SCOTTS VALLEY CHRONOLOGY AND TEMPORAL STRATIGRAPHY

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ABSTRACT

The chronology and stratigraphy of the Scotts Valley site indicate that this deposit has extraordinary duration and antiquity for the region. An archaeological record of cultural activities is present at this site for possibly the entire Holocene. Studies of the site's geology, soils, and chronology show that much of the site has physical integrity with datable soil horizons. Furthermore, thin, crusty layers of mineral concentration in portions of the lower culture-bearing strata have served to seal in many of the older cultural materials by apparently minimizing disturbance of bioturbation. The data-base on the chronology and stratigraphy of the site is presented to demonstrate the unique and ultimately important character of the site.

BACKGROUND

During an archaeological survey of land adjacent to Carbonera Creek in Scotts Valley, I was shown artifact collections which had been gathered by local residents. The collections contained an atlatl weight and a net-weight, artifact types which tend to be in assemblages of known Early or Archaic Period sites in the general region. Test excavations were conducted in the vicinity (Cartier 1980) where the early artifacts had been found (SCr-33) and also at the Scotts Valley site (SCr-177) (Figure 1). At the time of the excavations, the antiquity of both sites was estimated to be Early Period (3,000-5,000 B.P.). This estimation was based upon the few artifacts observed and the leached character of the lower, culture-bearing levels especially at SCr-177. Both the Carbonera Creek site and the Scotts Valley site were radiometrically dated at that time (1980), and the Carbonera Creek site did in fact yield an Early Period date of 3,580 B.P. But the surprising dates were from the Scotts Valley site which came back at 7,180 and 10,080 B.P. (see Table 1 for full detail on dates). The first reaction to these older dates was that they must have been from non-cultural or contaminated samples, for sites of this antiquity had not been documented in the San Francisco or Monterey Bay areas prior to this time. However, the dates came from samples and contexts that appeared to be from cultural context without indication of contamination. The oldest sample, from unit 5, was excavated from an apparent prehistoric hearth/cooking feature comprised of fire-altered stones and char-

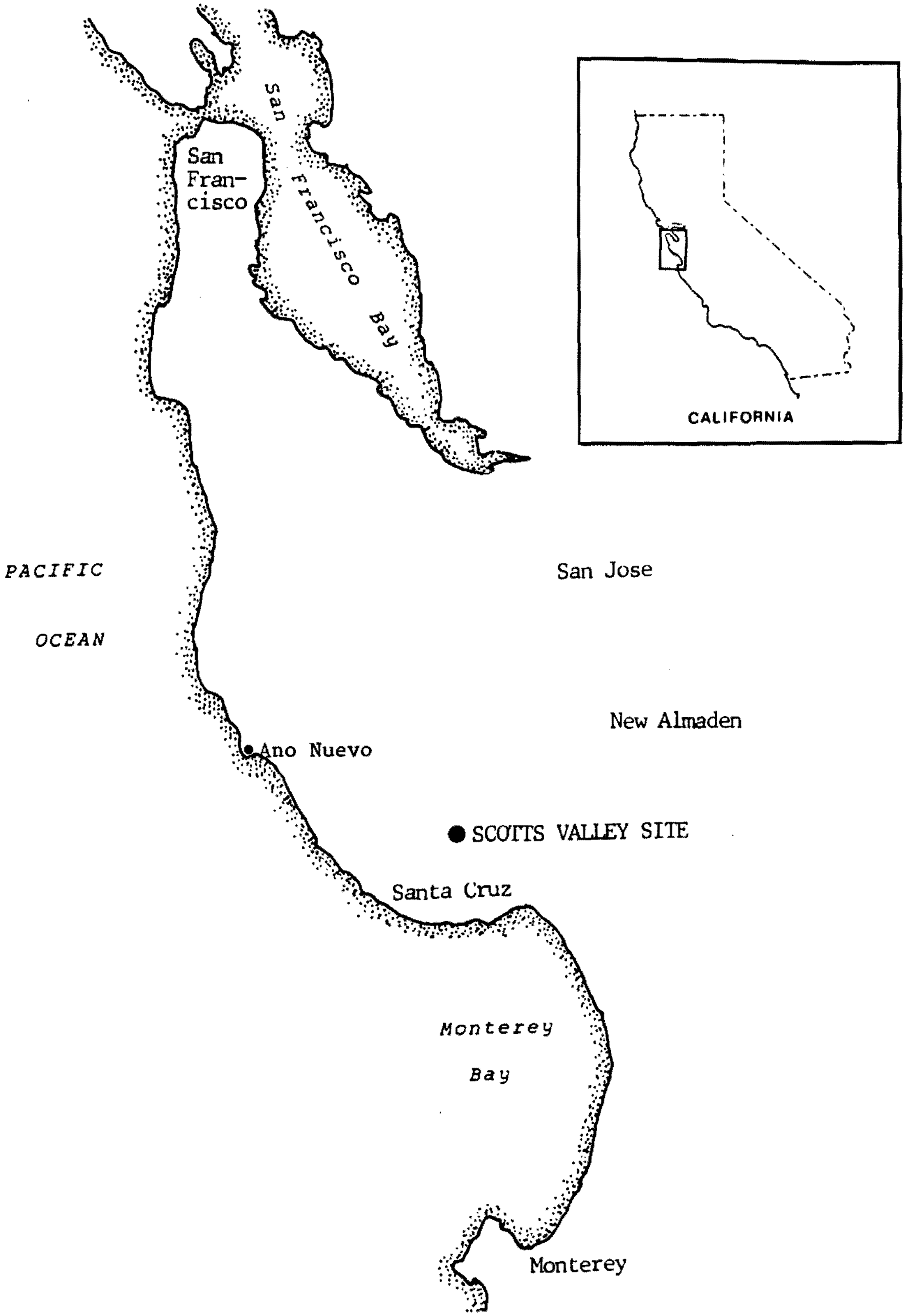


FIGURE 1. The location of the Scotts Valley site.

coal-rich soil. This hearth was located in a midden deposit of light-colored sandy soil. Three years later, this location came to be included in excavation Area B during the Memorial Day excavation (the area which yielded the eccentric crescent).

During the 1983 Memorial Day weekend excavation at the Scotts Valley site, samples for chronological studies were recovered through controlled excavation, some samples being in association with cultural features. The analyses of these samples and artifacts led to the conclusion, in all cases, that the Scotts Valley site contained a temporal component of at least 7,000 years. However, the samples and artifacts recovered for dating purposes were not plentiful, and some uncertainties remained. These uncertainties involved the actual range of time represented in the deposit and possible contamination of the radiocarbon samples. In an attempt to establish better control upon these factors, a specialized control unit was excavated to recover radiocarbon samples in stratified proveniences. This entailed the excavation, flotation, and wet-screening of soils from control unit 101, which yielded thousands of small charcoal particles recovered in 10 cm excavation levels. The charcoal samples produced radiometric dates which indicated a longer time range for the deposit than was previously realized. These data served in a large part to clarify the uncertainties which had previously existed regarding the temporal character of the site. Radiometric dates from from unit 101 reached over a range of time from 580 B.P. to 12,390 B.P. Superpositioning present among the dated samples from unit 101 is important in appreciating the credibility of the radiocarbon chronology. The suite of dates from this control unit also assisted greatly in developing an understanding of the age of the soils strata within the deposit.

A continued and more intensive effort was placed on chronological studies during the 1987 archaeological investigation of the Scotts Valley site. The chronological studies followed previous avenues of temporal inquiry established from the analyses of the 1983 excavations. These chronological investigations centered on the early component at the site--pre-7,000 B.P. (Cartier 1987). Radiometric dates from the 1980 and 1983 excavations at the site included a range of time spanning the entire Holocene with a cluster at approximately 7,000 B.P. However, the greatest uncertainties about this span remained in the older extent of the range between 7,000 and 12,390 which was evidenced by only three radiometric dates.

To further research the earliest component of the Scotts Valley deposit, excavations during 1987 were placed in the northern side of the site where previous study had produced early artifacts and radiocarbon dates. The presence of early diagnostic artifacts and characteristics of soil stratigraphy led the author to believe that the basal component of the cultural assemblage was present in the vicinity of area exposures A, B, and C during 1983. A new set of exposures--AA, BB, and CC--were therefore located in 1987 adjacent to the locations of the 1983 exposures (Figure 2). This produced the desired sample data from the early component while also creating a physical connection between the 1983 and 1987 exposures for interrelating stratigraphic understandings. Area D on the southern side of the site was also excavated during 1987 with hopes that the more recent end of the chronological range would be sampled in that location.

THE RADIOMETRIC SAMPLES

In the early stages of excavation at the site (1980-83), charcoal was recovered from cooking stone/hearth features. These features of fire-baked soil and thermally altered stone contained artifactual lithics which were also in levels above and below the features. In order to date one of the cooking debris features, two charcoal samples were collected from unit B26 and a third from unit B29. Of the two samples from unit B26, one was above the rock feature at 0-20 cm and the second was within the feature at 40-60 cm. The sample from unit B29 also came from within the rock feature at 60-80 cm. As can be seen in the table of radiometric dates (Table 1), the two samples from within the cultural feature both dated to approximately 7,000 B.P. (6,970 $\pm$ 150 and 7,050 $\pm$ 110), whereas the sample which came from two 20 cm excavation levels above the feature (0-20 cm) dated to 2,370 $\pm$ 150 B.P. In this manner, the dating of the rock feature establishes temporal control over remains that are clearly cultural while also acting as a temporal reference for artifact-bearing strata above and below the feature.

As mentioned above, the radiometric samples were all of charcoal. Being highly acidic, the soil in the site has not preserved shell, bone, or large amounts of carbonized wood. All radiometric samples recovered before wet-screening was implemented at the site were small--usually less than a gram in weight and less than 5 mm in average diameter. Those charcoal samples collected at the 1983 excavation of area exposures were identified during hand-excavation and dry-screening. This resulted in single nodules that were usually too small for a normal radiocarbon isotope count. The 3 samples analyzed from units B26 and B29 were exceptionally large for the charcoal samples found at the site, being over a gram in weight at the time of submittal to the radiocarbon laboratory.

