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ARCHAEOLOGICAL INVESTIGATIONS AT NELSON WASH, FORT IRWIN, CALIFORNIA

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CHAPTER 7 - ASSEMBLAGE COMPOSITION ANALYSIS by Margaret Lyneis and Claude N. Warren

INTRODUCTION

Seven sites yielded surface assemblages in the course of data recovery along Nelson Wash. The four northernmost, 4-SBr-4965, -4963, -4967, and -5267, are small sites on the banks of the wash, situated on old surfaces that lack naturally-occurring raw materials for lithic production. To the south of them are 4-SBr-4968, situated where the toe of a fan of Pleistocene volcanics intersects the wash, and so expected to include both residues of primary lithic production and occupation; and the Henwood site (4-SBr-4966), a large, complex site with subsurface deposits as well as surficial assemblages. The southernmost site is 4-SBr-4969, in a pavement of volcanic gravels some meters away from the edge of the wash. The differences in the sizes, situations and yields of these sites leads us to expect some differences in their assemblages. In addition to expecting differing mixes of occupation and lithic production residues depending on the on-site presence of lithic raw materials, we must ask whether the Henwood site is different in kind from the other sites along the wash. It is situated where Bicycle Wash joins Nelson Wash. Its extent and apparent complexity may result from the activities of its occupants being more varied during longer stays than on the small sites, consistent with use of the site as a residential base in contrast to the small sites along the wash used as field camps. The Nelson Wash research design, Chapter 1, predicts that residential bases will not be present along Nelson Wash, but admits the possibility that the dichotomy of field camps and specialized sites may be found. Alternatively, the Henwood site may simply have been the most favored location for field camps along the wash, and over the span of Early Times, have been used in this fashion more often than the small sites. In this case the extent and density of the materials at the Henwood site is the composite result of many occupations that were not different in kind from those on the small sites.

The analysis of the assemblages that follows is designed to explore these predictions. They predict variation in the assemblages due to the contributions of lithic production and of occupation.

To address these questions, we need to distinguish tools from the byproducts of lithic reduction, and we try to measure the diversity of the assemblages as one way of testing whether the Henwood site is different in kind from other sites. As we search to understand the variability among the Nelson Wash sites, it should not be forgotten that they are a localized subset of Early Times sites, all situated in very similar environments, and that our primary prediction should be a great degree of homogeneity among them. This homogeneity will be apparent, but until we have assemblages to contrast with them from the residential bases hypothesized to occur major drainages, the degree of homogeneity will go unmeasured.

ANALYSIS OF THE SURFACE ASSEMBLAGES

The small size of many of the sites and the concentrations within them, compounded by the small sampling fractions possible under the terms of the contract, resulted in the recovery of many small samples, marginal for representing the site assemblages. In order to use these collections for comparison, it was necessary to group them to provide more meaningful counts whenever such grouping was reasonable. Two principles were used to guide the grouping. Samples from the same locus, concentration or site were grouped when their spatial proximity suggested it and both the following conditions held:

1. The ratio of metavolcanic flakes to flakes of chert/chalcedony were similar.
2. The quantitative composition of the assemblage, in terms of the major categories of bifaces, projectile points, unifaces and cores, was similar, or, tools were present in such small quantities that the assemblage composition, even at this gross level, was obscure.

Table 7-1 summarizes the grouping of field samples into the analytical samples used to analyze assemblage composition.

Morphological classes of artifacts as described in a previous section are the units for characterizing the assemblages. The questions that guide this examination would best be explored through the use of functional categories, but a fully functional classification has not emerged for the Nelson Wash sites. Cores and projectile points are functional categories, and unifaces are all tools. The biface category, and the classes that compose it, are the most numerous, and at the same time, least suited to approximating activities. Bifaces include both pieces that are regarded as accidents and discards at various stages of lithic reduction as well as finished tools of unknown function. The analysts were unable to distinguish these two very different functional groups, so the mixed nature of the category, bifaces, and the classes that comprise it must be kept in mind, and will be the subject of further discussion. In the course of the assemblage composition analysis, artifact classes were sometimes grouped for particular purposes, and these groupings will be identified as they are incorporated into the discussion that follows.

Diversity

The first characteristic to be examined is diversity. In regard to this characteristic, Kintigh (1984:1) notes that:

> Its utility, in part, derives from its robust ability to summarize a rather inspecific sort of variability in an archaeological assemblage (Cannon 1983). In informal usage, diversity is a concept that is related to the number of classes of items present in an assemblage.

Jones, Grayson and Beck (1982) showed that apparent diversity of archaeological assemblages is strongly affected by sample size, however, and the relationship between number of classes present and number of tools classified and counted can be graphically expressed as a regression.

Diversity might be a measure of the difference in the expected assemblages of residential bases and field camps, or of field camps and specialized camps, so the number of tool classes present in each assemblage was ascertained using the ungrouped morphological classes in the categories of bifaces, projectile points, unifaces and cores. In counting classes, residual categories such as amorphous, unclassified fragments, etc., were not included. The number of tools includes all tools classed into the major categories. When the assemblages from the Nelson Wash sites are plotted, the distribution is nearly linear (Figure 7-1). It is apparent that we cannot argue on the simple basis of the number of tool classes present that the Henwood site, or loci within it such as Locus A and Locus B, are more diverse than the small sites because there is a clear relationship between the number of tools and the number of classes present. The greater artifact density and larger area of the Henwood site remain facts, however. In addition, there are differences in the kinds of tools present in assemblages, even if the number of classes is a function of their sample size.

Assemblage Composition

The first indication that there are substantial differences between the assemblages of the Nelson Wash sites comes from an examination of their composition viewed through the relative quantities of the major classes present: cores, unifaces, projectile points and bifaces. Groundstone is very rare on these sites and is omitted here. Although groundstone was recovered from several of these sites, only 4-SBr-5267 yielded groundstone in the systematic controlled surface collections that are analyzed in this section. Table 7-2 lists counts and percentages of major classes for each assemblage. To express the variation present, the assemblages can be viewed on a cumulative frequency graph (Figure 7-1). If there were "assemblage types" present among the Nelson Wash sites, we would expect lines of some of the assemblages to coincide. It is evident that they do not, however. Instead, they fan out over a considerable range of variation.

The order in which the assemblages fall on the cumulative frequency graph (Figure 7-1) is primarily a function of the frequency of bifaces, and secondarily, of unifaces. The most striking observation is that the two sites with the lowest biface frequencies are 4-SBr-4968 and 4-SBr-4969, the two sites that are situated on gravels containing metavolcanic cobbles and boulders. It is evident that if biface production was taking place at these sites where raw material was available, it must be only primary reduction with little breakage, and wholesale removal of the stage forms created there. At the other side of the distribution, two locations at the Henwood site prove to have bifaces to the virtual exclusion of other tool types. Locus C Concentration 2 and Locus C Biface Concentration are on the banks of Nelson Wash almost directly across the wash from the metavolcanic-, chert- and chalcedony-bearing gravel deposits on which 4-SBr-4968 is situated. Locus C Concentrations 3-6, next highest in biface frequency, are just to the north. To the south of Locus C, Loci A and B show more moderate biface frequencies, resembling the "inland" loci of the Henwood site and the small sites to the north.

The contribution of unifaces to the assemblages can be judged from the steepness of the line between the core and uniface points on the cumulative frequency graph. 4-SBr-4968L and 4-SBr-4968H, Locus F at the Henwood site and 4-SBr-5267 all show high uniface frequencies.

In order to better understand the variation in biface contribution to the various assemblages, the distribution of biface classes was examined. When the morphological classes are spread out among the assemblages, they are very thinly distributed (Table 7 3). In this form the data are unsuitable for statistical analysis. Inspection indicates very little except that three assemblages, 4-SBr-4965, Loci D and H at the Henwood site, each have a number of representatives of classes that are subdivisions of Class 18, and lack or have very few representatives of classes 1 through 5, in contrast to other assemblages.

In an attempt to approximate a distinction between bifaces that are finished tools and bifaces that are products of lithic reduction, the biface categories were grouped into small bifaces (classes 1-13 and 19) and large bifaces (classes 14-18 and 20-25). Table 7-4 shows the distribution of the assemblages ranked by increasing frequency of small bifaces. The assemblages are quite variable in this characteristic. Perhaps of greatest interest is the workshop site, 4-SBr-4969. We have already noted that it is deficient in the number of bifaces present, and it can now be seen that six of the seven that are there are large, as might be expected in a workshop for primary reduction. The assemblages fall into two clusters; cluster 1 contains assemblages with between 14.3% and 55% small bifaces, and cluster 2 with assemblages containing between 61%

Table 7-1: Surface Assemblages, Grouped Samples.

Field Samples	Grouped Samples
4-SBr-4963	
random and judgmental	4-SBr-4963
4-SBr-4965	
Locus A 100%, Locus B 100%, Locus C 100% and Locus D 100%	4-SBr-4965
non-locus	4-SBr-4965 non locus
4-SBr-4966	
Locus A random and judgmental	4-SBr-4966 Locus A
Locus B random and judgmental	4-SBr-4966 Locus B
Locus C, concentration 1 random	4-SBr-4966 Locus C1
Locus C, concentration 2 random and judgmental	4-SBr-4966 Locus C2
Locus C concentration 3 judgmental, concentration 4 judgmental, concentration 5 100% and concentration 6 100%	4-SBr-4966 Locus C3-6
Locus C flake concentration	4-SBr-4966 Locus Cf
Locus C biface concentration, random and biface concentration, judgmental	4-SBr-4966 Locus Cb
Locus C low-moderate density, random	4-SBr-4966 Locus Cl
Locus D, 100%	4-SBr-4966 Locus D

Table 7-1: Continued.

Field Samples	
4-SBr-4966	
Locus E, 100%	4-SBr-4966 Locus E
Locus F, 100%	4-SBr-4966 Locus F
Locus G high density	4-SBr-4966 Locus G
Locus G moderate density	4-SBr-4966 Locus Gm
Locus H concentration 1 random concentration 2 random and concentration 2 judgmental	4-SBr-4966 Locus H
concentration 1 random	4-SBr-4966 Locus H,
concentration 1-south	
Locus I	4-SBr-4966 Locus I
4-SBr-4967 judgmental	4-SBr-4967
4-SBr-4968 Locus A high density	4-SBr-4968H
4-SBr-4968 Locus A low density	4-SBr-4968L
4-SBr-4969 Loci A, B, C, D, E, G, K, O, P	4-SBr-4969
4-SBr-5267 Locus 1(A) Locus 2(B) random Locus 2(B) judgmental Locus 4(D) random Locus 4(D)-N 100% Locus 4(D)-C 100% Locus 4(D)-S 100% Locus 8(H) judgmental Locus 10(J) random	4-SBr-5267

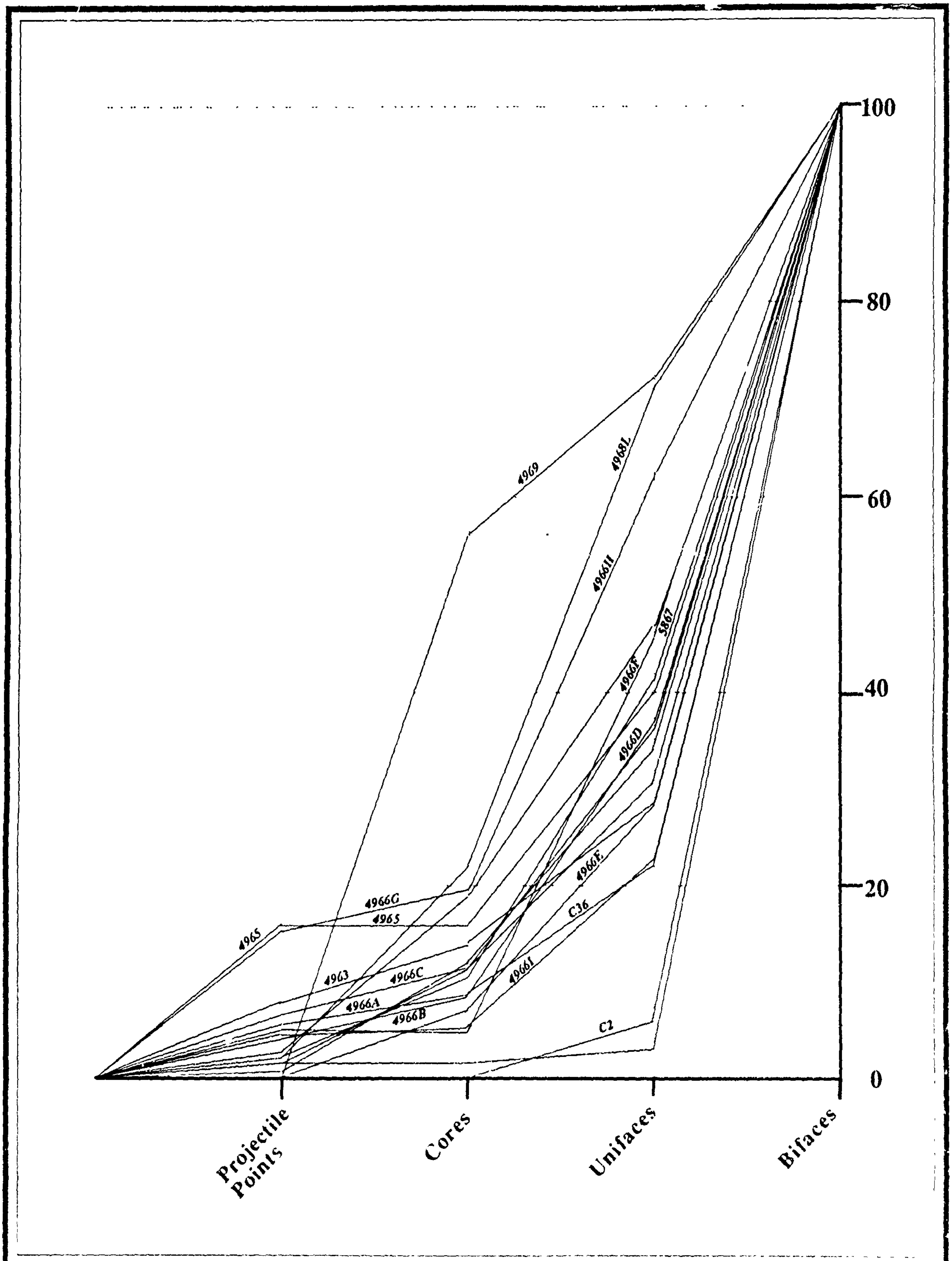

FIGURE 7.1. CUMULATIVE FREQUENCIES OF ARTIFACT TYPES AT NELSON WASH SITES

Table 7-2: Macro-composition of Nelson Wash Surface Assemblage

Assemblage	SBr-4963		SBr-4965		SBr-4966 Locus A		SBr-4966 Locus B		SBr-4966 Locus C/1	
	N	%	N	%	N	%	N	%	N	%
Bifaces	45	59.2	17	70.8	261	65.7	114	67.1	11	68.8
Unifaces	20	26.3	3	12.5	94	23.7	39	22.9	3	18.8
Cores	5	6.6	0	0.0	19	4.8	13	7.6	1	6.2
Proj. pts.	6	7.9	4	16.7	23	5.8	4	2.4	1	6.2
Total	76		24		397		170		16	

Assemblage	SBr-4966 Locus C/2		SBr-4966 Locus C/3		SBr-4966 Locus C/B		SBr-4966 Locus D		SBr-4966 Locus E	
	N	%	N	%	N	%	N	%	N	%
Bifaces	32	94.1	35	77.8	68	97.1	20	64.5	8	66.7
Unifaces	2	5.9	6	13.3	1	1.4	7	22.5	3	25.0
Cores	0	0.0	2	4.4	0	0.0	4	12.9	1	8.3
Proj. pts.	0	0.0	2	4.4	1	1.4	0	0.0	0	0.0
Total	34		45		70		31		12	

Assemblage	SBr-4966 Locus F		SBr-4966 Locus G		SBr-4966 Locus H		SBr-4966 Locus I		SBr-4968 Locus H	
	N	%	N	%	N	%	N	%	N	%
Bifaces	16	59.2	8	53.3	34	66.7	26	76.5	37	42.0
Unifaces	10	37.0	4	26.7	11	21.6	6	17.6	33	37.5
Cores	0	0.0	1	6.7	5	9.8	0	0.0	14	15.9
Proj. pts.	1	3.7	2	13.3	1	2.0	2	6.0	4	4.5
Total	27		15		51		34		88	

Assemblage	SBr-4968 Locus L		SBr-4969		SBr-5267	
	N	%	N	%	N	%

Table 7-2: Continued

Bifaces	16	32.0	11	30.5	84	57.5
Unifaces	26	52.0	5	13.9	49	33.6
Cores	8	16.0	20	55.6	6	4.1
Proj. pts.	0	0.0	0	0.0	7	4.8
Total	50		36		146	

Table 7-3: Biface Distribution in Nelson Wash Sites

Class	Sites and Loci: 4963	4965	4966 A	4966 B	4966 C1	4966 C2	4966 C3-6	4966 Cb	4966 D	4966 E	4966 F	4966 G	4966 H	4966 I	4968 H	4968 L	4969	5267
1A	3	1	16	9	-	6	3	4	1	1	-	-	-	1	3	-	-	4
1B	-	-	6	1	-	-	-	-	-	-	-	1	-	-	-	-	-	
1C	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2A	-	1	4	1	-	-	-	2	1	-	1	-	-	1	2	-	-	
3A	1	-	7	3	-	-	1	2	1	-	-	-	-	-	1	-	-	1
3B	-	-	2	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3C	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
4A	-	-	2	1	-	-	-	-	-	-	-	-	1	-	-	-	-	-
4B	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
5A	-	2	5	3	1	1	2	5	-	-	-	-	-	1	-	-	-	-
5B	-	-	1	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-
6A	2	-	8	2	-	1	-	1	-	-	-	1	-	1	-	-	-	3
6B	-	-	1	-	1	1	-	1	-	1	-	-	-	-	1	-	-	-
7A	-	-	-	-	-	-	1	-	-	-	-		-	-	1	-	-	1
7B	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
7C	1	-	2	-	-	-	-	-	-	-	-	-	1	1	-	-	-	1
8A	-	1	7	-	-	-	2	2	-	-	-	-	-	1	-	-	-	1
8B	-	-	4	1	-	1	-	-	-	-	-	-	-	-	-	-	-	3
8C	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-
9A	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
10A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-

Table 7-3: Continued

11A	-	-	1	1	-	-	1	2	-	-	-	-	1	-	-	-	-	1
11B	-	-	1	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-
12A	1	-	2	1	-	-	1	1	-	-	-	-	-	-	-	1	-	-
12B	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-
13A	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
14	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
15A	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	2	2	-
16A	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
16B	-	-	2	1	1	-	-	-	-	-	1	-	2	1	1	-	-	1
16C	-	-	1	1	1	1	-	1	-	-	-	-	-	-	-	-	-	-

Sites and Loci

Class	4963	4965	4966 A	4966 B	4966 C1	4966 C2	4966 C3-6	4966 Cb	4966 D	4966 E	4966 F	4966 G	4966 H	4966 I	4968 H	4968 L	4969	5267
17A	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
17B	-	-	2	-	-	-	-	-	-	-	1	-	-	-	-			1
18A	3	-	7	9	3	1	1	5	2	1	-	-	2	-	1	-	-	2
18B	1	-	-	2	-	-	-	-	-	1	1	-	1	-	1	1	1	2
18C	-	4	8	4	-	-	-	5	4	-	-	2	2	1	2	1	-	2
19A	4	1	18	9	1	2	4	6	-	-	-	-	1	2	3	1	1	8
19B	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
20A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
20B	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-
21A	1	-	-	4	1	-	-	-	-	-	1	-	-	-	1	2	-	-
22A	-	-	1	3	-	-	-	-	1	-	-	-	-	1	-	-	-	1
22B	-	-	-	1	-	1	1	-	-	1	-	-	-	-	-	-	-	-
23A	1	-	2	2	-	-	-	1	1	-	-	-	-	-	1	-	-	.
24A	-	-	4	1	-	-	-	-	-	-	-	-	-	-	1	-	-	-
24B	-	-	3	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-
25A	-	1	4	1	-	-	-	2	1	-	-	-	-	1	-	-	-	-
99.	1	1	13	3	-	2	1	2	-	-	2	1	9	1	2	1	1	5
0.0	1	-	19	1	1	2	1	6	-	-	-	-	10	1	1	-	-	5

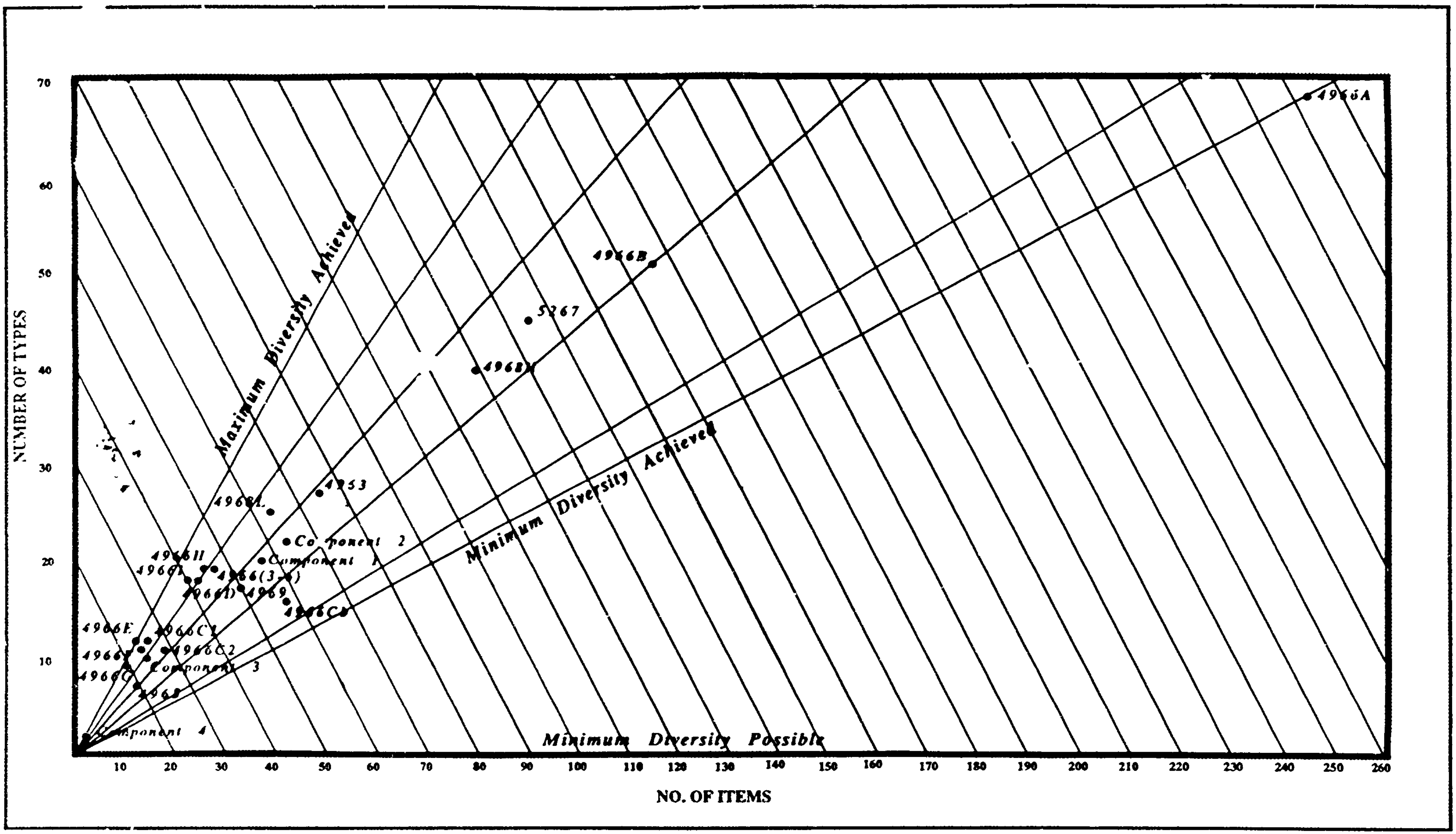

FIGURE 7.2. SCATTERGRAM SHOWING DIVERSITY OF ARTIFACT ASSEMBLAGES AMONG NELSON WASH SITES

and 89.5% small bifaces. These percentages suggest that the assemblages with less than 55% small bifaces include more items representing activities in which bifaces were used.

