FLAKED AND GROUND STONE TECHNOLOGY AT CA-ALA-554: MORTAR BOWLS AND STOCKTON POINTS

KARI LENTZ
WILLIAM SELF ASSOCIATES, INC.

Over 2,900 flaked stone and 170 ground stone artifacts were recovered during the 2011 excavation of the Castlewood site (CA-ALA-554). A variety of diagnostic items, such as bifaces, mortars, pestles, charmstones, pipes, and stone ornaments, compose the rich Augustine pattern assemblage. This paper considers how analysis of flaked and ground stone technology answers questions about chronology, settlement organization, exchange, and mortuary practices at the site and within the Amador Valley. This paper also puts forward a preliminary discussion on the chronological and functional implications of pestle shaft wear patterns.

BACKGROUND: THE CASTLEWOOD SITE (CA-ALA-554)

During the spring of 2011, William Self Associates, Inc. (WSA) conducted data recovery at CA-ALA-554 (also known as the Castlewood site), a large prehistoric site in Pleasanton, California, that is situated on a parcel of land slated for the development of a large retail center (Figure 1). Prior investigations indicated that a large portion of ALA-554 within the project area contained intact archaeological deposits and human remains. In order to minimize the disturbance to the archaeological deposits and the burials, WSA archaeologists monitored and excavated underground utility trenches within the previously recorded site boundary. A total of 187 burials and 25 features were recovered from a thick cultural midden associated with the prehistoric occupation (Estes et al. 2012:1).

Three habitation levels were identified within the midden that correlate to a sequence of occupation phases. Stratum III, concentrated in the southern portion of the project site, represents the initial phase of intensive habitation at ALA-554. Its contexts are situated at the lower limit of the midden that overlays sterile, native alluvial sediments. Stratum II encompasses the main period of occupation at ALA-554 based on the high volume of burials recovered in this layer. Dramatic population growth is evident in this stratum because over 90 percent of the burials recovered during the archaeological excavations were encountered in this level, which expands to the north and east of the earlier core area represented by Stratum III. Stratum I, the upper limit of the midden, corresponds to the last occupation phase at the site, wherein the number of burials drops off severely.

CHRONOLOGY

Diagnostic flaked and ground stone artifacts are key pieces of evidence that establish a chronology for the prehistoric occupation at ALA-554. These respective assemblages provide information on the date of initial site occupation and the temporal range of the site's habitation. In addition, these artifacts offer an opportunity to determine if relative typological dates support absolute dates derived from hydration and radiometric testing.

Projectile points are subject to frequent morphological change that can correspond to population migrations, shifting technological traditions, and the transmission of cultural ideas (Justice 2002). Around A.D. 1100, large bifacial darts fell out of favor with the introduction of bow-and-arrow technology, which is associated with the promulgation of small projectile points in the Bay Area (Bennyhoff 1994a:54; Hylkema 2002:49; Moratto 1984:563). The beginning of the Augustine pattern (A.D. 1200 to 1720) at the onset of the Late period is marked by the arrival of Stockton series projectile points (Bennyhoff 1994b:74; Groza 2002). Stockton cluster points feature lateral margins with notching retouch that creates distinctive serrations (Figure 2). These points originated in the Sacramento Delta region around A.D. 700 and

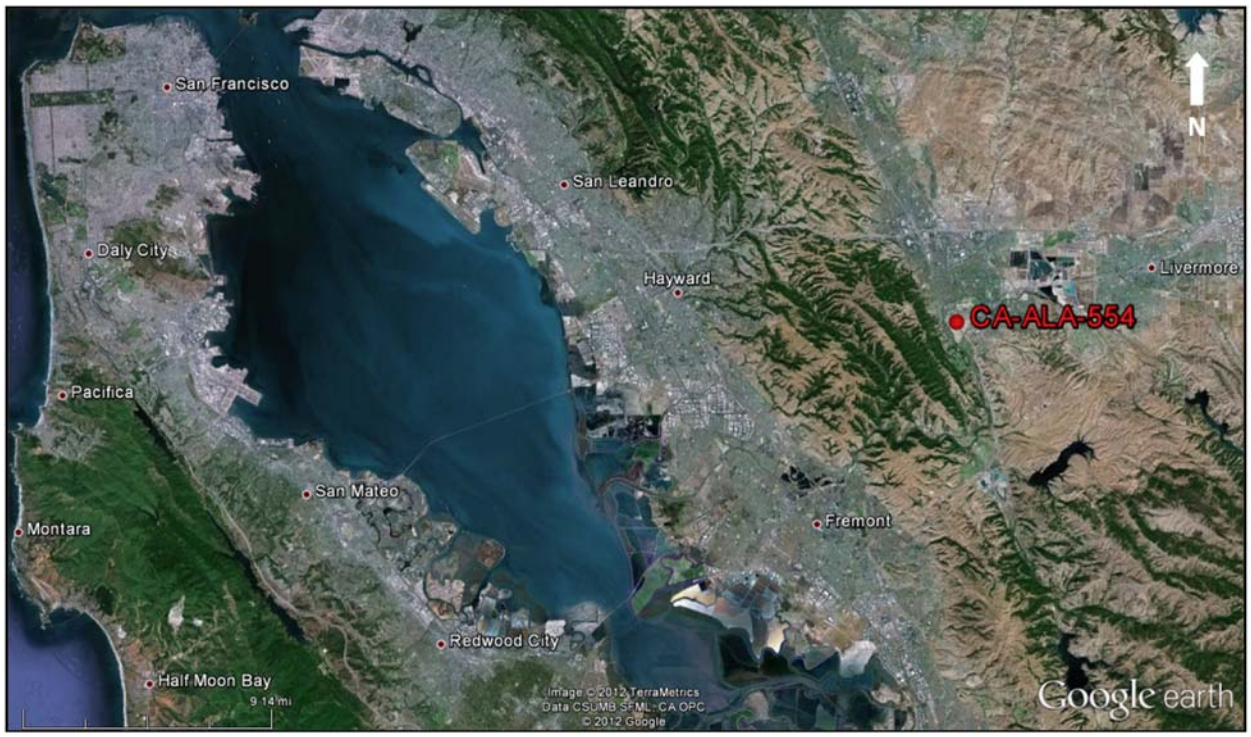

Figure 1: Site location within the Bay Area.

eventually spread to today's south Alameda County around A.D. 1100 to 1250 (Justice 2002:631; Milliken et al. 2007:117). Stockton Expanded Stem projectile points are characterized by narrow haft elements that expand at the base (refer to Figure 2). This kind of notching gives the stem a flared or expanded appearance. The serrations tend to decrease in size towards the distal end of the point, and the maximum width usually occurs at the shoulder (Justice 2002:360). Expanded Stem points have similar geographic distributions and Augustine/Late temporal affiliations as the Stockton cluster. Stockton Expanded Stem type projectile points with less than four serrations are thought to date to the end of Late period 1 and the beginning Late period 2 (A.D. 1550 to 1720) (Bennyhoff 1968; Groza 2002).

The majority of the diagnostic projectile points from ALA-554 are attributed to the Stockton series. Eight burials, all in Stratum II, were interred with nine Stockton series and six Stockton Expanded Stem projectile points. Three Stockton series points and two Expanded Stem points were submitted to Origer Associates for hydration testing. These points returned band dates that ranged from A.D. 1514 to 1790. The obsidian hydration dates, though late in most Stockton point chronologies, fall within the normal temporal range established for these points. The upper end of this temporal spectrum would push back the date of Stockton series points into the Mission period; however, the margin of error in hydration analysis (±0.2 microns) could account for the discrepancy. Postdepositional damage to the specimen, from plowing for example, may also be a reason for the late date.

Eight additional hydration samples from indeterminate bifaces, flake tools, and flakes yielded dates that ranged from A.D. 1335 to 1752. Two early dates from Burial 151 in Stratum II were recorded which included an early-stage biface with a date of ca. A.D. 238, and a flake dated ca. A.D. 341. These two dates predate all other site components by approximately 800 years. The older dates may indicate that some obsidian was scavenged from quarries where it was previously detached from the source or from earlier tools or debris present in the Amador Valley.

Diagnostic ground stone artifacts also provide insight into the temporal range of site habitation. Mortar bowls and charmstones are placed into typologies based on morphological traits. These types are indicative of distinct temporal shifts in the prehistory of central California (Beardsley 1954; Milliken et al.

Figure 2: Stockton Expanded Stem projectile points (left, right) and broken Stockton cluster biface (center).

2007; Moratto 1984). The distribution of these artifacts within distinct strata provides a relative method of dating the cultural layers at the site.

Mortars were classified by type, based on morphological traits. Mortar bowls were divided into three categories based on size, style, and quality of workmanship (Beardsley 1954:9). Type A mortars, also known as show mortars, were strategically shaped to have thin, completely shaped basins, exteriors, and round, flat bases. The exteriors of Type B mortar bowls retain the original shape of the source cobble and feature irregular or minimally shaped rims. Type D mortar bowls, also known as hopper mortars, are flat slabs with central shallow basins where bottomless baskets were attached with asphaltum (Figure 3).

The first appearance of mortar-and-pestle technology in the Bay Area occurred around 4000 B.C.; this correlates with the decreased use of milling slabs and hand stones for processing seeds during the onset of the Windmiller pattern (5000 to 2500 B.C.) (Milliken et al. 2007:104, 115). During the Middle to Late period transition (MLT), mortars and pestles became the grinding tools of choice in the East Bay region (Bennyhoff 1994a:66). Finely executed show mortars appear around A.D. 1200 and are indicative of a Late-period occupation (Milliken et al. 2007:116, 211).

