

Early and Middle Holocene Hearth Features Along the Garlock Fault, Western Fremont Valley, California

Jill K. Gardner, Sally F. McGill, and Mark Q. Sutton

Abstract

During geologic trenching in the spring of 1994, 12 zones of burned soil, some containing fire-affected rocks, were discovered at an archaeological site (CA-KER-3939) in the western Fremont Valley. Three of these burn zones were subsequently identified as hearths. Radiocarbon assays were obtained on all but three of these burn zones, including the hearths. Two assays from one of the hearths returned results of approximately 7,000 RCYBP, which are among the earliest archaeological radiocarbon dates in the western Mojave Desert. This paper reports the results of the analysis of all of the zones of burned soil and the hearths, as well as a discussion of the significance of these results for archaeology in the Mojave Desert. (This report is a revised version of a paper presented at 1994 Kelso Conference, Little Lake, and the 1994 Society for California Archaeology Data Sharing Meeting, Los Angeles.)

Introduction

In May of 1994, 12 zones of burned soil were discovered during geologic trenching (conducted by Sally McGill) adjacent to the Garlock fault in the western Fremont Valley, just south of Red Rock Canyon State Park (Fig. 1). The purpose of the trenching was to determine the slip rate and seismic hazard of the western Garlock fault (McGill 1994a, 1994b; McGill et al. 2003). Stephen G. Wells, then at the University of California, Riverside (UCR), visited the trenches and suspected that the burn zones might be archaeological in nature. On the advice of Joan Schneider, also at UCR, McGill contacted Mark Q. Sutton at California

State University, Bakersfield (CSUB). Shortly thereafter, all three authors met at the site to determine if these formations were cultural. Upon further examination of the burn zones, it was determined that at least three of them were hearths. The site has since been recorded as CA-KER-3939.

In this report, the terms “zone of burned soil” or “burn zone” are used in cases where it was not possible to determine whether the feature was cultural in origin, at least as far as could be observed within the exposure of Trench 6 (see below). The observed portions of these burn zones consisted mainly of scatterings of charcoal and charred dirt, most with no associated fire-affected rocks. The term “hearth,” on the other hand, is used to denote a feature of definite cultural origin, as shown by the existence of charred rocks in an organized placement. Soil samples from all three of the hearths and all but one of the burn zones were collected for further analysis, and charcoal specimens from most of these formations were submitted for radiocarbon analysis (see below). One significant finding came from Hearth Feature 6H, which returned two separate assays of approximately 7,000 RCYBP, providing two of the oldest archaeological radiocarbon dates in the western Mojave Desert.

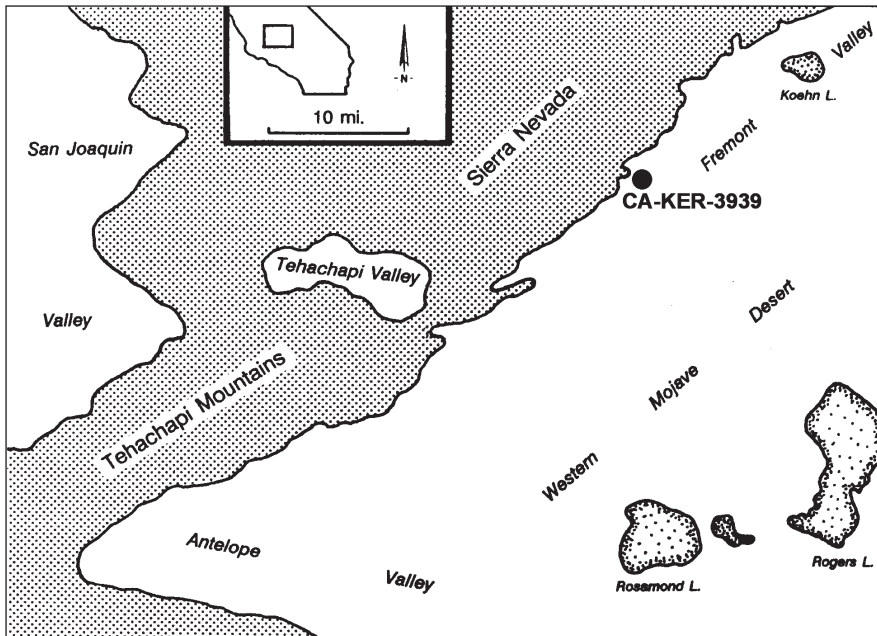


Fig. 1. Approximate location of CA-KER-3939 in the western Mojave Desert. (Map is adapted from Yohe 1993:62.)

Site Description

CA-KER-3939 is located in the western Mojave Desert just west of Highway 14, approximately 10 miles northeast of Mojave, California, at an elevation of approximately 866 m (2,840 ft.), on public land administrated by the Bureau of Land Management (Fig. 1). The current vegetation in the site area is characteristic of the Lower Sonoran Zone, which includes the creosote bush (*Larrea tridentata*), Joshua tree (*Yucca brevifolia*), thistle sage (*Salvia carduacea*), and numerous wildflowers (Munz 1974). The mean annual precipitation of the western Mojave Desert ranges from less than 4 inches in the lower elevations to more than 30 inches at the highest elevations in the mountains (Morrison 1965:267), and is extremely variable, with occasional flash flooding. High winds are also common features of this region. Drainage is internal, “and the few perennial streams that rise in the high mountains...lose themselves in playas or salt lakes” (Wahrhaftig and Birman 1965:300). Daytime summer temperatures can sometimes exceed 100°F, while winter temperatures sometimes fall below freezing.

The hearth features and burn zones discovered at CA-KER-3939 were found within colluvium (slope wash) that was deposited within and near the margin of an ancient channel that had incised into a Late Pleistocene alluvial fan. The channel has been offset approximately 60 m left laterally along the Garlock fault. Six geologic trenches were excavated in the vicinity of the channel (Fig. 2), and a number of radiocarbon dates were obtained on charcoal samples from the various trenches in order to constrain the age of the offset channel wall. When the burn zones and hearths were discovered, additional radiocarbon assays were obtained in order to determine their antiquity.

