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The Pahoehoe Site: A Lanceolate Biface Cache in Central Oregon

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CHIPPED stone artifact caches are a common but poorly understood archaeological phenomenon in the northern Great Basin, the southern Columbia Plateau, and throughout western North America. Because many lithic caches occur as isolated finds lacking associated artifact assemblages and datable contexts (e.g., Cressman 1937; Weide and Weide 1969; Hanes and Botti 1980; Pavesic 1985; Hanes 1986), often their explanatory potential is not fully realized. Lithic caches are treated primarily as utilitarian features whose production technology relates to a surplus of raw material and tool storage.

A chipped stone artifact cache recently recovered from the Pahoehoe site (35DS268) in the Cascade Mountains of Oregon offers an opportunity to: (1) demonstrate the culturally determined reduction system employed to manufacture the lanceolate-shaped biface artifacts found in the cache; (2) compare this production technology and biface cache with current interpretations of lanceolate biface assemblages; and (3) discuss the possible function of this biface cache technology.

PAHOEHOE SITE DESCRIPTION

The Pahoehoe lithic cache was discovered in 1984 by artifact collectors who illegally removed 90 lanceolate-shaped obsidian bifaces from the site. The USDA Forest Service recovered the bifaces from the collectors and subsequently conducted controlled excavations to avert further vandalism. This effort yielded 20 additional bifaces in stratigraphic context and the lithic workshop where the bifacial artifacts were manufactured nearby.

Geographically, the Pahoehoe site (35DS268) is located on the eastern flanks of the Cascade Mountains in central Oregon on the northwestern periphery of the northern Great Basin (Fig. 1). The site is surrounded by ponderosa pine (*Pinus ponderosa*) forest and lies adjacent to an extensive Pliocene-age lava flow. Site elevation is 1,450 m. a.s.l. Obsidian is an abundant raw material source throughout this volcanically-shaped region. Obsidian quarries, lithic workshops, and flake scatters are therefore common (Davis and Scott 1986). Currently, 20 obsidian sources are identified within a 50-km. radius of the Pahoehoe site (Skinner 1983).

The obsidian bifaces were recovered from the sideslope of a small, lava-capped knoll in a mixed deposit of Mount Mazama tephra within 30 cm. of ground surface. None of the bifaces were recovered near the interface of the Mazama tephra and the underlying paleosol, located at a depth of 70 cm. below ground surface, indicating the cache post-dates the Mount Mazama eruption of 6,800 B.P. (Bacon 1983:104). The lithic workshop, located two meters south of the cache, yielded the bifacial point manufacturing debitage in the same stratigraphic context as the cached bifaces. Sediment from a 1 x 1-m. excavation unit in the workshop was water-screened through 1-mm. wire

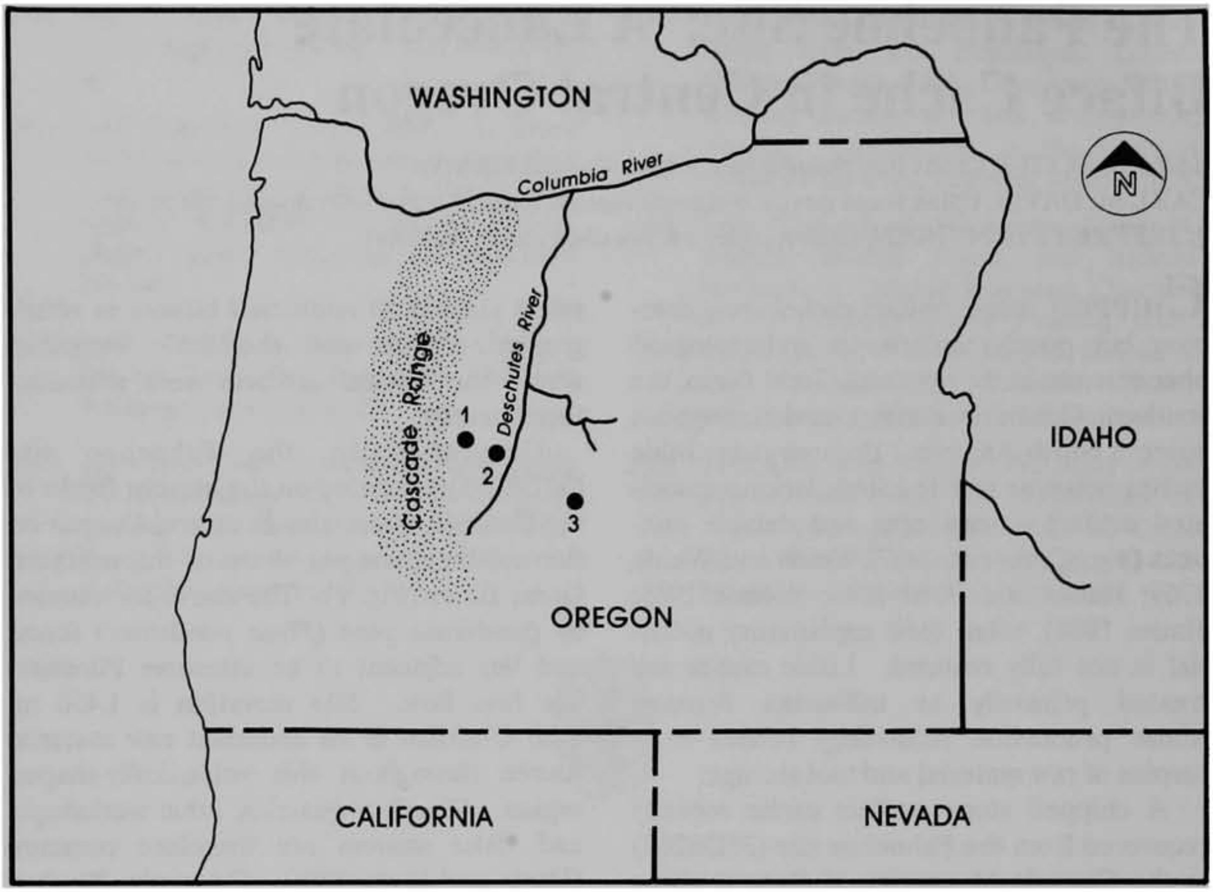

Fig. 1. Map showing the location of bifacial point caches discussed in text: 1, Pahoehoe Cache; 2, Lava Island Rockshelter; 3, China Hat Cache.

mesh, providing a representative sample of lithic debitage.

