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Are obsidian subsources meaningful units of analysis?: temporal and spatial patterning of subsources in the Coso Volcanic Field, southeastern California

Jelmer W. Eerkens[a]*, Jeffrey S. Rosenthal[b]

[a] *Department of Anthropology, University of California at Davis, One Shields Avenue, Davis, CA 95616-8522, USA*
[b] *Far Western Anthropological Research Group, 2727 Del Rio Place—Suite A, Davis, CA 95616, USA*

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Abstract

Archaeologists frequently assign artifacts to chemically discrete subsignatures of major obsidian sources. While the technical ability to do so has been demonstrated, it remains to be shown that such information is behaviorally meaningful. Indeed, some analysts choose not to make such determinations under the presumption that the data are not anthropologically relevant. Using a case study from the Coso Volcanic Field, which has at least four distinct subsignatures, we examine this problem and conclude that subsource identification can be useful and quite interesting. This is particularly so when large datasets encompassing spatially expansive areas can be assembled and statistically analyzed.

Keywords: Obsidian fingerprinting; Intra-source variability; Coso Volcanic Field; California; Great Basin

1. Introduction

As chemical analytical techniques have improved in the natural sciences, the quality and quantity of archaeological data resulting from their application has increased exponentially. Obsidian sourcing, or fingerprinting, has greatly advanced our understanding and knowledge of obsidian use in western North America. For example, in eastern California this technique is regularly used to reconstruct prehistoric patterns in exchange, mobility, and land use, among other topics (e.g., [1,3,4,10,13]). Recent analytical advancements now allow archaeologists to even recognize related but discrete signatures, or subsources, of obsidian derived from distinct source zones (e.g., [7,15,16,19,21]). While possible analytically, the interpretive value of identifying such subsources has not been explored.

Since at least the 1930s [12], the Coso Volcanic Fields have been recognized as a regionally important source of obsidian by archaeologists. While the pioneers Jack and Carmichael [17,18] recognized a single discrete chemical source, in more recent studies others have noticed the presence of distinct sub-signatures ([11,14]; see [6] for reservations and potential problems). Although more chemically similar to one another than to other obsidian source zones, such as Casa Diablo or Fish Springs, these subsources can be differentiated using most modern analytical techniques, such as X-Ray Fluorescence (XRF) and Instrumental Neutron Activation Analysis (INAA). To date, four main Coso sources are consistently recognized by analysts, including Sugarloaf Mountain, West Sugarloaf Mountain, Joshua Ridge, and West Cactus Peak, though others may be present as well. These subsources represent different flows of obsidian (Fig. 1 shows the location of the study region and the different Coso "source zones").

It was originally thought that differentiating subsources might be useful in hydration studies since it is known that different sources hydrate at different rates [11,14]. Recently Gilreath and Hildebrandt [13] have suggested that the West Sugarloaf and Sugarloaf Mountain subsources hydrate at the same rate (see also

* Corresponding author. Tel.: +1-530-752-0745; fax: +1-530-752-8885
E-mail address: jweerkens@ucdavis.edu (J.W. Eerkens).