For an independent approach to the question of the role of lithic production in shaping the assemblage, flake-to-tool ratios for each assemblage were calculated for the material categories metavolcanic and chert/chalcedony (Table 7-5). These ratios can be seen to be highly variable, and it is reasonable to assume that a high flake-to-tool ratio for a particularmaterial means lithic production. Two general observations can be made regarding the distribution. First, assemblages with high ratios in metavolcanics also have high ratios in chert/chalcedony, suggesting that lithic manufacture in these two very different materials was generally associated. The second is that on the whole, flake to tool ratios are higher for metavolcanics than for chert/chalcedony. While this might reflect greater conservation of chert/chalcedony, it is more likely the results of the different response of these two materials to flaking, with the platy structure of the metabasalt resulting in much more shatter than the chert/chalcedony.

Table 7-4: Nelson Wash Surface Assemblages Ranked by Biface Size.

Assemblage	No. Small Bifaces / No. Typed Bifaces	% Small Biface
4SBr-4969	1/7	14.3
4SBr-4966F	1/6	16.7
4SBr-4968L	1/5	20.0
4SBr-4966D	3/13	23.1
4SBr-4966C1	3/9	33.3
4SBr-4966H	4/11	36.4
SBr-4966E	2/5	40.0
SBr-4965	4/9	44.4
SBr-4966G	2/4	50.0
SBr-4966B	36/67	53.7
SBr-4968H	13/21	61.9
SBr-4966Cb	26/40	65.0
SBr-5267	25/38	65.8
SBr-4966C2	10/15	66.7
SBr-4963	13/19	68.4
SBr-4966I	9/13	69.2
SBr-4966A	95/132	72.0
SBr-4966C3-6	17/19	89.5

Judging from flake-to-tool ratios, nine assemblages have substantial amounts of lithic production waste. Two of the small sites, 4-SBr-4963 and -4965, the workshop site 4-SBr-4969, and six loci at the Henwood site, (4-SB1-4966C1, D, E, F, G, H) all have more than 15 flakes per tool. The nine remaining assemblages (4-SBr-4966A, B, C2, C3-6, Cb, I, -4968H, -4968L, -5267) have flake-to-tool ratios of ≤7:1.

The assemblages are grouped into categories of high and low lithic production on the bases of flake:tool ratios (≥15=high; <15=low). Biface distribution is examined again and the classes regrouped as they would have been for 10 biface classes instead of 20-plus that are used in the

Table 7-5: Flake-Tool Ratios, Nelson Wash Surface Assemblages.

Assemblage	Meta-volcanic flk	Meta-volcanic tool	Chert-Chalcedony flk	Chert-Chalcedony tool	Jasper flk	Jasper tool	F/T	(T:F)[1]	B:F[2]	<55%> sm. bif.
4969	952	15	139	1	44	0	1135/16	(1:71)	1:162	<
4966E	408	7	123	4	19	0	*551/11	(1:50)	1:110	<
4965	561	22	24	1	1	0	*586/24	(1:24)	1:65	<
4966D	607	26	7	1	0	0	614/27	(1:23)	1:47	<
4966C1	265	12	8	3	0	0	273/15	(1:18)	1:30	<
4966G	233	12	10	1	0	1	*244/14	(1:17)	1:61	<
4966H	664	42	31	5	0	0	695/47	(1:15)	1:63	<
4966F	386	26	7	0	0	1	393/27	(1:15)	1:65	<
4963	975	60	29	11	2	0	*1015/71	(1:15)	1:53	>
4966B	1028	123	112	32	9	2	1149/157	(1:7)	1:17	<
4966I	181	28	16	6	0	0	197/34	(1:6)	1:15	>
4968H	411	45	91	11	0	5	*511/74	(1:7)	1:24	>
4966C2	179	34	5	0	0	0	184/34	(1:5)	1:12	>
4966A	1810	330	85	44	10	2	*1907/378	(1:5)	1:14	>
4966C3	168	41	4	2	0	0	172/43	(1:4)	1:10	>
4968L	113	28	29	11	3	3	145/42	(1:3)	1:29	<
5267	396	103	52	34	4	3	*454/142	(1:3)	1:3	>
4966Cb	177	56	0	4	0	0	177/72	(1:2)	1:3	>

*Count includes obsidian flakes and/or artifacts not shown in table.
[1]F/T (T:F) Flake/Tool number and Tool:Flake ratio.
[2]Blade:Flake ratio using typed blades only

morphological distribution. A class, 22-25, consisting of forms present only in the basal fragments was also formed. Groups 12-14 were omitted because they are so rare. This results in the biface groups of Table 7-6. In this table, the 18 assemblages that have four or more typed bifaces are grouped by high and low ratio of flakes to tools, and their biface composition compared. While the contrasts between the two summed distributions can be seen the grouped figures are also sufficient for Chi-square. The distribution of biface groups appear significantly different for the low and high flake:tool ratios, with a probability of less than .003. The grouped classes of bifaces were also used to compare the distribution of low and high lithic production loci with the low and high occurrence of small bifaces (Table 7-6a). The two clusters recognized in the relative frequency of small bifaces provided figures sufficient for another Chi-square (Table 7-6a). Again the two distributions are significantly different, with a probability of less than .001. The correlation of high frequencies of small bifaces with low flake:tool ratios and of low frequencies of small bifaces (or high frequencies of large bifaces) with high flake:tool ratios suggests that a distinction can be made between sites of intense biface reduction and sites where biface reduction was not a major activity. Only a small group of three loci, comprised of 4-SBr-4963, a small residential base or campsite; 4-SBr-4966B, a larger residential base or campsite with a relatively small number of bifaces; and -4968L, a locus of an occupation site, do not reflect this relationship between percent of bifaces and flake:tool ratios.

Most of the differences between the two groups of sites can be identified as originating from the insufficient numbers of small bifacers from the lithic production sites, and the excessive frequency of items in classes 17-18 and 20-21 on the same sites suggests that those items are byproducts of biface production.

Table 7-6: Grouped Typed Biface Distribution in Assemblages with High and Low Flake:Typed Biface Ratios.

Sites and Loci with ≥15:1 Ratio of Flakes to Typed Bifaces

Grouped Classes	4969	4966 F	4966 E	4966 G	4966 H	4966 D	4965	4963	TOTAL
1-5	0	1	1	1	1	3	2	5	14
6-11	0	0	1	1	2	0	1	3	8
15-16	2	1	0	0	2	0	0	0	5
17-18	1	2	2	2	5	6	4	4	26
19	1	0	0	0	1	0	1	4	7
20-21	3	1	0	0	0	0	0	1	5
22-25	0	1	1	0	0	4	1	1	8
Total	7	6	5	4	11	13	9	18	73

Sites and Loci with ≤15:1 Ratio of Flakes to Typed Bifaces

Grouped Classes	4969 H	4966 I	4966 A	4966 C1	4966 C2	4966 C3-6	4966 Cb	4966 B	4965 L	5267	TOTAL
1-5	6	3	45	1	7	6	13	23	0	5	109
6-11	4	4	26	1	2	5	6	4	0	11	63
15-16	1	1	4	2	2	0	1	3	0	4	18
17-18	4	1	19	3	1	1	10	16	2	8	65
19	3	2	21	1	2	4	6	9	1	9	58
20-21	1	0	0	1	0	0	0	4	1	0	7
22-25	2	2	14	0	1	1	3	8	0	1	32
Total	21	13	129	9	15	17	39	67	4	38	352

Table 7-6: Continued.

Grouped Classes	< 15 flakes per biface	≥ 15 flakes per biface	
1-5	109	14	
6-11	63	8	
15-16	18	5	$X^2=20.45$
17-18	65	26	df=6
19	58	7	$P<0.003$
20-21	7	5	
22-25	32	8	

The unifaces are very thinly distributed among the morphological classes (Table 7-7) making them unsuitable for statistical analysis. One significant observation, however, is that the number of unifaces per assemblage varies considerably but does not covary with the size of the sample. In an attempt to distinguish some meaningful categories the unifaces were combined into three groups: (A) unifaces made by shaping the outline by major unifacial flaking (types 1-4, 5-9, 10, 15, 20); (B) unifaces made by retouching flake edges with minimum of modification to outline (types 11, 12-14, 19); and (C) sharp pointed engraving tools (type 16). Uniface types 17-18, 21-23 are omitted because they are too fragmentary to classify (17-18) or too few in number (21-23).

The grouping of unifaces, shown in Table 7-8, reveals that Group A comprises up to 100% of the uniface assemblages, and when samples containing less than 5 unifaces are omitted from consideration that range narrows to 0 to 50. However, no correlations can be identified between different categories of unifaces, or between uniface categories and flaking material, or uniface categories and biface categories. Apparently too many of the assemblages have such small numbers of artifacts (Table 7-9); no clear pattern emerges, and Group 1 unifaces still comprise between 1 and 100% of the uniface assemblage, and between 1 and 22.4% of the artifact assemblage (Table 7-10).

Table 7-6a: Grouped Biface Distribution in Assemblages with High and Low Occurrence of Small Bifaces

Biface Assemblages with ≤ 55% Small Bifaces

Grouped Classes	4969	4966F	4966E	4966G	4966H	4966C1	4966D	4966B	4965	4968L	TOTAL
1-5	-	1	1	1	1	1	3	23	2	-	33
6-11	-	-	1	1	2	1	-	4	1	-	10
15-16	2	1	-	-	2	2	-	3	-	-	10
17-18	1	2	2	2	5	3	6	16	4	2	43
19	1	-	-	-	1	1	-	9	1	1	14
20-21	3	1	-	-	-	1	-	4	-	1	10
22-25	-	1	1	-	-	-	4	8	1	-	15
Total	7	6	5	4	11	9	13	67	9	4	135

Biface Assemblages with > 55% Small Bifaces

Grouped Classes	4963	4968H	4966I	4966A	4966C2	5267	4966C3-6	4966Cb	TOTAL
1-5	5	6	3	45	7	5	6	13	90
6-11	3	4	4	26	2	11	5	6	61
15-16	-	1	1	4	2	4	1	1	13
17-18	4	4	1	19	1	8	1	10	48
19	4	3	2	21	2	9	4	6	51
20-21	1	11	-	-	-	-	-	-	2
22-25	1	2	2	14	1	1	1	3	25
Total	18	21	13	129	15	38	17	39	290

Table 7-6a: Continued:

Grouped Classes	<55%	>55%	
1-5	33	90	
6-11	10	61	
15-16	10	13	$X^2=42.019$
17-18	43	48	df=6
19	14	51	$P<0.001$
20-21	10	2	
22-25	15	25	

Table 7-7: Uniface Distribution in Nelson Wash Sites.

Sites and Loci

Class	4963	4965	4966 A	4966 B	4966 C1	4966 C2	4966 C3-6	4966 Cb	4966 D	4966 E	4966 F	4966 G	4966 H	4966 I	4968 H	4968 L	4969	5267
1.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	3	-	-
2.1	-	-	-	5	-	-	-	-	-	-	-	1	-	-	-	1	-	-
2.2	1	-	4	3	-	-	-	-	1	-	-	-	-	-	2	1	-	4
3.1	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	1	-	1

Class	4963	4965	4966 A	4966 B	4966 C1	4966 C2	4966 C3-6	4966 Cb	4966 D	4966 F	4966 F	4966 G	4966 H	4966 I	4968 H	4968 L	4969	5267
3.2	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	2
4.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	1
5.2	-	-	-	-	1	-	-	-	-	-	-	-	-	-	2	2	-	-
5.3	-	-	1	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-
5.4	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-
5.6	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Table 7-7: Continued.

Class	Sites and Loci																	
	4963	4965	4966 A	4966 B	4966 C1	4966 C2	4966 C3-6	4966 Cb	4966 D	4966 E	4966 F	4966 G	4966 H	4966 I	4968 H	4968 L	4969	5267
6.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-
7.1	-	-	-	1	-	-	-	1	-	-	-	-	-	-	2	-	1	2
7.2	-	-	1	1	-	-	-	-	-	-	-	-	1	-	1	-	-	2
7.3	-	-	4	-	-	-	-	-	1	-	-	-	1	-	-	-	-	1
8.1	-	-	1	1	-	-	-	-	1	-	-	-	-	-	1	1	-	3
9.0	-	-	2	1	-	-	-	-	-	-	-	-	-	-	-	1	-	-
10.2	1	-	2	-	-	-	-	-	-	-	-	-	-	-	1	-	-	2
11.0	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	1	-	1
12.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-
12.2	1	-	1	1	-	-	-	-	1	-	-	-	-	-	1	1	-	1
13.1	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-
13.2	-	-	2	1	-	-	-	-	-	-	-	-	-	-	-	1	-	1
13.3	1	-	2	1	-	-	-	-	-	-	-	-	-	1	-	-	-	-
13.4	3	-	7	1	-	-	-	-	-	-	1	1	2	-	2	2	1	1
13.5	-	-	-	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-
13.6	-	-	5	-	-	-	-	-	-	1	-	-	-	-	4	1	1	2
14.1	-	-	8	3	1	-	1	-	1	1	2	-	-	-	1	-	1	1
14.2	6	2	22	1	-	1	2	-	1	-	2	-	2	2	6	2	1	9
14.3	4	-	8	5	-	-	1	-	-	-	1	1	1	-	-	4	-	4
15.2	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
15.3	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
16.1	1	-	1	1	-	-	-		-	-	1	-	1	1	2	-	-	1
16.2	-	-	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2
16.3	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2
17.0	-	-	6	2	-	-	-	-	-	-	2	-	-	1	-	-	-	3
18.0	1	1	5	3	-	-	2	-	1	1	1	-	3	-	-	-	-	2
19.0	-	-	-	-	1	1	-	-	-	-	-	-	-	-	2	-	-	-
20.0	-	-	2	1	-	-	-	-	-	-	-	-	-	-	1	-	-	-
21.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
22.0	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
24.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-
0.0	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-
Total	20	3	93	39	3	2	6	1	7	3	10	4	12	6	32	24	5	49

The projectile points from the controlled surface sample are also so thinly distributed among the morphological types that they are difficult to deal with statistically (Table 7-2, above). It appears that the relative frequencies of projectile points (as expressed by percentage of assemblage) does not covary with the size of the sample. However, the assemblages with the largest and the smallest percentage of projectile points tend to be those with the smallest number of artifacts suggesting that there is probably less range in variability than indicated by these small samples. If we limit our comparison to only those assemblages within 40 or more artifacts, the range narrows to 0.0 to 7.5 percent. There are clearly some assemblages that have no projectile points and others that have certainly as many as 7.5 percent. We may also speculate that some small sites, like 4-SBr-4963, may be more oriented toward hunting and therefore contain a higher percentage of projectile points, whereas at other sites activities were oriented toward lithic reduction (e.g. -4969) or biface reduction (-4966Cb) and therefore contained few or no projectile points.

Table 7-8: Distribution of Combined Uniface Types in Nelson Wash Assemblages (ranked by Group B%).

Assemblages	Group A N/%	Group B N/%	Group C N/%	Total
SBr-4965	0/0	2/100	0/0	2
SBr-4966E	0/0	2/100	0/0	2
SBr-4966C2	0/0	2/100	0/0	2
SBr-4966C3-6	0/0	4/100	0/0	4
SBr-4966I	0/0	4/80	1/20	5
SBr-4969	1/20	4/80	0/0	5
SBr-4963	2/10.5	15/79	2/10.5	19
SBr-4966A	22/26.8	55/67	5/6.1	82
SBr-4966C1	1/33.3	2/66.6	0/0	3
SBr-4966H	2/25	5/63	1/12	8
SBr-4966B	14/42.4	18/54.5	1/3	33
SBr-4968H	13/40.6	17/53.1	2/6.3	32
SBr-4968L	11/47.8	12/52.2	0/0	23
SBr-4966D	3/50	3/50	0/0	6
SBr-[illegible]6G	2/50	2/50	0/0	4
SBr-5267	18/4[illegible]	19/44.2	5/11.6	43
SBr-4966Cb	1/100	0/0	0/0	1

Table 7-9: Uniface Assemblages Ranked by Percent of Assemblages Comprising Unifaces.

Assemblages	No. of Artifacts	No. of Unifaces	% comprised by unifaces
4966Cb	70	1	1.4
4966C2	34	2	5.9
4965	24	3	12.5
4966C3-6	45	6	13.3
4969	36	5	13.9
4966I	34	6	17.6
4966C1	16	3	18.8
4966D	31	7	22.6
4966B	170	39	22.9
4966H	52	12	23.1
4966A	397	94	23.7
4966E	12	3	25.0
4963	76	20	26.3
4966G	15	4	26.7
5267	148	49	33.1
4966F	27	10	37.0
4968H	88	33	37.5
4968L	50	26	52.0

Table 7-10: Uniface Distribution in Assemblages with >40 Artifacts (ranked by % of Assemblages Comprised by Group A Unifaces).

Assemblage	No. of Artifacts	No. of Unifaces	Groups (N/%) A	B	C	% Comprised by Group A
4966C3-6	45	6	0/0	4/67	0/0	0.0
4966Cb	73	1	1/00	0/0	0/0	1.4
4963	80	20	2/10	15/80	2/10	2.5
4966H	52	12	2/17	5/42	1/8	3.8
4966A	399	94	22/24	55/59	5/5	5.6
4966B	174	39	14/36	18/46	1/3	8.0
5267	147	48	18/38	19/40	5/10	12.2
4968H	87	34	13/38	17/50	2/6	14.9
4968L	49	24	11/46	12/50	0/0	22.4

In an attempt to identify variability in the distribution of projectile point types, the more refined types were regrouped into more inclusive categories. These are Group 1: Lake Mojave-Silver Lake Series (types 1a, 1b, 1c, 2, 16); Group 2: Pinto Series (types 3a-3e); Group 3: large stemmed and notched points (types 6-9); Group 4: non-stemmed points (types 13-15; Group 5: parallel edged basal fragments (type 17); and Group 6: other fragments (types 18-19). All that can be said about the distribution of these groups is that assemblages 4-SBr-4963, -4966A, -4966B -4966I, -4968H and -5267 have one or more points of the Lake Mojave-Silver Lake Series which suggests occupation of considerable antiquity. Assemblages 4-SBr-4966A, -4966F and -4966G contain one or more Pinto points, suggesting somewhat later occupation accounts for at least some portion of these assemblages. The remaining points are either not time sensitive or date from a still later period. Assemblages 4-SBr-4966H, -4966C1 and -4966C3-6 contain only these later points, but in such smaller number as to be of no use in dating the occupations represented.

Lithic Materials

It was apparent during fieldwork that some sites, loci, and concentrations had relatively larger amounts of chert, chalcedony, and jasper than others. In the course of analysis chert and chalcedony are not separated, for they grade into one another and are generally present at the same sources. While jasper is separated, it is found in such small quantities that it cannot be seen to vary significantly from one assemblage to another. The variation in lithic materials among the surface assemblages can be seen in Table 7-11. Chert, chalcedony and jasper have been combined to show the percentages of cryptocrystalline silicates. They can be seen to vary from less than 1% to more than 20%.

Surface assemblages exhibit a cluster with less than 6% chert, chalcedony and jasper. The rest of the assemblages are very widely distributed along the axis. The relation of this variation to tool frequencies was next examined. Unifaces and cores are the two tool categories in which chert and chalcedony are frequently used. These two categories should play very different roles, however, for unifaces are truly tools, scrapers and gravers, for instance, and cores are evidence of flake production, a manufacturing activity. The two classes might have very different distribution in comparison to flakes, unless production and use of unifaces took place on the same sites.

To examine the relationship between the distributions of cryptocrystalline flakes and tools, the surface assemblages were divided into the four major tools classes: bifaces, projectile points, unifaces and cores. Broken out by material on Table 7-12 the surface assemblages are ranked in order by increasing percent of their flakes that are chert, chalcedony, and jasper. It can be seen that neither the percentages of unifaces or of cores of these materials is strongly correlated with the flake percentages. What does correlate well with flake percentages greater than 5% are the percentages of total tools, including cores, of these materials. In general, it appears that flaking of and flake production with cryptocrystalline silicates took place in the locations where unifaces were used. Some additional observations are in order. At 4-SBr-4969, which falls right on the line of association, the cryptocrystalline silicate assemblage is dominated by cores, not

Table 7-11: Variation in Flake Material, Nelson Wash Surface Advantages.

Assemblage	Meta-Volcanic	Chert Chalced	Jasper	Obsidian	Total	% ch/ch/ja
SBr-4963	975	29	2	9	1015	3.1
SBr-4965	561	24	1	0	586	4.3
SBr-44966A	1810	85	10	2	1907	5.1
SBr-4966B	1048	112	9	0	1149	10.5
SBr-4966C1	265	8	0	0	273	2.9
SBr-4966CL	77	2	1	0	80	3.8
SBr-4966C2	179	5	0	0	284	1.8
SBr-4966C3-6	169	4	0	0	173	2.3
SBr-4966Cf	286	1	0	0	287	0.3
SBr-4966Cb	177	0	2	0	179	1.1
SBr-4966D	607	7	0	0	614	1.1
SBr-4966E	408	123	19	1	551	25.7

Table 7-11: Continued.

