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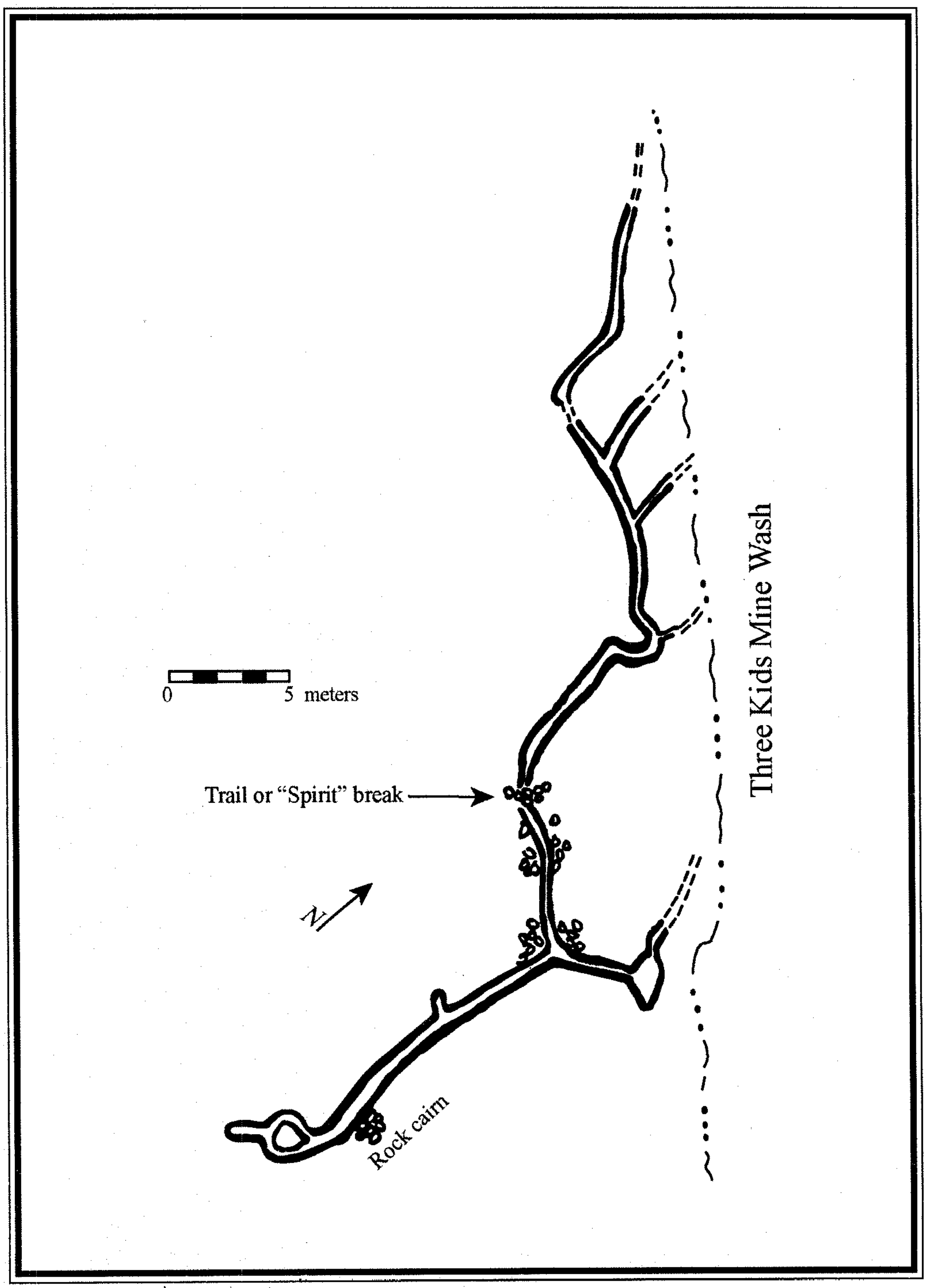

NEVADA ARCHAEOLOGICAL ASSOCIATION

Nevada Archaeological Association

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Cover:
Sketch map of Earth Figure/Intaglio site, 26CK4509/BLM 53-5669. From "The Las Vegas Wash Intaglio and Patayan/Yuman Occupation of the Las Vegas Valley" by Kevin Rafferty, page 4.

Code of Ethics

The purpose of the Nevada Archaeological Association (NAA) is to preserve Nevada's antiquities, encourage the study of archaeology and to educate the public to the aims of archaeological research. Members and chapters of the NAA shall:

1. Uphold the purpose and intent of the NAA.
2. Adhere to all antiquities laws.
3. Seek the advice, consent and assistance of professionals in archaeology and/or history in dealing with artifacts, sites and other materials relating to antiquities.
4. Assist professionals and educators in accomplishing the objectives of the NAA.
5. Be a personal envoy of the NAA and responsible for conducting themselves in a manner so as to protect the integrity of the artifacts, sites, or other material.

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Editor's Corner

Greg Haynes

This particular volume of the *Nevada Archaeologist* focuses on southern Nevada, an area of the country that has seen unprecedented growth and development over the last several decades. According to the Las Vegas Convention and Visitor Authority website (http://www.lvca.com accessed on 03/02/2009),the population of the Las Vegas metropolitan area saw a four-fold increase from 1980 to 2008, from 462,000 people to over 1.9 million. These numbers do not even include other burgeoning communities in Pahrump, the Moapa Valley, or along the lower Colorado River corridor. Lifelong residents of southern Nevada, along with many others who seek to make the area their home, are concerned that this growth threatens to destroy the area's fragile cultural resources. At the same time, and as a response to this threat, significant efforts designed to protect and learn from the region's rich human history has allowed for a myriad of research opportunities in archaeology, as well as other related disciplines.

The articles contained within this volume, in many respects, are a result of these two trends, that is, the large-scale growth that often threatens cultural resources and the efforts to preserve our heritage. Notwithstanding the southern Nevada theme, the articles vary considerably in their purpose and content. The first half of the volume presents context-rich narratives that cover the late prehistoric ceramic (Rafferty), contact (Jones), and early modern eras (Valentine). The last half of the volume presents the results of field- and laboratory-based data analyses. Here, methods of inquiry range from inventory level observations (Ettinger), to data collection and subsequent laboratory analyses (Roberts and Flenniken, Holz), to landscape-scale site prediction models (Branigan). What ties these articles together are their relevance and applicability to current research themes in southern Nevada, specifically, and human occupation and use of the arid West, more generally.

Many people helped to guide this project to fruition. Manuscripts were initially solicited by Eva Jensen and Laureen Perry. Hal Rager, along with Mark Giambastiani , Dayna Giambastiani, and Andrea Catacora at ASM Affiliates, proved instrumental in redesigning certain *problem figures*, so that they would fit the constraints imposed by journal format and overall cost. Anne McConnell deserves special mention because the entire layout of the journal you see before you, including the format of each manuscript, was completed by her. She did this as a volunteer and at no cost to the NAA. In addition, Anne gently nudged me along in the editing process when my efforts would slow. And all of the authors put up with long delays, coupled with bursts of phone calls and e-mails from me trying to ready their manuscripts for publication. Each one of you has my thanks.

In conclusion, this volume of the *Nevada Archaeologist* follows a number of recent thematically organized editions. Last year's journal, Northern Nevada Across Time (Volume 22, 2007), is a companion piece to this one and contains research specific to northern Nevada archaeology and history. As editor of the southern Nevada theme journal, it is my hope that you will find each of these articles worthwhile, and that they contribute in meaningful ways to your own understanding of Nevada's rich human history.

The Las Vegas Wash Intaglio and Patayan/Yuman Occupation of the Las Vegas Valley

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Before the 1980s it was generally accepted that during the late prehistoric/early historic era the Las Vegas Valley was the almost exclusive territory of bands of Southern Paiute. The occupational picture of this area has become more complicated than once realized thanks to a significant increase in research in the valley, particularly in the Las Vegas Wash region. A significant number of sites in the Las Vegas Wash area have yielded large quantities of ceramics and other artifacts that can be associated with the Patayan/Yuman cultural tradition. One of the most significant sites recorded in the Las Vegas Wash area is an intaglio, 26CK4509, the first known intaglio recorded north of traditional Patayan territory. This article presents a detailed discussion of 26CK4509: its morphology, its size and geographic location, and associated artifacts. Data concerning intaglios and their role in Patayan/Mojave religious and political life will also be included. Finally an argument regarding the role the Las Vegas Valley may have played as part of Patayan/Mojave traditional territories will be developed.

Since the mid-1980s a significant amount of cultural resource management work has been conducted in the Las Vegas Valley, leading to a rethinking of many commonly accepted ideas about the prehistory of the region. One of the most interesting areas of research has been the re-examination of the interrelationships of various prehistoric populations in the Las Vegas valley, particularly during the last 1,000 years when Southern Paiute/Numic populations and Patayan/Yuman groups from the Lower Colorado River Valley both appear to have heavily used the Las Vegas Valley. Prior to the mid-1980s it was generally accepted that the valley was the almost exclusive territory of at least one, if not more, bands of Southern Paiute who were part-time hunter-gatherers and part-time horticulturalists who exploited a wide range of territory and numerous ecological zones for the acquisition of necessary resources (Rafferty 1984, 1985a; Warren and Crabtree 1986).

More so than a resource zone, the Las Vegas Valley and southern Nevada was considered a "holy land" to the prehistoric Southern Paiute. It was the portion of the earth in which they had been created and Mount Charleston, the highest peak in southern Nevada, was the center of their spiritual universe (Spicer 1957; Stoffle and Dobyns 1983). This mountain is located on the western edge of the Las Vegas Valley and can be seen as the primary topographic feature of the region for miles in any direction.

Recent research has suggested that the picture of the occupation of this area is more complicated than once realized. Shutler (1961) first suggested the idea that the Las Vegas Valley may have been popular with groups residing along the Lower Colorado River. Valley-wide cultural resource survey projects (Ahlstrom et al. 2004; Ezzo 1995; Rafferty 1984, 1985a, 1986; Seymour and Hatzenbuehler 1995) and academic research (Hatzenbuehler 1995; Seymour 1997) have revealed a much larger and more intense Patayan/Yuman presence in the greater Las Vegas Valley region than had previously been conjectured. More specifically, survey, excavation, and artifact collection work in the Las Vegas Wash area in the southeastern portion of the valley (Ahlstrom and Roberts 2001; Ferraro and Ellis 1982; Rafferty 1990a;

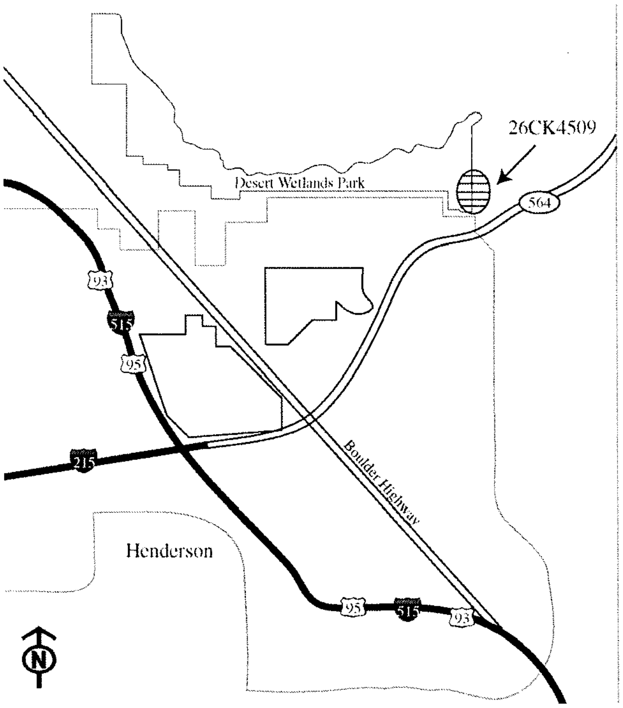

Figure 1. *General location of the Las Vegas Wash Intaglio, 26CK4509.*

Roberts and Ahlstrom 2000) has recorded a number of sites yielding large quantities of ceramics and projectile points that can be associated with the Patayan/Yuman cultural tradition.

One of the most significant Patayan/Yuman sites recorded in the Las Vegas Wash area is an intaglio, 26CK4509 (Figure 1), first recorded by Rafferty (1990a;Figure 2) and reinvestigated by Woodman and Valentine (1999;Figure 3). This site is the first known intaglio recorded in the area, and is one of only two that have been distinctly identified and recorded as such. This intaglio is a "classic" type of intaglio in that it is located on an alluvial terrace covered with desert pavement alongside a water course, like the majority of intaglios recorded to the south of the Las Vegas Valley in "traditional" Patayan/Yuman territory (cf. Johnson 1985).

The focus of this paper will be a detailed discussion of 26CK4509: its morphology, its size and geographic location, and associated artifacts. Data concerning intaglios and their role in Patayan/Mojave religious and political life will also be included. Finally the role the Las Vegas Valley may have played as part of Patayan/Mojave traditional territories will be undertaken, with data from elsewhere in the valley incorporated into a larger picture of the Patayan/Yuman presence in the region.

INTAGLIOS: DEFINITION AND PAST RESEARCH

Humans modify the landscape to suit their cultural needs. These needs may be subsistence related, concerned with housing and shelter, or may have a spiritual/religious purpose. As such, archaeological sites of any kind are both physical manifestations of man's impact on the local environment, and become symbols within a "built environment" that imitates or represents conscious or subconscious aspects of life as perceived by a particular cultural group. They become visible physical expressions of culture and can serve a communicative role by embodying and conveying meaning for individuals within a group, and convey messages between groups. They often demonstrate how the built environment corresponds to idealized conceptions of social, political, and religious life (Lawrence and Low 1990:466).

According to Johnson (1985:6–7) the term geoglyph (or Earth Figure) identifies all man-made alterations of the desert surface that are purposeful and is imbued with cultural meaning or significance. This obviously refers to prehistoric or protohistoric features with symbolic meaning, and decidedly excludes alterations such as house structures, roads, off-road vehicle tracks, or accidental/incidental alterations of the desert's surface. He identifies three major construction techniques:

1) Selective displacement of the surface gravels to reveal the lighter colored desert surface underneath.
2) Tamping of gravels down into the subsurface soils.
3) Patterned foot traffic that creates a trail or foot path image.

Other alteration processes occur that are added to the geoglyph construction, including the heaping of stones or gravel into piles or cairns, and the alignment of rocks into larger earth patterns. All of these processes may be used to create larger patterns in the desert pavement (Johnson 1985:7).

Johnson subdivides intaglio figures into two categories based on their functional origin and use. Some figures were created as an end product, and these are usually distinct representations of life forms or geometric designs, created for a specific purpose. There are many types of these figures along the Colorado River. In addition, footpaths that lead to various features, or circular dance pattern areas, are the result of human activity but are not deliberately manufactured as are the figures. Although they may comprise a portion of the overall figure pattern, their original purpose was not as a part of the figure (Johnson 1985:6–8).

More specifically, an intaglio is a design, of varying size and morphology, created on desert pavement surfaces by scraping away or removing the dark pavement to reveal lighter soil underneath. The scraped area forms the design which is often bordered by rocks or stones that create ridges outlining the figure. They inevitably are situated on terraces covered with desert pavement, making the juxtaposition of the lighter figure with the darker surrounding desert pavement a dramatic and obvious presentation of the message being conveyed by the figure. These figures come in a variety of shapes: zoomorphic, geometric, anthropomorphic, or of more abstract design. The designs tend to resemble rock alignments, petroglyphs, and ground paintings found in the Patayan/Yuman tradition (Solari and Johnson 1982:419; in Woodman and Valentine 1999:9)

These figures and patterns appear to be related to the Native American groups who have resided along the Colorado River for the last several hundred years at least. Specifically they have been identified as belonging to the Patayan/Yuman cultural tradition. Previously recorded intaglios occur in "traditional" Patayan/Yuman territory along the Colorado and Gila Rivers and in the Mojave desert (Johnson 1985; Rogers 1945). The intaglios were a physical representation of the Patayan/Yuman spiritual world view; served as dance and ceremonial centers; and recounted tribal creation and origin myths (Johnson 1985). In this vein the intaglios served as identifiers of social identity, symbols, or signs that the group employing them shared a common cultural or ethnic identity. They served to distinguish members of the group from outsiders while carrying intragroup significance (Royse 1982:7). They appear to be related to the cosmological or world view belief systems of these peoples, being involved in ceremonial or religious practices. These practices could include the creation rite, healing or curing rites, rites of passage for girls, purification ceremonies, scalp or war dances, and various ceremonies involved in the agricultural or subsistence cycles followed by these peoples for many years (Knack 1981; Johnson 1985:15–16).

Several researchers—Johnson 1985; Rafferty 1990a, and most particularly Woodman and Valentine (1999:10–12—have summarized previous intaglio research, which is reproduced in truncated form here. The earliest report in print of the existence of such features is that of Captain Lorenzo Sitgreaves in 1851 and William Blake in 1853 (Smith 1983:89). Intaglios became better known in the 1930s when a pilot, George Palmer, photographed the "Blythe Giants" and brought them to the attention of Arthur Woodward of the Los Angeles Museum. Woodward then publicized them in various sources (Woodward 1932). Rogers (1939), Harner (1953), Smith (1983), and Von Werlhof (1987) have since contributed to our knowledge and understanding of such features.

Since 1932, numerous "effigies" and intaglios have been recorded in the California Deserts and the river terraces overlooking the Colorado River in Arizona and California. Several researchers have noted that intaglios are often accompanied by other features. Rogers (1966) noted that the Inyo County intaglios are associated with flakes and 28 cairns. Von Werlhof's (1987) work in Death Valley also noted an association with intaglios and cairns, along with trails, lithics, rock circles, and other alignments. Numerous other intaglios in the California Desert have also been associated with cairns, artifacts, trails, and other features (Davis and Winslow 1965).

The classic terrace intaglios can be found in locales such as Pilot Knob (Ezzo and Altschul 1993a), Senator Wash (Ezzo and Altschul 1993b), Ripley (Holmund 1993), Parker (Rogers 1966), Needles (Smith 1983), and near the ruins of Fort Mojave. On the Fort Mojave Reservation, the latest intaglios to be recorded consist of three separate loci or sites with several intaglio features and other associated features: a small anthropomorphic figure, footpaths, depressions, pits, and circular pathways (Rafferty 1990b).

The Las Vegas Wash Intaglio (26CK4509) is the first intaglio feature recorded in Nevada. A site in the Muddy River Valley, 26CK1937, has a "patterned area" which Ezzo (1996:75) defines as an intaglio based on his examination of the site sheet. However this site was recorded in an era (the 1950s–1960s) when the recording standards were significantly lower than they are now. The detail on the site sheet does not match that of current IMACS forms and thus the identification of this site as an intaglio is questionable until the site can be field checked.

Another intaglio (26CK5221) exists south of Boulder City within the Lake Mead National Recreation Area (Steve Daron, personal communication 2005). In the process of being recorded by the National Park Service, the site has been damaged by vehicular traffic and other disturbances, and does not appear to be as distinct or well-preserved as that in the Las Vegas Wash.

THE INTAGLIO

The Las Vegas Wash Intaglio (26CK4509) is located on a low-lying alluvial terrace just 2–3 m above an active bed of the Three Kids Mine Wash (Figure 2). This feature was first recorded in September 1990 (Rafferty 1990a; Figure 2; Figure 3) and revisited by Boma Johnson, then Yuma Bureau of Land Management (BLM) District Archaeologist, on June 18, 1991. Johnson graciously provided the author and the Las Vegas District BLM with written copies of his observations and a detailed sketch map based on his observations. It was reinvestigated by HRA, Inc. (Woodman and Valentine 1999;Figure 4) at the request of the Las Vegas District of the BLM.

The feature was originally defined as being roughly humanoid in shape, with a pointed head 4 m in diameter and 8 m long on the south end of the feature (Figures 2 and 3). Woodman and Valentine (1999:14) note that the scraped area averaged 1–6 cm deep in different areas. Johnson (1985; 1991) suggested that the head was actually part of a loop trail. It was associated with a cairn located at the eastern edge of the loop. The "torso" is approximately 30 m long and averages 65 cm in width

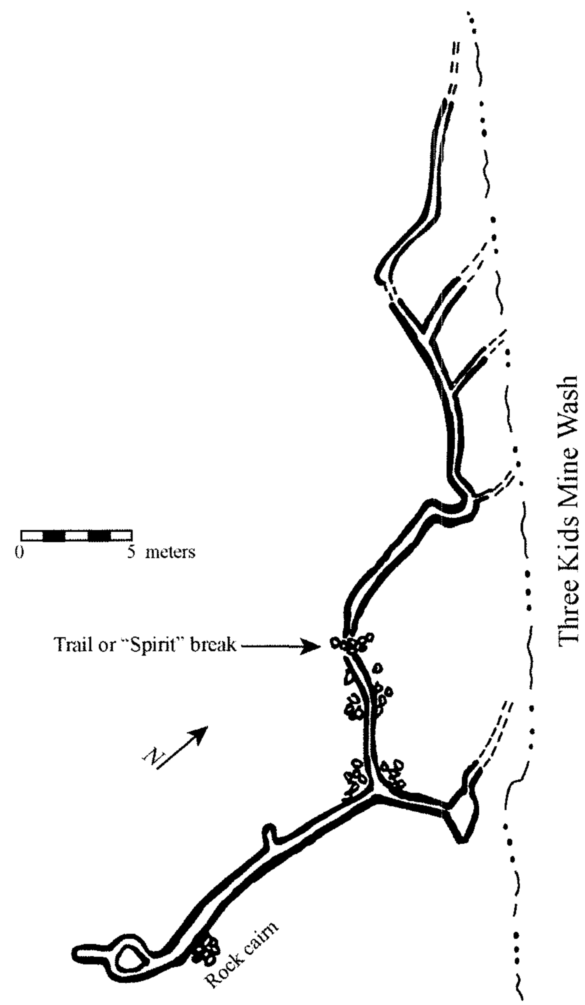

Figure 2. *Sketch map of earth figure/intaglio site, 26CK4509/BLM 53-5669 (from aerial photograph and original B. Johnson sketch).*

where the desert pavement and gravels have been removed to reveal the lighter colored soil underneath. Approximately 17 m north of the "head" is a small arm or phallus that was originally defined as being 2 m long. The later investigation (Woodman and Valentine 1999:14) indicated it as being 9 m long. It points towards the west or northwest.

At the base of the torso are splayed or separated "legs." The eastern leg is 10 m long and ends at an oval 3.75 m in maximum diameter, which has a small (2 m long) abutment on its north end. Johnson (1991) suggests that this may be a small dance cul-de-sac associated with dance ceremonials of the historic Mojave. The western leg is 8 m long along the terrace, then dips into a small side wash and reappears on the northern side of the wash 1 m

Figure 3. *Aerial photograph of the Las Vegas Wash Intaglio, 26CK4509. The arrow points north. (Photograph taken by Bureau of Reclamation, Lower Colorado River Region, Boulder City, Nevada.)*

away, then continues to the northwest for another 12 m (Woodman and Valentine 1999:14). On the south side of the wash is the remnants of another cairn, and at the juncture of the wash and the northern extension of the "leg" is a linear feature of rock that cross-cuts the leg that Johnson (1985; 1991) calls a "spirit break" type of trail barrier (Figure 2).

At the "foot" of this leg an additional system of trails continues along the edge of the wash for an additional 30–40 m at a minimum, crossing over several small erosional rills cut into the embankment of the main wash terrace. At two areas small side trails abut the main trail heading north and terminate in the wash itself. Johnson (1985; in Woodman and Valentine 1999:14) describes such trails as being part of a "trail pattern" figure, composed of paths or trailways used in Mojave ceremonials to commemorate migrations or sacred journeys of their ancestors.

Woodman and Valentine (1999) have identified other loci of cultural activity associated with the intaglio (Figure 4). There are several different types of rock piles. The first rock pile (RP-1), adjacent to the head of the intaglio, consists of over 38 boulders and measured 1 m tall and nearly 1.5 m wide. Scratched on this pile is the legend WM/-19/MS. Rock Pile 2 is a smaller pile of 12 boulders/cobbles less than 1 m high, and may be a mine claim. Rock Pile 3 is an additional pile of over 33 boulders/cobbles less than 1 m high, again possibly a mining claim. Rock Pile 4 is a collapsed cairn, while RP-5 is a locus of roughly 42 boulders/cobbles standing over 1 m high and wide. It contains a pack rat nest.

Several isolated artifacts occur near the intaglio, including a welded rhyolite tuff secondary flake, a multicolored chalcedony multidirectional core, a brown rhyolite tuff assay cobble, and an isolated white/brown chert primary flake next to RP-1. On top of the desert pavement are numerous chalcedony and welded rhyolite tuff nodules, that Woodman and Valentine (1999:17) suggest were opportunistically quarried at more than eight separate locations.

INTERPRETATION

As noted above, normally figures such as these were located alongside the Colorado River within the 'traditional' Mojave/Patayan homelands, and were usually associated with ceremonial or religious functions. One such function was a dance ground or pattern involved in celebrations or, more importantly, healing ceremonies. Certain anthropomorphic figures found among historic Mojave groups are connected with the creator figure of myth and thus are involved in healing ceremonials as central factors in the cure. These religious concepts may be similar to those found among the Navajo who employed sand paintings to create a sacred healing ground for the cure (Johnson 1985). The Las Vegas Wash geoglyph may fall in this category.

More likely the figure may represent *Mustamho* (*Kumustamho*) the Creator God of Mojave legend and the source of all culture for the Mojave. He was the origin of all truth and knowledge and was the creator of the heavens and Earth.

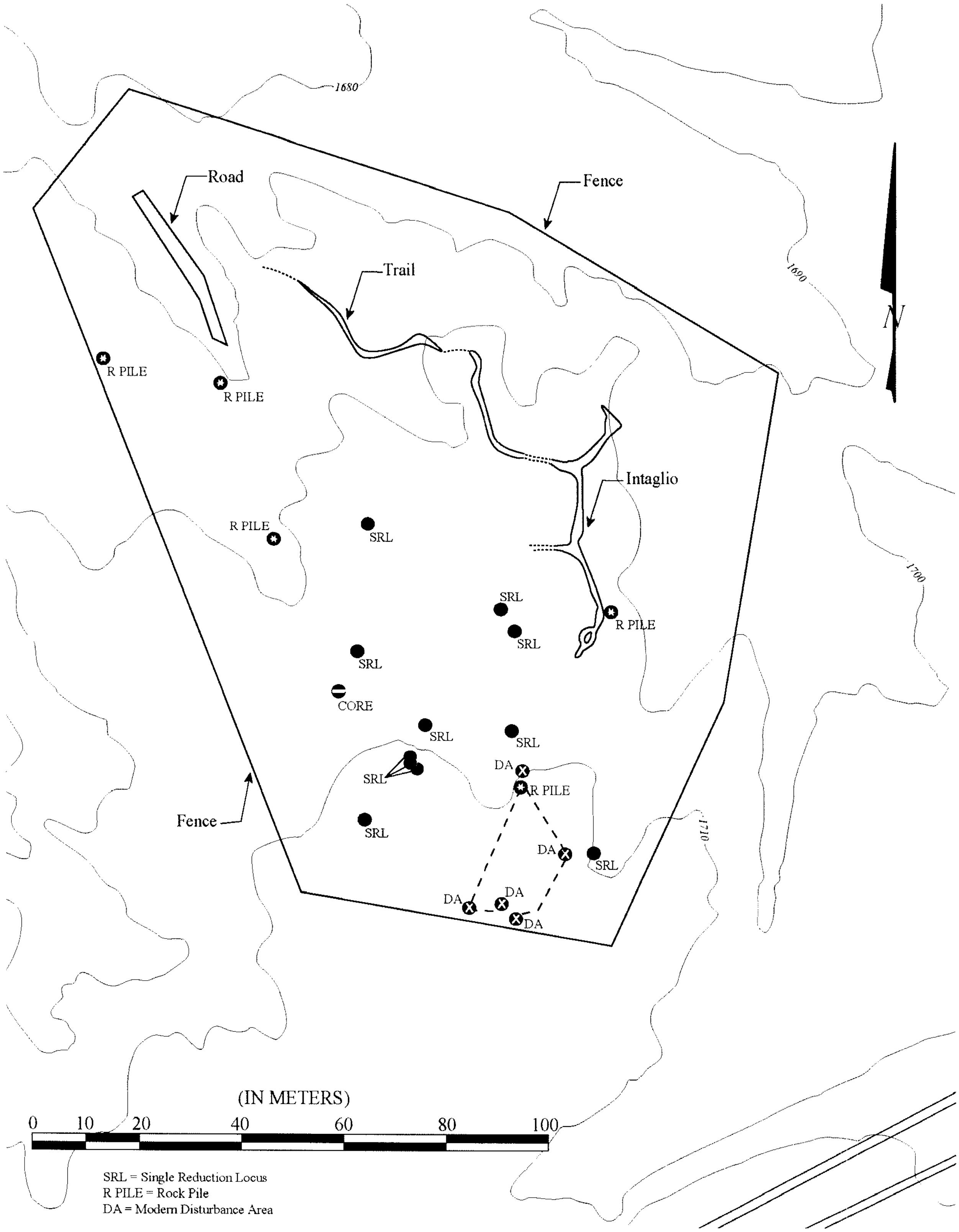

Figure 4. *Map of the Las Vegas Wash Intaglio (prepared by Lake Las Vegas).*

He taught the people agriculture and how to live in peace, and then went to the eastern sky with a promise to return someday in the future (Harrington 1908; in Johnson 1985).