Diagnostic mortar bowls from ALA-554 provide evidence of the presence of the Augustine pattern. The majority of mortar bowls were recovered from Stratum II and consist of 13 Type A mortars (43 percent), nine Type B mortars (30 percent), and one Type D mortar (3 percent). Stratum I has two Type A mortars. No mortars were recovered in Stratum III. The presence of show mortars in Strata I and II correspond to the Late period. The uppermost cultural phase may extend into the Late period 2, because one hopper mortar was interred in a Stratum I burial (Groza 2002; Milliken et al. 2007:117).

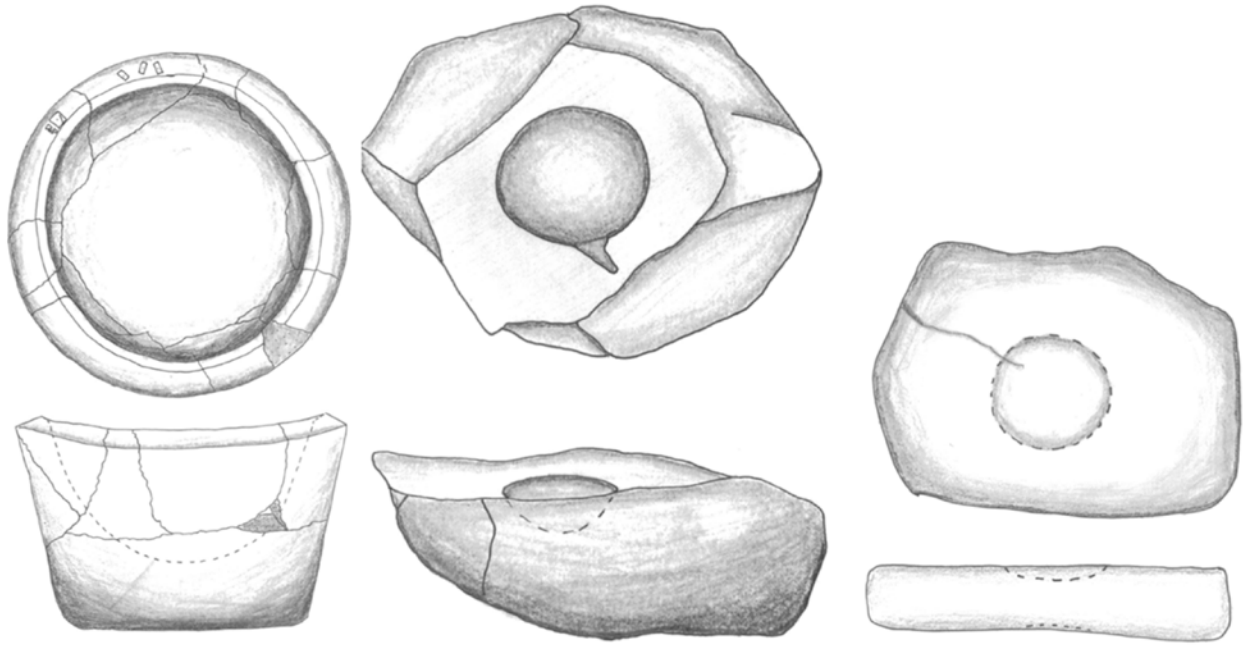

Figure 3: Type A or show mortar (left), Type B mortar (center), and Type D or hopper mortar (right). Not to scale.

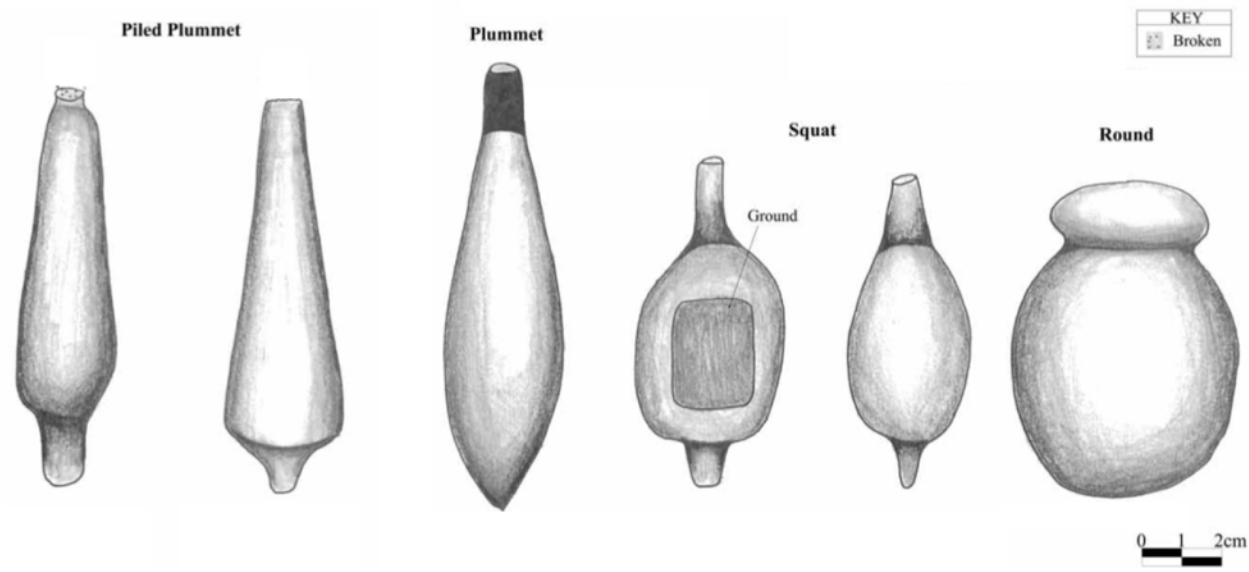

Figure 4: Piled plummet (first and second from the left), plummet (third from the left), squat (fourth and fifth from the left), and round (right) charmstones, according to Elsasser and Rhode's charmstone typology.

A Late-period occupation of ALA-554 is supported by the presence of diagnostic charmstones. Piled plummet charmstones are teardrop-shaped, with a long proximal end that bulges out while the distal end contracts to a narrow neck. Plummet charmstones have a neck on one end, a bulbous body, and terminate in a rounded end. Squat charmstones are similar in shape to plummets except that both ends terminate in narrow necks. The bodies of these charmstones are globular. Round charmstones have spherical bodies with a neck on one end and are generally shorter and smaller than plummet charmstones (Elsasser and Rhode 1996:77-91) (Figure 4). There are two plummet, three piled plummet, and two squat charmstones

Figure 5: Magnesite bead from Burial 166, with dorsal (left), side (center), and ventral (right) views.

associated with burials. Eighty-four percent of the charmstones from burials are in Stratum II. Eleven piled plummet, one plummet, one squat, and one round charmstone were found in non-burial contexts. Simple plummet charmstones have been found throughout central California at sites that date from the Middle to the Late period (200 B.C. to A.D. 1720) (Bennyhoff and Hughes 1987:149; Elsasser and Rhode 1996:23). Piled charmstones appeared in the Bay Area during the MLT and continued into the Late period. Round charmstones are present in the region from the Early to Middle Transition period (500 B.C.) to the Late period. Squat charmstones are common from the Early period to the Late period (Elsasser and Rhode 1996:23–27). Piled plummet types account for 70 percent of all charmstones at the site. In addition, none of the charmstones were perforated, which also suggests Middle-period to Late-period occupation.

Magnesite tubes and beads are restricted to Late period 2 in central California (Bennyhoff 1994a:66; Milliken et al. 2007:117). Burials 166 and 167, located in Stratum II, contained a total of six conical magnesite beads, which were unique to the site (Figure 5). These beads will be discussed further in the exchange section.

Two cylindrical stone pipes were discovered in association with two burials located in Stratum II. A sandstone pipe was found in Burial 47, and a black steatite pipe was recovered from Burial 149. The UC Davis Archaeological Metabolomics Group submitted bone collagen samples from these individuals for radiocarbon dating as part of an ongoing study on the proliferation of smoke plants in prehistoric North America. The test results indicated that Burial 47 was inhumed between A.D. 1324 to 1439 and Burial 149 was ensepulchered between A.D. 1304 to 1415. Therefore, the probable last use and subsequent deposition of these pipes occurred during the Late period 1.

Pestles as Augustine Pattern Markers

Although use wear on pestles has been an overlooked topic in central California and the Bay Area as a source of chronological information, evidence from ALA-554 suggests that if wear patterns on pestles could be reliably matched with specific mortar types, then date attribution of pestles based on wear pattern would be possible.

An experimental exercise was conducted with a mortar and pestle that had been interred with Burial 1 (Figure 6). The 36.0 cm long cylindrical pestle was moved in an up-and-down motion while keeping its side in contact with the interior bevel of the mortar rim. This motion resulted in a pattern that exactly matched the existing 12.0 cm ground section on the shaft of the pestle, which correlates to the 13.0 cm depth of the Type A mortar. Based on the compatible use wear evident on these two artifacts, as shown by this exercise, these artifacts were likely used together during their use life; however, definitive proof of stone-on-stone contact would require microscopic analysis, which was not conducted.

