THE LITTLE LAKE BIFACE CACHE, INYO COUNTY, CALIFORNIA

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The Little Lake biface collection comprises 26 complete biface preforms. The bifaces are believed to have been found in a cache acquired near the vicinity of the town of Little Lake, Inyo County, California. All the complete bifaces have hydration values falling within a very tight range measuring from 3.5 to 3.8 microns and were determined to have come from the West Sugarloaf subfield of the Coso quarry cluster. These rim readings signify a brief single episode of time and would date to the very late Haiwee or the early Marana Periods in the Owens Valley cultural sequence or ca AD 1300. The cache would lend some limited support to the continued use of large biface cores as a means of production and transport of portable units of toolstone significantly later than might be expected and in a volume/mass that is surprising.

Biface caches have been found in various contexts throughout the world. The origins of the practice of caching are uncertain but Scandinavian offerings date to the Mesolithic (Levy 1982) and during the Solutrean period large stone bifaces were cached from 16,500 to 22,000 years ago (Stanford and Bradley 2000:55). A cache can be defined variously but is most simply a hiding place in the ground for food, ammunition, or treasure.

Caches or "collections" of multiple bifaces are often recognized in mortuary contexts as burial offerings (Bryan 1993:89-93; Green *et al*. 1998:449-452; Putnam 1988). Also biface caches have been placed in an isolated context for storage and hoarded for later use. These caches usually indicated a planned repetitive land use by aboriginal peoples (Smith and McNees 1999). We believe the present collection represents the latter condition.

The Little Lake biface cache is comprised of 26 complete biface cores and one fragmentary specimen. The best information we have indicates the bifaces were found together, as an isolated collection near Little Lake, Inyo County, California.

Many biface caches have been identified as similarly isolated occurrences without any other associated archaeological materials. Several caches of prehistoric obsidian biface performs have been found in the northwestern United States. Also, caches of Clovis bifaces have been the focus of much discussion in the archaeological literature (Frison and Bradley 1999; Gramley 1993; Hoffman 1995).

John Wesley Powell observed a method for the "hiding or storing away of any articles of value" for use at a later time where one would dig a hole in the ground and place the articles of value in it, stones and sand would be filled in above the cache. In the scenario described by Powell, a fire would be burned to mask the cache location, destroying any scent that might lead animals to uncover it. Such caches would be so thoroughly hidden that others would rarely if ever discover them (Hanes and Botti 1986:5; Fowler and Fowler 1971:49).

BACKGROUND AND HISTORY

The senior author first learned of the unusual collection of bifaces on August 22, 2001, when meeting with Elva Younkin, Curator of Prehistory for the Maturango Museum in Ridgecrest, California. Upon inquiring further, it was learned that the collection had been housed at the museum since 1963 when it was first established. Rhea Blenman, wife of the Commanding Officer of the China Lake Naval Weapons Center and then Director of the newly established museum, had attended the China Lake

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Gem and Mineral Show. She saw the collection on display, recognized the potential importance of the objects, and acquired them for the museum.

Unfortunately Ms. Blenman has passed on and no record of the identity of the collector or specific provenance was recorded, save the general descriptor of "Little Lake." Perhaps the former owner of the collection wanted to remain anonymous or Ms. Blenman thought it inappropriate to identify the source of her acquisition. No other information is available regarding the details of the find. Ms. Younkin shared our intended research with museum members through their newsletter and queried that group to see if any further information would come to light, but no further details were forthcoming.

In the last two decades, a substantial knowledge base has been assembled pertaining to the regional prehistory of eastern California (Bettinger 1975, 1977, 1982; Basgall 1983, 1990; Basgall and McGuire 1988; Delacorte 1990; Elston and Zeier 1984; Gilreath and Hildebrandt 1997; Goldberg *et al*. 1990; Hall 1983; Jackson 1985; Meighan 1981; Schroth 1994; Yohe 1992). Moreover, adjacent regions such as the Kern Plateau, southern Sierra Nevada foothills and the southern San Joaquin Valley are now becoming better understood archaeologically (Ambro *et al*. 1981; Bard *et al*. 1985; Garfinkel *et al*. 1980, 1984; Hartzell 1992; McGuire and Garfinkel 1980). Archaeological studies now routinely incorporate numerous obsidian source determinations and hydration rim measurements into their analyses. Additionally, a large corpus of Coso obsidian hydration data is now available for purposes of comparison. Temperature- and source- specific Coso hydration rates are now available that conform reasonably well to independently dated archaeological assemblages (Basgall 1990; Basgall and Hall 2000; Hildebrandt and Ruby 1999; Gilreath and Hildebrandt 1997; King 2000; Pearson 1995).