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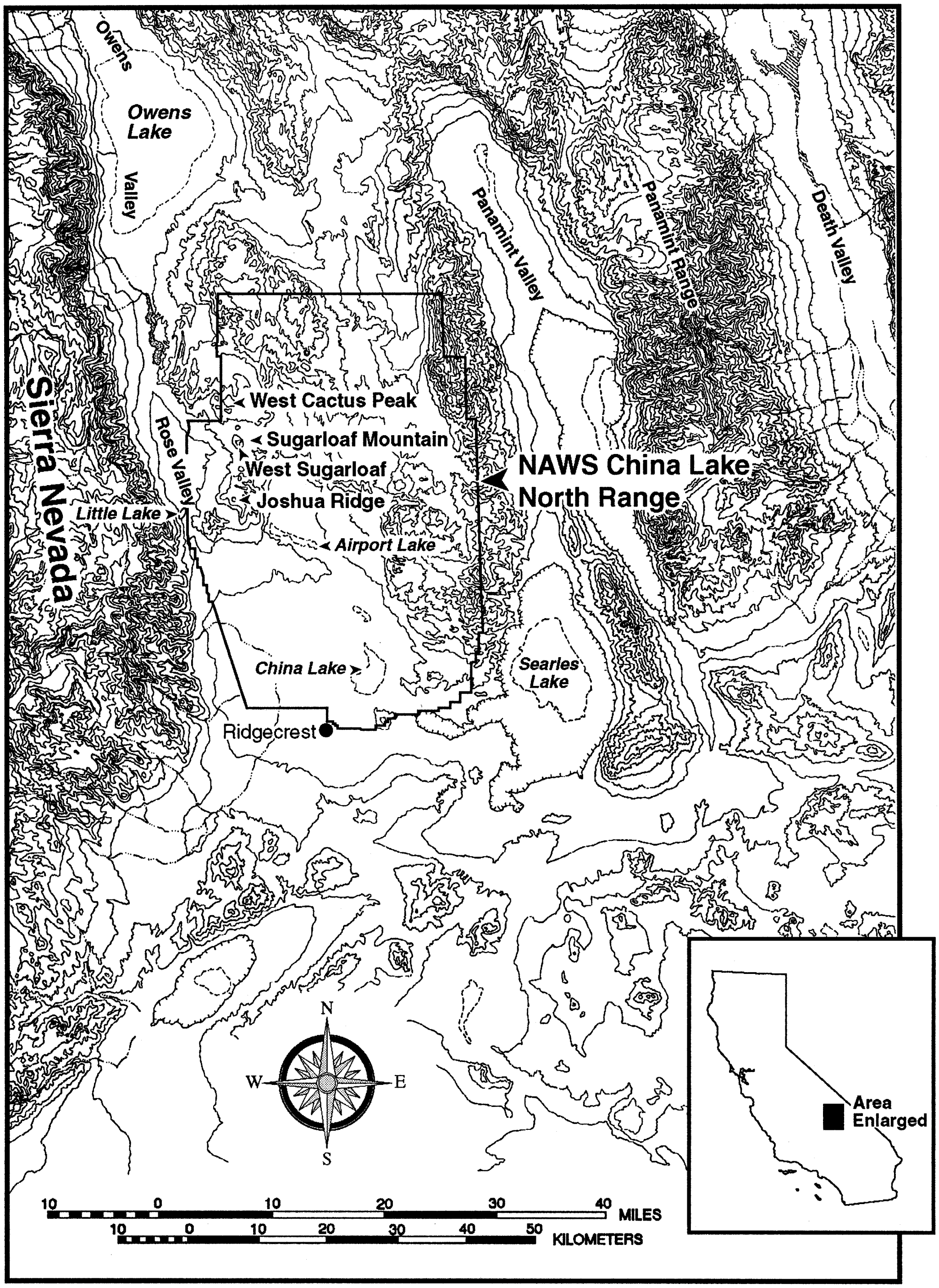

Fig. 1. Map of region and Coso subsources.

[22,23]). Analyses presented in Table 1, which shows hydration data for different temporally diagnostic projectile point types collected in the China Lake region (see [5]), support this result and suggest that all four subsources hydrate at a similar rate. There are no statistically significant differences in the average hydration readings for temporally diagnostic projectile points, though the sample sizes are small for Joshua Ridge and West Cactus Peak. Thus, in our estimation, differentiating subsources does not assist or refine our ability to tell time with Coso obsidian artifacts.

Thus, while the Coso subsources can be chemically differentiated, a more important question involves the significance of doing so. In other words, does it really matter whether a piece of obsidian comes from West Sugarloaf instead of Sugarloaf Mountain? Does the

Table 1
Comparison of point types and average hydration measurements

Point type	Subsource				
		WS	SM	JR	CP
Desert Series	Avg.	3.3	2.2	3.0	
	Stdev	0.72	0.75	2.4	
	Count	12	4	2	
Rosegate	Avg.	5.1	5.1	4.9	
	Stdev	0.97	0.93	1.22	
	Count	31	11	5	
Thin Elko	Avg.	7.2	6.9*	7.6	8.4
	Stdev	1.31	0.93	0.78	1.33
	Count	10	4	2	3
Pinto	Avg.	10.4	15.8	11.2	19.5
	Stdev	2.0	3.52	–	–
	Count	13	12	1	1
Stemmed	Avg.	12.3	14.2	11.9	19.0
	Stdev	2.69	2.93	6.17	–
	Count	25	10	6	1

Notes: All readings in microns; Avg.=Average; Stdev=Standard Deviation; WS=West Sugarloaf; SM=Sugarloaf Mountain; JR=Joshua Ridge; WCP=West Cactus Peak.