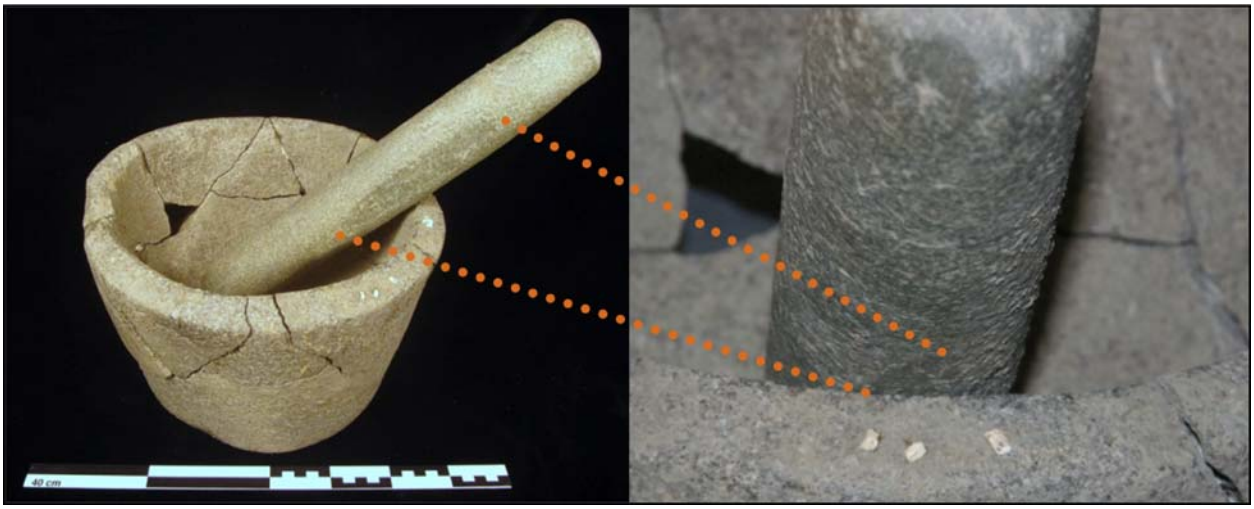

Figure 6: Pestle and mortar from Burial 1 (left) and close-up of ground medial shaft in contact with the beveled rim (right).

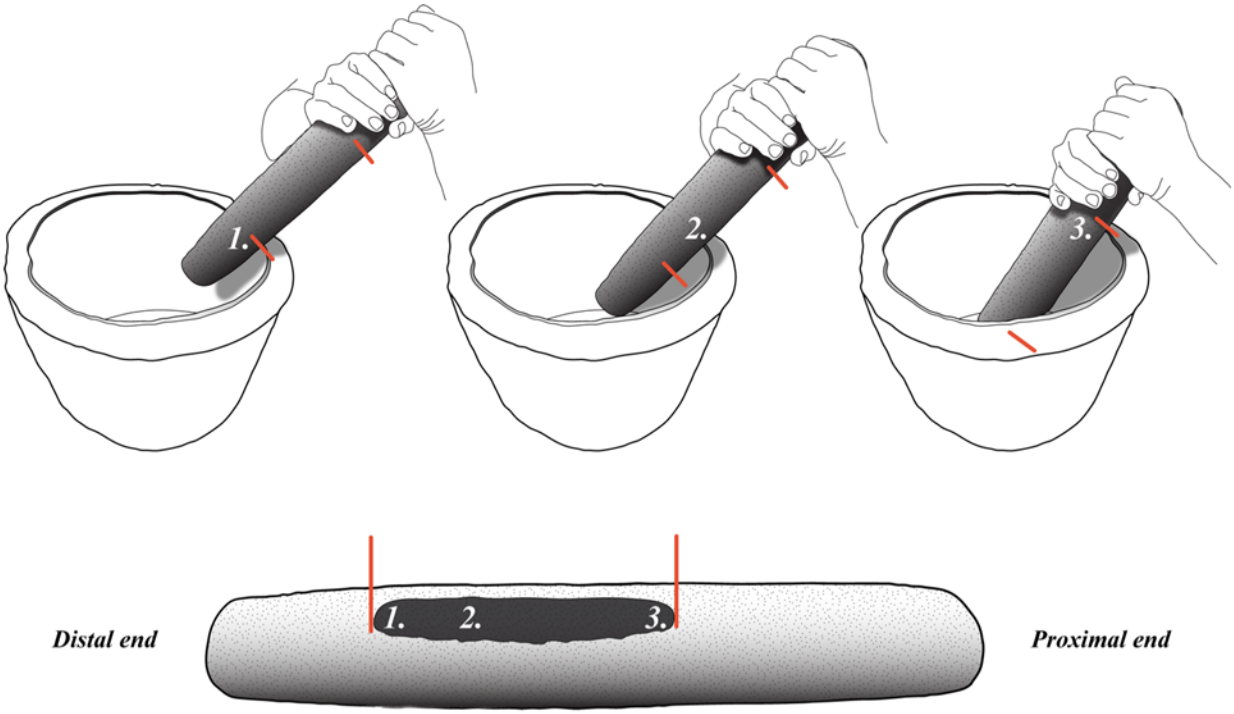

Figure 7: Sequence of a pestle down-stoke and corresponding medial shaft wear (dark gray area with limits demarcated by red lines) from contact with the bevel (shaded area on interior of rim) of a Type A mortar. Series begins at #1 (the distal limit of the shaft grinding) and terminates at #3 (the proximal limit of the grinding).

Pestles that are used with Type A mortars have medial grinding and polishing on the shaft that is oriented but not adjacent to the distal end (Figure 7). The depth of the show mortar corresponds with the length of the ground area on the shaft of the pestle. Although the interior rim bevels on Type A mortars may be a stylistic choice, they could be an intentional technological adaptation that increased the efficiency of pestle strokes. Four pestles with this mode of wear were recovered from Burials 27, 33, 41A, and 130 in Stratum II, while an additional two pestles with this wear type were recovered from Burials 7

and 23 in Stratum I. Strata I and II have occupation dates that correspond with the Late period (A.D. 1200 to 1720), which is characterized by Augustine-pattern cultural material that includes Stockton series projectile points, show mortars, Types M and K *Olivella* bead series, and "banjo"-type *Haliotis* ornaments (Estes et al. 2012:xxviii; Groza 2002). Archaeologists can infer that pestles with this pattern of wear are indicative of the Augustine pattern, because Type A mortars only occur in the Bay Area during the Late period (Beardsley 1948:17; Milliken et al. 2007:116, 212; Moratto 1984:262).

If this hypothesis is correct, then pestles with medial grinding and polishing on the shaft can be assigned to the Augustine pattern. This proposition needs to be tested by future researchers at other sites throughout central California.

SETTLEMENT ORGANIZATION

An examination of the flake and ground stone assemblage reveals evidence about the intensity and seasonality of the inhabitation at ALA-554. Although a complete landscape survey of the Amador Valley is necessary to make strong inferences about settlement patterns, the nature of salvage archaeology prevents such analysis. This study is confined in its attempt to interpret material from a single locale in order to help build a more holistic view of regional settlement strategies within the Amador Valley.

The presence of certain flake stone tools and material types can potentially indicate the mobility level of the occupants of ALA-554. Energy expended in tool production and raw material procurement correlates with types of settlement systems employed by prehistoric peoples (Andrefsky 1991; Kelly 1988; Parry and Kelly 1987). Settlement mobility models developed by lithic specialists predict that the flake stone assemblage at a sedentary village site with ample access to low-quality material will largely consist of less formalized or expedient tools (Andrefsky 1991, 2008:159; Parry and Kelly 1987). Thus, dominance of expedient flake tools and the early production of flakes from local material suggest that these tools were produced on site. Informal cores and tools are expected to occur at sites with higher degrees of sedentism, when raw material is readily available. This low-cost, high-waste method of production is consistent with the site assemblage. As a permanent village site, ALA-554 fits the model of increasing population density and resulting sedentism during the Late period in the Bay Area (Milliken et al. 2007:107).

The composition of the ground stone collection provides evidence that ALA-554 was a large occupation site that was inhabited year-round. Mortar-and-pestle technology is indicative of permanent or semipermanent settlements because these tools were utilized in the reduction of vegetal materials in quantities that necessitated storage (Bard et al. 1992:68). In addition, the size and weight of mortar bowls tend to prohibit high mobility. Six of the mortars at ALA-554 weighed over 23.0 kg (50.0 lbs.), which would prevent their use as portable items. The heaviest mortar in the collection, with a weight of 90.7 kg (approximately 200.0 lbs.) would require multiple individuals to move even a short distance. Mortar weights ranged between 13.7 and 90.7 kg, with a mean weight of 30.7 kg (67.5 lbs.). The large quantity of heavy mortar bowls would prevent high mobility of the ALA-554 population.

EXCHANGE

Analysis of flake and ground stone artifacts answers questions about the presence and nature of long-distance exchange at ALA-554. Source identification of foreign materials is crucial to the reconstruction of possible conveyance routes of wares within California. Local materials are those procured from a radius of less than 20.0 km because these goods could be obtained within a one-day round- trip on foot. Nonlocal resources are acquired from sources that are situated more than 20.0 km away from ALA-554. An examination of raw material selection and local versus nonlocal tool production helps answer the above questions related to trade routes and the nature of exchange.

