that less mobile groups such as these would not have the built-in opportunities to access obsidian directly, therefore making down-the-line trade their most likely option for obtaining the material.

Archaeological predictions for this type of material conveyance suggest that significant amounts of material should be present from sources that are well outside the typical seasonal territories and ranges of direct access (King et al. 2011). It can also be expected that sources would be utilized in a more regular temporal pattern than they would be by highly mobile groups with an embedded procurement approach (i.e., the same sources represented in much the same frequencies throughout the year; Basgall 1989). Furthermore, it should be expected that some other classes of artifacts should not be identified crossing these boundaries. For example, projectile point types associated with the Coso region are not found along the coast, and vice versa, although Coso obsidian is found in both areas. Most models that rely on trade and exchange to explain conveyance point to a Late Archaic (1275 – 650 BP) reduction in obsidian production which resulted from a collapse in the trade system caused by a decrease in demand for obsidian, a decline in subsistence resource availability, increased territoriality and local control over Coso obsidian quarries, and/or technological changes (e.g., Gilreath and Hildebrandt 1997, 2011; Jones et al. 1999). For example, Ericson (1981) observed that there was a distinct drop off in Coso obsidian in Chumash assemblages that indicated a cultural factor(s) may have been limiting its trade into that region beginning sometime between A.D. 1,000 to 1,200. Gilreath and Hildebrandt (2011) attributed this to direct access restrictions resulting from the increased territoriality and less demand for the material due to factors such as technological shifts and subsistence strategy changes. King et al. (2011) posited that, if the trade system collapsed in the Late Archaic, we would expect to see a shift to a lower ratio of obsidian to other lithic materials at nonlocal sites, instead of a general reduction in the quantities of lithics (the latter would most likely suggest lower population densities rather than a simple decrease in demand).

Meighan (1992) supported the notion that Coso obsidian was traded to groups in the southern Sierras and the California coast. He detailed several lines of evidence that suggested this: the long duration over which long distance movement of Coso material occurred (he identified this as A.D. 0 to 800); extremely high volumes outside of the Coso region; ethnohistorically known routes of travel; caches of Coso blanks between the origin point and the coast that were larger than an individual was likely to utilize for themselves; shell beads originating from the coast documented throughout the same region(s).

Hildebrandt and McGuire (2002) suggested that there was a prestige big game hunting complex in California during the Middle Archaic. They argued that distant obsidian may have been considered a prestige item that signaled the high status of hunters who possessed it. This may have spurred the long-distance trade of such material. Jones et al. (1999) argued that the MCA resulted in the downfall of many systems in California, including the obsidian exchange network that moved material from the east side of the Sierras to the California coast. It seems likely that the MCA would have brought the big game hunting complex to an end, which could have resulted in a collapse in the demand for foreign obsidian as items of prestige for hunters.

However, other scholars have argued that this supposed reduction in production and trade of obsidian artifacts could be more accurately described as a shift in production strategies that has been mistaken for a generally reduced production. Ericson (1982) argued that the Late Archaic drop off in production at the St. Helena, Bodie Hills, and Casa Diablo quarries was due to a shift from biface production to flake and blade production for later processing to create arrowheads at more distant sites. Also, he suggested that demand increased dramatically. These factors combined to create a situation in which the production of flakes and/or unknapped raw material (less labor intensive than biface production) would have been the only way to keep up with demand. If this were true, we would expect to see much less evidence of production at the quarries and a sustained or increased amount of obsidian at nonlocal sites. However, King et al. (2011:153) noted that there was less obsidian production in both quarries and nonlocal sites in the Coso area. So, this model may not apply as well to Coso material as it can to those more northern sources.

Gilreath and Hildebrandt (1997, 2011) have suggested that Coso obsidian was being traded to groups in the southern Sierras, the southern San Joaquin Valley, and along the southern Californian coast in high volumes in the Middle Archaic. While Coso obsidian peaked in frequencies at southern California archaeological sites in general during the Middle Archaic, Fort Irwin sites decreased to their lowest frequencies. Fort Irwin sites saw a clear increase in the presence of Coso obsidian during the Late Archaic, which is the same time that the frequencies of Coso material at all other southern California locales dropped to a new low. They also suggested that local populations exerted control over Coso quarries and were likely restricting direct access to it by outside groups. Furthermore, they suggested that Coso was conveyed to the Mojave Desert during the early and middle Holocene through direct access by highly mobile groups, while it was mainly conveyed to the rest of southern California through trade and exchange at that time. Formerly, they inferred decreases in residential mobility between ca. 1275 and 800 BP in the Coso region (see also Eerkens 2003 who argued the same for ca. 1350 – 650 BP) and this was interpreted as being accompanied by increased territoriality and therefore more local control over the obsidian quarries (see also Bettinger 1982 who argued the same for the Fish Springs source in Owens Valley). This meant less opportunities for direct access by groups such as those in the Mojave. Thus, the questions remain: how did groups at Fort Irwin increase their consumption of Coso Material during this period? And why do Coso obsidian frequency profiles at Fort Irwin appear to be reversed in the rest of southern California?

This body of theory will be utilized to provide insights into the methods that were used by the people of the Northwestern Region and the Eastern Region to obtain and transport obsidian. The obsidian distribution data will be assessed by the various archaeological predictions presented above. And the models that have been discussed will be used to support arguments presented below (see Chapter 5: Discussion).

CHAPTER THREE

METHODS

In order to understand which obsidian sources were being utilized during the Late Prehistoric period in the Northwestern and Eastern Regions of the western Mojave Desert, available data was gathered, synthesized, and analyzed. To do this, the large existing body of both published academic literature and non-published archaeological reports was searched for appropriate information. This data was then subjected to an independent samples *t* test.

Literature Review

The initial step was to perform a comprehensive literature review to collect all relevant obsidian sourcing information and compile it into a database (see Appendix A for the database and the sources from which the data came). Several types of sources were relied upon to achieve this. Academic literature was the initial focus and peer-reviewed academic journals were prioritized (Rogers and Yohe 2014; Sutton 1984, 1987a; Sutton and Schneider 1996). However, there is a paucity of appropriate geochemically sourced obsidian data presented in journal articles for the subject region and time period. Additional published data was taken from books, edited volumes, doctoral dissertations, and master's theses (Bark 2017; Byrd et al. 1994; Cameron 1984; Pinto 1989; Schneider 1987; Sutton 1987b, 1988a; Sutton et al. 2000). To gather these sources, libraries, internet-based resources, and personal communications with various scholars were utilized.

The body of non-published archaeological reports is much vaster but is unfortunately less available. It accounts for slightly under half of the original sources of information utilized in the current study (Kelly and Warren 1984, unpublished, 1985a, unpublished, 1985b, unpublished; Lerch 1985, unpublished; McGuire et al. 1982, unpublished; Pacific Legacy, Inc. 2010, unpublished; Shackley 1993, unpublished, 1996, unpublished, 2017, unpublished, 2021, unpublished; Yohe et al. 2019, unpublished). There is surely more that exist which could contribute to the database, but it was not accessed. Cultural resources management reports, XRF lab reports, and Department of Parks and Recreation cultural resources site records were the primary types of documents that were found to be useful. These sources were gathered via records searches performed in person at various California Historical Resources Information System information centers, which are operated under agreement with the California Office of Historic Preservation. These locations included: the South-Central Coastal Information Center located at California State University, Fullerton; the Southern San Joaquin Valley Information Center located at California State University, Bakersfield; the Eastern Information Center located at the University of California, Riverside. Additional data from non-published archaeological reports was obtained through internet-based resources and personal communications with cultural resources management professionals and scholars.

Several parameters were developed for decisions regarding what data would be included in the database. This thesis is focused on the Late Prehistoric period, which has been most notably defined as spanning from AD 1100 to contact (Sutton et al. 2007). However, Sutton (Sutton 1989:101) has also defined the late period as AD 1000 to contact. Furthermore, both of these periods have some overlap with the Saratoga Springs period, which lasted from AD 500 to 1200 (Warren 1984). In an effort to be more inclusive of these various designations, and in the interest of creating the most robust database possible, data was included from sites as long at least 10 percent of the date range overlapped with the late period, and the early end of its date range was no older than 2200 BP. Some of the data that was included was reported only with obsidian hydration dates that provided a single date and no range. For these sites, nothing older than 1300 BP was included. Some data was rejected based on weak dating, such as in cases where multiple lines of evidence were in substantial disagreement as to what the date range was.

Data that was sourced using less reliable techniques such as visual assessment was not included in the database. However, not all of the data which was included was clear as to what methods they utilized. Some sources stated that "geochemical" sourcing was done but gave no indication as to which technique was provided. And other sources did not clearly state their methods at all. However, in cases such as these, contextual information was used to determine whether the material was more likely sourced geochemically or visually. Early geochemical testing was not as accurate as it is today. Techniques, databases, and geochemical signatures are continually refined. In an effort to avoid less accurate geochemical results, no data that was sourced before 1982 was included. Finally, “unknown” source specimens were included in the database but were not included in the independent samples *t* test. This was done because “unknown” indicates an inconclusive result. Therefore, an “unknown” result could be from Coso, an Eastern Source, or anywhere else.

Statistics

After the data was compiled, it needed to be processed via a statistical test known as an independent samples *t* test (otherwise called the two samples *t* test). Without running such a test, it would not be possible to state with any statistical confidence whether the samples (the data gathered here from both regions) were representative of the populations (the totality of all obsidian that existed in the two spheres during the Late Prehistoric). This would mean that any interpretations made without running the test could be misleading due to the vagaries of sampling. In other words, the *t* test allowed the sample of Eastern Region data and the sample of Northwestern Region data to be pooled together, resulting in a statement of how likely it was that the two samples could have been chosen from the same population.

Two independent samples *t* tests were conducted. One was meant to compare the Northwestern Region and the Eastern Region in terms of the amount of nonlocally sourced specimens (i.e., all sources other than Eastern Source ones) per site as a percentage of total specimens per site. The other test was meant to compare the two regions in terms of the amount of Coso specimens per site as a percentage of total specimens per site.

To prepare the data for the independent samples *t* test, the percentage of nonlocal obsidian sources was calculated for each site as a decimal. For example, if a site contributed four sourcing results that consisted of three Coso and one Bagdad, its value would be 0.75. These values were then entered into SPSS Statistics and were associated with either the Northwestern Region or the Eastern Region. The independent samples *t* test was then run to produce the final results.