Assemblage	Meta-Volcanic	Chert Chalced	Jasper	Obsidian	Total	% ch/ch/ja
SBr-4966F	386	7	0	0	393	1.8
SBr-4966Gh	161	3	0	1	165	1.8
SBr-4966Gm	72	7	0	0	79	8.9
SBr-4966H	664	31	0	0	695	4.5
SBr-4988H1s	50	10	0	1	61	16.4
SBr-4966I	181	16	0	0	197	8.1
SBr-4967	37	1	0	0	38	2.6
SBr-4968H	411	91	0	9	511	17.8
SBr-4968L	109	29	3	0	141	22.7
SBr-4969	952	139	0	44	1153	12.2
SBr-5267	396	52	4	2	454	12.3

unifaces, so the interpretation of this site as primarily a workshop is not undermined by its apparent similarity to other sites. Site 4-SBr-4968H also falls right on the line, and here the large number of chert, chalcedony, or jasper tools is contributed by bifaces as well unifaces, a situation found elsewhere only in Component 2, the subsurface material from Locus E in the Henwood site, discussed below. At 4-SBr-4968H, 42% of the tools are bifaces, and of those, 27% are chert, chalcedony, or jasper. Outliers from this line are locations in which either flake production or tool use do not appear to be associated. Site 4-SBr-4963 Locus G High Density and Locus H at the Henwood

site have more tools of cryptocrystalline silicates than their flake percentages would predict, and Locus E at the Henwood site and possibly -4968L are deficient in tools of cryptocrystalline silicates relative to the quantity of flakes recovered.

Table 7-12: **Correlation of Percent of Flakes and Tools of Chert, Chalcedony and Jasper**

Assemblages ranked by % of ch/ch/ja flakes	% of tools that are ch/ch/ja cores	% of tools that are ch/ch/ja unifaces	% of all tools are ch/ch/ja	No. of Artifacts
4966Cf	0	0	0	8
4966Cb	0	0	6.8	73
4966D	3.0	0	3.0	33
4966C2	0	0	0	32
4966C3-6	2.2	2.2	4.3	46
4966F	0	3.6	3.6	28
4966Gh	7.7	15.4	23.1	13
4966C1	6.3	6.3	25.0	16
4963	3.8	7.5	16.3	80
4965	0	0	4.0	25
4966A	2.5	7.2	11.0	399
4966H	5.8	3.8	21.2	52
4966I	0	5.7	17.1	35
4966B	4.0	11.5	17.6	174
5267	2.0	15.0	22.9	147
4969	27.8	3.5	30.5	36
4968H	12.6	20.2	43.8	89
4968L	14.3	24.5	36.7	49
4966E	12.5	12.5	25.0	12

Summary of the Analysis of Composition of Surface Assemblages

The summary presented here is based on the analysis of the systematic surface collection from 5x5 m units. The large surface collection made from other portions of the sites with horizontal control maintained by transit mapping of the location of each artifact is analyzed below.

Nothing that has emerged in the course of this analysis would support the contention that the use made of the Henwood site was different in kind from the use of the small sites along Nelson Wash. No dichotomy such as residential base in contrast to field camp, or field camp in contrast to specialized sites would be appropriate to differentiate them. Instead, it would appear that the

Henwood site was used more times (more often and/or over a longer span of time) than the small sites. The assemblages from the various loci and concentrations at the Henwood sites are surprisingly variable, suggesting that the site served different purposes during different visits to it, and that some activities were spatially segregated. Biface production appears to have been concentrated along the wash, particularly in the northern part of the site, although it was by no means restricted to that part of the site. The south stretch of the bank was most heavily used, and was the scene of whatever uses the bifaces served as tools, in an occupation context. Loci away from the wash's banks are generally deficient in bifaces.

Of the small sites to the north, 4-SBr-4963, -4965 and -5267 yielded enough materials for comparison. For their sample size, these sites show as much diversity in their assemblages as do those at the Henwood site. They appear to be other field camps, less frequently used, and include considerable evidence of biface reduction of their assemblages.

Site 4-SBr-4969 shows characteristics consistent with the prediction that it is primarily a lithic workshop, for cores form more than 50% of it assemblage. Bifaces and fragments are not common, although metavolcanic flakes are numerous, leading to the suggestion that only primary biface production, with few accidents and wholesale removal of the products to other sites, was undertaken in the quarry/workshop area.

Site 4-SBr-4968, in contrast, show little evidence of being a workshop, despite its setting, which led to the prediction that it would exhibit a mixture of occupation and primary reduction residues.

Some clues as to the course of biface production from metavolacanics have emerged. Primary reduction may have gone on in workshops at the source, but it appears that early stage forms were removed to field camps where they were further reduced and used (eg. SBr-4966 Loci C1, Cb, B, A of the Henwood Site). Based on the association of particular biface classes with quantities of metavolcanic flakes, it can be ventured that biface classes 15, 16, 17, 18, 20, and

21 may contain many of the stage preforms, and that classes 1 and 11 may be predominantly finished tools.

With respect to lithic production based on cherts, chalcedonies, and jasper, there is a tendency for percentage of flakes and tools of these materials to be correlated, suggesting that shaping of them generally took place on the sites where they were used, even though flake production from cores seems to have been particularly done at the workshop site, 4-SBr-4969.

SUBSURFACE DATA RECOVERY AT 4-SBr-4966 by Margaret Lyneis

Hand excavation, generally in 1X2 m units, was used to test for subsurface deposits as well as to investigate areas that proved to have buried cultural materials. During the exploratory phase of data recovery, at least one 1X2 was placed in each surface locus. As it became evident that surface artifact distribution was not a good indicator of subsurface cultural material, some 1X2 m units were placed between loci in portions of the site with Holocene alluvium. As backhoe trenches began to cut across the site, the berms of backdirt were systematically examined and any artifacts or cultural materials were pinflagged. Exploratory 1X2 m units were then placed adjacent to portions of the trenches that seemed to have some concentration of flakes. These trenches also intersected several gray stains that were treated as features and excavated. In the final phase of heavy equipment use, scrapes with the box blade encountered several concentrations of rock. These were treated as features, exposed, and the deposits in their vicinity excavated.

In most cases, exploratory excavation revealed only limited and diminishing quantities of flakes as the unit deepened. Excavations were not pursued in such areas. While the materials recovered from these isolated units are part of the site's assemblage, their relationship to other materials in the site cannot be ascertained, and they are not considered in the quantitative analysis below.

In four locations, quantities of flakes increased as initial excavation units moved down through 10 cm levels. In these locations excavation was expanded laterally until flake quantities per level diminished. Each of these four locations is considered a subsurface component. They all occurred in the gravelly, unconsolidated deposits (Unit B) of the Holocene fan. Each of these components proved to be limited in extent, the largest one enclosed in an area of about 11 m north to south by 8 m east to west. In each of them, the elevated flake counts per level seemed to characterize all levels to the base of the unconsolidated deposits. Depth ranged from 50 to 80 cm below the surface, and usually the final excavated level showed a great reduction in flake counts as excavation cut into the underlying sterile Wisconsin-age sediment (Unit C), or stopped at the contact in mid-level.

The cultural concentrations are manifested only by their counts of flakes and bone. The gravelly granitic soils do not result in the preservation of organic staining that ordinarily accompanies occupation, so there was no way that components could be excavated following cultural depositional stratification. Within the Holocene alluvial soils, deposition was the accumulation of myriad small cuts and fills as the fan surface built, and natural strata could no more be followed than the invisible cultural strata.

Within individual components, non-existent may be a better term than invisible for cultural strata. It is evident that the occupation occurred on the surface of the fan when it was actively building, in the sense of net deposition exceeding net removal, in the locations where cultural material is buried. The surface was unconsolidated, and cultural materials would be stirred into the upper few centimeters by human traffic. At least localized redistribution of smaller pieces of debitage must have happened when the downpours of heavy rain that characterized desert storms struck. In addition, the soils have been much affected by rodent burrows. The deposits are old enough that only the recent rodent burrows are visible within the soils. As has been pointed out above (Chapter 2) that at the contact of the Holocene alluvial soils with the mid-Wisconsin soils, the surface of the more consolidated underlying deposits are much sculptured by rodent burrowing, indicating much more mixing of the Holocene deposits than is evident in the soil profiles. The fact that the distinctive material composition of the flakes from the subsurface deposits of Locus E are reflected in the surface collection from that locality indicate the extent of mixing of the Holocene deposits.

Considering the natural processes that have affected the artifact-bearing processes and the distribution of cultural materials, we are left with little choice but to treat each of the concentrations of buried material as a discrete unit essentially lacking internal structure, either horizontally or vertically. When flake densities for each component are plotted in plan, they approximate a diminishing concentric distribution, each with a central high, and lower frequencies toward the margin. When the flake counts for the units within each component are examined vertically, they exhibit a unimodal distribution, generally approximating a normal distribution, skewed slightly toward the upper levels but peaking at 30 to 40cm below the surface. That the components were spatially limited seems clear. That they are vertically mixed seems evident. We are left with three possibilities for understanding the nature of each of the subsurface components.

1. Each component represents a single visit to the site, the residues of which were subsequently locally redistributed, first by human traffic and erosional/depositional processes, and subsequently, after burial, by rodent burrowing.

2. Each component represents several sequential visits to the same, very restricted portion of 4-SBr-4966, but mixing of the deposits, in combination with the imposition of arbitrary excavation levels, combined them so that the remains of the individual visits cannot be distinguished.

3. The general nature of the individual occupations of the Henwood site may have been brief visits by small groups who, when they camped on the upslope portions of the site where their residues might be buried, chose their campsites in a rather unpatterned way, resulting in the wide distribution of flakes in low densities on the surface and in test units within and between loci and components. The subsurface concentrations that we discovered and excavated as components would be the random coincidence of several visits rather than the patterned reoccupation of chosen locations within the site. If this is the case, the residues of the sequential visits have been irretrievably mixed, just as in the case of alternative 2.

Each of these interpretations of the deposition of the cultural materials now buried has difficulties that impede its acceptance. The volume of materials seems excessive for a single, short visit by a small group. Admittedly these materials consist primarily of flakes, and debitage would accumulate quickly if lithic production was the primary activity of the occupants. Congruent superposition of sequential visits seems unlikely, for the upslope portions of 4-SBr-4966 seem almost a featureless plain, and there is no apparent reason to occupy one area of it over another. It must be admitted, however, that we do not understand the pattern of occupation of the site, for there is no apparent reason that the upslope portions of the site, away from the margins of Nelson Wash, were chosen as campsites or places for lithic production at all. There are no concentrations of cooking rocks that could be reused, nor are there remains of pits or depressions that might ease the preparation of ground for renewed erection of temporary structures. People did camp well away from the margins of Nelson Wash, however. Locus E and Locus G are each more than 200 m from the edge of the wash. Perhaps these interior portions of the site were occupied to avoid mosquitoes bred in the ponds on the floor of the wash in early to mid-Holocene times. We cannot rule out the possibility that occupation was patterned by factors that we do not understand, and that the superposition of small occupations was not accidental.

Even if each component is the mixture of several occupations, as seems likely, we cannot factor them out, and each component is treated as a single, indivisible entity. This somewhat arbitrary treatment may be rendered more acceptable if one keeps in mind that to some extent, reoccupation of the same locality may well involve some of the same reasons, and activities engaged in on subsequent visits should be somewhat similar. In addition, the materials incorporated into the deposits in each component seem to be the products of a limited time span, in that three components are dominated, top to bottom and edge to edge, by debitage of metabasalt, the use of which dominates the Lake Mojave and Pinto periods. The fourth component, the one in Locus E, is richer in flakes of cherts and chalcedonies than the other components.

Component 1 (Locus G)

The spoil pile of Trench 1 showed a concentration of flakes along part of its length, and an initial excavation unit (S1686 E2085) showed quantities of metabasalt flakes extending to more than 110cm. Other 1X2 units were placed in the vicinity and the limits of the concentration were defined. In the course of the work 31 contiguous units were excavated, bounded by grid lines S1676, S1687, E2083 and E2091. The contents of these units below 10 cm depth are considered as comprising Component 1. Materials from nearby units are perhaps also related to Component 1, but the deposits are shallower and material frequencies lower. Since the nature of their relationship is uncertain they are excluded. The surface of the area that includes Component 1 came to be defined as Locus G in the recovery of surface materials.

The distribution of materials in Component 1 has all the characteristics of a single deposition. Highest flake frequencies are found in its central part, and they drop away in all directions. High flake counts generally coincide with the distribution of a scatter of fragments of granitic rocks at about 30-40 cm in the central part of the component.

When flake distributions from the units are inspected for vertical distribution, they show a unimodal curve, usually peaking at about 40 cm and diminishing above and below.

Component 1 also included Feature 15, a circular gray-stained area, which was centrally located in the component in the area of high flake counts at a depth of 28 to 58 cm. The congruent distributions of granitic rocks and high flake counts with which Feature 15 coincides is taken to indicate that this association is an original, cultural one, even though the materials have been locally redistributed. The matrix of Component 1 is the gravelly soil of the AS-2 unit, and the walls of Trench 1 adjacent to the component show that here as elsewhere, the soil unit's deposition was the combined result of many small cuts and fills.

Component 2 (Locus E)

The presence of numbers of subsurface materials in Locus E was indicated by discovery of features and groundstone in Trench 4. A block excavation comprised of 14 excavation units was undertaken in this area, and the contents of these units below the depth of 10cm is considered Component 2. They are bounded by grid lines S1455, S1462, E2009, E2017.

Component 2 is a complex area. It included six features: four (Features 10, 14, 21, and 22) were localized concentrations of gray soil; Feature 16 was a cache of metabasalt and chalcedony flakes; and Feature 12 was a hearth associated with a gray stain. Ferraro (personal communication, 1986) suggests that the features occurred in two levels, judging from profiles. In four non-adjacent excavation units, S1455E2011, S1455E2015, S147E2015 and S1459E2011, vertical flake distributions exhibit two highs per unit, one at -10 or -20 cm, and the second at -40 cm.

Soil stratification or, more accurately, the lack of it, prevented excavation by depositional units within Component 2. The matrix of Component 2 is gravelly, sandy alluvial sediments of Unit B. In the quantitative analysis the internal distributions of materials in the component will be examined before deciding whether it should be divided into two analytic units. The soils that include Component 2 are considered to be slightly younger than those in which Component 1 was encountered.

Component 3 (Non-locus)

Fourteen contiguous units were excavated in the course of exploring the matrix of Feature 17, first encountered in Scrape B. The feature proved to be a scatter of large granitic rocks about 40 cm below the surface. The units are bounded by grid lines S1567, S1675, E2111 and E2119. Flake counts from these units show diminishing quantities as one moves from the center of the excavation to its periphery. No gray-stained areas were encountered in Component 3, but here, as in Component 1, we have apparently congruent distributions of large angular fragments of granitic rocks and flakes. Excavation units penetrated to depths of 60 to 70 cm, and flakes show unimodal vertical distributions with the highest counts at 40-60cm. Cultural materials from below 30 cm in these units are considered to form Component 3. No concentration of surficial materials was discerned in the vicinity, and Component 3 falls in a non-locus portion of the Henwood site. Sedimentin this area of the site is gravelly Holocene alluvium of Unit B. In the quantitative analysis below, materials from Component 3 are considered a single analytical unit.

Component 4 (Non-locus)

Cultural materials from below 30 cm in six contiguous units bounded by grid lines S1628, S1636, E2099 and 2101 are included as Component 4. Flake densities in Component 4 are less than in other components. They peaked at depths of 50 to 60 cm, and units generally penetrated to 70 or 80cm below the surface. The matrix of Component 4 is the gravelly Holocene alluvium, Unit B. Cultural materials from the excavation units in Component 4 are considered as a single unit in the quantitative analysis. No concentration of surface materials was found in the vicinity of Component 4, and it falls in a non-locus portion of 4 SBr-4966.

ASSEMBLAGE COMPOSITION ANALYSIS OF SUBSURFACE COMPONENTS

Four subsurface components were excavated at the Henwood site (4-SBr-4966). Component 1 is located in the area of Locus G, and Component 2 is in Locus E. The two smaller ones, Components 3 and 4, are northeast of Locus G in a nonlocus area of the site. Of the four subsurface components, three yielded 20 or more tools and their assemblages can be compared, both to one another and to the surface assemblages. Component 4 produced only four tools, so that while they will appear on tables, little can be said about this component. It will be seen in the course of this analysis that the subsurface components differ greatly from the surface components in the ratios of flakes to tools. This must be attributed to differences in recovery, for the subsurface materials were screened through one-eighth inch mesh, accounting for much greater flake recovery than from grid-controlled surface collections. On the other hand, the tools from the two very different samples are judged to be recovered in a comparable manner, and the subsurface and surface materials should be directly comparable with respect to relative frequencies of tool types. In some situations this would be an unwarrented assumption. In the case of the Nelson Wash sites, however, none of the classes of tools are made on small flakes or are very subtle, so it is reasonable to assume that tools are not missed in controlled surface collections, even though smaller flakes and flakes of chert and chalcedony probably are.

Diversity

Among the four components, diversity as measured by the number of classes present shows the same relationship to number of tools as it did in the surface assemblages. Not only is there a close correlation, but the relationship is the same as in the surface assemblages, and Components 1, 2 and 3 fall right in the scatter of the surface assemblages (Figure 7.2, above).

Assemblage Composition

Like the surface assemblages there are some significant differences between the subsurface components, even if the total number of tool classes present is largely a function of the number of tools recovered. The components differ in the relative frequencies of major tool classes. Table 7-13 compares the distribution of the categories cores, unifaces, bifaces and projectile points. The totals for Components 1 and 2 are sufficient to meet the continuity requirements of Chi-square, and it can be seen that the assemblages of these two components are significantly different. The contrast of Component 3 with these two can only be judged by inspection, but Component 3 looks very different from Components 1 and 2.

Table 7-13 Distribution of Major Tool Categories and Number of Classes, Henwood Site Components. Component 1

	COMPONENT 1				COMPONENT 2			
	No. of Classes	Tools Typed	No. of Tools	% of Tools	No. of Classes	Tools Typed	No. of Tools	% of Tools
Cores	1	1	1	1.6	3	10	11	13.9
Unifaces	10	18	19*	30.2	7	11	13	16.5
Proj. Pts.	0	4	10	15.9	0	0	0	0.0
Bifaces	10	14	33	52.4	14	20	55	69.6
Total	21	37	63		24	41	79	

	COMPONENT 3				COMPONENT 4			
	No. of Classes	Tools Typed	No. of Tools	% of Tools	No. of Classes	Tools Typed	No. of Tools	% of Tools
Cores	2	3	3	15.0	1	1	1	25.0
Unifaces	3	7	8	40.0	2	1	2	50.0
Proj. Pts.	1	0	3	15.0	0	0	0	0.0
Bifaces	4	4	6	30.0	0	0	1	25.0
Total	10	20	14		3	2	4	

*No. of Tools includes the untyped fragments which are not counted as a type.

Table 7-13 Continued.

	Components 1	2	
Bifaces	33	55	
Unifaces	19	13	$X^2 = 23.453$
Cores	1	11	df = 3
Proj. pts.	10	0	$P < .001$
	63	79	

Lithic Material

Each of the components has a distinctive distribution of lithic materials as reflected in flakes recovered. Table 7-14 summarizes flake counts by material and shows flake-to-tool ratios by material for each of the components. The amount of chert, chalcedony and jasper varies from about 7% to 40% among the components. Components 1 and 4 have about the same amount of metavolcanic debitage, but differ greatly in the amount of obsidian. In fact, the 49 obsidian flakes from Component 4, consituting 7.6% of the flake assemblage, is higher than any of the surface assemblages, as well as being the greatest among the subsurface components.

Table 7-14: Flake Counts and Flake-to-Tool Ratios, Henwood Site Components.

	Meta-Volcanic	Chert and Chalcedony	Jasper	Obsidian	Quartz	Other	Total
Component 1							
Flakes	9616	765	22	88	1	1	10492
Tools	39	22	2	0	0	0	63
Flakes:Tool	247:1	35:1	11:1	-	-	-	167:1

Table 7-14: Continued.

	Meta-Volcanic	Chert and Chalcedony	Jasper	Obsidian	Quartz	Other	Total
Component 2							
Flakes	9490	6388	76	3	3	0	15955
Tools	34	44	1	0	0	0	79
Flakes:Tool	279:1	145:1	76:1	-	-	-	202:1
Component 3							
Flakes	2792	708	2	19	2	0	3532
Tools	7	13	0	0	0	0	20
Flakes:Tool	399/1	54:1	-	-	-	-	176:1
Component 4							
Flakes	536	59	2	49	0	0	646
Tools	2	2	0	0	0	0	4
Flakes:Tool	268:1	30:1	-	-	-	-	162:1

Table 7-15 summarizes the relative amounts of cryptocrystalline silicates among flakes and tools in the subsurface components. It appears that there is some association between relative number of tools and of flakes of chert, chalcedony and jasper among components 1, 2 and 4. Component 4 has only 4 tools, however. Component 2 is very high in flakes relative to tools on this plot, as well as having by far the greatest frequency of chert, chalcedony and jasper flakes of any of the components.

In order to understand some of the differences between the components, we need to look once again at the tool assemblages. The numbers of bifaces is small enough so that little or nothing can be seen when they are spread among the morphological biface classes. Table 7-16 shows the distribution of the classes grouped as they were for the surface asemblages. The figures are not sufficient for testing by Chi-square, but inspection does not suggest that they are significantly different.

Table 7-15: Relative Amounts of Chert, Chalcedony or Jasper Among Flakes and Tools, Henwood Site 94-SBr-4966)

	% of flakes that are ch/ch/ja	% of assemblage that is ch/ch/ja cores	% of assemblage that is ch/ch/ja unifaces	% of assemblage that is ch/ch/ja bifaces	% of all tools that are ch/ch/ja*
Component 1	7.5	0	17.5	11.1	38.1
Component 2	40.5	12.7	7.6	36.7	57.0
Component 3	20.1	15.0	30.0	10.0	65.0
Component 4	9.4	0	25.0	25.0	50.0

*Difference between these percentages and the sum of the three columns to the left, are accounted for by projectile points of chert, Chalcedony or jasper.

However, when we return to the four major categories of tools, bifaces, projectile points, unifaces and cores (Table 7-17) we see that there are some differences in the materials used for different tool types. Component 2 has large number of bifaces, but more notable is that more than half of them are of chert, chalcedony or jasper. No other assemblage from Nelson Wash, surface or subsurface, except 4-SBr-5267, resembles Component 2 in this respect. Component 2 is also high in cores, but along Nelson Wash cores area usually of chert or chalcedony, and not of metabasalt. It seems reasonable to suggest, in view of the high frequencies of cryptocrystalline silicate flakes and the large number of bifaces of that same material that biface production in this material was a major activity in Component 2.

Looking back at Table 7-14 which shows flake-to-tool ratios for the components, Component 2 has the highest in both metavolcanics and cryptocrystalline silicates. Since biface morphology is much affected by material, it makes sense to look once again at the Component 2 bifaces, this time divided by material as well as morphological class (Table 7-16). The bifaces of cryptocrystalline silicates do not exhibit highs in the classes proposed as stageforms based on the analysis of the

surface assemblages. But then, cryptocrystalline silicate stageforms are probably

Table 7-16: Comparison of Biface Assemblages by Material, Components 1 and 2 of the Henwood Site.