The most striking patterns in the flaked stone assemblage are the different modes of production associated with two raw material resources; obsidian and cryptocrystalline silicate (CCS) material. Sources of CCS are locally available as a component of the geological Franciscan assemblage that bounds the

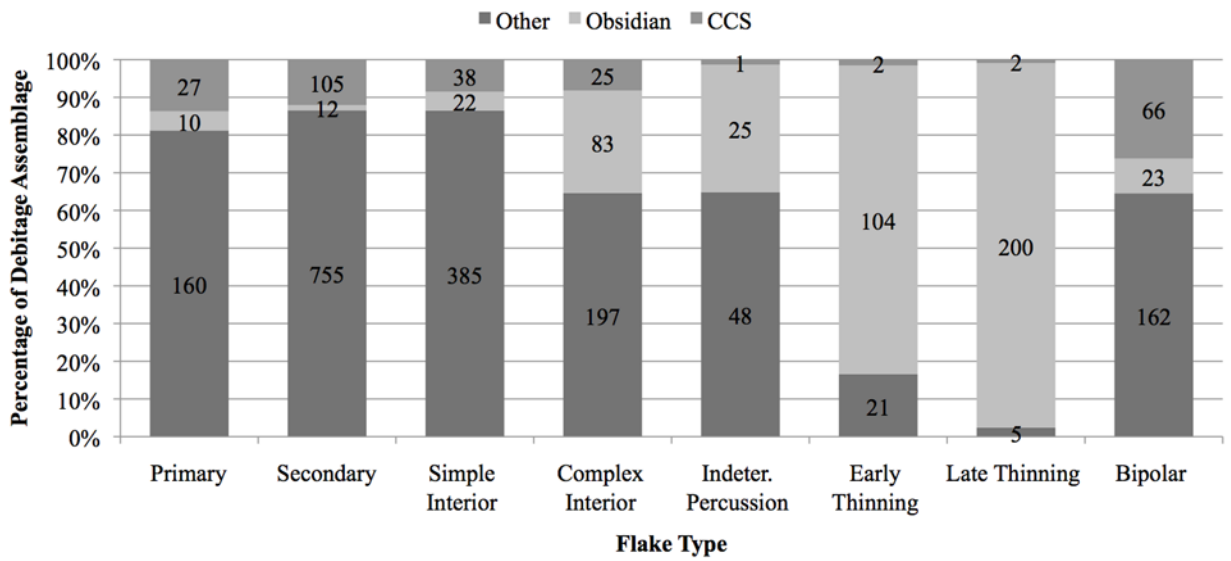

Figure 8: Percentage of flake types by raw material.

Amador Valley to the west, east, and south (Sloan 2006:222-223). Small pieces of CCS stone could be easily accessed in streambeds, uplifted deposits, and eroded watercourses throughout the valley (Odell 2003:2). The CCS collection from ALA-554 is composed of one biface, 47 flake tools, 27 cores, and 1,794 flakes. All of the cores recovered from the site are CCS angular and split cobbles. The absence of intensively exploited cores supports the assertion that CCS was not scarce within the Amador Valley. The majority of flake tools are made of CCS; in addition, simple flake tools outnumber modified flake tools. The use of early-stage flake types for all flake tools indicates that these tools were being produced on site. Sixty-seven percent of flakes from all strata are characterized as early-stage CCS debitage.

Obsidian artifacts – the most easily recognized nonlocal resource at ALA-554 – exhibit a different technological manufacture pattern than the CCS sample. The 692 obsidian artifacts consist of 106 bifaces, 21 flake tools, 565 flakes, and no cores. Unless general practice was to completely exhaust obsidian cores, it seems likely that obsidian was brought to the site primarily in the form of preform blanks that were finished or retouched on site. Although the majority of flake tools are CCS, the presence of obsidian flake tools indicates use of debris from biface reduction. Flakes may have been reworked in order to maximize exploitation of a scarce resource. The obsidian debitage assemblage is skewed towards the later stages of biface manufacture (Figure 8). The sparseness of percussion obsidian flakes and the prevalence of obsidian pressure flakes suggest that preforms were imported into the site. Final stage four and five shaping and reworking of bifaces occurred at the village.

A sample of obsidian artifacts, including 10 bifaces, one flake tool, and four pieces of debitage, was submitted to the Geochemical Research Laboratory for XRF testing in order to identify the source of these materials. Twelve of the samples had chemical signatures that matched the Napa Valley source near the modern town of Saint Helena. One biface and one flake originated from the Annadel source located 15.0 km southwest of the Napa Valley source. One piece of debitage was derived from the Bodie Hills source to the east, in the Sierra Nevada mountains.

Previous research on the technological organization of obsidian use in the Amador Valley indicates common patterns wherein Napa Valley preform cores were imported into the Amador Valley to produce small projectile points (Bieling 1997; Bieling and Psota 1997; Jackson and Schultz 1975). Because no obsidian cores were recovered during the 2011 fieldwork at ALA-554, it was not possible to adequately test this analytical model. However, there are two trends that were observed in the analysis of obsidian use at ALA-554 that support this conclusion: a reduction trajectory marked by a high quantity of late-manufacture

Table 1. Summary of obsidian hydration and XRF results from the 2002 and 2011 excavations at ALA-554.

Period	Dating Scheme D2 (Groza 2002)	North Bay Sources				Eastern Sierra Sources		Total
		Napa Valley			Annadel	Bodie Hills	Lookout Mtn.	
		Band 1	Band 2	Band 3				
Historic	A.D. 1720	8	--	1	1	--	1	11
Late 2	A.D. 1550	3	1	--	--	--	--	4
Late 1	A.D. 1200	9	1	--	2	--	--	12
Middle Late Transition	A.D. 1000	4	--	--	1	1	--	6
Middle 4	A.D. 800	2	--	--	--	--	--	2
Middle 3	A.D. 600	--	--	--	--	--	--	--
Middle 2	A.D. 450	--	--	--	--	--	--	--
Middle 1	210 B.C.	2	--	--	--	1	--	3
Early Middle Transition	500 B.C.	--	--	--	--	--	1	1
Early	1500 B.C.	--	--	--	--	--	--	--
Archaic	3000 B.C.	--	--	--	--	--	--	--
Total		28	2	1	4	2	2	39

Table 2. Flake stone assemblages from sites within the Amador Valley, by tool category and material type.

Category	Material	ALA-554	ALA-554 (2002)	ALA-613/H	ALA-555	ALA-42	ALA-483	ALA-483/ext.	Total
Bifaces	CCS	1	1	9	2	1	10	1	25
	Obsidian	106	20	139	133	17	15	9	437
	Other	--	--	1	--	--	--	--	1
	Total	*107*	*21*	*149*	*135*	*18*	*25*	*10*	*463*
Flake tools	CCS	47	20	28	19	6	5	3	123
	Obsidian	21	15	11	88	--	--	1	136
	Other	1	5	4	6	--	1	--	17
	Total	*69*	*40*	*43*	*113*	*6*	*6*	*4*	*276*
Cores	CCS	27	6	56	19	12	16	9	157
	Obsidian	--	6	11	6	--	--	14	37
	Other	1	1	1	5	--	3	--	11
	Total	*28*	*13*	*68*	*30*	*12*	*19*	*23*	*205*
Debitage	CCS	1794	854	828	207	347	18	9	4217
	Obsidian	565	145	1942	759	62	44	14	3451
	Other	329	132	229	98	7	48	--	827
	Total	*2688*	*1131*	*2999*	*1064*	*416*	*110*	*23*	*8495*
Grand Total		*2892*	*1205*	*3259*	*1342*	*452*	*160*	*60*	*9439*

pressure flakes (refer to Figure 8), and an increased frequency of obsidian from Napa Valley occurring at the site in the place of obsidian from eastern Sierra sources (Table 1).

Patterns of obsidian use at ALA-554 build on previous analyses of obsidian assemblages from ALA-42 (Bieling 1997), ALA-613/H (Price et al. 2005), and earlier testing conducted at ALA-554 (Price et al. 2002). Small, serrated points dominate the biface collections at all these sites. In addition, the low occurrence of obsidian cores and flake tools indicate that obsidian was traded with the intent of biface production (Table 2). At ALA-42, ALA-613/H, and ALA-554, the majority of CCS flakes are early reduction, while late reduction flakes are principally obsidian (Price et al. 2002:56, 2005:149). Prehistoric inhabitants of these sites conducted late-stage manufacture or reworking of imported blanks or nearly finished obsidian bifaces.