The Geologic Trenches

As noted above, six geologic trenches were excavated during the geologic study. Only three of these trenches (Trenches 1, 2, and 6; Fig. 2) revealed zones of burned soil, which were interpreted at the time as zones of sediment that were darker as a result of incorporation of fine charcoal dust and occasional charcoal fragments from natural fires. Trench 1 revealed a diffuse

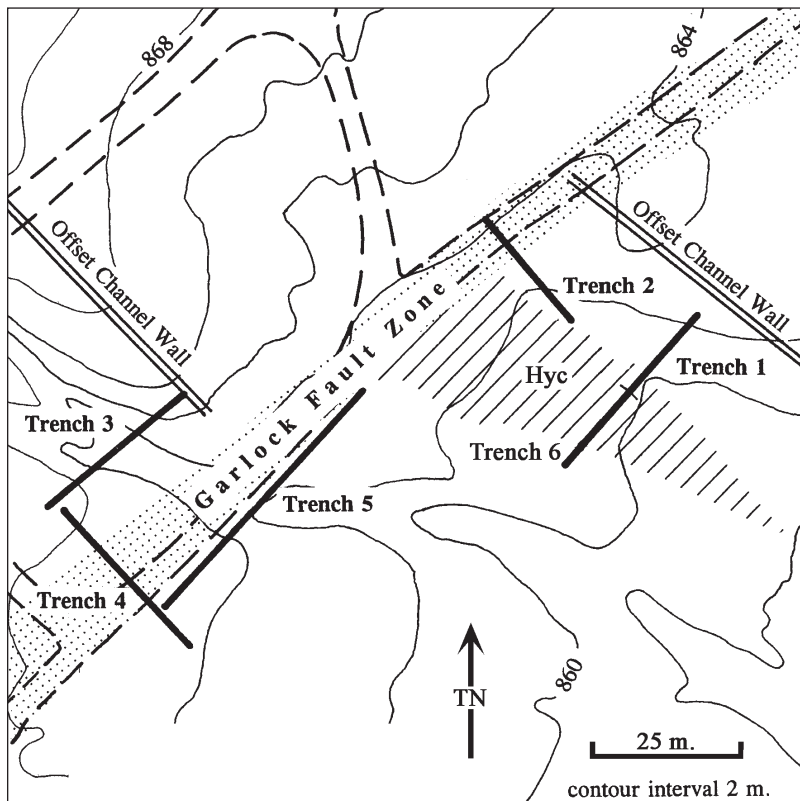


Fig. 2. Map of geologic trenching in and near CA-KER-3939. The area labeled Hyc has the potential to contain prehistoric occupational debris (see text for details).

zone of darker colored sediment with relatively common charcoal fragments. This zone was about 2.5 m wide and 30 to 50 cm thick and was located about 1 to 1.6 m beneath the ground surface in the northwestern wall of the trench. A charcoal sample from this burn zone, which was later determined to be contiguous with Burn Zone 6A-3 from Trench 6 (Fig. 3), yielded an age of $5,950 \pm 70$ RCYBP (calibrated age of 6,570 to 6,980 years B.P.; AA-9172) (see Table 1). A similar burn zone was revealed in the southeast wall of Trench 1. This zone was about 2.7 m long, about 20 to 30 cm thick, and was at a depth of about 1 to 1.3 m beneath the ground surface.

Broad, diffuse zones of darker sediment with relatively common charcoal fragments were also found in both walls of Trench 2. In the northeastern wall of Trench 2, the darker, charcoal-rich zone was 9 m long and about 40 to 75 cm thick. The top of this burn zone

was located about 10 to 40 cm beneath the ground surface, except where it was more deeply buried by an artificial berm at the edge of a dirt road. In the southwestern wall of Trench 2, the darker, charcoal-rich zone was about 7.8 m long, about 5.0 to 30.0 cm thick, and the top of the burn zone ranged from 5.0 cm to 1.0 m beneath the ground surface. A charcoal sample from this burn zone yielded an age of $1,025 \pm 55$ RCYBP. The surface projection of these trenches is shown in Figure 2. After the geological analysis was completed for Trenches 1 and 2, they were backfilled. As no soil samples were collected from the burn zones in these trenches, the presence of cultural materials could not be ascertained.

Trench 6

The hearths and burn zones that were analyzed as part of the archaeological component of this project

were discovered in Trench 6 and were labeled 6A to 6H, generally from stratigraphically highest to lowest, although the stratigraphic positions of Zones 6D and 6E relative to 6F, 6G, and 6H were somewhat obscure because of the discontinuous nature of the bedding between these features. Subsequent to the backfilling of Trench 1, Trench 6 was excavated in the same location, lengthening and deepening the line of Trench 1 for the purpose of better exposing the channel wall

that had been offset by the Garlock fault. The maximum depth of Trench 6 was about 5.3 m (17 ft.). For safety purposes, the trench was excavated with three vertical tiers separated by two horizontal benches on each side of the trench. The two uppermost tiers were each about 1.5 m tall, and the deepest tier was about 2 m tall and was supported by hydraulic shoring. Nine burn zones were exposed in Trench 6, some of which contained concentrations of charred cobbles.

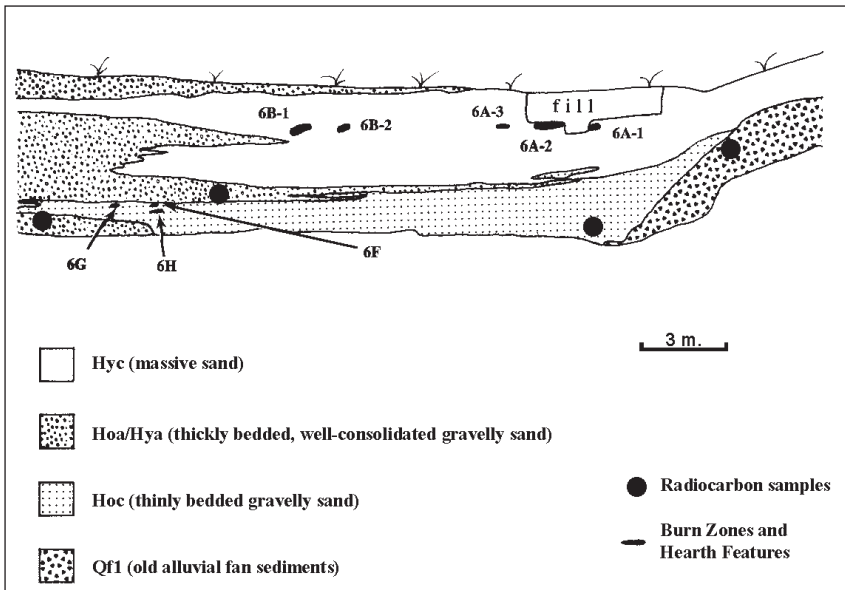


Fig. 3. Soil profile of west wall of Trench 6, CA-KER-3939

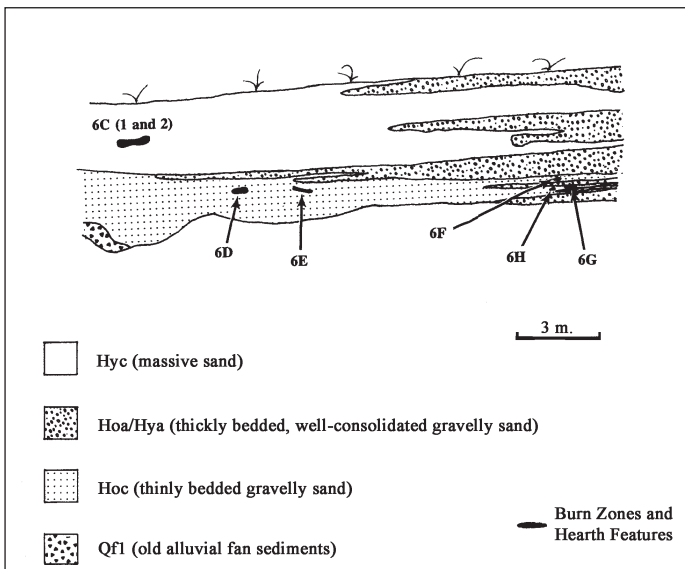


Fig. 4. Portion of the east wall profile of Trench 6, CA-KER-3939.