Although the actual test was completed by using the software SPSS Statistics, a brief review of how the test works follows (see Drennan 2009:153–156 for a more in-depth consideration of this). The pooled standard deviation was needed to begin. Variables involved in its calculation included: *sp*, the pooled standard deviation; *s1*, the first sample's standard deviation; *s2*, the second sample's standard deviation; *n1*, the amount of elements the first sample has; *n2*, the amount of elements the second sample has. It was obtained via the following expression:

$$sp = \sqrt{\frac{(n_1 - 1)s_1^2 + (n_2 - 1)s_2^2}{n_1 + n_2 - 2}}$$

The result of this expression was then used to calculate the pooled standard error (*SEp*). This is calculated via the following expression:

$$SEp = sp\sqrt{\frac{1}{n_1} + \frac{1}{n_2}}$$

To understand the level of statistical confidence, it was then necessary to ascertain the amount of difference in pooled standard errors there was between the means of each sample. Variables involved in its calculation included: *t*, the desired value described here; $\bar{X}_1$, the first sample's mean; $\bar{X}_2$, the second sample's mean. This is calculated via the following expression:

$$t = \frac{\bar{X}_1 - \bar{X}_2}{SEp}$$

A *t* distribution table can then be used to find what level of confidence there is that the samples are representative of the populations from which they came. The value is found in the table, which corresponds to a percentage, or range of percentages. That percentage represents how likely it is that the observed difference between the samples is simply a result of the vagaries of sampling.

CHAPTER FOUR

RESULTS

The body of research covering obsidian source utilization in the western Mojave Desert during the Late Prehistoric period is limited. Sutton (1989) provided the most robust consideration of the subject to date. However, he did not run any statistical tests on his data to assess confidence levels of the perceived differences in obsidian usage between his various spheres. There was therefore an uncertainty of how statistically significant the differences reported between these areas are. Furthermore, the amount of additional data that has accumulated in the years since that study was published is voluminous and could increase such confidence if added to the database.

This chapter begins with the presentation and description of the obsidian source utilization data gathered during the current study. The results of an independent samples *t* test which was conducted using this data is then presented, and the proportions of the different sources are compared between the two regions. This effectively answers research questions 1 and 2. The inferred boundaries separating the Northwestern Region and Eastern Region are displayed in Figure 3.

Obsidian Source Utilization Data

In total, data from 411 individual obsidian specimens were added to the database utilized by the current study (see Appendix A). However, 29 of these specimens produced inconclusive results (denoted as “unknown” in Appendix A).

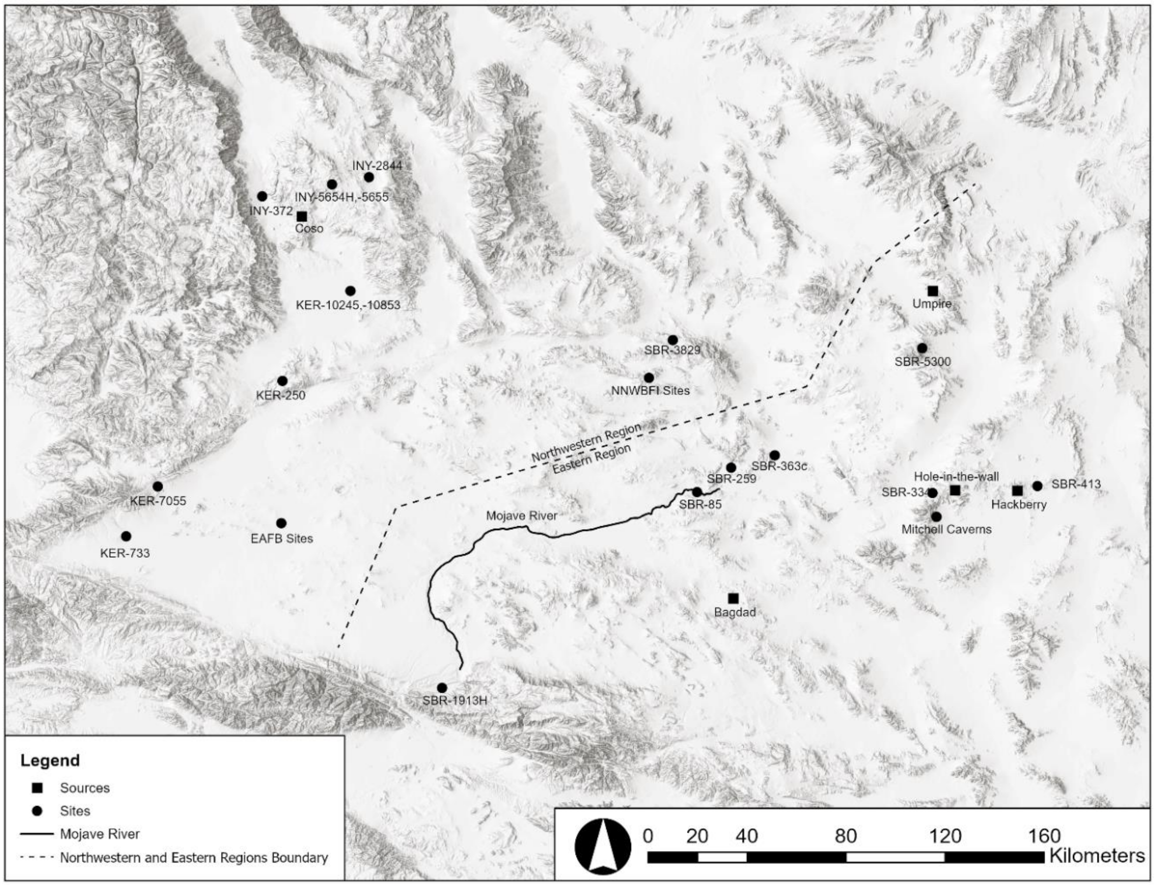

Figure 2. Results Map. Includes: key obsidian source/quarry locations; locations of the sites from which obsidian source data was obtained for the database; the proposed boundary which separates the Northwestern Region and the Eastern Region. Some sites that were too close together to display separately at this scale were represented by a single point (e.g., EAFB Sites)

Other than figures 2 through 4, the results discussed below will not include these “unknown” specimens nor the sites which contained only these specimens. This data was gathered from 84 archaeological sites. To develop this database, 23 separate sources were relied upon. Of these sources, four were journal articles (Rogers and Yohe 2014; Sutton 1984, 1987a; Sutton and Schneider 1996), six were books or chapters in edited volumes (Byrd et al. 1994; Cameron 1984; Pinto 1989; Sutton 1987b, 1988a; Sutton et al. 2000), two were master’s theses (Bark 2017; Schneider 1987), seven were unpublished cultural resources management reports (Kelly and Warren 1984, unpublished, 1985a, unpublished, 1985b, unpublished; Lerch 1985, unpublished; McGuire et al. 1982, unpublished; Pacific Legacy, Inc. 2010, unpublished; Yohe et al. 2019, unpublished), and four were lab reports commissioned for cultural resources management studies (Shackley 1993, unpublished, 1996, unpublished, 2017, unpublished, 2021, unpublished). Although less than half of those sources were unpublished, many of the published sources had gotten their data from non-published archaeological reports.

Eastern Region

In total, the database included 49 specimens from the Eastern Region (not including "unknown" results) that were collected from eight sites. The Eastern Sources accounted for 24 of these artifacts which were collected from six of these eight sites. All four of the known Eastern Sources were represented

Table 1. Number of Specimens Per Source Found in the Eastern Region. 'Number of Sites' denotes the amount of archaeological sites from which the specimens were collected.

Source	**Number of Specimens**	**Number of Sites**
Bagdad	12	4
Unknown	10	5
Coso	9	3
San Felipe, Baja CA	9	1
Umpire	8	1
Hackberry	2	1
Hole-in-the-wall	2	1
Casa Diablo	2	1
Fletcher	1	1
Inyo Crater	1	1
Buck Mountain	1	1
Queen	1	1
Obsidian Butte	1	1

in this collection of obsidian. However, most of the specimens procured from the Eastern Region were from nonlocal sources, such as Coso (see Table 1. below). Nonlocal obsidian was found at six of the eight sites there. There were 12 sources identified in this region, eight of which were nonlocal sources.

Northwestern Region

The Northwestern Region included 335 specimens which were collected from 76 individual sites (not including "unknown" specimens and sites which contained only that source type). Only one Eastern Source obsidian artifact was reported from a site in this area. Nearly all of these sites included at least one Coso specimen. The exceptions to this were five sites in Edwards Air Force Base, which included: one unknown source specimen from KER-1439; four unknown source specimens from LAN-1189/H; one Casa Diablo specimen from LAN-1318/H; the one Bagdad specimen (an Eastern Source) from LAN-1805 on Edwards Air Force Base; one Obsidian Butte specimen from LAN-828/H. There were six sources identified in this region, five of which were nonlocal sources.

Table 2. Table 2. Number of Specimens Per Source Identified Within the Northwestern Region. 'Number of Sites' denotes the number of archaeological sites from which the specimens were collected.

Source	**Number of Specimens**	**Number of Sites**
Coso	314	73
Unknown	19	8
Casa Diablo	8	2
Obsidian Butte	8	4
Mt. Hicks	3	1
Queen	1	1
Bagdad	1	1

Total counts of Northwestern Region specimens per source are provided below in Table 2. Certain geographic areas are particularly overrepresented in the data. For example, Fort Irwin contributed five sites and 56 specimens, and Edwards Air Force Base contributed 60 sites and 145 specimens (refer to Figure 5). This is due mainly to the enormous number of studies that are conducted by the base archaeologists compared to other areas.