One concern regarding the charcoal samples involved the possibility that the samples were contaminated with bituminous material (Gerow 1983). Geologic reports for the region mention the presence of natural hydrocarbons in the soils and rock in the form of bituminous tars and asphalt (Clark 1981). The possibility of organic or inorganic compounds being misidentified for charcoal, or hydrocarbons being leached into the cultural charcoal samples, were thus concerns to be addressed in selecting radiocarbon samples and in interpreting radiometric analyses (Cook 1964; Riddell 1969). Of additional concern was the possibility of carbon-lens migration (Brown and Gould 1964). To deal with these concerns, microscopic inspection of radiocarbon sam-

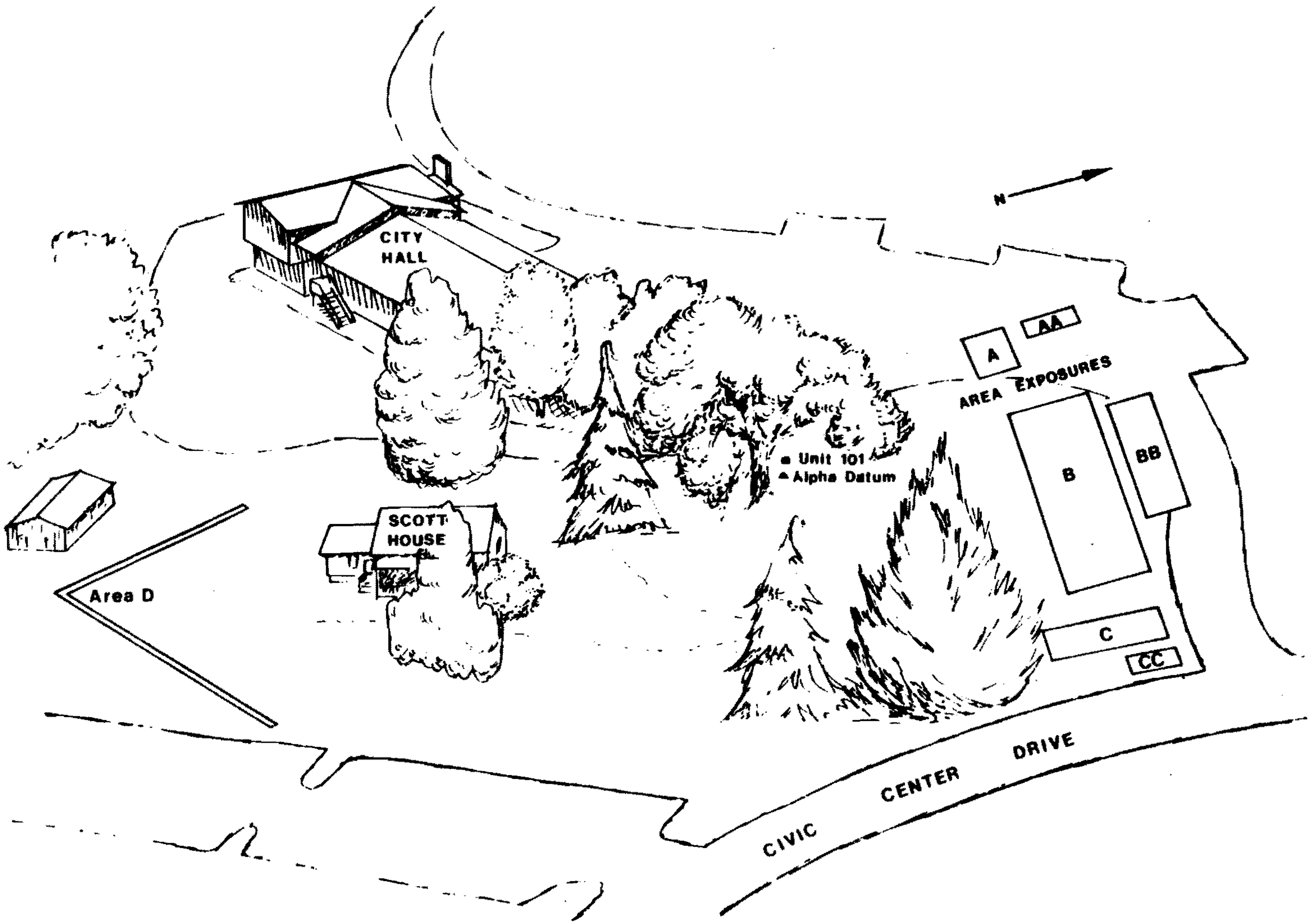


FIGURE 2. Location of area exposures at the Scotts Valley site.

TABLE 1

CA-SCR-177 RADIOCARBON DATES
(In order of submittal)

Sample No.	C14 age years B.P.	Unit	Depth (cm)	Fragipan
1980 Excavations				
RL-1374	7180 ± 290	2	140-190	
RL-1373	10080 ± 460	5	100-110	
1983 Program				
Beta-7712	2370 ± 150	B26	0-20	
Beta-7713	6970 ± 150	B26	40-60	
Beta-7714	7050 ± 110	B29	60-80	
Beta-19702	580 ± 130	101	40-50	
Beta-19703	1680 ± 230	101	50-60	
Beta-19704	2230 ± 160	101	60-80	
Beta-19705	3490 ± 320	101	80-90	
Beta-19706	4960 ± 160	101	90-100	
Beta-19707	4690 ± 140	101	100-110	
Beta-19708	5100 ± 120	101	110-120	
Beta-19709	5970 ± 200	101	120-130	
Beta-19710	6540 ± 140	101	130-140	
Beta-19711	7310 ± 220	101	140-150	
Beta-19712	8720 ± 740	101	150-160	
Beta-19713	12390 ± 610	101	160-180	
1987 Program				
Beta-21293	10650 ± 180	AA120-121	100-110	
Beta-24202	6710 ± 140	AA138	80-90	
Beta-24203	7100 ± 180	AA138	100-110	
Beta-24204	6440 ± 260	AA138	120-130	
Beta-22327	3540 ± 170	BB135	20-30	
Beta-22328	8500 ± 250	BB135	50-60	
Beta-22329	9580 ± 260	BB135	70-80	
Beta-22330	9070 ± 340	BB135	80-90	
Beta-22331	9200 ± 230	BB135	90-100	
Beta-22332	8500 ± 450	BB135	110-130	
Beta-21926	10090 ± 420	BB140	53-64	GS10,11a,11b
Beta-21925	12520 ± 740	BB140	80-94	GS 4,5,6
Beta-24205	3960 ± 130	BB142	40-50	
Beta-24206	9470 ± 300	BB142	71-78	E
Beta-24207	10120 ± 320	BB142	88-90	I
Beta-24208	10790 ± 340	BB142	120-130	K
Beta-24409	7470 ± 140	CC139	60-80	
Beta-25369	6250 ± 250	D111	70-80	
Beta-25370	5990 ± 220	D111	100-110	
Beta-25371	6690 ± 160	D111	140-150	

CA-SCR-177 RADIOCARBON DATES
(In order by age)

Sample No.	C14 age years B.P.	Unit	Depth (cm)	Fragipan
Beta-19702	580 ± 130	101	40-50	
Beta-19703	1680 ± 230	101	50-60	
Beta-19704	2230 ± 160	101	60-80	
Beta-7712	2370 ± 150	B26	0-20	
Beta-19705	3490 ± 320	101	80-90	
Beta-22327	3540 ± 170	BB135	20-30	
Beta-24205	3960 ± 130	BB142	40-50	
Beta-19707	4690 ± 140	101	100-110	
Beta-19706	4960 ± 160	101	90-100	
Beta-19708	5100 ± 120	101	110-120	
Beta-19709	5970 ± 200	101	120-130	
Beta-25370	5990 ± 220	D111	100-110	
Beta-25369	6250 ± 250	D111	70-80	
Beta-24204	6440 ± 260	AA138	120-130	
Beta-19710	6540 ± 140	101	130-140	
Beta-25371	6690 ± 160	D111	140-150	
Beta-24202	6710 ± 140	AA138	80-90	
Beta-7713	6970 ± 150	B26	40-60	
Beta-7714	7050 ± 110	B29	60-80	
Beta-24203	7100 ± 180	AA138	100-110	
RL-1374	7180 ± 290	2	140-190	
Beta-19711	7310 ± 220	101	140-150	
Beta-24409	7470 ± 140	CC139	60-80	
Beta-22328	8500 ± 250	BB135	50-60	
Beta-22332	8500 ± 450	BB135	110-130	
Beta-19712	8720 ± 740	101	150-160	
Beta-22330	9070 ± 340	BB135	80-90	
Beta-22331	9200 ± 230	BB135	90-100	
Beta-24206	9470 ± 300	BB142	71-78	E
Beta-22329	9580 ± 260	BB135	70-80	
RL-1373	10080 ± 460	5	100-110	
Beta-21926	10090 ± 420	BB140	53-64	GS10,11a,11b
Beta-24207	10120 ± 320	BB142	88-90	I
Beta-21293	10650 ± 180	AA120-121	100-110	
Beta-24208	10790 ± 340	BB142	120-130	K
Beta-19713	12390 ± 610	101	160-180	
Beta-21925	12520 ± 740	BB140	80-94	GS 4,5,6

ples was carried out and all samples submitted were treated at the radiocarbon laboratory to remove any possible hydrocarbon residues. Microscopic inspection identified the visual pattern and texture of wood grain on samples submitted. For removal of possible contamination in the radiocarbon laboratory, the samples were given a hot acid wash, repeatedly rinsed to neutrality, given a hot alkali soaking, again rinsed to neutrality, subjected to another acid wash followed by a final rinsing to neutrality (Tamers 1983).

A second concern regarding the radiocarbon samples centered on the question of whether the charcoal could have been transported into the deposit by the water table. If this were the case, the samples, and of course the entire chronology, would be spurious. However, this does not appear to have occurred for at least four reasons: First, the charcoal is physically much too large in particle size to have moved through the interstices between the sand grains in the soil (which is relatively clean, compact sand, especially in the lower cultural levels). Second, the great majority of the charcoal particles used for samples have wood-gain texture showing that these particles were not liquified in solution, transported in the water table, and then reconstituted into solid form (Brown and Gould 1964). Third, the horizontal and vertical provenience of the charcoal show it to be correlated closely with the distribution of cultural materials in the deposit (Table 2). And fourth, the radiocarbon dates have a high degree of superpositioning and correspondence with other dating techniques. One would expect this from cultural material rather than from samples that may have otherwise been brought into the deposit by a non-cultural vehicle as the water table.