*Removing one large outlier of 16.2 microns.

effort expended on systematically identifying subources tell us anything interesting about prehistoric behavior that we did not already know? As discussed below, we believe the answer to this question is yes.

2. Obsidian in the Coso Volcanic Fields

As discussed by Elston and Zeier [9] and Gilreath and Hildebrandt [13], obsidian across the Coso Volcanic Fields varies in its quality, abundance, state of availability (whether as lag or primary seam quarries), distance to water and food resources, and accessibility (i.e., requiring a steep hike up an unstable slope, above or below the surface, etc). These factors must have affected how different subsources were used by the Paiute, Shoshone, and their ancestors. Thus, certain high-quality subsources may have been ignored because they were difficult to access, while other poor-quality sources may have been exploited because they were closer to water. Although evaluating all of these factors (i.e., quality, abundance, availability, etc.) for each subsource is beyond the scope of this discussion, some basic differences are apparent.

West Sugarloaf is a primary obsidian deposit occurring as large blocks in seams. These deposits were accessed prehistorically by excavating benches into the sides of domes and mining horizontally into the hillside, requiring considerable expenditure of effort [9]. The large size of obsidian blocks, as opposed to smaller nodules often available at lag quarries, made this source particularly attractive as a wider range of artifacts could have been produced (i.e., the raw material imposes no limits on tool size or shape). The West Sugarloaf subsource is also located near Rose Springs and Little Lake, readily available sources of water, and is easily accessible from those locations. These factors may have made territorial control over the quarry from permanent base camps possible.

Sugarloaf Mountain obsidian is also available in primary seam deposits. However, the abundance of obsidian in these deposits seems to be lower than in West Sugarloaf, and they are slightly further from Owens and Rose Valleys. Sugarloaf Mountain deposits may also have been less feasible for bench mining than the West Sugarloaf quarry due to reduced topographical relief. If so, more labor-intensive and difficult pit-mining would have been necessary.

Joshua Ridge also contains primary deposits and seams of obsidian, but again, the density and abundance seem to be lower than at West Sugarloaf. However, less archaeological work has been carried out in the vicinity of this subsource and exact descriptions of the abundance and accessibility are not available. Numerous lag deposits are available and also seem to have been exploited. This subsource is also located at a greater distance from permanent water and is not visible from such locations, making control over the resource difficult.

Finally, West Cactus Peak is only available in scattered lag deposits, occurring primarily as weathered nodules. The lack of primary deposits may have made this subsource less attractive. Moreover, it is located at some distance, and is visually removed, from more permanent sources of water.

3. Methods

All obsidian artifacts from Naval Air Weapons Station China Lake (NAWSCL) that had been assigned to one of the four subsources by chemical means (e.g., XRF or INAA) were assembled within a large database. This included sourcing studies from a diverse range of habitats and project types. Where possible, each artifact was assigned to a chronological period based on a hydration reading, or its type if a projectile point [5]. Of the 1275 artifacts in the database, 1165 have hydration information and 242 are chronologically sensitive projectile point types.

For comparative purposes, a similar database was assembled for obsidian artifacts from Owens Valley to the northwest (*n*=407), the Mojave Desert to the southeast (*n*=132), and the southern California coast (*n*=55). The majority of the Owens Valley pieces were collected in the southern end of the valley, with a small number of additional artifacts from the central portion. The Owens Valley artifacts include 291 items with hydration information and 146 diagnostic projectile points. Of the

Table 2
Representation of Obsidian sources among projectile points from NAWSCL

Point type	Period	Source					Total
		WS (%)	SM (%)	JR (%)	WCP (%)	Other (non-Coso) (%)	
Desert Series	Marana	66.7	22.2	11.1	0.0	0.0	n=18
Rosegate	Haiwee	60.8	21.6	11.8	0.0	5.9	n=51
Thin Elko/Humboldt	Newberry	46.0	28.0	16.0	8.0	2.0	n=50
Pinto/Thick Elko/Gypsum	Little Lake	38.9	42.6	11.1	1.9	5.6	n=54
Stemmed/GBCB/Fish Slough	Early Holocene	49.3	24.6	13.0	10.1	2.9	n=69
Totals		50	28.5	12.8	5.0	3.7	n=242

Notes: WS=West Sugarloaf; SM=Sugarloaf Mountain; JR=Joshua Ridge; WCP=West Cactus Peak; GBCB=Great Basin Concave Base. Other (non-Coso) sources given for comparative purposes.