Fortunately, a rather more refined knowledge of the regional subsistence-settlement systems characterizing the various chronological and cultural periods of eastern California prehistory has evolved (Bettinger and Taylor 1974; Bettinger 1975; Basgall and McGuire 1988, Hildebrandt and Gilreath 1997; Zeanah and Leigh 2002). From further investigation, we have developed a better understanding of Coso obsidian diachronic quarry production (Eerkens and Rosenthal 2004; Elston and Zeier 1984; Gilreath and Hildebrandt 1997). Trans-Sierran exchange systems (Gilreath and Hildebrandt 1997) and technological considerations, regarding the characteristic trajectory and reduction sequence, of Coso obsidian have also been the subject of extended studies (Gilreath and Hildebrandt 1997; Schroth 1994; Schroth and Yohe 2001;Yohe 1992, 1998).

General Description of the Cache

Twenty-six complete bifaces and one broken biface fragment (perhaps ½ or more of the original piece) were identified in the cache. They were originally catalogued through the auspices of the Maturango Museum under accession numbers 63.30.1 through 63.30.27 and are housed at their facilities in Ridgecrest.

Only two of the bifaces retained any remnant surfaces from the original external surfaces (cortex) in which they were quarried. The only biface that was immediately and easily identifiable as Coso was the broken and incomplete specimen that contained two gas vesicles that are characteristic of Coso obsidian (in a limited geographical context). These gas bubbles, within the volcanic glass matrix, are quite distinctive and have characteristic small tan/white inclusions that adhere to their interiors. This characteristic makes the macroscopic visual identification of the specimen as Coso obsidian quite certain when found in southern California.

Technological Analysis

Quarry studies throughout the West have demonstrated that the predominant prehistoric lithic reduction strategy was the manufacturing of bifaces to be used as cores. In eastern California, the vast majority of quarrying is focused on biface reduction. The unifacial reduction of "bifaces" (the Uniface Biface) is one distinctive approach that has been identified at the Casa Diablo obsidian quarry (Skinner and Ainsworth 1991). Elston and Zeier (1984:104) have described another strategy used to reduce Coso obsidian resulting in elongated, biconvex, or plano-convex flakes. "Coso cores" were split down their long axis, using hammer and anvil technique, yielding two plano-convex pieces or flake blanks. These large flakes would then be roughly percussion flaked, from one side, to regularize the object in cross-section. Subsequent reduction set up the bifacial core. The bifacial cores in the cache were reduced from large flakes. Ventral remnants are evident on several of the bifaces indicating this fact. There is a preference during reduction for concentrating on the dorsal surface for the initial flake removals.

INTERPRETIVE COMMENTS

All but one of the bifaces were manufactured from flakes removed from larger cores. Due to margin manipulation, "trimming," is evident on all the bifaces. This was done to bolster margin sturdiness. At least two of the bifaces were produced on flakes from the same core; probably more of the reduced flakes came from the same core given similarities in the old remnant surfaces. The size and shape of the bifaces in the cache indicates they would be a source of hundreds of usable flakes (Wilke and Flenniken 1988). These flakes could be used as tools without further modification or they could be further modified to produce other tools such as stone arrow points. More than one hundred arrow points could easily be produced from just one of these cores (Wilke and Flenniken 1988); these bifaces are slightly smaller than those reported on by Wilke and Flenniken. All reduction of the bifaces in the cache was accomplished via percussion flaking.

Convexity and concavity were considered (as topography is considered in all reduction) when determining from which face most flakes would be removed. A pronounced bulb on the initial flakes created a biconvex cross section that facilitated the goal of a robust and regular bifacial core. The hammer used was harder than that usually used by modern flintknappers to flintknap obsidian. Judging from the impact scars, pronounced force was used to shape the cores. This did not present a problem given the early stage and mass of the cores. Several of the bifaces have cone fractures and checks. Again, these flaws did not keep the knapper from curating these biface cores, since the cores were robust and the flaws did not present an obstacle to further successful reduction. In most cases, it appeared that the orientation of the biface to the original flake was such that the tip was the termination end and the base was the initiation end of the original flake. The sides of the biface were the sides of the original flake.

Summary metrics for the bifaces are presented in Table 1. The bifaces were similar in dimension and form suggesting that the intended biface form, was a roughly ovate or lanceolate biface of about 139 mm in length, 88 mm in width, approximately 31 mm in thickness, and weighing about 350 grams. The entire cache was presumably packed from the Coso quarry, a short 5 kilometers from Little Lake. The cache weighed 9,300 grams or about 25 pounds.

REPLICATION

A large flake of similar size to that on which the bifaces were made was removed from a block of Casa Diablo obsidian. Using a small (10x10 cm) quartzite hammer stone, the flake was bifacially reduced. Platforms were not prepared any more than that on the cache bifaces. They were positioned and ground to facilitate this reduction. The piece was reduced to a stage and form like that of the preponderance of specimens from the cache. The entire reduction process, including platform preparation and grinding, took only five minutes time. As such, the entire cache could have been manufactured in less than three hours.