In no instance did the samples submitted produce unusally old dates which would have indicated that geologically associated hydrocarbons were being dated or contaminating the samples. Rather, all of the dates fell within a reasonable time range expected for the hypothesized antiquity and consistent with the other dating techniques employed in the study. Furthermore, charcoal samples (with cultural associations) unearthed in excavation units over 20 meters apart were dated to virtually the same time period. This correspondence between dates was obtained from two different radiocarbon laboratories--Radiocarbon Limited and Beta Analytic. Charcoal from unit 2 near the Alpha Datum recovered in 1980 (Radiocarbon Limited) dated to 7,180 $\pm$ 290 which is statistically coeval with the two dates in the rock feature in units B26 and B29 (Beta Analytic). If geologic hydrocarbons from a Miocene/Pliocene formation where mistakenly submitted as samples or if such geologic hydrocarbons contaminated the cultural charcoal, one would expect to see radical contrasts between the dates--not the consistent cluster as exhibited in units 2, B26, and B29.

Unit 101: Unit 101 was excavated in a central portion of the deposit as a focused effort to collect charcoal for further radiocarbon analysis at the site. Wet screening and flotation of

TABLE 2

RELATIONSHIP BETWEEN CHARCOAL AND ARTIFACT FREQUENCIES IN TEMPORAL CONTROL UNITS 101 AND 142

Level	Charcoal Wt. (gms)	Frequency of Artifacts
Unit 101		
30-40	0.9	12
40-50	3.2	29
50-60	1.5	21
60-70	1.3	18
70-80	0.8	21
80-90	1.4	23
90-100	2.4	16
100-110	3.6	14
110-120	4.4	37
120-130	3.3	13
130-140	5.1	13
140-150	1.8	6
150-160	1.5	8
160-170	0.5	9
170-180	0.6	4
180-190	0.7	1
190-200	0.4	0
200-210	0.2	0
Unit 142		
0-10	historic disturbance	3
10-20	historic disturbance	3
20-30	historic disturbance	12
30-40	1.6	9
40-50	2.1	21
50-60	0.8	9
A 60-63	1.0	4
B 63-69	0.3	2
C 69-70	0.4	2
D 70-72	0.7	2
E 72-79	1.5	7
F 79-80	0.8	2
G 80-86	1.2	6
H 86-88	0.6	1
I 88-90	1.5	10
J 90-92	0.6	4
K 92-102	0.7	5
K 102-110	1.4	4
K 110-120	1.0	5
K 120-130	1.2	5
K 130-140	0.5	6
K 140-150	0.2	2
K 150-160	0.2	0
160-170	0	0
170-180	0	0

a 50-by-50 cm soil column produced thousands of small charcoal particles from 10 cm arbitrary excavation levels. Twelve samples were analyzed from between 50 to 180 cm (see Table 1 and Figure 3). The amount of charcoal recovered paralleled the relative frequency of cultural modified lithics in the levels of unit 101, and all dated levels contained cultural remains. The results of the radiometric analysis of the unit 101 samples was somewhat surprising. As can be seen in Table 1, the dates range from 580 ± 130 to 12,390 ± 910, and a wide--but gradual--continuum is present reaching across the Holocene. The superpositioning among the samples was remarkable, and this may be partially attributable to the use of hundreds of charcoal particles in any particular sample (thus possibly correcting for minor mixing expected in normal bioturbation). The lower and oldest date of 12,390 ± 910 B.P. was viewed with skepticism. The most important insights gained from the unit 101 data were: 1) the wide range of time represented at the site, 2) the effective use of flotation and wet-screening for obtaining carbon samples at the site, and 3) the dating of the site's soil strata. A good deal of the methodology and research focus at the site in the later excavations followed from the insights gained from unit 101.

From the 1987 Memorial Day weekend excavation, 20 radiometric dates were generated from charcoal samples gathered through flotation and wet-screening of soils from temporal control units (Table 1). The control units were placed in each of the four area exposures, with particular emphasis on Area BB. Area BB received the greatest amount of temporal study due to 1) its large size and volume of artifacts, 2) this area being recognized from the 1983 excavation as containing early diagnostic artifacts including the eccentric crescent, and 3) its containing a highly developed soil stratigraphy that warranted chronological investigation. A brief summary of the samples, the dates, and their respective proveniences for all of the 1987 excavation areas is provided below.

Area AA: Four radiometric dates were run from numerous charcoal samples floated and wet-screened from a feature pedestal (units 120-121) and a one-by-one meter temporal control unit, 138. In the pedestal feature (Figure 4), three large metate fragments were unearthed in the Bs soil stratum (Cartier 1987). According to the interpretations of soils chronology at the site, it was predicted materials in this stratum (unless intrusive) should have dated to at least 8,000 B.P. This feature dated to 10,650 ± 180 (sample #21293). A small chert biface resembling a Cascade point was excavated below and one-meter to the south of the metates and the radiometric sample. From the wet-screening of the soil in the metate feature, it was clear that this specific area was especially rich in charcoal, and multiple samples were collected. It is questioned if the cluster of metate fragments may have been a marker possibly associated with funeral behaviors or other activities which left the charcoal-rich pocket directly under the stones.

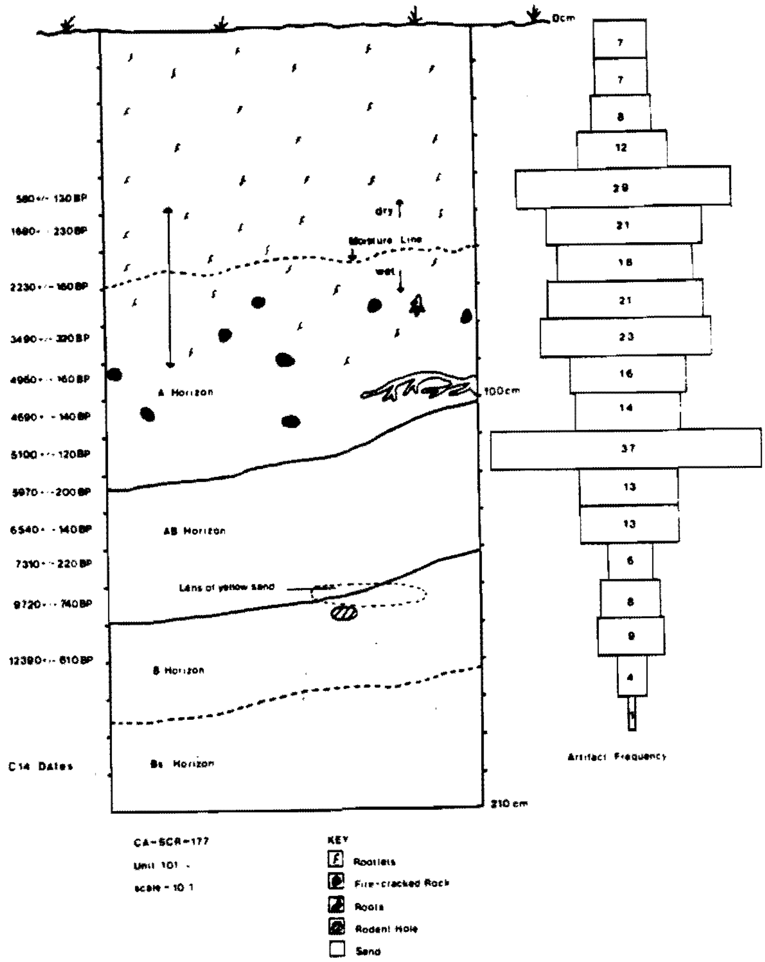


FIGURE 3. Profile of Unit 101.

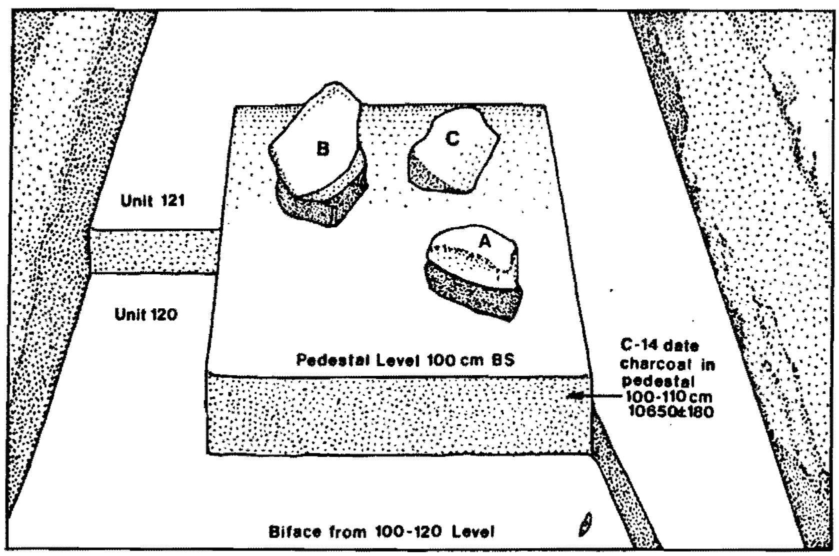


FIGURE 4. Pedestal feature in Area AA.

Three radiometric dates from unit 138 in Area AA are from charcoal excavated in a wet-screen temporal control excavation placed on the east side of the exposure. Results of the radiometric analysis of these samples indicated a cluster around 6,700 B.P. and a lack of clear superpositioning. The three dates, 80-90 cm, 6,710 ± 140; 100-110 cm, 7,100 ± 180; and 120-130 cm, 6,440 ± 260 do not correspond with sample Beta-21293 which was taken only two meters to the west and which differs by 3,000 years. The lack of superpositioning in the three dates may be indicative of disturbance and mixing in the soils of unit 138. Bioturbation is probably the most logical explanation for the lack of complete harmony in all of the radiometric data within Area AA. Additional analysis of the charcoal samples in the metate pedestal may shed some light on this question.