Mojave Desert artifacts, only 27 items have hydration information and 21 are diagnostic points, making this database slightly less useful for comparative purposes. Finally, of the southern California coast pieces, only three are projectile points but all have hydration data. The latter database is the least useful for comparison due to its small sample size, but most informative when examining patterns in long-distance transport.

While there is no reason to believe that archaeologists preferentially select certain subsources for sourcing analysis (e.g., because they look peculiar), it is clear that the artifacts in the database are not a random sample of those on the landscape. Certain types have been differentially selected for analysis, specifically projectile points and other formal tools. Casual flake tools and debitage are underrepresented in the database. Thus, if some subsources were differentially selected for making formal tools their representation within our dataset will be higher, by definition. We revisit this issue below. As much as possible, we have tailored the analyses to minimize the effects of such biases in the underlying dataset. Finally, we had no control over the spatial location of previous projects. Since some projects are closer to certain subsources, it is possible that spatial proximity might be biasing the results. Specifically, it is clear that sites in and around Sugarloaf Mountain contribute a greater percentage of artifacts to the overall database than do sites near West Cactus Peak, and to a lesser extent Joshua Ridge. On the other hand, it is also likely that archaeological effort has been differentially expended on areas where sites, and by extension prehistoric obsidian exploitation, was more intensive.

In the sections below, we follow the general temporal framework proposed by Bettinger and Taylor [5]. This chronology has been adopted with slight modifications by most archaeologists working in the region. Specifically, we recognize five major time periods defined by particular projectile point types. The Early Holocene, sometimes referred to as Lake Mojave, represents our earliest period (pre 6000 BP) and is characterized by large stemmed points, including Lake Mojave, Silver Lake, and Great Basin Stemmed. Ensuing periods include Little Lake (6000–3500 BP; Pinto and Little Lake points), Newberry (3500–1500 BP; Thin Elko points), Haiwee (1500–600 BP; Rosegate points), and Marana (600–100 BP; Desert Side-Notched and Cottonwood points).

Table 3
Representation of Coso subsources sorted by hydration readings in NAWSCL

Micron range	Time period	Subsource				Total
		WS (%)	SM (%)	JR (%)	WCP (%)	
<4.2	Marana	58.9	25.0	5.4	10.7	n=56
4.2–5.6	Haiwee	50.3	28.3	10.7	10.7	n=186
5.7–8.6	Newberry	47.1	28.0	20.0	4.8	n=476
5.7–6.6	Late Newberry	57.0	21.0	17.3	4.7	n=215
6.7–7.6	Middle Newberry	44.1	28.9	23.0	3.9	n=152
7.7–8.6	Early Newberry	32.1	40.4	21.1	6.4	n=109
8.7–11.4	Little Lake	41.0	41.9	12.4	4.8	n=210
11.5+	Early Holocene	25.9	57.2	13.5	3.3	n=242
Total		42.7	36.4	15.2	5.6	n=1170

Notes: WS=West Sugarloaf; SM=Sugarloaf Mountain; JR=Joshua Ridge; WCP=West Cactus Peak.

4. Results

Results from the study suggest that there have been significant shifts through time in the use of different Coso subsources. Table 2 and Table 3 show subsource information by temporal period using projectile points (Table 2) and hydration (Table 3) information. Both tables show a steady increase in the use of West Sugarloaf relative to Sugarloaf Mountain through time, a pattern most pronounced in the hydration data. In the earliest time period Sugarloaf Mountain outnumbers West Sugarloaf by a ratio of 2 to 1. By the latest time period this trend is fully reversed; West Sugarloaf dominates Sugarloaf Mountain by a ratio of over 3 to 1.