RESEARCH RESULTS

Analysis was performed on the biface collection to determine their individual hydration rim values and to chemically characterize them to subfield source. Craig Skinner of the Northwest Research Obsidian Studies Laboratory in Corvallis, Oregon conducted the trace element characterization using x-ray fluorescence analysis. Tom Origer, of Origer's Obsidian Laboratory performed the obsidian hydration studies.

DATING AND SOURCE DETERMINATION

All the complete bifaces (26 of 27) have hydration values falling within a remarkably tight range measuring 3.5 to 3.8 microns (Table 1). The one larger reading of 5.6 microns is attributed to a smaller "chunk" of obsidian that was probably scavenged at the quarry. All of the bifaces were quarried from the West Sugarloaf subfield of the Coso obsidian quarry cluster.

The 26 rim readings signify a brief episode in time and would date the manufacture of the bifaces to the hinge point between the Haiwee and Marana periods in the Owens Valley cultural sequence (see Table 3). Using Basgall's Coso hydration rate (Basgall 1990), the mean hydration value of 3.7 microns would equate with 650 years before present or ca. A.D. 1300. Applying Pearson's or King's Coso hydration equation (King 2000; Pearson 1995) (both provide virtually identical ages), they are a bit earlier, ca. A.D. 1150 or about 800 years before present. In either assessment, they were manufactured 650 to 800 years ago, probably during the waning years of the Late Haiwee period. The single older fragmentary biface would originally have been manufactured ca. A.D. 500.

Table 1: Little Lake biface cache hydration rim readings, source determinations and summary metrics.

Lab #	Sample #	Band Measurement Mean	Source
1	63.30.1	3.7	West Sugarloaf Mountain
2	63.30.2	3.7	West Sugarloaf Mountain
3	63.30.3	3.7	West Sugarloaf Mountain
4	63.30.4	3.7	West Sugarloaf Mountain
5	63.30.5	3.7	West Sugarloaf Mountain
6	63.30.6	3.6	West Sugarloaf Mountain
7.1	63.30.7	3.8	West Sugarloaf Mountain
7.2	63.30.7	-	-
8.1	63.30.8	3.7	West Sugarloaf Mountain
8.2	63.30.8	-	-
9	63.30.9	3.8	West Sugarloaf Mountain
10	63.30.10	3.8	West Sugarloaf Mountain
11	63.30.11	3.8	West Sugarloaf Mountain
12	63.30.12	3.7	West Sugarloaf Mountain
13	63.30.13	3.7	West Sugarloaf Mountain
14	63.30.14	3.7	West Sugarloaf Mountain
15	63.30.15	3.7	West Sugarloaf Mountain
16	63.30.16	3.7	West Sugarloaf Mountain
17	63.30.17	3.7	West Sugarloaf Mountain
18	63.30.18	3.7	West Sugarloaf Mountain
19	63.30.19	3.8	West Sugarloaf Mountain
20	63.30.20	3.6	West Sugarloaf Mountain
21	63.30.21	3.7	West Sugarloaf Mountain
22	63.30.22	3.7	West Sugarloaf Mountain
23	63.30.23	3.8	West Sugarloaf Mountain
24	63.30.24	3.8	West Sugarloaf Mountain
25	63.30.25	3.5	West Sugarloaf Mountain
26	63.30.26	3.7	West Sugarloaf Mountain
27	63.30.27	5.6	West Sugarloaf Mountain

Summary Hydration Statistics and Biface Dimension Metrics:
N=27; Hydration Range: 3.5-5.6 microns; Mean=3.8; S.D. .37; CV .09
N=26 (all complete bifaces with fragmentary outlier removed)
Hydration Range: 3.5-3.8 microns; Mean= 3.7; S.D. .07; CV .01

	Range	***Mean***	***S.D.***	***C.V.***
Length	117-160	139	11.4	.08
Width	77-94	85.4	4.0	.05
Thickness	22-40	30.9	4.6	.15
Weight	243-529	348	68.6	.20

S.D.= Standard Deviation, C.V.= Coefficient of Variation, N= Sample Size

Coso Quarry Production and Trans-Sierran Exchange

Gilreath and Hildebrandt (1997) showed that prior to the Middle Newberry period (1200 to 500 B.C.), widely dispersed and limited procurement of Coso obsidian was typical. Exploitation shifted to major obsidian outcrops only in Late Newberry (500 B.C. to A.D. 600) times and continued into the Haiwee interval (A.D. 600 to 1300). Obsidian quarrying in the Late Newberry and Haiwee periods was confined to a few massive exposures rather than the less plentiful but more widespread secondary deposits. In the Haiwee period, nearly exclusive use of the massive Sugarloaf exposure occurred with other deposits largely ignored. Marana period quarries are completely lacking (Coso hydration readings of 3.7 microns or smaller), suggesting that the volume of large biface production diminished very dramatically.