Obsidian was traded into the Pleasanton area from the east and north. Eastern Sierra obsidian originated from the Bodie Hills, Casa Diablo, Lookout Mountain, and Mount Hicks sources. These sources were utilized more frequently from the Archaic to Middle period (3000 B.C. to A.D. 1200) in the Amador Valley (Bieling 1997:76; Groza 2002). Napa Valley obsidian, including Annadel, Napa Valley, and Borax Lake sources, was traded into the Pleasanton area from as early as the Archaic period. The beginning of

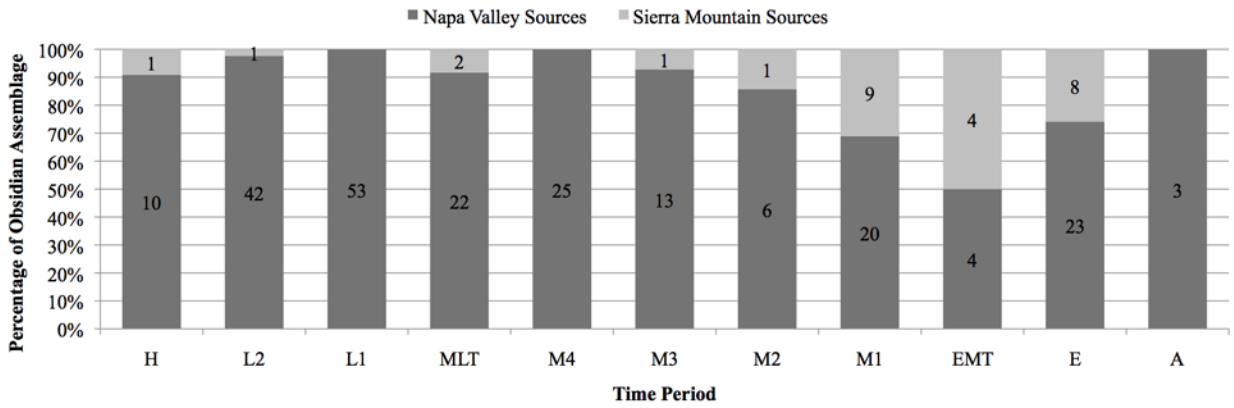

Figure 9: Diachronic change in obsidian source procurement within the Amador Valley (CA-ALA-42, CA-ALA-483, CA-ALA-483/ext., CA-ALA-554, CA-ALA-555, and CA-ALA-613/H).

the Late period is marked by a dramatic increase in the number of obsidian flakes being brought from Napa Valley into the East Bay (Milliken et al. 2007:117).

Seventy-five percent of the obsidian from eastern sources at ALA-554 dated to or before the MLT period (Table 1). One Lookout Mountain flake was dated to A.D. 1822, but this hydration date may be the result of post-occupation damage. The shift to almost exclusively Napa Valley sources during the Late period has been identified at ALA-42, ALA-483, ALA-483/ext., ALA-555, and ALA-613/H (Bieling 1996:142; Price et al. 2005:149). Table 2 summarizes the results of hydration by source for all available hydration samples from ALA-42, ALA-483, ALA-483/ext., ALA-554, ALA-555, and ALA-613/H (Bieling 1996:142, 1997:80; Price et al. 2002:109, 2005:355). Ninety-three percent of all Sierra sources (n = 25) date to or before the MLT period, with only 3.5 percent (n = 1) dating to the Late period, and 3.5 percent (n = 1) dating to the Historic period. Although obsidian from the Napa Valley is present throughout the prehistoric occupation of the Amador Valley, Sierra obsidian is most common during the Early to Middle 1 period. Figure 9 clearly indicates that the frequency of Sierra obsidian dropped significantly by the Middle 4 period (A.D. 800 to 1000) (Groza 2002)

Table 3 illustrates the Late-period increase in exchange of Napa Valley obsidian to the Pleasanton area. One hundred and eighteen Napa Valley sourced obsidian samples from ALA-42, ALA-483, ALA-483/ext., ALA-554, ALA-555, and ALA-613/H date to before the Late period, while only 105 Napa obsidian samples date after A.D. 1200. The roughly equivalent quantity of Napa samples prior and subsequent to the onset of the Late period is deceptive because the younger samples occurred over a 600-year period, while the older samples were quarried and traded over 9,000 years, a time span almost 15 times longer than that of the younger samples. The distinct boost in intensity and volume of obsidian acquired through long-distance trade during the Late period is probably connected to growing populations and the increased complexity of trade networks in the Amador Valley.

The presence of ground stone artifacts fashioned from nonlocal materials indicates that the residents of ALA-554 engaged in complicated trade networks, which were a characteristic of the Augustine pattern (Milliken et al. 2007:211). Two black cylindrical steatite pipes were discovered at ALA-554. Prehistoric pipe manufacturers preferred steatite because the material possesses superior heat-tolerance qualities (Heizer and Treganza 1944:306). The nearest known steatite source documented as being quarried by native Californians is located near present-day Cloverdale, 200 km northwest of the site (Gifford and Kroeber 1937:179) (Figure 10). The pipes at the site were likely exchanged through long-distance trade networks.

During the Late period 2, ornaments made of magnesite became valuable items that were exchanged throughout central California (Bennyhoff 1994c:66; Heizer 1978:311). According to Heizer and Treganza (1944), the Southeastern Pomo controlled two magnesite quarries near Clear Lake that

Table 3. Hydration dates by source for sites within the Amador Valley (ALA-42, ALA-483, ALA-483/ext., ALA-554, ALA-555, and ALA-613/H).

	North Bay Sources			Eastern Sierra Sources				
Period	Napa Valley	Annadel	Borax Lake	Bodie Hills	Casa Diablo	Lookout Mtn.	Mt. Hicks	Total
Historic	10	--	--	--	--	1	--	11
Late 2	38	4	--	1	--	--	--	43
Late 1	47	6	--	--	--	--	--	53
Middle Late Transition	21	1	--	2	--	--	--	24
Middle 4	23	2	--	--	--	--	--	25
Middle 3	11	1	1	--	1	--	--	14
Middle 2	6	--	--	1	--	--	--	7
Middle 1	20	--	--	3	4	1	1	29
Early Middle Transition	4	--	--	1	1	2	--	8
Early	21	--	2	4	2	2	--	31
Archaic	5	--	--	--	--	--	--	5
Total	206	14	3	12	8	6	1	250

supplied all of central California (Figure 11). Five magnesite ornaments were recovered in Burial 166, and one in Burial 167. The conical shape of these chalky grayish-green ornaments is unconventional because magnesite beads are typically tubular or disk-shaped. Heizer and Treganza (1944:335) assert that every tribe within a 250-km radius of Clear Lake held magnesite ornaments in high regard. Since ALA-554 was located 185 km south of the magnesite source, the inhabitants of the site probably prized the beads that were conveyed to the East Bay through long-distance trade routes.

MORTUARY PRACTICES

One hundred and eighty-seven burials were recovered from an area that represents less than 10 percent of the total recorded site, which indicates that at its zenith of residents during the first half of the Late period ALA-554 was one of the most densely populated villages in the Amador Valley. Burial-associated flake and ground stone artifacts provide insight into the relationships between mortuary treatments and demographics, such as sex and age; however, the following assertions are tentative because of the limited sample size.

Although the sample of bifaces associated with burials is small, several possible patterns associated with specific demographics are apparent. Eight Stockton series projectile points (32 percent), six Stockton Expanded Stem projectile points (24 percent), two semi-serrated bifaces (8 percent), four large bipoint bifaces (16 percent), and five indeterminate biface fragments (20 percent) were intentionally placed with an individual upon internment. Eleven males and two females were buried with bifaces; it follows that males were more likely than females to have bifaces as grave goods at ALA-554 (Table 4). Although middle adults represent the largest portion of burials at the site (n = 46, 24.6 percent), projectile points were most frequent in the burials of adolescents and young middle adults. Bifacial grave goods may be indicative of the living activities of deceased individuals at ALA-554. The prevalence of projectile points in the graves of young adult males suggests that these individuals may have been hunters and/or warriors.

In the Bay Area, large populations and a greater number of settlements are signatures of the Augustine pattern. Increased social complexity and hierarchical social stratification are reflected in variations in grave goods (Fredrickson 1973:128). The frequency of unique artifacts rose in high-status burials and cremations during this time (Fredrickson 1993). The Augustine-pattern mortuary practice of cremation and pre-interment artifact burning was reserved for persons of high status at ALA-554 (Moratto 1984:211). Social differentiation is indicated by the presence of wealth items in burials, which are defined by the quantity or uniqueness of burial-associated artifacts (Hylkema 2002; Milliken and Bennyhoff 1993; Wiberg 1997). For example, large numbers of shell beads or “banjo” *Haliotis* pendants mark