Changes through time in the use of Joshua Ridge and West Cactus Peak are less clear. Both subsources were used in minor but relatively stable amounts throughout most periods. However, one clear trend is an increase in the use of Joshua Ridge during the Newberry period. As seen in Table 3, this increase occurs throughout the Newberry time period and is not confined to a particular part. One possible explanation for this increase is that as obsidian consumption intensified during the Newberry period and West Sugarloaf and Sugarloaf Mountain were being heavily used [13], flintknappers sought to increase production at other quarry zones with primary seams. While Joshua Ridge contains such seams, West Cactus Peak does not, which may explain the lack of a production peak in this subsource during the Newbery period. After the Newberry period, however, interest in Joshua Ridge seems to have waned, particularly as a source for export (see below). This decline may relate to the location and visibility of Joshua Ridge. If the primary users of Coso obsidian after the Newberry period were more sedentary and living near permanent sources of water, such as Rose Spring and/or Little Lake, Joshua Ridge may have been too distant for convenient exploitation.

Fig. 2 presents a histogram of hydration readings from NAWSCL for each of the four subsources. While West Sugarloaf and Joshua Ridge (and to some extent West Cactus Peak) show clear peaks in use between 5.0 and 9.0 microns, this is not the case for Sugarloaf Mountain. The latter seems to have been used almost as intensively in earlier time periods as during the Newberry period. In other words, while exploitation intensified at the other three subsources, it remained constant at Sugarloaf Mountain. Thus, the shift in use observed between West Sugarloaf and Sugarloaf Mountain (i.e., a 1:2 ratio early in time versus a 3:1 ratio later in time) is really more a product of intensification at West Sugarloaf and Joshua Ridge than a reduction in the use of Sugarloaf Mountain.

Table 4 presents information on the distribution of Coso subsources within NAWSCL by type of artifact and obsidian hydration measurement. Only projectile points, bifaces, formed flake tools, casual flaked tools, and unmodified flakes were considered (note that slight differences in the totals between Table 3 and Table 4 are due to a small number of cores or "unknown" artifact types omitted in the latter). The table is instructive at a general level in showing how different subsources were used to fashion different kinds of artifacts. For example, relative to the amount of debitage, West Sugarloaf was differentially used to fashion projectile points. This is true throughout all of prehistory. Sugarloaf Mountain, Joshua Ridge, and West Cactus Peak, on the other hand, were often made into bifaces and formed flake tools. The pattern is most pronounced in the post-Newberry period where over two-thirds of all projectile points were made of West Sugarloaf obsidian, yet less than half the debitage is from that same source.