Statistics

Results of the independent samples *t* tests indicated that the samples

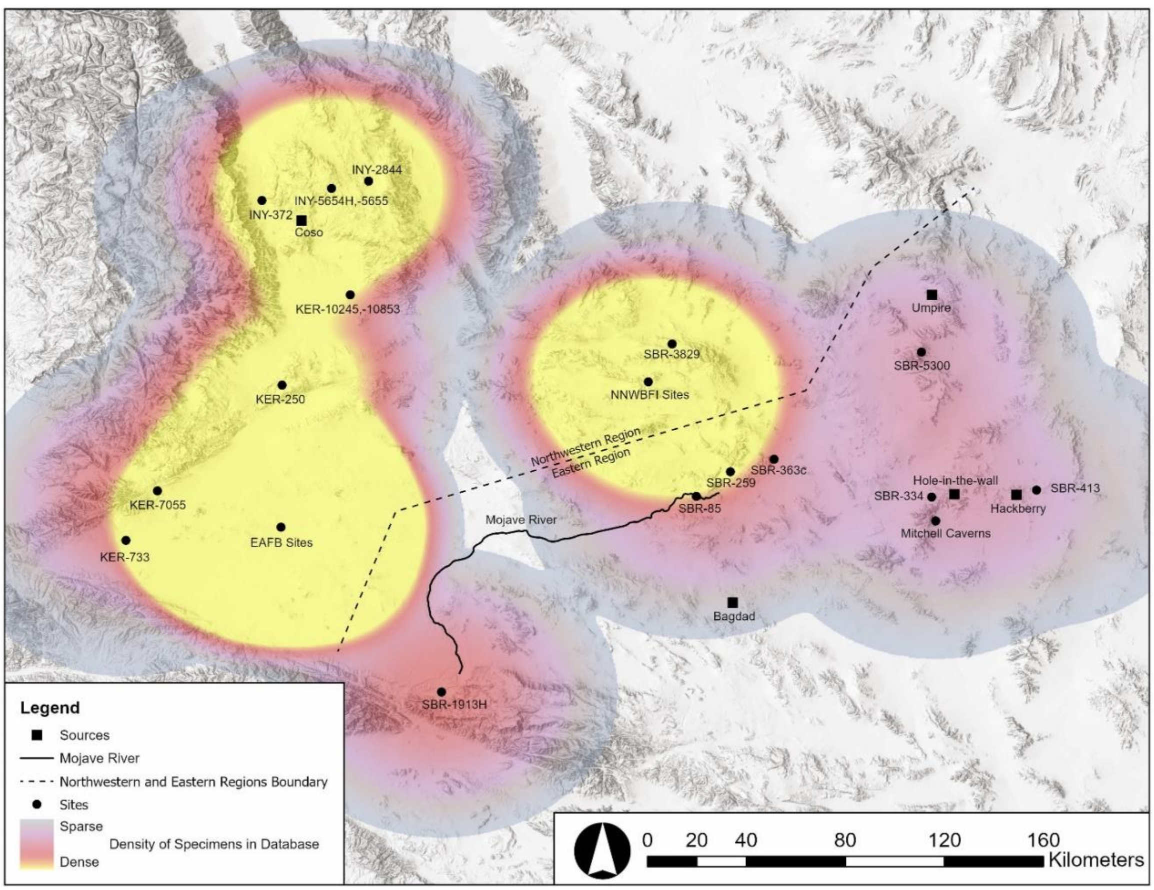

Figure 3. Heat Map Showing the Density of Specimens. Including "unknown" sources at Late Prehistoric sites in the western Mojave Desert.

taken from the Northwestern and Eastern Regions were statistically significantly different from each other at a 95 percent confidence interval in terms of their ratios of nonlocal obsidian to total obsidian per site, and of Coso obsidian to total obsidian per site (see Appendix B for SPSS Statistics results). This means that these differences were not simply due to the vagaries of sampling. Rather, this difference was representative of a real disparity between the populations from which the samples were taken.

The Eastern Region was comprised of 48.98 percent Eastern Source sites

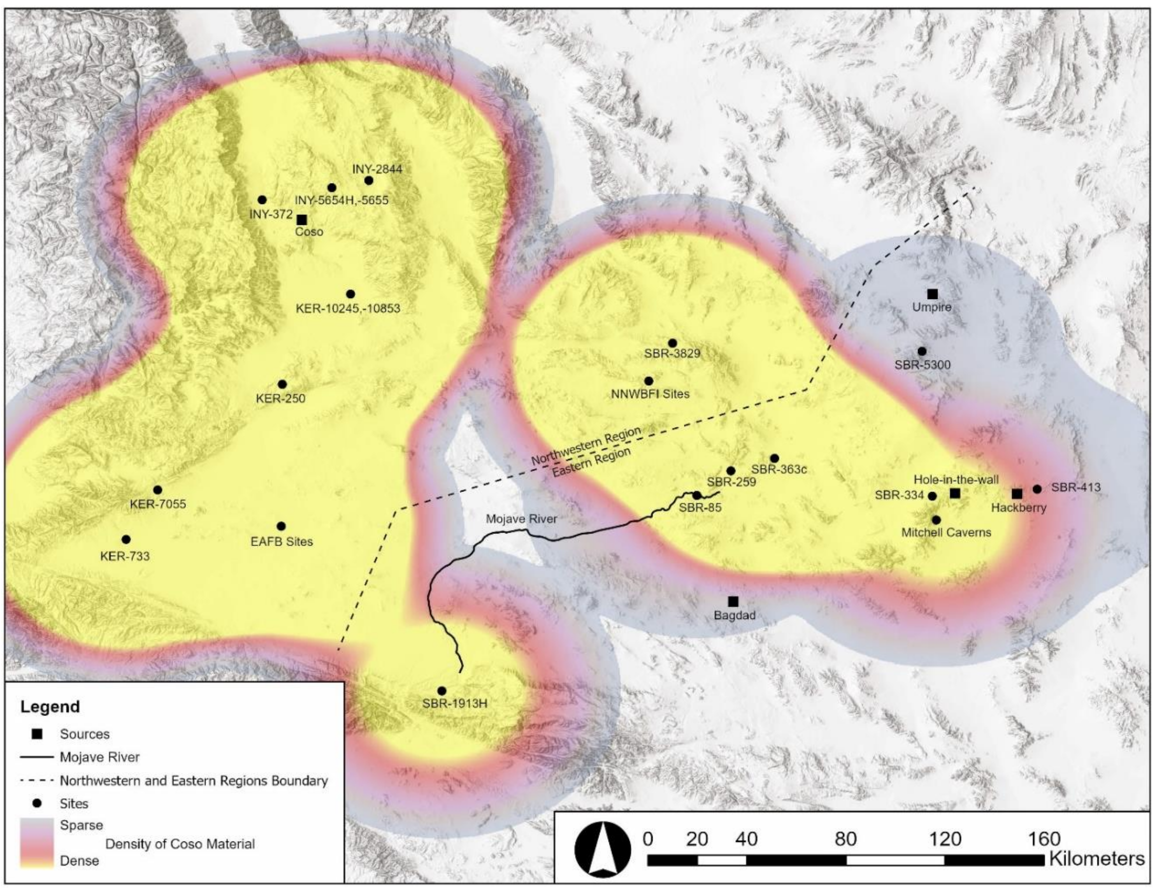

Figure 4. Heat Map Showing the Ratio of Coso Material (compared to all sourced material at Late Prehistoric sites in the western Mojave Desert).

artifacts. Compared to the Northwestern Region's 0.3 percent proportion, this is a drastic difference. Nonlocally sourced obsidian was found at 75 percent of the in the Eastern Region and represented 51.02 percent of its total sample. Coso specimens were collected from only 37.5 percent of the Eastern Region sites and represented 18.37 percent of its total sample. By comparison, 98.68 percent of the sites in the Northwestern Region had nonlocal obsidian, which represented 99.7 percent of its total sample. And 96.05 percent of the sites there had Coso specimens, which represented 93.73 percent of its total sample. The average percentage of nonlocal specimens to total specimens per site in the Northwestern Region was 98.68 with a standard deviation of 0.11471 and in the Eastern Region was 45.63 with a standard deviation of 0.44916. The average percentage of Coso specimens to total specimens per site in the Northwestern Region was 96.9 and in the Eastern Region was 10.38. The average number of specimens per site (including "unknown" source specimens) in the Eastern Region was 7.38. The average number of specimens per site (including "unknown" source specimens) in the Northwestern Region was 4.41. This does not necessarily represent the total amount of obsidian that was recovered from each site. Instead, it is the number of specimens that were selected to be sourced per site.

CHAPTER FIVE

DISCUSSION

This chapter will cover three main sections: (1) an evaluation of the accuracy of Sutton's (1989) claims as they concerned obsidian source utilization in the western Mojave Desert; (2) a discussion of the potential explanations for why Coso and other nonlocal obsidian sources represented a smaller proportion of sourced specimens in the Eastern Region than they did in the Northwestern Region; (3) potential material conveyance methods responsible for the observed obsidian distribution.

Evaluation of Previous Research

Sutton (1989) claimed that Coso and other northern source obsidian dominated northern and western sphere assemblages and Eastern Sources dominated eastern sphere assemblages. The current study has reaffirmed that Coso was the most well-represented source in the Northwestern Region. However, it also showed that there were less Eastern Source specimens present in the Eastern Region than nonlocal sources, although it was nearly even (Eastern Sources represented 48.98 percent of the total there). Furthermore, the single most well-represented source there was Bagdad, an Eastern Source. He observed that Obsidian Butte, Casa Diablo, and Mt. Hicks material was only found outside of the eastern sphere. This study has reaffirmed that claim for Mt. Hicks material, but it has also shown that Obsidian Butte and Casa Diablo material have been identified in the Eastern Region, albeit in very low frequencies (see Table 1).

A correlation between the Takic and Numic ethnographic territorial boundary and Sutton's proposed northern and eastern sphere boundary was noted as an explanation for the limited amount of Coso obsidian in the eastern sphere. This concept, along with alternative explanations, will be explored in the following section.

Potential Causes of the Obsidian Distribution

As was discussed in Chapter Two, prior research has pointed to the known presence of two distinct Northern-Uto-Aztecan linguistic groups, Numic to the north and Takic to the south, in an attempt to better understand the differences between the material cultures of the Eastern Region and Northwestern Region. The current study is specifically concerned with the differing obsidian source utilization that was occurring between these two areas, although multiple classes of artifacts were noted as differing as well. The foundation of this explanation was a general correlation between portions of Sutton's (1989) eastern and northern spheres' boundaries and the territorial boundaries between the Numic speaking Kawaiisu and the Takic speaking Serrano (as described by Bean and Smith 1978:570; Blackburn and Bean 1978:564; Kroeber 1925; Zigmond 1986:398–399, 564). However, it should be noted that ethnographic records of Californian groups have been called into question extensively, especially concerning issues of territorial delineation (e.g., Keter 2009). Even so, the correlation is worth exploring because alternative explanations have tended to be unconvincing.

Linguistic Evidence

While there is no absolute consensus on the location of the Numic homeland, many scholars utilizing various lines of evidence (e.g., linguistic, oral historical, genetic) place it, at least in part, in the general vicinity of the ethnographic location of the Kawaiisu (Fowler 1972, 1983; Kaestle and Smith 2001; Sutton 1993). Sutton (2017) placed the "Proto Numic" of the Late Holocene (as early as 4000 BP) in a region ranging from the southern Sierras, through the Coso Range (north of Ridgecrest), to the western edge of Death Valley. It has also been suggested that a Numic group was occupying the western Mojave prior to the Late Prehistoric period or as late as 500 BP before moving into the southern Sierras (Kroeber 1925; Sutton 2010, 2017). A "Pre-Numic" presence has also been alluded to as occupying the northeastern Mojave from the eastern portion of Death Valley to the Pahrump area (Sutton 2017). This group may have been in that area until sometime around the beginning of the Late Prehistoric period.