Burn Zones 6A-1, 6A-2, and 6A-3 are the expression in Trench 6 of the burn zone originally exposed in the northwest wall of Trench 1. These three burn zones, along with Burn Zones 6B-1 and 6B-2 (Fig. 3), were exposed in the northwest wall of Trench 6, near the base of the uppermost tier, just above the upper bench. Burn Zones 6D and 6E (Fig. 4) were exposed in the southeast wall of Trench 6, in the deepest tier of the trench. Burn Zones 6F and 6G, as well as Hearth 6H (Figs. 3 and 4), were exposed primarily in the northwest wall of the deepest tier of the trench, but thin extensions of these layers were also visible in the southeast wall. Hearth features 6C-1 and 6C-2 are the expression in Trench 6 of the burn zone originally exposed in the southeast wall of Trench 1 (Fig. 4). These hearths were exposed on the southeast wall, near the top of the second tier, just beneath the upper bench.

The hearths and zones of burned soil exposed in the walls of Trench 6 were photographed and sketched on McGill's geologic cross sections of the trench. Radiocarbon assays were obtained on all three hearths, as well as six of the burn zones. All of the radiocarbon samples consisted of charcoal specimens removed in the field by McGill, with the exception of the charcoal from Hearth 6C-2, which was retrieved during laboratory analysis of the soil samples. Most radiocarbon analyses reported here were performed by accelerator mass spectrometry (AMS) at the University of Arizona, although two were performed by liquid scintillation analysis at Beta Analytic, Inc. The sample ages were originally calibrated with the "Calib" program (Stuiver and Reimer 1993), then updated and revised using the 1998 atmospheric decadal dataset (intcal98.14c) of Stuiver et al. (1998). Results of the radiocarbon assays are discussed below and presented in Table 1.

Table 1. Radiocarbon assays for burn zones and hearth features from Trench 6 at CA-KER-3939.

Designation	^{13}C ‰ ^a	Radiocarbon Age (at 1-sigma)	Calibrated Age (Years B.P.)		Stratigraphic Unit ^c	Lab. Number ^d
			Median	Range ^b		
Burn Zone 6A-1	-22.0	5,516 ± 98	6,310	6,500-6,000	Hyc	AA-14547
Burn Zone 6A-3 ^e	(-25.0)	5,950 ± 70	6,780	6,980-6,570	Hyc	AA-9172
Burn Zone 6D	-25.3	7,040 ± 94	7,860	8,010-7,680	Hoc	AA-14549
Burn Zone 6E	-24.3	7,056 ± 103	7,870	8,110-7,680	Hoc	AA-14550
Burn Zone 6F	-23.8	6,918 ± 71	7,750	7,920-7,620	Hoc	AA-14552
Burn Zone 6G	-23.6	6,888 ± 88	7,730	7,920-7,580	Hoc	AA-14551
Hearth 6C-1	-22.6	5,602 ± 71	6,390	6,550-6,210	Hyc	AA-14548
Hearth 6C-2	--	5,600 ± 50	--	6,475-6,295	Hyc	Beta-112551
Hearth 6H	-23.4	6,968 ± 109	7,800	7,970-7,605	Hoc	AA-14553
Hearth 6H ^f	-24.9	7,170 ± 140	7,980	8,290-7,680	Hoc	Beta-74108

a. Assumed values are in parentheses. All other values are measured.

b. Calibrated age ranges are reported in years before 1950, with 2-sigma uncertainties, and are rounded to the nearest five years. For cases in which the calibration resulted in multiple possible age ranges, those ranges have been combined.

c. See text for definitions of stratigraphic units.

d. All but two of the radiocarbon assays are from the University of Arizona NSF AMS Facility, the exceptions being the one from Hearth Feature 6C-2 and the second assay from Hearth Feature 6H, both of which are from Beta Analytic, Inc., in Miami, Florida. All of the radiocarbon samples were charcoal specimens.

e. While this radiocarbon sample was not derived directly from Burn Zone 6A-3, it came from an area in Trench 1 that is likely contiguous with this burn zone.

f. This second sample from Hearth Feature 6H is a conventional radiocarbon assay; all others were AMS dated.

Upon completion of documentation of the hearths and burn zones in Trench 6, bulk soil samples were collected from all except Burn Zone 6G. These soil samples were transported to the CSUB archaeology laboratory for analysis. In the laboratory, the soil samples were processed by wet screening through No. 35 mesh. After the samples were dried, they were examined under a dissecting microscope and recovered materials were placed in glass vials. All materials were then catalogued by provenience and given consecutive catalogue numbers.

Results

As noted above, examination of the burn zones and hearths at CA-KER-3939 indicated the presence of at least three hearths. Laboratory analysis of the soil samples revealed that all of these formations contained unburned botanical remains and little else. The following is a discussion of the field and laboratory results of the burn zones and hearths from Trench 6.

Burn Zones

Nine burn zones of unknown origin were identified in Trench 6. These burn zones were exposed in the trench, but no three-dimensional excavations of these zones were undertaken. Isolated pieces of charcoal were collected from various geologic units exposed within the six trenches at the site. These were transported as detrital clasts and were deposited along with the fluvial, colluvial, and debris flow sediments in which they were found. What distinguishes the burn zones from these isolated, detrital charcoal fragments is the existence of multiple charcoal samples in close proximity as well as the darkened nature of the surrounding sediment, presumably as a result of a concentration of charcoal dust near an in-situ burn, whether cultural or noncultural (e.g., a lightning strike) in origin. Although there might be sedimentary mechanisms that could concentrate charcoal fragments in such close proximity, the dark color of the sur-

rounding sediment seems difficult to explain by means of anything other than an in-situ burn.