	Component 1		Component 2	
Biface Clusters	Meta-Volcanic	ch/ch/ja	Meta-Volcanic	ch/ch/ja
1-5	4	1	2	3
6-11	0	1	0	3
15-16	1	1	0	1
17-18	5	0	4	0
19	0	0	2	1
20-25	0	0	1	2
TOTAL	10	3	9	10

Table 7-17: Major Tool Categories by Material, Henwood Site Components (4-SBr-4966).

	Metavolcanics		Ch/ch		Jasper		Obsidian		
	N	%	N	%	N	%	N	%	Total
Component 1									
Bifaces	26	41.3	7	11.1	0	0	0	0	33
Unifaces	8	12.7	10	15.9	1	1.6	0	0	19
Proj. pts.	4	6.3	5	7.9	1	1.6	0	0	10
Cores	1	1.6	0	0	0	0	0	0	1
Total	39	61.9	22	34.9	2	3.2	0	0	63

Table 7-17: Continued.

	Metavolcanics N	Metavolcanics %	Ch/ch N	Ch/ch %	Jasper N	Jasper %	Obsidian N	Obsidian %	Total
Component 2									
Bifaces	26	32.9	28	35.4	1	1.3	0		55
Unifaces	7	8.9	6	7.6	0	0	0		13
Proj. pts.	0	0	0	0	0	0	0		0
Cores	1	1.2	10	12.7	0	0	0		11
Total	34	43.0	44	55.7	1	1.3	0	0	79
Componen' 3									
Bifaces	4	20.0	2	10.0	0	0	0		6
Unifaces	2	10.0	6	30.0		0	0		8
Proj. pts.	1	5.0	2	10.0	0	0	0		3
Cores	0	0	3	15.0	0	0	0		3
Total	7	35.0	13	65.0	0	0	0	0	20
Component 4									
Bifaces	0	0	1	25.0	0	0	0		1
Unifaces	1	25.0	1	25.0	0	0	0		2
Proj. pts.	0	0	0	0	0	0	0		0
Cores	1	25.0	0	0	0	0	0		1
Total	2	50.0	2	50.0	0	0	0	0	4

fundamentally different in their morphology from those of metavolcanics because they respond to flaking so differently.

Millingstones, Manos

Five groundstone items were recovered from the subsurface components. These include three (3) slab metate fragments from Component 1, one (1) block metate fragment from Component 2 and one (1) complete mano from Component 3. The metate fragments are all so incomplete that little can be said about them. They do appear to be unshaped and only slightly used. The mano, on the other hand is well made and exhibits two adjacent grinding faces which produce an unusual form. The real significance of these milling tools is that they document the association of a milling complex with Lake Mojave points in Component 1 at a very early date.

Summary and Comments

The artifact samples (excluding flakes) from the subsurface components are judged to be recovered in a comparable manner to the artifact assemblages of the surface loci and are here considered to be directly comparable with respect to relative frequencies of tool types.

Diversity within the subsurface artifact assemblages is a reflection of the size of the assemblages; however, there are clear cut differences between artifact assemblages in the frequencies of major tool classes. Component 1 and 2 are significantly different in tool assemblages, Component 3 appears to different from both Components 1 and 2, and Component 4 has an insufficient number of artifacts for meaningful comparisons.

Although bifaces are the most numerous category in the artifact assemblages of Components 1 and 2, cryptocrystalline is used in production of 53% of Component 2 bifaces but only 23% of Component 1 bifaces. Cores are also far more common in Component 2 than Components 1 and 3, and the number of cryptocrystalline flakes per tool in Component 2 is nearly seven times (6.75) as great as in Component 1. On the other hand, Component 2 has no projectile points whereas 15.9% of the assemblage from Component 1 is projectile points. Uniface tools also make up 30.25 of the Component 1 assemblage but only 16.5% of the assemblages of Component 2. On this basis it would appear that activities at Component 1 were directed toward hunting and processing game, whereas Component 2 activities consisted largely of processing and reducing cryptocrystalline materials.

Component 3 has a small number of artifacts, but with a ratio of 35 cryptocrystalline flakes per tool it appears to have had more activity directed toward reduction of cryptocrystalline material than did Component 1. Component 3 also exhibits a higher percentage of unifaces than either Component 1 or 2 and a relatively small numbers of bifaces. This suggests a third set of activities with less emphasis on hunting large game than Component 1 and less processing of cryptocrystalline than Component 2. The relatively large number of unifaces in Component 3 suggests that some resource(s) perhaps small game or vegetable products, were processed at this location.

The difference noted in tool assemblages is carried over to the lithic materials. Each component has a distinctive combination of lithic materials. Components 1 and 4 are similar in occurrence of metavolcanics but Component 4 differs from all the others by having a large (7.6) percentage of obsidian flakes. Component 2 is set off from the others by the large percentage of cryptocrystalline material (40%). Component 3 again is intermediate between Components 1 and 2 in occurrence of cryptocrystalline and metavolcanic materials.

Three of the four subsurface components contain at least one millingstone, clearly indicating that millingstones were a part of the artifact assemblages at Nelson Wash.

CHAPTER 8 - NON-CONTROLLED COLLECTIONS AND THEIR RELATIONSHIPS TO THE CONTROLLED ASSEMBLAGES by Claude N. Warren

The controlled surface samples (SC) discussed in Chapter 7 form only 43.3% of surface assemblages. Artifacts, including flakes, that were not collected in the controlled surface grids, were marked for collection during the pinflagging when the site/locus boundaries were identified for mapping (NG samples). Coordinates for the location of each of these artifacts were determined by use of the transit. In addition, a few artifacts were also collected in an uncontrolled manner during the early reconnaissance and evaluation of these sites. It was assumed that the controlled sample made in collection grids would be significantly different from the less controlled samples, and Chapter 7 was limited to a discussion of the controlled surface samples and excavated assemblages. The assumption that the controlled surface sample was significantly different from other surface collections is undoubtedly correct to some degree (Table 8-1). It cannot be assumed that the two samples from the same site/locus are from the same population because the controlled surface samples included all artifacts removed from the sample of collection units, and the non-grid sample was collected from other areas of the site. Therefore, the different samples should reflect some variation of artifact distribution within the sites so sampled. When the Chi-square test is applied to the 10 sites/loci with sufficiently large samples (Table 8-2) only two sites/loci (SBr-4966A, SBr-5267) exhibit differences that could clearly be attributed to differences in sampling procedures. The Chi-square score for Loci 4-SBr-4966C and 4-SBr-4966H suggests that the two samples from each locus are from the same population. The degree of similarity in assemblage composition between the two samples from each site/loci varies considerably and is shown graphically in Figure 8-1. Of those sites/loci with the great disparity between the two samples, one or both samples is unusually small (4-SBr-4966D, -4966E, -4966G, -4966I, -4965) or one sample is essentially non-existent (-4966F and -4967). Some sites/loci, however, exhibit considerable differences between samples both of which have relatively large numbers (4-SBr-4963, -4966A, -4968, -4969, -5267). Only loci SBr-4966B, -4966C and -4966H exhibit similar macro-assemblages in their two samples (Table 8-2).

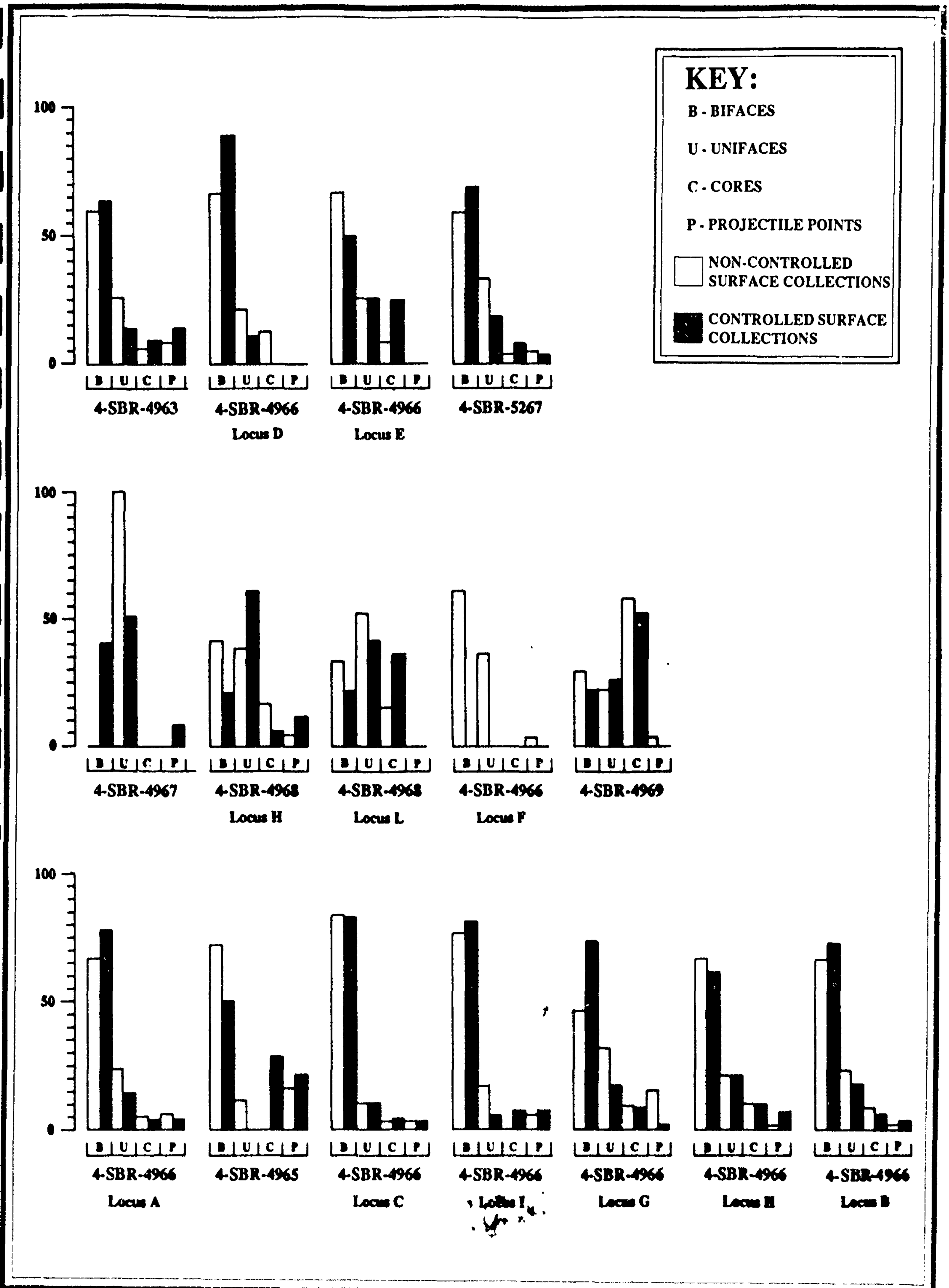

FIGURE 8-1. VARIABILITY OF CONTROLLED AND NON-CONTROLLED SURFACE ASSEMBLAGES

Table 8-1: Comparison of Macro-composition of Surface Samples from 5x5m Control Grids (SC) with Non-grid Surface Collections (NG).

Assem-blage	SBr-4963 SC	NG	Total	SBr-4965 SC	NG	Total	SBr-4966A SC	NG	Total
Bifaces	45	51	96	17	8	25	261	218	479
Unifaces	20	12	32	3	0	3	94	41	135
Cores	5	7	12	0	4	4	19	9	28
Proj. Pts.	6	11	17	4	3	7	23	12	35
Total	76	81	157	24	15	39	397	280	677

Assem-blage	SBr-4966B SC	NG	Total	SBr-4966C SCc1	SCc2	SCc3	SCcb	Total SC*	NG	Total
Bifaces	114	254	368	11	32	35	68	155	307	462
Unifaces	39	59	98	3	2	6	1	19	40	59
Cores	13	22	35	1	0	2	0	5	15	20
Proj. Pts.	4	10	14	1	0	2	1	6	14	20
Total	170	342	512	16	32	46	73	185	376	561

*Includes artifacts from loci not listed separately

Assem-blage	SBr-4966D SC	NG	Total	SBr-4966E SC	NG	Total	SBr-4966F SC	NG	Total
Bifaces	20	9	39	8	1	9	16	3	19
Unifaces	7	1	8	3	1	4	10	0	10
Cores	4	0	4	1	1	2	0	0	0
Proj. Pts.	0	0	0	0	0	0	1	0	1
Total	31	10	41	12	3	15	27	3	30

Table 8-1: Continued.

Assem-blage	SBr-4966G SC	NG	Total	SBr-4966H SC	NG	Total	SBr-4966I SC	NG	Total
Bifaces	8	70	78	34	62	96	26	36	62
Unifaces	4	15	19	11	21	32	6	2	8
Cores	1	6	7	5	10	15	0	3	3
Proj. Pts.	2	2	4	1	7	8	2	3	5
Total	15	93	108	51	100	151	34	44	78

Assem-blage	SBr-4967 SC	NG	Total	SBr-4968 SCH	SCL	NG	Total
Bifaces	0	10	10	37	16	9	62
Unifaces	0	14	14	33	26	16	75
Cores	0	0	0	14	8	10	32
Proj. Pts.	0	2	2	4	0	2	6
Total	0	26	26	88	50	37	185

Assem-blage	SBr-4969 SC	NG	Total	SBr-5267 SC	NG	Total
Bifaces	11	12	23	86	189	275
Unifaces	5	15	20	49	49	98
Cores	20	29	49	6	23	29
Proj. Pts.	0	2	2	7	11	18
Total	36	58	94	148	272	420

Table 8-2: Chi-square Scores for Artifact Assemblages of Controlled Surface (SC) and Uncontrolled Surface (NG) Samples from the Nelson Wash Sites.

Assem-blage	SBr-4963			SBr-4966 Locus A			SBr-4966 Locus B		
	C,S[1]	OV[2]	CSC[3]	C,S	OV	CSC	C,S	OV	CSC
Bifaces	a,sc	45	0.0466	a,sc	261	1.4085	a,sc	114	0.4267
	b,ng	51	0.0437	b,ng	218	1.9970	b,ng	254	0.2267
Uniface	c,sc	20	1.3128	c,sc	94	2.7800	c,sc	39	1.3672
	d,ng	12	1.2318	d,ng	41	3.9413	d,ng	59	0.6737
Core	e,sc	5	0.1126	e,sc	19	0.4055	e,sc	13	0.1811
	f,ng	7	0.1057	f,ng	9	0.5750	f,ng	22	0.0893
Pj. Pts.	g,sc	6	0.6039	g,sc	23	0.2986	g,sc	4	0.0835
	h,ng	11	0.5666	h,ng	12	0.4233	h,ng	10	0.0412
Chi-square	=4.02			=11.83			=3.12		
df	=3			= 3			=3		
P	<0.260			<0.008			<0.374		

Assem-blage	SBr-4966 Locus C			SBr-4966 Locus H			SBr-4969		
	C,S	OV	CSC	C,S	OV	CSC	C,S	OV	CSC
Bifaces	a,sc	155	0.0460	a,sc	34	0.0766	a,sc	11	0.5452
	b,ng	307	0.0226	b,ng	62	0.0391	b,ng	12	0.3384
Uniface	c,sc	19	0.0107	c,sc	11	0.0034	c,sc	5	0.9235
	d,ng	40	0.0053	d,ng	21	0.0017	d,ng	15	0.5732
Core	e,sc	5	0.3859	e,sc	5	0.0009	e,sc	20	0.7660
	f,ng	15	0.1849	f,ng	10	0.0004	f,ng	29	0.0504
Pj. Pts.	g,sc	6	0.0537	g,sc	1	1.0721	g,sc	0	0.7660
	h,ng	14	0.0264	h,ng	7	0.5468	h,ng	2	0.4754
Chi-square	=0.741			=1.741			=3.75		
df	=3			=3			=3		
P	>0.864			>0.628			<0.290		

[1]Cell, Sample
[2]Observed Value
[3]Chi-Square Contribution

Table 8-2: Continued.

Assemblage	SBr-5267			SBr-4968 Locus SCH/SCL			SBr-4968 Locus SCH/NG		
	C,S[1]	OV[2]	CSC[3]	C,S	OV	CSC	C,S	OV	CSC
Bifaces	a,sc	86	1.2271	a,h	37	0.2035	a,h	37	0.6580
	b,ng	189	0.6677	b,l	16	0.5342	b,ng	9	1.5649
Uniface	c,sc	49	6.0604	c,h	33	0.5685	c,h	33	0.0649
	d,ng	49	3.2975	d,ng	26	0.9999	d,l	16	0.2923
Core	e,sc	6	1.7419	e,h	14	0.0001	e,h	14	0.4964
	f,ng	23	0.9478	f,l	8	0.0001	f,ng	10	1.1806
Pj. Pts.	g,sc	7	0.0681	g,h	4	0.8235	g,h	4	0.0119
	h,ng	11	0.0370	h,l	0	1.4493	h,ng	2	0.0283
Chi-square	=14.08			=4.68			=4.16		
df	= 3			=3			=2		
P	<0.003			<0.197			<0.245		

Assemblage	SBr-4968 Locus SCL/NG			SBr-4966 Locus SCL&SCH/NG		
	C,S	OV	CSC	C,S	OV	CSC
Bifaces	a,l	16	0.1854	a,sc	53	0.3453
	b,ng	9	0.2506	b,ng	9	1.2877
Uniface	c,l	26	0.1436	c,sc	59	0.0003
	d,ng	16	0.1941	d,ng	16	0.0013
Core	e,l	8	0.5315	e,sc	22	0.4145
	f,ng	10	0.7182	f,ng	10	1.5461
Pj. Pts.	g,l	0	1.1494	g,sc	4	0.1131
	h,ng	2	1.5533	h,ng	2	0.4217
Chi-square	=4.73			=4.13		
df	=3			=3		
P	<0.193			<0.248		

[1]Cell, Sample
[2]Observed Value
[3]Chi Square Contribution

There are several possible explanations for the differences in the two samples from the various loci and sites. The most obvious are the biases in the sampling procedures. These biases may be seen in the relative size of the contribution that each artifact class makes tothe Chi-square score (Table 8-2). In sites/loci 4-SBr-4966A, -5267, -4963, -4966B and -4969, the uniface class is the largest contributor to the Chi-square score. In the samples with the small Chi-square scores (4-SBr-4966C and -4966H), the unifaces make small contributions to the Chi-square score. These data suggest that many, if not most, of the differences between the controlled grid (SC) and the non-grid (NG) samples are found in the uniface class.

These differences are in large part due to the fact that many more small, unifacially-worked flakes (Groups 2 and 3) were recognized and recovered in the controlled grid samples (SC) than in the less controlled non-grid (NG) samples. This difference can be explained by the fact that crew members carefully removed all cultural debris from the one meter and five meter grids during the controlled grid sampling, whereas crew members recovered artifacts from the non-grid sampling that they recognized during the pinflagging of the site. Consequently, the simple flake tools that exhibit only retouched edges or use-wear were recovered less frequently during the non-grid sampling. This difference in sampling is clearly illustrated when the unifaces are divided into: Group 1 unifaces made by shaping the outline by major unifacial flaking; and Groups 2 and 3 unifaces made by retouching flake edges with minimum of modification to the outline, and sharp pointed engraving tools also made on flakes (Tables 8-3a and 8-3b).

The distribution and Chi-square scores illustrate that the flake scrapers and gravers (Groups 2 and 3) are relatively more numerous in the controlled grid samples than in the non-grid samples (Table 8-4). These differences in distribution and Chi-square scores demonstrate that there is a strong correlation between the Group 2 unifaces and the controlled surface collections. This is most apparent in those sites/loci where the samples exhibit large differences in the number of unifaces (Table 8-3b), but it is also true of those where the differences in number of unifaces makes only a secondary contribution to the Chi-square score (Tables 8-5a and 8-5b). This strong correlation between the Group 2 and 3 unifaces and the controlled surface sample, and between the Group 1 unifaces and the non-grid surface sample, is most likely caused by the differences in the procedures used in collecting the samples.

Table 8-3a: Distribution of Group 1 and Group 2 & 3 Unifaces in Controlled Grid and Non-Grid Surface Collections.

	Non-Grid		Controlled Grid	
Sites/locus	Group 1	Group 2 & 3	Group 1	Group 2 & 3
4963	6	5	2	17
4966A	21	15	23	60
4966B	35	17	13	18
4966C	23	14	2	13
4966H	8	13	2	6
4968	11	4	25	30
4969	4	8	1	4
5267	32	15	18	23
Total	140	91	86	171

Table 8-3b: Chi-Square Test of Non-Grid and Controlled Grid Artifact Samples from the Nelson Wash Sites.

	Non-Grid	Controlled Grid	Total
Group 1	140	86	226
Groups 2 & 3	91	171	262
Total	231	257	488

Chi-square = 34.96
df = 1
P < 0.000001

Table 8-4: Chi-Square Scores for Unifaces of Controlled Surface (SC) and Uncontrolled Surface (NG) Artifact Assemblages from the Nelson Wash Sites.

Uniface	SBr-4963			SBr-4966A			SBr-4966B		
Group	C,S[1]	OV[2]	CSC[3]	C,S	OV	CSC	C,S	OV	CSC
1	a,ng	6	2.25	a,ng	21	4.32	a,ng	35	0.71
	b,sc	2	1.30	b,sc	23	1.83	b,sc	13	1.10
2 & 3	c,ng	5	0.82	c,ng	15	2.07	c,ng	17	0.90
	d,sc	17	0.47	d,sc	60	0.88	c,sc	18	1.41
Chi-square	=4.84			=8.83			=4.14		
df	=1			=1			=1		
P	<0.03			<0.003			<0.042		

Uniface	SBr-4966C			SBr-4966H			SBr-4968		
Group	C,S	OV	CSC	C,S	OV	CSC	C,S	OV	CSC
1	a,ng	23	1.23	a,ng	8	0.01	a,ng	14	0.20
	b,sc	2	2.94	b,sc	2	0.02	b,sc	25	0.08
2 & 3	c,ng	14	1.09	c,ng	13	0.00	c,ng	4	0.34
	d,sc	13	2.62	d,sc	6	0.01	d,sc	30	0.13
Chi-square	=8.33			=0.051			=4.47		
df	=1			=1			=1		
P	<0.004			<0.82			<0.036		

Uniface	SBr-4969			SBr-5267		
Group	C,S	OV	CSC	C,S	OV	CSC
1	a,ng	4	0.00	a,ng	32	0.38
	b,sc	1	0.00	b,sc	18	0.30
2 & 3	c,ng	8	0.00	c,ng	15	0.21
	d,sc	4	0.00	d,sc	23	0.16
Chi-square	=0.001			=4.28		
df	=1			=1		
P	<0.97			<0.040		

[1]Cell, Sample
[2]Observed Value
[3]Chi Square Contribution

Table 8-5a: Distribution of Uniface Groups from Sites in Which Unifaces Make Large Contributions to Chi-Square Scores (SBr-4963, 4966A, 4966B, 4969, 5267).