Sutton (2009) suggested that a Takic language (Kitanemuk) spread east from the southern Sierras to the Yuman groups in the Mojave Desert and Central-Eastern Transverse Ranges between 1500 and 1000 BP. Due to episodes of higher moisture levels beginning around 1000 BP, the Mojave River became a more productive environment for resources and surface water was likely more often available (Ohmart and Anderson 1982). This attracted people to form permanent villages along it at this time, such as those described in the ethnohistoric literature. Sutton and Earle (2017) argued that this was likely a Takic group, perhaps the Serrano. Whether this was a spread of Takic language to the existing groups in that area or a spread of people from the southern Sierras region who replaced the Yuman population in the western Mojave is uncertain. In either case, this change may have been related to any potential political problems between the Eastern Region and Northwestern Region. Such tension may have resulted in limitations placed on trade between the two groups. The positioning of a Takic speaking group along the length of the Mojave River in permanent villages would have served as a strong boundary preventing the Eastern Region from being accessed by Northwestern Region groups. A more complete discussion of this linguistic-political-economic situation would require a full review of the existing linguistic literature for the period and region, which is beyond the scope of the current thesis.

Alternative Factors and Explanations

There are no clear geographic barriers that would limit the ability of groups in the Eastern Region and Northwestern Region from trading with one another. Although the Mojave River roughly corresponds to the borderland of these areas, paleoenvironmental data generally suggests that moisture levels in the Mojave Desert during the Late Holocene (2000 BC to modern) were more or less comparable to those that persist today, despite periodic fluctuations (Sutton et al. 2007; Walker and Landau 2018). The river itself rarely runs above the surface today, and the same would have been true throughout most of the Late

Holocene. Furthermore, as is the case today, there was plenty of vegetation and sources of fresh water for people to reliably travel across the desert. Therefore, as a dry riverbed which is easily navigable on foot, it would have posed no limitation to trade relations in the Late Prehistoric period.

It is possible that Eastern Region inhabitants had less demand for nonlocal obsidian because they had direct access to Eastern Source obsidian quarries. There are no known obsidian sources located in the Northwestern Region other than Coso. However, many parts of the Northwestern Region (e.g., Fort Irwin) are closer to an Eastern Source than to the Coso quarries. This would seem to suggest that geographic proximity is not the driving factor behind choices in obsidian source preference. Therefore, it could alternatively be political issues between Numic and Takic groups that limited the movement of Coso south and Eastern Sources north and west. However, several other factors should be considered. Was preference for obsidian source based instead on: perceived material quality or manufacturing needs; material abundance and availability; established trade relations?

The quality of Coso vs. Eastern Source material could have played a role in preferences for one over the other. However, the knapping characteristics of the Eastern Sources have not been clearly characterized in the existing literature and such a study is beyond the scope of the current thesis. Therefore, a comparison of the qualities is not possible at this time.

It is implicitly understood that Coso quarries produced large amounts of obsidian and Eastern Sources were far less productive by comparison. Because

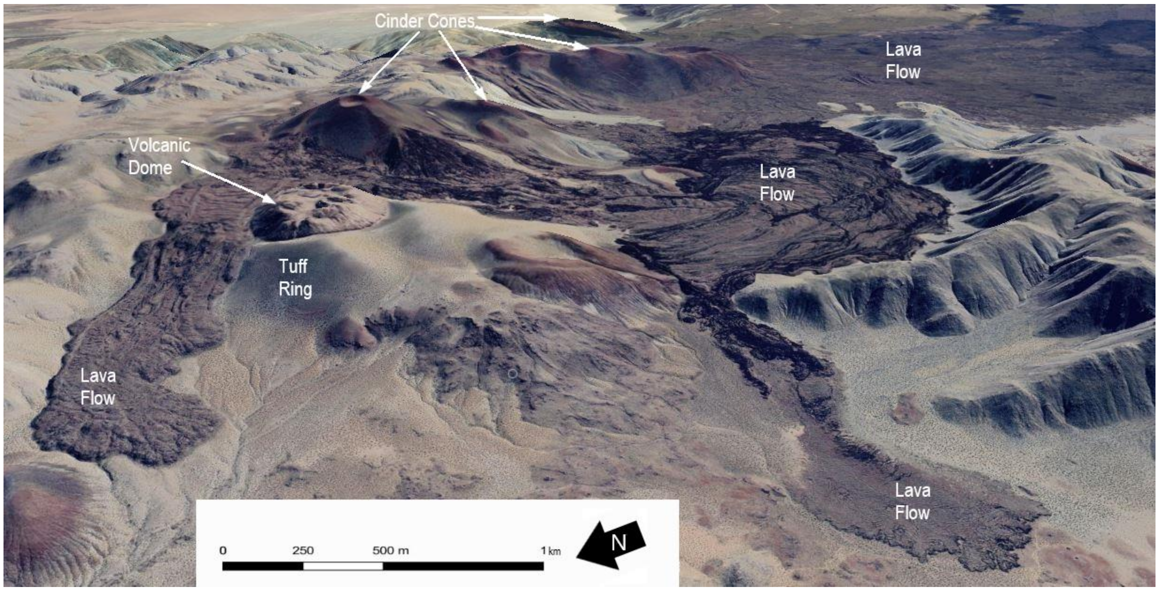

Figure 5. Satellite Image Showing the Coso Volcanic Fields (Google 2024).

there was so much Coso material available, the supply was there to meet the demand (or at least some of it) in areas throughout southern California. But Eastern Sources had less supply. It may have only been abundant enough to supply approximately half of the Eastern Regions demand for obsidian. Or this could have been one of several contributing factors to the observed obsidian source utilization ratios there. This explanation would require further research to develop more fully, which is also beyond the scope of the current thesis.

Coso obsidian had a well-established trade network throughout southern California, as evidenced by the presence of its material along the California coast from Chumash inhabited regions to modern day Orange County and nearly everywhere in between (Gilreath and Hildebrandt 2011; Jackson and Ericson 1994:394). It has been argued that some of these routes passed through the western Mojave Desert as well (Scharlotta 2014). By comparison, material from the Eastern Region's sources was rarely conveyed outside of that area. The fact that there was apparently no established trade industry surrounding Eastern Region obsidian while Coso already had a longstanding and likely well-known one that was present in the Mojave Desert may have discouraged the development of such an industry for the former area. Coso quarries were supplying abundant material for thousands of years to southern California and were well-known. Why settle for an unknown source when an abundant material with understood qualities and trade networks already existed?

Conveyance Methods

There are three main types of material conveyance methods which have been explored extensively in the literature concerning obsidian movement in California. These methods consist of embedded procurement, direct access, and trade and exchange. Based on the models that have been developed by numerous scholars and their archaeological expectations, the following discussion has assessed which methods provide the best explanations as to how the obsidian specimens gathered for the current thesis arrived at their final geographic locations.

Eastern Region

Based on the results of the current thesis, embedded procurement and direct access both fit the evidence provided from the Eastern Region equally well. However, because the size and extent of the seasonal rounds of Eastern Region groups is not clear enough, and there were not enough obsidian specimens per site, we cannot differentiate between them. The Eastern Region evidence presented in chapter four also fits the expectations of trade and exchange models quite well. Therefore, a combination of direct access, including the possibility of an embedded procurement strategy, and trade and exchange is recommended as the best explanation for this area.

Based on Sutton’s (2017) model of the seasonal movements of western Mojave Desert groups, Eastern Region groups did not typically move beyond the northern edges of the desert during their seasonal rounds. His model suggested that, other than groups that permanently occupied villages along the Mojave River, the desert was utilized as a common pool resource zone by the people that typically resided in the upland peripheries of the desert. In this model, the desert was shared, to some extent at least, while the regions at and just beyond its edges were more territorially controlled. Therefore, Eastern Region groups would have been able to easily obtain Eastern Source material via direct access and/or embedded procurement. It follows that Coso material was not typically acquired through embedded procurement or direct access because of these boundaries. Territoriality and control over the Coso quarries likely began to increase starting in the early part of the Late Archaic (Gilreath and Hildebrandt 1997, 2011; Jones et al. 1999). This would have meant less opportunity, perhaps none, for the groups that did not control the Coso region to access it directly and/or via an embedded procurement strategy.

Basgall (1989) posited that a high diversity of material sources represented at a site would indicate that the material was acquired via embedded procurement. This was because people would have gathered obsidian from multiple sources as they drew near to them during their seasonal rounds. The Eastern Region featured a relatively high diversity of obsidian sources (see Table 1.). Therefore, the Eastern Region fits Basgall's prediction quite well. There is a problem with this interpretation though. Some of the sources in the Eastern Region are far enough away to have made them impractical for direct access, especially considering the availability of Eastern Source material. In total, 15 of the 49 Eastern Region specimens (30.61 percent) were from sources that were between approximately 332 and 734 kilometers away. This is well beyond any reasonable extension of the seasonal territory laid out previously. It follows that it is unlikely that Coso and all other nonlocal sources were being accessed by Eastern Region groups via direct access and/or embedded procurement. The collection from this region has a high diversity, in part, because of the inclusion of nonlocal sources. These sources should be excluded from consideration under Basgall's archaeological expectation based on the discussion above. However, this does not detract from the argument that both direct access and embedded procurement were utilized to obtain Eastern Source materials here.

Eerkens et al. (2008) predicted that, for direct access, there would be a very gradual falloff in frequencies of material as the distance to the source increased. That is not the case in the Eastern Region, even when considering distances between the sites and sources along navigable routes rather than Euclidean distances between them (Sutton and Des Lauriers 2002). For purposes of assessing this prediction, the Eastern Sources will be grouped together, and the Casa Diablo, Fletcher, Inyo Crater, and Queen sources (now referred to as the Owens Valley Sources) will as well. This is because the sources in both groups are in relatively close proximity to each other. The Eastern Source group has the highest frequency, which is to be expected. However, San Felipe and Coso tied for the second highest frequency at nine specimens per source. This was expected for Coso because it is the closest, but San Felipe tied for the third/fourth farthest out of five. It should be noted that the presence of San Felipe obsidian here is significant in that it demonstrates a connection between Eastern Region groups and the Yuman interaction sphere centered around the Colorado River and the Peninsular Ranges in southern and Baja California. Buck Mountain and Obsidian Butte tied for the lowest frequency at one specimen each. This was expected for Buck Mountain, but Obsidian Butte is the second closest source out of five (not counting the Eastern Sources). And although the Owens Valley Sources are roughly the same distance from the Eastern Region that San Felipe is, the former only contributed five specimens, which is just over half of what the latter did. These inconsistent results would suggest that direct access was not the form of procurement that was practiced for obtaining nonlocal source material, at least on its own.

Trade and exchange likely accounted for the majority of nonlocal obsidian in the Eastern Region. As outlined above: nonlocal sources lied outside the hypothesized seasonal limits of Eastern Region (and much of the Northwestern Region) groups; there was a longstanding Coso trade system, with routes that passed through portions of the western Mojave Desert, that would have provided a pre-existing means of easily obtaining Coso material (see Scharlotta 2014); Eastern Region groups were certainly trading for approximately 30.61 percent of their obsidian based on distance alone; territoriality and control over the Coso region and its quarries was potentially increased during the Late Prehistoric period. Combined, these factors portray a situation in which people had little or no ability to physically gather nonlocal obsidian themselves, while also having had easy access to trade for such material.