As well, Elston and Zeier (1984) document the late prehistoric mining of Coso obsidian at the primary West Sugarloaf exposure. Three periods of peak quarrying were recognized. The earliest period (ca. A.D. 1) dates the initial excavation of terraces into the side slope of Sugarloaf Mountain. The middle period (ca. A.D. 350) marks the inception of pit mining and its most recent expression (ca. A.D. 900) was restricted to the lower bench of the major obsidian outcrop at West Sugarloaf. This most recent quarrying is roughly coincident with the manufacture of the Little Lake cache.

According to Gilreath and Hildebrandt (1997), Late Newberry saw the beginning of highly specialized sites focused on the manufacture of biface blanks or preforms. This type of task differentiation was not observed earlier than Late Newberry. The prevalence of these secondary locations decrease during the following Haiwee period, probably shifting these activities to off-quarry locations. In the present case, the Little Lake village site of Pagunda or the Stahl site cave would be good candidates for such off quarry, late dating, occupation sites where the reduction of Coso obsidian took place and might be associated with the biface collection (Pearson 1995).

Gilreath and Hildebrandt (1997) comment that the level of stone tool reduction in Middle Newberry and earlier times directly correlates to the resident population's stone tool needs. The authors assert that the significant increase in obsidian production in the Late Newberry period is too large to be explained by population increase alone; the increase is best understood as a mixture of production for local consumption and surplus production intended for

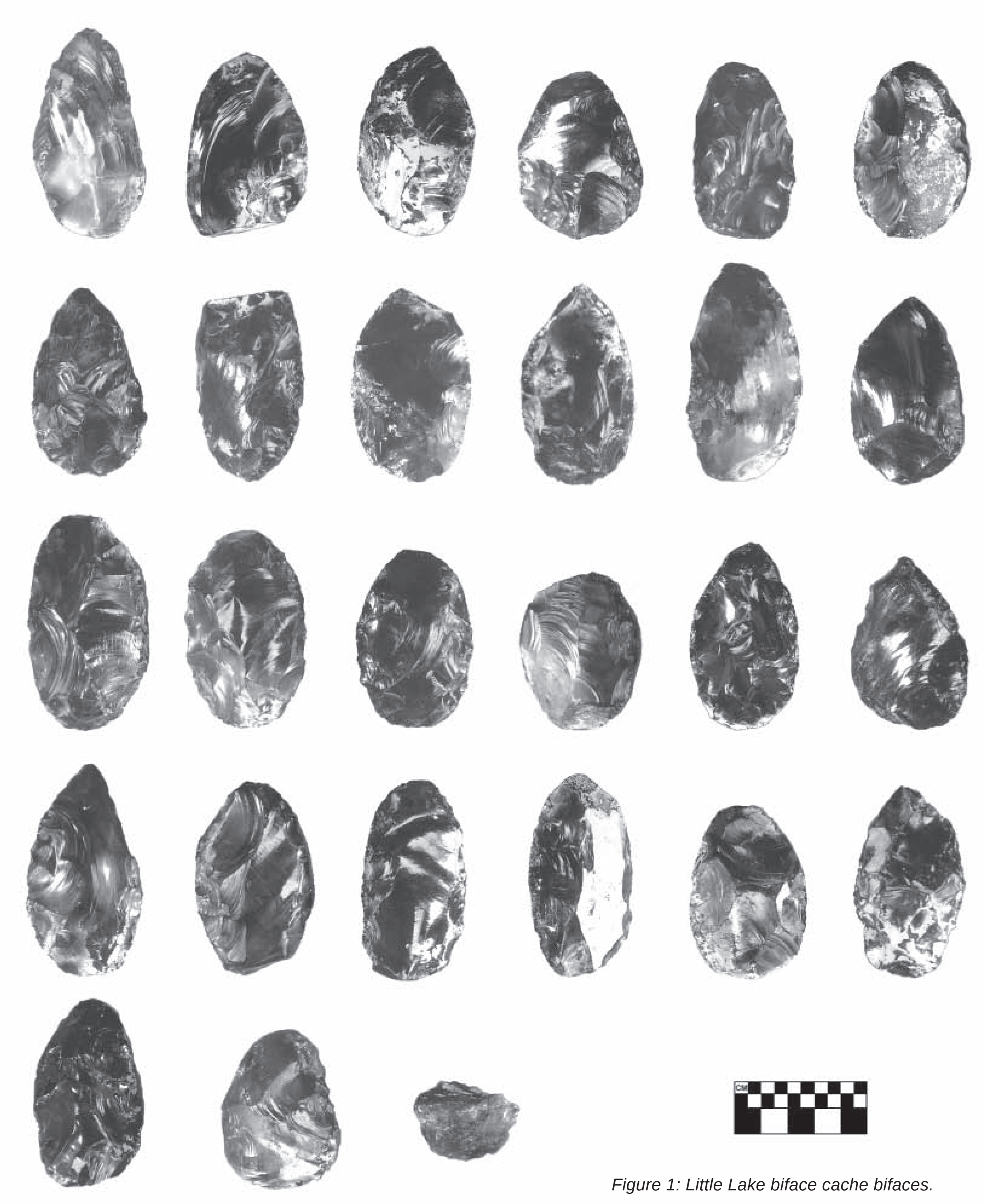

Figure 1: Little Lake biface cache bifaces.