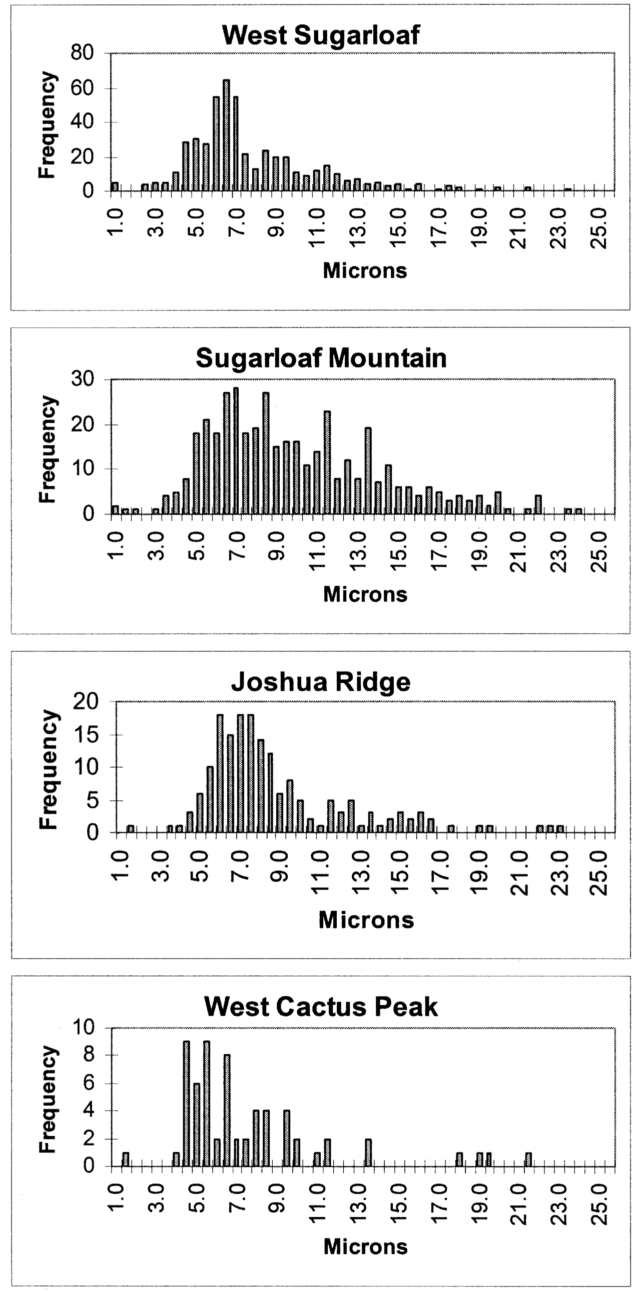

Fig. 2. Histogram of hydration readings from NAWSCL by subsource.

Why West Sugarloaf would be differentially targeted for making projectile points over other types of artifacts is unclear, but may relate to cultural preferences, slight differences in fracturing properties, and/or strength. For example, Steward [24] mentions that certain types of obsidians were thought of as being particularly "poisonous" by Owens Valley inhabitants. Certain subsources might create sharper edges more suitable for hunting and/or warfare, or may have had fracturing properties leading to more waste relative to tools. Presumably, the

Table 4
Distribution of Coso subsource by artifact type and hydration measurement within NAWSCL

Microns	Period	Artifact	Subsource				Total
			WS	SM (%)	JR (%)	WCP (%)	
<4.2	Marana	Points	66.7	23.8	9.5	0.0	*n*=21
		Bifs+Frmflktl	63.6	18.2	9.1	9.1	*n*=11
		FTs & Flakes	50.0	29.2	0.0	20.8	*n*=24
4.2–5.6	Haiwee	Points	72.7	13.6	13.6	0.0	*n*=44
		Bifs+Frmflktl	28.6	50.0	4.8	16.7	*n*=42
		FTs & Flakes	49.5	25.7	11.9	12.9	*n*=101
5.7–8.6	Newberry	Points	52.1	20.8	20.8	6.3	*n*=48
		Bifs+Frmflktl	40.0	31.7	3.3	25.0	*n*=60
		FTs & Flakes	47.4	28.5	22.7	1.4	*n*=365
8.7–11.4	Little Lake	Points	67.5	20.0	5.0	7.5	*n*=40
		Bifs+Frmflktl	22.2	55.6	5.6	16.7	*n*=18
		FTs & Flakes	35.6	47.0	15.4	2.0	*n*=149
11.5+	Early Holocene	Points	38.6	41.4	12.9	7.1	*n*=70
		Bifs+Frmflktl	36.4	54.5	0.0	9.1	*n*=22
		FTs & Flakes	18.7	64.7	16.0	0.7	*n*=150
Total			42.3	36.6	15.2	5.7	*n*=1165

Notes: WS=West Sugarloaf; SM=Sugarloaf Mountain; JR=Joshua Ridge; WCP=West Cactus Peak; Bifs=Bifaces; Frmflktl=Formed Flake Tool; FTs=Flake Tools.

Table 5
Representation of Coso subsources among projectile points from Owens Valley

Point type	Subsource				Total
	WS (%)	SM (%)	JR (%)	WCP (%)	
Desert Series	88.1	9.5	0.0	2.4	*n*=42
Rosegate	49.0	37.3	3.9	9.8	*n*=51
Elko & Humboldt	51.3	35.9	2.6	10.3	*n*=39
Pinto/Thick Elko	20.0	80.0	0.0	0.0	*n*=5
Stemmed/GBCB	66.7	11.1	11.1	11.1	*n*=9
Total	61.0	28.8	2.7	7.5	*n*=146

Notes: WS=West Sugarloaf; SM=Sugarloaf Mountain; JR=Joshua Ridge; WCP=West Cactus Peak; GBCB=Great Basin Concave Base.

Table 6
Representation of Coso subsources sorted by hydration readings in Owens Valley

Micron range	Period	Subsource				Total
		WS (%)	SM (%)	JR (%)	WCP (%)	
<3.7	Marana	65.2	24.6	1.4	8.7	*n*=69
3.7–5.1	Haiwee	68.8	23.4	6.3	1.6	*n*=64
5.2–7.6	Newberry	67.1	26.0	1.4	5.5	*n*=73
7.7–10.6	Little Lake	83.6	10.9	0.0	5.5	*n*=55
10.7+	Early Holocene	46.7	43.3	6.7	3.3	*n*=30
Total		68.0	24.1	2.7	5.2	*n*=291

Notes: WS=West Sugarloaf; SM=Sugarloaf Mountain; JR=Joshua Ridge; WCP=West Cactus Peak.

small pressure waste flakes resulting from the production of West Sugarloaf projectile points were less often recovered during archaeological field work (for example, due to the use of $\frac{1}{4}''$ screens). Alternatively, their small size may have made them less suitable than larger flakes for sourcing analysis, especially by XRF [8]. Additional research will be necessary to address this apparent discordance in the ratio of tools and debitage among the four subsources.