If this is truly the case and the figure does represent the religious sentiments of the Mojave or their ancestors, what implications does this have for understanding its location so far to the north of the traditional riverine homelands of the Mojave? It was mentioned earlier that symbols or features can be seen as part of a "built environment" that expresses the main tenets of the culture to the people who built the feature. In Mojave culture the concept of *puha* (power or energy) may be significant in connecting the intaglio with cultural meaning. *Puha* came into being at the time of creation and suffuses everything with its power, and is why everything in the universe is alive and capable of independent will and activity. Stoffle et al. (2004:17) suggest that in western terms the idea of a *living universe* is the best way to understand this approach to the universe. Following Miller (1983) they argue that any gathering of humans, who are "central figures in an interacting system of power holders" (Bean 1976:408, in Stoffle et al. 2004:18), will concentrate *puha*, and closed dance circles can contain the power for a significant amount of time.

Certain localities may exhibit concentrated power which produces "powerful places." These localities are then recognized and utilized by human beings. Stoffle et al. (2004:24) argue that three general types of localities can be identified in southern Nevada as foci of such power for Numic and Mojave peoples: creation places, ceremonial places, and residences. Ceremonial places consist of two subtypes, those created and used for acquiring *puha;* and for using *puha* to heal and in ceremonies used to balance the powers of the universe. Johnson (1985) suggests that ethnographically among the Mojave earth figures or intaglios could be involved in several ceremonial functions: healing ceremonies, tribal origin myths, or creation myths and associated ceremonies. The Las Vegas Wash geoglyph may have functioned as a special location where *puha* was focused for ceremonial functions.

The geoglyph in question may have served to express the idea of land ownership, a claim to the area as a portion of their homeland significant enough to lay a sacred claim to the land. If this is the case the identification of the geoglyph as *Mustamho* the Creator God would make sense given the fact that the builders were claiming this territory as part of their sacred homelands, a cultural marker of ownership. This would make the area sacred to them since this is where important religious ceremonials, including healing ceremonies, would take place. Sacredness is not to be found just anywhere but within the homeland of the people. Such figures would convey the message to all outsiders that this was Mojave/Patayan territory, and if they were not on good terms with the Mojave, they should leave the land immediately (Hatzenbuehler 1995).

ARCHAEOLOGICAL EVIDENCE OF PATAYAN OCCUPATION OF LAS VEGAS

Much of the earliest work that helped to identify a Mojave presence in the southern Nevada region was conducted by Malcolm Rogers (1929, 1945). His summary of his 25 years of work in the region, "An Outline of Yuman Prehistory" (1945) established an element trait list that would assist in identifying Yuman (Mojave) manifestations. Included in this list were specific house types, jewelry, grinding implements, buffware ceramics, trails associated with trail "shrines" or cairns and ceramics, geoglyphs (occasionally incorporated into the trails and trail systems), petroglyphs, and disposal of the dead. Although some of these characteristics are very generalized, when combined with buffware ceramics and geoglyphs, the identification of a Mojave/Patayan site is almost certainly guaranteed.

Evidence suggests that Lower Colorado/Patayan populations entered the Las Vegas Valley as early as A.D. 1000, during what Rogers (1945) called Patayan II (ca. A.D. 1050–1500) and Ahlstrom et al. (2004) call the Middle Ceramic period (ca. A.D. 1000–1500). Occupation, or at least use, of the valley continued through the Patayan III/Late Ceramic period, ca. A.D. 1500–1800 (Ahlstrom et al. 2004; Rogers 1945). Patayan occupation occurred in several distinct localities within the Las Vegas Valley.

Adjacent to and just north of the intaglio, within the Las Vegas Wash area (Figure 5), there

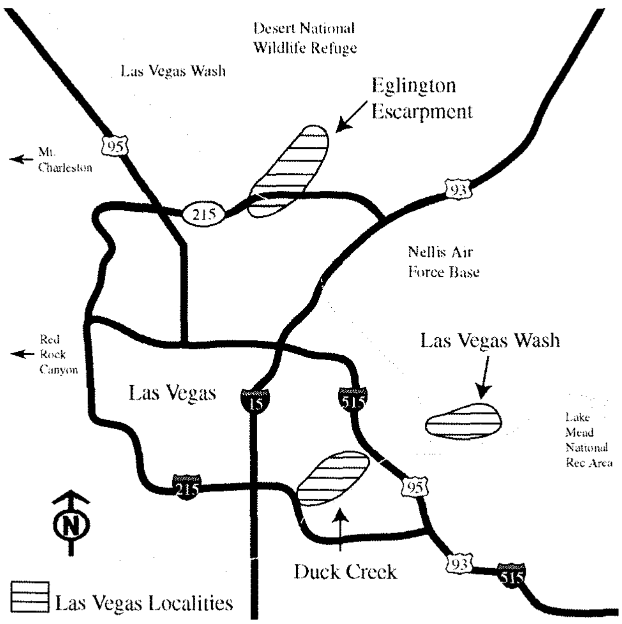

Figure 5. *Las Vegas Valley archaeological localities, as discussed in the article .*

are several sites that suggest a significant Patayan presence in the region. Two sites, 26CK1301 and 26CK1139, both rockshelters, contained a Patayan component to them. The latter was first excavated by the Nevada Archaeological Survey in the 1970s (Ferraro and Ellis 1982) while the former was tested much more recently (Roberts and Ahlstrom 2000). The ceramic and radiocarbon evidence point to a Patayan II/Middle Ceramic period use of both of these sites, with use of the latter extending into the Late Ceramic period. Another site, 26CK1282, a Paiute/Patayan habitation site or campsite, was tested in the 1970s and re-examined by HRA, Inc. in 2001 (Ahlstrom and Roberts 2001:Table 1.2). It contained a few Virgin Anasazi sherds, along with some Paiute plainwares, and Lower Colorado buffware sherds. These sherds, plus a radiocarbon date of A.D. 1490–1950 (Ahlstrom and Roberts 2001: Table 1.2), place the use of this site in the Late Ceramic period. In addition it contained Desert side notched points, chipped stone artifacts and waste flakes, and grinding stones (Ferraro and Ellis 1982; Roberts and Ahlstrom 2000). Also in the wash but east of 26CK1282, a small rockshelter (26CK3243) was tested and found to contain Lower Colorado buffware ceramics, Desert side-notched and Rose Spring projectile points, and two Paiute corrugated sherds (Rafferty 1985b). Ahlstrom et al. (2004:55–56) suggest that the artifact assemblage points to a Middle Ceramic period use of the site.

Evidence for Patayan occupation of the Las Vegas Valley extends to the north and west of Las Vegas Wash. In the far western Las Vegas Valley lies a site, 26CK4908, located adjacent to an abraded alluvial drainage cut through limestone outcrops at the base of the Spring Mountains. Originally described as containing three rock-shelters, a rock ring, and three roasting pits, work at the site in 2000 determined that two of the three shelters and the rock ring had been destroyed subsequent to their earlier recording in 1994 (Leavitt and Rafferty 1994). The site was mapped and data recovery was undertaken in 1999. The rockshelter was completely surface collected and excavated, with depth of deposit ranging from 10–50 cm. In addition to artifacts, charcoal, soils, and floral remains were collected for flotation, macrobotanical analysis, and radiocarbon dating. The roasting pits were excavated employing five interconnected backhoe trenches and then examined for *in situ* materials and radiocarbon datable samples. In addition a single 1 meter by 1 meter unit was excavated in the central depression of each roasting pit (Blair et al. 2000:178, 181).

The surface collections and excavations recovered significant amounts of data from the site complex. A total of 1,368 lithic artifacts were recovered, including the following categories: 33 projectile points (one pinto, three Rosegate, 10 Desert Side-Notched, 18 Cottonwood Triangular, and one historic metal point); 23 bifaces at various stages of manufacture; a single core; three hammerstones; one broken drill; one bifacial tool; and 1,282 pieces of debitage reflective of bifacial reduction activities. Also recovered were 19 pieces of groundstone from the excavations and eight pieces from the surface collections. A total of 479 ceramics were recovered, including Southern Paiute Brown Ware (138 sherds), Virgin Anasazi North Creek Gray (seven sherds), and two categories of Lower Colorado ceramics: Lower Colorado Buff (314 sherds, six varieties) and Tizon Brown (15 sherds, two varieties) (Blair et al. 2000: 282, Table 27). Other categories of artifacts include four beads (one of bone, three of shell), and four historic buttons (Blair et al. 2000:294–298).

Radiocarbon dates support the artifactual data in terms of chronological placement of the site. Five dates from the roasting pits ranged in age from the Virgin Anasazi occupation of the valley (1390±60 B.P./ A.D. 560–720 Calibrated) through the Paiute and Patayan/Lower Colorado occupation (510±60 B.P./A.D. 1405–1440;470±40 B.P./A.D. 1420–1445; 350±60 B.P./A.D. 1455–1640; 220±60 B.P./A.D. 1745–1805—all calibrated; Blair et al. 2000, Appendix II). Blair et al. (2000:308-314) noted that the ceramic and projectile point typologies and the radiocarbon dates supported a generalized picture of site occupation by Virgin Anasazi, Paiute, and Patayan populations in the region. The best that could be said chronologically is that all three groups probably occupied the site episodically, utilizing the site in similar ways for similar purposes. It was also suggested that as the Patayan ceramics dominated the ceramic assemblage at 26CK4908 and the ceramics were distributed mainly within the confines of the shelter, that the Patayan may have used the site on a seasonal basis and not just to gather and process agave. The rockshelter and roasting pits were situated at the confluence of several washes at the base of the Spring Mountains, allowing the inhabitants access to a number of environmental zones and thus a plethora of edible plants and animals: pine nuts, agave, lagomorphs, artiodactyls, and other edible resources.

Northwest of Las Vegas Wash there are (or were) several sites with a Patayan artifactual presence, all situated along the Eglington Escarpment (Figure 5). The Twin Dunes Site (26CK1525) (Rafferty 1985a) was surface collected and minimally tested in the early 1970s. The 663 collected artifacts yielded three buffware sherds and 11 projectile points dating to the Late ceramic period (Cottonwood triangular and Desert Side-notched varieties). Burnt Rock Mound (26CK3601) (Rafferty 1985a; Seymour and Rager 2001) was surface collected and tested in early 2000. The radiocarbon dates from the site suggest occupation from ca. 2000 B.P. into the Historic period, as did the artifacts. Twenty percent of the 645 sherds recovered were Patayan, suggesting more than casual use by Patayan populations. Finally 26CK3766 (White et al. 1989) revealed a minimal (three sherds out of 59) Patayan ceramic component.

South of Las Vegas Wash there are two locales that testify to a significant Patayan presence in the region. Hatzenbuehler (1992, 1995) located a series of rockshelters along the western face of Sunrise Mountain at the eastern margins of the Las Vegas Valley. Two ceramic scatters located at the shelters contained a total of 26 Lower Colorado buffware sherds.

One rockshelter site southeast of Las Vegas Wash also contained a significant amount of Patayan artifacts. The "Basic Site" (26CK1098) was excavated in the course of investigations for the Navajo-McCullough Powerline Project (Brooks and Larson 1975:246–276). Although a small shelter, it contained a significant amount of material: 32,000 flakes of rhyolite and chert; 31 projectile points or fragments (including one Cottonwood triangular, one Desert Side-notched, seven Rose Spring, one Elko eared, one Eastgate, one Humboldt concave base, and two Gypsum); a small variety of knives, scrapers, choppers, and cores; one metate fragment, seven manos or mano fragments, and two "other" groundstone pieces; 407 ceramic sherds, of which 76 percent were Lower Colorado buffwares with Virgin Anasazi and possible Paiute ceramics making up the remainder; olivella shell beads; and three pipe fragments. A single radiocarbon date of A.D. 705±145 was also derived from the site. Several of the projectile point varieties (Cottonwood, Desert Side-notched, Rose Spring, and Eastgate) are found throughout the Great Basin and are temporally diagnostic, but not necessarily culturally diagnostic. However the evidence suggests a probable early Patayan I (ca. A.D. 700–1000) (Rogers 1945) use of the site.

Brooks suggested that the results are consistent with the idea first suggested by Shutler (1961) that the Las Vegas area may have been popular with peoples from the Lower Colorado River, as the ceramic sequences from the shelter, the majority of the projectile points (Desert side-notched, Rose Spring, Cottonwood triangular, and Eastgate varieties) and the radiocarbon date all point to Patayan use of the site. The olivella beads and non-Patayan ceramics suggest inter-group contacts and trade. The earlier dated projectile points (Humboldt Concave base and Gypsum varieties) were found mixed sporadically within the excavation levels, suggesting some earlier use of the site by Archaic period peoples (Brooks and Larson 1975). Their presence in upper level excavation strata may represent bioturbation by Patayan peoples re-occupying the cave.

Southwest of Las Vegas Wash there were numerous sites containing Mojave/ Patayan artifacts in the Duck Creek area (Map 2). Seymour (1997: 121–125) analyzed 5,000 sherds from 33 sites located along the Duck Creek area and four from other locales from the Las Vegas Valley. Of the Duck Creek sherds, 2,393 came from surficial contexts while one site, the Berger Dump Site, yielded 2,542 sherds from a stratified deposit that was excavated in the late 1960s. Ten Duck Creek sites provided more than 100 sherds apiece and 11 provided more than 20 sherds each. Seymour's analysis indicated that Lower Colorado Buffware and Tizon Brown Ware, both Patayan varieties, were the highest in both percentage and total numbers at these sites. These sites also contained a significant amount of Virgin Anasazi ceramics and a small percentage of Paiute brownwares. The greatest majority of ceramics were manufactured during Rogers's Patayan II (A.D. 1050–1500) periods. Types included Topoc (Pyramid) Grey, and Parker, Palomas, and Salton Buffwares. Patayan III (A.D. 1500–1850) ceramic types were found at only five sites and in very low numbers, suggesting to Seymour (1997:124) only intermittent use of the Duck Creek area by Patayan peoples during this time.

Seymour's analysis of the Berger Site is even more revealing. The site deposits were over 70 inches deep and produced ceramics from all levels. Of the 2,542 sherds from the Berger Site, Lower Colorado wares dominated the assemblage, including what appears to be a locally made buffware, designated Las Vegas Buff by Seymour. Seymour suggests that the development of a local variant of the Lower Colorado buffwares means that habitation of the region by Patayan peoples was extensive and long-term enough to make the procurement of local sources of clay and temper worth while. His review of local data indicates that the ware was strictly of Las Vegas origin and used only in the valley, although they derived their inspiration from the general Patayan ceramic assemblages. The limited number of rim sherds recovered and identified by Seymour appear to be in the Patayan tradition. Five radiocarbon dates from the site (Seymour 1997:Table 10) fall entirely within or overlap the Patayan II/Middle Ceramic period.

One additional site in the Duck Creek area is indicative of the Patayan occupation of the region. The Midby Site Complex (26CK3115/3117), located one-half mile north of Duck Creek in the Paradise Valley area, was excavated by the Division of Anthropological Studies in 1984 (Rafferty and Blair 1984). The complex was centered around the remnants of an extinct spring mound. Test units excavated both by hand and with backhoes revealed a significant subsurface deposit that yielded evidence of use of the site by three different groups. A total of 293 sherds were recovered, of which 39 were Lower Colorado buffware examples.

Other distinctive Patayan cultural features have been recorded in the Las Vegas region. Three rock cairns were recorded alongside an aboriginal trail on Whitney Mesa, at a site designated 26CK3333 (Rafferty 1984). Hatzenbuehler (1995) recorded an extensive trail associated with lithic flakes, a chipping station, and a small abstract geoglyph near the confluence of Lake Mead and Las Vegas Wash.

The most recent work conducted in the valley that yields evidence of Patayan occupation was a major survey and inventory conducted by Ahlstrom et al. (2004) at the behest of the Bureau of Land Management for a land disposal project. A site file data base search and an inventory of a total of 46,761 acres of land yielded data on 100 cultural resource locations (58 prehistoric), including 47 newly recorded by the survey. This data was used to undertake a site distribution analysis of the Las Vegas Valley. Although several categories of data were examined, the ceramic data are most informative in light of the thesis of this paper. The distributions of ceramics recorded throughout the valley were charted and revealed several interesting patterns (Ahlstrom et al. 2004:272, Figure 5.4). Most important was the distribution of buffware (Patayan) ceramics within the valley. Buffware is much more heavily distributed than greyware (Virgin Anasazi) in the Lower Las Vegas Wash area near the intaglio and in the Duck Creek area (the southern Valley) while greyware dominates ceramic assemblages from the central valley northward. The one exception is 26CK4908 in the western Las Vegas Valley at the foot of the Spring Mountains (see above).

Ahlstrom et al. (2004:270–271) suggest that the contrasting distributions provide clues concerning paths of contact and travel for the two groups, particularly the Patayan. They note that the areas with the heaviest buffware distribution are those closest to the traditional homeland of the Patayan, the Lower Colorado River Valley, and thus the most easily accessible from the homeland. The presence of the intaglio is also mentioned in conjunction with the Lower Las Vegas Wash site complex, thus "suggesting that the southern portion of the Las Vegas Valley was near the northern end of the Patayan sphere of influence" (Ahlstrom et al. 2004:271).

In total, the archaeological evidence points to an extensive occupation of the Las Vegas Valley region by Patayan groups during the Patayan II period (A.D. 1050–1500). There is documentary evidence that the region was also occupied, or at least visited, by Patayan/Mojave peoples in the historic era as well. Hatzenbuehler (1995:19) cites the journal of John Steele, a Mormon missionary, recording the presence of both Paiute and *Iates* (Mojave) visiting the Mormon camps. The journal of George Bean in 1856 recorded a Mojave camp 14 miles south of the Mormon Mission, an area Hatzenbuehler (1995:19) identifies as being in the southern Duck Creek area of the Las Vegas Valley. Bean also recorded several other encounters with the Mojave in the Las Vegas Valley (Hatzenbuehler 1995:19).

What would have attracted the Patayan or Mojave populations to the Las Vegas Valley? For one thing, the presence of water and arable land. The Mojave combined flood water agriculture with the exploitation of wild flora and fauna into a well-rounded, solid subsistence regime that provided them with an abundant living. The most important crops were maize, tepary beans, and pumpkins, along with gourds and sunflowers. Among the most important wild foods were mesquite beans, along with grasses, pinyon nuts, cholla, pigweed, wolfberry, hackberry, and a variety of tubers. Rabbits and rodents were available in the fields and adjacent area, while deer and bighorn sheep were found in the mountains (Castetter and Bell 1951)

Prior to their final extinction in the 1950s, the Las Vegas Valley contained numerous springs and seeps (Carpenter 1915; Paher 1971). The Las Vegas Creek in the central valley encouraged the growth of grassy meadows in the area (Paher 1971) while Duck Creek was fed by several springs that helped make it an intermittent water source when the springs had exceptionally heavy discharge and sufficient precipitation created regional drainage runoff (Rafferty and Blair 1984). The Las Vegas Wash area was also a significant water source, often containing sufficient water to create a marshland.

This water helped to support a *Desert Riparian Biotic Community* along Duck Creek and Las Vegas Wash. This community contained numerous plants of economic use to the Mojave: desert willow, mesquite, cottonwood, canyon grape, hackberry, plus numerous grasses and forbes (Bradley and Deacon 1967). Faunal resources in or near this community would have included numerous lizards and snakes, rabbits, and the desert tortoise, large amounts of which was found at the Berger Site (Rafferty 1984).

In addition to the riparian resources historic travelers and early settlers reported a large mesquite forest three miles wide and 12 miles long along the eastern edge of the Las Vegas Valley. It extended down Las Vegas Wash to the base of Frenchman's and Sunrise Mountain and down towards the Colorado River (Paher 1971). In addition smaller concentrations of mesquite were found on the large sand dunes in the northern Las Vegas Valley (Rafferty 1984). Since one of the most important wild foods exploited by the Mojave was mesquite (Castetter and Bell 1951; Warren 1981) this large source of food would have proved to be very attractive.

In the mountains surrounding Las Vegas can be found deer and bighorn sheep, along with pinyon nuts and other floral resources.

Along Duck Creek and Las Vegas Wash, the soils consist of the Glendale-Land Soil Association (Langan et al. 1957). These are the best agricultural lands in the valley, being deep, well drained, medium textured, and moderately slowly permeable. As at least part-time farmers, these soils would have attracted Patayan settlers to the region, as they did the earliest American farmers that resided in the valley in the early 1900s (Paher 1971).

The final inducement for the occupation of the Las Vegas Valley by the Patayan would have been the possibility of trade. Historically the Mojave (the probable descendants of the Patayan) were heavily involved in regional trade patterns. Farmer (1935) cites historical evidence that the Mojave were trading for Pacific Coast shells as early as A.D. 1542. Culling from a variety of ethnographic and anthropological sources, Davis (1974:29–30) lists a variety of goods the Mojave traded to and received from various aboriginal groups during the historic period. Broad patterns of Southwestern prehistoric trade and trade routes involving the Patayan have also been identified by archaeologists (Brand 1938; Colton 1941; Tower 1945). Las Vegas was centrally located (partially due to water) on trade routes that extended north into the Great Basin and Columbia Plateau, and for this reason would have been attractive as a node of exchange between Patayan/Mojave populations and other regional prehistoric (Virgin Anasazi) or ethnohistoric groups (the Paiute or other Numic groups, Walapai, Havasupai, etc.).

SUMMARY

Based on the data presented in this paper it appears to be beyond contention that Patayan populations resided, or at least heavily exploited, the Las Vegas Valley. These populations were most likely horticultural with a hunting and gathering component, and are typified by a buffware and red-on-buff ceramic tradition. Survey and analysis of sites in the Las Vegas Valley, particularly the Duck Creek and Las Vegas Wash area, suggest that the Las Vegas region was the locale of a significant Patayan presence, indicating that the Las Vegas Valley served as a cultural contact point between various cultures who resided in the Great Basin and the northern Southwest as early as the Patayan II/ Middle ceramic period (A.D. 1000–1500) or perhaps earlier. The Las Vegas Wash intaglio suggests that the Patayan populations may have seen the valley as an extension of their traditional homeland, and used the intaglio as a part of their "built environment" to signify their claim to the area to other groups residing in the region.

Despite the recent increase in research into this topic of regional prehistory, we are at the beginning of our inquiries regarding the Patayan presence in the Las Vegas Valley. A number of basic questions remain to be answered. When did the Patayan first enter the Las Vegas Valley? Did they exhibit a permanent, year-around presence, or were they here on only a seasonal basis? What was the economic basis for Patayan occupation? To answer these, and many other questions, what is needed are more excavated sites with a significant Patayan component to them. Due to the extreme pace of economic and residential development in the Las Vegas Valley, it is uncertain that any sites remain within the valley proper with any substantial integrity that will help us deal with this problem domain. It is most likely that such sites will only exist at the margins of the valley in the form of rockshelters and roasting pit complexes in the foothills of the mountains surrounding the Las Vegas Valley. On a pessimistic note, we may be too late. But given the increase in cultural resource management work being conducted in conjunction with federal projects such as land sales, it is possible that this surmise is incorrect. The archaeological community can only hope that this is so.

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Cane Spring

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The finest workers in stone are not copper or steel tools, but the gentle touches of air and water working at their leisure with a liberal allowance of time (Henry David Thoreau).

This article presents the results of an intensive cultural resources reconnaissance at Cane Spring (26NY4) on the Nevada Test Site in southern Nevada. The field work was conducted in 2000 by the Desert Research Institute for the U.S. Department of Energy. Research questions focused on understanding the importance of water for people living in arid environments; the role that availability of water played in determining use of the landscape regarding settlement pattern, subsistence strategies and resource selection, and the relationship between springs and historic activities. Cane Spring is considered eligible to the National Register of Historic Places under criteria a. (properties associated with significant historic events), b. (properties associated with a significant person), and d. (may yield information important about prehistory or history).

The Cane Spring project, funded by the U.S. Department of Energy, National Nuclear Security Administration Nevada Operations Office, was conducted in 2000 (Figure 1). It included archival research, survey and recording, and data analysis and interpretation (Jones 2001). Cane Spring, site 26NY4, is a dual component prehistoric residential base and historic mining/transportation site. At the site are stone tools such as projectile points, drills, knives (bifaces), scrapers, utilized flakes, grinding stones, flakes from tool manufacturing, metal cans; glass; bullets; shell casings; and automobile parts. Features include rock rings, rock cairns, a possible cultivated area or farm plot, cabins, corrals, a water tank, a trench, and a mine shaft. Most of the artifacts (~20,000) are waste flakes from the manufacture of stone tools. Projectile points include Silver Lake (Worman 1969), Pinto, Elko, and Desert Side-notched. Dates associated with these points indicate the area has been occupied by American Indians for at least 10,000 years. Brownware pottery found at the site has been made for at least the last 700 years. All of the rock cairns are considered historic because historic artifacts are associated with several of these features. This type of cairn is typical of mining claims and their location on the landscape is consistent with this interpretation. The survey area is divided into five divisions as illustrated in Figure 2.

Figure 1. *General area around Cane Spring, cabins, and mine shaft under trees at right.*

ARTIFACTS AND FEATURES

Division 1

The first division contains stone artifacts, pottery, four rock rings, eleven rock cairns, a rock rectangle or foundation, a corral and a water tank, a historic trash scatter, cans, wood, pipe, a motor, and fence wire. There are more than 5,000 estimated

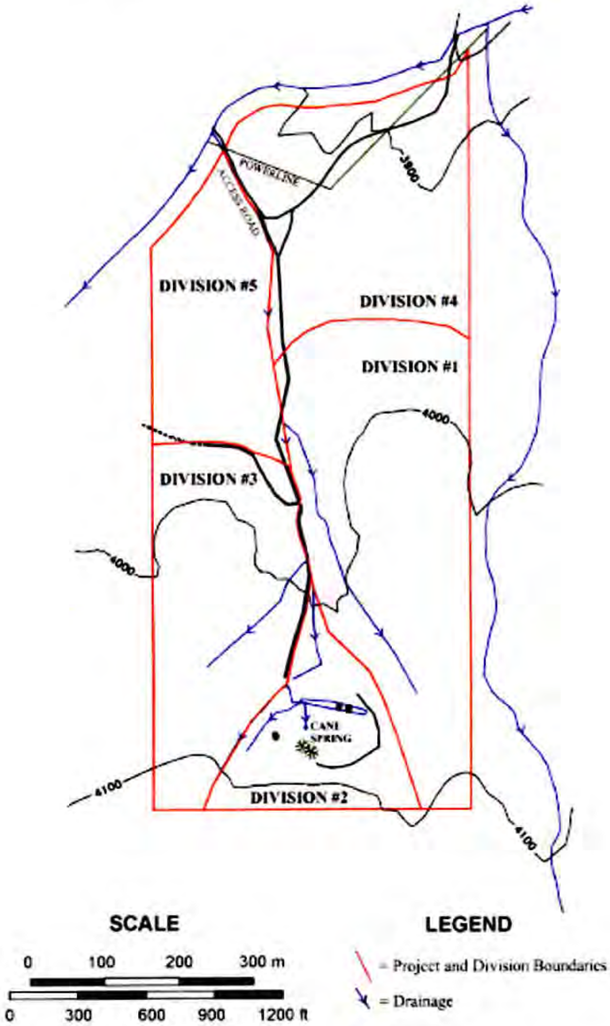

Figure 2. Location of cultural materials, project boundaries, and divisions.

stone artifacts in Division 1 with the largest percentage being flakes from the manufacture or maintenance of stone tools. The highest concentration of stone artifacts is on the east side of the division near the rock ring features and in the drainages.