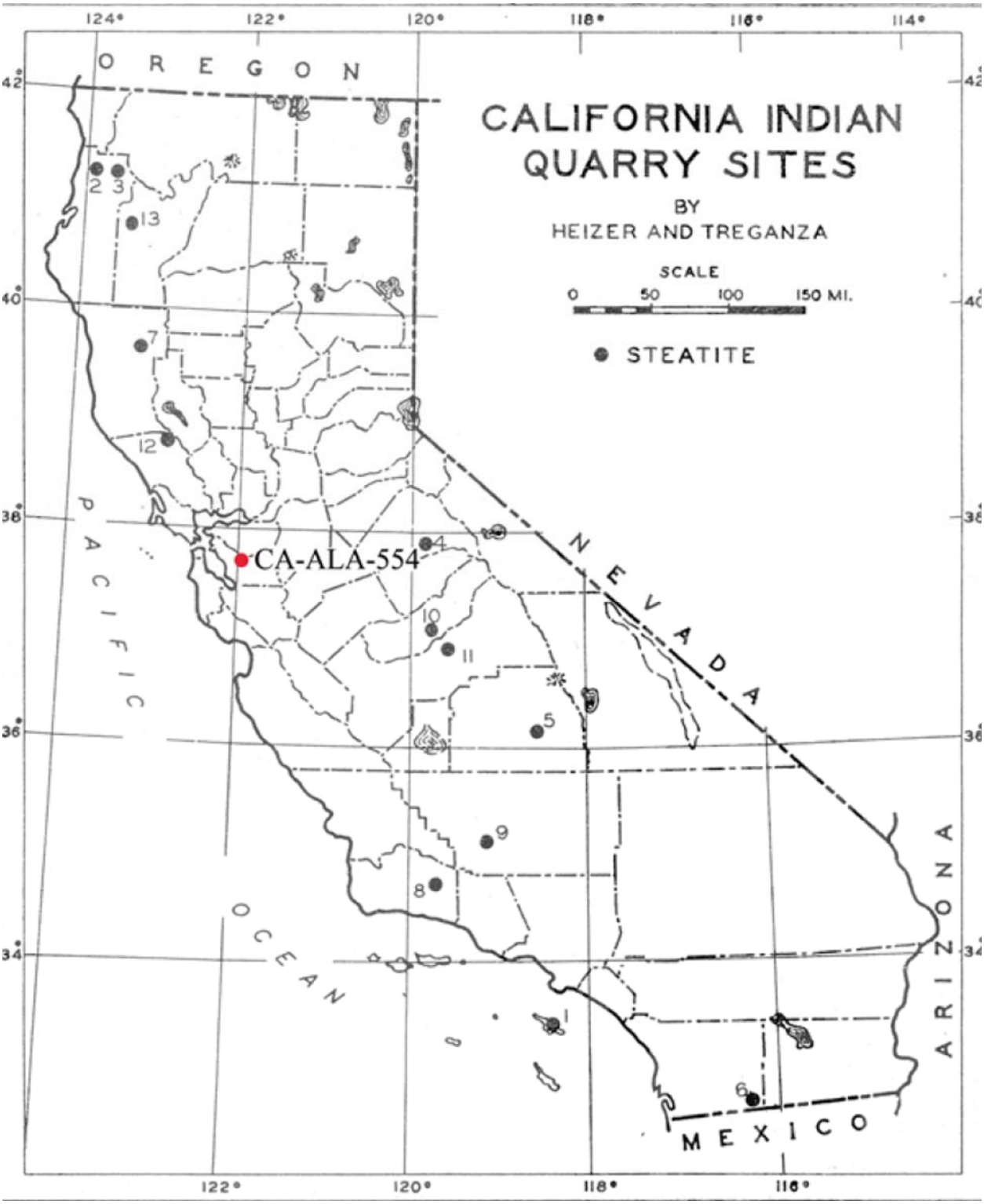

Figure 10: Documented prehistoric steatite quarries in California (Heizer and Treganza 1944:316).

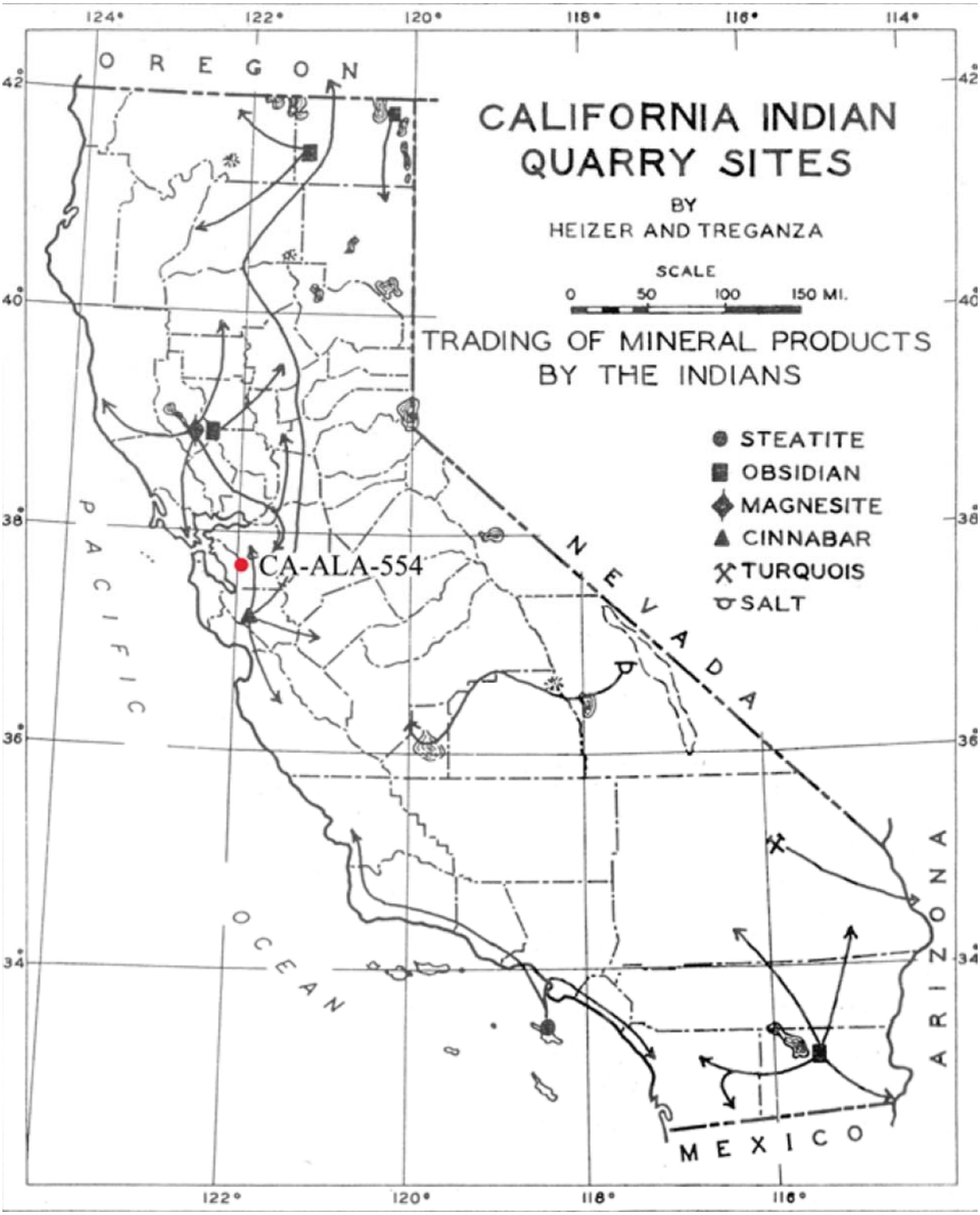

Figure 11: Routes of magnesite conveyance (Heizer and Treganza 1944:322).

Table 4. Burial-associated bifaces, by age and sex at ALA-554.

AGE	MALE	FEMALE	INDETERMINATE	TOTAL
Adolescent	--	--	6	6
Young adult	--	--	--	--
Young middle adult	19	2	--	21
Middle adult	4	--	--	4
Mature adult	1	--	--	1
Cremation	--	--	7	7
Total	24	2	13	39

membership in a prestigious regional ceremonial system throughout the East Bay (Chartkoff and Chartkoff 1984; Frederickson 1974; Leventhal 1993; Milliken et al. 2007).

At ALA-554, two intentional cremations, Burial 88 and Burial 149, possessed wealth items indicative of the presence of ceremonial or social demarcation. The sample is small, but these two cremations had an average of 3.5 points per burial, in comparison to the 2.6 biface average in non-cremated burials. In general, cremations contained rare artifacts and/or a large number of shell beads. Burial 149 contained a total of 1,344 mostly type A, type M, and spire-lopped *Olivella* beads, two Stockton series points, two obsidian projectile point fragments, and a phallic steatite pipe (Blake and Minturn 2012:310). The cremation matrix of Burial 88 included three obsidian biface fragments, 328 M series beads, six A series beads, one C series bead, five B series beads, and two "banjo" *Haliotis* pendants (Blake and Minturn 2012:229). The data from these burials are consistent with other evidence from central California that suggests cremations were reserved for high-status people buried with the most costly grave offerings. This Late-period development may be connected with familial wealth, ceremonial practices, or elevated status associated with a more hierarchical society.

Wealth goods are also indicators of surplus, craft specialization, and increased time dedicated to the production of nonutilitarian objects (Milliken et al. 2007:112-116). These artifacts are valuable because their production is energy- and time-intensive. Show mortars may have been the most expensive grave good at ALA-554. Twenty-eight percent of the mortars are made from nonlocal tuff, rhyolitic tuff, or vesicular basalt (n = 9). The igneous rock employed as mortars probably derives from Mount Diablo (Taff 1935:1085). The transport of these mortar bowls 30.0 km south to ALA-554 would have been a time- and labor-intensive process, because the average weight of these mortars is 28.0 kg (61.8 lbs). This long-distance quarrying is analogous to the pattern observed at MRN-232, where 20 vesicular basalt mortars that weighed between 9.1 kg (20.0 lbs) and 56.7 kg (125.0 lbs) were transported from a source quarry 40.0 km away from the site (Heizer and Treganza 1944:299).

Transportation is a less significant cost compared to the amount of time invested in shaping the bowls (Beardsley 1954:31). Alan Leventhal and George Seitz (1989:156-165) replicated a mortar from MNT-185/H, a Late-period site on the central California coast, wherein the researchers spent 17.2 hours pecking a 5.0 cm diameter basin in a granodiorite boulder. Richard Osborn and Joan Schneider conducted a similar experiment with a sandstone boulder. It took them 12.75 hours to peck a basin with a 215.0 cm^3 volume with a basalt hammer stone (Osborn and Schneider 1996:36). In both studies, the most time-consuming process was pecking during the final stages of production (Leventhal 1993:226; Osborn and Schneider 1996:36).

A WSA lithic specialist derived a formula to investigate the amount of time invested in the production of a sample of mortar bowls from ALA-554. Based on Osborn and Schneider's experimental data, 12.75 hours to peck a 215.0 cm^3 basin, a simplified pecking reduction rate was calculated to be 0.0593 hours/cm^3 of removed material. Therefore, the formula was as follows: $Y = 0.0593 X$, where X was the basin volume in cm^3 and Y was the total number of hours spent pecking (Table 5). Differences in material type, toolmaker variation, and reduction techniques were not taken into account. The formula was based solely on basin manufacture and did not address any exterior shaping. It yielded results that demonstrate that the

Table 5. Estimated manufacture times of Type A mortar bowl basins at ALA-554.