To compare these patterns with obsidian that was moved outside of NAWSCL, Coso subsource data from Owens Valley were tabulated in a similar fashion. Table 5 and Table 6 present the results of these analyses, the former tabulating subsources by projectile point type and the latter by hydration reading. Note that in the latter, different intervals for micron readings to estimate time have been used to adjust for temperature differences between Owens Valley and NAWSCL using Basgall's conversion rate [2]. Unfortunately, small sample size precludes breaking down Table 6 by artifact type and hydration reading as we did in Table 4. Table 5 and Table 6 show a much increased importance of West Sugarloaf obsidian in Owens Valley, comprising over 60% of all obsidian in all time periods. This suggests that from the Little Lake period onwards, West Sugarloaf was the predominant subsource that was moved north and west off NAWSCL.

In many ways the data from Owens Valley corroborate the patterns found within NAWSCL. Thus, there seems to be a marked increase in the use of West Sugarloaf obsidian through time, particularly for making projectile points. This dominance is particularly pronounced in the Marana period, comprising 88% of all Desert Series points, a figure even higher than that observed within NAWSCL. Use of Joshua Ridge also seems to be slightly higher during the Newberry and especially Haiwee periods.

On the other hand, there are notable differences between the two regions as well. For example, the percentage of Haiwee and Newberry points fashioned from Sugarloaf Mountain obsidian in Owens Valley is higher than that within NAWSCL. This comes mainly at the expense of West Cactus Peak and Joshua Ridge. Furthermore, use of Joshua Ridge is significantly lower than that seen on NAWSCL. This may be explained by the fact that Joshua Ridge is the most distant subsource from Owens Valley. Thus, the greater expense in carrying obsidian from this source to Owens Valley may have proven cost prohibitive. At the same time, the closer proximity of West Cactus Peak did not lead to an increase in its use in Owens Valley. Thus, distance to source is not be the primary factor governing the movement of all Coso obsidian into Owens Valley, at least from the Newberry period onwards. Other factors such as quality of the obsidian for flintknapping, territorial control over the quarries, and overall accessibility may have been more important factors governing the distribution of obsidian.

The dominance of West Sugarloaf obsidian is evident in other places as well. For example, although the sample size is significantly reduced (n=124), our tabulations of Coso subsources found to the south and east in the Mojave Desert suggest that West Sugarloaf comprises over 66% of all obsidian artifacts in *all* time periods, compared to 42.7% within NAWSCL as reported in Table 3, and 68% in Owens Valley as reported in Table 6. Sugarloaf Mountain comprises only 28%, Joshua Ridge only 6%, and West Cactus Peak is absent altogether. Unfortunately, the small sample size and lack of systematic hydration on these 124 artifacts precludes breaking down this distribution by time period.

Similarly, in a sample of obsidian artifacts from the Southern California coast near Santa Barbara (n=55), all but one piece (98%) are from the West Sugarloaf subsource, with the remaining piece assigned to Sugarloaf Mountain. Again, we could not break down this distribution by time period due to the small sample size.

5. Discussion and conclusions

At least two major patterns revealed above are worth considering in greater detail. First is the clear and dramatic increase in use of West Sugarloaf over Sugarloaf Mountain through time within NAWSCL. This increase, which is particularly pronounced in the post-Newberry period, implies that directly visiting the source, especially West Sugarloaf, rather than scavenging flakes from existing sites, was the primary method of obsidian acquisition. If scavenging was the primary method we would expect the distribution of different subsources to be roughly the same as previous time periods, from where raw material was, presumably, acquired.