The rock cairns are generally 8 to 20 stacked rocks. Six of the cairns have been constructed in a line on a north/south axis. The rock rectangle is made of two rock walls against a rock outcrop. It appears to have been constructed within the last 100 years and additional rocks have likely been added within the last 20 years. The corral is approximately 293 feet long on the west side and 154 feet long on the north side. It is made of barbed wire, mesh wire, and posts. The posts are railroad ties that are 5 x 9 x 80 inches in size and probably recovered from the Las Vegas and Tonopah Railroad bed after the railroad ceased operation in 1918. The water tank is a low-walled double basin made of painted concrete. Each basin is approximately 12 feet square with walls approximately 6 inches wide and 2 feet high. Water was piped to the tank from the spring by a 1 inch pipe. The trash scatter is at the north end of the corral and contains ceramics, glass, cans, metal, and a chisel. Dates for the cans range from about 1900 to the present; however, many of the cans date from 1913 to 1928 (Rock 1988). In the drainage just south of the corral is an engine and clutch assembly from a Jeep with a tag dated March 24, 1951.

Division 2

The second division contains stone artifacts, a mine shaft, a spring, a trench, a historic grave, two historic trash scatters, a clothesline, a fenced area, a roof or wall structure, a possible corral, a rock cabin, a wood cabin, and a collapsed wooden structure. Other artifacts within the division include cans, wood, pipe, and fence wire. There are more than 2,500 estimated prehistoric stone artifacts in the division. Most of these are waste flakes from the manufacture or maintenance of stone tools. The highest concentration of stone artifacts is south of the trench below the spring. The surface of this area is sandy and may be several feet deep with artifacts buried in the sandy soil.

Cane Spring is located 75 feet east of the rock cabin and 92 feet from a mine shaft. The spring has been modified by digging out a small cave into the face of the hill that allows for the collection of water. A trench extends 107 feet down slope from the spring. The trench is approximately 88 feet long, 20 feet wide, and 10 feet deep and was constructed after 1964 and collects water from the spring and runoff from two small drainages.[1] A historic miner's grave measures 11 x 9 feet and has been outlined with rocks (see Documented History). The mine shaft could not be entered and the dimensions remain unknown.

In the trash scatters are milk cans, sardine cans, meat cans, coffee cans, tobacco tins, fruit and vegetable cans, a spice can, oil cans, and one piece of a Ball jar. Dates for the cans start about 1900 and end at the present. The clothes line consists of three posts connected with two pieces of insulated wire.

Figure 3. *Rock cabin at Cane Spring (2000).*

Figure 4. *Wood cabin at Cane Spring (2000).*

The roof or wall structure consists of a 2 x 4 inch frame with corrugated metal sheeting and measures 10 x 10 feet. The small corral or livestock pen measures approximately 45 x 5 feet and is made of railroad ties and mesh wire. A metal pipeline passes through the corral here and probably supplied water for livestock.

The remains of a 16 x 14 foot rock cabin are west of the spring and consist of collapsed rock walls and a partial chimney on the west wall (Figure 3). Within the structure on the earth floor are pieces of corrugated metal and wood, collapsed elements of its roof, and a door jamb. In front of the cabin, concrete was poured to stabilize the soil on the slope. A wood-frame cabin is approximately 2 feet west of the rock cabin (Figure 4). It is a one room structure with a gable roof. Outside dimensions are approximately 13 x 11 feet. Exterior walls, floors, and structural framing are of wood with a corrugated metal roof. Interior finishes include cardboard and canvas. Another wood structure (collapsed) is just west of the wood cabin and may have been a workshop.

Division 3

This division contains stone artifacts, brownware pottery, a possible cultivated area or farm plot, six rock rings, four rock cairns, a historic road, and a rock structure that is a possible corral. Other artifacts within the division include cans and wood. There are more than 10,000 estimated prehistoric stone artifacts in the division. Again, most of these are waste flakes from the production and maintenance of stone tools. The brownware pottery has been made for the last 700 years. There are two dense concentrations of artifacts in a small saddle on the west side of the division. This area may contain buried artifacts as the soil is between 6 and 12 inches deep. There is a cleared area on the west side of the division that may have been cultivated. It is rectangular with sandy soil approximately 6 to 12 inches deep. A few rocks line the northeast corner, possibly to retain soil. On the surface are waste flakes and a small metal bucket.

Generally, the rock rings are three feet across and are constructed with 15 to 30 rocks. The rock cairns appear to be claim markers established during the early part of the twentieth century. A historic road crosses the divisions from west to east. This road was utilized by horse and wagon and vehicular traffic that probably date to the early twentieth century. There is a rectangular rock structure that measures approximately 48 x 35 feet in the bottom of a drainage. It is only a few feet west of the corral in Division 1 and it may have been a rock corral.

Divisions 4 and 5

Division 4 contains stone artifacts, brownware pottery, three rock cairns, and a few scattered cans. More than 1,000 prehistoric stone artifacts are estimated for this division with most being waste flakes from the production or maintenance of stone tools. The highest concentration of stone artifacts is in the north end of the division. Because the soil is shallow across the division, there are probably few buried artifacts. The cairns appear to be claim markers typical of others at the site.

Division 5 contains stone artifacts, brownware pottery, eight rock cairns, a few scattered cans, and the remains of a historic road. It is estimated that there are more than 1,000 prehistoric stone artifacts and most are waste flakes. The soil is shallow in the division and there are probably few buried artifacts. The cairns appear to be claim markers and similar to those in the previous divisions. A rusted and crushed fruit and vegetable can is at one of the cairns. Cans are commonly used to store claim information at claim markers.

Figure 5. *Byor Stone (courtesy of the MacKay School of Mines, University of Nevada, Reno).*

DOCUMENTED HISTORY OF CANE SPRING

Early History

Cane Spring was known as *Paga^{x}mbuhan* in Southern Paiute with *Paga^{x}m* being cane and *buhan* being much. It was also known as *Hugwap* in Shoshone for cane. The inhabitants of the spring were probably related to the Ash Meadows Southern Paiute and the Western Shoshone. According to Julian Steward (1933), one family resided at the spring around 1875 to 1880 and included *Wixna* who was born at *Tupipa* (Tippipah Spring), his wife *Paga^{x}mbuhan huvijiji* who was born locally, and two sons and one daughter.

When the first Euroamericans visited Cane Spring is not exactly known, but it may have been by members of the Mormon Battalion in 1847. Also, the camp at the spring might have been named for Colonel Kane who was the commander of the Mormon Battalion. Legend has it that one member of the Mormon Battalion, a Frenchman named La Quinta or Naquinta, was reported to be in the area in 1847.

Euroamerican Immigration and Transportation

The first documented Euroamerican use of Cane Spring is by a group on their way to the gold fields of California; the Death Valley 49ers. On December 7, 1849, Lewis Manly and John Rogers found a brush hut occupied by an American Indian man and his family (Manly 1894:127–128; Stoffle et al. 1990:42). They were given corn to eat and noted that there were corn stalks nearby (Manly 1894:128; Stoffle et al. 1990:42). The corn had been watered from the nearby spring. Manly and Rogers returned to the spring, which was then deserted, with other members of their party on December 9, 1849, and they stayed for nine days (Manly 1894:129–130; Stoffle et al 1990:42).

The visit to Cane Spring is important to the date of the rock cabin at the spring. The Byor Stone, is a welded rhyolite tuff shaped-stone that was used as a building block in the fireplace of the rock cabin at Cane Spring. It is inscribed *F.O. Byor 1847*, with a skull and crossbones to the lower left of the inscription (Figure 5). This stone has been used as evidence that the site was visited in 1847. However, Manly (1929) never mentioned a rock cabin at the spring during his visit in 1849. Since the party stayed in the area for nine days, if the cabin was present at that time it would have probably been noted in Manly's journal. Therefore, I conclude that the rock cabin was built after 1849. The Byor Stone must have been collected in the area and used in the construction of the cabin. The date on the stone signifies its inscription only and not the date of construction of the cabin.

Cane Spring was probably utilized as a stage stop on the freight line between Utah, southern Nevada, and San Bernardino, California prior to 1900 (Worman 1969) and the rock cabin may have been built at that time. The spring may have been part of the stage line from Carson City to Ivanpah or it was on the old emigrant road from Salt Lake City to Los Angeles. The use of the spring as a stage stop prior to and in the early 1900s could explain the rock corral at the site. The wooden corrals, however, are constructed of railroad ties that probably came from the Las Vegas and Tonopah Railroad.

After the railroad ceased operations, the spring was used for a stage or freight stop on the road between Beatty and Las Vegas.

Mining Activities

Besides the mine shaft, Cane Spring is also tied to mining activities at the now abandoned townsite of Wahmonie, located approximately six miles west of the spring. Prospecting in the Cane Spring and Wahmonie area likely began in the 1850s by Mormons with the discovery of the Hornsilver Mine; it had surely begun by 1905 when the geologist Sydney H. Ball mentions visiting this mine (Quade 1984:31). By 1928, Mark Lefler and his partner W. R. McCrea were promoting, organizing the mining camp of Wahmonie and the Wahmonie Mining District (Quade 1984:31). George Wingfield, a Tonopah mine owner and banker, purchased a portion of the mining claims (Quade 1984:31). By early 1929 optimism began to fade and people began leaving Wahmonie. At one time, a pipeline from Cane Spring to Wahmonie was proposed to carry water but it was never built. Water was carried in barrels from the spring to the town.

In 1922, the mine at Cane Spring was operated by Pete Black and owned by Paul Kenyon. It is not known if others owned or worked the mine. A search of the mining claim records in the Nye County Recorder's Office in Tonopah revealed that between 1922 and 1930 Kenyon owned at least seven mines in the area. The mines he owned were the Purple Butte #2, the North Star Fraction and Fraction #1, the Conglomerate and Conglomerate #1, and the Yellow Rose and Yellow Rose #1. It is possible that one of these is the mine at the spring.

Of the known occupants living at Cane Spring, the one most associated with the spring is Pete Black. On March 25, 1922, the *Las Vegas Age* reported that the body of Pete Black had been found in the cabin at Cane Spring. According to the article, J. W. Woodard and Paul Kenyon had left Las Vegas carrying supplies to Black who had been prospecting for Kenyon in the "Kane Springs district since January 26." Ed Weaver, who had been working with Black, had returned to Las Vegas on February 14 leaving Black alone. When Woodard and Kenyon arrived at the spring, they found Black "sitting on the side of the bed dead. He had evidently tried to get up during the night as a box of matches was still in his hands, partly open." By the condition of the body they assumed that he had been dead several days. A calendar on which Black was keeping track of the days had a last entry of March 12, 1922. He died either on that day or shortly thereafter. However, the death certificate for Black was signed "Charles Glenn Depty Sherriff [sic]" and indicates that he died "About March 5th, 1922." The cause of death is listed as "Found dead in bed, no signs of foul play, looked as if he had a hemmorage [sic] of the lungs, from all signs around the room it appeared as if he had been sick for some time." Black was buried "Near Cane Springs" on March 26, 1922. The death certificate was dated April 20, 1922 in Tonopah, Nevada, by C. J. Richards M.D. On the death certificate Black is listed as a white male prospector, 52 years of age, but in the newspaper article his age is 47. According to the *Las Vegas Age*, Black was unmarried, had a brother and sister living in Santa Monica, and another sister in Seattle. He had come from Seattle and was a Mason. Although little is known about Black, he is buried at Cane Spring. After burial, a wooden marker was placed as a headstone at the grave. In 1969 a wooden marker and a metal marker were at the grave. During the present project however, only the metal marker was found.

CONCLUSION

Interpretation of the data collected from the field work in 2000 at Cane Spring indicates that the spring has been an important location throughout prehistory and during historic times. The artifact assemblage shows intensive use of the area by American Indians for at least 10,000 years (i.e., Silver Lake points). Prehistoric activity areas and structures suggest subsistence activities related to stone tool manufacture and maintenance, food processing, and storage. Residential use is indicated by rock ring structures possibly used for a multifamily or extended family residence. These activities by American Indians can be assumed to have continued into the Historic Period until they were either displaced or they abandoned the site. Prehistoric and Contact Period artifact assemblages and features were then incorporated into historic use.

The Historic Period artifact assemblage indicates mining, transportation, and residential activities. The 1847 date on the Byor Stone, although not indicative of the date of construction of the rock cabin, shows early historic entry into the area. The rock cabin and the corrals indicate a stage stop in the late 1800s and into the early 1900s. Historical data supports the preceding activities and use of the wood cabins as a residence for trappers and miners. The mine shaft is evidence of mining in the early 1900s. Metal artifacts (cans) at the spring date from the early 1900s to the present.

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END NOTES

[1]This trench is not in a 1964 picture taken by Frederick Worman.

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Digging a Little Deeper at Alunite

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Archaeologists involved in Cultural Resource Management are required to assess the eligibility of discovered sites under all four criteria of the National Register of Historic Places. While archaeologists generally excel at evaluating historic sites for their data potential (Criterion D), evaluations for associations with significant events and people (Criteria A and B) and engineering or artistic values (Criterion C) are sometimes lacking. For mining sites and districts, there is a temptation to skim the mining literature for the presence of economically important mines when developing a context and evaluating mining sites. Without an important mine, there is in turn a tendency to overlook possibly important historic events and associations that may have occurred in the mining district in spite of the lack of an economic mine. This in turn could lead to the destruction of potentially significant properties in mining districts where large, important mines were not found and developed. Digging a little deeper into the literature can reveal that other, significant events occurred in some mining districts without the development of large mines. Examples from the Alunite Mining District in southern Nevada are used to illustrate this.

SCRATCHING THE SURFACE AT ALUNITE

Between Henderson and Boulder City, Nevada, is Railroad Pass, a low saddle through which passes U.S. Highway 93/95, several power and water lines, and the remnants of the Boulder City Railroad. South of Railroad Pass is Eldorado Pass, once the site of a busy road between Las Vegas and the mines of Eldorado Canyon, but now little used except by recreationists from Henderson. These passes, which divide the McCullough Range from the River Mountains, are defined by faults that fractured Tertiary volcanic rocks. These same faults allowed hot water and steam from deep in the earth to move through the bedrock, altering it and depositing a wide variety of minerals.

These minerals include the ores of useful metals such as gold (Hewett et al. 1936; Longwell et al. 1965; Vanderburg 1937), silver (Vanderburg 1937), and tungsten (Stager and Tingley 1988), and have in the past sparked the interest of prospectors and miners. Mine dumps, shafts, and adits are visible here and there in the passes and on the steep hillsides. Miners have referred to the area as the Vincent, Alunite, Railroad Pass, Glonite, or Flatiron mining district, although the boundaries of any of these districts were poorly defined and may include mining activity from other nearby areas (Averett 1963; Tingley 1998). Numerous "excitements" occurred within this area during the first decades of the twentieth century as Las Vegans attempted to expand the economic base of their small railroad town.

The first Euroamerican to notice mineralization in the area was Dick Lawrence in 1870. He was a miner and prospector traveling from the Vegas Valley to Eldorado Canyon. He noticed gold, staked a claim, and sank several shafts, one around 75 ft. deep, on several promising outcrops. His samples assayed from $4 to $64 per ton, but no one was interested in investing in his mine. All the potential financial backing needed to develop the property was tied up in Eldorado Canyon activity. By the time activity declined in Eldorado Canyon, Lawrence had relinquished the claims (*Las Vegas Age* [LVA] 1915a).

In 1906, the area experienced its first "rush" when good gold assays were reported. At that time, the district was referred to as the Vincent District. By May of 1906, over 35 men were prospecting and developing claims in the district, including the northern portions of the area, which was even then

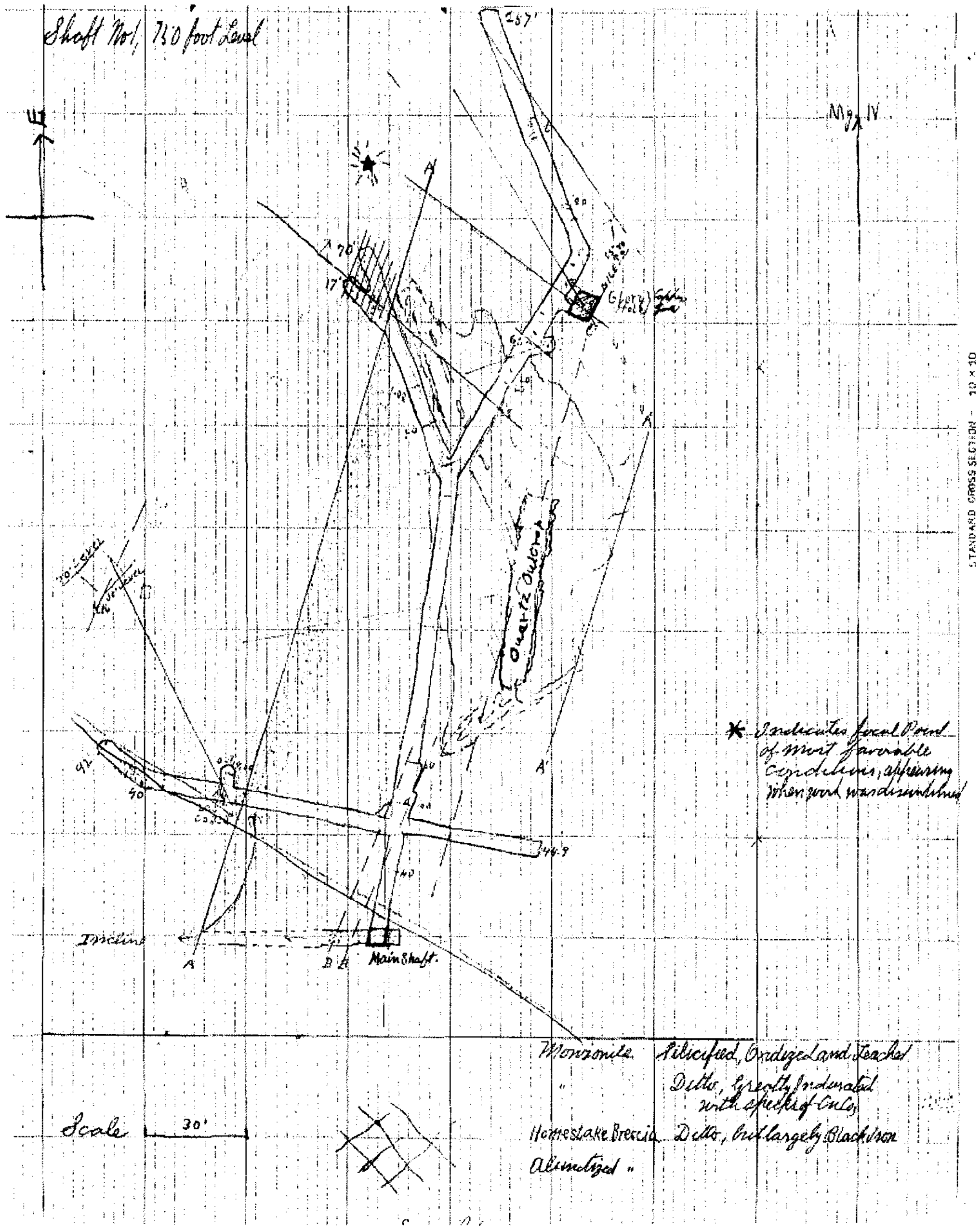

Figure 1. *Diagram of inner workings of Shaft No. 1, 750 foot level created by Robert T. Hill. (Robert T. Hill Collection, DeGolyer Library, Southern Methodist University, Dallas, Texas, A1981.0277.)*

known as Railroad Pass. One set of claims in the Railroad Pass area was staked by local residents Frank Duncan and Frank Quereaux (LVA 1906a, b). All of the activity from the Vincent District kept local Las Vegas assayers, Smith and Hecker, "... on the jump ..." (LVA 1906a).

Activity in the district began to slow as summer descended on southern Nevada. Heat and lack of water hampered mining and prospecting efforts, and many miners ceased activity during the hot summer months. A newspaper report optimistically predicted plenty of activity in the fall (LVA 1906c). A few hardy souls did continue working during the summer, such as the three miners working on the Bishop, Colson, and Jefferson claims, that had "... plenty of water in their cement cistern and comfortable working quarters" (LVA 1906d).

Activity did pick up in the fall of 1906, but not to the level predicted in the newspaper. Another company, the Oasis Copper and Gold Company, was formed to work a copper ledge in Railroad Pass and they proceeded with development work. Other activity included ore shipments from the Quo Vadis Mine and development work on claims such as the Alaska and Preston Groups (LVA 1906e, f). Little activity, however, was reported during 1907. The activity reported in the newspaper was on claimants (such as the Oasis Copper and Gold Company and Duncan and Quereaux) keeping up on the required yearly assessment work needed to keep the claims valid. Discussion of this activity was banished from the front page to the "Local Notes" section buried deep in the newspaper (LVA 1907a–c). It appeared as though the Vincent District was on its way to total abandonment.

The district was snapped out of its doldrums, at least for a while, during the summer of 1908, with the arrival of Robert T. Hill, a consulting geologist with headquarters in New York City. Hill announced that his work was an experiment, in that he believed Railroad Pass had potential for deeply buried gold deposits similar to those found at Goldfield, Nevada, a few years earlier. To prospect the area and develop any mineral deposits that might be found, the Alunite Mining Company was organized in New York under the umbrella of the Hill Syndicate. Mr. C. L. Graves was president, and W. D. Pearce the general manager. Robert T. Hill was the directing geologist (*Engineering & Mining Journal* [E&MJ] 1908a; LVA 1908b). The company brought in supplies and constructed a camp that contained an office building, a blacksmith shop, bunkhouses, and stables. A contract was let with Mr. E. B. Fredericks of Searchlight to sink exploratory shafts (LVA 1908b; *Searchlight Bulletin* [SB] 1908). These exploratory excavations were extensive (Figure 1). The most promising claim was patented (Knowlton 1909).

Although gold was found, it was apparently in small, isolated veins. Some of these veins assayed out quite high, which kept interest in the Railroad Pass properties, and the district in general, high for several years (LVA 1908a–g, 1909a–d, 1910a–f, 1911; SB 1911a, b). These finds were, however, not enough to make a paying mine and did not keep the Alunite Mining Company solvent. It went through a few different mine managers and a reorganization to become the Alunite Consolidated Mining Company. Robert Hill, and some close family members and friends, eventually ended up as sole owners of property (LVA 1910g, 1913, 1931, 1932). No more attempts to mine the property were made after 1913 (LVA 1913). Hill continued with his annual assessment work through at least 1915 (LVA 1915f), but let the claims lapse shortly afterward (LVA 1917a, b).

Figure 2. *December 1915 Las Vegas Age Advertisement for Lots at the Quo Vadis Townsite (LVA 1914j).*

Although Hill's mine was not doing well, a number of rich finds were made at the Quo Vadis property in the southern portion of the district. These discoveries resulted in additional investment in the Quo Vadis and other mines and the laying out of a town site known as Quo Vadis (Figure 2). Unfortunately, these discoveries also failed to be rich enough to support a sustained mining effort, and the district once again became inactive after late 1915 (LVA 1914a–l,1915a–e).

There were a few minor gasps later on, including resumption of work during the 1930s at the Quo Vadis by the Boulder Canyon Gold Mining Company (*Las Vegas Evening Review-Journal* 1934, 1935, 1937) and a short-lived gold excitement in 1949 that was quickly squelched due to the fact that the discovery was in the Federal reservation created for the Hoover Dam project (*Boulder City News* 1949).

There were also exploration attempts to characterize and mine some of the other minerals found in the district. Towards the end of Hill's attempts to mine gold, he also attempted to exploit the alunite mineral that helped lead him to the Railroad Pass location in the first place (SB 1911a). Through the years, various government agencies also examined the alunite deposits as a potential aluminum or potash source (Gale 1917:111; Hewett et al. 1936:144–145; Thoenen 1941). There was also some minor tungsten production from the Quo Vadis in 1973 (Stager and Tingley 1988:43). There currently are few active claims in the district, most of which are considered by the Bureau of Land Management to be "nuisance claims" (Myhrer 1995), and the only active mine in the area now is a large gravel pit operating on the south side of Railroad Pass.

At first glance, there is little to distinguish this mining district from many others in Nevada—it is characterized by a series of "excitements" and small rushes that failed to produce any significant amounts of ore or wealth. Cultural resource inventories that have occurred in this area reflect these facts, with a pronounced trend that finds many of the mining sites unassociated with any significant events and people and therefore ineligible to the National Register of Historic Places. At best, some sites in the district were evaluated and found eligible for their archaeological value (cf. Blair et al. 2001; Brooks et al. 1975; Lawrence 1999; Myhrer 1995; Myhrer and Hatzenbuehler 1994; White 1998). The following is a discussion on how the context and eligibility determinations for Alunite would have been improved by digging a little deeper into the district's history and placing it in a larger mining context. It also illustrates that while some mining districts may not have resulted in the creation of a large mine, they may be significant for other historic reasons or associations.

DIGGING A LITTLE DEEPER—PROSPECTING

The previous cultural resource work correctly identified an association between Alunite and a man named Robert T. Hill. A few of the previous archaeologists go so far as to cite one or two articles that Hill published in the *Engineering and Mining Journal* about his prospecting efforts in Railroad Pass (Blair et al. 2001; Myhrer 1995; White 1998). What these investigators failed to notice was that the two articles are part of a series of four written by Robert T. Hill (1908a–d).

In the first article, *Prospectors and Prospecting in Nevada*, Hill (1908a) asserted how he intended to proceed with his own scientific based prospecting efforts in an effort to find another ore body similar to the one at Goldfield. In this article, he outlined three steps that an informed, scientific prospector should take. The first was to become familiar with all of the published geologic material of the area one wished to prospect. The second was to interview prospectors that have already searched the area. The third and final step would be to study an already discovered ore deposit of the type one wished to find. Hill also discussed how prospecting was currently being practiced, and lamented the fact he ". . . did not meet a single man in Nevada who had the least conception of the law of characteristics of the ore occurrence . . ." He went on to say that prospectors ". . . worked on precedent, and precedents taught them to look for good old indications that do not accompany these erratic Nevada deposits" (Hill 1908a:1053).

Mining precedents that Nevada prospectors were using were actually very old. The earliest known European geology and mineralogy texts, *De Re Metallica* by Georgius Agricola (1950) and *Pirotechnia* by Vannoccio Biringuccio (1990), both first published in the early sixteenth century, discuss the search for metal deposits, or prospecting. Some of the more practical advice given includes: following stream placer deposits back to the source; examining vegetation for zones where the plants either don't grow as well or they somehow differ from the surrounding vegetation in color or type; or *by searching for veins that are discolored by their metal content* (emphasis added). This advice had worked well for mankind for untold centuries before being recorded, and continued to do so during the following centuries. As Hill (1908a) discussed, it was still being followed in the nineteenth- and early twentieth-century American West. Typical prospectors, few with any training in geology or mineralogy, roamed the hills and mountains searching for mineral stained quartz veins (rust colored for gold, gray and black for silver, green for copper) or gossans (also called iron hats—red and yellow stained deposits of chert and ochre resulting from the weathering of sulfide

Figure 3. *Robert T. Hill (on left) during his prospecting expedition. (Robert T. Hill Collection, DeGolyer Library, Southern Methodist University, Dallas, Texas, A1981.0277).*

ores). The few books on prospecting available at the turn-of-the-century include some discussion of rock types and give some practical advice, such as don't look for coal in volcanic regions (cf. Stretch 1900). Most prospectors based their knowledge of potential ores from working in mines where they learned what the ore looked like.

When a promising vein or gossan was found, a sample was crushed by hand. The resulting sand was panned or tested using simple chemical assay methods to determine the presence or absence of valuable minerals. Often, the discovery of a mine would precipitate a rush as others searched for similar deposits in the neighborhood (Lewis 1950; Young 1970, 1976). These types of prospectors found many important and significant mines, but also wasted much money and effort by mistaking barren rock for potential ore. One prominent Nevada example of this is the 1866 Hardin City rush in the Black Rock Desert region of northwestern Nevada, where barren rock mistaken for ore contributed greatly to a mining swindle (Raymond 1869:120–121).

The second article by Hill (1908b) was a synopsis of a description of the Goldfield ore body written by fellow geologist Frederick Ransome (1907). The Goldfield ore body was unlike the ores sought by the prospectors of the time, and its discovery was considered to be a lucky accident by two novices who had no idea of what they were doing (Young 1976). Hill believed there were several important points about the Goldfield deposit as described by Ransome. One of the most important was an association with the mineral alunite, which, like the gold, was deposited by acidic solfataric vapors acting on rhyolitic bedrock. Another important point was the fact that the ore body improved with depth.