Moreover, given the presence of clearly cultural hearth features at similar stratigraphic positions at nearby locations in Trench 6, it seems plausible that these burn zones represent the distal edges of hearth features that were not directly intersected by the trench wall. The only cultural item found in any of the burn zones, however, was a tiny obsidian flake recovered from the soil sample taken from Burn Zone 6B-2. That burn zone and two others (Burn Zones 6A-2 and 6B-1) contained insufficient or no materials suitable for radiocarbon dating and were virtually devoid of botanical specimens (none of which was carbonized); thus, they are not discussed further below. The results of the analysis of the other six burn zones are detailed below (also see Table 1).

Burn Zone 6A-1. Burn Zone 6A-1 was about 10 to 15 cm thick, and about 60 cm wide. It was located in the northwest wall of Trench 6, in an area of massive sand approximately 1.3 m below the ground surface (Fig. 3). An AMS assay on charcoal from this zone (collected in the field by McGill) returned a result of $5,516 \pm 98$ RCYBP (AA-14547). The median calibrated age of this sample is 6,310 years B.P. (see Table 1 for range of calibrated dates). The soil sample from this zone contained only a small amount of charcoal.

Burn Zone 6A-3. Burn Zone 6A-3 was about 10 to 15 cm thick, about 1 m wide, and was located in the northwest wall of Trench 6, in an area of massive sand approximately 1.5 m below the ground surface (Fig. 3). No charcoal from this zone was dated, but one dated sample from Trench 1 came from a portion of the burn zone that was probably contiguous with Burn Zone 6A-3. An AMS assay on this sample returned a result of $5,950 \pm 70$ RCYBP (AA-9172). The median calibrated age of this sample is 6,780 years B.P. (see Table 1 for range). A small amount of charcoal was

retrieved from the soil sample taken from this burn zone.

Burn Zone 6D. Burn Zone 6D was approximately 10 cm thick, about 30 cm wide, and was located in the southeast wall of Trench 6, in an area of thinly bedded, gravelly sand ca. 3.5 m below the ground surface (Fig. 4). One radiocarbon sample from this burn zone was submitted for AMS dating, returning an assay of $7,040 \pm 94$ RCYBP (AA-14549). The median calibrated age of this sample is 7,860 years B.P. (see Table 1 for range). The soil sample from this zone included charcoal, two very small, unburned bones, a small amount of unidentified insect frass, and several unburned, unidentified seeds.

Burn Zone 6E. Burn Zone 6E was about 5 cm thick, about 1 m wide, and was located in the southeast wall of Trench 6, in an area of thinly bedded, gravelly sand. This feature dipped gently to the southwest, at a depth ranging between 3.5 and 3.7 m below the ground surface (Fig. 4). The radiocarbon sample submitted for AMS dating of this burn zone returned an assay of $7,056 \pm 103$ RCYBP (AA-14550). The median calibrated age of this sample is 7,870 years B.P. (see Table 1 for range). The soil recovered from this zone contained a small quantity of charcoal. An additional soil sample containing uncharred sediment was taken between Burn Zones 6D and 6E. This sample contained only a small amount of unburned vegetation.

Burn Zone 6F. Burn Zone 6F was about 5 cm thick, 30 cm wide, and about 4.1 m below the ground surface. When the trench was excavated, this burn zone was apparently bisected. The northwest wall of the trench contained the largest cross section of this zone, but a thin extension could also be seen at the same stratigraphic level in the southeast wall (Figs. 3 and 4). The width of the trench at this depth was about 1 m. An AMS assay on Burn Zone 6F returned a result of $6,918 \pm 71$ RCYBP (AA-14552). The median calibrated age of this sample is 7,750 years B.P. (see Table

1 for range). The soil sample taken from this zone included charcoal, one unburned seed, and one very small, unburned bone.

Burn Zone 6G. Burn Zone 6G was about 5 cm thick and 25 cm wide, and was located in an area of thinly bedded, gravelly sand approximately 4.4 m below the surface of the trench (Figs. 3 and 4). This zone was also apparently bisected during excavation of the trench, which was 1 m wide at this location. As with Burn Zone 6F, the northwest wall of the trench contained the largest cross section of this feature, although a thin extension could also be seen at the same stratigraphic level in the southeast wall. An AMS assay on this burn zone returned a result of $6,888 \pm 88$ RCYBP (AA-14551) (see Table 1). The median calibrated age of this sample is 7,730 years B.P. No soil was collected from this layer, as only two charred cobbles were exposed in the trench wall and very little charred soil was apparent.

Hearth Features

No artifacts were found in association with these features, but their configuration and size, as well as the presence of numerous fire-affected rocks in each of them, confirmed their identification as hearths. The results of the analysis of these hearths are detailed below and in Table 1.

Hearth Feature 6C-1. Hearth 6C-1 was located in the east wall of Trench 6, in an area of massive sand approximately 1.35 m below the surface of the trench (Figs. 4 and 5). It was partially bisected during trenching, but was still relatively intact. The hearth was approximately 60 cm in diameter and approximately 20 cm thick. It consisted of at least 26 fire-affected rocks contained within a circular area of blackened soil. Plan and profile views of this feature are provided in Figure 6.

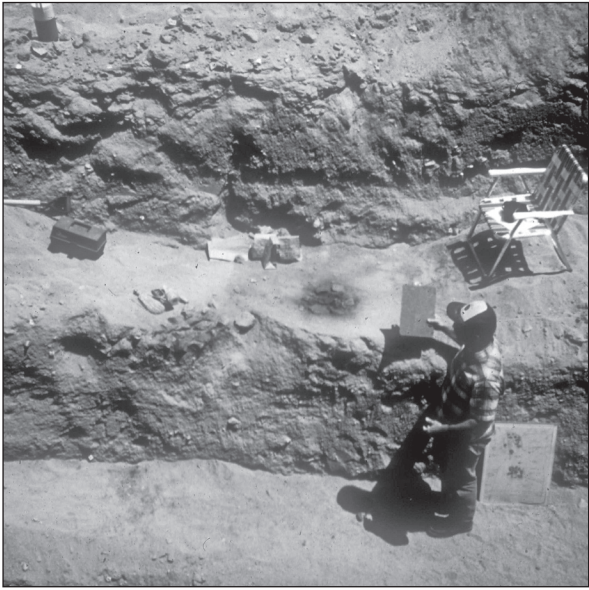


Fig. 5. Hearths 6C-1 (left) and 6C-2 (right).