As discussed earlier, West Sugarloaf obsidian is abundantly available in large primary blocks or seams. It is possible that increasingly intensive exploitation of Coso obsidian during the pre-Newberry period reduced the availability of easily accessible nodules at lag quarries. This may have encouraged a shift to exploitation of higher density subsurface deposits during the Newberry period, as seen at West Sugarloaf [9,13]. These bench mines may have still been serviceable later in time, providing access to plentiful and high-quality primary deposits during the Haiwee and Marana periods.

At the same time, in light of obsidian hydration information available within NAWSCL, it is interesting that so little Marana and Haiwee period quarrying behavior is evident at the sources themselves [13]. This suggests that, while people continued to make use of the primary sources, they did very little reduction there. Perhaps they chose to perform most reduction activities away from the source at nearby base camps instead. This is very much in line with the conclusions drawn by Gilreath and Hildebrandt [13], who point to sites like the Rose Springs Site (CA-INY-372) and Coso Junction Ranch (INY-2284) as Marana and Haiwee reduction loci (see also [20,25]). These sites lie to the west in Rose Valley, closer to West Sugarloaf than other Coso quarries.

The second major pattern concerns the distribution of Coso subsources outside of NAWSCL. It appears that the further one travels from NAWSCL to the north and south, the more West Sugarloaf dominates the subsource profile. Even in regions relatively close to NAWSCL, such as Owens Valley, West Sugarloaf comprises over two-thirds of all Coso obsidian since at least Little Lake times. This dominance is present from quite early in time, unlike within NAWSCL where West Sugarloaf does not comprise significantly over 50% of all pieces until the Haiwee and especially Marana periods. It is only within the Marana period that subsource profiles within NAWSCL match profiles outside of it. Interestingly, use of West Cactus Peak, and especially Joshua Ridge, is confined almost exclusively to NAWSCL, particularly during later time periods. These subsources rarely make it out of the China Lake region.

This suggests that a non-random selection of obsidian made its way off the base, especially in the Newberry, and to some extent, Little Lake and Haiwee, periods. In other words, while NAWSCL inhabitants were making use of a range of different subsources, those outside of this area were differentially receiving or procuring West

Sugarloaf. Why this discrepancy exists is not entirely clear, but two main explanations present themselves.

First, it is possible that NAWSCL inhabitants were only exchanging West Sugarloaf obsidian. Perhaps this subsource had superior flaking qualities and was desired by outsiders, for example, for its "poisonous" qualities. Alternatively, the state in which the raw material was available, that is, larger and unweathered blocks from seam deposits, may have been more amenable to the production of transportable bifaces. Thus, it may have been difficult to knap the long bifaces preferred by consumers off the base from the smaller and weathered nodules primarily available at the lag quarries of the other subsources. NAWSCL inhabitants may have been willing at times to make do with poorer quality obsidians from Joshua Ridge and West Cactus Peak, saving West Sugarloaf for exchange. Related to this idea, it is also possible that the groups of individuals who were engaged in exchange (i.e., had established reliable regional exchange relations) only had access to the West Sugarloaf quarry. That is, other groups of individuals may have controlled the Sugarloaf, Joshua Ridge, and West Cactus Peak sources, but may not have been motivated to engage in exchange.

The second possibility is that outsiders were directly procuring their own Coso obsidian on logistical trips to the region, but were differentially visiting the main West Sugarloaf quarry. Perhaps they were unaware of, or uninterested in, lag and primary quarries at Sugarloaf Mountain, Joshua Ridge, and West Cactus Peak. Given the distance, this explanation seems less likely for inhabitants of the Southern California coast, but could be viable for inhabitants of Owens Valley and regions of the Mojave Desert, who may have passed this obsidian on to groups on the coast. Additional research should be directed at answering this question, tracking the movement of different Coso obsidians across larger spatial units.

In response to our initial question, is it worthwhile to spend time and effort ascribing obsidian to chemically distinct subsources that are available in the same spatial location, we believe the answer is clearly affirmative. Although we have not exhausted the research potential of the database, it is clear that there are interesting trends in the exploitation of different Coso subsources through time, both within NAWSCL and outside the region. These patterns point to changes in prehistoric quarrying, exchange, and resource and landscape use that were not evident before. As a result, we encourage all obsidian analysts to continue, or begin, if they are not currently doing so, assigning obsidian from the Coso region to one of the four (or more) distinct subsources. Perhaps after several years of accumulating data from other parts of California, a more detailed picture of the movement of the Coso subsources across the state will emerge.

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