Area BB: Twelve dates where processed from the charcoal samples recovered in the three temporal control units in this area. The six dates from samples taken from unit 135 have a fair degree of superpositioning (taking into account the standard deviations), and they conform well to the stratigraphic chronology being used at the site. Sample Beta-22327 from 20-30 cm has produced a date of 3,540 ± 170 which probably indicates the presence of a shallow type "A" master soil stratum in this area. From 50 cm down to 130 cm in this unit, five additional dates show a cluster of approximately 9,000 B.P. from what appears to a relatively homogeneous soil, with possibly some mixing by the prehistoric activities or bioturbation.

Units 140 and 142 in Area BB were excavated in natural stratigraphic levels to secure carbon samples associated with these thinly layered strata. Units 140 and 142 also served as a means of directly studying these thin strata, or fragipans, to learn which of these layers contained cultural materials. It was discovered in the course of these particular excavations that many of the fragipans did contain lithic artifacts, and that the fragipans had somewhat sealed in the cultural materials with bisequal, hard, crusted strata (this is discussed in greated depth in a later portion of this article) (see Table 2). Radiometric samples were recovered from the fragipans which contained artifacts intrapped within and between the hard strata. In unit 140, three contiguous fragipan layers--GS (grain sample) 10, 11a, and 11b were radiometrically dated with a combined charcoal sample to 10,090 ± 420. Within these three fragipan layers, artifacts were excavated in situ. Below these first three layers another set of three fragipan strata layers--GS 4, 5, and 6--were excavated and charcoal was recovered. The upper two layers, 5 and 6, contained cultural lithics. Combining the charcoal from GS 4, 5, and 6 provided a minimal amount of carbon for a normal radiometric analysis, and a date was generated of 12,520 ± 740. This very early date is remarkably close to the basal date in unit 101 (12,390 ± 610). The unit 140 dates are especially important because of the intact fragipan stratigraphy which appears to have sealed in both cultural lithics together with charcoal. The two dates from this unit may very well be the most reliable basal chronology so far gleaned from the deposit.

Unit 142 was the second excavation at the site which exposed the fragipan stratigraphy by natural levels while also producing cultural lithics and charcoal within intact fragipan layers. The four radiometric dates from this unit came from the following levels: a 10 cm arbitrary layer above the fragipans, fragipan stratum E (71-87 cm), fragipan stratum I (88-90 cm), and fragipan stratum K (which was extremely thick and subdivided into 10 cm increments; the sample in this stratum for analysis came from 120-130 cm). Listed by these respective depths, the radiometric dates are: 3,960 ± 130, 9,470 ± 300, 10,120 ± 320, and 10,790 ± 340. We see in this group of dates excellent superpositioning and concordance with the temporal model at the site. In addition, there is a patterned repetition of an Early Period date, 3,960 ± 130, in the upper level of this unit as there was in unit 135 which yielded a sample dated at 3,540 ± 170. Thus it appears that there is an Early Period component in the upper levels in Area BB. It should also be noted that the dating analysis from 1983 produced a Middle Period date (2,370 ± 150) in the highest levels of Area B which at the site is only six meters to the southeast of unit 142. The general group of dates from the fragipan strata in units 142 and 140 display consistent superpositioning and may be our soundest measure of the oldest component at the site.

Area CC: Temporal control unit 139 in Area CC was excavated with a particular goal in mind. In both the 1983 and the 1987 excavations, large bifaces (Figure 7) were unearthed in Area C and Area CC, respectively. Obsidian elements were also recovered in these areas. The bifaces, obsidian, and other materials in the assemblage from this portion of the site were in a rather narrow stratigraphic context which is primarily master stratum B. Wet-sreen and flotation methodology used at temporal control unit 139 positioned at the south side of Area CC produced charcoal from master Stratum B. A charcoal sample from the 60-80 cm arbitrary level dated to 7,470 ± 140 B.P. This date accords with the previous cluster of dates generated out of the 1983 research, and it also is consistent with the model of temporal stratigraphy at the site. An important contribution made by this new date from unit 139 is that it functions to more exactly chronicle the large bifaces that were concentrated at this level of the CC and C areas and which were also scattered in the rest of the deposit in a more nebulous distribution. This date from unit 139 may be one of the most instrumental points of reference for the seriation of major diagnostic elements in the assemblage.

Area D: Three radiometric dates from Area D were run from a suite of charcoal samples excavated out of temporal control unit 111. The dated samples came from 10 cm arbitrary levels at 70-80 cm, 100-110 cm, and 140-150 cm. In respective order, the dates for these levels are 6,250 ± 250, 5,990 ± 220, and 6,690 ± 160. This cluster is relatively tight with some indication of superpositioning in the lower sample. It appears that based on the 80 cm of vertical separation between the samples, that a greater temporal range should have been represented in these three dates. In addition, the stratigraphic layers from which the samples were derived were the AB and B master strata, and thus a greater chronological range would have been expected. However, this is Area D--not previously well sampled, with a much more highly developed A stratum, and on the opposite side of the Scotts Valley site from the focus of previous studies. Perhaps the immediate location of unit 111 was simply subject to mixing within the deposit. It may be that only additional study will resolve the questions raised with the three existing dates from the southern portion of the site. When faced with the kind of uncertainties that exist in Area D, one becomes more aware of how relatively well we now understand the northern sector of the deposit where years of intensive research have been conducted.

THIRTY-SEVEN DATES IN TWELVE-THOUSAND YEARS

The complete set of radiometric dates from the Scotts Valley site totals 37 (Table 1). As points of time they are spread across a 12,000 year duration of the past. There are virtually no dates that stand out in isolation, but rather there is a continuum of temporal points that stretch from 580 to 12,520 B.P. Some patterns, clustering, and small hiatuses can, with close scrutiny, be discerned in the 37 point continuum (Figure 5). By studying these traits of the chronology, one can perceive possible trends and events in the archaeological record of the site.

An initial observation can be made in the range itself. Extending from 580 to 12,520 B.P., over 50% of the dates are older than 7,000 B.P. Being in all cases associated with cultural features and/or artifact bearing strata, these dates argue strongly for a component older than the 7,000 years initially hypothesized for the site's antiquity. The range of dates, overall, covers the entirely of the Holocene. The extreme ends of the chronological range as it is expressed at Scotts Valley give indication of general settlement patterns in the region.

At the most recent end of the site's chronological spectrum, a single date falls into the Late Period and three dates are within the Middle Period. Generally speaking, the frequency of recent dates from the site is somewhat low and gaps between the dates are evident from 3,500 B.P. to historic contact. This is probably the result of two things: sampling methodology, and actual reduction of site use after 3,500 B.P. When excavating the temporal control units at the site, the upper levels that consistently contained prehistoric artifacts were not dated if traces of historic disturbance were found in the midden content. With roughly 100 years of recorded historic activity on top of SCr-177, this meant that all surfaces (not including those that had been previously graded by historic earthmoving) had been repeatedly exposed to historic use and thus carbon samples from the upper levels were considered unreliable or not even collected.

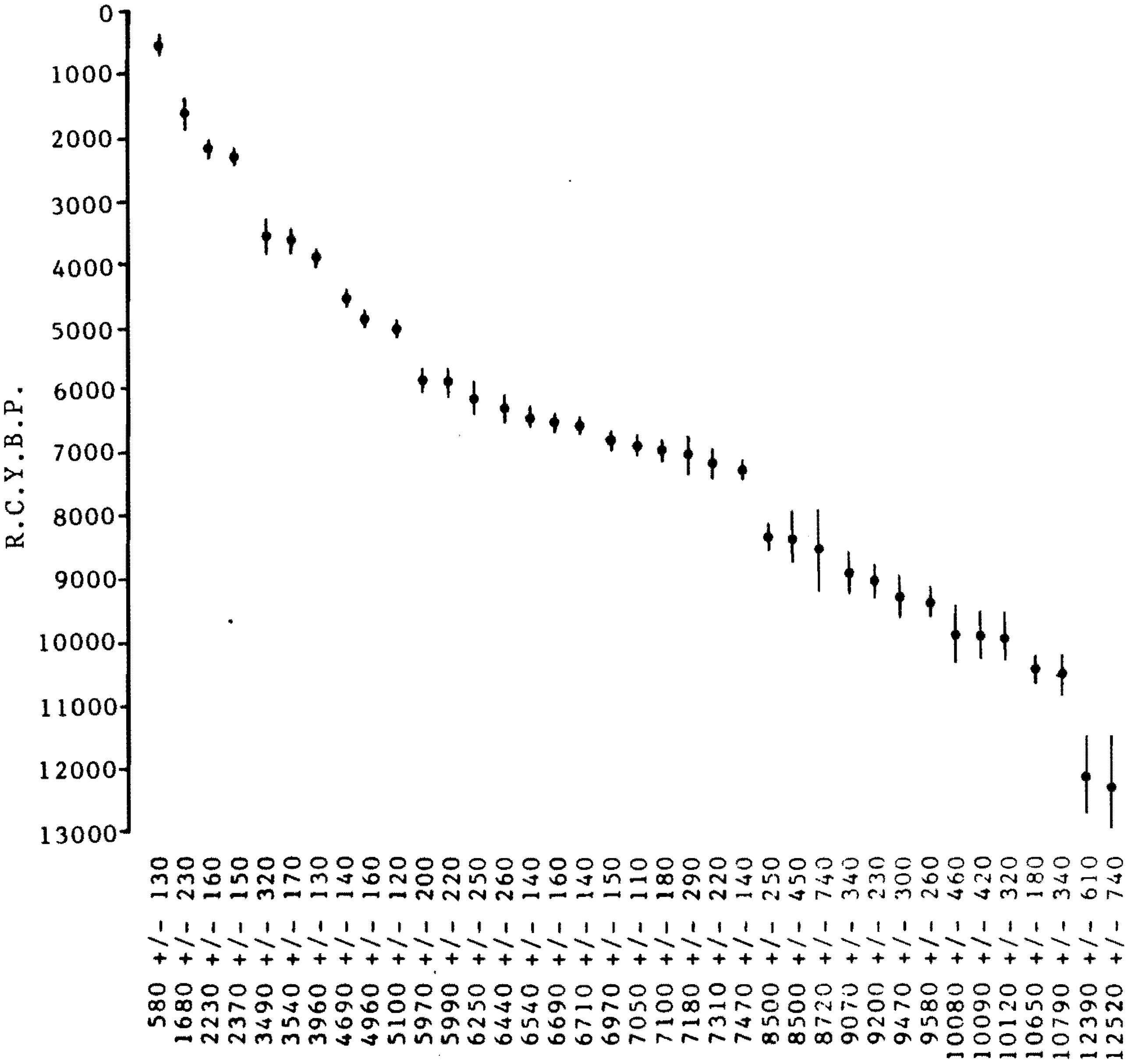


FIGURE 5. All radiocarbon dates from SCr-177.