exchange. Recent reflection on the volume of reduction during this period has revised their estimate; they now believe that reduction was tenfold greater than in the earlier Little Lake Period or in the later Haiwee Period. This emphasizes a dramatic increase in biface production/reduction and perhaps a corollary emphasis on surplus production intended for exchange (Hildebrandt and McGuire 2002:Figure 6).

Prehistoric Obsidian Mining Techniques

The Little Lake cache appears consistent in dating to a time when Elston and Zeier (1984) document the final period of late prehistoric exploitation of Coso obsidian at one of the largest and highest quality exposures at West Sugarloaf Mountain. The obsidian mining techniques at this late date entailed the excavation of vertical or horizontal pits, digging a bench into the mantle of the flow breccias around the margins of the Sugarloaf Plateau (see Elston and Zeier 1984:Figure 34, Area 1 identified as the "Mining Belt").

This is the same mining technique described over 50 years ago by Mark Raymond Harrington that so impressed him;

> More than two miles of ancient diggings, plainly visible along the edges of the bluff! A hillside covered with hundreds of tons of obsidian quarry refuse left by prehistoric workers! It did not seem possible, yet there it was, on the old Coso road northeast of Little Lake, the gateway to Owens Valley. We stood there in amazement that day early last November, thinking of the innumerable hands, the countless generations that must have been required to produce such a result.
>
> **The old quarry pits extend along the obsidian ledge just below the rim of a tableland some 200 to 300 feet above the valley floor. On the slope below are traces of other pits and artificial terraces,** and tumbled boulders of obsidian; in some places the steep hillside is actually composed of obsidian chips, most of them man-made; you cannot step without crunching them (Harrington 1951:15) [emphasis mine]

Elston and Zeier's research identified only two locations, a middle bench and lower bench at Maggie's site in the West Sugarloaf Mountain quarry area, that contained hydration rims in the 4 micron range. The largest sample of such readings came from a suite of only 11 hydration rims ranging from 3.8 to 4.8 microns that peak at 4.5 microns and have a single outlier at 8.1 microns. Given those small readings, that locus appears to date (in part) to the same general time period as the Little Lake cache. To verify that suggested temporal placement, the authors re-sampled that specific locality and obtained 26 additional items of flaked stone from the lower bench of Maggie's site. These were products of the biface reduction process (Table 2). It was hoped that through collection and analysis this sample would verify the recency of this deposit commensurate with the rim readings and temporal placement of the Little Lake cache.

Reevaluation of Maggie's Site

Sampling and restudy of Maggie's site verified Elston and Zeier's (1984) original research and that of Gilreath and Hildebrandt (1997) confirming the there exists a dramatic reduction in large biface production ca. 650 B.P., corresponding to roughly 3.8 microns of Coso hydration (Table 2). Technological analysis and a comparison of hydration readings strongly suggests that this lower bench at Maggie's site or a location very close to it served as the locus for the quarrying activities producing bifaces like those identified from the Little Lake biface cache.

Debitage collected from Maggie's site included biface reduction flakes, broken bifaces (both bending and perverse fractures), and flakes with biface margin fragments (flakes with bending initiations). The items with hydration rinds closest in measure to those of the cache, are biface reduction debitage and broken bifaces. All eleven of these items are fragments of bifaces just like those in the cache or flakes like those removed from the cores in the cache. The bifaces made at the Lower Bench of Maggie's site were also made on flakes just like those in the cache. This is precisely manifested by examples of ventral remnants of the original flakes on the broken bifaces and dorsal surfaces of the biface reduction flakes.

When removing flakes from a biface core, to maintain the future productivity of the core, the flinknapper must drive the major flake removals beyond the midline of the biface. For this reason, feather-terminated biface reduction flakes from a bifacial core are generally slightly longer than half the width of the core. The feather-terminated biface reduction flakes from Maggie's site have a length within the parameters of cores the size of those in the cache or a little larger.