Catalog Number	Material	Basin Diameter (cm)	Basin Depth (cm)	Volume (cm^3)*	Production Hours
B114-G1	Rhyolitic tuff	23.2	12.0	3699	219.4
B1-G4	Diabase	24.0	13.0	4100	243.1
B10-G1	Diabase	27.0	18.0	6,565	389.3
B155-G1	Diabase	33.7	12.1	9049	539.3
B118-G1	Diabase	36.0	14.0	10,173	603.3
B41A-G2	Vesicular basalt	17.0	18.0	12,835	761.1
B139-G1	Rhyolitic tuff	39.0	18.0	14,698	871.2

* Volume measurements are courtesy of Tammy Buonasera, a Ph.D. candidate at the University of Arizona.

Table 6. Killed burial-associated mortars, by sex and age at ALA-554.

Sex	Killed?	Child	Adolescent	Young Adult	Young Middle Adult	Middle Adult	Mature Adult	Indeter-minate	Total
Female	Killed	--	--	2	2	2	5	--	11
	Possibly killed	--	--	2	--	2	--	--	4
	Not killed	--	--	--	--	--	1	--	1
Male	Killed	--	--	--	3	--	1	--	4
	Possibly killed	--	--	--	--	3	--	--	3
	Not killed	--	--	2	--	--	--	--	2
Indeter-minate	Killed	1	1	--	--	--	--	--	2
	Possibly killed	--	1	1	--	--	--	--	2
	Not killed	3	--	--	--	--	--	3	6
Total		4	2	7	5	7	7	3	35

mortars recovered from ALA-554 were extremely time-intensive to produce, since the smallest basin took at least 219.4 hours to peck, and the largest basin may have taken 871.2 hours to peck.

Destruction and deposition of high-value artifacts within graves is a well-documented pattern in the Bay Area (Bennyhoff 1994a; Milliken et al. 2007:94). Unique and valuable artifacts were "killed" and deposited with their owner through manual fracturing or deliberate heat treatment (Gifford and Kroeber 1937; Latta 1949). Damaging artifacts may have created a symbolic division between the living and the dead, wherein the belongings of an individual traveled with the latter in the spirit realm (Parker 2000:26). The destruction of valuable mortars could indicate that a buried person had an elevated status or possessed a great amount of wealth. Half of all burial mortars were damaged, with show mortars most frequently killed. Young adults and mature adults had the most killed mortars, and females had more deliberately broken mortars than males (Table 6).

An examination of the types of ground stone artifacts present in burials indicates what activities prehistoric peoples engaged in during their lives (Table 7). At ALA-554, grave goods are 44 percent mortars, 37 percent pestles, 6 percent charmstones, 9 percent ornaments, and 2 percent pipes. Females had the majority of all burial-associated ground stone artifacts (44 percent), with only 20 percent recovered from male burials and 36 percent from burials of persons of indeterminate sex. Females had twice as many mortars, pestles, and charmstones, in contrast to the greater number of projectile points and pipes placed in male burials.

The largest quantities of mortars and pestles were found in female young adult, young middle adult, middle adult, and mature adult burials. It is possible that a female wealth was displayed through the quantity of owned ground stone artifacts. Mature females could have possessed great status or wealth because of the large number of mortars and pestles interred with this group compared to any other age or sex group. As females aged, they may have acquired or manufactured more mortars over their lifetime, therefore gaining wealth and high standing.

Two burial associated stone pipes were discovered at ALA-554: Burial 47 (a middle adult male) contained a sandstone pipe, and Burial 149 (a cremation) ensconced a steatite pipe. These individuals may

Table 7. Diagnostic burial-associated ground stone artifacts, by sex and age at ALA-554.

Sex	Age	Mortars	Pestles	Charmstones	Ornaments	Pipes	Total
Male	Child	--	--	--	--	--	--
	Adolescent	--	--	--	--	--	--
	Young adult	4	1	--	--	--	5
	Young middle adult	3	3	1	--	--	7
	Middle adult	4	5	--	--	--	9
	Mature adult	6	7	1	--	--	14
Male Total		*17*	*16*	*2*	--	--	*35*
Female	Child	--	--	--	--	--	--
	Adolescent	--	--	--	--	--	--
	Young adult	2	--	--	--	--	2
	Young middle adult	3	2	--	1	--	6
	Middle adult	3	2	--	--	1	6
	Mature adult	1	1	--	--	--	2
Female Total		*9*	*5*	*--*	*1*	*1*	*16*
Grand Total		*26*	*21*	*2*	*1*	*1*	*52*

have been involved in ceremonial practices that involved the smoking of tobacco. Bennyhoff (1994c:66) asserts that one of the basic traits of the Augustine pattern is a male-dominated shamanistic religion that utilized smoking pipes. The UC Davis Archaeological Metabolomics Group utilized Gas Chromatography-Time of Flight/Mass Spectrometry (GC/MS) techniques to test these stone pipes for psychoactive alkaloids derived from plants that were commonly smoked. The steatite pipe from Burial 149 and the bowl of the sandstone pipe from Burial 47 tested positive for the biomarker of nicotine, which indicates that these artifacts were unequivocally used for smoking tobacco (Eerkens et al. 2012).

CONCLUSIONS

Chronology

Absolute dates and temporally diagnostic artifacts from the flaked and ground stone assemblage – Stockton projectile points, piled plummet charmstones, magnesite beads, stone pipes, show mortars, and hopper mortars – corroborate an Augustine-pattern chronological scheme at ALA-554. The site was initially inhabited during the late MLT, ca. A.D. 1000, with the largest occupation during the early Late period and a terminal phase around A.D. 1650.

Settlement Patterns

ALA-554 was a large village inhabited year-round, as evidenced by the prevalence of informal flake tools made from local materials. The presence of a large quantity of mortar bowls and pestles that are capable of producing surplus food that necessitates storage indicates that the prehistoric occupants of ALA-554 practiced low mobility.

Exchange

Obsidian, steatite, and magnesite artifacts support the notion that the inhabitants of ALA-554 engaged in long-distance exchange. The results of XRF analysis indicate that the majority of all obsidian was imported as preforms from the Napa Valley source. Although most of the obsidian came from the north, XRF testing indicates that there was some interaction with peoples who controlled obsidian in the Sierra Nevada mountains. Magnesite beads and steatite pipes provide additional lines of evidence that support the existence of complex trade networks that linked the northern and eastern Bay Area.

Burial Practices

Less than 10 percent of the site was excavated during data recovery; thus the following assertions that link grave goods with social status and demographics are speculative. Within this limited sample, patterns in burial assemblages emerge that may reflect differences in social stratification, sex, and/or age. Vegetal processing tools were most often found interred with females, with older females tending to have the greatest quantity of mortars and pestles. It follows that females were responsible for food production and that their wealth may have been expressed through valuable mortar bowls. Males were typically buried with the greatest quantities of projectile points and stone pipes, which may speak to their roles as hunters, warriors, and/or shamans. During the Augustine cultural pattern, ground stone pipes were commonly utilized in ceremonial activities that involved smoking, which supports a view of males as ritual specialists.

ACKNOWLEDGEMENTS

I would like to thank the Garibay family for their support of WSA's data recovery and research. Special thanks are due to Dr. Allen Estes and Dr. James Allan for their guidance during the development of this presentation and paper. Thanks are given to Angela Turner for assistance in analysis of the flaked and ground stone artifacts. Dr. Eric Wohlgemuth (Far Western), Dr. Jelmer Eerkens (UC Davis), and Tammy Buonasera are owed credit for their microbiology, nicotine, and mortar volume data. The WSA field crew of Doug Alexander, Mary Alexander, Drew Bailey, Jennifer Blake, David Buckley, Carter Duvall, Kathleen Kabal, Lacy Kalber, Jennifer Lippel, Penny Minturn, Rhea Sanchez, Jeff Schaeffer, Chris Simon, Angela Turner, Brenna Wheelis, and Thomas Young are recognized for their superb work.

REFERENCES CITED

Andrefsky William, Jr.

1991 Inferring Trends in Prehistoric Settlement Behavior: Lithic Production Technology in the Southern Plains. *North American Archaeology* 12(2):129-144.

2008 *Lithic Technology: Measures of Production, Use and Curation*. Cambridge University Press, Cambridge, UK.

Bard, James C., Colin I. Busby, Michael R. Fong, Robert M. Harmon, Melody E. Tannam, Donna M. Garaventa, Angela M. Banet, Sondra A. Jarvis, Steven J. Rossa, and Rambir S. Sidhu

1992 *Archaeological Site Testing Report: CA-ALA-483, Laguna Oaks Project, Pleasanton, Alameda County, California*. Report to the City of Pleasanton Planning Department and the DeSilva Group, Pleasanton, California, from Basin Research Associates, San Leandro, California.

Beardsley, Richard K.

1948 Cultural Sequences in Central California Archaeology. *American Antiquity* 14:1–28.

1954 *Temporal and Areal Relationships in Central California Archaeology, Parts I and II.* University of California Archaeological Survey Reports No. 24 and 25. University of California, Berkeley.

Bennyhoff, James A.