LITHIC CACHE: TECHNOLOGY AND REPLICATION

The Pahoehoe cache is composed of 98 whole bifaces and 12 biface fragments (Fig. 2). Although the individual bifaces exhibit considerable morphological variation, as a group they can be characterized as having symmetrically convex sides and square to slightly rounded bases, with the widest portion of the biface approximately midway between the base and tip. Two separate lithic replication experiments were undertaken to determine the lithic reduction system used to manufacture the Pahoehoe cache. Forty bifaces were produced during the replication experiments (Fig. 3, bottom row). Reduction debitage from the experiments was compared with debitage from a 1 x 1-m. excavation unit in the Pahoehoe workshop. All stages of the Pahoehoe biface reduction sequence found at the site are represented in the lithic debitage resulting from the replication experiment. Based on the comparative analysis, the Pahoehoe lithic reduction system is reconstructed as follows.

Stage 1: Selection of Lithic Material

Bifacial flake cores rather than unworked pieces of raw obsidian were transported from

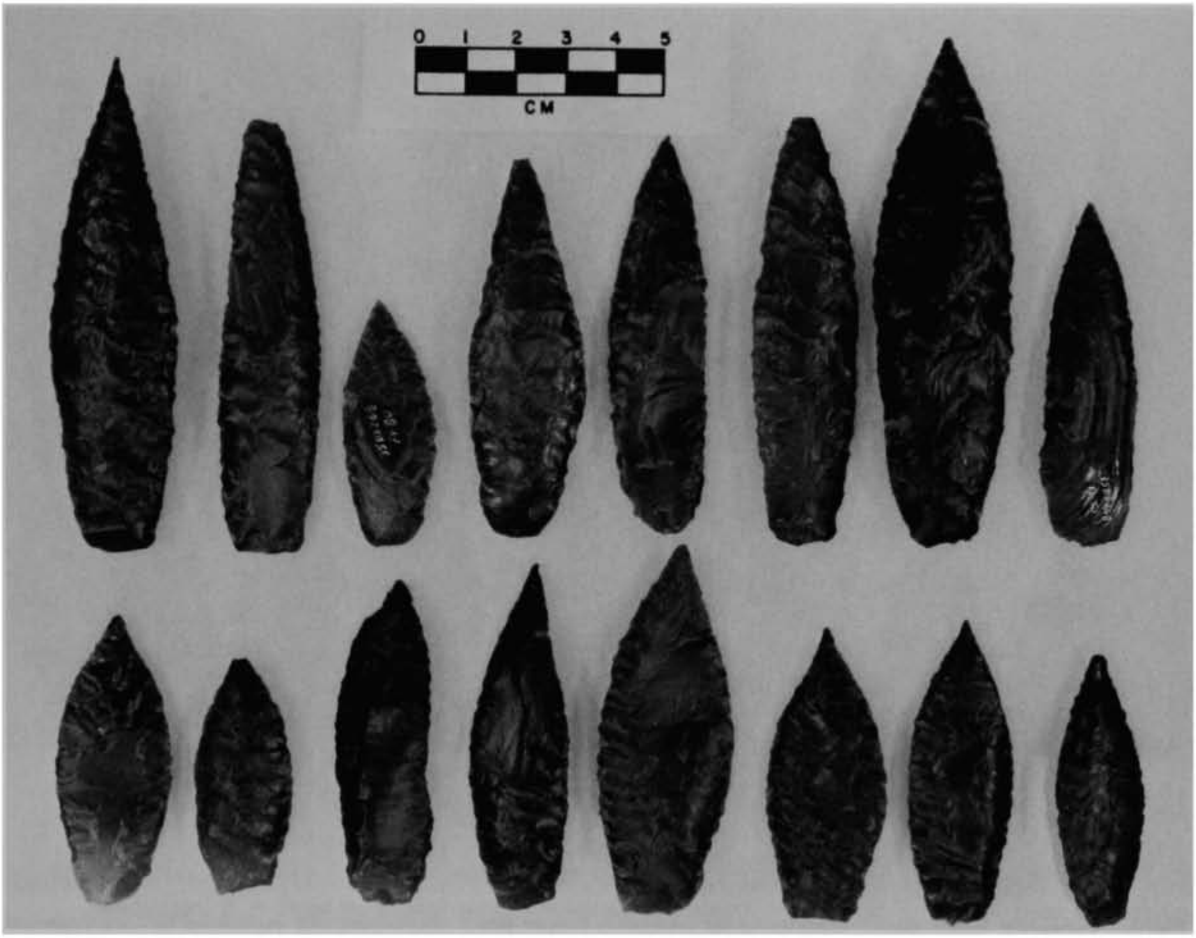

Fig. 2. Representative specimens from the Pahoehoe Cache.

the quarry to the Pahoehoe site (Fig. 4). The lack of primary and secondary decortication flakes and the presence of angular percussion flakes in the Pahoehoe workshop debitage suggest that minimally shaped bifacial cores were the source of the flakes used to produce the cache.

Obsidian X-Ray fluorescence (XRF) sourcing is useful for distinguishing between regional obsidian sources in the northern Great Basin. However, the trace element profiles of many local central Oregon obsidians, especially those in the Newberry Caldera, overlap (Hughes 1986). Thus, it is difficult to reliably distinguish the local obsidian source used to manufacture the Pahoehoe biface cache. Sourcing data correlates the Pahoehoe cache with McKay Butte and Quartz Mountain obsidian (Table 1). Visually, the Pahoehoe bifaces compare most closely with McKay Butte obsidian, a dense, grainy, grey-colored glass, rather than the waxy-textured, black obsidian from Quartz Mountain. Obsidian from the McKay Butte quarry, located 25 km. east of the Pahoehoe site, occurs naturally as small, fist-sized nodules and larger, brick-sized, tabular pieces. Complete and fragmentary bifacial cores have been recovered from the Mckay Butte quarry (Russo-Card 1982).