The level of disturbance at original surfaces averaged about 40 cm. It is thus realized that recent prehistoric carbon was probably not sampled in an effort to avoid historic contamination. However, Late Period diagnostic artifacts are lacking in the large lithic assemblage. This seems to indicate that a Late Period and probably Middle Period use of the site was very limited. The best possible answer that can be provided for this question, with the data available, involves the presence of the adjacent Carbonera Creek site (SCr-33). This neighboring prehistoric deposit is directly down slope from the Scotts Valley site and has known components of Early, Middle, and likely Late Periods. Therefore, it is interpreted that there was limited activity at the Scotts Valley site right into historic contact times, but the focus of prehistoric occupation/use in the area was at another site such as the Carbonera Creek deposit. The data from obsidian hydration at SCr-177 (presented below) mirror the idea of diminishing activity at the site in the recent end of the prehistoric record.

The older extreme in the suite of radiometric dates also has some patterns worthy of mention. From 8,500 to 10,790 B.P. there is a solid battery of dates. Then there is a small hiatus between 10,790 and the next two dates of 12,390 and 12,520 B.P. This might be a reflection of the sampling, standard deviations in the radiometrics, actual events in the archaeological record, or a combination of these factors. Sampling methods used in the procurement of the carbon for both of the 12,000 year dates required the combination of multiple samples to gain a large enough quantity of charcoal for a normal analysis. In unit 101, charcoal samples from two levels, 160-170 cm and 170-180 cm, were combined in contrast to almost all of the other charcoal samples in this unit which were submitted in 10 cm increments. This almost certainly resulted in the the loss of dates between 8,720 ± 740 and 12,390 ± 610. A similar situation is found in the second 12,000 date from unit 140 where carbon from three fragipans had to be combined to produce adequate carbon for a normal submission. In addition, the next sample in a superior level which was dated in unit 140 was separated by 16 cm that were not dated due to low charcoal weights. Thus, sampling situations may be a factor in the hiatus at the older end of the radiometric continuum.

Standard deviation in the samples may also be at play in the chronological gap at the early extreme of our chronology. The early date from unit 101 has a standard deviation of ± 610 years whereas the date from unit 140 has one of ± 740. Although these deviations are not especially large considering the antiquity of the dates and the small weights of the samples, the deviations could be partially accounting for the jump in dates under discussion.

Another possible answer to the early hiatus question could rest in cultural events (or lack thereof) at the time of the chronological gap. This possibilty would mean that there was a decrease, or even an abandonment, of prehistoric activity at the site at this point in time. However, no sterile strata are found at the site which would have supported this proposition. It seems much more likely that sampling conditions and/or standard deviation are involved in the missing sixteen centuries within the radiometrics.

A final possibility to consider in discussing the hiatus in the early dates is that the dates in the 12,000 year range are not reliable. If this is the case, then the range of reliable dates for the cultural record at Scotts Valley would terminate at approximately 10,000 B.P. However, for reasons stated above, the oldest dates seem to have cultural association, they lack evidence of contamination, and they repeatedly appear at the basal cultural level in different portions of the site. The hiatus may be best viewed as inconclusive and a subject or further study at the site.

Now looking at the central body of dates in the spectrum of radiometrics, we see other breaks and clusters. A fairly concentrated body of dates, 32.4%, clusters between 8,500 and 10,790 B.P. A second cluster, 35%, is found between 7,470 and 5,970 B.P. These two clusters may be really a single large group of 25 dates, 67% of the population, with a non-consequential hiatus between 7,470 and 8,500 possibly from random sampling error in carbon recovery. From 5,100 B.P. to the recent end of the radiometric continuum, the dates are less frequent and contain several small gaps. The 5,000 years in the recent portion of the continuum contains nine radiometric dates in contrast to the 23 dates in the 5,000 year period between 6,000 B.P. and 11,000 B.P. (However, it should again be pointed out that the most upper levels often were not dated due to various forms of historic disturbance.)

OBSIDIAN HYDRATION STUDIES

A total of 81 pieces of obsidian were submitted to the obsidian hydration faciltiy at Sonoma State University for analysis of geographic/geologic source and then cutting to determine hydration rim measurements. From this group of samples, 69 have thus far been sourced and measured. The Napa source was the most frequently identified of the obsidian samples, making up 70% of the population. The second highest ranking source was Annadel with 20%, third highest was Casa Diablo with 13%, and the fourth was Bodie Hills with 6.5%.

From the distribution of the micron frequency, it is immediately recognized that there is a strong trend for Napa obsidian to be dominating the older end of the micron range, whereas Annadel predominates in the recent end (Table 3). Even though the hydration rates are known to differ between the Napa and Annadel sources (Origer 1982), a major contrast in clustering is still clearly seen in the micron range. Napa obsidian has a micron range of 2.3 to 8 with a mean of 5.3. Annadel ranges in micron thickness from 1.8 to 4.3 with a mean of 2.8. Even more important for understanding the times of influx and use of obsidian at the site is the clustering of the distributions. There is a marked cluster in the Annadel obsidian at 2.3 microns. In the Napa obsidian, there is a fairly constant presence between 4 and 7 microns with a notable absence between 7 and 7.5, and then a minor cluster between 7.5 and 8 microns.

TABLE 3

DISTRIBUTION OF RIM MEASUREMENTS

```
Count
5                                            B
4                                            B
3      ?N                 N N     N N       XN
2      ANA                N A   NN?XNN  NB  XNNNBN N N      N   Z
1 A    AAAA   A   A       XAXNNNMXNXNN BNN NNNNNNNXN NN   ? ?N   NN
     2         3         4         5         6         7       8
                              Microns
```

Key: A Annadel; N Napa; B Bodie Hills; M Mono; X Casa Diablo

A comparison between the obsidian hydration frequency distribution and the distribution of radiometric dates reveals some interesting parallels. First, there is a solid and relatively contiguous body of data in the middle and older portions of both distributions. The Napa hydration readings display this pattern between 4 and 7 microns. The radiometric dates, in comparison, contain a tight run of isotope counts between the Early Period to 10,790 B.P. The break in the radiometric dates between 2,370 $\pm$ 150 and 3,490 $\pm$ 170 may very well be associated with the break in the hydration readings between 2.6 and 4 microns. Micron readings smaller than 2.3 and dates more recent than 2,370 probably mark a difference in the prehistoric activities at the site and the availability of Annadel rather than Napa obsidian at that time.

At the older end of the radiometric and hydration frequency distributions, another parallel can be seen. Both distributions have a break very near their oldest extreme and then both have a small cluster of data just prior to their termination. It is questioned whether these breaks and clusters represent the same points in the prehistoric record at the site. Based on the frequency configuration of both data sets, it would appear that there is an excellent match between the radiometric and hydration data.

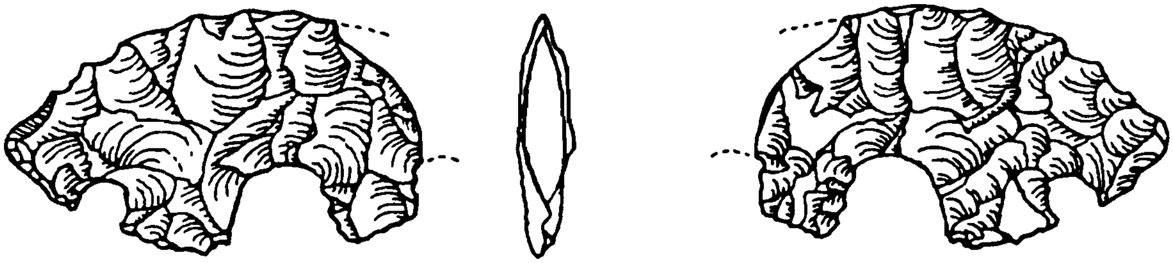
Hydration readings and radiometric dates have never before been found with this degree of antiquity in the Monterey or San Francisco Bay areas, or even in the central coastal region. It is thus very new data and lack comparisons for evaluating the obsidian chronology with other background studies. In studies of the obsidian and chronology of the Scotts Valley site in previous writings (Cartier 1985, 1987), an attempt was made to translate the micron readings into years to determine whether the hydration data corresponded to the assumed antiquity of the site. A constant was used of 196.4 for the Napa obsidian recovered in the Monterey Bay area when calculated using the formula of Friedman and Smith (1960). This constant was developed out of the well-dated assemblage at the Saunders site (Mnt-391) in Monterey and it was compared with other sites in the area including SCr-177 (Cartier 1985). Furthermore, it continues to fit the newly acquired corpus of data from the 1987 excavations. Other attempts to devise an age equivalent mechanism for obsidian in the Monterey and San Francisco areas have been often limited by the the small samples of obsidian recovered in excavations. The exceptions to this are the studies of the Saunders site (Cartier ibid.) and the Moss Landing site (Mnt-229) (Dietz et al. 1986). In the latter study a large body of radiometric and hydration data is presented and discussed with proposed absolute age equivalents for hydration measurements. Dietz (ibid.:134-5) has used the inland measurements developed by Origer (1982) for Monterey Bay with a correction factor of 10% per degree centimeter for Monterey's effective hydration temperature. Several problems evolved out of the temporal analysis of the Moss Landing site, many relating to the discrepancies within and adjustments made to the chronometric data. The Moss Landing age equivalents for obsidian do not fit well with the Scotts Valley data. The reason for this probably centers on the extreme antiquity of Scotts Valley and the lack of opportunities to apply equivalency calculations to a body of obsidian data of this age in Monterey Bay. It appears that the older/thicker the hydration data from Monterey Bay, the more difficult it becomes to apply constants from inland sites even with the proposed correction factors for temperature.