The third article in the series was entitled *A Scientific Search for a New Goldfield* (Hill 1908c). In this article Hill describes how he intended to use the geologic associations described by Ransome in finding another deeply buried Goldfield-type ore body, essentially creating and using a geologic model to guide his prospecting efforts. He was going to search for Tertiary rhyolitic volcanic rocks, intersecting faulting, evidence of hydrothermal activity, and rock alteration and mineralization which included the presence of alunite (Figure 3).

The fourth and final article, *Camp Alunite, a New Nevada Gold District* (Hill 1908d), describes the geology in Railroad Pass and its similarity to the ore deposits at Goldfield including the all important presence of alunite. The fault lines and basic bedrock were noted, the suspected presence of alunite was confirmed through laboratory testing, and traces of gold were found by panning of surface deposits. All that was left was the sinking of prospect shafts to confirm deeply buried, rich gold ores.

Prospectors had already been searching for Goldfield type deposits, and some similar discoveries had been made based on the presence of silicified ledges (Tingley et al. 2001). These discoveries were not the result of a search using geologic principles, but a continuation of the earlier practice of wandering the hills looking for rocks similar to those at an existing mine without taking into account bedrock geology, faulting, or indicator mineralization. Many geologists of the time felt that a greater application of the principles of geology was needed in the mining industry. This is illustrated by an author of a book on the subject, Josiah Spurr, who wrote:

> The writer was lead to attempt the present volume through the perception of how great a need there was, among mining men and students, of some work stating concisely those results of the science of geology which bear upon ore-deposits. No work of this type exists, so far as the writer is aware, in any language [Spurr 1907:v].

William Smith, using geologic data accumulated during canal construction projects, had published the world's first geologic map in 1815 (Winchester 2001). Some scholars date the beginnings of scientific mine geology to that point (Lynch 2002:104), although much geologic study and discovery at that time was limited to a core of independently wealthy men in Europe. It was not until the 1840s that geology began to be taught in universities and that geology students began to establish geological surveys and societies and to influence the mining industry (von Zittel 1901:145–152). Scientifically trained mining engineers and geologists began to be active in mining projects in the American West in the late 1840s (Spence 1993). These men, however, were largely employed at known mineral deposits and established mines determining the extent and nature of ore bodies and experimenting with new beneficiation processes (Alford 1971; Spence 1993), and it was rare to find them engaged in prospecting during the nineteenth century (Spence 1993:254–255). It was not until the 1910s that large numbers of trained mining engineers and geologists devoted their efforts to prospecting (Spence 1993:256). As mentioned above, most Nevada prospectors did not have any formal training in geology and merely wandered the areas around known discoveries in hopes of finding rocks that looked like the ores at the known mines. These old style prospectors were, however, still being relied upon to find new ore bodies (McClelland 1927). Shortly after the turn of the twentieth century, however, it was widely believed that few surface exposures of large, high-grade ore bodies were left to be found in the continental United States (EMJ 1908b). It was felt that undiscovered, buried high-grade deposits existed, but that they would not be found using current prospecting methods. The science of geology would have to be brought to bear to uncover these deposits. Hill's efforts appear to be one of, if not the first, attempts by a trained geologist to locate a buried ore deposit using an exploration strategy based on the latest geologic knowledge or model. This seems especially true for prospecting efforts in Nevada. The mining community, and the general public, watched Robert Hill's experiment with interest (EMJ 1908b; LVA 1908b; Lewis 1909; Lyle 1909; Ransome 1909).

One way to test the theory that Hill was the first in Nevada to use scientific geology in his prospecting efforts is to look at Nevada's mining districts and determine how discoveries were made. To do this, a United States Geologic Survey (U.S.G.S.) publication on western United States' mining districts was consulted. It indicated there were 187 mining districts in Nevada in 1912 (Hill 1912). An examination of some readily available mining literature (Hall 1994, 1998, 1999; Hill 1916; Ketner and Smith 1963; Lincoln 1982; Moore 1969; Paher 1984; Tingley 1998; Vanderburg 1988a–c) uncovered discovery stories on 126 (67 percent) of these mining districts. Of the districts with discovery stories, 88 (70 percent) of them are reported to have been found by old fashioned prospectors, with 28 percent of those prospectors clearly out searching an area around a recent discovery. Three prospector related stories indicate that the discovery was somewhat accidental: picking up a rock to throw at a recalcitrant mule only to discover that it was unusually heavy, stumbling on a promising outcrop while searching for a lost horse, or taking shelter from a storm under a ledge with a quartz vein exposure. Eight discoveries are attributed to Nevadans in other professions, such as cowboys, farmers, stage drivers, and a piano tuner, and four are ascribed to non-prospectors that were traveling through Nevada. Native Americans are recognized as the discoverer of a deposit in 20 (16 percent) of the discovery stories, and, based on a discussion presented by Raymond (1870:121) there are reasons to believe that figure should be higher. Clearly, scientifically trained geologists and mining engineers did not play much of a role in locating Nevada's mineral wealth up through the first decade of the twentieth century.

Although Robert T. Hill's experiment was a financial failure, it may have been the first prospecting effort guided by a scientific geological model in Nevada. Even if it is not, it certainly helped secure the role of geology and the geologist in prospecting. This is reflected in an examination of mining literature written in the years following Hill's experiment. For example, Hoskins states that "... the old-fashioned, venturesome kind of prospecting has been but recently crowded off the scene by the better, scientific kind..." (Hoskins 1912:45). McClelland (1927) affirmed that prospecting is guided by knowledge of geological associations and the peculiarities of known ore bodies, and acknowledges theoretically trained economic geologists should make the best prospectors. Young declared that buried "deposits can be discovered only by boring or deduced by geological reasoning from distant exposures," and that "another important consideration is rock alteration" (Young 1946:26–33).

Hill's boldly public prospecting experiment on the heels of Ransome's assumption that alunite is associated with gold ores also prompted advances in prospecting mineralogy. No simple field tests for confirming alunite existed when Hill ventured into southern Nevada (Hill 1908c:1157). By mid-1909, however, directions for a simple chemical field test for recognizing alunite were published (Gage 1909).

It must be noted that alunite is still considered an indicator of hydrothermal gold deposits. These types of gold deposits are, however, erratic and tend to be somewhat unpredictable. One prominent, modern exploration geologist who has identified, characterized, and outlined these types of ore bodies states that, "Luck and persistence are the most important techniques together with many, many drill holes." (Lowell 1999:181). Perhaps Hill's exploration ideas were ahead of the exploration technology needed to properly define the ore bodies associated with alunite.

Being the first, scientifically trained geologist using a geologic model in mineral exploration would indicate an association with the nation wide trend of using scientific geology in mineral exploration in the twentieth century. This would indicate that some properties in the mining district associated with Robert T. Hill's experiment might be eligible under Criterion A.

DIGGING A LITTLE DEEPER—INVESTMENT

Another association with nation-wide trends that should be considered is where Hill got the money used in his venture. Much of the money was his own, or borrowed from friends, relatives, and acquaintances throughout the United States and Europe. One friend that invested a significant amount of money in the venture was Sir John Murray. Sir John Murray was a British oceanographer that participated in the H.M.S. Challenger expedition of 1873–1876 (considered to be the world's first oceanographic exploration) and was appointed editor of the expedition reports (Alexander 1976:210). Apparently Hill and Murray had become acquainted when Hill helped direct a field trip for the Eighth International Geographic Congress through Mexico and the southwestern United States in 1904 (Alexander 1976:196).

Murray became alarmed about the disappearance of so much of his money into a hole in the desert, and paid Camp Alunite a visit in May 1911 (Figures 4 and 5). Although initially encouraged by Hill and indicating that he would continue with his support, Murray's financial backing was withdrawn in August 1911 (Alexander 1976:214). Hill bemoaned the fact that he was not able to dig any deeper (Alexander 1976:216).

John Murray's investment in Alunite appears to be part of the larger trend of British and other foreign investment in western United States mining that started circa 1860. This foreign investment was dominated by the British from 1860 to 1901, but continued with force until World War I (Spence 1995). Clearly, British investment was involved with the prospecting at Alunite. British investment

Figure 4. *Sir John Murray (on left) with his wife and daughter and Robert T. Hill (on right). (Robert T. Hill Collection, DeGolyer Library, Southern Methodist University, Dallas, Texas, A1981.0277).*

Figure 5. *Sir John and his daughter inspecting the shaft at Homestake No. 1. (Robert T. Hill Collection, DeGolyer Library, Southern Methodist University, Dallas, Texas, A1981.0277).*

was part of a larger, world-wide historic trend (Spence 1995), indicating that Hill's Alunite properties are also potentially eligible under Criterion A for that reason.

DIGGING A LITTLE DEEPER— ROBERT T. HILL

With all the discussion about Robert T. Hill, one has to wonder who exactly he was. Surprisingly, there was no effort to learn more about this man during the previous cultural resource management investigations in the Alunite Mining district. This is the case even though Hill's name is prominently associated with the district (cf. Blair et al. 2001; Lawrence 1999; Myhrer 1995; White 1998).

Without much effort it was possible to find three short biographies about Robert T. Hill (Block 1941; Marquis Who's Who 1966:565; Thrapp 1988:662–663). With a little more effort (interlibrary loans), it was possible to locate another short biography (Yochelson 1999:801–802), a multipage memorial (Wrather 1941), and a book length biography on Robert T. Hill (Alexander 1976). Alexander's book has an entire chapter devoted to Hill's efforts at Alunite (Alexander 1976:206–216)

Robert Thomas Hill (1858–1941) was a well respected geologist with wide ranging interests who worked in government, academic, and private sectors. Although he was orphaned during the civil war and hampered by the lack of a high school diploma, his interest and self-study of geology was sufficient to get him accepted to Cornell University (Alexander 1976). He received a bachelor's degree from Cornell in 1886, the year that he published his first scientific paper (Alexander 1976; Yochelson 1999).

Hill started his career working with the Smithsonian Institution and the U.S.G.S. During hiatuses with the U.S.G.S., he spent time with the Arkansas Geological Survey and was also the first professor of geology in the University of Texas system (1890–1891), where he earned the title of "professor." Hill was a great admirer of John Wesley Powell, and while emulating his hero he led the first exploratory expeditions down the canyons of the Rio Grande. In cooperation with the preeminent geologist Alexander Agassiz, he did considerable early exploration and geologic work in the West Indies, Central America, and Mexico. He was the first geologist on the scene after the eruption of Mount Pelée on Martinique in 1902, working at the behest of the National Geographic Society. His work there resulted in the first geologic description of a pyroclastic flow (Alexander

1976; Block 1941; Marquis Who's Who 1960; Yochelson 1999). It also appears as though he did some consulting geology work on the side during this period of his life (Hill 1903).

After a falling out with U.S.G.S. management, Hill resigned in 1903 and established himself as a full-time consulting geologist with headquarters in New York City. In addition to getting away from a management style that he found intolerable, he had a strong desire to make himself financially independent in order to continue his scientific studies in geology (Alexander 1976:185). Hill traveled extensively during this period, providing input on a number of mining properties throughout the southwestern United States and Mexico.

His attempts to become a rich mining geologist did not prove successful. He convinced himself that his notion of using a geologic model to discover a new Goldfield would be his salvation (Alexander 1976:207). This project was, however, a financial disaster. The venture cost him and his friends and family a total of $275,000 (Alexander 1976:216).

After his failure in Nevada, Hill moved to California, where he continued as a consulting geologist. He also did some college teaching, museum work, and contract work for the State of California and the U.S.G.S. At the onset of World War I, he established an office in Texas and became active in oil exploration, where he was able to recover some of his financial loses from the Alunite experiment (Alexander 1976).

Hill also worked on settling a boundary dispute between Texas and Oklahoma. For this work he was awarded an honorary law degree from Baylor University. Other degrees and honors bestowed upon him include: an honorary Doctor of Science from Southern Methodist University for his contributions to Texas geology; an honorary membership in the American Association of Petroleum Geologists; and a medal from the *Société Geologique de France*. As a government and academic geologist Hill is famous for his work in Texas, where he is known as "the father of Texas Cretaceous geology," and for his work in the Caribbean, where he is known as "the father of Antillean geology" (Alexander 1976; Yochelson 1999:802).

In 1931, Hill retired from active geologic work and moved to Dallas, Texas. There, at the age of 73, he began a second career as a feature writer for the *Dallas Morning News*. The articles were initially on petroleum geology, but grew to include other topics such as history, Indian life, and his personal reminiscences. Hill passed away in 1941 at the age of 81. He was cremated and his ashes spread over Round Mountain, a hill near his boyhood home of Comanche, Texas, where his interest in geology was first aroused (Alexander 1976).

Hill published over 200 professional works during his lifetime, making significant contributions to the field of geology. One biography states, "The total of Hill's writing (much of it still unpublished) represents one of the most distinguished series of studies of North American Geology ever struck off from the brain of one man" (Thrapp 1988:663).

Clearly, Robert T. Hill was an important person. Hill's experimental prospecting endeavor is directly related to his scientific interest in geology, the field in which he is most recognized. The Alunite experiment also occurred during the period in which he made significant contributions to geology. There is a clear association with Hill and many of the sites in the Alunite district. These are the main criteria needed for eligibility under Criterion B, and they should be considered for any future evaluations in the Alunite district. This is in spite of the fact that Hill's experimental prospecting work at Alunite did not result in the discovery of a large gold mine, and was a personal financial disaster for him.

CONCLUSION

Although Railroad Pass and the Alunite Mining District have been the scenes of cultural resource management work for 30 years, contexts prepared for the area's mining history have been lackluster. These prior efforts utilized few resources and concentrated on the lack of significant producing mines. By expanding the resource base used to include addition geologic literature, contemporary newspaper and journal articles, and other primary resources it was demonstrated that significant historic happenings and associations can be tied to the Alunite Mining District. It is hoped that archaeologists and historians will dig a little deeper into the histories of other mining districts that at first glance appear to be insignificant, and that more nuggets of Nevada's mining history will be found.

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A Report on Stemmed Point Sites at Lake Sarcobatus and Along the Amargosa River

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More than 10,000 years ago Pleistocene Lake Mojave near Baker, California; Lake Tonopah just west of Tonopah, Nevada; and Mud Lake just east of Tonopah, were occupied for substantial periods of time. It is likely that the culture who visited these areas did not originate around any of these Pleistocene lakes, but initially migrated from elsewhere. One point of origin may have been the San Joaquin Valley of California, over Tehachapi summit into the China Lake area. From China Lake, these people could have followed the Owens River north, and also gone south to Lake Mojave. Another point of origin may have been from southern California, over Cajon Pass to the Mojave River. A likely migration route between Lake Mojave and Lake Tonopah would have followed the Amargosa River, then past Lake Sarcobatus northwards to Lake Tonopah. Sarcobatus Flat, located north of Beatty, Nevada, and the Amargosa River south of Beatty, are both areas that have had very little modern archaeological review.

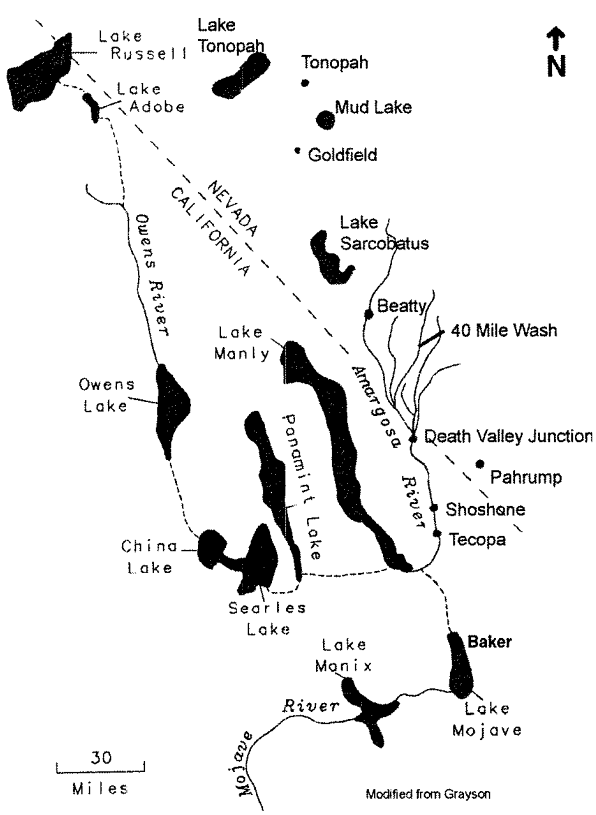

Figure 1. *Southern Great Basin pluvial lakes.*

Lake Mojave and Lake Tonopah were first studied by Elizabeth and William Campbell in the 1930s and funded by the Southwest Museum (Campbell et al. 1937; Campbell and Campbell 1940). The Campbells collected a few stemmed points from Sarcobatus Flat in the 1930s. These studies laid the foundation for future research of Paleoindian occupation in the Great Basin.

This article reviews my work, with the assistance of the Am-Arcs of Nevada, a local archaeological society in Reno, over a seven year period. The objective was to find evidence that a 10,000-year old migration route did in fact exist between Pleistocene Lakes Mojave and Tonopah (Figure 1).

LAKE SARCOBATUS

My first interest in Sarcobatus Flat came from a short note in *The Masterkey* by Mary Elizabeth and Richard Shutler (1959), describing some fluted points collected 25 miles north of Beatty in sand dunes along U.S. Highway 95. Sarcobatus Flat is located 25 to 40 miles north of Beatty, Nevada (Figure 2).

In 1998, a friend and I first visited Sarcobatus Flat and found numerous obsidian primary flakes on a large alluvial fan, located on the east side of Pleistocene Lake Sarcobatus. We did not find any projectile points at this time. Between 1998 and 2000, this same alluvial fan area was visited several times and several thousand obsidian flakes

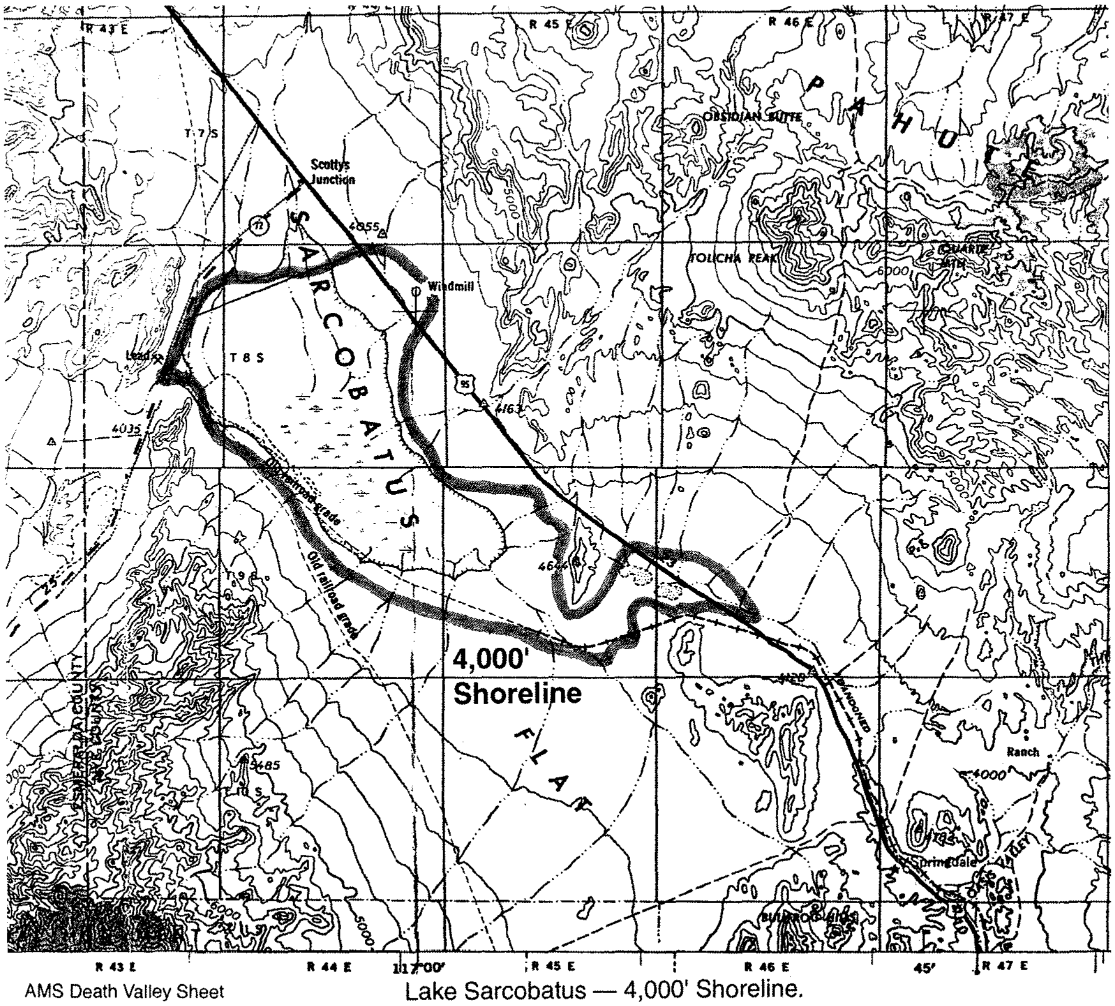

Figure 2. *Lake Sarcobatus 4,000 ft shoreline (from AMS Death Valley Sheet 1:250,000)*

were noted. Additionally, a few cobbles and millions of pebbles of obsidian were found scattered across the smooth surface of the fan. The source of the obsidian is Obsidian Butte, located some nine miles up Tolicha Wash on Nellis Air Force Range. Tolicha Wash at one time discharged into Lake Sarcobatus through the alluvial fan in a well-defined single channel (Figure 3).

A full set of USGS topographic maps covering the Sarcobatus Flat area was compiled and, using aerial photographs, I was able to locate one small area during field reconnaissance that looked like an ancient shoreline at the 4,000 ft elevation. No other obvious shorelines were noted during our field investigations.

In October 2001, a number of Am-Arcs members accompanied me on a three-day field trip to Sarcobatus Flat. With the added personnel, and zeroing in on the ancient 4,000 ft lakeshore eleva-

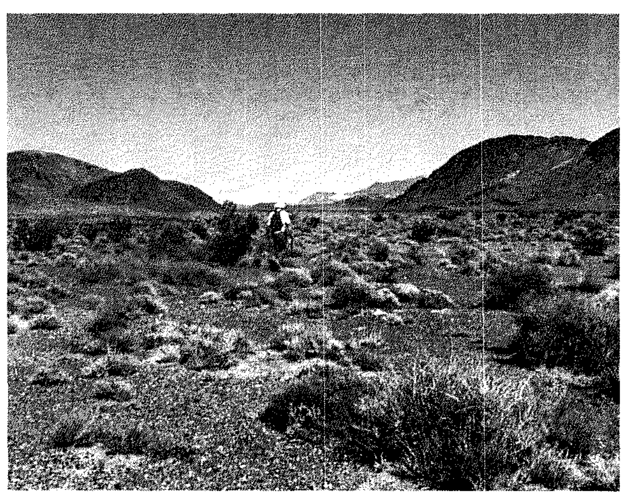

Figure 3. *Alluvial fan on the east side of Pleistocene Lake Sarcobatus cut by Tolicha Wash (looking east).*

tion, we were able to scout areas on the north and south shores of the old lakebed. The south shore—probably where the fluted points were found in the 1930s—yielded two stemmed points, while the north shore yielded four stemmed points and one scraper near an ancient south-flowing drainage that at one time must have entered the ancient lake. In October 2002, *Am-Arcs* members expanded survey on the same north and south shoreline areas. We found two more points in the south, and six more points and several scrapers in the north, but little debitage (Figure 4).

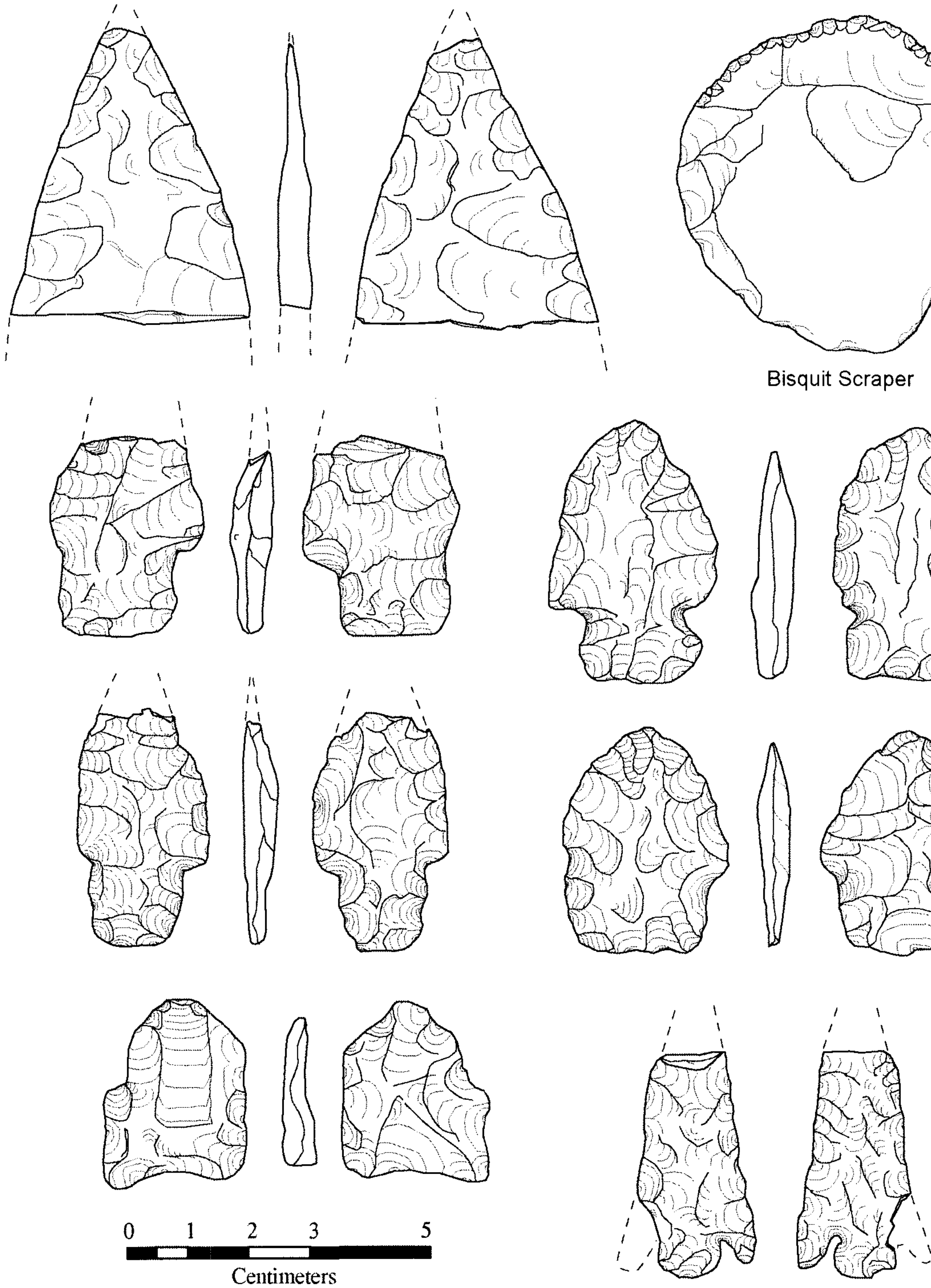

Figure 4. *Examples of chipped-stone tools at Paleoindian sites around Sarcobatus Flat. (The top two tools are made from white chert; all of the projectile points are made from obsidian.)*

On March 17, 2003, the first group of professional archaeologists toured Sarcobatus Flats with me. Included in the group were BLM archaeologists Pat Barker, Tom Burke, Sue Rigby, and Mike Baskerville, as well as Eugene Hattori, the Curator of Anthropology for the Nevada State Museum. Areas toured included the north 4,000 ft shoreline and the alluvial fan, east of the old lakebed and south of Tolicha Wash. Several broken up stemmed points were found, including the first white chert stemmed point base. These artifacts were found along the northern 4,000 ft shoreline, where a white chert "biscuit" or dome-shaped scraper had previously been found (see below, Figure 4).