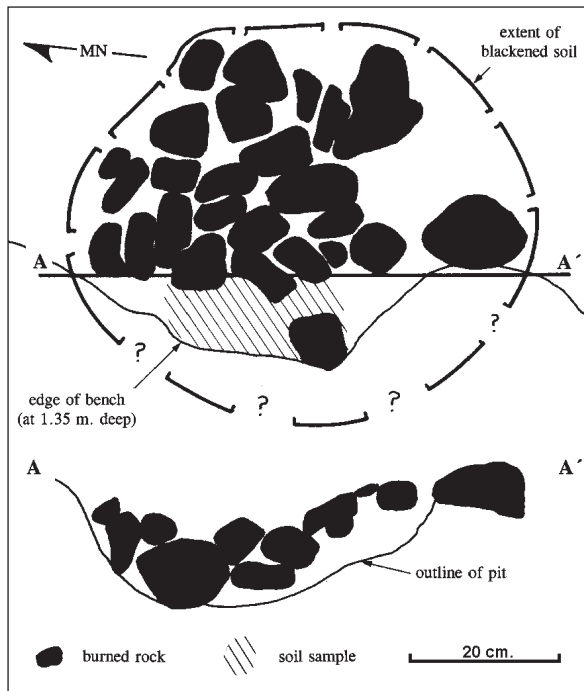


Fig. 6. Hearth 6C-1, plan and profile views.

The soil sample from Hearth 6C-1 was recovered from the upper and lower portions of the center of the hearth. Several charcoal specimens were extracted, as well as two unburned seeds and one complete, unburned insect (a fly). In addition, seven fire-affected rocks were collected from this feature. One radiocarbon sample from Hearth 6C-1 was submitted for AMS dating, returning an assay of $5,602 \pm 71$ RCYBP (AA-14548), calibrated between 6,550 and 6,210 calendar years B.P. (Stuiver et al. 1993; Talma and Vogel 1993; Vogel et al. 1993). The median calibrated age of this sample is 6,390 years B.P.

Hearth Feature 6C-2. Hearth 6C-2 was also located in the east wall of Trench 6, in an area of massive sand approximately 1.35 m below the surface of the trench (Figs. 4 and 5). It was laterally separated from Hearth 6C-1 by approximately 25 cm, and was undamaged during trenching. Although its thickness could not be determined due to the fact that only the surface of the hearth was exposed during trenching, the feature was approximately 45 cm in diameter, and was intact. It consisted of at least 11 fire-affected rocks, and was encircled by an area of blackened soil. A plan view of this feature is shown in Figure 7. Figure 8 illustrates the context and relationship of Hearths 6C-1 and 6C-2.

A soil sample was taken from the center of Hearth 6C-2. Small quantities of charcoal and unidentified insect frass were recovered from this sample. One radiocarbon sample from Hearth 6C-2 was submitted for AMS dating, returning an assay of $5,600 \pm 50$ RCYBP (Beta-112551), calibrated between 6,475 and 6,295 calendar years B.P. (Stuiver et al. 1993; Talma and Vogel 1993; Vogel et al. 1993).

Hearth Feature 6H. Hearth 6H, located about 4.5 m beneath the ground surface, was also bisected during excavation of the trench. A large portion of this hearth was still intact within the northwestern wall of the trench, with a thin extension in the southeast wall (Figs. 3 and 4). This feature was originally expressed

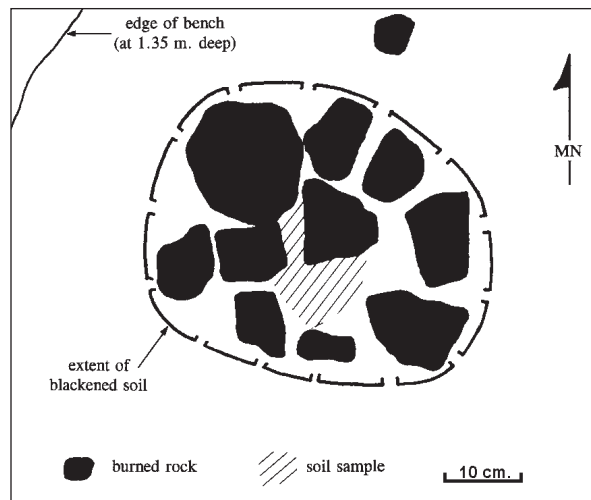


Fig. 7. Hearth 6C-2, plan view.

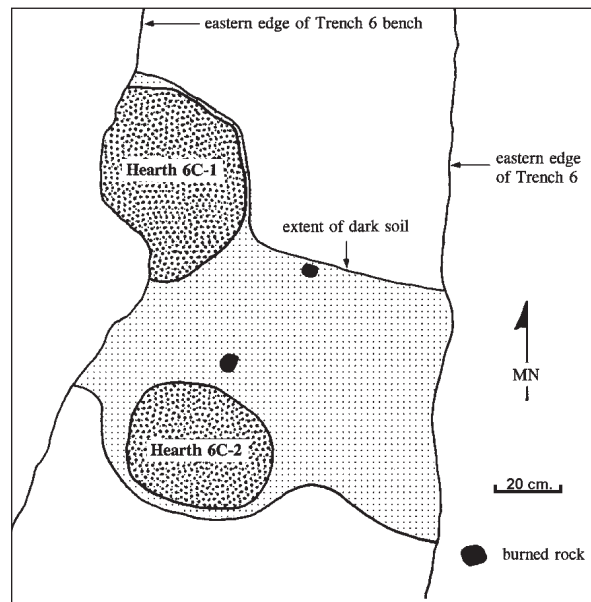


Fig. 8. Relationship between Hearths 6C-1 and 6C-2.

as a concentration of charred cobbles about 70 cm wide and 7 to 8 cm thick in the northwest wall of Trench 6 (Fig. 9). The intact portion contained at least 45 fire-affected rocks within a large area of blackened soil. The hearth continued farther into the wall of the trench, but further excavation was not practical at that time. While the hearth was not completely exposed, the portion that was exposed was approximately 80 cm in diameter and was composed of a single layer of closely spaced, charred cobbles that ranged in size from about 5 to 15 cm in diameter. In cross section, this layer of cobbles was concave upward and occupied a vertical thickness of 15 to 20 cm. Plan and profile views of this feature are presented in Figure 10.

A number of charred cobbles were collected from the portion of the hearth that was closest to the trench wall; the cobbles that were located farthest into the excavation unit were left undisturbed. After removing the cobbles nearest the trench wall, the blackened sediment and charcoal from beneath the hearth rocks were collected. Some of the cobbles were then replaced, in order to make the hearth easier to relocate if further excavation is ever undertaken.