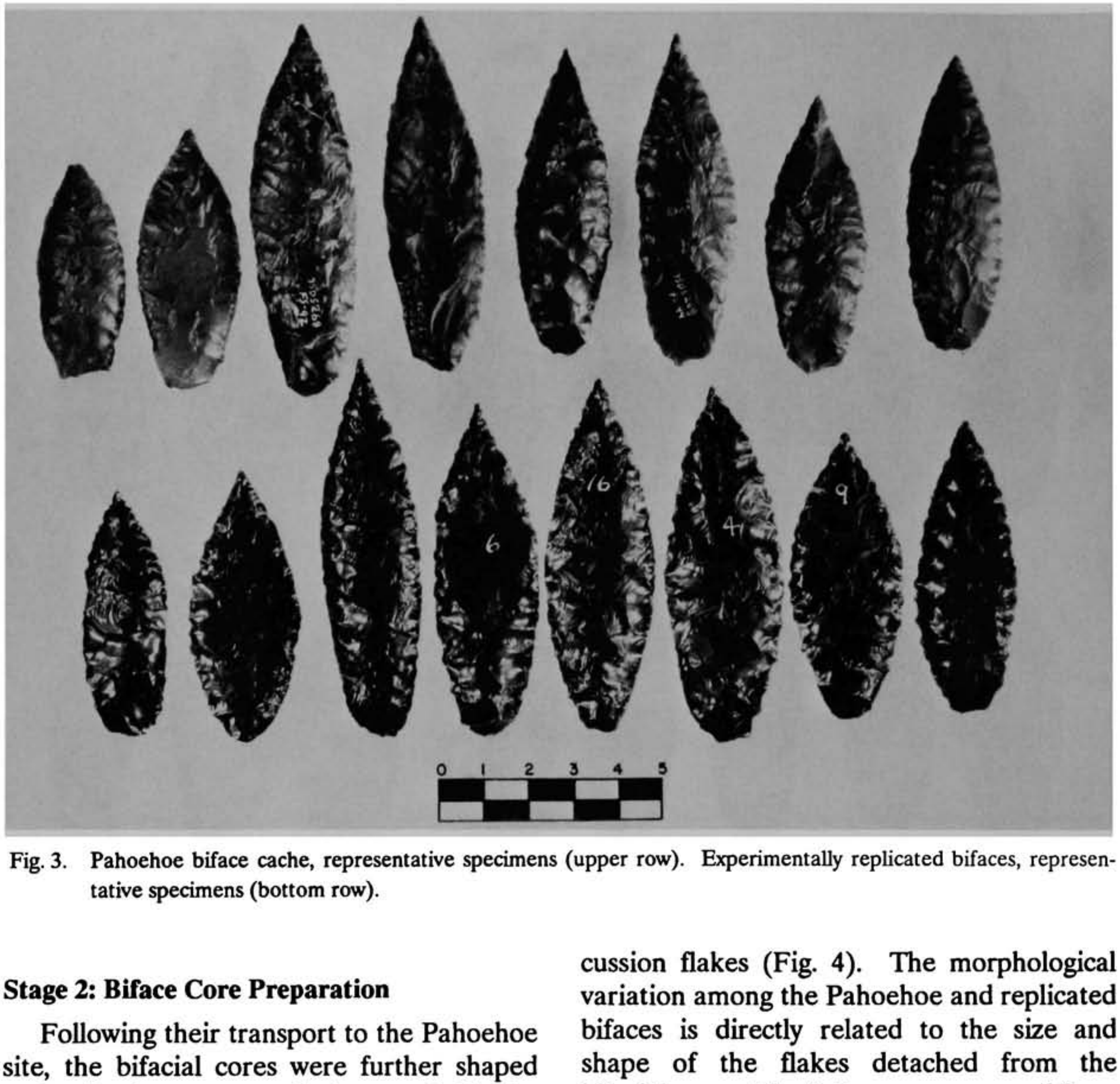

Fig. 3. Pahoehoe biface cache, representative specimens (upper row). Experimentally replicated bifaces, representative specimens (bottom row).

Stage 2: Biface Core Preparation

Following their transport to the Pahoehoe site, the bifacial cores were further shaped and refined to prepare platforms suitable for detachment of large percussion flakes (Fig. 4). This stage of the reduction sequence is documented in the workshop debitage by angular flakes and small biface-thinning flakes which were removed to facilitate platform preparation.

Stage 3: Flake "Blank" Production

After preparing the bifacial cores, the Pahoehoe flintknappers removed large percussion flakes (Fig. 4). The morphological variation among the Pahoehoe and replicated bifaces is directly related to the size and shape of the flakes detached from the bifacial cores. The flakes were removed from the cores by direct free-hand percussion.

Compression rings, radial striations, and remnant bulbs of force on the original ventral surface of the flake (detachment scar) on most cache bifaces (Fig. 5) indicate the flakes were removed multi-directionally from a biface core(s). The majority (75%) of the cache bifaces are oriented diagonally to the axis of force that detached the flake blank. The remainder are oriented perpendicular