	Non-Grid	Controlled Grid	Total
Group 1	98	57	155
Groups 2 & 3	60	122	182
Total	158	179	337

Chi-square = 29.57
df = 1
P < 0.000001

Table 8-5b: Distribution of Uniface Groups from Sites/Loci in Which Unifaces Make Large Contributions to Chi-Square Scores (SBr-4966C, 4966H, 4968H&L).

	Non-Grid	Controlled Grid	Total
Group 1	42	29	71
Groups 2 & 3	29	49	78
Total	71	78	149

Chi-square = 5.481
df = 1
P < 0.019

There are almost certainly other causes contributing to the differences of the two samples from each site/loci. Another cause alluded to above is that the two samples (SC and NG) from mutually exclusive portions of each site/loci are not sampling the same universe, and should be expected to reflect some of the variation of the artifact distribution within the site.

An examination of the Chi-square scores in Table 8-2 reveals that the biface categories make major contributions to the Chi-square scores in locus 4-SBr-4966A and sites 4-SBr-5267 and -

4968 (SCL and SCH/NG). That the biface samples were biased in a manner similar to that of the unifaces was considered. The bifaces were first divided into small (Classes 1-13 and 19), and large (Classes 14-18 and 20-25) categories on the assumption that biased sampling techniques would be reflected in the distribution of these categories of bifaces between the two samples. The small bifaces were predicted to be more numerous in the controlled grid samples than in the non-grid samples. However, Chi-square scores (Table 8-6) for the distribution of large and small bifaces indicate that there is little correlation of biface size and sampling procedure. Consequently, this analysis does not support the interpretation that the sampling procedure was a cause of differences in the distribution of bifaces of the controlled grid and non-grid samples.

The core categories make major contributions to the Chi-square scores in sites 4-SBr-5267 and 4-SBr-4968 (SCL and SCH/NG) (Table 8-2). A Chi-square score run on the distribution of nine core types in the NG and SC samples indicated only Type 2 cores had made a major contribution to the Chi-square score (Table 8-7). In this case it suggested that Type 2 cores were overrepresented in the SC samples and/or underrepresented in the NG sample. Examination of the distribution of core types on sites 4-SBr-5267 and 4-SBr-4968 (SCL and SCH/NG), showed that the frequency of Type 2 cores in the NG sample was greater than expected in site 4-SBr-5267, but less than expected in 4-SBr-4968. These differences, while interesting, cannot be explained at this time.

Projectile point categories make major contributions in locus 4-SBr-4966H. The projectile point contribution to the Chi-square score is almost certainly due to the small number of projectile points (total of eight) from that site.

Generally, it has been determined that most of the differences between the controlled grid samples and non-grid samples are due to differences in relatively large numbers of the Groups 2 and 3 unifaces in the controlled grid samples and relatively large numbers of Group 1 unifaces in the non-grid samples.

Table 8-6: Distribution of Bifaces by Size and Sample Type.

Sites/Loci			Non-Grid small	Non-Grid large	Controlled Grid small	Controlled Grid large
SBr-4963			16	10	13	6
Chi-square	=	0.026				
df	=	1				
P	>	0.871				
SBr-6965			5	0	4	4
Chi-square N/A						
SBr-4966A			78	49	95	37
Chi-square	=	2.791				
df	=	1				
P	<	0.091				
SBr-4966B			98	60	37	30
Chi-square	=	0.646				
df	=	1				
P	>	0.578				
SBr-4966C			120	87	60	27
Chi-square	=	2.673				
df	=	1				
P	>	0.102				
SBr-4966H			18	22	4	7
Chi-square	=	0.028				
df	=	1				
P	>	0.866				
SBr-4968			3	3	14	14
Chi-square N/A						
SBr-4969			2	7	1	6
Chi-square N/A						
SBr-5267			80	34	25	13
Chi-square	=	0.092				
df	=	1				
P	<	0.761				
Total			431	275	260	148
Chi-square	=	0.677				
df	=	1				
P	>	0.410				

Table 8-7: Chi-square Scores for the Distribution of Core Types in Controlled Surface (SC) and Non-grid (NG) Samples.

Core Type	C,S[1]	OV[2]	EV[3]	CSC[4]
1	a,ng	13	13.4	0.0145
	b,sc	10	9.6	0.0204
2	c,ng	34	42.1	1.5508
	d,sc	38	29.9	2.1808
3	e,ng	19	16.4	0.4247
	f,sc	9	11.6	0.5973
4	g,ng	9	7.0	0.5630
	h,sc	3	5.0	0.7917
6	i,ng	8	6.4	0.3841
	j,sc	3	4.6	0.5402
7	k,ng	43	40.3	0.1775
	l,sc	26	28.7	0.2496
Other Types	m,ng	9	9.4	0.0131
	n,sc	7	6.6	0.0185

[1]Cell, Sample
[2]Observed Value
[3]Expected Value
[4]Chi-square Contribution

Chi-square = 7.526
df = 6
P < 0.275

These differences in the uniface distribution are almost certainly due in large part to the differences in the way the two sets of samples were collected. The differences in the biface distribution in the two samples cannot be determined to be due to sampling procedures. There is virtually no correlation between biface size and the NG and SC samples. There may be other factors that biased the sampling that have not been identified. It seems likely that the more finely finished types of bifaces would be more easily recognized and therefore relatively more numerous in the non-grid samples. This criterion is probably closely correlated with biface size, which does not correlate with NG and SC samples. The distribution of cores and projectile points appears to be little affected by the procedures by which they were collected.

Another possible cause for the differences in the assemblages may be found in the fact that the two collections are from mutually exclusive areas of each site. Therefore, differences in artifact frequencies are expected between the two samples of each site; however, these differences reflect the uneven distribution of artifact types across the site. If the differences between the NG and SC samples caused by procedures are limited essentially to the uniface category, then it would be acceptable to group the two samples together to provide a more full range of artifact variation on each site. And since surface collections were made in the same or very similar way on all but one site (4-SBr-4967) the artifact assemblages resulting from such regrouping would still be comparable. Such a regrouping of the assemblages would be advantageous because the sample size would increase significantly in most instances.

CHAPTER 9 - EARLY TIMES IN THE CENTRAL MOJAVE DESERT: PROBLEMS OF CHRONOLOGY AND TRADITION by Claude N. Warren

INTRODUCTION

The investigations at Nelson Wash were directed toward addressing questions of chronology, culture history, and the adaptive strategy of the subsistence system during the late Pleistocene and early Holocene. The questions of chronology and culture history are addressed first so that the validity of the interpretive model of the cultural sequence can be tested before addressing questions regarding the subsistence focus model and the adaptive strategy of the subsistence system.

Inadequate data for the dating of Lake Mojave and Pinto Basin complexes have resulted in several different interpretations of the terminal date for the Lake Mojave complex and the initial date for the Pinto Basin complex. In 1962, Wallace suggested an initial date of 2500 B.C. for Pinto and a terminal date of circa 5000 B.C. for the Lake Mojave period. The intervening 2500 years were thought to represent a period when the Mojave was largely unpopulated. This interpretation was followed with minor modifications by Donnan (1964) and Kowta (1969). Susia (1964:31), on the other hand, argued that:

> The Pinto phase can be seen as probably the final time period in a tradition in western prehistory that can be traced back about 10,000 years to the Lake Mohave and Death Valley I surface finds.

Tuohy (1974), Warren (1984), and Warren and Crabtree (1986) have argued for a single tradition including both the Lake Mojave and Pinto Basin complexes. Thus, not allowing for a cultural hiatus makes the terminal date for the Lake Mojave period and the initial date for the Pinto period one and the same. Warren and Crabtree (1986) and Warren (1984) place this termination at 5000 B.C. whereas Bettinger and Taylor (1974) would date it after 4000 B.C. (the transition from their Mojave period to Little Lake period). The short and long chronology models are thus significantly different in two major attributes: 1) dates; and 2) presence or absence of cultural continuity. Hypotheses deduced from these models may serve to test their validity. The models should result in very different kinds of archaeological evidence and therefore such hypotheses are reasonably simple to construct. Hypothesis I states that "the Pinto Basin and Lake Mojave components represent continuous occupation with no hiatus." This hypothesis will be addressed first.

When fieldwork started on the Nelson Wash sites only two series of obsidian hydration measurements were available for the Pinto period: one from the Little Lake site (Meighan 1981) and one from the Awl site (Jenkins and Warren 1986). A single radiocarbon date of 8320 $\pm$ 160 B.C., applicable to a Lake Mojave occupation, was available (Warren and Ore 1978). Radiocarbon dates from components in the Nelson Wash sites, Rogers Ridge (Jenkins 1985) and the Awl site (Mark Basgall, personal communication 1986) now provide additional absolute dates, and the obsidian hydration samples from components of Nelson Wash sites and Rogers Ridge provide data comparable to that from the Awl and Little Lake sites.

The new radiocarbon dates and obsidian hydration evidence should provide data adequate for testing Hypothesis I. If Hypothesis I is correct, obsidian hydration measurements from the Nelson Wash sites and components will display a continuous distribution with the smaller measurements comparable to those from the Little Lake site (Meighan 1981) and radiocarbon samples from the Pinto components will date only slightly later in time than the Lake Mojave components. If this hypothesis is not correct the obsidian hydration measurements from Nelson Wash sites will form a discontinuous, bimodal pattern with a series of smaller measurements comparable to those of the Little Lake site and radiocarbon samples from Pinto components will be considerably younger than those from the Lake Mojave components, suggesting that a hiatus in the occupation of the central Mojave Desert did occur.

RADIOCARBON CHRONOLOGY

Five radiocarbon dates were obtained from two components and one surface locus of the Henwood site (4-SBr-4966). Two (AA-648 and AA-798), dated by accelerator mass spectrometry, were based on samples taken from Feature 15 in Component 1. Feature 15 consisted of a scatter of approximately 60 thermally affected stones and a dark soil stain. The stone scatter covered an area of 5X6 m. The main concentration of about 30 stones covered an area of only about 2 m in diameter. Most of the stones are very small (10 cm or less) though five exceed 15 cm in length. All are tabular fragments easily distinguishable from the intermittent gravels found in the surrounding alluvium due to their unique shape, color, texture, and material (gneiss). As with other cultural material the majority of these stones were located between 30 and 40 cm. below the surface. Artifact distributions drop off dramatically below 40 cm, apparently indicating that Feature 15 was contemporaneous with the deposition of artifacts around it.

The dark soil stain in Feature 15 was located 2 m east of the main concentration of the stones. It was first encountered at about 30 cm and continued to approximately 60 cm. It appears to have been bowl-shaped and somewhat irregular in outline at 40 cm deep, where it measured ca 60 by 75 cm. in diameter. It narrowed to 50 cm in diameter at 50 cm below the surface and was 30 cm in diameter at 61 cm deep where it terminated. Soil samples were taken from this stained area and through flotation in distilled water, two charcoal samples were collected for radiocarbon dating. Sample AA-648 weighed about 0.5 gm and was obtained from floating 16.75 l. of soil collected from between 28 and 50 cm deep. Sample AA-798 weighed approximately 0.1 gm and was also obtained from floating 16.75l. of soil, but was collected from between 40 and 50 cm deep. These samples were both collected from the same gray-stained feature, but gave quite different dates. Sample AA-798 produced a date of 2410 $\pm$ 280 B.C. and sample AA-648 gave a date of 6520 $\pm$ 370 B.C. Since these samples were taken from the same feature one of the dates must be wrong. Since two Lake Mojave points and a fluted point were found in close proximity to Feature 15 it is most likely that the younger date is incorrect. Therefore, it is disregarded and the date of 6520 B.C. accepted as the age of Component 1 at the Henwood site.

Two accelerator mass spectrometry dates were obtained from Component 2 of the Henwood site. Sample AA-649 was derived from Feature 10, a roughly bowl-shaped area of gray-stained soil. It had a roughly oval outline when first encountered at about 33 cm below the surface, and extended to a depth of 78 cm. Flotation of a 3.9 l soil sample collected from between 60 and 70 cm produced a carbon sample of 0.5 gm. This sample was dated at 5200 ± 290. A second sample, AA-800, collected from Feature 21, only four meters south of Feature 10. Feature 21 was another gray-stained area first recognized at 32 cm below the surface. It was oval in outline, 85 X 38 cm, and basin-shaped extending to the depth of 55 cm below the surface. Two fire-affected rocks were within the feature, but no other cultural materials were found in the feature. All of the soil was recovered for flotation. The carbon sample from this feature weighed less than 0.1 gm and was derived from 10 l of soil. Sample AA-800 dated to 5450 ± 280 B.C.

The fifth date was from Feature 2 which appeared as a gray stain in the south wall of back-hoe Trench 3 on the edge of Locus H. The top of Feature 2 was located 53 cm below the surface of the site. Between the top of the feature and the surface are two soil strata. The first stratum extends to a depth of about 40 cm and is comprised of coarse sands with some small gravel. The second stratum is located between 40 and 55 cm deep and is a water-laid gravel lens which contrasts with the finer matrix of the feature and the compact caliche into which the feature was dug. Feature 2 was a small hearth excavated approximately 14-18 cm into the caliche. The original surface from which the hearth was excavated appears to have been the top of the caliche or a soil above the caliche which was subsequently eroded away. Feature 2 was 40 cm in diameter and was filled with dark ashy sands, small gravel and bits of charcoal. A radiocarbon date (A-4051) of 5190 ± 290 B.C. was obtained from 0.7 gm of charcoal picked from this sample. Feature 2 contained two flakes, but no other artifacts could be associated with it. However, in the south end of Locus H, ca 10 m west of Feature 2, the two strata which overlay Feature 2 are not present and the surface of the ground is the caliche deposit into which Feature 2 was dug. The artifacts from the south end of Locus H are found lying on that surface, apparently the result of erosion of the sediments that once contained the artifacts.

The two strata which overlay Feature 2 are younger than that feature and therefore post- date 5190 ± 290 B.C. The artifacts from Locus H were associated with deposits that once overlay the caliche formation upon which they are now found. The missing deposits from which the artifacts have weathered may have been the same age as Feature 2, or they may have been the strata that now overlay Feature 2, or the artifacts could have eroded from both and represent a considerable period of time. However, it is clear that it is unlikely that the occupation represented by at least the south end of Locus H dates to a period older that ca 5200 B.C.

Based on these radiocarbon dates it is possible to place the components in chronological order:

Component	Radiocarbon age
Locus H	< 5200 B.C.
Component 2	5200 ± 290 B.C.
	5450 ± 280 B.C.
Component 1	6520 ± 370 B.C.

OBSIDIAN HYDRATION

Obsidian hydration dating involves a number of uncontrolled variables that make the results less than reliable. It has been used here because it is one of the few possible ways in which a chronology for the Nelson Wash sites might be developed. We have done so with caution and skepticism regarding the basic assumptions and our ability to deal with all the variables. Temperature is one variable that affects the hydration rate but it is impossible to reconstruct the changes in temperature that have occurred at each site. However, the Nelson Wash sites are all at about the same elevation and are in very similar environments; it is assumed that similar, if not identical, temperature changes occurred at all Nelson Wash sites.

One factor that almost certainly influences the rate of hydration is the surface temperature of the ground, which is significantly higher than subsurface temperatures. Subsurface and surface samples of obsidian have been separated in our analysis of the hydration measurements.

Obsidian from the Coso source has some special problems due to the fact that it appears to hydrate at a rapid rate. Jackson (personal communication, 1984) writes:

> Hydration rinds of large size (and presumably great age) are often highly variable and exhibit poorly demarcated diffusion fronts. This is not always the case, but such problems are common. Variations in the thickness of individual measurements along single hydration bands can exceed one micron (variation is expressed as a standard deviation on the data sheet). The variable

nature of measurements are inherent properties of the hydration itself, rather than phenomena produced by sample preparation or reading methods. It is entirely possible that these same phenomena occur with smaller hydration rinds, but they occur as a percentage of the total thickness and are, therefore, negligible with smaller bands. This is conjectural, but is a real problem that is not usually dealt with in hydration studies. This implies that hydration might be unable to provide precise chronometric dates.

If Coso obsidian is characterized by highly variable hydration measurements, then similar variability may be expected among hydration measurements of different items as well as among hydration measurements of a single specimen. Therefore, we assume that hydration measurements for a sample of Coso obsidian items from a short period of time will be highly variable. Consequently, it is stressed here that it is the mean of a group of measurements that is significant, not single or individual measurements. Standard deviation makes it possible to identify individual measurements that are aberrant. The coefficient of variation makes it possible to compare the dispersion of two or more groups of measurements that are different in size and/or have different means.

Single obsidian specimens with different measurements for two "edges"[4] are not uncommon. The different measurements for each edge may be due to flake removal at different times (by nature or man), highly variable hydration of the two edges, or other factors. In the following analysis when two different measurements are given for the same specimen they are first evaluated in terms of how great the difference is between the two measurements and then their positions in relation to the mean of the group are considered.

In the analyses presented below, the mean, standard deviation, and coefficient of variation have been calculated for each group of hydration measurements. Standard deviation makes it possible to identify individual measurements that are aberrant. The coefficient of variation makes it possible to compare the dispersion of two or more groups of measurements that are

[4]"Edge" is the term hydration analysts apply to the edge of the thin section, not the edge of the artifact.

different in size and/or have different means. The following procedures were employed during the analysis presented below:

1. Calculation of mean and standard deviation for all measurements within a group of artifacts. Include both measurements from specimens with different reading for each edge.

2. Ommission of all measurements that fall outside two standard deviations.

3. When one of two measurements from the same specimen falls within one standard deviation and the second outside one standard deviation, the measurement outside one standard deviation is omitted.

4. When two different measurements from the same specimen fall within one standard deviation they are counted as two separate measurements.

Ninety-one flakes and tools of Coso obsidian from the Henwood site and 26 obsidian specimens from other sites (4-SBr-4963, -4965, -4968, -5267) along Nelson Wash were analysed. These 117 Coso obsidian specimens are distributed among five sites along Nelson Wash (4-SBr-4963, -4965, -4966, -4968, -5267) and from both subsurface and surface collections (Table 9-1).

Two subclasses of Coso obsidian can be identified in these 117 items: Coso Hot Springs and Sample Group Six (Jack and Carmichael 1969:27; Nos. 27 and 28; Jack 1976:204, Hughes 1985). The distribution of the Sample Group Six is not random (Table 9-2), suggesting a change in the sources of the Coso obsidian during the occupation of the Nelson Wash sites.

If Sample Group Six and Coso Hot Springs obsidian hydrate at different rates, the differences in distribution of the two may affect the mean and variance for the hydration measurements of any given site or component. As a test, the mean, standard deviation and coefficient of variation of hydration measurements were calculated separately for Sample Group Six and Coso Hot Springs obsidian at site SBr-4963 (Table 9-3). This test assumes that the two sources of obsidian were used over the same period of time during the occupation of site SBr-4963. The Coso Hot Springs sample appears to be more variable as measured by the coefficient of variation, but both have a mean of between 14.4 and 15.1 regardless of the treatment of the "aberrant" measurements. Coso Hot Springs obsidian, on this basis, appears to produce greater variation in hydration measurements than the Sample Group Six. Calculation of F and t-tests for the hydration measurements from these two groups support this interpretation (Table 9-4). The results of the F and t-tests make

Table 9-1: Distribution of Analysed Coso Obsidian from Nelson Wash Sites.

	Site	Component	No. of Pieces
S	SBr-4966	1	22
U		"near" 1	3
B		2	4
		"near" 2	1
S		3	8
U		"near" 3	2
R		4	11
F		"near" 4	4
A		Non Locus	6
C			
E	Total Subsurface		61
	SBr-4966	Locus A	4
		Locus B	3
S		"near" Locus B	1
U		Locus C	5
R		Locus D	1
F		Locus E	5
A		Locus G	5
C		Locus H	1
E		Non Locus	5
	Total Surface from SBr-4966		30
	Total Surface from SBr-4963		17
	Total Surface from SBr-4965		1
	Total Surface from SBr-4968		1
	Total Surface from SBr-5267		7
TOTAL SURFACE			56
TOTAL SUBSURFACE			61
GRAND TOTAL			117

Table 9-2: Distribution of Sample Group Six and Coso Obsidian at Sites 4-SBr-4966 and 4963.

Site	Group Six	Coso
4966 subsurface	12	48
4963	12	5

Chi-square = 15.80
df = 1
$p < 0.001$

Site	Group Six	Coso
4966 surface	1	17
4963	12	5

Chi-square = 15.92
df = 1
$p < 0.001$

it possible to conclude that the samples were drawn from populations with equal means, but because the variances are unequal the samples probably did not come from one statistical population. These data also suggest that Coso Hot Springs and Sample Group Six obsidians hydrate at the same rate, but that Coso Hot Springs obsidian has a greater variability, perhaps resulting from a greater sensitivity to environmental changes. It is assumed that as long as interpretations of age are limited to means of the samples, the differences between Coso Hot Springs and Sample Group Six obsidian will not significantly affect the results.

Table 9-3: Obsidian Measurements, Means, Standard Deviation and Coefficient of Variation for Sample Group Six and Coso Obsidian from 4-SBr-4963.

Sample Group Six Catalog Number	Hydration Measurement
174-141	14.9
174-173(1)	14.4
174-173(2)	4.4 (omit)
174-134(1)	15.4
174-134(2)	17.1
174-55(1)	14.7
174-55(2)	6.9 (omit)
174-63	13.5
174-121-1(1)	14.8
174-121-1(2)	21.0 (omit)
174-121-2	15.3
174-127-1	16.5
174-127-2(1)	14.2
174-127-2(2)	16.5
174-133	15.5
174-354	12.7
174-410	14.8

Sample Group 6 Summary

n	=	17	n	=	14[1]
mean	=	14.27	mean	=	15.02
SD	=	3.73	SD	=	1.18
CV	=	26.14	CV	=	7.86

Coso Catalog Number	Hydration Measurements
174-257(1)	18.1 (omit)
174-257(2)	15.4
174-24	16.9
174-35	11.3
174-39(1)	15.7
174-39(2)	12.9 (omit)
174-77	15.4

Coso Summary

n	=	7	n	=	5[2]
mean	=	15.1	mean	=	14.94
SD	=	2.31	SD	=	2 13
CV	=	15.30	CV	=	14.26

1 Measurements 4.4, 6.9 and 21.0 omitted (adjusted Sample Group Six sample)

2 Measurements 12.9 and 18.1 omitted (adjusted Coso sample)

Table 9-4: F and t-test for Obsidian Hydration Measurements from Sample Group Six and Coso Obsidian.

Hypothesis: $M_a - M_b = 0$.

Sample	Mean	S	S^2	n
A. Group Six	14.73	0.98	0.9604	12
B. Coso Hot Springs	14.94	2.13	4.5369	5

$F_s = 4.724$
$F_{.05}[11,4] = 4.70 < F_s = 4.724$. Therefore, variances are unequal.