On the east side of Lake Sarcobatus was also found an obsidian stemmed point, a part of another projectile point or some other bifacial tool, and what may be a flute-flake, at about the 4,160 ft elevation. Found higher up on the fan was a small rock wall enclosure abutting a large boulder and a metate, evidence of a much later, short-lived, occupation.

In October 2003, the white chert "biscuit" or dome-shaped scraper was found on the north side of the old lake bed at about the 4,010 elevation (see above, Figure 4). Rare obsidian and very rare white chert flakes were also observed at a few isolated areas. These isolated scatters were found within two miles north (4,040 ft elevation), and a mile south (3,980 ft elevation), of the 4,000 ft shoreline on the north side of Lake Sarcobatus. Also, found on the south shore of the old lakebed was the tip of a white chert projectile point or bifacial tool, and an obsidian stemmed point, in low sand dunes at about the 3,995 ft elevation.

All projectile points and associated sites were provenienced using a GPS unit (UTMs) and IMACS site forms were completed. All of the site documents were sent to the Tonopah BLM Field Office and to the University of Nevada, Las Vegas, archaeological records repository at the Harry Reid Center for Environmental Studies.

THE AMARGOSA RIVER

Today, the Amargosa River south of Beatty, Nevada, like Sarcobatus Flats to the north, is a barren and forlorn area. However, based on extensive paleoenvironmental research in the northern Mojave Desert, the environment was likely much

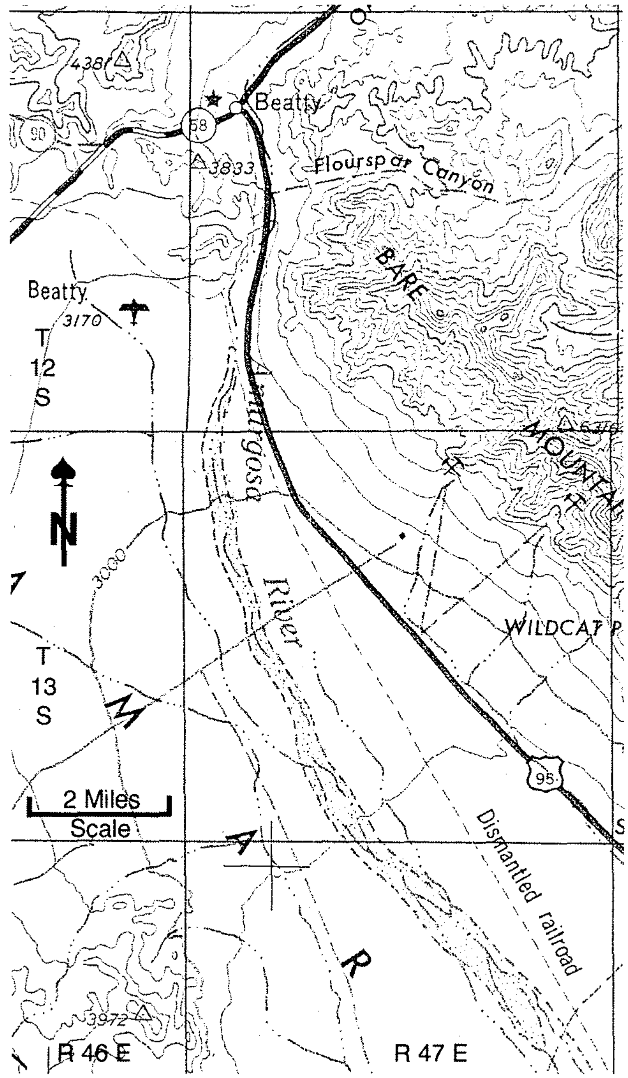

Figure 5. The Amargosa River survey south of Beatty, Nevada (from AMS Death Valley Sheet 1:250,000).

different some 10,000 years ago (see below). Field work I conducted from 2003 to 2005 along the terraces above the Amargosa River reveals Lake Mohave, Silver Lake, Pinto, and Elko styled points, and a variety of tools and many flakes. The terraces on both sides of the dry river channel were walked in places from Beatty southward for a distance of about 18 miles (Figure 5).

Approximately two miles of the east and west terraces above the Amargosa River seven miles south of Beatty were walked by Am-Arcs members over two days in October 2003. Numerous white chert flakes were found scattered over the distance along with various projectile points and tools.

The white chert appears to be obtained locally

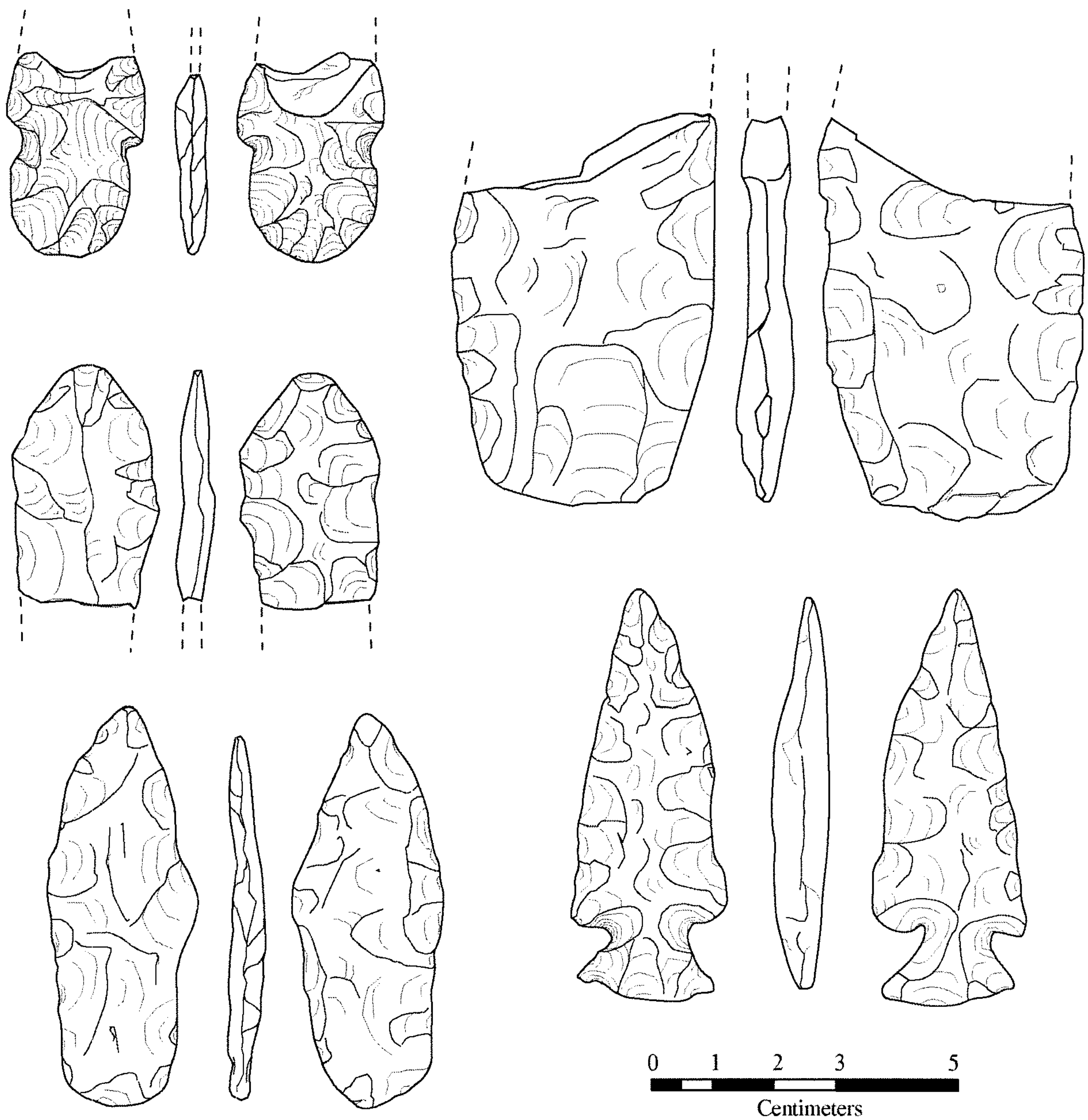

Figure 6. Examples of chipped-stone tools on Paleoindian sites along the Amargosa River. (The upper-left stemmed point is made from obsidian; all other tools are made from white chert.)

from nodules found along the river bank, much of which was of too poor quality to be used. The chert may have originally been associated with a lithic tuff that had been completely silicified, showing small clear blebs of what might be high temperature quartz crystals. Also found were points and tools made of tan chert, butterscotch chert with dendrites, silicified tan volcanics, tan silicified latite or rhyolite, obsidian, and fine-grained black basalt. Very rare small obsidian flakes were also noted.

All of the points, tools, and flakes found were on the surface of benches within 200 ft of the floodplain (Figure 6). A number of separate sites of numerous primary and secondary white chert flakes, some with the discarded central core, were found.

On the east bench, over a span of about one mile were a number of scrapers, along with flakes and parts of projectile points. A mano was found on the west bench, as well as a rock ring of black vesicular basalt.

About 16 miles south of Beatty, a site was recorded in a group of low slate hills along the east side of the Amargosa River. This site, about 100 m in diameter, consists of one reworked obsidian stemmed point, one chert scraper and about 20 chert flakes. Several hundred meters to the east, another chert scraper and part of a broken obsidian projectile point or bifacial tool were found as isolated artifacts. At this location, and for a distance of about four miles north and south, the river has a number of ribbon channels with poorly developed benches. Low floodplain banks about a mile south of the low hills yielded nothing.

Also visited was an occupation site at the narrows of the Oasis Valley along the Amargosa River, about seven miles north of Beatty. Several thousand chert flakes are on the surface in an area about 100 m in diameter. The site has likely been picked over for years and no diagnostic projectile points remain that could be used to date the site.

In 2006 and 2007, Am-Arcs members found a source of the silicified lithic tuff about three miles east of Beatty. Beatty Wash cuts through an old alluvial fan, which is several miles in size and forms to the east. Within a mile of the Amargosa River, a number of primary flaking sites of silicified lithic tuff were found on the old fan surface. East of these reduction sites, scattered cobble-size silicified tuff fragments were noted.

CONCLUSIONS

The Paleoenvironment

Recent paleoenvironmental work begins to put a picture together of what it was like around 11,000 to 9,000 years ago in the southern and central Great Basin. Some 14,000 years ago, at the end of the Wisconsin Glacial Period, the pluvial lakes of the Great Basin were full (Morrison 1991; Wigand and Rhode 2002). With warmer and drier conditions, water levels substantially dropped. About 11,000 years ago, on a global scale, it again began to get colder and wetter. This pulse, called the Younger Dryas, between 11,000 and 9,700 years ago, was a period when the pluvial lake levels generally rose, but likely with short cyclic fluctuations (Morrison 1991; Wigand and Rhode 2002).

Lake Mohave water level was at a high stand between 10,800 and 9,300 years ago with a very short dry period about 10,000 B.P. (Campbell et al. 1937). After 9,300 years ago, the lake fluctuated to dryness with one last short period of high stand at about 8,200 years ago and was thereafter essentially dry (Enzel et al. 2003).

Lake Manly in Death Valley fluctuated between 11,000 and 10,200 BP (Anderson 1999; Anderson and Wells 2003). Approximately 10,200 years ago was the end of the permanent lake, although there were fluctuations from wet to dry conditions in the valley after 10,200 B.P. (Anderson 1999).

Between 11,000 and 9,000 years ago, Lake Tonopah water levels fluctuated, but likely reaching depths of 80 ft at times, based on the 4,800 ft shoreline where Lake Mojave and Silver Lake points have been found (Kelly 1978; Pendleton 1979; Tuohy 1988).

Lake Sarcobatus water levels likely fluctuated similar to Lake Mojave and Lake Tonopah, reaching depths of 50 ft or more. The exact times of fluctuation are not known. When the waters reached the 4,000 ft shoreline, the lake area was some 75 to 80 square miles with a shoreline extending some 50 miles around the lake. Two major streams flowed into Lake Sarcobatus—from the east flowed Tolicha Wash and from the north an unnamed wash that stretches past Lida Junction. This unnamed wash likely formed a low, broad delta where it met Pleistocene Lake Sarcobatus. The very low gradient along parts of the north and south sides of Lake Sarcobatus probably made for a favorable environment with extensive marshes.

Over the past 160,000 years, the Amargosa River has gone through four 40,000 cycles of greater flow (downcutting), followed by little or no flow (metastable erosion surfaces) (Morrison 1991). In the last cycle, the Amargosa River flow increased between 35,000 to 11,500 years ago, then the flow decreased substantially, perhaps coincident with the so-called Clovis drought, until about 10,700 B.P., or the Younger Dryas pulse, when it got colder and wetter until about 9,700 B.P. (Morrison 1991). The climatic conditions then slowly became drier with fewer and shorter wet cycles until after 8,000 B.P., when the Great Basin was subject to severe drought conditions.

In terms of hydrology, our survey of the Amargosa River is revealing. During its life, the Amargosa River carved a well-defined channel with a flood plain as much as one-third mile wide with well developed benches 15 to 25 ft high in places. In other places, where the gradient was less, the channel formed ribbons with little or no flood-plain benches. In still other places the river entered broad, shallow basins forming shallow lakes.

Summary of Findings

Most of the points and scrapers found around Sarcobatus Flat were just above the 4,000 ft shoreline on low rises which may have been spits or bars, where a present day wash now feeds into Sarcobatus Flats from the north. This is similar to Lake Tonopah, where Lake Mohave and Silver Lake points where found close the 4,770 ft shoreline where Peavine Creek feeds into the lake. To date, we have found where Lake Mojave-Silver Lake peoples obtained their obsidian for points and several locations where they probably hunted and secured food, but we have not yet found their campsites or where they manufactured their points and tools. There are many miles of shoreline to reconnoiter around Sarcobatus Flat and this will be our goal in the next few years.

Diagnostic points found along the terraces above the Amargosa River, south of Beatty, and at various places along Pleistocene Lake Sarcobatus, north of Beatty, are evidence that this area was occupied by peoples of the Lake Mohave culture (ca. 10,000 years ago). Peoples of the Pinto and Elko cultures were also present for brief periods along the Amargosa River. This is consistent with studies at Lake Mohave (Campbell et al. 1937), Yucca Mountain (Haynes 1996), and Lake Tonopah (Kelly 1978; Pendleton 1979; Tuohy 1988). The occupations had to have been during cycles of wetter climatic conditions when water was flowing in the Amargosa River. These findings support the hypothesis that early peoples in the Great Basin camped at and followed a migration route that included Sarcobatus Flat and the Amargosa River. Animal and plants used for food and other products were undoubtedly obtained along this migration route.

Assemblage composition of points, tools, and flakes found along the Amargosa River terraces consist of approximately 98 percent white chert, one percent tan and brown chert, and less than one percent obsidian, including parts of four projectile points and rare small flakes. Two other points were made of rhyolite and a part of one point was made from black basalt. Assemblage composition along the shoreline of Pleistocene Lake Sarcobatus and on the alluvial fan east of the lake consist of 99 percent obsidian points and flakes, and less than one percent white chert, including one stemmed point, four scrapers, and a few flakes. A part of one point was made of black basalt.

This field study is in its early phases and future work will include reconnaissance over many additional miles of the Lake Sarcobatus shorelines and continuing southward along the terraces above the Amargosa River to its junction with Fortymile Wash, then southward to Shoshone and Tecopa, California.

Acknowledgements. Am-Arcs members participating in the Lake Sarcobatus and Amargosa River studies were: Jan Amesbury, Ray Anderson, David and Lucy Book, Joanie Botsford, Bill and Mary Courtland, Ann Ettinger, Joan Ferrick, David Freitas, Oyvind Frock, Athalie Gantert, Hal and Patti Oxner, Sonja Sacks, Carol Shamberger, Diane Shamberger, Jessica Shamberger, and Dan and Chris Urriola. Barb Walker and Howard Hahn, past president of Archeo-Nevada Society of Las Vegas, were also present.

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New Methods of Analyzing Flaked Stone Quarries

Heidi Roberts (HRA, Inc.) and J. Jeffrey Flenniken (Lithic Analysts)

Toolstone quarries are ubiquitous throughout southern Nevada and southwestern Utah. When impacts related to development are planned, data recovery becomes necessary. The resulting data recovery and curation costs can be out of proportion to the knowledge gained. Because quarries are common, and the expenses related to their analyses are prohibitive, many managers are hesitant to consider quarries significant. During two data recovery projects we conducted non-collection technological analyses of toolstone quarries, which provided insight into lithic procurement systems. The success of these undertakings has led us to conclude quarries can be adequately and inexpensively studied with in-field technological analyses.

In southern Nevada and Utah dispersed, surficial toolstone quarries are some of the most common, yet least studied, types of prehistoric sites. Such sites are generally not considered significant in southern Nevada because there is a perception that they lack information beyond what may be recorded during survey. In southwestern Utah these sites are seen as potentially significant, but according to Rood (1999), cultural resource managers "don't know what to do with the darn things."

Costs associated with data recovery are seen as out of proportion to the knowledge gained. Expenses can become prohibitive when traditional multi-stage data recovery methods are used. Such traditional methods, including mapping, artifact collection, and laboratory preparation require non-specialists to handle the artifacts multiple times before they are even seen by a specialist. To avoid cost, and to streamline the process HRA, Inc. contacted J. Jeffrey Flenniken of Lithic Analysts to conduct non-collection technological analyses at several dispersed toolstone quarries in southern Nevada in the fall of 1998. After a successful trial study on a large multi-site survey project we decided to conduct a similar study on chert and quartzite quarries in southwestern Utah during the spring of 1999.

This paper presents the findings of these two studies and discusses the labor and curation cost saving associated with an in-field as opposed to a traditional collection analysis. To our knowledge these two studies are the first technological analyses that have been performed on toolstone quarries in southern Nevada and southwestern Utah. My coauthor conducted the analysis using replicative systems analysis. Replicative systems analysis (RSA) is a methodological concept designed to understand the behavior prehistorically applied to flaked stone artifacts. The method involves replicating, through flintknapping experimentation, a hypothesized sequence of lithic reduction employed at a particular archaeological site.

FIELD METHODS

Chert, chalcedony, and quartzite quarry sites in two project areas, Apex and Coral Canyon, were selected for this study (Figure 1). The Apex project area is located in southern Nevada approximately 10 miles north of Las Vegas at the Apex intersection of Interstate 15. The Coral Canyon project is located approximately six miles north of St. George, Utah, at the intersection of Interstate 15 and Harrisburg Junction. Both of these data recovery projects contained multiple prehistoric sites that included quarries, lithic scatters, camps, and habitations. Radiocarbon dates obtained from the sites during data recovery indicate the areas were inhabited fairly continuously since the Early Archaic period (Ahlstrom and Roberts 2001; Ahlstrom et al. 2004; Blair and Wedding 2001; Roberts and Ahlstrom 2003)

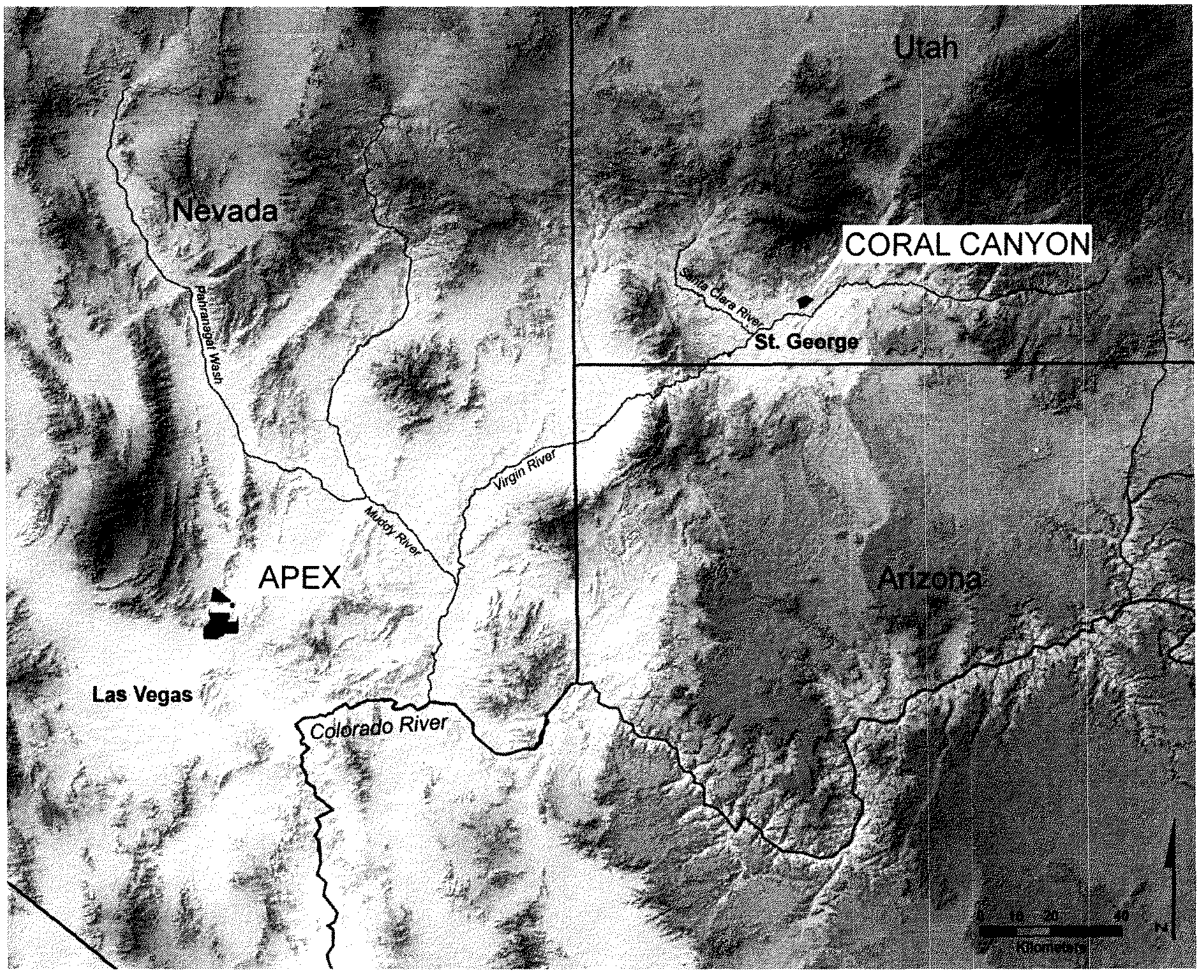

Figure 1. *Apex and Coral Canyon project area locations.*

Artifacts from the quarry sites in both projects were analyzed in the field, on each site, and replaced in their original surface location; artifacts were not collected from any of the nine Apex quarry sites; however, a sample of unmodified toolstone material was collected from each of the quarry sites evaluated (Ahlstrom and Roberts 2001; Flenniken 2001a, 2001b, 2003; Roberts and Ahlstrom 2003). Analysis of surface artifacts was controlled by 1–5 m long transects across each site. All surface artifacts identified during these transects were retrieved, analyzed, and replaced.

ANALYTICAL METHODS

Technological lithic analysis based upon RSA data was conducted both in the field and in the laboratory. Technological identifications were determined for all the artifacts, and all artifacts were examined on the basis of raw material types and reduction-stage categories (Flenniken 2001a: Appendix B). Reduction-stage flake categories were defined by comparing technological attributes of replicated artifacts from known and cataloged flaked stone tool reduction technologies to the prehistoric artifacts and associated attributes. In turn, by comparing the prehistoric artifacts (controls) to replicated artifacts in terms of manufacture, reduction stages were assigned to technologically diagnostic debitage. Some debitage, however, was considered technologically diagnostic due to the lack of identifiable attributes on fragmentary pieces such as shatter or flake margin fragments.

Technological analysis based upon replicative data (cf. Flenniken 1981) was selected over other analytical methods because distinctive and identifiable attributes on flakes are behaviorally sensitive and interpretable. Methods such as size-grading (cf. Ahler 1989) or morphological attribute analyses (length, width, thickness, weight, or completeness of flake) (cf. Sullivan and Rozen 1985) do not allow modeling of specific technological activities. Metric analyses do not take into account crucial variables such as raw material type, quality, shape, and flakeability; nor do they consider the skill level of the prehistoric knapper, the reduction sequence or sequences, or the intended end-product or products.

Size-grading of debitage as a form of "technological" analysis is also ineffectual as a means of providing accurate prehistoric lithic technological information (cf. Scott 1985, 1990, 1991). In one case where samples of debitage from six different sites were subjected to both size-grading analyses and technological analyses in an effort to define the lithic reduction activities, Scott (1985:69) found that "size-grading artificially separates debitage into classes that do not accurately reflect lithic reduction."

Ahler's (1989) work concerning size-grading analysis or "mass analysis of flaking debris" is the most comprehensive study to date. However, even using experimental controls, size-grading analysis proves inadequate for making inferences as to the reduction process due to the qualifications placed on interpretive comparisons. For example, Ahler's (1989) reduction modeling does not apply to multiple-material sites where the size, shape, and quality of the original raw materials may have influenced reduction strategies. Multiple flaking episodes are said to require interpretation through multi-variate statistical analysis even though statistics are not capable of "interpreting" data. Ahler's approach provides little or no accurate technological information concerning lithic reduction techniques because of inherent methodological errors regarding scientific experimental procedure. Reasoned sampling of large assemblages combined with technological attribute and stage analysis is more informative than are low-level descriptions of complete, large assemblages.

Replicative systems analysis (RSA) is a methodological concept designed to understand the behavior prehistorically applied to flaked stone artifacts (Flenniken 1981). The method involves replicating, through flintknapping experimentation, a hypothesized (based upon debitage frequencies documented during analysis) sequence of lithic reduction employed at a particular archaeological site. By comparing the prehistoric debitage with cataloged experimental debitage, it is possible to determine the reduction techniques and sequence (or sequences) that were employed at a given site by prehistoric knappers. Experimentation has also demonstrated that many by-products associated with tool manufacture can be mistaken for functional tools such as "scrapers" (cf. Flenniken and Haggarty 1979).

The RSA approach offers a reliable means to both identify and demonstrate the methods by which prehistoric knappers reduced available stone into flaked stone tools and weapons. Because flintknapping techniques are learned rather than innate behavior, reduction strategies can be both culturally and temporally diagnostic (Flenniken 1985; Flenniken and Stanfill 1980). Thus, by studying the reduction technologies employed at archaeological sites, it is possible, once the technological foundation based upon numerous technological analyses has been established, to correlate sites in time and space by identifying related or similar lithic technologies (cf. Flenniken and Stanfill 1980). The correlations may aid future research involving descriptions of regional mosaics of human activity patterns as they vary through time. In regions where volcanic or acidic sediments preserve very little of the archaeological record except stone artifacts, or where prehistoric activities left little or no traces, this method of gathering information can be extremely productive. The RSA approach to lithic analysis is useful and appropriate because it focuses on determining what lithic reduction strategies were used at a particular site, how these strategies may have changed through time, and whether these changes correlate to specific time periods.

Attributes evidenced on the prehistoric debitage, in conjunction with experimental analogs, are used to identify technologically diagnostic debitage, which made it possible to assign flakes to specific experimentally derived reduction stages (cf. Flenniken 1978, 1981). The remaining debitage is not ascribed to any reduction stage because of the fragmentary nature of the specimens; therefore, it is characterized as technologically non-diagnostic, although attributes such as material type, heat treatment, and presence/absence and type of cortex are noted.

For these analyses, debitage classification attributes are divided into five reduction-oriented technological categories that are, in turn, employed to define the reduction sequences used at each site. The five reduction-oriented technological categories or stages are:

(1) **core reduction**, that is, primary decortication debitage segregated on the basis of 100 percent cortex on the dorsal surface and platform configuration, secondary decortication debitage separated based upon partial dorsal cortex and platform type, and interior debitage categorized by platform attributes, dorsal arris count and direction, flake cross/long-section configuration, and especially, absence of dorsal cortex;
(2) **edge preparation**, that is, bifacial reduction debitage classified on the basis of multifaceted platform configuration and location, location of remnant bulb of force, dorsal arris count and direction, flake termination, flake cross/long-section orientation, and presence or absence of detachment scar;
(3) **percussion bifacial thinning**, that is, debitage segregated on the basis of multifaceted platform configuration, size, lipping, and location, dorsal arris count and direction, flake termination, cross/long-section orientation, and presence or absence of detachment scar;
(4) **pressure bifacial thinning**, that is, debitage separated on the basis of multifaceted platform configuration and location, dorsal arris count and direction, flake termination, platform-to-long axis geometry, cross/long-section orientation, and presence or absence of detachment scar; and,
(5) **non-diagnostic fragments**, that is, potlids, shatter, and flake fragments, with cortex or without cortex.