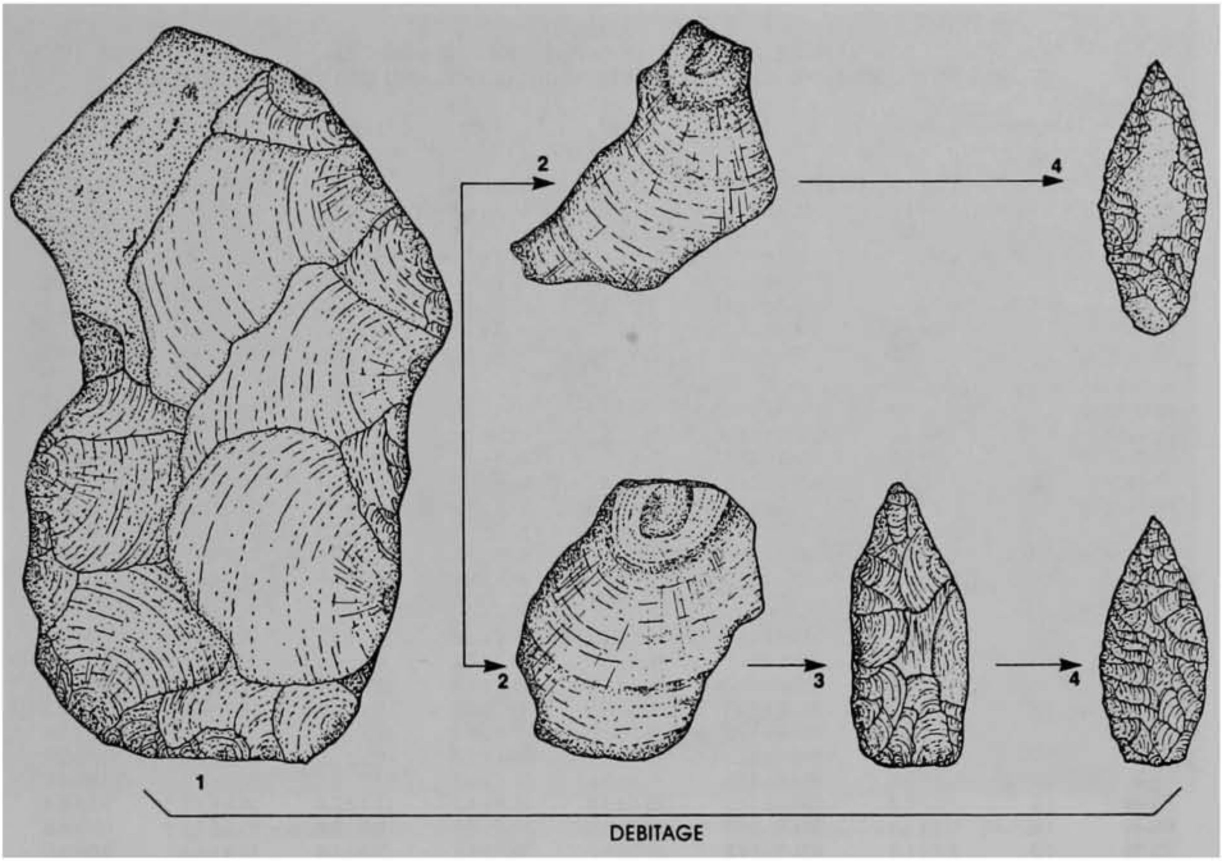

Fig. 4. Pahoehoe cache lithic reduction sequence: 1 = Stage 2, biface core preparation; 2 = Stage 3, flake blank production; 3 = Stage 4, bifacial point production, percussion; 4 = Stage 5, bifacial point production, pressure.

(15%) and parallel (10%) to the original flake platform.

The Pahoehoe workshop yielded a few fragmentary percussion flakes that either were broken during production or were too small to be manufactured into bifaces and thus were discarded. This situation occurred in the replication experiment when a few percussion flakes were not selected for further refinement because they were too fragmentary.

Stage 4: Bifacial Point Production (Percussion)

Over half of the Pahoehoe artifacts were minimally percussion-flaked to shape the bifaces into their characteristic lanceolate form and to remove areas of high mass (e.g., bulbs of percussion). Remnant percussion flake scars are visible on 30% of the Pahoehoe bifaces.

Debitage characteristic of this stage of reduction includes small biface-thinning flakes and percussion flakes that exhibit original detachment scars on their dorsal surfaces.

Stage 5: Bifacial Point Production (Pressure)

Flake edges were sheared by the Pahoehoe knappers to produce a margin that was sufficiently stout to allow for subsequent

Table 1
TRACE ELEMENT COMPOSITION OF BIFACES
FROM THE PAHOEHOE, LAVA ISLAND ROCKSHELTER, AND CHINA HAT CACHES

	Chi-Square	Cs*	Ba*	La*	Ce*	Pr*	Nd*	Sa*
Pahoehoe Cache								
FS-35	1.5	1.3±1.3	1056.9±14.3	29.6±3.8	61.6±4.3	9.3±2.5	24.9±6.0	0.0±0.0
FS-59	1.4	0.9±1.4	1080.7±15.6	26.9±4.0	60.2±4.5	17.1±2.7	22.1±6.4	0.0±0.0
FS-62	1.6	1.5±1.3	1042.1±14.8	31.6±3.9	53.5±4.3	0.0±0.0	4.2±6.2	8.6±4.4
FS-83	1.4	0.0±0.0	1090.2±16.4	32.9±4.2	61.2±4.5	9.6±2.8	16.1±6.7	0.0±0.0
FS-117	1.8	0.2±1.6	954.8±17.2	22.8±4.6	66.9±5.1	0.0±0.0	13.0±7.4	0.0±0.0
FS-120	2.2	0.0±0.0	992.2±14.1	32.2±3.8	52.8±4.3	0.0±0.0	21.5±6.2	0.0±0.0
FS-124	1.8	0.0±0.0	1016.5±15.7	31.1±4.3	57.3±4.6	11.3±2.8	29.0±6.6	0.0±0.0
FS-134	2.0	0.0±0.0	1020.1±14.0	23.6±3.9	54.9±4.2	0.0±0.0	27.4±6.1	0.0±0.0
Lava Island Rockshelter Cache								
FS-J-4-1	1.4	0.0±0.0	878.0±14.4	35.3±4.2	71.4±4.8	9.1±2.7	23.3±6.4	0.0±0.0
FS-0-17	1.6	1.8±1.2	856.1±13.0	23.2±3.8	61.9±4.3	7.0±2.5	17.2±6.1	6.8±4.5
FS-0-22	1.3	0.0±0.0	864.3±12.5	29.1±3.8	66.0±4.2	0.0±0.0	25.3±5.8	5.6±4.4
FS-0-29	1.5	0.0±0.0	823.6±14.3	34.2±4.4	66.6±4.7	7.0±2.7	10.9±6.5	0.0±0.0
FS-0-32	1.8	0.0±0.0	1006.7±15.1	30.4±4.0	53.6±4.3	7.7±2.7	24.9±6.4	0.0±0.0
FS-0-34	1.4	1.1±1.4	849.7±15.3	36.5±4.6	51.5±4.8	13.5±2.8	28.4±6.9	7.0±5.1
FS-0-36	1.9	0.1±1.4	987.9±15.0	28.3±4.0	65.5±4.5	0.0±0.0	23.2±6.5	0.0±0.0
FS-0-37	1.8	0.0±0.0	840.3±13.6	29.2±4.1	59.8±4.6	0.0±0.0	24.7±6.4	0.0±0.0
China Hat Cache								
FS-1	1.6	1.6±1.3	953.2±13.6	28.5±3.8	49.1±4.2	7.2±2.4	19.0±5.8	0.0±0.0
FS-5	1.6	1.7±1.4	1261.6±16.1	18.8±3.7	43.7±4.2	0.0±0.0	20.0±6.4	0.0±0.0
FS-7	1.4	0.3±1.2	852.4±13.0	33.4±3.8	61.5±4.3	13.3±2.4	16.5±5.9	14.5±4.5
FS-16	1.5	0.9±1.2	908.6±13.5	28.8±3.8	50.1±4.2	9.4±2.5	15.7±6.1	11.2±4.7
FS-22	1.4	0.3±1.3	886.8±14.2	34.7±4.0	70.2±4.5	10.3±2.6	21.0±6.4	0.0±0.0
FS-29	1.2	0.0±0.0	892.4±13.3	25.0±3.9	60.4±4.2	0.0±0.0	13.3±6.0	0.0±0.0
FS-31	1.8	0.0±0.0	894.6±13.5	39.4±3.8	58.4±4.3	12.7±2.5	32.6±6.1	10.8±4.5
FS-48	1.2	1.8±1.2	865.2±13.2	33.4±3.8	62.8±4.3	11.4±2.4	30.1±5.9	9.1±4.4
FS-49	1.8	0.2±1.4	854.1±15.7	21.7±4.5	52.7±5.1	0.0±0.0	23.4±7.1	0.0±0.0
FS-56	1.3	1.8±1.3	871.2±14.2	38.7±4.2	70.7±4.7	9.0±2.6	12.0±6.4	0.0±0.0
FS-61	1.7	0.7±1.4	855.0±15.0	31.9±4.4	54.6±4.9	10.4±2.8	20.1±6.8	0.0±0.0
FS-62	1.6	1.7±1.2	846.8±13.2	34.5±3.8	78.3±4.4	7.8±2.5	26.3±6.1	0.0±0.0
FS-69	1.5	1.8±1.2	878.6±13.5	40.1±4.0	65.9±4.4	10.5±2.5	31.0±6.2	0.0±0.0
FS-80	1.3	1.2±1.5	850.7±16.4	37.4±4.9	63.3±5.4	11.2±3.1	23.3±7.5	13.8±5.7
FS-83	1.3	1.8±1.5	906.3±16.7	34.0±4.7	61.0±5.3	11.0±3.0	25.6±7.3	0.0±0.0
FS-88	1.8	0.0±0.0	887.4±14.7	23.8±4.2	56.2±4.8	0.0±0.0	12.6±6.5	0.0±0.0
FS-98	1.6	1.2±1.3	862.8±13.5	32.3±4.1	76.5±4.5	0.0±0.0	14.9±6.1	6.8±4.5
FS-106	1.7	1.9±1.4	885.7±15.5	32.9±4.5	63.5±5.1	13.0±2.8	33.1±7.0	7.0±5.2