Two soil samples were removed from Hearth 6H; one from the level of the hearth and one from 0 to 5 cm above the hearth. Additionally, 41 fire-affected rocks were collected from this feature. The soil samples contained unburned vegetation and charcoal. One sample also contained one small, unburned bone. Ten charcoal specimens collected in the field were submitted for wood identification (Puseman 1994). All of these specimens were identified as being from a single member of the sunflower family (*Asteraceae*). Examples of this family include sagebrush (*Artemisia* spp.), baccharis (*Baccharis* spp.), rabbit brush (*Chrysothamnus* spp.), tarbush (*Flourensia cernua*), sunflower (*Helianthus* spp.), and arrow weed (*Pluchea sericea*). While positive identification was limited to the family level, the specimens compare most favorably to arrow weed and baccharis (Puseman 1994:2). The presence of these



Fig. 9. Hearth 6H.

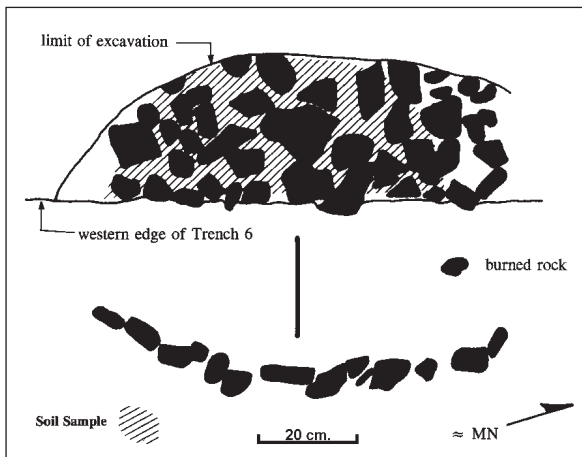


Fig. 10. Hearth 6H, plan and profile views.

charred botanical remains indicates that the occupants of the site must have used at least some members of the Asteraceae family for firewood.

Two radiocarbon samples were submitted from Hearth 6H, one for an AMS assay on a single charcoal fragment and one for a conventional radiocarbon assay on a collection of several charcoal fragments from the hearth. The AMS assay returned a result of $6,968 \pm 109$ RCYBP (AA-14553), with a calibrated age range

between 7,970 and 7,605 B.P. (mean calibrated age of 7,800 B.P.; Table 1). The conventional radiocarbon assay returned a result of $7,170 \pm 140$ RCYBP (Beta-74108), with a calibrated age range between 8,290 and 7,680 B.P. (mean calibrated age of 7,980 B.P.; Table 1). The close age range of these two assays supports the idea that these radiocarbon samples were derived from a single event.

Discussion

The stratigraphic position of two of the hearths (6C-1 and 6C-2) at approximately 1.35 m below the ground surface and one of the hearths (6H) at approximately 4.5 m below the surface suggests the presence of two distinct cultural components at CA-KER-3939. The radiocarbon dates obtained from Hearths 6C-1 and 6C-2 ($5,602 \pm 71$ RCYBP and $5,600 \pm 50$ RCYBP, respectively) and 6H ($6,968 \pm 109$ and $7,170 \pm 140$ RCYBP) provide further support for this suggestion.

The virtual absence of artifacts (with the exception of the one obsidian flake from Burn Zone 6B-2) makes it difficult to determine the nature of the occupation of the site. This lack of artifacts may be due to the limited archaeological testing conducted at the site, which precluded a full determination of the composition of the deposit. On the other hand, this absence of cultural materials could also be indicative of the nature of the site; that is, it may have been a very short-term camp (perhaps a single night) with few artifacts left behind by its prehistoric occupants. It should be noted that although springs are sometimes present along faults, there is currently no spring along the Garlock fault at this location nor is there evidence for prehistoric spring activity at the site (other than the hearths). Whether a spring may have been present there in the past is unknown at this time; thus, the question of whether prehistoric peoples would have lingered at the site for more than a few days remains unanswered. These are all issues that cannot be ascertained at this time.

The radiocarbon assays from Hearths 6C-1 and 6C-2 place this component of CA-KER-3939 within the time frame of the Pinto Complex, generally thought to fall between 7,000 and 4,000 B.P. (e.g., Warren 1980, 1984; Thomas 1981; Jenkins and Warren 1984; Warren and Crabtree 1986; Jenkins 1987; Vaughn and Warren 1987; Douglas et al. 1988; Sutton 1996). Sutton (1996:230) noted that at the two major Pinto type sites (Pinto Basin [Campbell and Campbell 1935; Rogers 1939] and Stahl [Harrington 1957]), diverse artifact assemblages were present, including millstones and projectile points. While this pattern has been observed at many Pinto-aged sites, however, such artifact diversity has not been reflected at all such sites (Sutton 1996:230-231; also see Jenkins and Warren 1986; Jenkins 1987; McGuire and Hall 1988; Warren 1991; Hall 1994). The radiocarbon assays from Hearth 6H suggest that this second component of the site dates earlier than Pinto times, perhaps to the terminus of the Lake Mojave Complex (ca. 10,000 to 7,000 B.P.; e.g., Warren 1984; Sutton 1996).

The stratigraphy in the geologic trenches and the radiocarbon dates on charcoal samples collected from the trenches reveal the geologic history of the site, which forms the context for the cultural occupation of the site. During the late Pleistocene, alluvial fan deposits (Qf1; see Fig. 3 for soil type descriptions) were aggrading at the site. Two charcoal samples from these alluvial fan deposits have calibrated radiocarbon ages of 22,600 and 21,700 B.P. (McGill 1994a, 1994b; McGill et al. 2003). After a depositional hiatus, represented by a buried soil horizon, an additional meter of alluvial fan sediments was deposited (Qf2). (Qf2 is not the active fan surface. It is a latest Pleistocene or earliest Holocene surface that was incised by the channel. Active deposition today occurs only within the channel and not on the Qf2 surface.) In the latest Pleistocene or early Holocene (sometime between 13,400 and 8,000 years ago), a large channel incised deeply into the alluvial fan deposits. The base of the early Holocene channel was not exposed in any of the

trenches. The depth of incision was thus greater than 9 m beneath the top of the alluvial fan deposits. The channel then began to fill with intermittent stream deposits of early Holocene age (Hoa). These deposits include a number of 10 to 25-cm thick beds of gravelly sand, with each bed lacking internal lamination or other structure. Each of these thick beds is interpreted as a single depositional event, probably a debris flow.

As one proceeds northeastward along the length of Trench 6, these thickly bedded deposits interfinger with and give way to pebbly sand deposits that are much more thinly and discontinuously bedded, and have sparser pebbles (Hoc). The thickly bedded deposits (Hoa) dominate the southwestern end of the trench, which is located closer to the center of the channel, and they thin and pinch out toward the northeast (Fig. 3). The thinly bedded deposits (Hoc) dominate the northeastern end of the early channel-fill deposits and they pinch out to the southwest. These relationships, as well as the nature of the bedding, suggest that the source of the thickly bedded deposits is sediment transported down the channel and that the thinly bedded deposits are colluvium (slope wash) derived from the channel wall.