$t'_s = 0.2693 < t_{.05} = 2.6755$. Therefore, cannot reject hypothesis that $M_a - M_b = 0$ and conclude that the samples are drawn from populations with equal means.

The highest flake frequencies are found in the central part of the component generally coinciding with a scatter of granitic rock fragments at 30-40 cm deep and a bowl-shaped "pit" containing charcoal-stained earth about 45 cm in diameter and between 30 and 60 cm deep (combined to form Feature 15). The flake count decreased with increasing vertical and horizontal distance from this central feature.

Subsurface Obsidian

All subsurface obsidian was derived from 4-SBr-4966, the Henwood site, with the greater part coming from components 1, 3, and 4. These components are buried in gravelly unconsolidated Holocene fan deposits (Unit B). Cultural strata appear non-existent. This is due to the fact that the material was deposited on a loose gravely fan surface, probably trampled by human traffic and moved by the erosional and depositional processes of the fan and subsequent burrowing by rodents. That there is any spatial patterning of the cultural material is noteworthy.

Component 1 is a subsurface and separate component from the surface material of Locus G, bounded by gridlines S1676, S1687, E2028 and E2091. Component 1 is defined as comprising the content of these units below 10 cm depth. Materials from nearby units may be related to Component 1 but their relationship is not clear and they are excluded from this discussion.

The distribution of the obsidian in Component 1 reflects the conditions described above. The obsidian is scattered throughout the deposit to a depth of ca 70 cm with greatest frequencies in the 30 to 40 cm level. The 24 obsidian hydration measurements from Component 1 are listed in Table 9-5. When considered as a single unit the 00.0 and 20.3 measurements are aberrant and omitted from further calculations resulting in a mean of 11.89 with a coefficient of variation of 18.25. The means and coefficient of variation for the levels at 20 cm increments are:

LEVEL	MEAN	S	CV	n
10-30 cm	11.9	2.21	18.65	6
30-50 cm	11.7	2.02	17.16	8
50-70 cm	12.1	2.67	22.12	8
TOTAL	11.9	2.17	18.25	22

The figures indicate considerable variation within each sample, but little variation among the means of the three vertical units. This suggests that mixing has occurred among the three levels and is further supported by the smallest measurement, 7.5 microns, occurring in the lowest level and the largest, 15.9 microns, occuring in the upper level.

Component 3 contained hydration measurements with a mean, standard deviation and coefficient of variation as shown in Table 9-7. Two measurements from Component 3 appear aberrant. A 19.8 micron measurement falls outside two standard deviations and it is omitted from further consideration. The 5.8 measurement falls just inside two standard deviations from the mean, but a measurement from the second edge of the same item was 12.0 microns. Therefore the 5.8 micron measurement is also omitted from further consideration. The adjusted mean, standard deviation, and coefficient of variation (Table 9-7) will be used in further calculations and analyses.

Table 9-5: Coso Obsidian Hydration Measurements from 4-SBr-4966, Component 1.

Catalog Number	Hydration Measurement	Excavation Unit	Depth (cm)
178-6731	11.8 ± .8	S1678E2085	10-20
178-6305	9.8 ± .4	S1681E2087	10-20
178-6622	15.9 ± .3[3]	S1679E2087	20-30
178-6309	12.2 ± .7	S1681E2087	20-30
178-6489	11.4 ± .4	S1685E2083	20-30
178-6876	10.0 ± .5	S1681E2089	20-30
178-6459	11.0 ± .3	S1683E2085	30-40
178-3205	11.0 ± .2	S1683E2085	30-40
178-6561	20.3 ± .7[2]	S1682E2083	30-40
178-6643	12.0 ± .3	S1679E2087	30-40
178-6743	9.5 ± .6	S1678E2085	30-40
178-6812	11.1 ± .4	S1282E2089	30-40
178-6879(1)	14.8 ± .6	S1681E2089	30-40
178-6879(2)	9.8 ± .4		
178-6976	0.0 ± .0[1]	S1679E2085	30-40
178-6984	14.7 ± .1	S1679E2085	30-40
178-3016	10.9 ± .3	S1686E2085	40-50
178-6387	13.1 ± .4	S1681E2085	40-50
178-3019	9.4 ± .3[3]	S1686E2085	50-60
178-6465(1)	15.1 ± .5	S1683E2085	50-60
178-6465(2)	13.1 ± .3		
178-6422	7.5 ± .3	S1683E2083	60-70
178-6867	12.4 ± .6	S1685E2087	60-70
178-6867	15.1 ± .5	S1685E2087	60-70

n	=	23.00	n	=	22.00[2]
Mean	=	12.2	Mean	=	11.89
S	=	2.79	S	=	2.17
CV	=	22.84	CV	=	18.25

Table 9-5: Continued.

Catalog Number	Hydration Measurement	Excavation Unit	Depth (cm)
Obsidian Hydration Measurements from locations near Component 1			
178-2968	13.4 ± .4[3]	S1715E2060	10-20
178-6098(1)	11.4 ± .2	S1698E2085	20-30
178-6098(2)	8.2 ± .2		
178-3108-1	8.9 ± .2[3]	S1685E2080	30-40

[1] Omitted from all calculations
[2] 20.3 measurement omitted from calculations
[3] Sample Group Six Coso obsidian. All others are Coso Hot Springs obsidian.

Component 2 yielded only three pieces of Coso obsidian giving four measurements. These are listed in Table 9-6.

Table 9-6: Coso Obsidian Hydration Measurements from 4-SBr-4966, Component 2.

Catalog Number	Hydration Measurement	Excavation Unit	Depth (cm)
178-7664(1)	13.0 ± .5	S1460E2013	10-20
178-7664(2)	11.5 ± .3		
178-8002	7.6 ± .3	S1459E2013	20-30
178-7711	9.3 ± .2	S1460E2013	50-60

n	=	4.00
Mean	=	10.40
S	=	2.07
CV	=	19.90

Obsidian Hydration Measurements from locations near Component 2:

178-5952	16.3 ± .9	SV East	10-20

Component 4 has a large coefficient of variation and standard deviation (Table 9-8), suggesting that two populations are represented in the sample. The sample was divided into two levels (20-50 cm and 50-70 cm).

LEVEL	MEAN	S	CV	n
20-50 cm	11.8	3.86	32.71	5
50-70 cm	16.1	3.47	21.55	6

All units with equal means and variances may be asumed to be of the same age as determined by obsidian hydration measurements. All subdivisions of Component 1 may be grouped together as a single component. Component 1, Component 3, and Component 4, 20-50 cm, can be grouped together as a single chronological unit. However, Component 4, 50-70 cm appears to represent a separate, earlier chronological unit.

Components 1 and 3 each appear to represent a single occupation level associated with a feature. The non-obsidian flakes are most numerous in close proximity to those features and decrease in number, both horizontally and vertically, as distance from the feature increases. This suggests that the occupation was probably a short interval associated with the feature. Post-deposition movement of flakes out from the occupation zone by rodents and other factors may explain the distribution. This is almost certainly part of the explanation for the distribution of flakes. However, correlation of greater hydration mean with greater depth suggests that Component 4 may have been occupied intermittently over a considerable period of time.

The subsurface components can now be ordered by size of the mean; theoretically, this ordering reflects the relative age of each. The data given in Table 9-9 indicate a relatively large dispersion of hydration measurements within each component and relatively little dispersion of the means. This suggests that the differences in age of these components may be small. The rate of hydration may be estimated by calculation for Component 1 30-50 cm, for which we have a radiocarbon date of 8470 ± 370 and a hydration mean of 11.7. This gives an estimated hydration rate of 724 years per micron.

Table 9-7: Coso Obsidian Hydration Measurements from 4-SBr-4966, Component 3.

Catalog Number	Hydration Measurement	Excavation Unit	Depth (cm)
178-7405(1)	12.0 ± .6	S1568E2113	30-40
178-7405(2)	5.8 ± .3[1]		
178-7451	12.2 ± .2	S1570E2115	30-40
178-7391	9.0 ± .3[2]	S1570E2115	40-50
178-7292	12.3 ± .7	S1570E2117	40-50
178-7381	19.8 ± .9[1]	S1570E2115	40-50
178-7265(1)	10.9 ± .3	S1572E2113	50-60
178-7265(2)	12.4 ± .6		
178-7625	12.1 ± .5	S1574E2113	50-60
178-7435	13.2 ± .1	S1572E2115	50-60

Calculations including outliers			Adjusted calculations excluding outliers		
n	=	10.00	n	=	8.00[1]
Mean	=	11.97	Mean	=	11.76
S	=	3.51	S	=	1.28
CV	=	29.32	CV	=	10.88

Obsidian Hydration Measurements from locations near Component 3

178-3064-2	8.2 ± .3	S1574E2121	40-50
178-3064	10.5 ± .3**	S1574E2121	40-50

[1] Outliers 5.8 and 19.8 dropped from final calculations of hydration measurements.

[2] Sample Group Six obsidian. All others Coso Hot Spring obsidian.

Table 9-8: Coso Obsidian Hydration Measurements from 4-SBr-4966, Component 4.

Catalog Number	Hydration Measurement	Excavation Unit	Depth (cm)
178-3478-1	8.9 ± .3	S1632E2100	20-30
178-3509	11.5 ± .4	S1632E2099	40-50
178-8107	11.2 ± .3	S1630E2105	40-50
178-3310-9	18.3 ± .9	S1630E2100	40-50
178-3310	8.9 ± .5[2]	S1630E2100	40-50
178-3315-7	14.9 ± .5	S1630E2100	50-60
178-8111-2	15.7 ± .5	S1630E2105	50-60
178-3488-2(1)	10.1 ± .6	S1632E2100	50-60
178-3488-2(2)	7.4 ± .4[1]		
178-3488-5	20.0 ± .3	S1632E2100	50-60
178-6156	17.4 ± .5	S1634E2100	50-60
178-3492	18.5 ± .2	S1632E2100	60-70

n	=	12.00	n	=	11.00[1]
Mean	=	13.57	Mean	=	14.13
S	=	4.395	S	=	4.25
CV	=	32.38	CV	=	30.07

Obsidian Hydration Measurments from near Component 4:

178-3263(1)	12.8 ± .5	S1630E2110	20-30
178-3263(2)	13.5 ± .3		
178-3264	11.2 ± .7	S1630E2110	30-40
178-7501	9.7 ± .3[2]	S1638E2098	30-40
178-7788	13.1 ± .5	S1648E2119	47

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[1] Measurement 7.4 omitted from calculation.
[2] Sample Group Six obsidian. All others Coso Hot Spring obsidian.

Table 9-9: Chronological Ordering of Components by Mean of Obsidian Hydration Measurements.

Component	Mean	S.	C.V.	n
2	10.4	2.38	23.00	4
3	11.8	1.28	10.88	8
4; 20-50 cm	11.8	3.86	32.71	5
1 (combined)	11.9	2.17	18.25	22
1; 10-30 cm	11.9	2.21	18.62	6
1; 30-50 cm	11.7	2.02	17.26	8
1; 50-70 cm	12.1	2.67	22.12	8
4 (combined)	14.1	4.25	30.07	11
4; 50-70 cm	16.1	3.47	21.55	6

However, since the differences in the means of the obsidian hydration measurements among the three levels of Component 1 are not significant it may be more accurate to use the mean of the larger sample, i.e., all of the hydration readings from Component 1. This larger sample has a mean of 11.9, giving a rate of 712 year per microns. Another calculation can be made by dividing the mean of the two radiocarbon dates from Component 2 (7275 BP) by the mean of the four hydration readings from Component 2 (10.4 microns) which gives a rate of 700 years per micron. The descrepancy between these rates is small and may be attributed to the difference in the size of the samples. The rate of 712 years per microns is not only the rate from the largest sample, but also the mean of the three rates calculated above. Using a rate of 712 microns per year, the age can be estimated for each subsurface unit from which we have hydration measurments on Coso obsidian. These are shown in Table 9-10.

Table 9-10: Estimated Age of Components in Radiocarbon Years.

Component/level	Mean[1]	S.	n	C^{14} estimate
2	10.4	2.38	4	5455 ± 1695 B.C.[2]
3	11.8	1.28	8	6452 ± 911 B.C.
4 20-50 cm	11.8	3.86	5	6452 ± 2748 B.C.
1 combined levels	11.9	2.17	22	6523 ± 1545 B.C.
1 10-20 cm	11.9	2.21	6	6523 ± 1573 B.C.
1 30-50 cm	11.7	2.02	8	6380 ± 1438 B.C.[3]
1 50-70 cm	12.1	2.67	8	6665 ± 1901 B.C.
4 combined levels	14.1	4.25	11	8089 ± 3026 B.C.
4 50-70 cm	16.1	3.47	6	9513 ± 2470 B.C.

[1] Mean of obsidian hydration measurements.
[2] Accelerator dates of 5200 ± 290 B.C. (AA-649) and 5450 ± 280 (AA-800) for this level.
[3] Accelerator date of 6520 ± 370 B.C.(AA-648) from this level.

In addition to the buried obsidian discussed above, six other pieces were recovered from excavation units in non-locus areas. These are listed in Table 9-11.

Table 9-11: Obsidian Hydration Measurements on Items Recovered from Non-locus Excavation Units, 4-SBr-4966.

Catalog Number	Hydration Measurement	Excavation Unit	Depth (cm)
178-7791	11.4 ± .4	Trench B2	35
178-3246(1)	10.7 ± .5	S1670E2100	0-10
178-3246(2)	13.0 ± .1		
178-3247	12.7 ± .7	S1670E2100	10-20
178-3364(1)	12.5 ± .7	S1604E2120	50-60
178-3364(2)	14.3 ± .3		
178-3355(1)	10.9 ± .6	S1604E2120	10-20
178-3355(2)	13.4 ± .2		
178-811' 2	15.7 ± .5	S1630E2105	50-60

Surface Obsidian

Thirty pieces of Coso obsidian, giving 34 readings, were collected from the surface of the Henwood site (4-SBr-4966). These are listed by locus in Table 9-12. Another 26 pieces, giving 36 readings, were collected from four other surface sites on Nelson Wash, and these are listed in Tables 9-13 and 9-14. These hydration measurements are used as one means of placing these sites in relative chronological order (Table 9-15).

The chronological order of the surface assemblages, arrived at by means of relative thickness of obsidian hydration rinds, must be considered tentative. The samples are small, possibly represent long periods of time, and the hydration may be highly variable because of unpredictable uncovering and recovering of the specimens. Furthermore, the hydration measurements from the surface obsidian are not comparable to those of the subsurface obsidian. We have in effect, two independent, relative chronologies. The problem is to integrate them and this can only be done by infering certain models and testing them with other data.

Table 9-12: Obsidian Hydration Measurements on Items from the Surface of the Henwood Site (4-SBr-4966).

Catalog	Hydration Measurement	Unit	Locus
178-241	14.1 ±	S1966E2003	A
178-1907	14.7 ± .3	S1960E1995	A
178-3541	12.2 ± .5	S1960E1992	A
178-1903	13.7 ± .9	S1965E1995	A

n	=	4.00
mean	=	13.70
S	=	1.07
CV	=	7.81

Table 9-12: Continued.

Catalog	Hydration Measurement	Unit	Locus
178-609	14.2 ±	S1740E1896	B
178-945	13.1 ± .6	S1725E1925	B
178-1499(1)	27.7 ± .7	S1716E1913	B
178-1499(2)	16.6 ± .3		

n	=	4.00	n	=	3.00[1]
mean	=	17.90	mean	=	14.60
S	=	6.69	S	=	1.79
CV	=	39.35	CV	=	12.26

Catalog	Hydration Measurement	Unit	Locus
178-4543	5.7 ± .5	S1727E1921	'near' B
178-571	15.1 ±	S1284E1769	C
178-2128	12.3 ± .3	S1380E1865	C
178-2172	5.6 ± .3	S1410E1760	C
178-2874	13.6 ± .5	S1520E1779(0-10cm)	C
178-5515	16.0 ± .4	S1496E1763	C

n	=	5.00	n	=	4.00[2]
mean	=	12.50	mean	=	14.30
S	=	4.12	S	=	2.83
CV	=	32.96	CV	=	19.79

Catalog	Hydration Measurement	Unit	Locus
178-2329(1)	9.1 ± .1	S1650E2000	D
178-2329(2)	13.4 ± .3	S1650E2000	D

n	=	2
mean	=	11.3

Table 9-12: Continued.

Catalog	Hydration Measurement	Unit	Locus
178-4905	0.0[3]	S1482E2019	E
178-3712(1)	14.0 ± .2	S1426E1940	E
178-3712(2)	11.9 ± .3	S1426E1940	E
178-4114	12.9 ± .2	S1461E1910	E
178-5382(1)	13.4 ± .2	S1458E1927	E
178-5382(2)	10.0 ± .5	S1458E1927	E
178-2412	11.0 ± .3	S1440E2010	E
n = 6.00[3]			
mean = 12.20			
S = 1.52			
CV = 12.46			
178-716	12.9	S1690E2136	G
178-718	12.7	S1693E2150	G
178-836	14.0	S1625E2100	G
178-838	9.9	S1644E2147	G
178-839	17.7	S1721E2045	G
n = 5.00			
mean = 13.40			
S = 2.82			
CV = 21.04			
178-3910	12.4	S1497E1935	H
178-575	11.3	S1177E1892	NL
178-574	9.6	S1182E1833	NL
178-708	13.8	S1196E1897	NL
178-5585	19.3 ± .8	S1102E1900	NL
178-4240	7.9 ± .3	S1797E2201	NL
n = 5.00			
mean = 12.40			
S = 4.74			
CV = 38.23			

[1] 27.7 measurement omitted from this calculation.
[2] 5.6 measurement omitted from this calculation.
[3] 0.0 measurement omitted from this calculation.

Table 9-13: Obsidian Hydration Measurements from Surface Sites with Small Obsidian Samples (4-SBr-4965, -4968, -5265).

Site/Catalog Number	Hydration Measurement
SBr-4965/	
176-76	10.8 ± .3
SBr-4968/	
180-68	28.3 ± .6
SBr-5267/	
440-1(1)	6.6 ± .4
440-1(2)	2.3 ± .1
440-192	14.1 ± .3
440-202[1]	8.9 ± .4
440-198	14.7 ± .3
440-247(1)	21.6 ± .0
440-247(2)	19.4 ± .5
440-490	27.1 ± .8
440-571(1)	10.3 ± .4
440-571(2)	12.5 ± .4

Complete Sample			Adjusted Sample		
n	=	10.00	n	=	7.00
Mean	=	13.80	Mean	=	12.40
S	=	7.39	S	=	4.23
CV	=	53.55	CV	=	34.11

The hydration measurements from the subsurface obsidian have been correlated with the radiocarbon dates to produce a rate of 712 years per micron. This rate obviously does not apply to the surface obsidian with its thicker hydration rinds. Therefore, we must attempt to make other correlations if we are to integrate these two independent techniques of relative dating. The surface obsidian at Locus E must be younger than the buried material of Component 2 which it overlies. Therefore, the Locus E surface obsidian must be younger than the 6950 radiocarbon

Table 9-14: Obsidian Hydration Measurements from 4-SBr-4963 (Surface).

Catalog Number	Hydration Measurement
174-141	14.9
174-173(1)	14.4
174-173(2)	4.4 (omit)
174-134(1)	15.4
174-134(2)	17.1
174-55(1)	14.7
174-55(2)	6.9 (omit)
174-63	13.5
174-121-1(1)	14.8
174-121-1(2)	21.0 (omit)
174-121-2	15.3
174-127-1	16.5
174-127-2(1)	14.2
174-127-2(2)	16.5
174-133	15.5
174-354	12.7
174-410	14.8
174-257(1)	18.1 (omit)
174-257(2)	15.4
174-24	16.9
174-35	11.3
174-39(1)	15.7
174-39(2)	12.9
174-77	15.4

Complete Sample			Adjusted Sample		
n	=	24.0	n	=	20.0[1]
Mean	=	14.5	Mean	=	14.9
SD	=	3.35	SD	=	1.46
CV	=	23.10	CV	=	9.80

[1] Measurements 4.4, 6.9, 18.1 and 21.0 omitted

Table 9-15: Chronological Ordering of Surface Assemblages Based on Obsidian Hydration Measurements.

Site/locus	Mean	S	CV	n
4966 E	12.2	1.52	12.46	6
5267	12.4	4.23	34.11	7
4966 G	13.4	2.82	21.04	5
4966 A	13.7	1.07	7.81	4
4966 C	14.3	2.83	19.79	4
4966 B	14.6	1.79	12.26	3
4963	14.9	1.46	9.80	20

years (5200 B.C.) for Component 2. The cultural material from Locus H must also be younger than the 5190 B.C. date for Feature 2 in that locus. The single obsidian hydration reading from Locus H is 12.4 microns. If the surface material represents the latest of a continuous occupation of the site, then we may assume that the age represented by the hydration measurements of the surface sample is only slightly younger than the age of the subsurface occupation. Therefore, the age of the surface material at both Locus H and Locus E is estimated to be about 5000 B.C. An age of 5000 B.C. for a hydration mean of 12.2 gives a rate of 570 microns per year. Using this rate the ages are estimated for the seven surface assemblages which co[illegible] three or more obsidian hydration readings (Table 9-16).

The estimated radiocarbon years may now serve as a means of tentatively integrating the subsurface and surface assemblages into a single chronological order (Table 9-17). In ordering these assemblages it is important to note that each is given a single date, but this date is based on the mean of a series of obsidian hydration measurements. Such a mean may represent a long or short occupation, a period when the obsidian was in use, or a number of other possibilities. The standard deviation and correlation of coefficent provide some indications as to the length of time represented by the variability in the hydration measurement (providing their is a correlation between hydration measurement and time).

The surface assemblages from 4-SBr-4966 A, -4966 B, -4966 E and -4963, and the subsurface Component 3 exhibit the relatively small coefficient of variation and standard deviations suggesting that they represent the occupations of shortest durations. Subsurface Component 4 and surface site 4-SBr-5267 exhibit the greatest variability in hydration measurements. This great variability may be due to greater length of occupation at the site or by some unknown causes. The mean, standard deviation and coefficient of variation for Component 4 (combined or not) are so large that it seem unlikely that it represents the age of occupation at that component. The standard deviation and coeffecient of variation for site 4-SBr-5267 are also large, but the mean is reasonable, suggesting that this site was occupied for a long period of time. Subsurface components 1 and 2, and surface loci 4-SBr-4966 G and -4966 C form an intermediate group between the two extremes of variation and may represent a relatively long duration of occupation.

Table 9-16: Estimated Ages of Surface Assemblages Based on Obsidian Hydration Measurements (rate of 570 microns/year).

Site/Locus	Mean	S	CV	n	Radiocarbon Years
4966 E	12.2	1.52	12.46	6	5000 ± 866 B.C.
5267	12.4	4.23	34.11	7	5118 ± 2411 B.C.
4966 G	13.4	2.82	21.04	5	5688 ± 1607 B.C.
4966 A	13.7	1.07	7.81	4	5859 ± 610 B.C.
4966 C	14.3	2.83	19.79	4	6201 ± 1613 B.C.
4966 B	14.6	1.79	12.26	3	6372 ± 1020 B.C.
4963	14.9	1.46	9.80	20	6543 ± 832 B.C.
4966 H	12.4			1	5118 B.C.
4966 D	11.3			2	4491 B.C.
4965	10.8			1	4206 B.C.