* = All values in parts per million (ppm). ± = Counting error uncertainty.

pressure flaking. Shearing was accomplished by moving a pressure flaker or other instrument along the lateral edge of the flake blank in a downward motion around the entire margin.

To facilitate pressure flaking, platforms were set to the same face of the biface being flaked. This platform preparation technique allowed the maximum amount of mass to be removed with each pressure flake. During pressure flaking, the knapper(s) worked from tip to base along one lateral edge, and from base to tip on the opposite edge on the same face, thereby producing the characteristic transverse parallel flaking evident on most of the bifaces. This flaking technique removed remnant platforms and produced the "finished" appearance and needle-sharp tips on many of the bifaces. Because only one series of pressure flakes was removed, the ventral (detachment scar) surfaces of the original flake blank are

Fig. 5. Pahoehoe bifaces showing detachment scar on original ventral surface of flake.

visible on 85% of the bifacial artifacts (Fig. 5). Bases were minimally flaked and exhibit no grinding or thinning.

This stage of reduction produced platform preparation flakes and slender, parallel-sided pressure flakes. An abundance of microdebitage was also produced when the Pahoehoe knappers sheared the lateral margins of the flake blanks.

The lithic reduction technology at the Pahoehoe site was both economical and expedient. Regardless of shape and size, nearly all flakes produced by the knappers were manufactured into bifaces. Little obsidian was wasted. The Pahoehoe knappers produced bifaces with a finished appearance, with transverse parallel pressure flaking and, in many cases, needle-sharp tips, by removing only one series of pressure flakes. This production technology produced a biface cache that exhibits a striking amount of morphological variability in what is otherwise a technologically homogeneous artifact assemblage.

The replication study provides an indication of the time expenditure required to manufacture the cache. During the replication experiments, three and one-half person-hours were required to produce 30 bifaces after the flakes were removed from the biface core, with an average time expenditure of seven and one-half minutes per biface. Thus, the Pahoehoe cache could have been produced by one or several knappers with little effort.

The biface core technology used to produce the Pahoehoe cache was a dominant lithic reduction strategy associated with

Table 2
OBSIDIAN HYDRATION READINGS

Site	Specimen Number	Number of Readings	Mean Width of Hydration Rind (microns)	Obsidian Source
Pahoehoe Cache				
	FS-35	6	1.5	McKay Butte[a]
	FS-59	6	2.2	McKay Butte
	FS-62	6	2.1	McKay Butte
	FS-83	6	1.3	McKay Butte
	FS-117	6	1.2	McKay Butte
	FS-120	6	1.4	McKay Butte
	FS-124	6	1.2	McKay Butte
	FS-134	6	1.4	McKay Butte
Lava Island Rockshelter Cache				
	FS-J-4-1	6	2.0	McKay Butte/Newberry[b]
	FS-0-17	6	NVR[c]	McKay Butte/Newberry
	FS-0-22	6	NVR	McKay Butte/Newberry
	FS-0-29	6	2.1	McKay Butte/Newberry
	FS-0-32	6	2.4	McKay Butte/Newberry
	FS-0-34	6	2.1	McKay Butte/Newberry
	FS-0-36	6	1.4	McKay Butte/Newberry
	FS-0-37	6	2.5	McKay Butte/Newberry
China Hat Cache				
	FS-1	6	1.7	Quartz Mountain
	FS-5	6	1.1	Unknown
	FS-7	6	1.0	McKay Butte/Newberry
	FS-16	6	1.1	Quartz Mountain
	FS-22	6	1.0	Quartz Mountain
	FS-29	6	1.1	Quartz Mountain
	FS-31	6	1.2	Quartz Mountain
	FS-48	6	0.9	McKay Butte/Newberry
	FS-49	6	1.0	Quartz Mountain
	FS-56	6	NVR	McKay Butte/Newberry
	FS-61	6	1.2	McKay Butte/Newberry
	FS-62	6	1.4	McKay Butte/Newberry
	FS-69	6	NVR	McKay Butte/Newberry
	FS-80	6	NVR	McKay Butte/Newberry
	FS-83	6	NVR	Quartz Mountain
	FS-88	6	1.2	Quartz Mountain
	FS-98	6	0.9	McKay Butte/Newberry
	FS-106	6	NVR	McKay Butte/Newberry

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[a] All eight Pahoehoe bifaces conform to the trace element profile of McKay Butte volcanic glass. However, there are marked similarities between these specimens and Quartz Mountain glass, principally due to Zr ppm values, which fall on the low end of concentration values observed for McKay Butte source standards. Trace element data do not match the obsidian profile from Newberry Volcano (Hughes 1986).