Territoriality and Numic Intrusions

The authors of the Coso Volcanic study (Gilreath and Hildebrandt 1997) assert that although access to the Coso source appears unrestricted early in time,

Lab #	Measurement Mean	Lab #	Measurement Mean
1	4.6	15	4.1
2	4.1	16	4.3
3	2.4/5.1	17	4.2
4	5.6	18	4.0
5	8.3	19	4.1
6	3.5/5.0	20	4.1
7	4.7	21	4.2
8	4.2	22	2.2/5.1
10	7.8	23	6.4/10.9
11	4.4	24	10.5
12	3.5/4.1	25	4.2/6.4
13	4.1	26	6.1
14	2.0/4.4	27	5.4

Table 2: Maggie's Site, lower bench, West Sugarloaf Coso quarry hydration rim readings. Summary hydration statistics: N= 22 (with four outliers removed, smaller of dual rims used for metrics); range: 2.0-6.4 microns; mean=4.2 microns; S.D. 1.0; CV .24

through the Late Newberry period, with the advent of the Haiwee period some measure of control is evidenced - suggesting a measure of territoriality. This is manifested by the restriction of quarrying operations to far fewer sites of selectively higher quality glass at primary exposures. They further posit that the extraordinary amount of secondary reduction occurring at the Portuguese Bench and Rose Spring sites, occupied principally during the Late Newberry period (500 B.C. to A.D. 600), were key nodes in an exchange system that, at that time, was well developed.

They also note the likely direction of this exchange. Large quantities of Coso obsidian moved from the habitation/secondary reduction workshops, up the Southern Sierra Canyons, into the Kern River drainage, and from there into the hands of South Coast groups. We add, from the recent work of Sutton (1999) and earlier by Schiffman and Garfinkel (1981) and Dillon (1988), there was directed exchange of Coso obsidian. That exchange, originating in eastern California, moved Coso obsidian into the southern San Joaquin Valley and the ethnographically ascribed territories of the Tubatulabal and Southern Valley Yokuts. Source characterization studies in the aboriginal territory of the latter groups indicate a nearly exclusive use of Coso obsidian (albeit in the case of the Southern Valley Yokuts in more minor quantities) in this region (Sutton 1999).

It is hypothesized that the dramatic decline of Coso obsidian trade came about when eastern California populations became increasingly territorial and direct access to the source was constrained (Gilreath and Hildebrandt 1997:181). Given the remarkable similarities in diachronic obsidian quarry production curves for Casa Diablo, Bodie, Coso and northern California and Oregon quarries, the most reasonable explanation is that similar factors effected their development and discontinuation in these other areas. Reduced mobility patterns, increasing territoriality, technological changes and subsistence shifts all appear to have been agents for this abrupt change in the decline of obsidian production.

Another rarely mentioned critical factor that likely effected the character of obsidian acquisition, exchange, and reduction, was the late prehistoric disruption of existing cultural systems by the intrusion of Numic populations into the area of eastern California (cf. Delacorte 1995). A number of single component, Haiwee-age sites fall within this transitional interval. Some of these sites are roughly contemporaneous with both the Little Lake biface cache and the intensive pit mining exhibited at Maggie's site at West Sugarloaf (Table 3).

Numic populations have been characterized as having residentially centralized settlements and intensive subsistence habits demanding greater efforts at collection and processing of foodstuffs (Bettinger and Baumhoff 1982, 1983). Such a pattern contrasts rather dramatically with highly mobile, pre-Numic populations. Pre-Numic populations primarily exploited the highest quality resources, such as large artiodactyls, requiring less effort to obtain and process. A number of specialized, principally Haiwee period, hypothesized Numic sites, indicate considerable intensification in the use of some lower quality subsistence resources that required greater processing and handling costs (Gilreath and Holanda 2000; McGuire *et al*. 1981). The targeted subsistence resources for these Numic immigrants were often times locally abundant game, including rabbits, grebes, and bighorn sheep. Such resources were obtained by groups in nearby base camps. These base camps within sight of the catchments for their targeted prey, routinely keeping travel costs low.

A hypothesized, labor-intensive Numic adaptation is consistent with the "adaptive pose" for obsidian exploitation patterns. This is recognized during this transitional period and displayed at the West Sugarloaf quarries. Pit mines, found on the lower bench of Maggie's site, date to this time period. High quality,

Site	N	Mean	sd	C.V.	Radiocarbon Determinations (uncorrected)
Late Period, Single Component, Coso Petroglyph Sites[1]					
14-5375	10	4.8	0.85	.18	
14-5339	10	4.7	0.67	.14	
INY-5190	10	5.0	1.20	.24	
INY-5191	9	4.7	0.60	.13	
KER-6188[2]	5	5.0	0.70	.14	
Lubkin Creek/INY-30 Late Newberry Components[3]					
Structure 11	28	5.4	1.0	.18	1220 +70, 1600+70
Structure 12	12	5.3	.5	.09	1540+80, 1860+70
Structure 14	15	5.4	.7	.13	1650+100, 1840+80
Late Haiwee					
Little Lake Cache	26	3.7	.7	.01	
Maggies Site (Lower Bench)	22[6]	4.2	1.0	.24	
KER-250 (Bickel Site)[4]	39	4.5	.7	.15	1255+110, 1050+90, 950+75, 650+65
INY-1428[5]	59[7]	4.4	.5	.11	1270+70, 990+80

1 — Gilreath 1999
2 — Garfinkel 2003
3 — Basgall and McGuire 1988
4 — McGuire et al. 1982
5 — Gilreath and Holanda 2000
6 — 4 outliers removed
7 — 2 outliers removed.