Table 9-17: Chronological Ordering of Loci and Sites by Estimated Radiocarbon Years Based on Obsidian Hydration and Limited Radiocarbon Dates.

Site/Locus	Estimated Radiocarbon Date
SBr-4966 E*	5000 ± 866 B.C.
SBr-5267*	5118 ± 2411 B.C.
SBr-4966 Comp. 2	5455 ± 1695 B.C.
SBr-4966 G*	5688 ± 1607 B.C.
SBr-4966 A*	5859 ± 610 B.C.
SBr-4966 C*	6201 ± 1613 B.C.
SBr-4966 B*	6370 ± 1020 B.C.
SBr-4966 Comp. 3	6452 ± 912 B.C.
SBr-4966 Comp. 4 (20-50cm)	6450 ± 2748 B.C.
SBr-4966 Comp. 1	6523 ± 1545 B.C.
SBr-4963*	6543 ± 832 B.C.
SBr-4966 Comp. 4 (combined)	8089 ± 3026 B.C.
SBr-4966 Comp. 4 (50-70cm)	9513 ± 2470 B.C.

*Surface assemblages

TYPOLOGICAL DATING

Typological dating is based on the understanding that formal attributes of an artifact type may be limited to a definable period of time, and if that period of time can be independently dated then that artifact can be used as a time marker for arranging the artifact assemblages in a relative, and sometimes chronometric, order. In the central Mojave Desert the typological dating of the early periods of occupation has been traditionally based on projectile point types. Although there is no universal agreement among archaeologists as to the absolute date that should be applied to the projectile point forms, there is general agreement in the relative ordering of those forms. The projectile points most often used as time markers for the early period of occupation in the central Mojave Desert are listed in Table 9-18.

Table 9-18: Correlation of Projectile Point Types and Chronological Periods.

Point Types	Chronological Period
Elko series Gypsum Humboldt series	Gypsum period
Pinto series	Pinto period
Lake Mojave series (including Silver Lake) Fluted points	Lake Mojave period

No chronometric age is given here because assigning absolute age to these periods is one of the problems under consideration. Before we address this problem the artifact assemblages from the Nelson Wash sites will be arranged in order based on the presence of the time sensitive projectile points. This ordering of sites will be compared to the chronological order arrived at through the use of obsidian hydration measurements. This will provide an independent test for the validity of the relative order of the sites/loci as determined by obsidian hydration measurements.

The distribution of projectile points are give in Table 9-19. Arranging the order of the Nelson Wash sites by projectile point types involves some problems of interpretation that

are explicitly stated here. Lake Mojave and Pinto series points are rather numerous, but Gypsum period points are few in number and some of the forms of large stemmed points can not be definitely identified as Gypsum period points. There are only two specimens that are so identified. However, the presence of questionable Gypsum period points are indicated on the tables illustrating the chronological ordering of the assemblages (Table 9-20).

The sites are ordered into four classes on the basis of the occurrence of Lake Mojave and Pinto points: Class 1 has Lake Mojave points, but no Pinto points; Class 2 has Lake Mojave and Pinto points; Class 3 has Pinto points but no Lake Mojave points; Class 4 has neither Pinto nor Lake Mojave points. A given site in any of these classes may have point types other than Pinto and Lake Mojave.

Table 9-19: Distribution of Projectile Points Among Nelson Wash Sites and Loci.

TYPE	4969	4968	4967	4966A	4966B	4966C	4966D	4966E	4966F	4966G	4966H	4966I	49661	49662	49663	49664	4965	4963	5267
Mojave Period																			
1A	-	4	-	3	2	-	-	-	-	-	-	-	2	-	-	-	-	5	2
1B	-	-	1	7	1	-	-	-	-	-	-	-	-	-	-	-	-	2	1
1C	-	-	-	3	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-
2	-	-	1	1	4	2	-	-	-	-	1	1	-	-	-	-	-	2	-
4	-	-	-	-	-	1	-	-	-	-	-	-	1	-	-	-	-	-	-
Pinto Period																			
3A	-	-	-	-	-	-	-	-	1	1	-	-	-	-	-	-	-	-	1
3B	-	-	-	-	-	-	-	-	-	1	1	-	-	-	-	-	-	-	-
3C	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-
3D	1	-	-	6	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-
3E	-	-	-	2	-	-	-	-	-	-	1	-	-	-	-	-	-	-	2
Gypsum Period																			
5	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	1	1
7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
Possible Gypsum Period																			
6	-	-	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-
8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
9	-	-	-	-	-	1	-	-	-	-	2	-	-	-	-	-	-	1	1
10	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	1	-	-
12	-	-	-	-	1	-	-	-	-	-	-	1	-	-	-	-	-	-	-
13	-	-	-	1	-	1	-	-	-	-	1	-	-	-	-	-	-	-	-
Other Points																			
8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
11	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-
14	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	1	-
15	-	1	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
16	-	-	-	1	-	1	-	-	-	-	-	-	-	-	-	-	-	3	-
17	-	-	-	2	-	1	-	-	-	-	-	-	-	-	-	-	-	-	2
18	-	-	-	1	1	3	-	-	-	-	-	-	1	-	1	-	-	1	3
19	1	1	-	8	3	7	-	-	-	1	2	2	6	-	2	-	6	1	3

The chronological orderings based on obsidian hydration measurements, radiocarbon dating and typological dating tend to support one another so that an integrated chronology can be constructed for the Nelson Wash sites. This chronology is presented in Table 9-20. It appears that the Lake Mojave and Pinto periods are not separated by a hiatus, and that the Pinto period probably begins even earlier than 5000 B.C. as proposed by Warren and Crabtree (1986), perhaps as early as 6000 B.C.

The data from the Nelson Wash sites do not support the interpretation of either a hiatus in occupation or the short chronology. These sites appear to represent a transition from the Lake Mojave to the Pinto period over a relatively short period of time. This transition is not clearly identified because the majority of the assemblages are limited to the surface and may represent mixed rather than transitional components.

Table 9-20: Ordering of Sites and Loci by Time-Sensitive Projectile Points and Estimated Age in Radiocarbon Years.

CLASS	Site/ Loci	Periods: Lake Mojave	Periods: Pinto	Gypsum	Estimated Age in Radiocarbon Years
C	SBr-4966 Cmp.4	No Projectile Points Class 4			8089 ± 3026 B.C.
L	SBr-4968	Class 1			---
A	SBr-4967[3]	Class 1			---
S	SBr-4966 Cmp.1	Class 1			6523 ± 1545 B.C.
S	SBr-4963[3]	Class 1		?	6543 ± 832 B.C.
	SBr-4966 Cmp.3	No Diagnostic Projectile Points			6452 ± 1695 B.C.
1	SBr-4966B[3]	Class 1		?	6370 ± 1020 B.C.
_	SBr-4966I[3]	Class 2		?	---
	SBr-4966A[3]	Class 2		?	5859 ± 610 B.C.
2	SBr-4966C[3]	Class 2			6201 ± 1613 B.C.
	SBr-5267[3]	Class 2			5118 ± 2411 B.C.
_	SBr-4966H[3]	Class 2			5118 B.C.[1]
	SBr-4969[3]	Class 3			
3	SBr-4966F[3]	Class 3			

Table 9-20: Continued.

CLASS	Site/ Loci	Periods: Lake Mojave	Pinto	Gypsum	Estimated Age in Radiocarbon Years
	SBr-4966G[3]	Class 3			5688 ± 1607 B.C.
	SBr-4966 Cmp.2	No Projectile Points Class 4			5455 ± 1695 B.C.
	SBr-4966E[3]	No Projectile Points Class 4			5000 ± 866 B.C.
	SBr-4966D[3]	No Projectile Points Class 4			4491 B.C.[2]
	SBr-4965	No Diagnostic Points Class 4			4206 B.C.[4]

1 Age based on one obsidian hydration measurement of 12.4 and a maximum age for the cultural deposit by radiocarbon date of 5190 B.C.

2 Age based on two obsidian hydration readings from a single item; 9.1 and 13.4 microns for a mean of 11.3.

3 Surface assemblages.

4 Age based on one obsidian hydration measurement of 10.8 microns.

COMPARATIVE ANALYSES

Another way in which the long and short chronologies can be tested is by comparative analyses utilizing data, recently described, from other sites of the Pinto and Lake Mojave periods.

In several papers, Jenkins and Warren (1984; 1986:142-153) compared obsidian hydration readings and radiocarbon dates from early period sites in the Mojave Desert. This material is reviewed in light of the material presented above. The main focus of the Jenkins and Warren papers has been the Awl site (4-SBr-4562), an early period site containing what appears to be both Lake Mojave and Pinto period material, and its chronological relationship to other sites in the area.

The Awl site (4-SBr-4562) is located adjacent to the ancient and undated overflow channel of Drinkwater Lake at the extreme western end of Drinkwater Basin. This outlet channel is now cut off from Drinkwater Playa by coalescing fans and there is no direct evidence that the occupation was contemporaneous with an outflow from Drinkwater Lake.

The Awl site is divided into two major loci (Jenkins and Warren 1986). Heavy erosion has removed the deposits and lowered the artifacts onto ancient lake deposits and hardpan in Locus B. Locus A has been protected by a granitic ridge and up to 2 m of cultural deposits have been preserved. However, the northeastern edge of Locus A is being eroded by a major arroyo and the headward cutting of small tributary arroyos has created a steep irregular slope that has cut into the deposits, exposing and displacing artifacts from the full 2 m depth.

Jenkins and Warren (1986) excavated four 1X1 meter test units in Locus A to sterile subsoil that varied in depth from 100 cm to 200 cm. Three of these units yielded obsidian flakes and artifacts, 30 of which have been identified as Coso obsidian and have had hydration measurements taken. All of the subsurface obsidian came from more than 40 cm below the surface. No obsidian was recovered between the surface and the 40 cm level. Hydration measurements were also taken on another 30 Coso obsidian items from the surface of Locus A and six from Locus B. The surface obsidian is assumed to have derived from all depths as well as the surface. However nine items could be identified as coming from the relatively level and uneroded portion of the surface of Locus A. Because of their location, these nine items are the ones most likely to have been exposed on the surface since the period of last occupation of the site. These are the pieces most likely to have been exposed to the intense heat of the ground surface for a long time and to reflect this in thicker hydration rinds.

The obsidian sample from the Awl site has been divided into four groups based on their contexts:

1. Unmixed surface sample. The nine flakes from the uneroded flat surface of Locus A.
2. Mixed surface sample. Twenty-one (21) pieces from the eroded slope of Locus A.
3. Subsurface sample. Thirty (30) pieces of obsidian from the excavation units at Locus A.
4. Locus B sample. Six (6) pieces of obsidian from the eroded surface of Locus B.

A summary of the hydration measurements for these groups is presented in Table 9-21.

Table 9-21: Obsidian Hydration Measurements for Awl Site, 4-SBr-4562.

Group	n	Mean	S	CV
1. Unmixed Surface, Locus A	9	12.5	1.7	13.70
2. Mixed Surface, Locus A	21	11.9	2.9	23.84
3. Subsurface, Locus A	30	14.3	3.1	21.75
4. Locus B	6	9.8	1.6	16.28

The 12.5 mean for the unmixed surface sample probably reflects the increase hydration rate due to high temperatures of the ground surface. Only one piece is outside two standard deviations, and when that piece is removed from the sample the mean increases to 13.0 (Table 9-22). The relatively low coefficient of variation indicates this group is less dispersed than the mixed surface and subsurface samples. Therefore, this sample may represent a relatively short period of occupation.

The large coefficient of variation for the subsurface and mixed surface suggests that each of these groups may be drawn from two or more periods of discontinuous occupation, or represent a long period of continuous occupation. The subsurface group includes three flakes with measurements greater than 20 microns. These are more than two standard deviations from the mean. These aberrant readings may represent an early occupation, but their distribution within the deposit suggests otherwise. A better explanation may be that they are readings on cortex or old surfaces of quarry material. We therefore remove them from the group and recalculate the mean, standard deviation and coefficient of variation (Table 9-22).

In the mixed surface group, two measurements (6 and 17 microns) are right at two standard deviations from the mean and when they are removed from the calculations the results are only slightly different (Table 9-22). This is clearly a mixed group. It has a smaller mean than either the unmixed surface or the subsurface. This is due to a relatively larger number of pieces between 7.0 and 10.0 microns in the mixed sample. However, given the mean, standard deviation and coefficient of variation for the unmixed surface sample it appears that the 7.0 to 10.9 micron readings probably did not derive from the surface. It seems more likely that the subsurface material between the surface and 40 cm deep is represented by the range of hydration measurements between about 7.5 and 10.9 microns.

The Locus B sample of six pieces of obsidian represents all of the obsidian from a considerably larger area than Locus A, but an area that has been severly eroded, and has minimal buried deposits still extant. Locus B appears to have had shallower deposits than Locus A, and probably less artifact density. Locus B may represent only the later portion of the occupation at the Awl site. The mean of these six hydration measurements is smaller than both the unmixed surface and the subsurface of Locus A, suggesting that these six specimens also eroded from the deposits in relatively recent times.

Table 9-22: Adjusted Obsidian Hydration Measurements from the Awl Site.

Group	n	Mean	S	CV
1. Unmixed Surface, Locus A	8	13.0	1.0	7.95
2. Mixed Surface, Locus A	19	11.9	2.4	20.28
3. Subsurface, Locus A	27	13.5	2.4	17.60
4. Locus B	6	9.8	1.6	16.28

The most common projectile point type from the Awl site was the Pinto (20 of 41 specimens). Other forms included leaf-shaped, and various stemmed points, including Silver Lake, Lake Mojave and Great Basin Stemmed, as well as some unnamed forms. There are no Humboldt points, but three of the Pinto points closely resemble Elko Eared points, and one fragmentary specimen may be a Gypsum point. The surface material appears to date primarily from the Pinto period, but some portion of it may have persisted from the late Lake Mojave period. A single Pinto point was recovered from 30 cm deep in the excavations, a single obsidian Silver Lake point from 50-60 cm in the same unit and a third stemmed point from another unit at 90-100 cm below the surface. As a result of more recent, and as yet unpublished, excavations at the Awl site by Far Western Anthropological Research Group, two accelerator dates have been obtained from between 80 and 100 cm deep. These dates are 7460 ± 115 B.C. (Beta 16100) and 7520 ± 115 B.C. (Beta 16313) (Mark Basgall, personal communication 1986).

The Little Lake Site (Harrington 1957) contained a large number of obsidian artifacts and flakes; Meighan (1981) reported hydration measurements on 65 identifiable obsidian projectile points from this site. Five of the points have no visible hydration rind, but the other 60 have hydration measurements ranging from 6.4 to 17.3 microns and appear to fall into two clusters. Meighan (1981:206) states: "The later group (n=46) ranges from 6.4 to 12.3 microns and averages 9.74. The earlier group (n=11) ranges from 13.5 to 17.3 microns and averages 15.45." When the mean is recalculated for the Little Lake Site with the methods used for calculating the means for the Nelson Wash sites/loci, a somewhat different picture is presented (Table 9-23).

Table 9-23: Mean, Standard Deviation, and Coefficient of Variation for the Little Lake Obsidian Hydration Measurements.

Original Calculations		Adjusted Calculations[1]	
Number	= 63.00	Number	= 58.00
Mean	= 10.57	Mean	= 10.14
S	= 2.97	S	= 2.30
CV	= 28.10	CV	= 22.68

[1] Five measurements (1.7, 3.2, 4.6, 17.2, 17.3) are omitted from these calculations.

The Little Lake obsidian hydration readings exhibit a mean that is very similar to the mean from Component 2 (10.4 microns) dated between 5450 and 5200 radiocarbon years B.C. at the Henwood site. When the hydration rate of 712 year/microns is used, an age for the mean hydration measurement is estimated at 5270 ± 1637 B.C. This date is considerably older than either of the age ranges (A.D. 572-1826 B.C. and 196-3902 B.C.) calculated by Meighan (1981:210) for the Little Lake projectile points.

At Rogers Ridge (4-SBr-5250) in the Tiefort Basin, Jenkins (1985:61-63, 179-182) reports buried cultural deposits associated with a now extinct spring, producing radiocarbon dates of 6230 ± 140 B.C. and 6460 ± 140 B.C. These deposits contain both Lake Mojave and Pinto points, and obsidian from which hydration measurements were made. The obsidian hydration measurements as reported in Jenkins (1985) cannot be correlated with the radiocarbon dates or the artifacts. Newberry Cave (Davis and Smith 1981) is another site of relevance to the dating of the Pinto points. Newberry Cave is clearly a Gypsum period site with Gypsum and Elko Series points, and no Pinto points. Also found in Newberry Cave are a large series of split-twig figurines. Seven dates from this site range from 1020 ± 250 to 1370 ± 180 B.C. and overlap at about 1200 B.C. On the basis of this cluster of dates, Davis and Smith (1981) suggest that the cultural material was deposited over a short interval, perhaps as short as 100 years and probably not longer than 500 years. However, an eighth date of 1815 ± 100 B.C. from Newberry Cave is consistent with the date of 1790 ± 170 B.C. for the period of greatest Gypsum point popularity at O'Malley Shelter (Fowler, Madsen, and Hattori 1973:42-43), and with dates on split-twig figurines in Arizona and Utah (Schroedl 1977).
Therefore, it appears that the Pinto period ended (with the introduction of Gypsum, Elko Series and/or Humboldt points) prior to ca. 1800 B.C.

The data from the central Mojave Desert do not yet provide a clear date for the beginning of the Pinto period. However, the data appear to support the interpretation that there is no hiatus between the Lake Mojave and Pinto periods and that if a hiatus exists it is found between the Pinto Basin assemblage and later assemblages characterized by the Elko and Gypsum points. The data from the Nelson Wash sites appear to support the hypothesis that the Pinto Basin and Lake Mojave Complexes represent a single cultural tradition (Table 9-24).

CULTURAL CONTINUITY AT NELSON WASH

Although not clearly demonstrated, the cultural remains from Nelson Wash appear to support a single cultural tradition that extends from the Lake Mojave period into the Pinto period. The Nelson Wash components appear to document occupation beginning before 6500 B.C. and contnuing until about 4000 B.C. The Lake Mojave - Pinto Basin cultural tradition may be validated by testing five hypothetical statements regarding the nature of this tradition. These are:

1. A preference for macrocrystalline material, usually volcanics or metavolcanics (e.g. basalt, rhyolite, felsite) in the manufacture of bifacial tools. Unifacial tools are more often made of cryptocrystalline materials.

2. An abundance of leaf-shaped or ovate bifaces that vary in size, are most often broken, and represent various stages of manufacture from very rough preforms to finished leaf-shaped cutting tools.

3. Unifaces vary considerably in shape but a large portion of most assemblages are well-formed with edges being modified to the extent that the shape of the original flake is much modified (Group 1 unifaces).

Table 9-24: Estimated Age of Early Times Components Based on Obsidian Hydration[1] and Radiocarbon Dates.

Site/Loci	Periods Lake Mojave	Pinto	Gypsum	Estimated Age B.C. Radiocarbon Years
SBr-4966 Cmp.4	No Projectile Points			8089 ± 3026
SBr-4562 Loc.A Sub.	?			7662 ± 1709[2]
SBr-4968				
SBr-4967				
SBr-4966 Cmp.1				6522 ± 1545[3]
SBr-4963	?			6543 ± 832
SBr-4966 Cmp.3	No Diagnostic Projetile Points			6452 ± 1695
SBr-5250 Loc.1				6460 ± 140[4]
				6230 ± 140[4]
SBr-4966 B	?			6370 ± 1020
SBr-4966 I	?			
SBr-4966 A	?			5859 ± 610
SBr-4966 C				6201 ± 1613
SBr-5267				5118 ± 2411
SBr-4966 H				5118[5]
Little Lake				5269 ± 1637
SBr-4969				

Table 9-24: Continued.

Site/Loci	Periods Lake Mojave	Pinto	Gypsum	Estimated Age B.C. Radiocarbon Years
SBr-4966 F				
SBr-4966 G				5688 ± 1607
SBr-4562	?			5460 ± 570
SBr-4966 Cmp.2	No Projectile Points			5455 ± 1695[6]
SBr-4966 E	No Projectile Points			5000 ± 866
SBr-4966 D	No Projectile Points			4491[7]
SBr-4965	No Diagnostic Points			4208[8]
Newberry Cave				1815 ± 180
				1020 ± 250[9]

[1] Obsidian hydration rate of 712 years/micron used for buried Coso obsidian and a rate of 570 years/micron used for surface Coso obsidian.

[2] Radiocarbon dates of 7460 ± 115 B.C. (Beta 16100) and 7520 ± 115 B.C. (Beta 16313) for subsurface deposits between 80 and 100 cm below surface. Five projectile forms were recovered from the buried occupation zone in more recent excavations by Far West Anthropological Group. These include one Pinto point and a series of points that appear to be variants of Silver Lake or straight stemmed Pinto forms.

[3] Radiocarbon date of 6520 ± 370 B.C. associated with obsidian sample and used to calculate hydration rate.

[4] Two radiocarbon dates only. Correlation of obsidian hydration measurements with excavation units not available at this writing.

[5] This date is based on only one obsidian hydration reading.

[6] Two radiocarbon dates from this component are 5200 ± 290 and 5450 ± 280.

[7] This date is base on two obsidian hydration measurements from one specimen.

[8] This date is based on one obsidian hydration reading of 10.8.

[9] These dates represent the range of eight radiocarbon dates from Newberry Cave.

4. Distinctive unifaces include relatively large elongate keeled and domed scrapers (Types 1 and 2). These scraper types very rarely occur in later assemblages.

5. Small flake engraving tools are also another distinctive artifact type for these early assemblages. This tool, however, is usually found in relatively small numbers and may be missing from small samples.

Each of these attributes, claimed as characteristic of the Early Times in the central Mojave Desert, will be reviewed here. The preference for the use of metavolcanic materials for the production of flaked stone tools, especially bifaces, is apparent when the data are considered in a chronological context. These data were presented in the discussion of assemblage composition (Chapter 7) and are only summarized here in the form of tables.

Table 9-25 demonstrates that the use of metavolcanics predominates in the lithic reduction of tools in all of the components except Component 2 and Component 3 where the tool assemblages are only 43% and 35% metavolcanic, respectively. The flake count indicates that only Component 2 has significantly fewer metavolcanic flakes than other components. Component 2 appears late in the sequence and may represent the beginnings of the change to a preference for cryptocrystalline materials for bifaces as well as unifaces.

The Nelson Wash loci and components also contain a large number of bifaces. The variation in relative number of bifaces in the assemblages does not appear to be due to diachronic change, since there are no correlations between relative number of bifaces and age of the site/locus. The variability in relative biface frequency is more likely related to different local resources, different activities, and in some cases to small sample size. The distribution of bifaces, by percentages of tool assemblage, is shown in Table 9-26.