[b] Trace element composition values are congruent with both McKay Butte and Newberry Volcano geochemical types. There is a marked overlap in Rb, Sr, Y, Zr, Ba, La, and Ce ppm values between these sources (Hughes 1986).

[c] No visible hydration rind.

Archaic-period sites in the northern and western Great Basin (Elston 1982; Scott 1985). The Archaic period (ca. 6,800 to 2,000 B.P.) in the northern Great Basin is characterized by the prevalence of side- and corner-notched dart points (Aikens 1970, 1982; Bedwell 1973; Hanes 1977; Heizer and Baumhoff 1978; Holmer 1986) that were manufactured using a bifacial core production technology (Flenniken and Raymond 1986). Thus, the Pahoehoe biface cache and Archaic period projectile point types appear to belong to the same lithic production technology.

COMPARISONS WITH OTHER BIFACE CACHES

A variety of lithic artifact caches have been found throughout the northern Great Basin and portions of the Columbia Plateau which differ from the Pahoehoe lanceolate bifaces and similar lithic caches described below. Many lithic caches are composed of large, percussion-flaked, ovate-shaped biface blanks or smaller, unifacially or bifacially-flaked, ovoid to triangular-shaped tool preforms (e.g., Cressman 1937; Weide and Weide 1969; Hanes and Botti 1980; Hanes 1986). In contrast, the Pahoehoe and related caches are composed of small, pressure-flaked, lanceolate-shaped bifaces which, in many cases, could be identified as projectile points of great antiquity in regional artifact typologies (e.g., Minor and Toepel 1984).

We have examined six bifacial point caches from central Oregon that are technologically similar to the Pahoehoe cache (Scott and Davis 1984). Other caches from the local area are in private artifact collections and are unavailable for scientific study. A large number of individual bifaces which resemble the Pahoehoe cache also have been collected from the surface of several middle-to-late Holocene tephra deposits, including that from Mount Mazama (6,800 B.P.) and Newberry Caldera (1,600 B.P.). Most biface caches occur as isolated finds lacking other associated artifacts and reduction debitage. Caches include from 33 to 2,130 individual bifaces and vary primarily in the degree to which they are "finished" (the number of pressure-flake series removed and presence of hafting element). Lanceolate biface caches from two sites, Lava Island Rockshelter (Minor and Toepel 1984) and the China Hat site (Scott and Davis 1984), were used for comparison in this study and are described briefly below.

Lava Island Rockshelter (35DS86) is located adjacent to the Deschutes River, approximately 25 km. west of the Pahoehoe site (Fig. 1). Excavated in 1981, the site yielded evidence of three putatively distinct cultural components, the earliest of which is represented by a cache of 33 lanceolate bifaces (Minor and Toepel 1984:12). Based on their morphological attributes, the artifacts were interpreted to be "Haskett-like" projectile points, and were used to date the earliest occupation of the shelter at 8,000 to 10,000 B.P. (Minor and Toepel 1984:22-23). However, stratigraphic evidence, two late radiocarbon dates, obsidian hydration measurements (Origer 1985), lithic technological data (e.g., the lanceolate points exhibit transverse parallel rather than the collateral pressure flaking typical of the Haskett type), and obsidian XRF sourcing data tentatively correlating the bifaces with prehistorically used Holocene-age obsidian quarries in the Newberry Caldera (dated to 6,800 and 1,600 B.P.), suggest that the Lava Island Rockshelter cache is of more recent origin and likely falls within the same time range as the Pahoehoe cache.

The China Hat site (35DS270) is located 50 km. east of the Pahoehoe site adjacent to an extensive lava field in isolated ponderosa pine forest (Fig. 1). Though the site was vandalized severely in 1984, the Forest Service was able to recover 430 lanceolate bifaces from artifact collectors and 20 from controlled excavations (Scott and Davis 1984). The cache was located from 30 to 60 cm. below ground surface in mixed Mount Mazama tephra (dated to 6,800 B.P.) which was capped by rhyolite pumice from the 1,600 B.P. eruption of the Newberry Caldera (MacLeod et al. 1981). These stratigraphic data provisionally date the cache to a time period between 6,800 and 1,600 B.P. The China Hat bifaces also share the same characteristics as the Pahoehoe and Lava Island Rockshelter bifaces: a biface core technology, transverse parallel pressure flaking, and a wide range in artifact morphology (e.g., size, shape, and thickness).

Neither archaeological site yielded an associated workshop or precise chronological data. Both assemblages were used as comparative collections during our replication experiment but, lacking associated lithic debitage, could not be analyzed nor replicated to the same degree as the Pahoehoe biface cache.

AGE OF PAHOEHOE AND RELATED CACHES

The age of the Pahoehoe cache must currently be inferred from stratigraphic and obsidian hydration data as no organically datable material was recovered from the site. The provenience of the Pahoehoe cache in mixed Mount Mazama tephra indicates the cache post-dates the 6,800 B.P. eruption. The fact that all bifaces and associated lithic debitage in the adjacent workshop were found atop or close to ground surface in the mixed Mazama tephra, as opposed to being deeply buried within it, suggests that the bifaces were introduced recently into the site deposit, apparently well after the eruption of Mount Mazama.

Obsidian hydration measurements (Table 2) taken from eight Pahoehoe bifaces ranged from 1.2 to 2.2 microns (Origer 1985). Hydration measurements from a sample of eight bifaces from Lava Island Rockshelter and eighteen from the China Hat site also ranged from 1.2 to 2.5 microns (Table 2). Source-specific, site-specific hydration rates were not determined for the cache sites and at present no obsidian hydration curve exists for the obsidians in question in this region. The biface samples include obsidians from a variety of chemically distinct, local sources (Hughes 1986) which may express differential hydration and abrasion rates (Jackson 1985). How either site location or chemical variation may have affected the hydration readings currently is unknown and will be the topic of future studies. Thus, a precise age for the biface caches cannot be established using the hydration data. The thin hydration rinds on all cache samples tentatively do support the stratigraphic evidence suggesting the Pahoehoe, Lava Island, and China Hat sites substantially post-date 6,800 B.P.