Generally speaking, the obsidian studies from Scotts Valley support the chronological interpretation of the site as having an extended period of use with an early component in excess of 7,000 B.P. However, the exact range of antiquity cannot be established from the obsidian, and continued research on the obsidian from the site may be helpful in addressing these uncertainties.

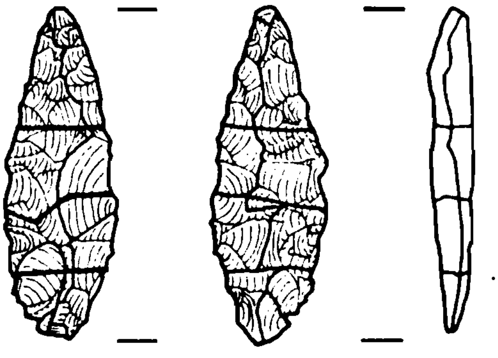
DIAGNOSTIC ARTIFACTS

The third avenue of investigation in the study of chronology at SCr-177 centers on the diagnostic artifacts. Most of the diagnostic artifacts were recovered on the weekend of the 1983 Memorial Day excavation, and all of the diagnostic artifacts are lithics. Of the over 14,000 lithic elements collected in the assemblage, several are recognized as time-sensitive artifacts and one--the eccentric crescent--is clearly a temporal indicator.

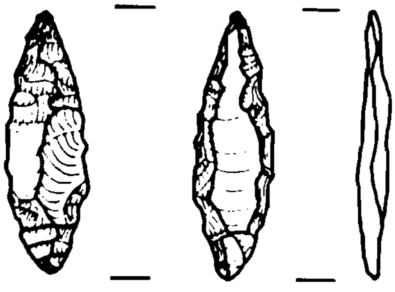
The eccentric crescent (Figure 6, specimen 177-1318) was unearthed in a central portion of the Memorial Day weekend excavation, Area B, unit 16, at 40-60 cm. As reported by G. Fenenga (1985), the crescent is one of the more temporally sensitive ar-



177-1318



177-134



177-2100

FIGURE 6. Crescent and small bifaces.

tifacts in all of North American archaeology. In instances where crescents have been excavated in reliable chronological context, they seem to date most frequently to a 7,000 to 10,000 year period (Wallace 1978).

Several bifaces and unifaces in the Scotts Valley assemblage manifest characteristics of a temporal nature. These are made of chert, basalt, quartzite, and possibly sedimentary rock. One biface category is distinguished on the basis of having snapped bases or being snapped at the mid-sections; and these have been interpreted as potential "blanks" for trade to be later shaped into more refined artifacts. Many similar examples of this artifact type have been found at the quarry source at Ano Nuevo. Examples of this artifact form are specimens #136 and #3636 (Figure 7). A second category consists of leaf-shaped bifaces which, in some cases, have careful working on the basal end and have indications of being used primarily on the basal edge (Figure 8, specimen #1321). A third category of smaller bifaces encompass two similar specimens that are symmetrically leaf-shaped and approximately 5 cm long (Figure 9, specimens #1315 and #723). If any of the artifacts in the collection were used as functional points, these two elements are the best candidates.

Unifaces in the collection includes large well-formed scraper-like artifacts made primarily out of basaltic materials. One specimen (Figure 10, #1352) is of a basaltic (greenstone) material, and the second (Figure 10, #1319) is a fine-grained gray basaltic rock. A third specimen, #878-1, is also a fine-grained basaltic similar in nature, but smaller than specimen #1319. These unifaces are distinct in size, form, and lithology, comparing very similarly with specimens reported from distant archaeological sites in southern California and other portions of the western United States (Davis et al. 1969).

These bifaces and unifaces are similar in morphology and in their radiometric context to those in other sites in northern, central, and southern California. The bifaces and unifaces seem to be part of a cultural tradition typically dated between 7,000 and 10,000 B.P. Although not nearly as temporally sensitive as the eccentric crescent, the bifaces and unifaces fit a pattern of lithic industry associated with early archaic sites. The Harris site, SDi-149, (Warren 1966, 1967); Rancho Park North, SDM-W-49, (Kaldenberg and Ezell 1974); Tulare Lake complex (Riddell and Olson 1969), Buena Vista Lake, Ker-116, (Fredickson and Grossman 1977); and the Borax Lake site, Lak-36, (Meighan and Haynes 1970) are some of the more well-known sites which have yielded bifaces, unifaces, as well as crescents comparable with the assemblage from Scotts Valley.

TEMPORAL STRATIGRAPHY

Based on the chronological knowledge of the site gained from the various dating methods discussed above, the recognizable strata at the site can be temporally identified. A basic pattern

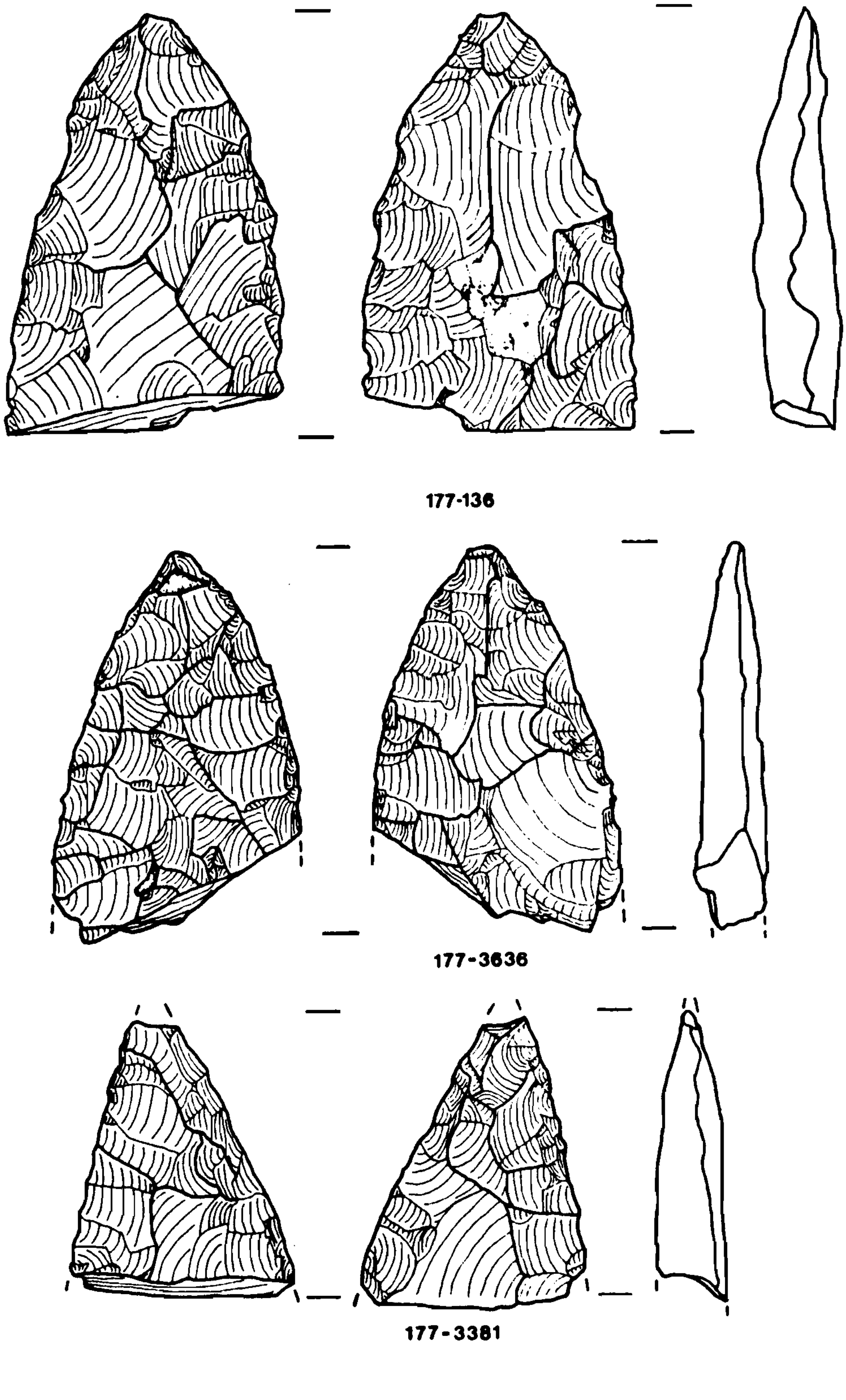


FIGURE 7. Large bifaces.