Interpretation of the reduction sequence from each site considered only the technologically diagnostic artifacts.

All of the artifacts (debitage, formed tools) noted from the investigations of each site were analyzed and assigned to specific technological categories and reduction stages (see above). Certain technologically diagnostic debitage assigned to specific reduction categories served as the basis for the interpretation of site activities. Formed artifacts were also included in these technological analyses. The stages described for the assemblage from the archaeological sites are specific and may not be directly applicable to other site assemblages because of potential differences in lithic reduction technologies.

The artifacts from the Coral Canyon and Apex sites (Flenniken 2001a, 2003) were analyzed and identified with one of the above five categories. Then, each site was identified with one or more of the following behavioral designations (for example, one site area may be a quarry site with an associated workshop site, both with several segregated reduction locations present):

(1) *Prospect Site* (Wilke and Schroth 1989). This type of site is directly associated with surface-exposed lithic toolstone. The parent material may be pebble, cobble, or boulder sized, and exist as surface "float" (lithic pavements). Debitage may represent numerous diachronic knapping events. The reduction technology or technologies present on these sites are difficult to define as most of the debitage will represent the testing of material for quality. Debitage will be predominately primary and secondary decortication flakes (Stage 1, core reduction) representing the very beginning of core preparation reduction. Formed artifacts are limited to tested or assayed parent raw materials. Prospect sites are usually limited in size to the availability of surface toolstone. However, if surface toolstone materials were readily available over a very large area, prospect sites may be extremely large given diachronic exploitation.
(2) *Quarry Site*. Quarry sites are directly associated with bedrock toolstone as opposed to float material. Shallow or deep "quarry pits" may be visible as a result of prehistoric exposure of subsurface toolstone materials. The majority of the technologically diagnostic debitage at quarry sites will include primary and secondary decortication flakes, as well as interior flakes (Stage 1, core reduction), and a *very* low percentage of early biface thinning flakes (Stage 3, percussion bifacial thinning), and it may represent numerous diachronic knapping events. Formed artifacts associated with these sites are broken and/or low-quality quarry blanks (flake blanks, bifacial blanks) and/or cores (conical, bifacial, multi-platform, etc.).
Quarry sites are similar to prospect sites in that quarry sites usually are limited in size to the availability of subsurface toolstone. However, if subsurface toolstone materials are available by excavation over a very large area, quarry sites may be extremely large given diachronic exploitation of the toolstone.
(3) *Workshop Site*. These sites are associated with toolstone source areas, but not necessarily directly with the source materials. In other words,

workshop sites are nearby but not at the toolstone source location. Numerous diachronic knapping events will be reflected by technologically diagnostic debitage representing one or more reduction sequences identifiable by decortication flakes, interior flakes, and bifacial thinning flakes (Stages 1–4). Large quantities of debitage may result in the presence of small talus slopes and/or mounds. Formed artifacts will include rejected tools due to manufacturing errors and low-quality "tools" of various stages of production. Workshop size is usually restricted to one small location. Site restrictions are governed by such attributes as view, proximity to water, fuel, and transportation routes (trails), and distance from the source area.

(4) *Segregated Reduction Location* (Flenniken and Stanfill 1980). Segregated Reduction Location (SRL) sites may or may not be associated with a toolstone source. These sites are small, discrete concentrations of technologically diagnostic debitage that represents a single knapping event. In most cases multiple SRLs do not overlap at these sites. Debitage will be restricted to one complete reduction sequence (Stages 1–4) or a portion of one reduction sequence. Formed artifacts found at SRLs will include one or several broken stage-diagnostic artifacts. The size of an SRL varies depending upon the number of associated SRLs. If one SRL is isolated, it will be very small, approximately 3–5 m in diameter. SRLs may overlap, creating a larger area of debitage concentrations. SRLs are not associated with any specific locational attribute.
SRLs and prospect sites differ in that prospect sites are directly associated with the toolstone source, whereas SRLs are not. Prospect sites contain limited technologically diagnostic debitage (decortication flakes), but SRLs will frequently contain entire reduction sequences (both debitage and broken formed artifacts). SRLs represent single, discrete, synchronic, knapping events; prospect sites represent numerous diachronic knapping events. In other words, prospect sites were used as a toolstone source over a long span of time, yet SRLs represent single knapping episodes.

(5) *Chipping Station Site.* This site type is not directly associated with a toolstone resource area and represents numerous synchronic knapping events involving the same flaked-stone reduction technology. Debitage mounds and/or talus slopes are not present. The technologically diagnostic debitage will support one entire reduction sequence (Stages 1–4) or any single stage of reduction. Formed artifacts will include numerous broken and/or low-quality stage-diagnostic artifacts. Chipping station sites are frequently rather small, but the debitage is concentrated in one area. Site attributes may be related to view, proximity to water, fuel, and trails.

(6) *Lithic Scatter Site.* Lithic scatter sites are not associated with a toolstone resource area and may include numerous diachronic knapping events representing potentially a variety of flaked-stone reduction sequences with differing end products. Technologically diagnostic debitage will include one or more entire reductions sequences (Stages–4 of several different reduction sequences) and/or single stages from different reduction sequences. Formed artifacts will include broken and/or low-quality stage-diagnostic artifacts as well as "spent" or broken projectile points.
Lithic scatters potentially are associated with other resource-exploitation artifacts such as milling stones, battered implements, scant faunal remains, fire hearths, and fire-cracked rock. Lithic scatters are directly associated with either seasonal or permanent water, vary in size from very small to literally hundreds of meters in length, and are frequently located in areas sheltered from the weather.

Battered Implements

One category of formed artifact that occurred at several of the Coral Canyon sites warrants special comment. Prehistoric flaked-stone assemblages from southern California, Utah, and Nevada, as well as the American Southwest, contain a common artifact identified by archaeologists by a variety of names, including chopper, hammerstone, pounder, milling stone, flaked hammerstone, handstone, battered hammerstone, masher, basher, utilized core, scraper plane, pecking stone, fist ax, and hand ax, to name a few (cf. Dodd 1979:231; Wallace 1978:28–29). Many of these artifacts are employed as archaeological identifiers of specific prehistoric cultures (Kowta 1969; Wallace 1954). Others are simply weighed, measured, and described generally as plant and animal resource processing tools.

Dodd (1976, 1979) and others (for example, Ambler 1985; Geib 1986) have devoted considerable time and energy to the identification and function of these rather unsophisticated but highly specialized and important prehistoric tool class, battered hammerstones. Battered hammerstones are separated from other artifact classes on the basis of pock marks located on one or more intentionally prepared areas on a single tool that are a result of repeated pounding against another hard object. These implements are most frequently produced from conchoidal fracturing, subrounded-to-subangular, spherical-to-discoidal, cobble-sized quartzite, metavolcanic, and volcanic nodular alluvial materials.

The manufacturing process includes the selection of a check-free rock—a rock without internal flaws or exhausted flake core—of the appropriate material and size. After material selection, a unifacial or bifacial sinuous edge, or platform edge on a flake core, is produced by direct free-hand percussion. The sinuous edge may have been situated on the side of the nodule, end of the nodule, or completely surrounding the nodule. The debitage produced as a result of edge manufacture is characteristic of initial cobble reduction, but is not well-patterned due to the variation in size, shape, and quality of the selected cobble. Because a sinuous edge is the intended end-product, general debitage characteristics may include cortex (in varying amounts) on the dorsal surfaces and platforms, few dorsal surface arises, hinge terminations, thick flake cross-sections, angular flake planviews, single-facet platforms, and, more rarely, multifaceted platforms (interior flakes).

Once the sinuous edges are produced to satisfaction, the linear-edged hammerstone is ready for use. The use of these hammerstones produces battered edges: the longer the use, the more intense the battering. At some time during the use process, the battered hammerstone required resharpening. Resharpening includes the removal of flakes by direct free-hand percussion along the sinuous margin until the battered edge surfaces are partially or totally eliminated. A portion of the debitage produced during the resharpening process is very distinctive in that the battered edge, once on the hammerstone, is present on the proximal end of the dorsal surface of the resharpening flake. However, flakes that do not exhibit battering on their dorsal surface are also produced, and these prove impossible to assign to the resharpening process. Once again, the hammerstone is ready for use. After numerous use/resharpening events, battered hammerstones are discarded into the archaeological context. These discarded "battered implements" occur as exhausted, well-worn, intensely battered tools or as resharpened, sharp-edged, small hammerstones with isolated areas of intense battering on one or more previously used margins. The latter are discarded because they are too small and lack the specific gravity to function efficiently.

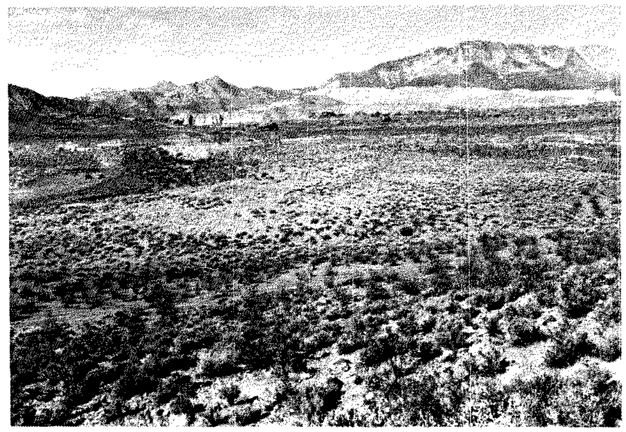

Figure 2. *The Coral Canyon Project area looking north to the Pine Valley Mountains.*

Experimental (Flenniken et al. 1993) and ethnographic (Bartlett 1933:4; Hayden and Nelson 1981; Hill 1982; Hough 1897; Lange 1959; Michelsen 1967; Simpson 1952) data document that groundstone tools, mainly manos and metates, were manufactured, sharpened, and resharpened with battered implements.

CORAL CANYON SITES

In the spring of 1999 HRA conducted a data recovery project at 16 Native American sites for SunCor Development (Roberts and Ahlstrom 2003). The property is currently being developed into a golf course and housing development (Figure 2). The project area is located in the St. George Basin of southwestern Utah (Figure 1). The quarry sites in this project area were found on the edges of the basalt flow and in the sandstone area surrounding these outcrops.

The sites in the project area were originally recorded as lithic scatters, camps, or lithic procurement sites. Radiocarbon dates obtained during data recovery from the non-quarry sites indicate that the area was used during the historic Paiute period and

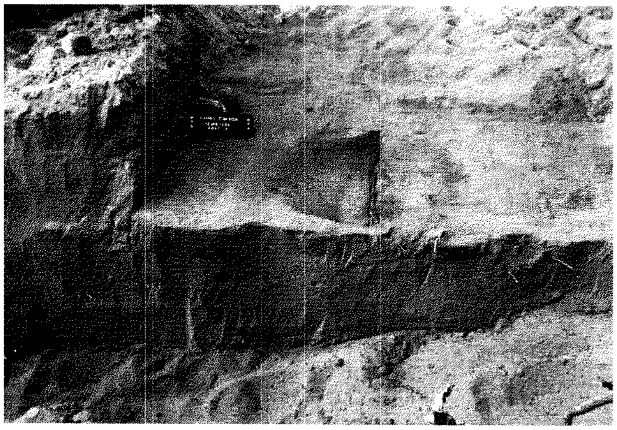

Figure 3. *Feature 1 at Site 42WS1233 after the north half of the fill was excavated, looking east.*

during the Middle and Late Archaic periods. The largest most complex site contained a protohistoric Paiute component and three earlier components; the oldest of which, dated to 4355 to 4220 B.C. A hearth found in a small lithic scatter adjacent to three of the quarry sites yields an Archaic date of 1435 to 1215 B.C. (Figure 3).

We conducted the in-field analysis on nine of the 16 sites. The dominant lithic materials used by prehistoric knappers were chert eroded from the Chinle Formation and nodular quartzite found near or on the sites. The chert occurred in small, pebble size angular pieces, while the quartzite occurred in subangular/subrounded cobbles-to-boulders.

The toolstone analyses indicate that three of the sites were quartzite quarries of various sizes. The reduction methods used at these sites were virtually identical. Two of the sites were quartzite SRLs and one also had evidence of metate shaping. Two of the sites were limited prospects of chert and one was a chert quarry with at least three SRLs. Only one of these sites, the largest quartzite quarry, is discussed in detail below.

Site 42WS1224

Site 42WS1224 is a large quartzite procurement site. It is positioned at the base of a southeast-facing ridge on a bench overlooking a wash. Pebbles, cobbles, and boulders of quartzite are common across the site.

The technological interpretation is that large blocks of homogenous quartzite were selected by the prehistoric knappers for reduction. These nodules were placed on the ground, or possibly the knapper's lap, so that one or more acute-angled ridges or angular edges were easily accessible for use by direct free-hand percussion as platforms. The first flakes removed from the core were covered with cortex. Because of the sequence of overlapping flake removal, flakes still retained natural/cortical platforms. Once the cortical-platform flakes were removed from the bifacial platform of the cores, the pieces of debitage still possessed cortex on their dorsal surfaces, but the flake platforms were no longer cortex covered; these flakes had faceted platforms. At this step in the reduction sequence, intended flake blank production began. The remaining interior flakes include all sizes of cortex-free flakes, both small debitage and large flake blanks, and represent rejected flake blanks. The intended end products of this reduction technology were flake blanks. An acceptable flake blank was a flake, approximately 5–20 cm long, 0.5–3.0 cm thick, and free, or near free, of cortex. These flake blanks (n=6) were subsequently reduced into bifacial blanks by direct free-hand percussion.

Within the context of this site, platform-to-dorsal surface angle and platform preparation are two diagnostic attributes that aid in the separation of the specific core-reduction techniques. Flake blanks (and interior flakes) with cortical, single-facet, and, to a lesser extent, multifacet platforms with platform-to-dorsal surface angles of 15 degrees to 40 degrees were most frequently produced from a biface edge core, while flake blanks with platform-to-dorsal surface angles of 70 degrees to 90 degrees were more likely produced from multidirectional/multiplatform cores. Platform preparation indicates the degree to which flake blank platforms were intentionally altered (on the core) to produce the flake blank. At this site, platform preparation was almost nonexistent, as evidenced by the poor representation of multifacet platforms on debitage (n=5) and the lack of quartzite early bifacial-thinning flakes.

Exhausted/discarded cores are described as large quartzite blocks (some cortex remaining) with one or more sinuous, large-flake-scarred, bifacial edges located where the original cortical-ridge platform (or platforms) once existed. Flake-core size ranged from less than 10 x 10 x 10 cm to much

Figure 4. Boulder core from Site 42WS1224.

Figure 5. Limestone battered implement from 42WS1231.

larger. Four of the flake cores identified at this site weighed in excess of 40 kilograms (Figure 4).

In summary, prehistoric knappers at 42WS1224 selected locally occurring, fine-grained quartzite cobbles and boulders to produce, by direct free-hand percussion, flake blanks from multidirectional, single-platform, boulder and bifacial-edge cores. Flake blanks were reduced by direct free-hand percussion into prepared flake blanks, which in turn, were reduced into bifacial blanks. Prepared flake blanks and, to a lesser extent, bifacial blanks were exported from the site.

Coral Canyon Technological Conclusions

The prehistoric lithic technology delineated by artifacts from the Coral Canyon sites represents two distinct, but major activities. First, this area was exploited in prehistory for lithic resources to replenish tool kits. From a simplistic perspective, prehistoric flaked-stone tool kits included quantities of cores, blanks, preforms, finished products, and broken, but useable, tools. These tool kits were carried with the prehistoric knapper, and when cutting edges or projectile points were needed, artifacts were removed from the tool kit. Thus, this tool kit involved a dynamic process in which flaked-stone artifacts were constantly added to the tool kit at the "beginning" stages as cores, for production of flake tools, and blanks. When tools were required, they were removed from the tool kit from the "end" stages as flake tools or projectile points. Therefore, the dynamic process of "feeding" and "maintaining" the tool kit was never-ending. The Coral Canyon artifact assemblage suggests the

Figure 6. Metate or grinding slick from Site 42WS1231, broken during direct free-hand-percussion facing or sharpening with a battered implement.

prehistoric inhabitants resupplied their tool kits as well as, at some of the sites, conducted maintenance on their hunting equipment such as repairing broken projectile points.

The second major prehistoric activity, plant processing, was supported by large quantities of battered implements (Figure 5) and battered-implement flakes. The presence of a partially shaped metate (Figure 6) along with a number of battered hammerstones at one site suggests that metates were being manufactured there. Dodd (1976, 1979) and others (for example, Ambler 1985; Geib 1986) have found that battered hammerstones are separated from other artifact classes on the basis of pock marks located on one or more intentionally prepared areas on a single tool that are a result of repeated pounding against another hard object. Experimental and ethnographic data document that groundstone tools, mainly manos and metates, were manufactured, sharpened, and resharpened with battered implements.

The toolstone procurement activities complement the emerging picture of use by mobile hunter and gatherers. Paiutes today know the project area as an important travel corridor. It is likely that Archaic and later Paiute hunter/gatherers camped in the project area sporadically, and they may have hunted game at the springs, gathered plant resources, and refit their tool kits. We suspect that the groundstone implements were manufactured and used at the sites during the Archaic period and that they were reused during the later periods. We had hoped to learn what plants were processed from flotation samples. Unfortunately, these samples did not contain charred seeds or plants. The pollen data, however, hint that cactus procurement and processing may have been important during wetter periods when the dunes were stabilized. Our analysis shows that toolstone procurement was an important activity during the Archaic and possibly Paiute periods.

APEX TOOLSTONE QUARRIES

Between August 1998 and January 1999, HRA, Inc. conducted a sample survey of approximately 4,000 acres of Bureau of Land Management (BLM) land located north of Las Vegas in Clark County, Nevada (Figure 1) (Ahlstrom and Roberts 2001). The purpose of the survey was to develop a model for predicting the location of Native American sites in the steep, inaccessible regions of the proposed land exchange (Figure 7). To assist with significance assessments during the survey, we performed the in-field analysis of surface artifacts at five tool stone quarry sites (26CK3779, 5628, 5696, 5698, and 5702) in the upland project area. These lithic-debitage-dominated sites included three SRL sites and two quarry sites.

As part of data recovery small rock shelters in the project area were excavated. Analysis of the excavation data suggested that the rock shelters were the product of brief visits by small groups of people to forage for plants and tortoises. Radiocarbon dates from sites in the project area and the adjacent region produced evidence for the most intensive use of the immediate area between A.D. 1300 and 1650 (Ahlstrom and Roberts 2001). The only temporally and culturally diagnostic artifacts consistently recovered from these sites were Desert Side-notched arrow points.

Figure 7. *Photograph of the upland regions of the Apex project area studied by HRA.*

Two toolstone materials were defined during the analyses of the five sites. The most common material was bedded chert, ranging from poor-quality, granular, and white/light gray in color to high-quality, homogenous, fine-grained, and black in color. A nodular, white/light colored, homogenous chert was also identified at one site (26CK3779). Another less common local material was chalcedony, which is partially translucent, white/light gray in color, homogenous, and may occur as beds or nodules across the landscape. One of these sites, 26CK5698, a large chert quarry with several SRLs, is discussed below.

26CK5698

Site 26CK5698 is a large talus chert quarry (Figure 8). The source of this light-to-dark-gray, high-quality but grainy talus chert is a result of upslope limestone bedrock weathering. Six specific SRLs were identified on the surface of this quarry. However, the entire quarry area is littered with debitage, tested pieces of raw material, complete biface blanks, and flake cores.

The flintknapping that occurred at all six of the SRLs on 26CK5698 exhibited the same activities: manufacture of bifacial blanks from surface-collected angular pieces of chert and the production of flake blanks (useable flakes) from unidirectional and multidirectional cores.

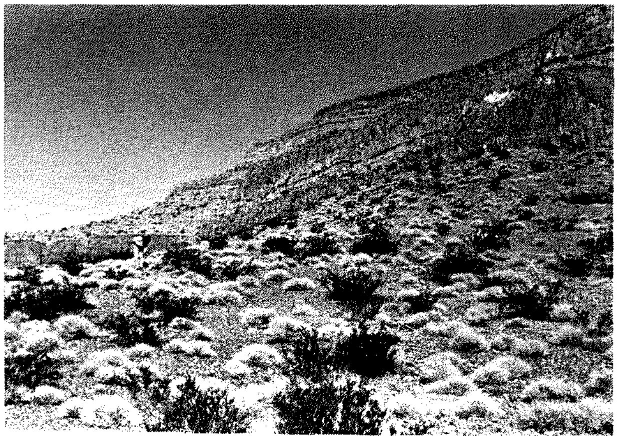

Figure 8. *Photograph of Site 26CK5698.*

Bifacial blanks were manufactured from angular pieces of chert by direct free-hand percussion employing only natural platforms. Reduction was terminated prior to the knapper being forced to prepare biface-margin platforms to ensure large, percussion, thinning-flake removal. Most likely this practice of minimal biface manufacture at the quarries throughout the Apex Project Area was a result of toolstone maintenance. In other words, large, thick, high-quality, incipient bifacial blanks with maximum useable core material were transported from the quarries (Figure 9). Throughout the blank/core's use-life, flakes were removed as needed for flake tools until the blank/core was thinned to the stage where projectile point manufacture could occur. At that stage of thinness, the blank was reduced into a bifacial tool such as a projectile point or the thinned blank simply discarded. Flakes (flake blanks) were also produced at this site and most likely transported across the landscape to be employed as needed as tools for various cutting and scraping requirements. These flake blanks may have been discarded after use or laterally cycled into bifacial tools.

Apex Conclusions

At all five Apex sites, the flintknapping activities were identical, in that prehistoric knappers manufactured bifacial blanks and flake blanks to be transported away from the sites of manufacture to areas on the landscape where various tools would be required at numerous events in the future. Like at Coral Canyon, this activity resulted in restocking the knapper's tool kit.

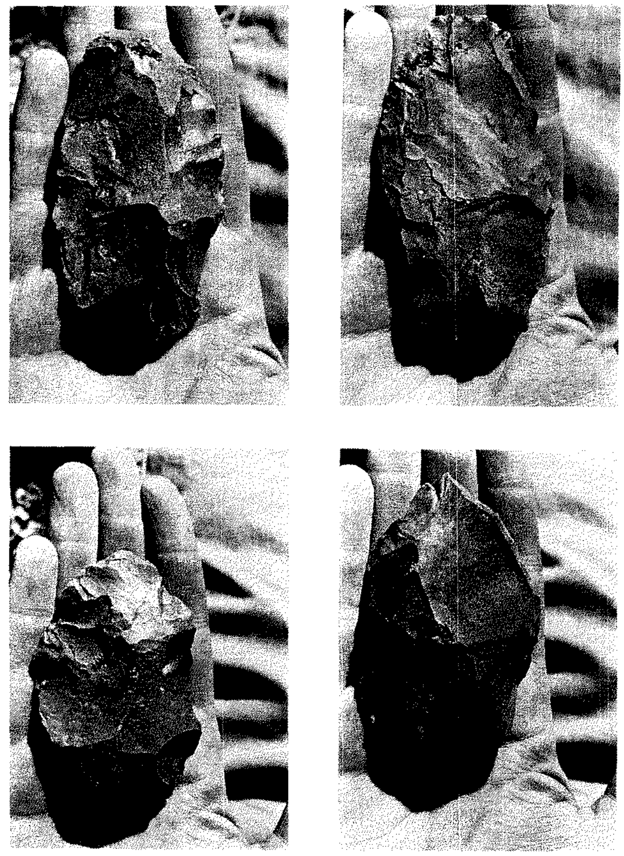

Figure 9. *Bifacial blanks from Site 26CK5698: (top left) length = 8.5 cm; (top right) length = 10.5 cm; (bottom left) length = 8 cm; (bottom right) length = 9 cm.*

CONCLUSION

In conclusion, through our in-field technological study we were able to gain important insight into the prehistoric toolstone production activities in southwestern Utah and southern Nevada. Although the quarries lacked temporally diagnostic artifacts or carbon for radiocarbon assays, radiocarbon dates were obtained from adjacent campsites and rock shelters in both project areas. Since the occupants of the camps and rock shelters made use of the toolstone from the quarries, we can infer that the quarries were likely used when the project areas were the most intensively occupied. The Apex project area was occupied most intensively during the protohistoric period (Ahlstrom and Roberts 2001:Figure 12.2), which suggests that the toolstone sites were likely used during that period. The Coral Canyon project area was occupied during the Middle Archaic, Late Archaic, and Paiute periods. The most common toolstone recovered from the

Coral Canyon campsites was the Chinle Chert and the locally available quartzite, which suggests toolstone materials from the quarries we investigated were used by the occupants of the Coral Canyon project area for 7,000 years.

Despite the variety of materials available at the sites studied, toolstone procurement methods involved manufacturing bifacial blanks and flake blanks to be transported to camps or habitations where they would be used for tools in the future. Because the artifacts were analyzed in the field, rather than collected, the analysis cost approximately one fourth as much as it normally would, using traditional collection methods. It is our hope that future technological analyses of toolstone quarries in the region will lead to distinct patterning that may be linked to temporal or cultural affiliation.

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Social Persona From Six Feet Under: Revisiting the Saxe-Binford Hypothesis

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As a graduate student in physical anthropology and archaeology an interesting problem was presented to me on July 6, 1994. An abandoned veterans' cemetery in Las Vegas, Nevada, needed to be moved for development purposes. Clark County was responsible for the disinterment. I contacted the County and volunteered my services to assist in the location, identification, and removal of individuals. This opened up an opportunity to test the Saxe-Binford hypothesis regarding the determination of social persona through the analysis of certain grave-associated items. These items or symbols common to treatment of the dead are burial types (cremation, casket, mausoleum) and material remains found with an individual after death (coffin type, headstones, clothing, jewelry, etc.). This paper represents the findings and conclusions of this rather interesting project.

A modern population from an abandoned veterans' cemetery located in the city of Las Vegas was used to test the Saxe-Binford hypothesis regarding social persona: the place an individual holds in life can be reflected in associated grave goods after death. A total of 128 individuals (veterans n=11, non-veterans n=117) were disinterred. These remains were in various states of decomposition, two different burial types (casket, copper box) and three different burial locations (infant and crema-tion section, stacked section, mausoleum). The county knew that the property had changed hands several times with no one claiming ownership. Records regarding the number of deceased, burial types, location of the bodies, and the boundaries of the cemetery within the vacant lot were unclear. What was clear was that the population needed to be disinterred and reinterred into a new location on Eastern Avenue in Las Vegas.

If in fact the symbolism represented in components of burial locations and burial types do cooperate in representing different social persona, then it should be evident in this study. This was a veteran cemetery therefore veterans should receive preferential treatment over non-veterans. This study will test two hypotheses based on Arthur Saxe's and Lewis Binford's early 1970s work: (1) burial types and material remains associated with the deceased will be important factors in establishing social persona, and (2) different burial locations will represent different social persona.