Archaeological predictions of trade and exchange have been presented by King et al. (2011). They posited that “meaningful quantities of obsidian well outside the range of embedded, or even direct logistical, procurement” would be present. Sources which are considered here to be outside the embedded and direct access ranges of Eastern Region groups account for 30.61 percent of the obsidian specimens from the Eastern Region. This is certainly a “meaningful” amount. They also suggested that material that was traded between different groups would be found in areas which did not share other classes of artifacts. For example, the Eastern Region contained mainly Cottonwood projectile points and both brownware and buffware ceramics, while the area north of the Mojave River contained both Cottonwood and Desert Side-notched points and mainly brownware ceramics. Although there was some overlap, there was a clear difference in assemblages between the regions based on artifact types.

Northwestern Region

Results of the current thesis have shown that trade and exchange likely accounted for the conveyance of much of the obsidian in the Northwestern

Region. Based on the vast distances between the Northwestern Region and the more distant sources, It is unlikely, although possible, that any of those distant sources were being obtained by any other method. While it is argued here that embedded procurement accounted for the smallest portion (or none) of the conveyance in this region, results suggest that direct access must have been a major means of material acquisition, especially for groups whose main territory was based in the Coso area.

Basgall (1989) predicted that higher diversity of materials at a site would indicate an embedded procurement strategy. The Northwestern Region had exceedingly low diversity, as its sample was composed of 93.69 percent Coso material. However, it should be noted that Basgall's study was based on central-eastern California, where there was an abundance of obsidian sources within much closer proximity than is available in the Mojave.

If Northwestern Region groups (not including Coso-region-based ones) were travelling to areas north of the Coso Region, whether it was for direct access of distant sources or such access occurred as part of an embedded procurement strategy, they would have passed through the Coso Region again on the way back most likely. King et al. (2011) predicted that there would be more material present from sources that would have been visited more recently during the seasonal movement of the responsible group. Results of the current thesis indeed fit King's model well because Coso would have been the last source location passed when reentering the Northwestern Region from the north, and Coso material accounted for 93.69 percent of the obsidian included in the database (see Appendix A). However, because the seasonal rounds of the Northwestern groups remain unclear, it should be noted that such rounds could have begun or ended by entering or exiting through the Southern Sierras, rather than the Owens Valley and the Coso Region. Furthermore, Sutton's (2017) interpretations of the seasonal rounds practiced in the region would suggest that people here would not have ventured outside of their core areas and the desert itself as part of their seasonal movements.

When it comes to the groups that resided in the vicinity of the Coso Region and utilized the desert south of it, embedded procurement may not apply

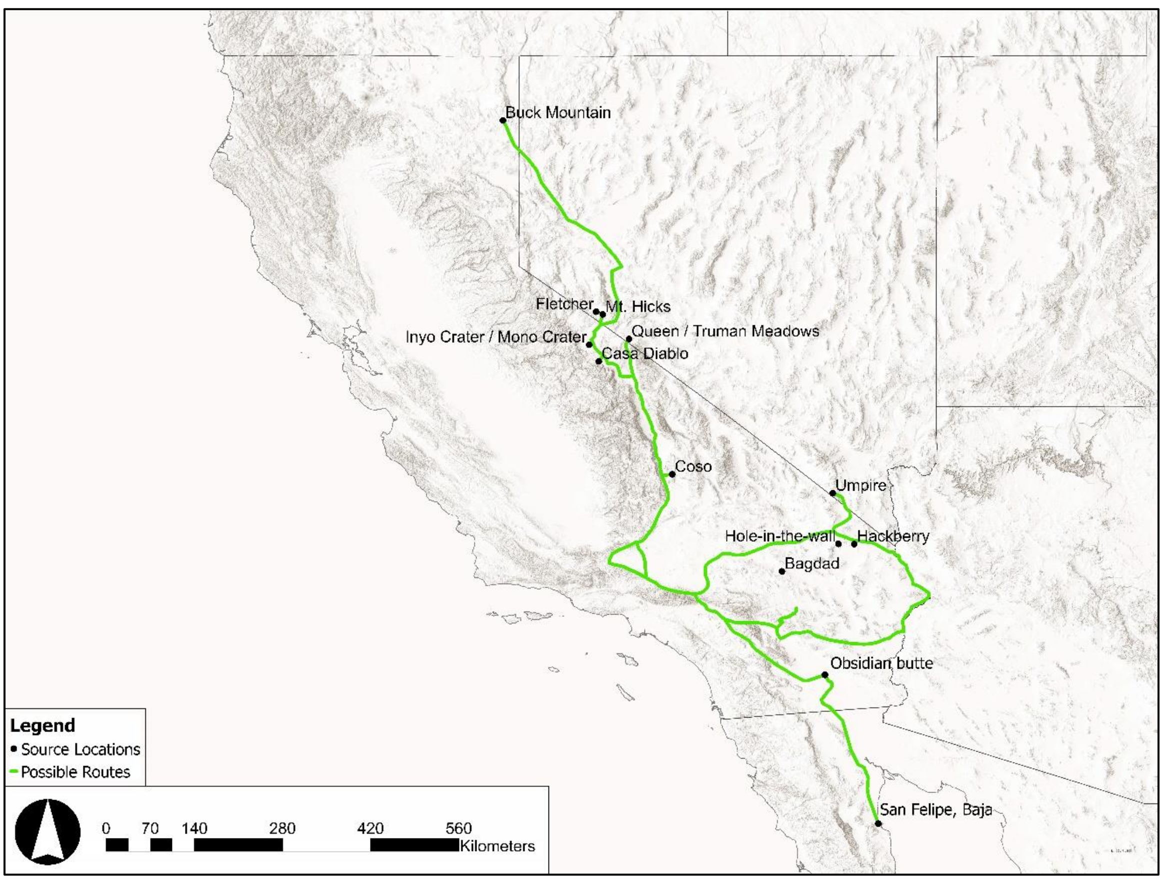

Figure 6. Map of Locations of All Sources and Possible Trade Routes. Trade routes are based on topography and ethnographically described trails (Davis 1961).

perfectly. These groups surely had physical access to Coso quarries and may have exerted territorial control over them. For this reason, calling their quarrying activities embedded procurement would be a misnomer. It would be more appropriate to refer to this type of procurement as direct access for those in the Coso region.

The groups that resided mainly in the southern Sierras, the Tehachapi mountains, and the western San Gabriel Mountains could have conceivably had seasonal access to the Coso quarries, although this would not be in concert with Sutton's (2017) model either. Scharlotta (2014) argued that Coso obsidian was being transported directly through the Northwestern Region as part of the large trade network linking the coast and the Coso Range, so there would have been built-in access to trade for Coso obsidian. This would have made travelling to the quarries themselves less appealing to groups in the western portion of the Northwestern Region. The southern Sierras in particular are well known for having participated heavily in this trade system (Bettinger 1982; Gilreath and Hildebrandt 1997, 2011; Meighan 1992). Some of the groups that inhabited and/or utilized the Northwestern Region likely resided mainly in the southern Sierras or very close to them. So, the likelihood of trade being responsible for these groups' acquisition of Coso material is high.

Eerkens et al. (2008) suggested that, if a group was acquiring material mainly through direct access, there would be little difference in the frequencies of materials which came from sources of varying distances. Overall for the Northwestern Region, this is not a good fit, even when considering distances between the sites and sources along navigable routes rather than Euclidean distances between them (Sutton and Des Lauriers 2002). The results of the current study suggest that Coso obsidian made up 93.69 percent of obsidian found in the Northwestern Region and at least five other sources account for the remainder, meaning that there is a large difference in frequences of different material sources. However, the model argued for thus far does account for this. People were not making long logistical trips for direct access, during which they would have had opportunities to visit different sources. They were instead visiting almost exclusively the Coso quarries, and rarely obtaining distant material via trade.

Predictions made by King et al. (2011) suggested that “meaningful quantities” of material from distant sources would be expected if trade and exchange were the primary conveyance methods. Results of the current study suggest that only 5.97 percent of the obsidian found in the Northwestern Region originated from sources that could be considered distant. Although King et al.’s prediction does not fit the evidence gathered from the Northwestern Region, the circumstances discussed above are extenuating. Furthermore, King et al. also posited that material that was traded between different groups would be found in areas which did not share other classes of artifacts. This is the case when comparing the westernmost Mojave Desert and the northern portion of the Northwestern Region. While Sutton’s (1989) western sphere was mainly shown as having Cottonwood points and almost no ceramics, his northern sphere was described as containing mainly Desert Side-notched and Cottonwood points with predominantly brownware ceramics.

CHAPTER SIX

CONCLUSION

Sutton's (1989) proposal that there was a difference in obsidian source utilization between the portion of the Mojave Desert south of the Mojave River (the Eastern Region) and the area to its north and west (the Northwestern Region) was tested as part of the current thesis. Sutton asserted that in the Northwestern Region, groups relied almost exclusively on Coso obsidian, which comes from the Coso Volcanic Fields located on the Naval Air Weapons Station, China Lake approximately 26 miles north of Ridgecrest. In the Eastern Region, Sutton claimed that the majority of culturally modified obsidian came from four sources (Bagdad, Umpire, Hole-in-the-wall, and Hackberry Mountains sources) which were located within that area. Results of an independent samples *t* test have indicated that there is a statistically significant difference between the obsidian source frequencies of the regions. This difference has been characterized as a nearly exclusive reliance on Coso obsidian in the Northwestern Region and a nearly equal reliance on Eastern Source material and nonlocal source material in the Eastern Region.

Potential factors that could have affected the frequencies of material from various obsidian sources in these areas have been discussed. These factors included: (1) political limitations on trade based on cultural differences (i.e., differing linguistic affiliations) and historical factors (i.e., immigration of Takic people or diffusion of Takic language into the Eastern Region); (2) preference based on perceived material quality and/or manufacturing needs; (3) material abundance and availability; (4) established trade relations. While the obsidian source frequencies were most likely affected by a combination of these factors rather than by one alone, factors 3 and 4 are the simplest and most reasonable. It would be difficult to argue that Coso material was not significantly more abundant, and therefore available, than Eastern Sources. And there is a wealth of evidence that suggests that groups throughout southern California were aware of Coso obsidian and its established trade network. Furthermore, Eastern Sources may not have become useful to anyone at all until the bow and arrow became established in the Eastern Region because marekanite nodules are typically too small to craft projectile points larger than small arrowheads. So, while it is certainly possible that political factors and material preferences played a significant role in the obsidian choices made by Late Prehistoric people, it is difficult to say with any certainty whether they actually did.