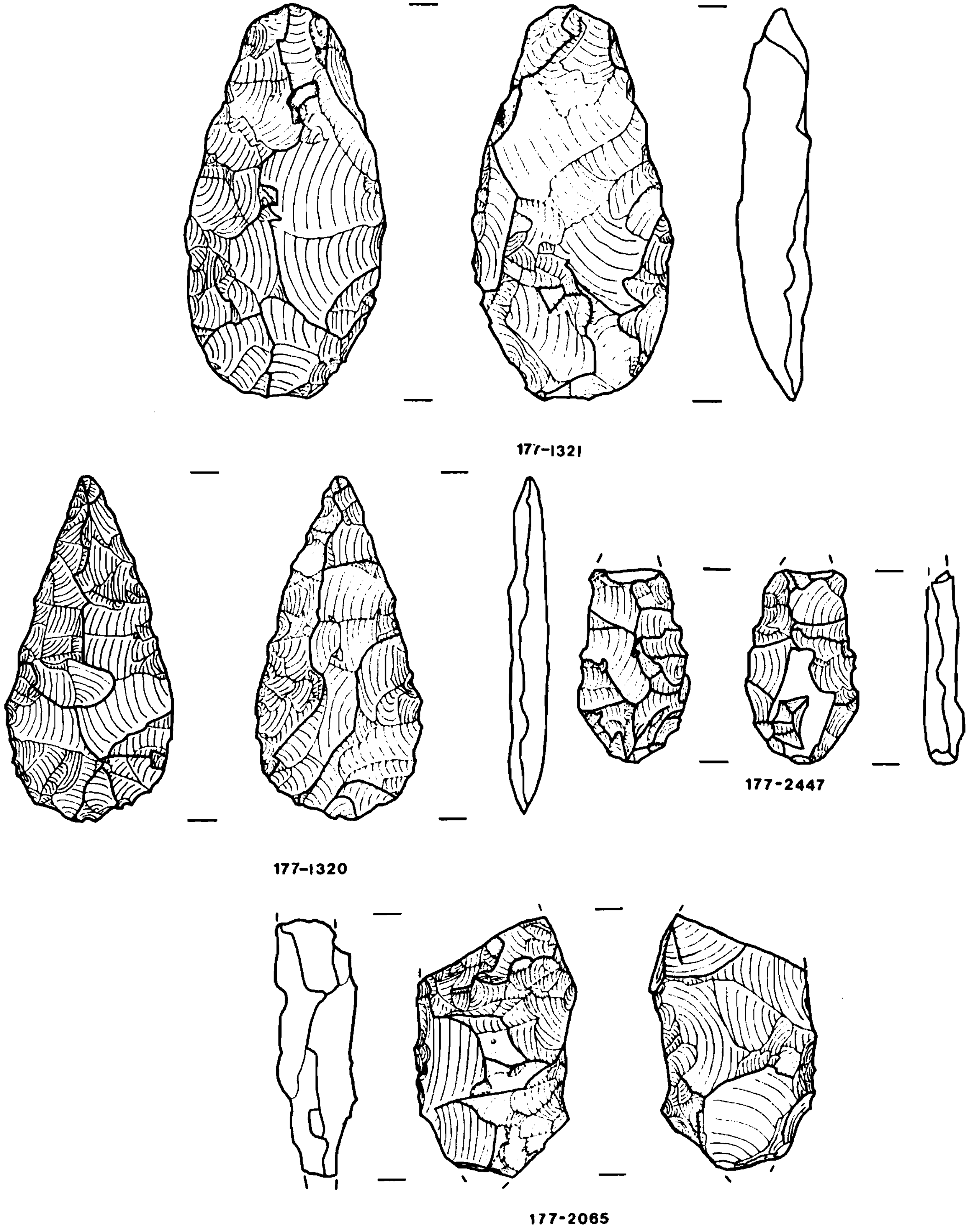


FIGURE 8. Large and medium bifaces.

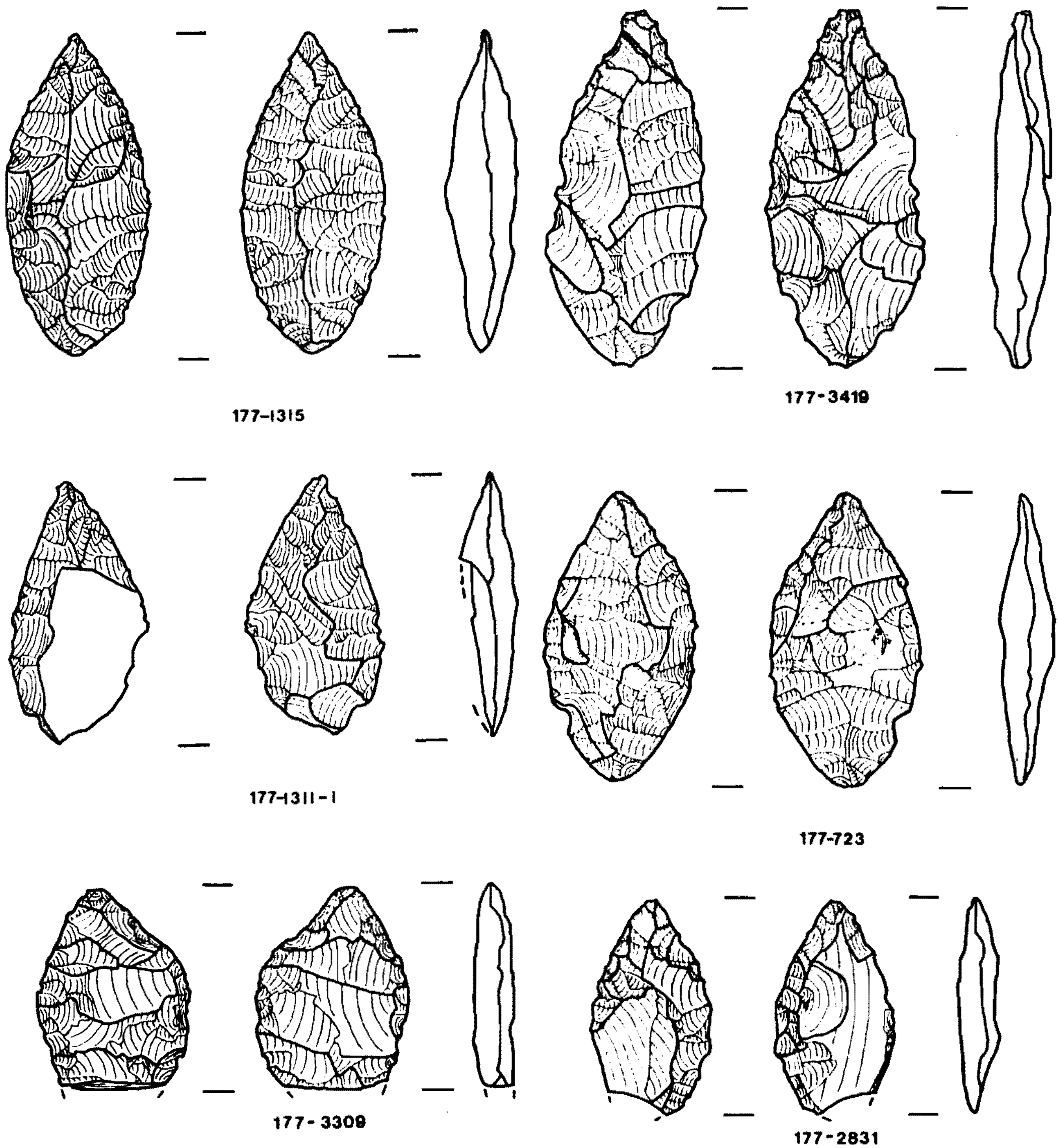


FIGURE 9. Medium and small bipoints.

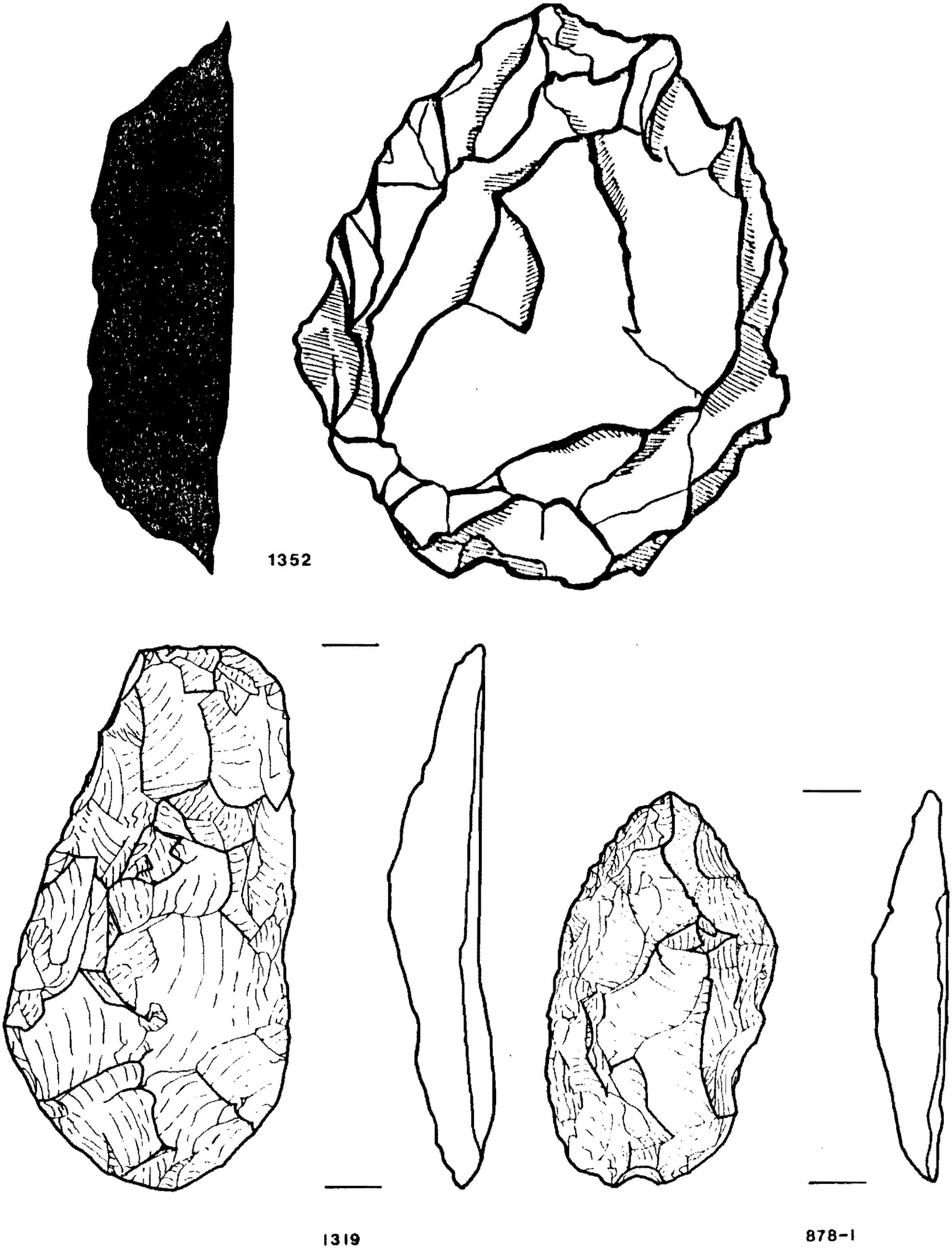


FIGURE 10. Unifaces.

of major or master horizons are found at the site which can be used for chronological discussion (Table 4). The uppermost master horizon is a dark brown loam rich in organics. Underlying this is second master horizon that is much lighter in color, lacks the organics, and is a washed sand. A transitional zone occurs between these two master horizons in which properties of both horizons are mixed. In the lower master horizon, bisequential subordinate strata are present characterized by cemented and loose sand layers. Beneath this are non-archaeological soils with increasing consolidation.