THE CASE STUDY

The veterans' cemetery is located in the city of Las Vegas, on Foremaster Lane South, between Las Vegas Boulevard North and Main Street. (Figure 1). The population consisted of 11 veterans

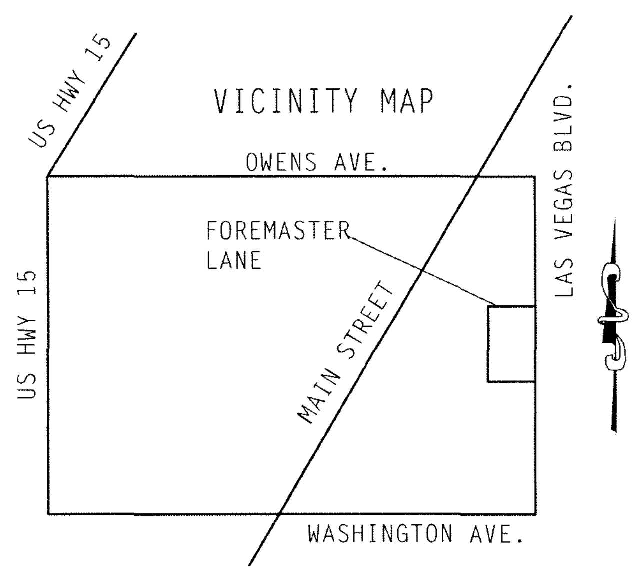

Figure 1. *Project site in Clark County, Las Vegas, Nevada.*

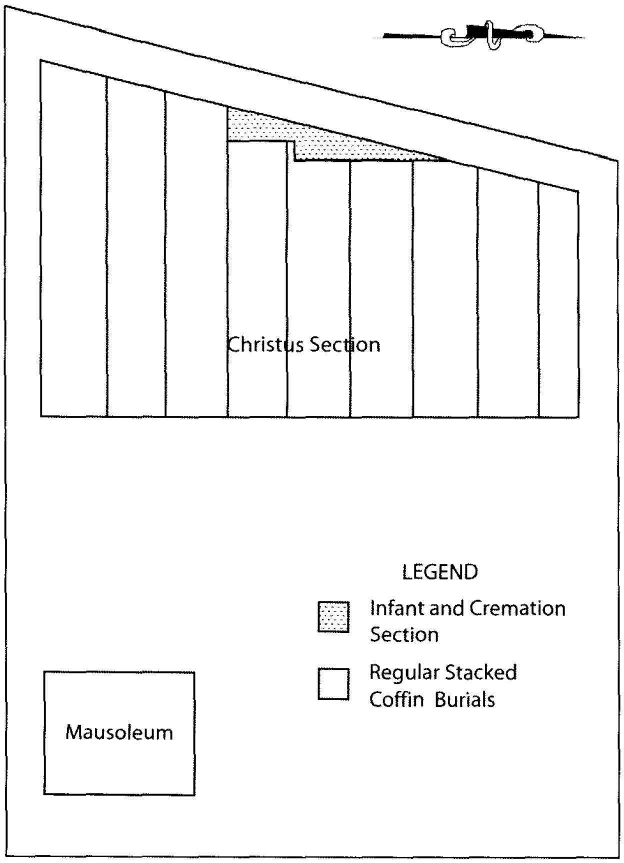

Figure 2. *Plan view of cemetery burial locations.*

(two from WW I, nine from WW II), and 117 non-veterans who were interred between 1967 and 1975. Death certificates were available for 110 of the deceased.

Clark County Genealogical Society catalogued the property on October 13, 1984. This included inventory of the existing headstones, listing of names to be checked with county records, and matching the names with death certificates. At the time of field work it was noted that there were more names than headstones and some of the headstones were not associated with graves. A map of the divisions of the cemetery was also obtained through county records (Figure 2). The legal description of the parcel was obtained, however the actual boundaries of the cemetery within the parcel were unknown. Several archaeological methods were employed to establish boundaries, locate the deceased, locate headstones, and map the project area. These methods are presented in the original thesis (Holz 1996). Only the findings and conclusions of the thesis are presented here.

SAXE-BINFORD HYPOTHESIS

Many archaeologists and physical anthropologists concerned with the study of social systems of prehistoric and modern societies (e.g., religion, social organization, social persona, and economic cooperation) believe that the material remains associated with burials are an important tool for extracting such social information (Bartell 1982; Bell 1990; Binford 1971; Brown 1981; Buikstra 1981; Chapman 1981; Chapman and Randsborg 1981; O'Shea 1981; Quilter 1989; Saxe 1970; Tainter 1978). In the study of social systems from burials, most researchers hold certain major assumptions:

> 1) the deceased are given a set of representations of his or her various social identities or roles when alive so that their status or social position may be given material form after death (e.g., grave-goods, monuments, place of burial etc.). 2) the material expressions of these roles may be compared between individuals. 3) The resulting patterns of role differentiation may be ranked hierarchically as divisions existing within the society under study [Pearson 1982:99].

Saxe and Binford built on Radcliffe-Brown's early position in rejecting the earlier theories of burying the dead strictly for the reason of corpse fear. Radcliffe-Brown, in his ethnography of the Andaman Islanders, argues that in the death process "a person occupies a definite position in society, has a certain share in the social life, and is one of the supports of the network of social relations" (Radcliffe-Brown 1922:285).

Saxe's position is that mortuary ritual is a medium in which social relationships entered into during life are represented at death. He also shows strong disagreement for the cultural-historical climate of the time that viewed the various different treatments of the dead (cremation, inhumation, mummification) as being the result of outside influences. Saxe viewed cemeteries and their contents as having structure (in the systems sense) that has potential to inform the researcher of certain organizational principles underlying the associated community. According to Brown (1995), Saxe and Binford focused on patterned differences in the way that individuals were treated in death attempting to establish an individually oriented theory that would link archaeological remains to behavior.

The underlying foundation in Saxe's work is that archaeologists must understand the role of the dead among the living within different types of social systems. Along this same thought, Binford explains that "there are two general components of the social situation to be evaluated when attempting to understand the types of social phenomena symbolized in any given burial situation"(Binford 1971:7). For example Binford, in his 1971 study of mortuary rites and their archaeological potential, uses the symbolic quality of the burial custom to explain the social phenomenon of mortuary ritual. He explains that when studying mortuary ritual, there is an observed class of phenomenon that consists of technical and ritual acts. Within the technical phenomena, burial customs provide for the disposal of the potentially unpleasant body of the deceased. In the ritual phenomena, mortuary rites consist of the employment of a number of symbolic acts that may vary in two ways: in the form of the symbols employed and, in the number and kinds of referents given symbolic recognition. The forms of symbols may vary independently of their referents and vise versa (Binford 1971:16). Binford also proposes that in order to understand the social phenomenon of mortuary rituals, one must concentrate on the symbolism in a particular burial situation. For example, he warns that the "forms taken by symbols in mortuary practices should not be confused with what is actually being symbolized" (Binford 1971:16).

Simply put, a symbol is an object used to represent something abstract. Examples are the monumentality of a headstone or the elaborateness of a coffin. In our society these items are interpreted as a symbol of wealth of the deceased, when in fact the deceased who is accompanied by one of these items after death could be someone of minimal income who was frugal enough to save throughout his or her lifetime to afford such expensive items.

In support of Saxe and Binford, Tainter (1978) explains that archaeological studies sometimes neglect the diversity of symbolic forms employed in the mortuary ritual, thus assuming that the grave goods are the most important data class. Tainter feels that other variables (e.g., type of interment facility, location of grave, etc.) should be included in the final analysis to derive complete social information.

As stated by Chapman and Randsborg (1981:7) "the Saxe-Binford hypothesis and philosophical perspectives have formed the basis of many social analyses of mortuary practices within the last decade."

ANALYSIS

Both statistical and non-statistical techniques were employed in the analysis of the mortuary practices at the Las Vegas veterans' cemetery. Quilter, in his study of the Paloma burials, states the importance of this analytical approach. According to Quilter (1989) statistical studies permit the determination of complex patterning, while non-statistical studies are better for noting significant individual or unique characteristics of these data.

In this study non-statistical techniques will be the major type of analysis. The statistical technique is in the form of frequency distributions and will be used to support the outcome of the former non-statistical technique. According to Tainter (1978: 118), mortuary attributes utilized in mortuary analysis should be selected carefully. The criterion for selection must be that such attributes display common variance or deviation. This, of course, has a bearing on what types of attributes the researcher chooses to use. The mortuary attributes chosen for study are: (1) burial location, (2) burial type (coffin, cremation), (3) headstone type, and (4) material remains as they relate to the hypothesis.

Within this population study, burial location is not an accurate indicator of social persona after death. If in fact burial location is an attribute to be considered these data should reflect spatial differences between the placement of veterans and non-veterans. However, there was no differential patterning in burial locations.

An examination of Figure 3 reveals a 92 percent frequency of the deceased, both veterans (n=11) and non-veterans (n=107), were disinterred from the Christus Section. Spatially, within this location, all the deceased were haphazardly placed. There were no preferences for males versus females or veterans versus non-veterans. According to

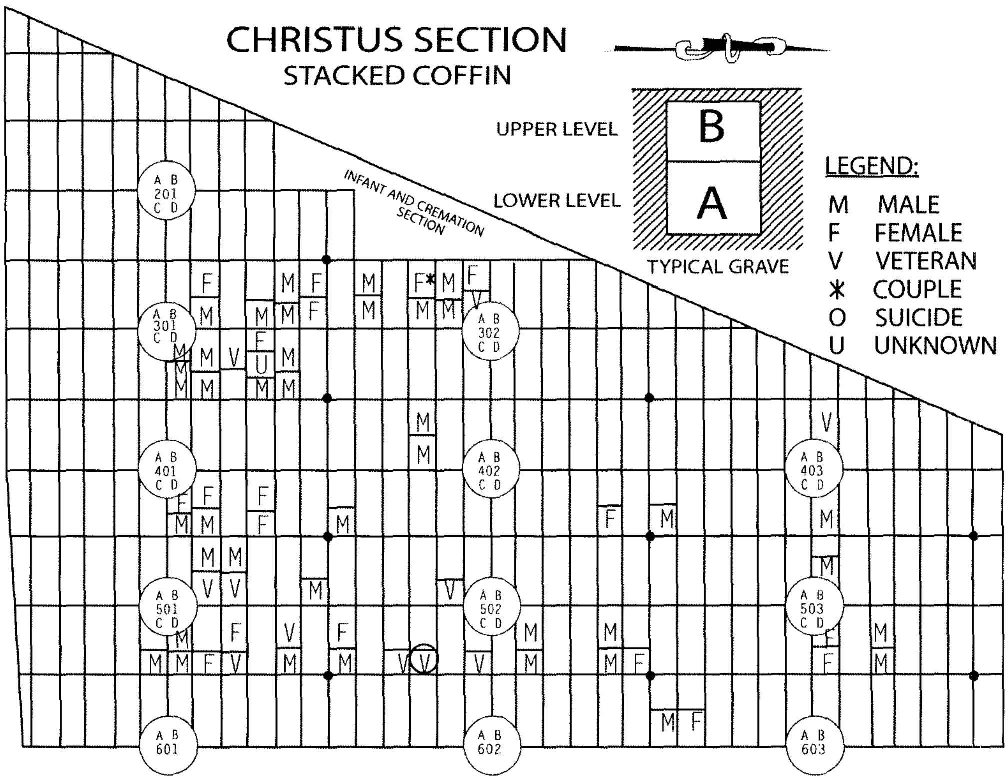

Figure 3. *Plan view of the Christus Section stacked coffin burial locations.*

Table 1. *Cemetery price list.*

	Christus Section	Mausoleum	Infant and Cremation
Top 2 Rows		$595.00	
Middle 2 Rows		$645.00	
Eye Level Rows		$795.00	
Companion		$1,495.00	
Veteran Site	$230.00		
Double Depth	$150.00		
Infant and Cremation			$100.00

Table 1, all the spaces within the Christus Section (stacked coffin) were double depth, at a price of $150.00 per plot. The price list also indicates that a veteran grave site was $230.00 (single depth), however those deceased were shown no special placement within this section. During the disinterment, in all cases, veterans were located in the stacked plots ($150.00) and in seven out of 10 cases veterans were placed in bottom plots. According to Figure 3 eight of the women disinterred from the regular stacked coffin burials were on the bottom and 10 were in the top position. Due to this randomness it was concluded that placement is based on time of death. This was confirmed by the dates on the death certificates. This is also the case for the cremation, infant, and mausoleum burial locations. The cremation and infant sections were the second most populated burial locations with a non-veteran-to-veteran ratio of 46:1 (Figure 4). This section was interesting in that it held a 10.4 percent frequency of suicides; none were veterans.

The infant and cremation sections rank second on the cemetery price list plots priced at $100.00. Forty-three percent of the cremations and 51 percent of infants did not have headstones. The burials within this subsection were also haphazardly placed. Veterans did not receive preferential treatment, nor did infants or women.

The only differences within this section were that the burials were laid side-by-side. The reason for this was the size of the plot. The regular stacked coffins in the Christus Section were all adult; therefore, they required more room due to the full size coffin.

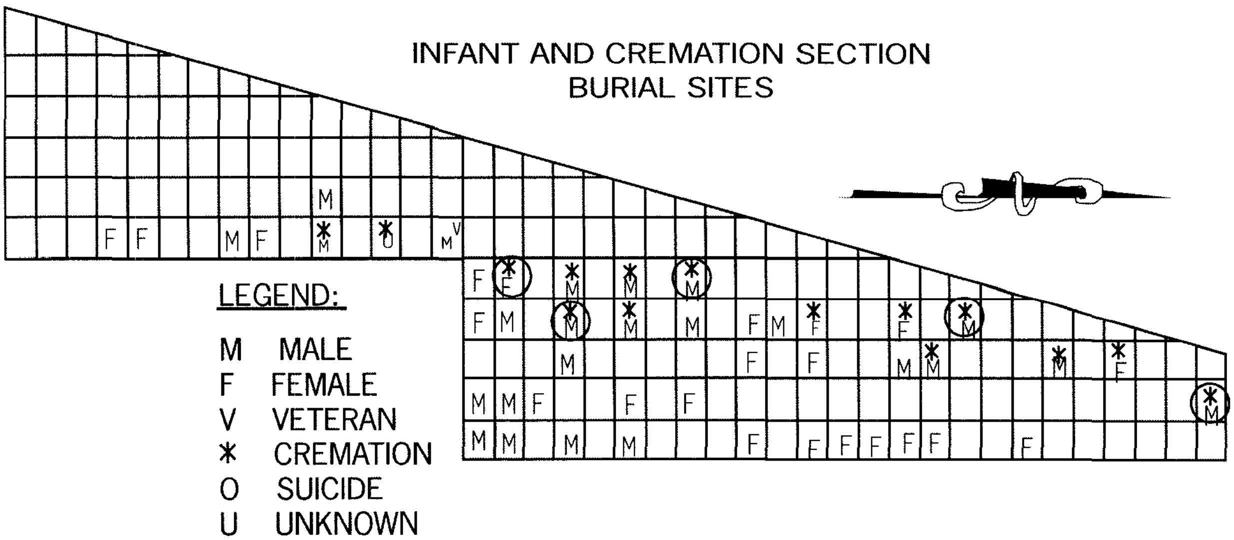

Figure 4. *Plan view of the Infant and Cremation burial locations.*

The adult cremations were not separated from the infant coffin burials, the only defining characteristics differentiating these two burial types were: (1) copper boxes or (2) wooden coffins. The age ranges for infants was birth to three months (birth certificate data) with a 32:1 ratio being interred in small wooden coffins, as opposed to plastic cases. One hundred percent of the cremations were interred in copper boxes.

The mausoleum was the least populated location of the cemetery with 10 individuals disinterred. This consisted of a 7:3 male-to-female ratio. All were non-veterans. In the mausoleum area there is a definite correlation between the price of the plots and number disinterred. According to the price list for this section the least expensive plots are the top two rows at $595.00, with the most expensive being companion plots at $1,495.00 (Table 1). The remaining plots were the middle two rows priced at $645.00 and eye level rows priced at $795.00. All of the individuals disinterred were from the eye level rows, the second most expensive plots available. Suicides were nonexistent. Name plaques were nonexistent. The only forms of identification were slips of paper taped to the bottom of the coffin.

Individuals within the mausoleum section were also haphazardly placed. According to a schematic of the walls all the deceased should have been together. Upon the removal of the marble facades individuals were scattered throughout the eye level rows. The deceased were not in the slots they were assigned. Sixty percent of individuals were over 50 and died of natural causes.

Analysis of the actual findings indicate only a few direct correlations between burial location, the symbolism of burial types, coffin type, presence or absence of headstones and social persona. We see a patterning of veterans associated with two headstones, infants in plywood coffins, cremations in copper boxes and placed side-by-side, and the mausoleum lacked veterans and any type of name plaques.

ANALYSIS

As stated above evidence should point to veterans and non-veterans being symbolically differentiated through burial location, burial types (cremations, casket, mausoleum), and material remains (grave associations, coffin types, headstone). Upon disinterment of the veterans, it was evident that this was not the case.

Symbolically it is expected that within each different burial type, there is a container differentiating veterans and non-veterans. For example within the casket burial type we should see a more uniform casket type (wood or steel) for the veterans (all of the veterans being interred in steel, while non-veterans are interred in either wood or steel). Or, within the cremation burial type it would be expected that a veteran would be interred in an urn engraved with his name and rank. Whereas a cremated non-veteran might be buried in an urn (lacking engraving) or other container type supplied by the crematorium. The same distributions also indicate that if a veteran were cremated they were not interred in an urn, but in copper boxes common to the cremation section.

Another example would be within the mausoleum. We would see veterans interred in the eye level rows (more expensive), in metal caskets, while the non-veterans (less expensive) would be distributed throughout the upper levels in wood or steel caskets. The frequency distributions indicate that veterans were completely absent from the mausoleum.

Material remains (grave associations, coffin types, headstones) were also not symbolically differentiating. We would expect to find veterans buried in a uniform representative of their branch of service or rank. We should also find other items such as medtals, guns, or other military memorabilia. Frequency distributions show no such special body treatments. Veterans were buried in street clothing as were the non-veterans. No special material remains (medals, guns, etc.), were located to differentiate veterans from non-veterans. Material remains found with veterans were the same as nonveterans (e.g., eye-glasses, wedding bands, false teeth).

Actual findings indicate a blue-collar status cemetery in a generally poor location within Las Vegas. Eighty-nine percent of the total cemetery population was interred within the low price range burial locations, 91 percent were interred in low price range interment type (wood coffins, copper boxes rather than urns for cremations), 48 percent lacked headstones, and only three percent were associated with any grave goods. The lack of grave associations also makes a statement of our changing mortuary habits and values from the 1900s to the present. It used to be that a person was buried in their best clothes and material items that were extremely special to them. For example a woman might request that she be buried with her diamond wedding ring or brooch. Recently (1970-present) morticians are influencing family members of the deceased to inter their deceased without such expensive material items.

The present state of the case study within Las Vegas might very well reflect the social status of the general population of the area from the 1960s through the early 1970s. Three percent of the population was buried without headstones or any type of identification except age and sex (clothing as the main indicator). No material remains with the exception of coffin type would indicate any differences. What does this tell us of our current society? An individual income status during life is not reflected in death. Or, we as a society are less prone to waste money on the nonliving.

CONCLUSION

In conclusion, the Saxe-Binford hypothesis was helpful in establishing an analytical model. This model was only partially supportive in proving the studies hypotheses regarding the social persona of this veteran/non-veteran population. Regarding hypothesis one: different burial locations represent different social persona is supported by the following data: (1) all of the veterans were buried in the Christus Section; (2) all infants were separated; and (3) all cremations were separated, and those interred in the mausoleum were non-veterans. However, if as stated by Saxe and Binford that social persona is associated with burial location, then the actual findings should show females separated from males, veterans separated from non-veterans (with preferential treatment), suicides separated from those who died of natural causes, cremations separate from caskets, and infants in a separate area. The following findings then do not support the above hypothesis: (1) males were commingled with females; (2) veterans were mixed in with non-veterans and suicides; (3) placement (stacking) was solely determined by time of death; and 4) infant and cremations were placed in a separate area within the Christus Section, but they were mixed. Within the regular stacked casket section burials were stacked. Only one of these burials represented a married couple. The remaining individuals were also stacked, however, they were not related in any way.

Hypothesis two states that symbolism in the form of burial types and material remains should be important factors in establishing social information. This hypothesis is supported by: (1) all veterans had two headstones; (2) all infants were in small plywood coffins; (3) all cremations were in copper boxes; and (4) all infants were embalmed in a different way than adults. However, the following findings do not support the association of symbolism in burial types as representative of social information: (1) veterans and non-veterans show no differentiation of coffin types; (2) veterans and non-veterans were not differentiated from one another regarding grave associations or corpse treatment; (3) those interred in the mausoleum were not treated any differently than those interred in stacked plots; (4) those interred in the mausoleum were not associated with monuments; (5) not all non-veterans were associated with any type of monument at all; and (6) there is no correlation between cause of death and interment.

Through the careful analysis of the actual data, based on the expected findings, it can be determined that for this particular case study the Saxe-Binford hypothesis was a good analytical model. However, it was not an effective approach in determining the social persona of this recent case study. Even though there were several known variables utilized in this project, in the form of death certificates and an original map of the cemetery, distinguishing a separate social persona for the veterans or the non-veterans was next to impossible. The most the study did was to determine a slight archaeological pattern of veterans being buried with two headstones, infants in small plywood coffins placed side-by-side, cremations in copper boxes, and infants separated from adults. A further conclusion is that the Saxe-Binford hypothesis is much more applicable in determining the social persona of prehistoric populations than modern American ones.

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Neither Gone, Nor Forgotten: GIS Prehistoric Probability Modeling on the Spring Mountain National Recreation Area

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A Landscape Assessment is being prepared for the Spring Mountain National Recreation Area for the U.S. Forest Service. Cultural resources are a part of the landscape and as such the Spring Mountain Ranger District of the Humboldt-Toiyabe National Forest has determined that one way to consider these resources and to include them in the planning process is through the building of archaeological resource sensitivity models within a Geographic Information System framework. These models can be viewed as areas of potential human use. A landscape level model on an arbitrary unit such as a "Forest" presents unique challenges such as east/west rain shadow effects, north/south environmental gradients, and cultural incongruities that require a different set of modeling tools to increase the usefulness of the models. This paper explores these issues after presenting a general overview of the modeling process.

GENERAL MODEL FORMULATION

The use of predictive location models is not new and has existed in many forms long before the advent of the computerized Geographic Information System (GIS). Many cultural resource managers have general intuitive models that reflect the distribution of historic and prehistoric properties under their stewardship. These models are often based on distance to particular resources deemed to be important facets of aboriginal land use. These variables include, but are not limited to, distance to water, slope, aspect, elevation, and landforms such as ancient shorelines, stream terraces, rock shelters and caves, and resource procurement areas. For modeling purposes, these characteristics of the landscape are known as independent variables, which are defined as "a measurable entity that is free to assume any of a prescribed set of values" (Rose and Altschul 1988:183). Cultural resource managers can also include ethnohistorically derived social and cultural factors for inclusion into their model formulations, albeit with due caution.

The problem with intuitively or judgmentally derived "models" is that they are not available for peer review or other forms of verification. Most are in paper or hard-copy formats that are hard to present, interpret, and change. And only a few of these models are ever systematically tested. Constructing and storing models in a GIS framework insures that they are available to all who intend to use or review them. Besides the model for the Spring Mountains, the Humboldt-Toiyabe National Forest (HTNF) is going to construct predictive models for the six million acres of land under their stewardship to aid in planning and other management decisions. Although each management unit within the Forest has unique characteristics in terms of environmental conditions that influence the location of cultural resources, one statistical method will be used to provide consistency and ease of interpretation for all models developed for the HTNF.

Compliance with historic preservation legislation governing archaeological resources has never been attempted on a large scale across the HTNF using GIS predictive modeling. A robust predictive model, together with other lines of evidence, can provide a powerful GIS-based decision support framework that can serve both immediate and long-range management decisions regarding cultural resources. The benefits include more efficient and cost-effective planning, inventory, and improved compliance capabilities for locations that have been determined through statistical analyses to have a high potential for cultural resources. As Kvamme (1990:289) states: "If powerful resource location models can be developed then cultural resource managers could use them as planning tools to guide development and land disturbing activities around predicted archaeologically sensitive regions."

A very brief review of modeling is presented below, but for more detailed reviews of GIS applications the reader is referred to Wescott and Brandon (2000), Wheatley and Gillings (2002), and any works by Kvamme and Lock. For a more general review of predictive models, especially in regards to cultural resource management, see Judge and Sebastian (1988).

A landscape-scale modeling approach is deemed the most appropriate for large management areas, and it is worth noting that the unit of analysis for landscape level probability models is not the archaeological site. In a GIS environment the unit of analysis is a cell of a user-defined size that represents some value for a specific variable. For example, all sagebrush cells in a vegetation layer have the same value, while cells that are pinyon pine dominant have another value, and the analysis works on these series of cells. Attributes (or dependent variables) are then recorded for these landscape units or cells, and the attributes of importance here are archaeological in nature: presence or absence of artifacts/sites, artifact/site density, artifact/site types, etc. Inputs (or independent variables) to the model are generally non-archaeological information about the cell or unit, and in the case of the HTNF models are most often environmental variables such as vegetation, elevation, slope, distance to water, and other kinds of resources. The end-users of these models must be aware that these inputs are constructed from data that represent the modern landscape. If paleoenvironmental data is available, this can be used to recreate the environment to reflect its past water and vegetation regime. This is accomplished by including the results of packrat midden, pollen samples, dendrochronology, or the results of other paleoenvironmental analyses into GIS layers. As more work is done, this too can be used to refine current models, or added as a layer when considering various survey strategies.

Statistical methods used to derive models include Bayesian Weights of Evidence (WOFE), chi-square analyses, logistic methods, fuzzy logic, neural networks, or combinations of the above. Though there is more than one method to model the location of cultural resources, WOFE is one good method for handling millions of acres of land where previous surveys have been spotty and cultural resources underreported. WOFE is a statistical method originally developed in the medical field to predict the occurrence of some disease, based on a certain set of symptoms. Its use has expanded widely especially in geology where it has been used to predict the location of gold deposits.

The WOFE method provides a straightforward approach to the integration of diverse environmental and archaeological information. This approach is used for the construction of models with statistically-derived variables that can best predict the location of archaeological sites. The model is then used as a base map where proposed project work is overlain to determine areas that may have a high probability of containing cultural resources. WOFE is a data driven method that requires a set of known archaeological sites. In lieu of adequate samples, another method of predicting areas with a high likelihood of archaeological resources can be constructed based on geographic or cultural resource overviews, ethnographies, or some theory of site location for a given region.

The steps involved in conducting a WOFE analyses begins with defining an area for study. In GIS, this is a set of grid cells that define a region or locale, in this case a mountain range. The number of known sites is then counted, and a prior probability of a raster or cell containing cultural resources is determined by dividing the number of sites by the size or number of cells in the total study area. Finally, after including independent variables as evidence (vegetation, slope, aspect, etc.), the probability of a cell containing artifacts/sites is recalculated. These results are expressed as positive (W+) or high probability, and negative (W-), or low probability. Those evidential themes with the highest weights are combined to produce a map of high, medium, and low probabilities of locating cultural resources in a raster or cell (see Bonham-Carter 1994; Mensing et al. 2000; Raines 1999). Table 1 is a list of common definitions used in WOFE models.

Table 1. Common terms used in Bayesian Weights of Evidence (WOFE) models.

Term	Definition
Landscape	"Mosaics of temporally and spatially dynamic resource patches in which ecological, geomorphological, and cultural systems operate at various scales. It is not an aggregate of types of sites, nor is it simply a large area" (Church et al. 2000:146).
Bayesian Weights of Evidence	A data exploration method that uses the location of known sites to predict the occurrence or probability of sites in unexplored areas.
Prior Probability	The probability that a unit cell contains artifacts, sites, a cultural resource point, or however the researcher determines to represent archaeological materials before taking into account the independent variables (evidential themes).
Posterior Probability	The probability that a unit cell contains a training point after consideration of the independent variables (evidential themes).
Evidential Theme	A theme whose attributes is associated with the occurrence of sites. It is the same as an independent variable.

Independent variables for any given study region vary according to the nature of that particular region. Some areas are very well-watered and this particular variable will not be a limiting factor in predicting cultural resources, in which case water will not be statistically relevant. The location of water sources can be very problematic in the construction of models. Ephemeral water sources such as seeps and seasonal springs, tinajas, or even areas with high water tables cannot be modeled accurately hence their use may have been as ephemeral as their nature.

Modeling requires that variables be carefully studied to insure that they are appropriate to the questions being asked. The independent variables must also be tested to make sure they are not correlated. When variables measure the same dimension, their predictive value may be more related to each other than the location of sites. With environmental variables whose relationships are often symbiotic, this happens quite frequently. For example, vegetation types are often dependent on soils, solar insolation, and climate. Soil types in turn are dependent on bedrock geology and climatic processes, which also affect vegetation in an area. When possible these dependencies must be minimized or eliminated or the resulting model will have no meaning because the variables are describing the relationship among each other and not the location of cultural resources

While building a model, testing and validating independent variables is undertaken. By the time a final model is produced, the variables of interest have been tested against a "non-site sample." This usually consists of creating a grid from areas that have been surveyed, but do not contain sites. WOFE is then run on this set of "non-site" cells and the results of the site and non-site analyses are compared using a chi-square or K-S test of association. If the results show that sites are randomly associated with a particular variable, that variable is either dropped from the analysis or further studied to determine if the association is a result of environmental or other factors. A final probability map consists of cells whose likelihood of containing sites is low, moderate, or high.