The methods by which obsidian was conveyed across the western Mojave Desert were then explored. In the Eastern Region, people obtained Eastern Source material via direct access and/or embedded procurement while the majority of nonlocal source material was acquired through trade and exchange. In the Northwestern Region, people inhabiting the Coso area got Coso material through direct access while most other groups used trade and exchange to get all their obsidian.

Several aspects of these interpretations could be improved by further research. A clearer understanding of the methods of conveyance would be possible with insights gained from additional lines of evidence. For example, distinguishing between embedded procurement and direct access was challenging. By studying evidence of the seasonal movements of western Mojave groups and their lithic technologies (e.g., late vs. early-stage lithic reduction material from various obsidian sources) it would be possible to discern between the two better. While the samples that have been utilized for the current study were sufficient to make statistical inferences, a larger sample size would improve insights, especially for the Eastern Region. Some archaeological predictions were not practical to assess given the somewhat limited size of the Eastern Region's sample. For example, Eerkens et al. (2008) predicted that there would not be a large difference in the frequencies of materials that were varying distances from the sites at which they were found. One site alone (CA-SBR-1913/H) provided all the known San Felipe source specimens for the entire western Mojave Desert. Not only that, but San Felipe tied with Coso for the second most well-represented source in the Eastern Region. The addition of one more site could perhaps significantly change the ratios of material present in the region.

A considerable body of data exists for this subject that was not available for the current study. Much of it was not attained because access to military base records, especially Marine Corps Air Ground Combat Center Twentynine Palms (from which no data was collected), was not granted. Data from Edwards Air Force Base and Fort Irwin was obtained, but this was only what was available to the public via published material. Far more data exists from those bases as well and could have an impact on the results of the current study.

There is also great potential for further expansion on the topic of the current study. For example, a diachronic aspect could enhance the utility of insights. Are Eastern Region sites on average older or younger than Northwestern Region ones? What conveyance methods were at play in preceding time periods? Was Eastern Source material relegated to the Eastern Region throughout its history of exploitation, or has it been conveyed to other areas farther in the past? These questions, along with others that the current study may raise, will lead to a more detailed understanding of obsidian distribution and conveyance, intergroup political and linguistic relations, and obsidian source qualities and preferences.

The western Mojave Desert lies between the area containing the Colorado River and the Southwest, the Great Basin, the Coso region and Owens Valley, and the rest of Southern California, including the coast and Channel Islands. Well-documented trade networks of obsidian, shell beads, and Southwestern goods run directly through it. This makes it an important area for understanding material conveyance and intergroup interactions throughout the region. The insights made here have further illuminated the behavior of the people in the Late Prehistoric western Mojave Desert. Ultimately, this promises to enrich the understanding of all of these intermingled groups and places.

APPENDIX A

OBSIDIAN SOURCE DATA

Site	Obsidian Source	Date Range	Method of Sourcing	Region	Source
KER-733	C (4)	RS - LP (AD 1000 - ca. AD 1810)	N/A	W	Sutton (1984)
SBR-85	BD (8); Unk (2); C (1)	LP	N/A	E	Schneider (1987)
SBR-3829	C (9); Unk (1)	RS - PC (AD 900 - 1840)	EDXRF	N	(Sutton 1987b)
Mitchell Caverns	Hackberry (2); Unk (2); C (1)	RS - PC (began ~AD 500)	Geochemical	E	Pinto (1989)
KER-250	C (34); Unk (1)	RS - LP (AD 700 - 1300)	EDXRF	N	McGuire et al. (1982)
SBR-5300	Umpire (8); CD (2); Fletcher (1)	RS - LP (beginning ~AD 1000)	XRF	E	Lerch (1985)
SBR-259	BD (2); Unk (1)	LP - PC (AD 1280 - 1800)	N/A	E	Sutton (1988a)
SBR-334	Hole-in-wall (2); BD(1)	LP (beginning ~AD 1500)	Geochemical	E	Sutton et al. (1987)
SBR-363C	Inyo Crater (1); Buck Mountain (1)	LP - PC (AD 1000 - modern)	INAA	E	Cameron (1984)
SBR-4504	Mt. Hicks, NV (3); OB (2); C (2); Unk (1)	LP (AD 1660-1780)	WXRF	N	Kelly and Warren (1985a, 1985b)
SBR-4454	C (7)	RS, LP, PC (AD 900 - modern)	WXRF	N	Kelly and Warren (1985b)
SBR-4483	C (28); OB (4); Unk (1)	LP	WXRF	N	Kelly and Warren (1984)
SBR-4458	CD (7); Unk (3); C (1)	PC	N/A	N	Sutton (1988a)
SBR-4457	C(1); OB (1)	RS - LP (AD 500 - 1900)	WXRF	N	Kelly and Warren (1985a)
*KER-1180	C (5)	LP - PC (AD 1283 - 1955)	EDXRF	W	Byrd et al. (1994)
SBR-413	Unk (4); Queen (1)	RS - LP (AD 1000-1500)	Geochemical	E	Sutton et al. (2000)
KER-7055	C (19)	LP (~AD 1300)	Geochemical	N	Pacific Legacy (2010)
INY-372	C (4)	RS -LP (AD 900 - 1900)	Geochemical	N	Rogers and Yohe (2014)
INY-2844	C (5)	LP - PC (AD 1300 - mid 1800s)	EDXRF	N	Shackley (1993)
INY-5654/H	C (29)	RS - LP (AD 500 - 1300)	EDXRF	N	Shackley (2021)
INY-5655	C (21)	RS - LP (AD 500 - 1300)	EDXRF	N	Shackley (2021)
SBR-1913	San Felipe, Baja Ca (9); C (7); OB (1); BD (1); Unk (1)	LP - PC (~AD 500 - modern)	EDXRF	E	Shackley (1996); Sutton and Schneider (1996)
KER-10245	C (1)	RS - LP (AD 606 - 1160)	EDXRF	N	Shackley (2017)
KER-10853	C (1)	RS - LP (AD 914 - 1264)	EDXRF	N	Yohe et al. (2019)
*KER-1189	C (2)	RS - LP (AD 849 - 1213)	N/A	W	Bark (2017)
*KER-1439	Unk (1)	PC (AD 1752)	N/A	W	Bark (2017)
*KER-1763	C (1)	PC (AD 1829)	N/A	W	Bark (2017)
*KER-1810/H	C (2)	LP (AD 1497 - 1531)	N/A	W	Bark (2017)
*KER-1830	C(1)	RS (AD 790)	N/A	W	Bark (2017)
*KER-1922/H	C (5); Unk (7)	RS - PC (AD 667 - 1906)	N/A	W	Bark (2017)
*KER-2007	C (1)	RS (AD 729)	EDXRF	W	Bark (2017)
*KER-2016	C (13)	RS, LP, PC (AD 729 - 1873)	N/A	W	Bark (2017)
*KER-2025	C (1)	LP (AD 1067)	N/A	W	Bark (2017)
*KER-2038/H	C (1)	RS (AD 906)	N/A	W	Bark (2017)
*KER-2059	C (1)	PC (AD 1859)	N/A	W	Bark (2017)
*KER-2124	C (1)	RS (AD 1015)	N/A	W	Bark (2017)

*KER-2234	C (2)	RS (AD 667 - 729)	N/A	W	Bark (2017)
*KER-2533	C (1)	RS (AD 961)	N/A	W	Bark (2017)
*KER-2816	C (1)	LP (AD 1564)	N/A	W	Bark (2017)
*KER-2817	C (9)	RS, LP, PC (AD 849 - 1812)	N/A	W	Bark (2017)
*KER-3158	C (1)	RS (AD 667)	N/A	W	Bark (2017)
*KER-3377	C (1)	LP (AD 1213)	N/A	W	Bark (2017)
*KER-3875/H	C (8)	LP (AD 1424 - 1625)	N/A	W	Bark (2017)
*KER-3876/H	C (2)	PC (AD 1752 - 1773)	N/A	W	Bark (2017)
*KER-4153/H	C (1)	PC (AD 1793)	N/A	W	Bark (2017)
*KER-4400	C (2)	RS - LP (AD 1015 - 1067)	N/A	W	Bark (2017)
*KER-4754	C (1)	LP (AD 1259)	N/A	W	Bark (2017)
*KER-4926	C (1)	RS (AD 961)	N/A	W	Bark (2017)
*KER-4956	C (1)	RS (AD 849)	N/A	W	Bark (2017)
*KER-4978	C (1)	LP (AD 1117)	N/A	W	Bark (2017)
*KER-4997	C (1)	PC (AD 1705)	N/A	W	Bark (2017)
*KER-525/H	C (1)	RS (AD 729)	N/A	W	Bark (2017)
*KER-5306	C (4)	LP (AD 1117 - 1497)	N/A	W	Bark (2017)
*KER-534	C (1)	LP (AD 1166)	N/A	W	Bark (2017)
*KER-549	C (1)	RS (AD 849)	N/A	W	Bark (2017)
*KER-5716	C (1)	LP (AD 1531)	N/A	W	Bark (2017)
*KER-5717	C (1)	LP (AD 1302)	N/A	W	Bark (2017)
*N/A	C (13)	RSs, LP, PC (AD 667 - 1729)	N/A	W	Bark (2017)
*LAN-1103	C (3)	RSs, LP, PC (906 -1845)	N/A	W	Bark (2017)
*LAN-1162	C (1)	RS (AD 1015)	N/A	W	Bark (2017)
*LAN-1185	C (3)	RS - LP (AD 849 - 1117)	N/A	W	Bark (2017)
*LAN-1189/H	Unk (4)	RS (AD 729 - 849)	EDXRF	W	Bark (2017)
*LAN-1207	C (1)	LP (AD 1259)	N/A	W	Bark (2017)
*LAN-1227	C (1)	LP (AD 1595)	N/A	W	Bark (2017)
*LAN-1283	C (1)	LP (AD 1117)	N/A	W	Bark (2017)
*LAN-1289/H	C (3)	RS (AD 667 - 1015)	N/A	W	Bark (2017)
*LAN-1296/H	C (19); Queen (1)	RS, LP, PC (AD 667 - 1793)	N/A	W	Bark (2017)
*LAN-1307	C (1)	LP (AD 1259)	EDXRF	W	Bark (2017)
*LAN-1310/H	C (1)	LP (AD 1166)	N/A	W	Bark (2017)
*LAN-1318/H	CD (1)	RS (AD 849)	N/A	W	Bark (2017)
*LAN-1585	C (2)	LP (AD 1213 - 1344)	N/A	W	Bark (2017)
*LAN-1798	C (1)	LP (AD 1213)	N/A	W	Bark (2017)
*LAN-1805	BD (1)	LP (AD 1385)	N/A	W	Bark (2017)
*LAN-2254	C (1)	LP (AD 1067)	N/A	W	Bark (2017)
*LAN-2302	C (1)	PC (AD 1705)	N/A	W	Bark (2017)
*LAN-2397	C (1)	RS (AD 729)	EDXRF	W	Bark (2017)