We initially hoped that obsidian XRF sourcing data would shed light on site age by correlating the bifaces to Holocene-age obsidian quarries in the adjacent Newberry Caldera. However, only the comparative sample from Lava Island Rockshelter was sourced to the Newberry Caldera indicating it apparently post-dates 6,000 B.P., the age of the oldest prehistorically used obsidian sources in the caldera proper. The Newberry sources, however, cannot yet be chemically distinguished from each other. Thus, these data provide only a relative age for the Lava Island Rockshelter (and other) biface cache(s). Future XRF sourcing studies in the Newberry Caldera may help to pinpoint the age(s) of the biface caches and other lithic-dominated sites in central Oregon.

In sum, several lines of evidence are strongly suggestive of a comparatively late age for the Pahoehoe, Lava Island Rockshelter, and China Hat biface caches. Lithic technological, stratigraphic, and obsidian hydration data indicate that the three biface caches substantially post-date the 6,800 B.P. eruption of Mount Mazama.

THE FUNCTION OF THE BIFACE CACHES

Superficially, many of the larger bifaces in the Pahoehoe, China Hat, and Lava Island

Rockshelter cache assemblages are similar to "Paleoindian" projectile point types from the northern Great Basin, and many areas throughout western North America (e.g., Minor and Toepel 1984:20-23). However, this initial impression is countered by the chronological and technological data indicating that the biface caches were manufactured within the last 6,800 years. During this period, a biface core technology was used widely throughout the northern Great Basin to produce side- and corner-notched dart points and other tools (Elston 1982; Scott 1985). However, it is unlikely that the Pahoehoe bifaces are preforms or "blanks" for side- or corner-notched projectile points because preforms for such items are triangular, rather than slender and lanceolate-shaped.

Lanceolate-shaped bifaces ("points," "knives," "blades") occur during all prehistoric time periods in the northern Great Basin (e.g., Jennings 1957; Aikens 1970; Bedwell 1973), although they are especially abundant in "Paleoindian" and "early Archaic" lithic assemblages. Many bifaces were stored in small lithic caches (e.g., Ice 1962:56). In the Great Basin, lithic tool caches apparently were related to logistic mobility and resource scheduling (Thomas 1983:81). Resource caches were maintained to offset resource shortages in specific environments (Binford 1980:12).

Storing obsidian flakes and tools in logistically convenient locations in order to enhance resource scheduling and exploitation may explain the occurrence of numerous percussion-flaked blanks and preform caches found throughout the northern Great Basin. However, this hypothesis does not adequately explain the distinctive production technology of the Pahoehoe and related bifacial point caches, their abundance in both quantity and frequency, their isolated locations, their necessity in an obsidian-rich environment, nor their ultimate abandonment.

One possible non-utilitarian explanation is that the bifacial point caches were manufactured as burial tools similar to the pattern documented at the DeMoss Burial site in west-central Idaho (Green et al. 1986). Although none of the biface point caches we analyzed or examined were accompanied by human burials, the pumaceous soils of central Oregon apparently are not conducive to skeletal (or faunal) preservation (Davis and Scott 1986:107). The isolated locations of the caches adjacent to lava flows and in rockshelters are likely burial locations. However, this pattern of tool (biface) disposal is comparatively rare in this region of northern Great Basin (Cressman 1933) and until skeletal material is found associated with the caches, this interpretation is difficult to support.

At present, as a working hypothesis, we believe that the bifacial point caches may be explained most logically within the context of a prehistoric exchange system. The ethnographic literature of the northern Great Basin, northern California, and southwestern Oregon, documents the use of obsidian as an item of exchange for desired or scarce resources. Obsidian was highly valued for its barter potential and as an item of social ranking among many historically known Indian tribes of northwestern California (Powers 1877; Kroeber 1960; Gould 1966; Hughes 1978). The Wappo and Washo, who lived near extensive obsidian quarries, traded obsidian for bows, beads, fish, berries, and other resources (Davis 1961). Among the Hupa, Karok, Yurok, and Wiyot of northwestern California, obsidian was a highly favored raw material which was sought through direct access and regional exchange systems (Powers 1877; Hughes 1978). Many obsidian items were valued as ceremonial

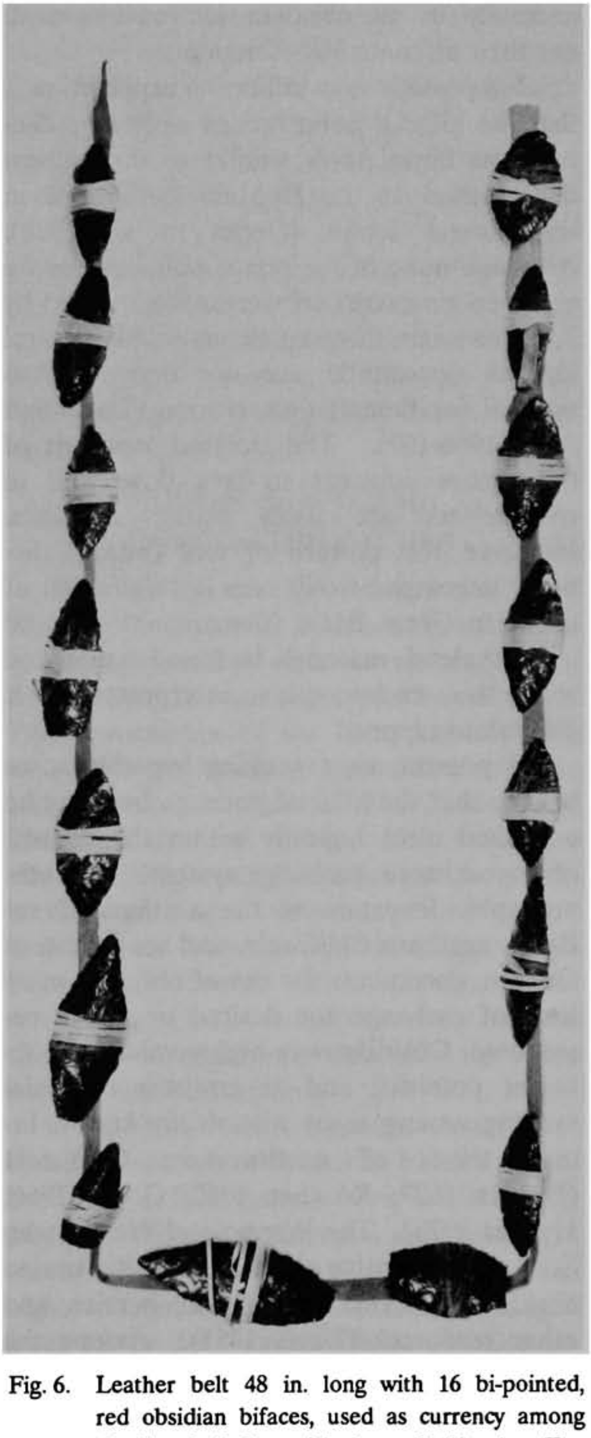

Fig. 6. Leather belt 48 in. long with 16 bi-pointed, red obsidian bifaces, used as currency among the Karok Indians, Northern California. The bifaces are 1.25 to 3.25 in. long and from 0.5 to 1.25 in. wide. Photograph courtesy of the Museum of the American Indian, Heye Foundation, New York.

objects, currency, and trade items. For example, the ethnographic collection at the Museum of the American Indian, Heye Foundation, contains a Karok "currency belt" made of sixteen obsidian lanceolate bifaces attached with sinew and vegetal binding to a thin strip of leather (Fig. 6).