1968 A Delta Intrusion to the Bay in the Late Middle Period in Central California. Paper presented at the 2nd Annual Meeting of the Society for California Archaeology, San Diego.

1994a Central California Augustine: Implications for Northern California Archaeology. In *Toward a New Taxonomic Framework for Central California Archaeology: Essays by James A. Bennyhoff and David A. Fredrickson*, edited by Richard E. Hughes, pp. 65-74. Contributions of the University of California Archaeological Research Facility No. 52. Berkeley.

1994b Variation within the Meganos Culture. In *Toward a New Taxonomic Framework for Central California Archaeology: Essays by James A. Bennyhoff and David A. Fredrickson*, edited by

Richard E. Hughes, pp. 81-92. Contributions of the University of California Archaeological Research Facility No. 52. Berkeley.

1994c A Delta Intrusion to the Bay in the Late Middle Period in Central California. In *Toward a New Taxonomic Framework for Central California Archaeology: Essays by James A. Bennyhoff and David A. Fredrickson*, edited by Richard E. Hughes, pp. 7-14. Contributions of the University of California Archaeological Research Facility No. 52. Berkeley.

Bennyhoff, James A., and Richard E. Hughes

1987 Shell Bead and Ornament Exchange Networks between California and the Western Great Basin. *Anthropological Papers of the American Museum of Natural History* 64:79-175.

Bieling, David G.

1996 Obsidian Studies. In *Archaeological Excavations and Burial Removal at Sites CA-ALA-483, CA-ALA-483 Extensions, and CA-ALA-555, Alameda County, California*, edited by Randy S. Wiberg, pp. 119-160. Coyote Press, Salinas, California.

1997 Obsidian Studies at CA-ALA-42. In *Archaeological Investigations at Site CA-ALA-42, Alameda County, California: Final Report*, edited by Randy S. Wiberg, pp. 67-81. Coyote Press, Salinas, California.

Bieling, David G., and Sunshine Psota

1997 Obsidian Studies at CA-ALA-42. The Web Pages of Bieling & Psota, Archaeological Consultants, Sonoma, California. Electronic document, http://www.sonic.net/~dbieling/ala42.html, accessed 8 June 2011.

Blake, Jennifer and Penny Minturn

2012 *Report on Archaeological Data Recovery at CA-ALA-554, Pleasanton, California, Volume II: Human Osteology*. Edited by Allen Estes, Melanie Medeiros, and James Allan. William Self Associates, Orinda, California. Submitted to Property Development Centers and Safeway, Inc.

Chartkoff, Joseph L., and Kerry K. Chartkoff

1984 *The Archaeology of California*. Stanford University Press, Stanford, California.

Eerkens, Jelmer, Shannon Tushingham, Kari Lentz, Jennifer Blake, Dominique Ardura, Mine Palazoglu, and Oliver Fiehn

2012 GC/MS Analysis of Residues Reveals Nicotine in Two Late Prehistoric Pipes from CA-ALA-554. *Proceedings of the Society for California Archaeology* 26.

Elsasser, Albert B., and Peter T. Rhode

1996 *Further Notes on California Charmstones*. Coyote Press Archives of California Prehistory No. 38. Salinas, California.

Estes, Allen, David Buckley, Kari Lentz, Rhea Sanchez, Brenna Wheelis, Eric Wohlgemuth, Jennifer Blake, Paul Farnsworth, Heather Price, Aimee Arrigoni, Nazih Fino, and Thomas Young.

2012 *Report on Archaeological Data Recovery at CA-ALA-554, Pleasanton, California, Volume I: Data Recovery*. Edited by Allen Estes, Melanie Medeiros, and James Allan. William Self Associates, Orinda, California. Submitted to Property Development Centers and Safeway, Inc.

Fredrickson, David A.

1973 Early Cultures of the North Coast Ranges, California. Unpublished Ph.D. dissertation, Department of Anthropology, University of California, Davis.

1974 Cultural Diversity in Early Central California: A View from the North Coast Ranges. *Journal of California Anthropology* 1:41-53.

1993 Archaeological Taxonomy in Central California Reconsidered. In *Toward a New Taxonomic Framework for Central California Archaeology: Essays by James A. Bennyhoff and David A. Fredrickson*, edited by Richard E. Hughes, pp. 90-103. Contributions of the University of California Archaeological Research Facility No. 52. Berkeley.

Gifford, Edward W., and Alfred L. Kroeber

1937 Culture Element Distributions: IV Pomo. *University of California Publications in American*

Archaeology and Ethnology 37:117-253. Berkeley.

Groza, Randy G.
2002 An AMS Chronology for Central California *Olivella* Shell Beads. Unpublished Master's thesis, Department of Anthropology, California State University, San Francisco.

Heizer, Robert F.
1978 Introduction. In *California*, edited by Robert F. Heizer, pp. 1-5. Handbook of North American Indians, Vol. 8, William C. Sturtevant, general editor. Smithsonian Institution, Washington, D.C.

Heizer, Robert F., and Adam E. Treganza
1944 Mines and Quarries of the Indians of California. *California Journal of Mines and Geology* 40(3):291-359.

Hylkema, Mark G.
2002 Tidal Marsh, Oak Woodlands, and Cultural Florescence in the Southern San Francisco Bay Region. In *Catalysts to Complexity: Late Holocene Societies of the California Coast*, edited by Jon M. Erlandson and Terry L. Jones, pp. 233-262. Perspectives in California Archaeology No. 6. Cotsen Institute of Archaeology, University of California, Los Angeles.

Jackson, Thomas L., and Peter D. Schultz
1975 Typology, Trade, and Trace Analysis: A Test of Local Manufacture of Sacramento Valley Obsidian Tools. *Journal of New World Archaeology* 1(2):1-8.

Justice, Noel D.
2002 *Stone Age Spear and Arrow Points of California and the Great Basin*. Indiana University Press, Bloomington.

Kelly, Robert L.
1988 Three Sides of a Biface. *American Antiquity* 53:714-734.

Latta, Frank F.
1949 *Handbook of Yokuts Indians*. Bear State Books, Oildale, California.

Leventhal, Alan M.
1993 A Reinterpretation of Some Bay Area Shell Mounds: A View from the Mortuary Complex, ALA-329. Unpublished Master's thesis, Department of Social Sciences, San Jose State University, San Jose, California.

Leventhal, Alan M., and George Seitz
1989 Flaked and Ground/Battered Stone, and Experimental Archaeology: Mortar Replication Study, Description, and Analysis. In *Results of the General Development Plan Archaeological Test Excavation Conducted at CA-MNT-185/H*, pp. 141-151. Report on file, Northwest Information Center, Sonoma State University, Rohnert Park, California.

Milliken, Randall T., and James A. Bennyhoff
1993 Temporal Changes in Beads as Prehistoric California Grave Goods. In *There Grows a Green Tree: Papers in Honor of David A. Fredrickson*, edited by Greg White, Pat Mikkelson, William Hildebrandt, and Mark Basgall, pp. 381-395. Center for Archaeological Research at Davis, University of California, Davis.

Milliken, Randall T., Richard T. Fitzgerald, Mark G. Hylkema, Randy Groza, Tom Origer, David G. Bieling, Alan M. Leventhal, Randy S. Wiberg, Andrew Gottsfield, Donna Gillete, Viviana Bellifemine, Eric Strother, Robert Cartier, and David A. Fredrickson
2007 Punctuated Culture Change in the San Francisco Bay Area. In *California Prehistory: Colonization, Culture, and Complexity*, edited by Terry L. Jones and Kathryn A. Klar, pp. 99-123. Altamira Press, Lanham, Maryland.

Moratto, Michael J.
1984 *California Archaeology*. Academic Press, Orlando, Florida.

Odell, George H.
2003 *Lithic Analysis*. Springer Science Business Media, New York.

Osborne, Richard H., and Joan S. Schneider
1996 A Model for the Production of Portable Stone Mortars and Bowls. *Pacific Coast Archaeological Society Quarterly* 32(4):27-40.

Parker, Pearson M.
2000 *The Archaeology of Death and Burial*. Texas A&M University Press, College Station.

Parry, William J., and Robert L. Kelly
1987 Expedient Core Technology and Sedentism. In *The Organization of Core Technology*, edited by Jay K. Johnson and Carol A. Morrow, pp. 285-304. Westview Press, Boulder, Colorado.

Price, Heather, Aimee Arrigoni, Eric Strother, Kyle Brown, Thomas Young, and Jennifer Price
2005 *Data Recovery, Burial Removal and Construction Monitoring at the Canyon Oaks Site, CA-ALA-613/H, Pleasanton, Alameda County, California*. Report to KB Home South Bay, Pleasanton, California, from William Self Associates, Orinda, California.

Price, Heather, Eric Strother, Kyle Brown, Allen Estes, Nancy Summerlin, Martin Wells, Marin Pilloud, James Allen, and William Self
2002 *Pleasanton Gateway Project: Report on Archaeological Data Recovery at CA-ALA-554, Pleasanton, Alameda County, California: Volume 1, Data Recovery*. Report to South Bay Development Company, Pleasanton, California, from William Self Associates, Orinda, California.

Sloan, Doris
2006 *Geology of the San Francisco Bay Region*. University of California Press, Berkeley.

Taff, Joseph A.
1935 Geology of Mount Diablo and Vicinity. *Geological Society of America Bulletin* (46)7:1079-1100.

Wiberg, Randy S.
1997 *Archaeological Investigations at Site CA-ALA-42, Alameda County, California: Final Report*. Coyote Press, Salinas, California.