Table 3. Radiocarbon dates and Coso lowland hydration rims for Haiwee and Newberry Period single component sites.

easily-accessed sources of Coso obsidian were, by this time, either mined out or being monopolized by competing, pre-Numic populations. Hence, the exploitation of Coso obsidian, during this brief period, necessitated more labor-intensive methods.

Such reduction strategies resulted in the pit mining operations Elston and Zeier (1984) described and the present researchers further examined. The narrow range and specialized nature of roughly contemporaneous Numic subsistence efforts are recognized at a number of sites during the Haiwee period and are documented mainly during this brief episode of prehistory—not before or after that date. Hence the late-dating pit mines are temporally placed within this transitional phase when initial Numic presence is hypothesized in the area (Table 3).

Coso hydration rims for these transitional, single-component, Late Haiwee deposits have mean rims of 3.7 to 4.5 microns. Such sites generally appear after the latest manifestations of the pre-Numic, Late Newberry/Early Haiwee age, expressions. Those latter sites exhibit Coso rim suites averaging 4.7 to 5.4 microns (Table 4). A temporal overlap between Numic and pre-Numic occupations, lasting at least two centuries, has been posited by a number of Great Basin researchers (Fowler and Madsen 1986; Madsen 1986; Marwitt 1986; Young and Bettinger 1992). Such a series of occupations would in part explain the two contemporaneous patterns observed in eastern California obsidian procurement and subsistence strategies.

Table 4: Chronological periods and Coso lowland hydration rims (after Gilreath 1999:12, with revisions by Rosenthal et al. *2001)*

Single Period	Age (years before present)	Hydration Range (microns)
Marana	<650	<3.7
Haiwee	650-1275	3.7 to 4.9
Newberry	1275-3500	4.9 to 7.65
Little Lake	3500-6600	7.65 to 11.4
Early	>6600	>11.4

Kern Plateau Exchange Partners

Kern Plateau studies identified that aboriginal peoples were the nearly exclusive users of obsidian - with over 98 percent of their flaked stone assemblages composed of this stone (Garfinkel n.d.). That obsidian was found to have originated almost exclusively within the Coso quarries.

Using replicative experiments and a detailed examination of the debitage from archaeological sites in the Kennedy Meadows and Rockhouse Basin areas, Rob Jackson (1981) reconstructed the dimensions of the large obsidian bifaces being transported into the area. His work indicated that the bifaces were on average 150 mm long, 80 mm wide, and 40 mm thick. Given the fragmentary nature of the archaeological record, he based his reconstruction on small pieces of broken biface fragments, Stage 2 secondary thinning flakes, broken flakes and flakes that were the product of edge preparation and pressure flaking. His conclusions are remarkably similar to ours and indicated the same dimensions as the Little Lake cache.

Context, Function and Big Biface Production

Given the recent date for the Little Lake cache, these biface cores were prepared as convenient units for the production of arrow rather than dart points and other biface tools. This is surprising to some given the mass and weight of the bifaces. Replicative experiments by Phil Wilke and Jeff Flenniken (1988) demonstrated that bifaces of these dimensions could be used to produce hundreds of arrow points. Given the size and number of bifaces of the Little Lake cache, such a large amount of production is excessive and argues for a mixture of production for local consumption and some surplus intended for trans-Sierran exchange.

The latter supposition is surprising given the diachronic production curve reconstructed from the studies of Gilreath and Hildebrandt (1997) for the Coso quarry and other similar patterns noted for central eastern California obsidian sources. During late Haiwee times a dramatic decline in obsidian production is recognized from the Coso quarry and other Inyo-Mono sources. During the Marana period, it is accepted that expedient flake tools were often scavenged rather than produced from prepared cores. This characteristic pattern differs dramatically from the prepared core/"big biface tradition."

Yet, a number of studies (e.g., Allen 1986:52-56; Yohe 1992:219-234) demonstrate that the production of large bifaces was characteristic of the eastern California Coso reduction sequence throughout most of prehistory, even after the time when projectiles were significantly reduced in size from darts to arrows. It was only when Desert Series points were produced during the Marana interval (A.D. 1300 – contact), that we see bifaces significantly reduced in size, and even during this period only small reductions in the size of the bifaces occurred. This pattern also occurred contemporaneously for populations using the Calico quarries (Binning *et al.* 1986).

Prehistoric Land-Use

Although the Little Lake biface cache data are certainly insufficient to contradict the bevy of proposals from many other researchers, some anthropologists have painted a different scenario for the evolution of exchange systems, territoriality, and sociocultural complexity in eastern California. The Little Lake cache lends some limited support to the continued use of large bifaces of surprising volume and mass as a means of production and transport of toolstone somewhat later than previously hypothesized.