*LAN-2423	C (1)	PC (AD 1729)	N/A	W	Bark (2017)
*LAN-2661	C (1)	LP (AD 1344)	N/A	W	Bark (2017)
*LAN-3406	C (3)	LP (AD 1213 - 1564)	N/A	W	Bark (2017)
*LAN-3472	C (7)	LP - PC (AD 1259 - 1859)	N/A	W	Bark (2017)
*LAN-715	C (1)	LP (AD 1653)	N/A	W	Bark (2017)
*LAN-828/H	OB (1)	LP (AD 1344)	N/A	W	Bark (2017)
*LAN-863	C (1)	LP (AD 1531)	N/A	W	Bark (2017)
*SBR-5789	C (1)	LP (AD 1302)	N/A	W	Bark (2017)
*SBR-6151	C (1)	RS (AD 729)	N/A	W	Bark (2017)
*SBR-8852	C (1)	LP (AD 1117)	N/A	W	Bark (2017)

Key for abbreviations used in the table: LP - Late Prehistoric; RS - Rose Spring; PC - post-contact; C - Coso; OB - Obsidian Butte; Unk - Unknown; BD - Bagdad; CD - Casa Diablo; N - Portion of the Northwestern Region to the North of the Mojave River; W - Portion of the Northwestern Region to the West of the Mojave River; E - Eastern Region

*On or adjacent to Edwards Air Force Base

APPENDIX B

INDENDENT SAMPLES *t* TEST RESULTS

Comparison of the Northwestern Region and the Eastern Region in terms of their numbers per site of nonlocally sourced specimens (Buck Mountain, Casa Diablo, Coso, Fletcher, Inyo Crater, Mt. Hicks, Obsidian Butte, Queen, San Felipe) as a percentage of total number of sourced specimens (not including “unknown” source results)

Group Statistics

	Geographic location in reference to the Mojave River	N	Mean	Std. Deviation	Std. Error Mean
The fraction of sourced specimens at a given site that are not from sources located in the Eastern Sphere	NW Sphere	76	.9868	.11471	.01316
	Eastern Sphere	8	.4563	.44916	.15880

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means							
						Significance				95% Confidence Interval of the Difference	
		F	Sig.	t	df	One-Sided p	Two-Sided p	Mean Difference	Std. Error Difference	Lower	Upper
The fraction of sourced specimens at a given site that are not from sources located in the Eastern Sphere	Equal variances assumed	71.740	<.001	8.346	82	<.001	<.001	.53059	.06358	.40412	.65707
	Equal variances not assumed			3.330	7.096	.006	.012	.53059	.15934	.15484	.90635

Independent Samples Effect Sizes

		Standardizer[a]	Point Estimate	95% Confidence Interval	
				Lower	Upper
The fraction of sourced specimens at a given site that are not from sources located in the Eastern Sphere	Cohen's d	.17105	3.102	2.226	3.964
	Hedges' correction	.17263	3.074	2.206	3.928
	Glass's delta	.44916	1.181	.210	2.105

a. The denominator used in estimating the effect sizes.
Cohen's d uses the pooled standard deviation.
Hedges' correction uses the pooled standard deviation, plus a correction factor.
Glass's delta uses the sample standard deviation of the control (i.e., the second) group.

Comparison of the Northwestern Region and the Eastern Region in terms of their numbers per site of Coso specimens (Buck Mountain, Casa Diablo, Coso, Fletcher, Inyo Crater, Mt. Hicks, Obsidian Butte, Queen, San Felipe) as a percentage of total number of sourced specimens (not including “unknown” source results)

Group Statistics

	Geographic location in reference to the Mojave River	N	Mean	Std. Deviation	Std. Error Mean
The fraction of sourced specimens at a given site that are from Coso	NW Sphere	76	.9309	.23566	.02703
	Eastern Sphere	8	.2288	.34938	.12353

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means							
						Significance				95% Confidence Interval of the Difference	
		F	Sig.	t	df	One-Sided p	Two-Sided p	Mean Difference	Std. Error Difference	Lower	Upper
The fraction of sourced specimens at a given site that are from Coso	Equal variances assumed	3.231	.076	7.635	82	<.001	<.001	.70217	.09196	.51922	.88512
	Equal variances not assumed			5.553	7.685	<.001	<.001	.70217	.12645	.40848	.99586

Independent Samples Effect Sizes

		Standardizer[a]	Point Estimate	95% Confidence Interval	
				Lower	Upper
The fraction of sourced specimens at a given site that are from Coso	Cohen's d	.24742	2.838	1.984	3.679
	Hedges' correction	.24971	2.812	1.965	3.646
	Glass's delta	.34938	2.010	.727	3.250

a. The denominator used in estimating the effect sizes.
Cohen's d uses the pooled standard deviation.
Hedges' correction uses the pooled standard deviation, plus a correction factor.
Glass's delta uses the sample standard deviation of the control (i.e., the second) group.

REFERENCES

Bark, Richard Gerard

2017 Investigations into the Suspected Late Holocene Decline in Obsidian Use at Sites on Edwards Air Force Base. Unpublished Master of Arts thesis, California State University, San Bernardino, San Bernardino, California.

Basgall, Mark E.

1989 Obsidian Acquisition and Use in Prehistoric Central Eastern California. In *Current Directions in California Obsidian Studies*, edited by Richard E. Hughes, pp. 111–126. Contributions of the University of California Archaeological Research Facility No. 48, Berkeley, California.

Beals, Ralph, and Joseph A. Hester

1971 A New Ecological Typology of the California Indians. In *The California Indians, A Source Book*, edited by Robert F. Heizer and Mary A. Whipple, pp. 73–83. University of California Press, Berkeley, California.

Bean, Lowell John, and Charles Smith

1978 Serrano. In California, edited by R. F. Heizer, 8:pp. 570–574. Handbook of North American Indians. Smithsonian Institution, Washington D. C.

Bettinger, Robert L.

1982 Aboriginal exchange and territoriality in Owens Valley, California. In Contexts for Prehistoric Exchange, edited by Jonathan E. Ericson and Timothy K. Earle, pp. 103–128. Academic Press, New York.

Bettinger, Robert L., and Martin A. Baumhoff

1982 The Numic Spread: Great Basin Cultures in Competition. *American Antiquity* 47(3):485–503.

Binford, Lewis R.

1962 Archaeology as Anthropology. *American Antiquity* 28(2):217–225.

1965 Archaeological Systematics and the Study of Culture Process. *American Antiquity* 31(2).

Blackburn, Thomas C., and Lowell John Bean

1978 Kitanemuk. In *Handbook of North American Indians*, edited by William C. Sturtevant and Robert F. Heizer, 8:pp. 564–569. Smithsonian Institution, Washington D. C.

Byrd, Brian F., Jerome King, William R. Hildebrandt, and Kelly R. McGuire
2011 *Prehistoric Archaeological Overview and Research Design, Mojave National Preserve, San Bernardino County, California*. Report on file at the Mojave National Preserve, Bastow, California.

Byrd, Brian F., Drew Pallette, and Carol Serr
1994 *Prehistoric Settlement Along the Eastern Margin of Rogers Dry Lake, Western Mojave Desert, California*. Brian F. Mooney Associates, Anthropological Technical Series 2, San Diego.

Caldwell, Joseph R.
1964 Interaction Spheres in Prehistory. In *Hopewellian Studies*, edited by Joseph R. Caldwell and Robert L. Hall, 12:pp. 133–143. Scientific Papers. Illinois State University, Springfield.

Cameron, Constance
1984 *The West Pond report : archaeological investigations at SBR-363c Soda Springs (Zzyzx), California*. California State University, Fullerton: Museum of Anthropology.

Christensen, Don, Jerry Dickey, David Lee, Charlotte Lee, and Amy Leska
2004 *P-36-199 Site Record*. Department of Parks and Recreation.

Davis, James T.
1961 *Trade Routes and Economic Exchange Among the Indians of California*. Reports of the University of California Archaeological Survey 54. University of California, Berkeley, California.

Earle, David D.
2005 The Mojave River and the Central Mojave Desert: Native Settlement, Travel, and Exchange in the Eighteenth and Nineteenth Centuries. *Journal of California and Great Basin Anthropology* 25(1):1–38.

Eerkens, Jelmer W., Amy M. Spurling, and Michelle A. Gras
2008 Measuring Prehistoric Mobility Strategies Based on Obsidian Geochemical and Technological Signatures in the Owens Valley, California. *Journal of Archaeological Science* 35:668–680.

Ericson, Johnathan E.
1981 *Exchange and Production Systems in California Prehistory: The Results of Hydration Dating and Chemical Characterization of Obsidian Sources*. B.A.R., Oxford.

Ericson, Jonathan E.
1982 Production for Obsidian Exchange in California. In *Contexts for Prehistoric Exchange*, edited by Jonathan E. Ericson and T. K. Earle, pp. 129–148. Academic Press, New York.

Ericson, Jonathan E., and Clement W. Meighan
1984 Boundaries, Alliance and Exchange in California. In *Exploring the Limits: frontiers and boundaries in prehistory*, edited by Suzanne P. De Atley and Frank J. Findlow, pp. 143–152. B.A.R., Oxford, England.

Fowler, Catherine S.
1972 Some ecological clues to Proto-Numic homelands. In *Great Basin Cultural Ecology: A Symposium*, edited by D. D. Fowler, pp. 105–121. Desert Research Institute Publications in the Social Sciences, no. 8, Reno, Nevada.
1983 Some Lexical Clues to Uto-Aztecan Prehistory. *International Journal of American Linguistics* 49(3):224–257.

Gardner, Jill Kathleen
2006 The Potential Impact of the Medieval Climatic Anomaly on Human Populations in the Western Mojave Desert. Unpublished Doctor of Philosophy dissertation, University of Nevada, Las Vegas, Las Vegas.

Gilreath, Amy J., and William R. Hildebrandt
1997 *Prehistoric Use of the Coso Volcanic Field*. 56. Berkeley, California.
2011 Current Perspectives on the Production and Conveyance of Coso Obsidian. In *Perspectives on Prehistoric Trade and Exchange in California and the Great Basin*, edited by Richard E. Hughes, pp. 171–188. The University of Utah Press, Salt Lake City.