The prehistoric and ethnographic movement of obsidian in this region of the northern Great Basin is tentatively documented (Hughes 1978; Hughes and Bennyhoff 1986:238-243, Fig. 2). As an abundant resource, obsidian was readily available to stockpile and trade in order to maximize a resource surplus. This abundance may have logistically instigated prehistoric exchange systems similar to those documented in the ethnographic and archaeological record of northern California and southern Oregon, and represented in the archaeological record by the Pahoehoe, Lava Island, China Hat, and other bifacial point caches. In a rigorous High Desert environment devastated by frequent volcanic eruptions throughout most of the Holocene (Bedwell 1973; Scott 1985), aboriginal groups living in this area may have used obsidian trade to offset food and material resource shortages.

Lithic technological data from the Pahoehoe site and related biface caches suggest the caches were part of a prehistoric exchange system in which direct access was limited to only a few prehistoric groups. The cache assemblages are extremely homogeneous in terms of their production technology. The lithic products are uniformly the same. The caches were produced expediently and economically; flakes of a wide variety of sizes were used in biface production. Most caches are composed of large quantities of obsidian bifaces whose production emphasized a "finished" appearance rather than functional utility. The caches apparently were produced and stored in isolated areas, presumably to control access and supply and demand. Finally, the caches appear to be generally of about the same age and comprise a common archaeological phenomenon in this region.

The direction to which this prehistoric exchange system was focused is currently unknown and is an objective of current research. Extant archaeological and ethnographic documentation is suggestive of a southward movement through Oregon and northwestern California (Hughes 1978) rather than northward toward the southern Columbia Plateau. However, obsidian XRF sourcing research in this region has thus far been minimal and very site-specific. Whether XRF sourcing techniques are sufficiently advanced to reliably distinguish between local obsidians and those obtained from distant sources through long-range prehistoric trade is currently problematic since obsidian chemical profiles frequently overlap and source comparisons are often local or regional, rather than inter-regional, in scope.

Further, whether the bifaces remained unaltered after trade (as suggested by the ethnographic Karok cache) or were further modified into either functional tools (as suggested by a few Lava Island Rockshelter bifaces which show basal modification), ornaments (e.g., Hattori 1982:44-48), or perhaps burial goods (e.g., Contreras 1957: 29-33) is also unknown. Determining the nature and direction of this posited lanceolate biface exchange system will necessitate lithic technological studies and comprehensive obsidian XRF sourcing of mid-to-late Archaic lithic assemblages containing unmodified and finished lanceolate-shaped bifaces from the northern Great Basin and adjacent regions.

Explanations for the abandonment of these large biface caches are also accommodated within the context of the exchange system hypothesis. Because exchange systems are directly tied to supply and demand economics, production was correlated to fluctuations in demand (Ericson 1982:132; Luedtke 1984:65). For example, a change in obsidian demand possibly was associated with the transition from the use of atlatl darts to arrowpoints at ca. 2,500-2,000 B.P. This transition may correlate with changes in production technologies (i.e., large atlatl dart point preforms versus small arrow point flake blanks) and a general morphological diminution in projectile point size. Large bifacial point caches assembled for exchange with groups lacking direct access to quarries may no longer have been in demand due to changes in production technologies and desired tool forms, and subsequently were abandoned.

Frequent late Holocene volcanic eruptions, especially of the Newberry Caldera (MacLeod et al. 1981), altered the topography of central Oregon and apparently buried many caches (as best demonstrated by the 1,600 B.P. Newberry pumice atop the China Hat cache), making them difficult, if not impossible, to relocate. This situation, possibly in concert with a lack of economic demand, ensured that many biface caches were removed from prehistoric circulation and subsequently left in a context suitable for archaeological discovery.

Future investigations of lithic cache sites in the northwestern Great Basin and in the southern Columbia Plateau may provide alternative functional hypotheses for this widespread archaeological phenomenon. Caches composed of percussion-flaked quarry blanks and preforms may best be explained as tool stores. However, many of the more finely and expediently made pressure-flaked biface caches found in such abundance in this particular region may reflect lithic trade products circulating in prehistoric exchange systems. In short, they may have served some non-utilitarian function. Whatever the case, interpretations regarding prehistoric caches and caching behavior should rest on empirically-derived and testable data, including lithic technological studies, obsidian trace element sourcing, and hydration dating, especially for caches lacking associated artifacts and datable contexts. This research approach should advance our understanding of prehistoric resource logistic strategies, exchange and trade networks, wealth acquisition, and entrepreneurship.

CONCLUSIONS

The Pahoehoe, Lava Island Rockshelter, China Hat, and other lanceolate biface caches from this region, are examples of the amount of morphological variability that can occur in artifacts produced by the same manufacturing technology. Our lithic replication experiments demonstrate that the caches are products of a bifacial core reduction technology that produced artifacts superficially similar to Paleoindian projectile points. However, technological, stratigraphic, obsidian hydration, and obsidian XRF sourcing data strongly suggest the caches post-date the eruption of Mount Mazama at ca. 6,800 B.P. They appear to be contemporaneous with the production of Archaic dart points, or possibly, Late Period arrow points. In this context, it is difficult to explain the function of the artifact caches as huge stores of projectile points or other hunting tools.

Based on ethnographic data, coupled with the homogeneous and expedient production technology of the biface caches, an alternative functional explanation is offered. In light of the abundant obsidian in this region, the caches may be assemblages of trade objects used in a prehistoric exchange system similar to that documented in the archaeological and ethnographic record of northern California. A lack of demand for these trade items as a result of the transition from an atlatl to bow and arrow technology, in concert with problems of cache relocation associated with late Holocene volcanic eruptions, may account for their ultimate abandonment and frequent appearance in the archaeological record of this region.

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