The uppermost horizon is called an A horizon in soil taxonomy based on its combination of organic matter, in dark loam of quartz rich sand. The dark brown color, 10YR 2/4, is characteristic of this layer. Its age, based on radiometric dating is from modern at surface back to approximately 5,000 B.P. The pH of these soils is 5.4 and the quartz sand particles are subrounded. Lithic artifacts are common in the A horizon on site with a count of 72 per cubic meter (using sample data from unit 101). The lower extent of this horizon makes a transition with color change, reduced humic content, and increased clay at approximately 100 cm below surface.

The transition layer below the A horizon has a grayish brown color, 10YR 5/2, indicating a decomposition and leaching of the organics from the mineral content. Considering that the characteristics of the A horizon are still dominant in the transition horizon it is designated as the AB horizon (the first letter designating the dominant horizon in the transition). This follows the taxomonic device for transitional layers in Birkeland (1984). Cultural materials in the AB horizon are clearly present with an average of 192.5 lithics per cubic meter (in unit 101). Depth of the AB horizon varies slightly; as it was found in unit 101, depth ranged from 110 to 145 cm below surface. Age of the AB horizon, based on radiometric dating of unit 101, is approximately 5000 to 8000 B.P.

Directly beneath the AB horizon at the site is a B horizon, containing eroded and transported sands redeposited from the surrounding parent bedrock formations. The B horizon lacks the organic matter characteristic of the A horizon, and instead contains leached marine sands from the assumed parent material of Santa Maragarita Sandstone (poorly consolidated quartz-rich sand). The master B horizon contains variation in its internal traits and is found with subordinate sedimentary layers. In unit 101, the B horizon was present from approximately 140-190 cm below the surface. Artifactual materials were consistently recovered in the top 40 to 100 cm of B horizon in the many different sample locations on the site. As noted in an analysis by G. Fenenga of the site's lithic technology (1988), the cultural assemblage extends into and then terminates in this horizon. Using unit 101 as a reference, culturally modified lithics averaged 53 elements per cubic meter in the B horizon. (The B horizon produced greater frequencies in more northerly sample areas on

TABLE 4

MASTER HORIZONS USED AT CA-SCR-177

	pH	% Sand	% Silt	% Clay	Color	Description
A	5.4	53	35	10	10YR 4/2	loam

This layer is a dark brown loam, rich in orangics with a particle content of quartz sand. Some disturbance is present in the upper 50 cm and the lower portions of this horizon may show an increase in moisture content.

AB	5.3	65	20	8	10YR 5/3	sandy loam

As a transitional layer between master horizons A and B, this gray brown layer has less of the organics noted in the A horizon and a larger porportion of clean quartz sand. It is more compact than A and is rich in cultural materials.

B	5.2	85	15	5	10YR 5/4	sand with loam

Contrasting markedly to the A horizon, this soil layer consists of a tan sand with only a small content of organics and silts. It appears non-cultural upon visula inspection, but consistently proves to yield lithic artifacts in its upper portions.

Bs	5.8	86	9	3.5	10YR 6/4	sand with loam

This horizon is in fact a subordinate of subtype of the B horizon with its characteristic difference being a color trait of orange-brown instead of tan. Sesquioxides in the soil are identified as the cause of this color an thus the "s" suffix on the master B horizon designation.

Bxi	5.3	73	15	12	10YR 4/4	sand with loam

This is a subordinate of the B master horizon and is characterized as distinct by its dark banding and density. It is interpreted as a fragipan and thus the "x" designation. The "i" suffix relates to the illuvial trait.

Be	5.3	85	10	3	10YR 6/3	sand with loam

Another subordinate horizon of the B, this is the eluvial layer associated with the fragipan bisequal formation. Without the fragipan association, it generally resembles the soil of the B horizon. The "e" designation refers to its eluvial nature.

the site.) Radiocarbon samples from the B horizon in unit 101 (160-180 cm) dated between approximately 8000 and 12,390 RCYBP.

Variations in the B horizon included color hues of yellow-brown especially in the northwest part of the site. The yellow-brown discoloration in portions of the B horizon is apparently caused by sesquioxides in the soil. Sesquioxides are oxides and hydroxides of iron and aluminum concentrated by vertical or lateral water movement. The orange-brown color was particularly noted in the lower reaches of unit 101 and Areas A and AA. In unit 101, the sesquioxide-rich layer started at 170 cm below surface, containing a few flakes, and dated in excess of 12,000 B.P. At Area AA, the sesquioxide-rich layer was directly beneath the AB horizon and ranged from approximately 7,000 to 10,000+ B.P. The orange-brown Bs layer appears to lack a midden character but does in some cases, as in the proveniences cited, contain the deepest and oldest portions of the cultural assemblage. The foremost example of cultural materials within the orange-brown B horizon is the metate feature exposed in the pedestal within units 120-121 (see Figure 3).

Another variation of the B master horizon is the presence of narrow (1-20 cm) strata of dark, hard cemented soils described as bisequential fragipans (Cartier 1987). These hard, narrow bands are separated by light-colored sands typical of the B horizon. The bands generally tilt in a contour following the original landform surface on the alluvial terrace at the site. Undulating patterns often are present in the bands which sometimes fold, bifurcate, and terminate in complex forms. The upper surface of the dark, hard layers tends to be smoother than the lower side of these same layers which, in contrast, have small depressions and irregularities.

The formation the fragipans involves a hydrological, subsurface process. In this process, underground water episodically saturates the soils and transports silt, clay, and sesquioxides to concentrate them at the high water marks in the water table. Fluctuations in the water table generate a series of bisequal strata which are paired--one concentrated in interstitial materials such as silt and sesquioxides and the second strata leached of these interstitial materials, leaving the larger matrix particles, predominantly sand. After initial formation, the concentrated layers stay cemented together, bound by the sesquioxides and other fine interstitials. Once this initial formation is started, the presence of a cemented layer acts to impede the movement of water, thus apparently inducing the another formational episode of pair strata, leached and concentrated, adjacent to the last pair.

Bisequential Banding Strata

Strata type Bxi "Resistant Layer, Hard Layer, Dark Layer"
This layer is an illuvial, cemented strata ranging from 1-20 cm thick. It is rich in mafic or sesquioxides, silt, and clay. When density is measured with a penetrometer, it is greater than 4.5 kg/cm2. The quartz sand grains are subrounded to subangular and have cemented coatings adhering to their surfaces. Color designation is 10YR 4/4. As a taxonomic designation, B is the master horizon; x denotes a hard, resistant, cemented subsurface layer as a fragipan; and i identifies the layer as illuvial (or concentrated in interstitial materials).

Stata type Be "Soft Layer, Sand Layer, Light Layer"
This layer is an eluvial, unconsolidated strata commonly no thicker than 7 cm but having occasional large pockets or wedges. It has been washed or leached of interstatial materials (relative to Bxi, and its density averages 2.0 kg/cm2 with increasing density in upper layers. The quartz sand is subrounded. Taxonomically, it is designated as a subordinate strata of the B master horizon. The suffix e is given for its eluvial character.

Fragipan is a term used specifically for the hard-cemented layer in bisequential soils formation of eluvial and illuvial strata (Birkeland 1984). The origin and exact formational process of fragipan is obscure to soil scientists (ibid.), but these soil strata are commonly found in noncalcareous soils, in environments with loamy material subjected to dynamic subsurface water, and in vegetation communities dominated by forest. Furthermore, the binding materials in fragipans are commonly hydrated oxides of aluminum and iron (sesquioxides) and they are seen as commonly forming in the Holocene and possibly slightly earlier (see Table 4).

The presence of the fragipan layers, in combination with the temporally identified master soil horizons at the site, provides a heuristic background for chronological studies of the Scotts Valley site. With the extreme duration and antiquity of the deposit, it is key that chronological and stratigraphic control be maximized to enable placement of artifacts, features, and other data in proper temporal sequence. The frequent condition of deposits in California, with extensive rodent and other forms of bioturbation, makes the exceptional superpositioning and sealed lower layers at Scotts Valley invaluable and unusual. By understanding the alternating banding stratigraphy as fragipan formation, it is possible to integrate our knowledge of paleo-environmental climates and flooding in Scotts Valley with the stratigraphic banding in and below the deposit.

CONCLUSION AND IMPLICATIONS

The various lines of chronological research pursued in the study of the Scotts Valley site all lead to the conclusion that the site greatly exceeds the previously recognized antiquity for the San Francisco and Monterey Bay areas. Radiometric dates, obsidian hydration studies, and comparison of artifact forms all point to prehistoric activity on the site at least 7,000 years in the past.

The three types of temporal analysis used in this study are mutually supportive in their conclusions. In addition, they provide different types of detail about the cultural activities associated with the early antiquity. The 37 radiometric dates indicate possible times of concentrated cultural activity and also potential hiatuses in the record of site use. Likewise, the obsidian studies indicate a wide temporal range at the site, while also documenting the chronological periods of cultural trade with various geographical areas. Study of the typological artifacts from the site demonstrates parallels in lithic artifact types with other early Holocene sites in western North America, especially sites well-dated to between 7,000 to 12,000 B.P. in other portions of California.

The site clearly has a concentrated period of use at approximately 7,000 B.P., with strong evidence of prehistoric activity back to 10,000 B.P., and possible use as early as 12,000 B.P. This in itself is not surprising, for other well-documented sites have been reported in the literature in northern and southern California with this antiquity. What is especially notable about the deposit is its apparent span across almost the entire Holocene. It is exceptional to have such a record at a single archaeological site, and SCr-177 appears to contain an assemblage of the local prehistoric lithic industry over this duration of time. Furthermore, the superpositioning of many of the radiometric dates, and the sealing of cultural materials in mineral concentrations (fragipans) in some of the lower levels of the deposit, provide excellent research opportunities for several lines of investigation which are currently underway.

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