Data Considerations

A predictive location model is only a reflection of available data layers for a given area under study. For the Spring Mountains, questions regarding temporal and functional variability at prehistoric sites are not addressed. General site types or categories, such as prehistoric sites, lithic scatters, and isolated artifacts are the highest levels of attributes. The model presented here is built solely for prehistoric sites. There is not yet a generally accepted method for building an historic site location model. Because historic sites are generally more visible and historic records more accessible, a modeling procedure for historic sites has not been a high priority for the HTNF. GIS specialists are considering the issue especially with respect to mining sites which are often associated with bedrock geology and historic roads.

Datasets for analysis are provided through the corporate data library at the HTNF Supervisor's Office in Sparks, Nevada. Variables or evidential themes for models consist of a 30 meter resolution Digital Elevation Model (DEM) which serves as a

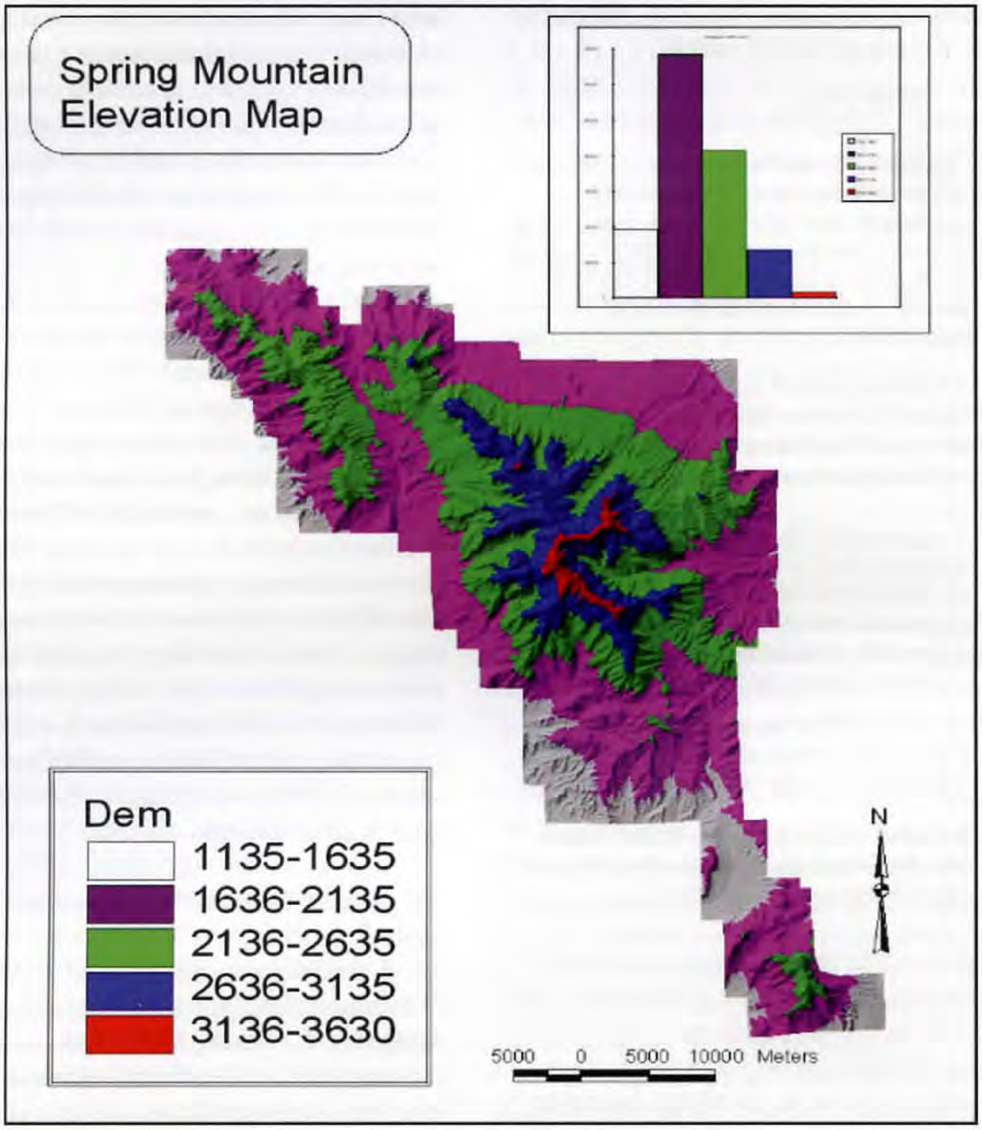

Figure 1. *Elevation model for the Spring Mountain National Recreation Area. (The image represents over 3,000,000 acres. The largest elevation zone is 1636–2635 m.)*

base layer. From this layer, slope, aspect, and hillshade are computed. Vegetation layers are derived from the USGS Gap Analysis Program (GAP) which depicts dominant vegetation types. Hydrology layers consist of springs, perennial streams, and water bodies. Gnomon, Inc. provided data for all the sites and inventories compiled for the Nevada SHPO's NVCRIS project. Ms. Kathleen Sprowl, former archaeologist at the SMNRA, provided a GIS site layer compiled from an atlas into Arc8.x coverages and ArcView shapefiles. A total of 267 sites and 226 inventories were used in the analyses.

SPRING MOUNTAIN MODELING RESULTS

The Spring Mountain National Recreation Area (SMNRA) is an isolated mountain range in southern Nevada just outside of Las Vegas, and the Recreation Area is the third largest in the National Forest System. According to the Outside Las Vegas Foundation there are: "39 identified bio-diversity 'hot-spots' within the NRA. A drive up Kyle Canyon will bring you in touch with five of the six North American life zones, a unique experience only available in a few places on this continent" (Outside Las Vegas 2008). Conifer forest domi-

Table 2. Proportional analysis for survey and site area within elevation zones (500 m intervals).

	1135-1635	**1636-2135**	2136-2635	2636-3135	3135+	Total
Total Acres	1,743,453	**6,168,609**	3,745,908	1,239,912	166,887	13,064,769
Proportion	13.34	**47.22**	28.67	9.49	1.28	100.00
Inventory Acres	104,220	**347,508**	125,532	6,975	387	584,622
Proportion	17.83	**59.44**	21.47	1.19	0.07	100.00
Proportion Total Acres Inventoried						
	0.80	**2.66**	0.96	0.05	0.00	4.47
Number of Acres Associated with Sites						
	6,678	**55,476**	6,336	2,547	39,123	110,160
Proportion	6.06	**50.36**	5.75	2.31	35.51	100.00

nates the north end of the range, and Mojave vegetation the southern portion. Pinyon-Juniper woodland forms an elevation ring around the mountain. The Spring Mountain NRA is the richest landscape modeled for the HTNF, to date, in terms of the variety of archaeological resources (see Stoffle et al. 2004). While the mountain range's acres are small by HTNF standards, they are unique. The cultural resources on the SMNRA include, but are not limited to, roasting pits, rock features, petroglyphs and pictographs, rock shelters, and numerous historical resources. As well, the mountain has long been used by a variety of cultural groups, in particular various Southern Paiute tribes.

Forest Service acreage for the Spring Mountains totals 316,000. Approximately 17,000 acres of survey have been conducted on these landholdings (~5 percent). The quality of some surveys and the level of detail of the sites recorded within them varies, many being old surveys using less than ideal recordation methods. Variables used for building the Spring Mountain model include elevation, slope, distance to water, and vegetation (see below).

Validating the Variables

Elevation (Figure 1, Table 2). Table 2 shows both the proportion of acres surveyed and the proportion of site area within each elevation zone. The table illustrates several facts. Elevation zones two (1626–2135 m) and three (2136–2635 m) have received inventories proportional to their overall area and we can assume that the percentage of site area is an accurate representation of the two elevation zones. The elevation zone over 3135 m also shows an interesting trend. A high proportion of site area relative to class area is observed. This may be due to the fact that the Spring Mountains are extremely rich in rock shelters and petroglyphs, both common at higher elevations and on steeper slopes. This zone should be further surveyed as part of any inventory strategy, especially in a landscape assessment. This observation is also borne out in the slope analysis (see below). Survey strategies should include a higher proportion of steeper slopes located at higher elevations in order to more accurately assess human use of the landscape. This could be aided by constructing a separate model for rock shelters and rock art and determining if there is a relationship to aspect, viewshed, or some other factors.

Both the proportional analysis (Table 2) and an associated chi-square analysis (not shown here) illustrate that elevation class two (1636–2135m) is the zone statistically predictive of sites.

Slope (Figure 2, Table 3). Slope is derived from the DEM base layer. Normally slope is classified into 5 m intervals for predictive models. This

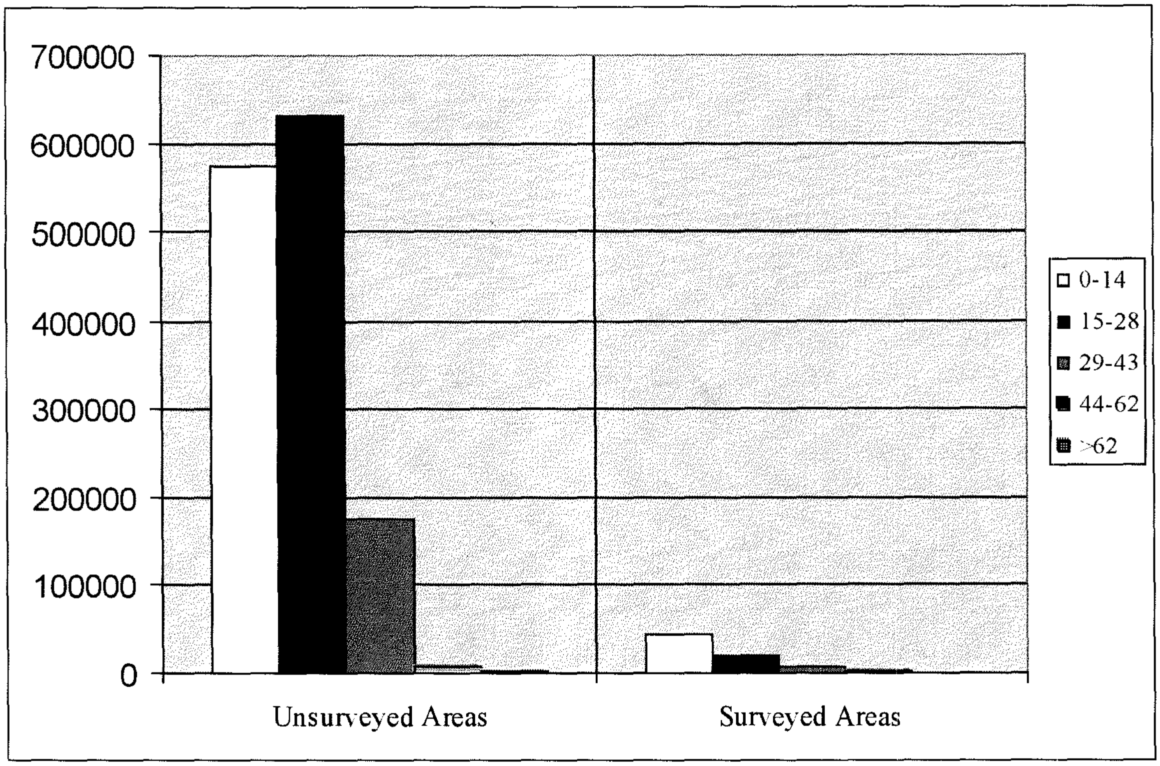

***Figure 2.** Surveyed areas within 14 degree slope intervals.*

***Table 3.** Proportional analyses of slope interval zones (slope in degrees).*

	0-14	14-28	28+	Total
Total Acres	**5,569,533**	5,849,883	1,645,353	13,064,769
Proportion	**42.63**	44.78	12.59	100.00
Inventory Acres	**376,200**	165,726	42,696	584,622
Proportion	**64.35**	28.35	7.30	100.00
Proportion Total Acres Inventoried	**2.88**	1.27	0.33	4.47
Number of Acres Associated with Sites	**36,333**	19,494	4,446	60,273
Proportion	**60.28**	32.34	7.38	100.00

particular interval did not work for the Spring Mountains. After studying histograms for slope values and the proportion of survey and site area within different slope zones, a value of 14 degrees is considered an optimal class size for slope. This is a reflection of the steep topography of the area, and the fact that rock art and rock shelters are generally found on steeper slopes.

Based on the proportional and chi-square analyses, slopes between 0–14 degrees are most predictive for prehistoric sites, while 14–28 degrees are moderately predictive (Table 3). Over half of the inventory to date has been in the 0–14 slope range (64.35 percent) and this zone makes up approximately 42 perent of the total area. Based on the proportion of area this zone represents through-

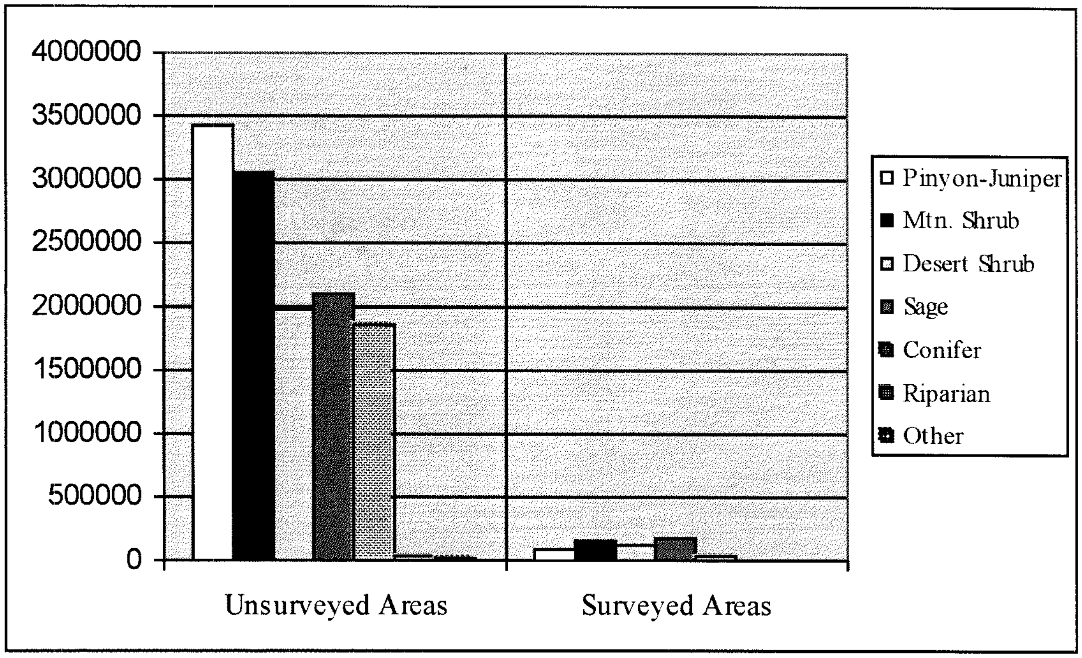

Figure 3. *Histogram of areas surveyed in vegetation classes.*

Table 4. *Proportional analysis of desert scrub and sage/grassland vegetation zones.*

	Shrub/Scrub	Sage/Grassland
Total Acres	2,102,454	2,281,554
Proportion	16.12	17.49
Inventory Acres	121,095	176,976
Proportion	20.72	30.28
Proportion Total Acres Inventoried	0.93	1.36
Number of Acres Associated with Sites	25,407	17,730
Proportion	42.15	29.42

out the Spring Mountains, the 14–28 degree slope zone is under-surveyed. Future surveys should include a higher proportion of this particular zone to accurately characterize human use of the landscape. Moreover, the majority of survey has occurred on the eastern slopes of the Spring Mountains, where most development projects have been conducted. Future survey should focus more on the western slopes of the range and include the steeper slopes all around. Rock art locations probably influence the results of both slope and elevation probability analyses and these relationships require field testing.

Vegetation (Figure 3, Table 4). The vegetation layer is derived from the USGS Gap Analysis Program (GAP). GAP data is problematic because of its coarse grain scale. It must be handled carefully for analysis and is weighted less heavily than other variables. The WOFE analysis shows that, based on the relative area of vegetation zones compared to the number of sites found within each unit area, Sage/Grasslands, Mountain Shrubs and Desert Scrub areas produce the highest values.

Proportional and chi-square analyses confirm that the Shrub/Scrub zone, relative to its area, is more predictive of site locations than the other

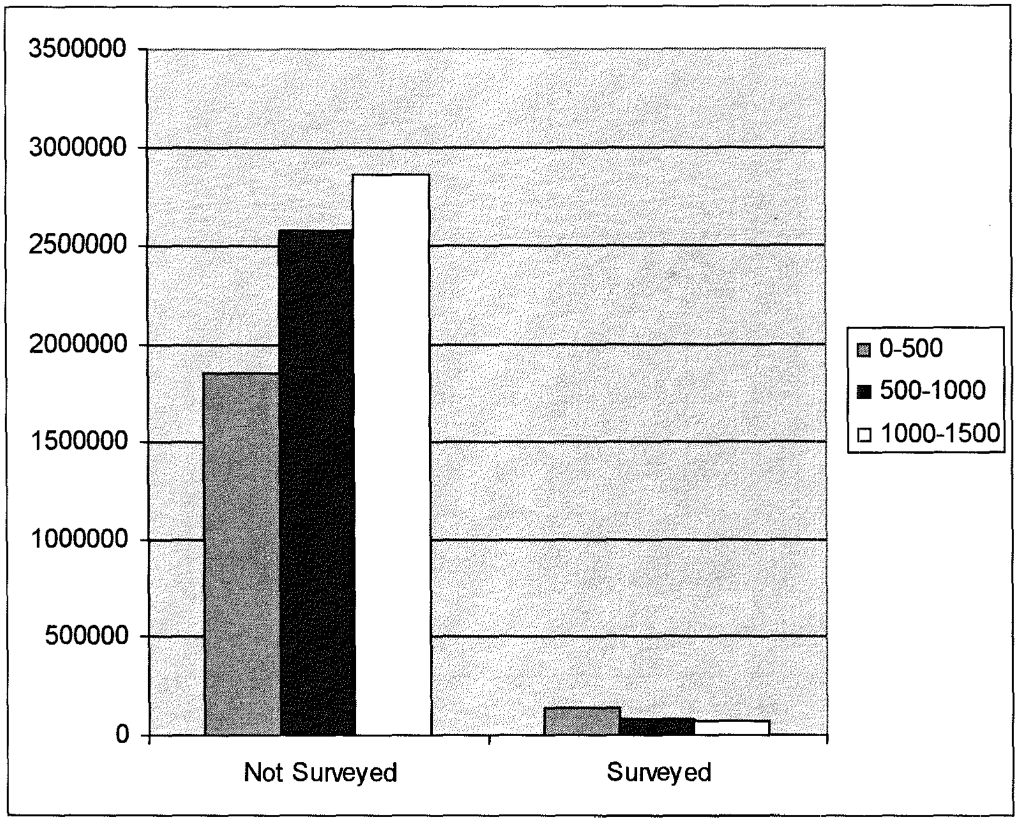

Figure 4. *Distance to water in meters.*

Table 5. *Proportional analysis for distance from water.*

	0-500 m	501-1000 m	1001-1500 m	Total
Total Acres	1,998,738	2,655,774	2,937,474	7,591,986
Proportion	26.33	34.98	38.69	100.00
Inventory Acres	140,778	87,066	76,257	304,101
Proportion	46.29	28.63	25.08	100.00
Proportion Total Acres Inventoried	1.85	1.15	1.00	4.00
Number of Acres Associated with Sites	14,526	15,507	15,777	45,810
Proportion	31.71	33.85	34.44	

vegetation zones (Table 4). Figure 3 illustrates that the Pinyon/Juniper zone has received less attention relative to its size and should be an area that is more heavily included in any future survey strategy.

Water (Figure 4, Table 5). The hydrology layer also proved difficult to quantify. When permanent streams are separated from all other drainages, only eight streams are classified as such. Springs are numerous in the area (~70), but it cannot be determined to what extent these were active during prehistoric times. Distance rings or buffers around major drainages and springs were constructed to make a water layer. The problem with

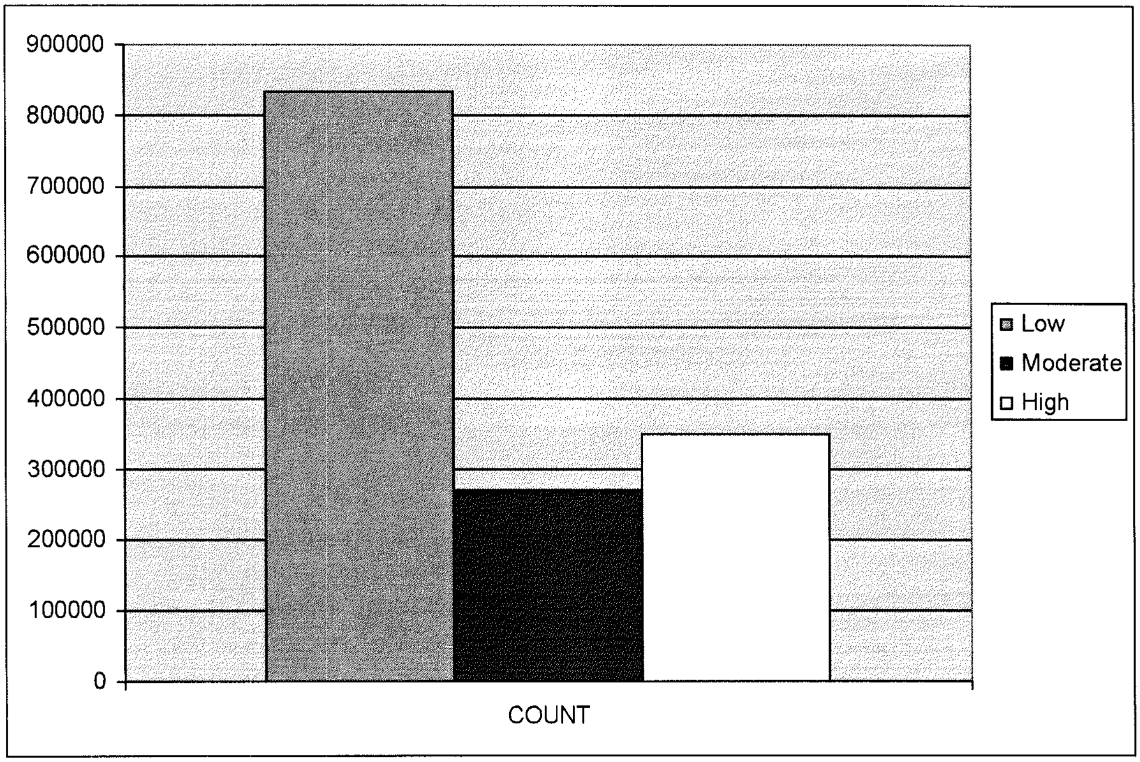

Figure 5. *The proportion of area (in number of 30 meter squares) on the Spring Mountain National Recreation Area for each sensitivity zone.*

water can be seen in the proportional table, where no class is more predictive than another (Table 5). The numerous springs and drainages in the area may have meant that water was not a limiting factor for site location. Ambiguous distances probably reflect the topography of the area and the fact that sites may be located horizontally close to water, but vertically distant. Again, the nature of many of the sites (i.e., rock art) probably skews the analytic results for this variable. Both horizontal and vertical distance to water sources should be considered in future analyses. And areas around water sources and drainages of select size and relief should be considered as part of a special survey strategy. For this reason, water is not considered statistically robust in that it cannot help to predict where sites are located. One solution is to identify drainages of optimal relief and area to act as proxy data for permanent water.

Final Model

Results of the above analyses indicate that of the variables, slope has the greatest influence on the location of sites in the Spring Mountains, followed by vegetation, then elevation. Permanent water sources have no influence for this model. Before combining these variables into a final map, specific classes within each variable are weighted according to their predictive power. For example, the elevation between 1636–2135 m is given the greatest weight of any elevation zone. While chi-square analysis shows the influence of 3100+ m elevation zone, not enough survey has been completed here to validate its true influence on site locations.

The proportional area of each sensitivity zone and associated acres is given in Figure 5. When sites are treated by area, instead of points, and added to the sensitivity map we get a sense of the proportion of site and survey area that falls within each sensitivity zone. However, the use of the area of sites is problematic. When sites are treated as points, 108 sites fall within the high zone, 54 in the moderate and 47 in the low. When treated as areas represented by polygons of a given size, 58 percent of site area falls in the low sensitivity zone. Here, a few sites displayed as very large polygons on the map in low probability areas are unduly influencing the percentage of site area to model area. These large sites should be re-examined to confirm their topographic position and extent. This shows the analytic beauty of the WOFE method, in that variables can easily be added or removed, layers reclassified, and the model re-run any number of times to achieve a better result. Also, each variable can be statistically examined to find patterns.

Proportional and chi-square analyses reveal that of all variables and variable classes, slopes between 0–14 degrees were found to be the most predictive for the location of sites in the Spring Mountains, while slopes between 14–28 degrees are moderately predictive. Over half of the inventory to date has been in the 0–14 slope range (64.35 percent), which makes up 42 percent of the total area. The 14–28 degree slope zone is under-surveyed, based on the proportion of area it represents. Future inventories should include a higher proportion of surveys in this steeper zone to accurately characterize human use of the landscape. In addition, the majority of survey has occurred on the east slopes of the Spring Mountains. This is due to access and project needs. Future survey should focus on the western slopes and include the steeper terrain. Rock art locations probably influence the nature of the slope and elevation probability values. Results from surveys on the western side of the mountain range should aid in understanding aboriginal use of the mountain and determine if the higher use of the east side is more real than apparent.

Preliminary Field Test Results

Approximately 2800 acres were surveyed in the Spring Mountains in 2003 and 2004. Results of this work were used to test the predictive location model. A grid of 500 m squares was latticed over the model, and a number of these squares were chosen for inventory: 60 percent of the area chosen for survey was in high probability, 30 percent in moderate, and 10 percent in low. During the inventory, 99 sites and 206 isolated finds were recorded. And of these, 90 sites and 193 isolated finds were found in the high probability area, eight sites and 31 isolates were found in moderate, and one site was observed in the low probability area. Accounting for acres of survey in each zone, there was a much greater probability of locating sites in high probability areas and a very small chance of finding sites in low. These field tests demonstrate that the model is useful as a planning tool, but the small sample size requires further work. An intuitive or judgmental survey of the north and south areas of the Spring Mountains by the author indicate that further model and field testing is necessary. A revised model is being developed and should be completed in winter 2009.

FUTURE MODELING RECOMMENDATIONS

The Spring Mountain ecosystem regime is very diverse. Great Basin vegetation is common towards the north end of the range, while Mojave Desert plants are found towards the south. Indeed, this mountain range has been termed a "sky island" (USDA-U.S. Forest Service 2007:2); it is, in essence, a high elevation refuge for plants, animals, and people. This makes the region a unique and interesting modeling exercise. The next model iteration will consist of separating the range into two or three separate modeling units, but how to analytically split the area is not straightforward. Just like the Great Basin in general, the division can be made into hydrologic, physiographic, or cultural units.

The Spring Mountains NRA is divided into two distinct hydrogeographic areas, the west ultimately drains into the west-central Great Basin, and the eastern slopes flow into the Colorado River by way of the Las Vegas Wash. Splitting the mountain at the divide would be one way to model the area and could help quantify the east/west rain shadow effects. The range could also be broken into three mini "sky islands" consisting of Mt. Stirling, Mt. Charleston, and Rainbow Mountain, capturing both hydrographic and physiographic characteristics.

We know from archaeological and ethnographic evidence that cultural boundaries were fluid, that the Range has many cultural properties, and that it was home to Virgin Anasazi, Shoshone, and Paiute groups creating a rich tapestry of cultures. The current database does not lend itself well to these kinds of distinctions and creating divisions based on pottery or projectile point styles as ethnic markers would likely be spurious. This being said, a cultural layer could be created as a method to guide survey and include special areas into a survey strategy. Likewise, inductive (theory driven) models could be employed in areas where there is a paucity of survey and site data and these should follow the most up-to-date theories about human behavior. Again, the beauty of the WOFE modeling technique is that numerous models can be run and tested within a GIS framework. New layers can easily be created and added, or subtracted, from the analyses in a fairly straightforward manner. The effect of each new variable can quickly be seen within the resulting WOFE analysis tables.

Despite what some may think, modeling for cultural and other resources is widely practiced. The nature of cultural resource privacy laws, however, does not lend itself to sharing these analytic tools outside of the agency domain. To most archeologists, it may seem as though GIS modeling is not being carried out. In fact, probability modeling is not gone or forgotten, but is actually becoming more prevalent as budgets shrink and streamlining field work becomes more imperative.

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