The oldest hearth features and burn zones were found within the crudely stratified, thinly bedded colluvial sand and gravel that were deposited by slope wash from the channel wall. At higher stratigraphic levels, the colluvium is unstratified, suggesting a slower rate of colluvial deposition, thus allowing more time for bioturbation to homogenize the sediments, destroying the stratification. For the hearth and burn zones within the stratified colluvium, the area of darkened sediment was generally a few centimeters thick and up to a few tens of centimeters long. For the upper burn zones and hearths within the unstratified, sandy colluvium, the zones of darkened sediment were much larger and more diffuse, generally being a few tens of centimeters thick to many meters long, with diffuse boundaries. These burn zones may represent longer

periods of continuous use of the hearths. The very slow accumulation of colluvial sediment shed from the channel wall and from the fault scarp at this time may have allowed the hearths to remain in use for longer periods of time, thus allowing the charcoal fragments and charcoal dust to be spread over a broader region around the hearths and to be mixed into the surrounding soil through bioturbation.

At the time of the early occupation of this site (roughly 7,000 to 8,000 B.P.), the hearth and burn zones would have been at the bottom of a channel, probably an ephemeral channel, that was 7 m deep and 85 m wide. Burn Zones 6D and 6E were close to the channel wall, whereas Hearth 6H and Burn Zones 6F and 6G were located closer to the center of the channel, near the southwestern end of the colluvial deposits, where they interfingered with the debris-flow deposits from the channel. If Burn Zones 6F and 6G were cultural in origin, then the site remained occupied or was occupied intermittently during a time period in which 25 cm of colluvium was deposited. Shortly after the formation of Burn Zone 6F, the site was inundated by two large debris flows, both of which buried Zone 6F, Zone 6G, and Hearth 6H, and one of which also buried Zones 6D and 6E, extending nearly all the way to the northeastern wall of the channel.

For the next thousand years or so, there was no apparent occupation of the site, although a thorough search for evidence of occupation has not been undertaken. During this time, additional alluvial and colluvial deposits continued to fill the channel, raising the floor of the channel by about 2.5 m. The dates from Hearths 6C-1 and 6C-2 suggest that the site became occupied again around 6,500 years B.P. The colluvial deposits in the lower half of the exposure in Trench 6 (Hoc) are thinly bedded, whereas those in the upper half (Hyc) are massive, perhaps suggesting a greater degree of homogenization through bioturbation.

A younger episode of channel incision and filling was revealed in Trench 5 (see Fig. 2). This channel incised at least 3.3 m into the Hoa deposits and was then filled with late Holocene intermittent stream deposits (Hya), from which several detrital charcoal samples yielded calibrated ages of about 2,500 years ago. On the northwestern side of the Garlock fault, any Hoa or Hoc deposits that might have existed were eroded and washed away by incision of the late Holocene channel. On the southeastern side of the fault, however, the Hoa and Hoc deposits (including those that are exposed in Trench 6) were preserved because they had been moved into a protected position, out of the path of the late Holocene channel, by left-lateral slip along the Garlock fault. After the late Holocene channel had completely filled, a thin veneer (about 0.8 m) of the late Holocene stream deposits (Hya) buried a portion of the surface of the earlier (Hoa) deposits (Fig. 3).

While the late Holocene channel was filling, colluvium continued to be shed from the channel wall, and Hearths 6C-1 and 6C-2, as well as Burn Zones 6A and 6B, were buried by another 1.3 to 1.5 m of colluvium. Finally, the modern channel incised to a depth of 2 to 3 m beneath the top of Hya and has since been filled with up to 1 m of sediments. The modern channel is an ephemeral stream that is dry most of the time.

Although no direct evidence of human occupation was found that was younger than Hearths 6C-1 and 6C-2, the burn zone that was exposed in Trench 2 (Fig. 2) is intriguing. This burn zone was similar in appearance to Zones 6A and 6B, except that it had a greater length. No charred cobbles were visible within the trench wall, but the sandy colluvium was dark in color and contained abundant charcoal. Numerous charcoal fragments were collected, and one was dated, yielding a median calibrated age of 1,870 years B.P. (see Table 1). Unfortunately, no soil samples were collected at the time the trench was open during an earlier phase of McGill's geological trenching in the spring of 1992, and was backfilled nearly two years before Trench 6

was excavated and the hearth features were discovered. As a result, there was no opportunity for the discovery and analysis of potential cultural materials in Trench 2.

Information about possible occupation of this site during the late Holocene may remain buried within the triangular-shaped deposit of Hyc that is preserved in the corner of the offset channel (see Fig. 2). At greater depth within this triangular region are the hearth-bearing early and middle Holocene deposits (Hoc and lower part of Hyc) that were conveniently preserved from erosion during late Holocene incision by virtue of being offset by the Garlock fault into an out-of-the-way position. Re-excavation of Trenches 2 and 6, or other excavations within this triangular deposit, may yield additional information about the occupation of this site. Additional paleoseismic information also remains buried at this location, including information on the timing of and amount of slip in past earthquakes on the fault. This site has unique paleoseismic characteristics and may contain information that could be crucial to understanding the seismic hazard posed by the Garlock fault, as well as any effect it might have in modulating activity on the San Andreas fault.

Conclusions

It was only through serendipity that the hearth features, as well as the burn zones of possible cultural origin, were discovered at CA-KER-3939. Hearth 6H was located 4.5 m below the surface, considerably deeper than most archaeologists would venture due to practical and financial constraints. Had it not been for the paleoseismic study conducted by McGill, during which several very large and deep trenches were excavated, it is not likely that these hearths would have been discovered. This situation is particularly acute in places such as the Mojave Desert, where it is often assumed that due to low precipitation, land surfaces have remained relatively stable, and sites are therefore

often presumed to be primarily surficial rather than deeply buried (Sutton 1996:225).

The radiocarbon assays from one of the hearths (Feature 6H) at CA-KER-3939 are among the oldest archaeological radiocarbon dates in the western Mojave Desert. In light of these findings, further investigation of this Pinto Complex—and possibly late Lake Mojave Complex—site could enhance our meager knowledge of the ecology and population of this region during the early and middle Holocene. Cooperative efforts between archaeologists and geologists can be greatly beneficial for such purposes, as demonstrated by the collaboration that took place during this study. In the absence of such collaboration, the deepest archaeological component of this study area would likely have remained undetected.