Gilreath and Hildebrandt (1997:120) remarked that Haiwee bifaces recovered from the primary quarries are extremely large with complete specimens weighing nearly 200 grams, yet the Little Lake cache averages just under 350 grams per biface! Compared with their collection of Stage 1 bifaces described from the Coso Volcanic Field (1997:Table 52, page 121), the Little Lake cache bifaces are longer and heavier. With respect to later Marana period specimens, the Coso Volcanic Study reports that there were no Stage 1 bifaces recognized and the present collection of Little Lake bifaces increases by several orders of magnitude the known Haiwee/Marana Coso biface inventory.

As Gilreath and Hildebrandt report, no Marana age quarries were identified in their study area (1997:128). Only two Haiwee period quarries have been investigated—those at Joshua Ridge (Gilreath and Hildebrandt 1997) and the West Sugarloaf location studied by Elston and Zeier (1984).

Exchange, Territoriality and Sociopolitical Complexity

Rather than a wholesale decline in Coso obsidian production, what may have taken place was a restructuring of the system to use off-quarry, secondary reduction locations. Secondary reduction locations within the Coso Volcanic Field are less common in the Haiwee Period and almost nonexistent in the following Marana Period. Therefore secondary reduction must have occurred at the quarry locations themselves or at sites outside the Coso Volcanic Field, such as the villages at Little Lake or on the Kern Plateau itself.

Such a pattern of secondary, off-quarry reduction has now been recognized for the Bodie Hills quarry (Halford 1998, 2001) where such deposits exhibited peak periods of use during both Marana and pre-Newberry contexts. Marana period reduction activities appear to include scavenging of earlier materials as exhibited by dual rim readings obtained through obsidian hydration studies.

A bimodal pattern of Coso hydration rims are noted at the Pagunda site at Little Lake, the Stahl rockshelter, and at Lubkin Creek (Pearson 1995). The hydration curve and debitage reduction volumes reconstructed for Pacific Crest Trail sites on the adjacent Kern Plateau reveal a similar pattern (Garfinkel n.d.).

Owens Valley Regional Trade |and Exchange

In the Owens Valley there are two conflicting models regarding the timing and elaboration of regional trade. Owens Valley marine shell bead assemblages evidence systematic trade with coastal southern California. Such exotic trade goods occur in greatest abundance only during the Haiwee and Marana periods in the local sequence postdating A.D. 700 (Milliken 1999). Yet, this pattern is at odds with the rest of the Great Basin where the most prevalent periods of shell bead trade are decidedly earlier (Bennyhoff and Hughes 1986).

This pattern is also distinctly different from the diachronic production curves developed for some eastern California obsidian sources. These include the Coso source (Gilreath and Hildebrandt 1997), the Casa Diablo source, and earlier portrayals of the Bodie production curve (Ericson 1982; Singer and Ericson 1977; Hall and Basgall 1994). All purportedly indicate a dramatic decline at precisely this same time.

Alternatively, if a lively trade in both obsidian (although admittedly greatly reduced from earlier Newberry and Haiwee times) and marine shell beads is actually characteristic of the southern Owens Valley region, then this trade can best be understood as correlating with the proliferation of resource intensification, patterns of increased territoriality, and emerging sociopolitical complexity (Bettinger 1982, 1994). This topic is one deserving of further research.

Conclusion

It is hypothesized that recent immigrants to the Coso region, journeyed from Little Lake to the obsidian quarries at West Sugarloaf Mountain to produce a collection of 26 obsidian biface cores. On a steep hillside, about 700 years ago, a flintknapper traveled to the quarry pits. There he located just the right material for the biface cores and roughed out his intended products. Using a hammer stone and striking with considerable precision and substantial force he drove flakes off a large block of volcanic glass. He labored, over several hours, roughly shaping his intended products. He crafted the material into nicely formed, transportable units of glassy stone. His discards remain on the hillside to this day and are strewn about along an obsidian ledge, just below the rim of the tableland, above the valley floor.

The manufacturer of the bifaces placed his efforts in a carrying sack or conical basket, most likely on his back, for the ensuing journey. Hiking a short few miles, the 25-pound parcel would not have been overly burdensome. With his package, he knew that from his efforts he could, if required, manufacture hundreds of projectile points to tip his arrows. He also knew that he and his kin had located a suitable source of high quality stone and though it took a bit more effort than simply collecting the intended materials, the quarry pits were not controlled by their neighbors and hence access to them was unrestricted. He could as well use the bifaces in exchange with his distant neighbors when they met at their next trading opportunity.

The flintknapper returned to Little Lake and decided that his collection of bifaces was not immediately needed. So it was concealed, near his camp and out of the way, such that others would not know of its whereabouts. He could then access it when he deemed it necessary. For whatever reason he never returned to his cache of valuables. He did not know that through advances in archaeometry and other analytical studies his cache would provide much information about his prehistoric lifeways.

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