Google
2024 Satellite Imagery of the Coso Volcanic Fields. Electrnoic document, https://earth.google.com/web/search/coso+volcanic+fields/@35.95426886,-117.85565596,1311.89612976a,6207.07273186d,35y,116.54163585h,64.94803343t,-0r/data=CigiJgokCaNbVDhCD0FAEWVXYWJHDUFAGVDsUjoNbV3AIbJz0KtYbl3AMikKJwolCiExQVRFWU4wRWMzVS1VZHVacjFpeVk4c1E1N0pPNHNiOHQgAToDCgEw

Hughes, Richard E.
1992 California Archaeology and Linguistic Prehistory. *Journal of Anthropological Research* 48:317–338.
1994 Methodological Observations on Great Basin Prehistory. In *Across the West: Human Population Movement and the Expansion of the Numa*, edited by D. B. Madsen and D. Rhode, pp. 67–70. University of Utah Press, Salt Lake City.

2011 Sources of Inspiration for Studies of Prehistoric Resource Acquisition and Materials Conveyance in California and the Great Basin. In *Perspectives on Prehistoric Trade and Exchange in California and the Great Basin*, pp. 1–21. The University of Utah Press, Salt Lake City.

Jackson, Thomas L., and Jonathan E. Ericson
1994 Prehistoric Exchange Systems in California. In *Prehistoric Exchange Systems in North America*, edited by Timothy G. Baugh and Jonathan E. Ericson. Plenum Press, New York.

Jones, Terry L., Gary M. Brown, L. Mark Raab, Janet L. McVickar, W. Geoffrey Spaulding, Douglas J. Kennett, Andrew York, and Phillip L. Walker
1999 Environmental Imperatives Recondsidered: Demographic Crises in Western North America During the Medieval Climatic Anomaly. *Current Anthropology* 40:137–170.

Kaestle, Frederika A., and David Glenn Smith
2001 Ancient Mitochondrial DNA Evidence for Prehistoric Population Movement: The Numic Expansion. *American Journal of Physical Anthropology* 115:1–12.

Kelly, Michael S., and Claude N. Warren
1984 *An Evaluation of 22 Selected Sites in No Name West Basin, Fort Irwin, San Bernardino County, California*. On file at the South Central Coastal Information Center.
1985a *Archaeological Studies in No Name West Basin, Fort Irwin, San Bernardino County, California, Volume I: The Field Phase of Data Recovery at 10 Loci*. Report on file with the South Central Coastal Information Center.
1985b *Archaeological Studies at No Name West Basin, Fort Irwin, San Bernardino County, California, Volume 2: The Field Phase of Data Recovery at Two Sites*. On file at the South Central Coastal Information Center.

Keter, Thomas S.
2009 All Those Things that You're Liable to Read in the Ethnographic Literature They Ain't Necessarily So. In . Modesto, California.

King, Jerome, William R. Hildebrandt, and Jeffrey S. Rosenthall
2011 Evaluating Alternative Models for the Conveyance of Bodie Hills Obsidian into Central California. In *Perspectives on Prehistoric Trade and Exchange in California and the Great Basin*, edited by Richard E. Hughes, pp. 148–170. The University of Utah Press, Salt Lake City.

Kroeber, Alfred
1925 *Handbook of the Indians of California*. Government Printing Office, Washington.

Lerch, Michael K.
1985 *Archaeological Studies at the Colosseum Mine: Surface Collections and Test Excavations at CA-SBr-4889, -5300, and -5303, Clark Mountain Range, San Bernardino County, California*. Report on file with the South Central Coastal Information Center.

McGuire, Kelly R., Alan P. Garfinkel, and Mark E. Basgall
1982 *Archaeological Investigations in the El Paso Mountains of the Western Mojave Desert: The Bickel and Last Chance Sites (CA-Ker-250 and -261)*. Report on file with the Bureau of Land Management, Bakersfield.

Meighan, Clement W.
1992 Commentary: Obsidian and "Exchange Systems." *International Association of Obsidian Studies Bulletin* 6:2–3.

Moratto, Michael J.
1984 *California Archaeology*. Academic Press, New York.

Ohmart, Robert D., and Bertin W. Anderson
1982 North American Desert Riparian. In *Reference Handbook on the Deserts of North America*, edited by Gordon L. Bender, pp. 433–466. Greenwood Press, Westport, Connecticut.

Pacific Legacy, Inc.
2010 Department of Parks and Recreation Site Record: CA-KER-7055. On file at the South San Joaquin Valley Information Center, Bakersfield.

Pinto, Diana G.
1989 *The Archaeology of Mitchell Caverns*. No. 25. State of California, Resources Agency, Department of Parks and Recreation, Resource Protection Division, Cultural Heritage Section.

Rogers, Alexander, and Robert M. Yohe
2014 Obsidian Re-Use at the Rose Spring Site (CA-INY-372), Eastern California: Evidence from Obsidian Hydration Studies. *Journal of California and Great Basin Anthropology* 34(2):273–286.

Rogers, Malcolm J.
1929 Report of a Reconnaissance in the Mojave Sink Region. *San Diego Museum Papers* 1:1–13.

Scharlotta, Ian

2014 Trade Routes and Contradictory Spheres of Influence: Movement of Rhyolite Through the Heart of the Western Mojave Desert. *California Archaeology* 6(2):219–246.

Schneider, Jane

1987 Archaeological Investigations at Afton Canyon (CA-SBR-85) Mojave Desert, San Bernardino County, California. Unpublished Master of Arts thesis, University of California, Riverside.

Shackley, M. Steven

1993 An Energy Dispersive X-ray Fluorescence (EDXRF) Analysis of Obsidian Artifacts from Three Prehistoric Sites near Darwin, Inyo County, California. University of California, Berkeley.

1996 An Energy Dispersive X-Ray Fluorescence (EDXRF) Analysis of Obsidian Artifacts from CASBR- 1913, San Bernardino County, California. University of California, Berkeley.

2017 Source Provenance of Obsidian Artifacts from Archaeological Sites on the Naval Weapons Station China Lake, Inyo, Kern, and San Bernardino Counties, California. University of California, Berkeley.

2021 Source Provenance of Obsidian Artifacts from Eight Sites on the Naval Weapons Station China Lake, Inyo County, California. University of California, Berkeley.

Shackley, Steven M.

1994 Intersource and Intrasource Geochemical Variability in Two Newly Discovered Archaeological Obsidian Sources in the Southern Great Basin. *Journal of California and Great Basin Anthropology* 16(1):118–129.

Sutton, Mark Q.

1984 Archaeological Investigations at Ker-733, A Special Purpose Site in the Western Mojave Desert. *Pacifc Coast Archaeological Society Quarterly* 20(4):33–55.

1987a The Archaeology of Southcott Cave, Providence Mountains, California. *Journal of California and Great Basin Anthropology* 9(2):232–250.

1987b Excavation at CA-SBR-3829, The Denning Springs Rockshelter, Avawatz Mountains, San Bernardino County, California. *Coyote Press Archives of Prehistory* 10:115–139.

1988a Obsidian Analyses in the Mojave Desert, California: Results, Cautions, and Comments. In *Obsidian Dates IV*, edited by Clement W. Meighan and Janet Scalise, pp. 51–63. Institute of Archaeological Monographs XXIV, University of California, Los Angeles.

1988b *An Introduction to the Archaeology of the Western Mojave Desert, California*. Coyote Press, Salinas, California.

1989 Late Prehistoric Interaction Spheres in the Mojave Desert. *North American Archaeologist* 10(2):95–121.
1993 The Numic Expansion in Great Basin Oral Tradition. *Journal of California and Great Basin Anthropology* 15(1):111–128.
1996 The Current Status of Archaeological Research in the Mojave Desert. *Journal of California and Great Basin Anthropology* 18(2):221–257.
2009 People and Language: Defining the Takic Expansion into Southern California. *Pacifc Coast Archaeological Society Quarterly* 41(2 & 3):31–93.
2010 A Reevaluation of Early Northern Uto-Aztecan Prehistory in Alta California. *California Archaeology* 2(1):3–30.
2017 Chasing Ghosts? Rethinking the Prehistory of the Late Holocene Mojave Desert. *Pacific Coast Archaeological Society Quarterly* 53(1):1–78.

Sutton, Mark Q., Mark E. Basgall, Jill K. Gardner, and Mark W. Allen
2007 Advances in Understanding Mojave Desert Prehistory. In *California Prehistory: Colonization, Culture, and Complexity*, pp. 229–245. AltaMira Press, Lanham, Maryland.

Sutton, Mark Q., and Matthew R. Des Lauriers
2002 Emerging Patterns in Obsidian Usage in the Southern San Joaquin Valley, California. *Pacific Coast Archaeological Society Quarterly* 38(2 & 3):1–18.

Sutton, Mark Q., Christopher B. Donnan, and Dennis L. Jenkins
1987 The Archaeology of Southcott Cave, Providence Mountains, California. *Journal of California and Great Basin Anthropology* 9(2):232–250.

Sutton, Mark Q., and David D. Earle
2017 The Desert Serrano of the Mojave River. *Pacific Coast Archaeological Society Quarterly* 53(2 and 3):1–61.

Sutton, Mark Q., Robin Novickas, and Gregory R. Seymour
2000 Archaeological Investigations at Vontrigger Spring, Eastern Mojave Desert, California. In *Archaeological Passages: a volume in honor of Claude Nelson Warren*, pp. 153–168. Western Center for Archaeology & Paleontology.

Sutton, Mark Q., and Jane Schneider
1996 Archaeological Investigations at Guapiabit, CA-SBR-1913. *San Bernardino County Museum Association Quarterly* 43(4):1–79.

Sutton, Mark Q., and Philip J. Wilke
1984 New Observations on a Clovis Point from the Central Mojave Desert, California. *Journal of California and Great Basin Anthropology* 6(1):113–115.

Walker, Lawrence R., and Frederick H. Landau
2018 *A Natural History of the Mojave Desert*. The University of Arizona Press, Tucson.

Warren, Claude N.
1984 The Desert Region. In *California Archaeology*, edited by Michael J. Moratto, pp. 339–430. Academic Press, Orlando, Florida.

Williams, Audrey
2009 Archaeological Investigations in the Western Mojave Desert at Freeman Spring, CA-KER-6106. Unpublished Master of Arts thesis, California State University, Bakersfield, Bakersfield.

Yohe, Robert, Theresa Lechmer, Daniel Martinez, Brad Beacham, and Robert Fiske
2019 3-Inch and 5-Inch Impact Target Cultural Resource Inventory, Naval Air Weapons Station (NAWS) China Lake, Inyo, Kern, and San Bernardino County, California (FINAL) Volume I: Report. Epsilon Systems Solutions, Inc.

Zigmond, Maurice L.
1986 Kawaiisu. In *Handbook of North American Indians*, edited by William C. Sturtevant and Robert F. Heizer, 11:pp. 398–411. Smithsonian Institution, Washington D. C.