Acknowledgements

We thank Stephen Wells at the University of Nevada, Reno, and Joan Schneider at UCR for their assistance in this project. The botanical remains were analyzed by Kathryn Puseman of Paleo Research Laboratories in Denver, Colorado. The comments of Robert E. Parr and Robert M. Yohe II were most helpful and appreciated. We also thank Beth and Chris Padon of the PCAS Quarterly Committee and an anonymous reviewer for their assistance in the production of this article. This study was conducted under the auspices of the Bureau of Land Management in Ridgecrest, California, and the geological component of the project was made possible through support from United States Geological Survey Grant No. 1434-92-G-2210 and from National Science Foundation Grant No. EAR 9205669.

References Cited

- Campbell, E. W. C., and W. H. Campbell
1935 The Pinto Basin Site. *Southwest Museum Papers* No. 9.
- Douglas, Charles L., Dennis L. Jenkins, and Claude N. Warren
1988 Spatial and Temporal Variability in Faunal Remains from Four Lake Mojave-Pinto Period Sites in the Mojave Desert. In, *Early Human Occupation in Far Western North America: The Clovis-Archaic Interface*, J. A. Willig, C. M. Aikens, and J. L. Fagan, editors, pp. 131-144. Nevada State Museum Anthropological Papers No. 21.
- Hall, M. C.
1994 Middle Holocene Human Occupation of Site CA-SBR-5251 in Tiefert Basin, Fort Irwin, San Bernardino County, California. In, *Off Limits in the Mojave Desert*, R. E. Reynolds, editor, pp. 71-80. San Bernardino County Museum Association Special Publication 94-1, Redlands.
- Harrington, Mark R.
1957 A Pinto Site at Little Lake, California. *Southwest Museum Papers* No. 17.
- Jenkins, Dennis L.
1987 Dating the Pinto Occupation at Rogers Ridge: A Fossil Spring Site in the Mojave Desert, California. *Journal of California and Great Basin Anthropology* 9(2):214-231.
- Jenkins, Dennis L., and Claude N. Warren
1984 Obsidian Hydration and the Pinto Chronology in the Mojave Desert. *Journal of California and Great Basin Anthropology* 6(1):44-60.
- 1986 Test Excavation and Data Recovery at the Awl Site, 4-SBr-4562, a Pinto Site at Fort Irwin, California. Fort Irwin Archaeological Project Research Report No. 22. Report on file at the San Bernardino County Archaeological Information Center, San Bernardino County Museum, Redlands.
- McGill, Sally F.
1994a Holocene Activity on the Central Garlock Fault. In, *Geological Investigations of an Active Margin, Geological Society of America, Cordilleran Section Guidebook*, S. F. McGill and T. M. Ross, editors, pp. 356-364. San Bernardino County Museum Association, Redlands.
1994b Preliminary Slip Rate and Recurrence Interval for the Western Garlock Fault near Lone Tree Canyon, California. Geological Society of America, Abstracts with Programs 26:72.
- McGill, S. F., H. Anderson, T. Daneke, J. Grant, M. Slates, J. Stroud, S. Tegt, and J. D. McGill
2003 Slip Rate of the Western Garlock Fault near Lone Tree Canyon, Mojave Desert, California. Geological Society of America, Abstracts with Programs 35(4):64.
- McGuire, Kelly R., and M. C. Hall
1988 The Archaeology of Tiefert Basin, Fort Irwin, San Bernardino, California. Report on file at the San Bernardino County Archaeological Information Center, San Bernardino County Museum, Redlands.
- Morrison, Roger B.
1965 Quaternary Geology of the Great Basin. In, *The Quaternary of the United States, a Review Volume for the VII Congress of the International Association for Quaternary Research*, H. E. Wright, Jr., and D. G. Frey, editors, pp. 265-285. Princeton University Press, Princeton.

- Munz, Philip A.
1974 *A Flora of Southern California*. University of California Press, Berkeley.
- Puseman, Kathryn
1994 Identification of Wood and Charcoal from the Mojave Desert, Southern California. Paleo Research Labs Technical Report 94-67, Denver.
- Rogers, Malcolm
1939 Early Lithic Industries of the Lower Basin of the Colorado River and Adjacent Desert Areas. *San Diego Museum of Man Papers* No. 3.
- Stuiver M., and P. J. Reimer
1993 Extended 14C Data Base and Revised CALIB 3.0 14C Age Calibration Program. *Radiocarbon* 35(1):215-230.
- Stuiver M., P. J. Reimer, and T. F. Braziunas
1998 High-Precision Radiocarbon Age Calibration for Terrestrial and Marine Samples, 1998. *Radiocarbon* 40(3):1127-1151.
- Stuiver, M., A. Long, R. S. Kra, and J. M. Devine
1993 Calibration 1993. *Radiocarbon* 35(1).
- Sutton, Mark Q.
1996 The Current Status of Archaeological Research in the Mojave Desert. *Journal of California and Great Basin Anthropology* 18(2):221-257.
- Talma, A. S., and J. C. Vogel
1993 A Simplified Approach to Calibrating C14 Dates. *Radiocarbon* 35(2):317-322.
- Thomas, David Hurst
1981 How to Classify the Projectile Points from Monitor Valley, Nevada. *Journal of California and Great Basin Anthropology* 3(1):7-43.
- Vaughn, Sheila J., and Claude N. Warren
1987 Toward a Definition of Pinto Points. *Journal of California and Great Basin Anthropology* 9(2):199-213.
- Vogel, J. C., A. Fuls, E. Visser, and B. Becker
1993 Pretoria Calibration Curve for Short Lived Samples. *Radiocarbon* 35(1):73-86.
- Wahrhaftig, Clyde, and J. H. Birman
1965 The Quaternary of the Pacific Mountain System in California. In, *The Quaternary of the United States, a Review Volume for the VII Congress of the International Association for Quaternary Research*, H. E. Wright, Jr., and D. G. Frey, editors, pp. 299-340. Princeton University Press, Princeton.
- Warren, Claude N.
1980 Pinto Points and Problems in Mojave Desert Archaeology. In, *Anthropological Papers in Memory of Earl H. Swanson, Jr.*, L. B. Harton, C. N. Warren, and D. R. Tuohy, editors, pp. 67-76. Idaho Museum of Natural History, Pocatello.
1984 The Desert Region. In, *California Archaeology*, by M. J. Moratto, pp. 339-430. Academic Press, San Diego.
1991 Archaeological Investigations at Nelson Wash, Fort Irwin, California. Fort Irwin Archaeological Project Research Report No. 23 (2 vols.). Report on file at the San Bernardino County Archaeological Information Center, San Bernardino County Museum, Redlands.
- Warren, Claude N., and Robert H. Crabtree
1986 Prehistory of the Southwestern Area. In, *Handbook of North American Indians*, Vol. 11, Great Basin, W. L. d'Azevedo, ed., pp. 183-193. Smithsonian Institution, Washington.