The sites/loci at the extreme range are in each case unusual in their assemblage composition. Two of the components in the Class 1 sites have small samples; Component 4 yielded only three artifacts and Component 3 only 17. The other excavated component (1) in a Class 1 sites has 68 artifacts in its chipped stone assemblage. The surface site/locus, of Class 1, with less than expected numbers of bifaces is 4-SBr-4968, an occupation site with an unusually heavy occurrence of uniface tools and cores. The large numbers of uniface tools suggest a more specialized activity center than most other sites, and the numerous cores suggest that the heavy surface gravels in which this site is located were used as a lithic source. Site 4-SBr-4967 is a small site which yielded only 26 flaked stone artifacts with a greater number of unifaces than expected and no cores.

In Class 2 sites, 4-SBr-4966C yielded more bifaces (82.0%) than expected. This site appears to be a location at which many of the rough bifaces from the quarry sites were further reduced.

In Class 3 sites, 4-SBr-4969 is a quarry site with a very large number of cores that sets it apart from other sites of this class.

Table 9-25: Percent of Metavolcanics in Tool and Flake Assemblages of the Nelson Wash Sites.

Site/locus	% of Metavolcanics in Flakes	% of Metavolcanics in Artifacts	Estimated age in ^{14}C years B.C.
Class 1 sites			
SBr-4966 Cmp.4	83.0	50.0	8089 ± 3026
SBr-4968	79.8	58.0	
SBr-4967	97.4	----	
SBr-4966 Cmp.1	91.6	67.9	6522 ± 1545
SBr-4963	96.1	83.7	6543 ± 832
SBr-4966 Cmp.3	79.0	35.0	6452 ± 1695
SBr-4966 B	89.6	82.4	6370 ± 1020
SBr-4966 I	91.9	82.9	
Class 2 sites			
SBr-4966 C	90.4	93.8	6201 ± 1613
SBr-4966 A	94.9	89.0	5859 ± 610
SBr-4966 H	94.4	78.8	5118[1]
SBr-5267	87.2	77.1	5118 ± 2411
Class 3 sites			
SBr-4966 F	98.2	96.4	
SBr-4966 G	95.5	76.9	5688 ± 1607
SBr-4969	83.9	69.5	
Class 4 sites			
SBr-4966 Cmp.2	59.5	43.0	5455 ± 1695[2]
SBr-4966 E	74.0	75.0	5000 ± 866
SBr-4966 D	98.9	97.0	4491[3]
SBr-4965	95.7	96.0	4208[4]

[1] Age based on one obsidian hydration reading.
[2] Two radiocarbon dates from this component are 5200 ± 290 and 5450 ± 280.
[3] This date is based on two obsidian hydration measurements from one specimen.
[4] This date is based on one obsidian measurement.

Table 9-26: **Distribution, by Percentage, of Bifaces in Nelson Wash Sites.**

Site/Locus	% of tool assemblage represented by bifaces		Estimated age in ^{14}C years B.C.
Class 1 sites	# of bifaces	% of assemblage	
SBr-4966, Cmp.4	1	33.3	8089 ± 3026
SBr-4968	62	35.4	
SBr-4967	10	38.5	
SBr-4966, Cmp.1	35	51.5	6522 ± 1545
SBr-4963	97	61.4	6543 ± 832
SBr-4966, Cmp.3	6	28.6	6452 ± 1695
SBr-4966 B	376	71.1	6370 ± 1020
SBr-4966 I	67	78.8	
Mean		65.1	
Class 2 sites			
SBr-4966 C	464	82.0	6201 ± 1613
SBr-4966 A	494	70.5	5859 ± 610
SBr-4966 H	97	63.4	5118
SBr-5267	276	65.9	5118 ± 2411
Mean		73.0	
Class 3 sites			
SBr-4966 G	78	72.2	5688 ± 1607
SBr-4966 F	24	68.6	
SBr-4969	23	24.5	
Mean		62.4	
Class 4 sites			
SBr-4966 Cmp.2	51	68.9	5455 ± 1695
SBr-4966 E	9	60.0	5000 ± 866
SBr-4966 D	31	72.1	4491
SBr-4965	25	64.1	4208
Mean		66.5	

Class 4 sites all exhibit the expected range of variability in biface counts, given the size of the samples collected from these sites.

Another test of the "single cultural tradition" hypothesis is by examination of the distribution of the bifaces by type. In order to have sufficient numbers within each "type" the bifaces have been regrouped into the "grouped classes" used above in the analysis of assemblage composition (Tables 9-27, 9-28). The distribution of the grouped bifaces by site class is certainly nonrandom (Chi-square of 55.88 and a P=.00000930). There is a clear correlation between site classes and the grouped bifaces (Tables 9-27, 9-28). However, since biface types 1-13 and 19 are small and others are large, the correlation is probably with biface size and not the grouped biface types. In the discussion of assemblage composition the large bifaces were shown to correlate with those sites with a flake:biface ratio greater than 15:1. This suggests that these sites are locations where intensive lithic reduction occurred, especially in the manufacture of bifaces.

These same data are presented in Tables 9-29 and 9-30 to show a correlation of site classes and changes in biface:flake ratio and number of small bifaces. These correlations suggest that site use in Nelson Wash underwent some significant changes. From Table 9-30 it is apparent that the higher the percentage of small bifaces the lower the flake:biface ratio. The higher flake:biface ratio and the greater numbers of large bifaces, the more intense was the production of bifaces at the site. The later sites (Classes 3 and 4) have greater percentages of large bifaces and higher flake:biface ratios than do the early sites (Classes

Table 9-27: Summed Distribution of Grouped Bifaces by Class of Sites.

Grouped Bifaces	Class 1	ef	Class 2	ef	Class 3	ef	Class 4	ef	Total
1-5	121*	106 9	220-	227.1	16-	19.1	14-	17.9	371
6-11	41-	55.6	142*	118.1	3-	10.0	7-	9.3	193
19	46-	47.2	108+	100.4	5-	8.5	5-	7.9	164
20-21	13*	9.5	11-	20.2	7*	1.7	2+	1.6	33

Table 9-27: **Continued.**

Grouped Bifaces	Class 1	ef	Class 2	ef	Class 3	ef	Class 4	ef	Total
22-25	36+	34.9	65-	74.1	10*	6.2	10*	5.8	121
17-18	76-	78.6	160-	167.1	17+	14.1	20*	13.2	273
15-16	19-	19.3	42+	41.0	5+	3.5	1-	3.2	67
Total	352		748		63		59		1222

Chi square = 55.88
df = 18
P = .00000930

* significantly larger than expected frequency
+ larger than expected frequency
- smaller than expected frequency

1 and 2). It appears, therefore, that there was a general increase of intensity of tool manufacture through time on the Nelson Wash sites.

Unifaces vary considerably in morphology but a portion of most assemblages are Group 1 unifaces (Types 1-10, 15, 20), made by shaping the outline of the tool by major unifacial flaking. Among these unifaces are domed (Type 1) and keeled (Type 2) types that are rarely found in late assemblages and appear to be diagnostic of Early Times in the central Mojave Desert. Small flake engraving tools are another distinctive artifact type of these early assemblages. The small engraver, however, is usually found in relatively small numbers and may be missing from small samples.

Table 9-28: Grouped Biface Distribution by Site Classes.

Grouped Bifaces	Class 1 Sites 4966 B	4966 Cm1	4963	4967	4968	4966 I	4966 Cm3	Class 2 Sites 4966 A	4966 C	4966 H	5267
1-5	84	6	10	3	7	11	-	75	90	9	46
6-11	19	1	11	-	4	6	-	58	46	7	31
15-16	12	2	2	-	1	1	1	12	16	4	10
17-18	52	5	8	-	7	2	2	50	65	18	27
19	22	1	8	1	6	7	1	37	39	6	26
20-21	8	-		1	1	3	- -	-	6	2	3
22-25	23	1	5	1	3	3	-	27	25	5	8
Total	220	16	45	6	31	30	4	259	287	51	151

Grouped Bifaces	Class 3 Sites 4966 F	4966 G	4969	Class 4 Sites 4966 E	4966 Cm2	4965	4966 D
1-5	1	14	1	2	5	4	3
6-11	-	3	-	1	3	3	-
15-16	1	1	3	-	1	-	-
17-18	2	12	3	3	5	4	8
19	-	3	2	-	3	2	-
20-21	1	1	5	2	-	-	-
22-25	1	9	-	2	2	1	5
Total	6	43	14	10		194	16

Table 9-29: Distribution of Small Bifaces by Site Classes (based on controlled surface [cs] sample only).

Site Class Assemblages	Number of Small Bifaces / Number of Typed Bifaces	% Small Bifaces	Biface:Flake Ratio
Class 1			
4966 I	9/13	69.2	1:15
4963	13/19	68.4	1:53
4967	4/6	66.7	not known
4968	14/26	53.8	1:25
4966 B	36/67	53.7	1:17
Total	76/131	58.0	1:23
Class 2			
4966 A	95/132	72.0	1:14
4966 C	56/83	67.5	1:13
5267	25/38	65.8	1:3
4966 H	4/11	36.4	1:63
Total	180/264	68.2	1:15
Class 3			
4966 G	2/4	50.0	1:61
4966 F	1/6	16.7	1:65
4969	1/7	14.3	1:162
Total	4/17	23.5	1:104
Class 4			
4965	4/9	44.4	1:65
4966 E	2/5	40.0	1:110
4966 D	3/13	23.1	1:47
Total	9/27	33.3	1:65

Table 9-30: Small Biface Count and Flake Ratio by Summed Site Classes.

	Class 1	Class 2	Class 3	Class 4	Total
# Small Biface	76	180	17	27	300
Flake per biface	23	15	104	65	207
Total	99	195	121	92	507

Chi square = 237.002
df = 3
p < 0 001

The unifaces generally decrease in relative frequency (percent of total assemblage) from early (Class 1) to late (Class 4) sites (Table 9-31). Only Class 3 sites contain a number of unifaces that is slightly too high - 2% or 4 unifaces too many. This distribution illustrates that the assemblage composition was changing through time but that uniface tools continued to be a substantial part of the assemblages throughout the period of occupation.

Table 9-31: Uniface Distribution by Summed Site Classes.

Site Class	Number of Unifaces	Number of Flaked Stone Tools	% comprised by unifaces
1	240	1062	22.6
2	296	1839	16.1
3	41	237	17.3
3&4	64	408	15.7
4	23	171	13.5

Other diachronic changes in the distribution of unifaces can be seen when the uniface category is broken down into smaller taxonomic units. The 25 uniface types are organized into four large groups for purposes of our analysis here. Three of these groups illustrate the continuity of uniface tool types throughout the occupation of the Nelson Wash sites. Group 1 unifaces are made by shaping the outline by unifacial flaking and include Types 1-10, 15 and 20. Group 2 unifaces are made by retouching flake edges with minimum of modification of the flake outline, and include Types 11-14, and 19. Group 3 unifaces are sharp-pointed engraving tools, or spiked gravers, usually made by unifacial pressure flaking to form one or more small sharp spikes or beaks on the edge of a flake or tool. Group 3 is comprised of only Type 16 unifaces. Group 4 unifaces are fragments that are too incomplete to classify or types that are represented by too few specimens to be statistically significant. Group 4 is omitted from the following analysis.

Details of the changing frequency of the three uniface groups are illustrated in Table 9-32. There is a steady decrease in the relative percentage of Group 1 unifaces from early sites (Class 1) to late sites (Class 4). There is also a fluctuation in the number of Group 3 unifaces with the greater relative number occurring in the Class 2 sites, and an absence of that type in the Class 4 sites. Group 2 unifaces increase from early to late as expected in opposition to Group 1 unifaces. It appears that the Groups 1 unifaces declined and were replaced by the simpler retouched flakes of Group 2 unifaces. This suggests that certain uniface types are chronologically sensitive, changing in relative frequency through time.

An examination of the distribution of the domed and keeled unifaces (Types 1-2) shows that these types appear to be characteristically early (Tables 9-32 and 9-33). Chi-square tests on this distribution in opposition to other artifacts types support this observation (Tables 9-34, 9-35, 9-36, 9-37, 9-38, 9-39, 9-40, 9-41 and 9-42). These illustrate that the distribution of domed and keeled unifaces (Types 1-2) is different from that of retouched flakes (Types 13-14), spiked gravers (Type 16), and all other unifaces combined. This series of Chi-square tests also illustrates that the distribution of Lake Mojave period points (Fluted, Lake Mojave and Silver Lake points) is different from that of retouched flakes (Types 13-14) and Pinto points have a different distribution from both domed and keeled unifaces (Types 1-2) and retouched flakes (Types 13-14).

Table 9-32: Distribution of Summed Uniface Groups by Site Classes.

Class Site/Locus	Group 1		Group 3		Group 2		Total
Class 1 Sites	#	%	#	%	#	%	#
SBr-4966B	50	55.5	1	1.1	39	43.3	90
SBr-4966 Cmp.1	6	30.0	1	5.0	13	65.0	20
SBr-4963	8	26.7	2	6.7	20	66.7	30
SBr-4967	7	63.6	-	0.0	4	36.4	11
SBr-4968	37	50.7	2	2.7	34	46.6	73
SBr-4966I	3	37.5	1	12.5	4	50.0	8
SBr-4966 Cmp. 3	3	37.5	-	0.0	5	62.5	8
Total	114	47.5%	7	2.9%	119	49.6%	240
Class 2 Sites							
SBr-4966A	47	37.3	6	4.8	73	57.9	126
SBr-4966C	25	48.1	1	1.9	26	50.0	52
SBr-4966H	11	36.7	2	6.7	17	56.7	30
SBr-5267	50	56.8	3	3.4	35	39.8	88
Total	133	44.9%	12	4.1%	151	51.0%	296
Class 3 Sites							
SBr-4966F	-	0.0	1	14.2	6	85.7	7
SBr-4966G	8	47.1	-	0.0	9	52.9	17
SBr-4969	5	29.4	-	0.0	12	70.6	17
Total	13	31.7	1	2.4	27	65.9	41

Table 9-32: Continued.

Class Site/Locus	Group 1		Group 3		Group 2		Total
Class 4 Sites							
SBr-4966D	4	57.1	-	0.0	3	42.9	7
SBr-4966E	1	33.3	-	0.0	2	66.7	3
SBr-4966 Cmp. 2	1	9.1	-	0.0	10	90.9	11
SBr-4965	-	0.0	-	0.0	2	100.0	2
Total	6	26.1	0	0.0	17	73.9	23

Table 9-33: Distribution of Selected Artifact Types by Site Class.

Class	Projectile Points		Unifaces			
Site/locus	L.Mojave	Pinto	1-2	16	13-14	Other
Class 1 Sites						
SBr-4966 B	7	0	17	1	37	48
SBr-4966 Cmp.1	3	0	1	1	9	11
SBr-4963	9	0	2	2	20	8
SBr-4967	2	0	1	0	1	2
SBr-4968	4	0	15	2	27	31
SBr-4966 I	1	0	0	1	3	5
SBr-4966 Cmp.?	0	0	0	0	5	3
Class 1 Total	26	0	36	7	107	108
Class 2 Sites						
SBr-4966 A	14	8	9	6	71	56
SBr-4966 C	3	2	7	1	24	28
SBr-4966 H	1	2	1	2	17	13
SBr-5267	3	3	12	3	32	49
Class 2 Total	21	15	29	12	144	146

Table 9-33: Continued.

Class Site/locus	Projectile Points L.Mojave	Pinto	Unifaces 1-2	16	13-14	Other
Class 3-4 Sites						
SBr-4966 F	0	1	0	1	6	3
SBr-4966 G	0	2	1	0	11	7
SBr-4969	0	1	1	0	12	7
SBr-4966 Cmp.2		0	0	0	0	6
SBr-4966E	0	0	0	0	2	2
SBr-4965	0	0	0	0	2	1
SBr-4966 D	0	0	2	0	2	3
Class 3-4 Total	0	4	4	1	42	29

Table 9-34: Chi-Square Test on Distributions of Uniface Types 1-2, 16, and 13-14.

	Uniface Types 1&2	16	13-14
Class 1 Sites	36	7	102
Class 2 Sites	29	12	144
Class 3&4 Sites	4	1	41

Chi-square = 9.491
df = 4
P = 0.05

Table 9-35: Chi-Square test on Distribution of Uniface Types 1-2, 16 and Other Types.

	Uniface Types		
	1&2	16	Other
Class 1 Sites	36	7	168
Class 2 Sites	29	12	290
Class 3&4 Sites	4	1	71

Chi-Square =13.261
df = 4
P = 0.010

Table 9-36: Chi-Square test on Distribution of Uniface Types 1-2 and Types 13-14.

	Uniface Types	
	1-2	13-14
Class 1 Sites	36	102
Class 2 Sites	29	144
Class 3&4 Sites	4	41

Chi-Square = 7.901
df = 2
P < 0.0193

Table 9-37: Chi-Square Test on Distribution of Lake Mojave Points, Pinto Points and Uniface Types 1-2, and 13-14.

	Projectile Points		Uniface Types	
	Lake Mojave	Pinto	1-2	13-14
Class 1 Sites	26	0	36	102
Class 2 Sites	21	15	29	144
Class 3&4 Sites	0	4	4	41

Chi-Square =29.664
df = 6
P < 0.000046

Table 9-38: Chi-Square Test on Distribution of Lake Mojave Points and Uniface Types 13-14.

	Lake Mojave Points	Uniface Types 13-14
Class 1 Sites	26	102
Class 2 Sites	21	144
Class 3&4 Sites	0	41

Chi-Square =11.084
df = 2
P < 0.004

Table 9-39: Chi-Square Test Distribution of Pinto Points and Uniface Types 1-2.

	Pinto Points	Uniface Types 1-2
Class 1 Sites	0	36
Class 2 Sites	15	29
Class 3&4 Sites	4	4

Chi Square =17.788
df = 2
P < 0.00014

Table 9-40: Chi-Square Test on Distribution of Pinto Points and Uniface Types 13-14.

	Pinto Points	Uniface Types 13-14
Class 1 Sites	0	102
Class 2 Sites	15	144
Class 3&4 Sites	4	41

Chi-Square= 10.147
df = 2
P < 0.0063

Table 9-41: Chi-Square Test on Distribution of Selected Artifact Types.

Site	Projectile Points			Unifaces			
Class	Mojave	Pinto	Other	1-2	16	13-14	Other
	#/%	#/%	#/%	#/%	#/%	#/%	#/%
1	26/8.9	0/0	12/4.1	36/24.8	7/4.8	102/70.3	108/42.7
2	21/5.4	15/3.9	21/5.4	29/15.7	12/6.5	144/77.8	146/44.1
3&4	0/0	4/4.9	2/2.4	4/8.5	1/2.1	42/89.4	29/38.2

Chi-Square =33.434
df =10
P < 0.0003

Table 9-42: Chi-Square Test on Distribution of Summed Uniface Groups

	Summed Uniface Groups 1	3	2
Classes 1 and 4 w/out Pinto Points	120	7	136
Classes 2 and 3 with Pinto Points	146	13	178

Chi-Square = 0.845
df = 2
P > 0.655

Domed and keeled unifaces (Types 1-2) are most common early (in Class 1 sites) and decrease through time. Retouched flakes (Types 13-14) are present in some numbers in the early sites (Class 1) and increase through time relative to the number of other unifaces. Spiked gravers (Type 16) are found early in the sequence (Class 1 sites), increase slightly during occupation of the Class 2 sites and, decline and apparently disappear during the occupation of Class 3 and 4 sites.

The Lake Mojave points appear to have a distribution pattern that is very similar to that of the domed and keeled unifaces (Types 1-2) and different from that of the retouched flakes (Types 13-14). The Pinto points have a distribution that appears to be most similar to the spiked gravers (uniface Type 16).

Class 1 sites (early) are marked by the presence of Lake Mojave, Silver Lake and occasional fluted or basally thinned points, domed and keeled unifaces and spiked gravers. Retouched flake unifaces and other projectile point forms also occur. Bifaces are characterized by greater occurrence of small forms and fewer large bifaces than in later classes. Milling tools occur, though rarely.

Class 2 sites are characterized by the occurrence of Lake Mojave and Silver Lake forms together with Pinto points. Domed and keeled unifaces decrease in relative frequency, spiked gravers increase as do retouched flake unifaces. Other unifaces combined remain essentially unchanged in frequency. Small bifaces are still dominant, but large specimens are more frequent than in Class 1 sites. Millingstones occur infrequently.

Class 3 and 4 sites exhibit a general decline in number of points with Lake Mojave points absent from both classes, while Pinto points are found in Class 3 but are absent from Class 4. The "Other" points group also decresase in relative numbers from the earlier site classes. Large bifaces become more frequent in Classes 3 and 4 and tend to dominate the biface assemblage although small bifaces continue to be well represented. Domed and keeled scrapers (unifaces 1 and 2) are found in relatively small numbers as are spiked gravers which are absent from Class 4 sites. The "Retouched Flake Unifaces" is the only flake tool class that appears to increase in relative frequency. Millingstones apparently occur more frequently in Class 4 sites than in any of the earlier classes of sites.

Through this analysis it becomes apparent that the cultural sequence in Nelson Wash reprsents a single tradition marked by an intensive use of basalt and metavolcanics in making chipped stone bifaces. The assemblages are characterized by bifaces in large numbers, together with domed and keeled scrapers (decreasing through time). Lake Mojave and Silver Lake points are characteristic of Class 1; Pinto, Lake Mojave and Silver Lake points for Class 2; Pinto points for Class 3, and a paucity of points for Class 4. Class 3 and 4 sites may represent a time when Nelson Wash had all but been abandoned as a hunting area, but people still came to the area for tool stone, hunting small game, and collecting plant resources and reptiles such as lizards and tortoise. From the present data it appears that there are no major breaks in occupation and that a single cultural tradition is represented throughout the occupation with changes occurring in response to the changing environmental conditions.

CHAPTER 10 - SUBSISTENCE FOCUS AND CULTURAL CHANGE IN THE CENTRAL MOJAVE DESERT by Claude N. Warren

INTRODUCTION

The Lake Mojave-Pinto Basin cultural tradition is thought to have persisted through the major climatic and environmental changes of the early Holocene. During this period of circa 8000 to 2000 B.C., the Pleistocene lakes dried up, rivers stopped flowing, marshes and springs ceased to exist and far-reaching changes in vegetation and fauna occurred. These changes required adjustments in the subsistence system of the human populations of the Mojave Desert. These adjustments, in turn, must have resulted in changes in settlement patterns and ultimately in socio-political organization. It is the problem of understanding the nature of these changes that is addressed here.

The subsistence focus model (Warren 1986; Warren et al. 1986) forms the theoretical foundation upon which the following analysis is based. This model holds that a subsistence system comprises a series of subsystems called production sets. A production set is defined as procurement and processing activities carried out by individuals or organized groups of individuals through the use of systemically related tools, facilities, techniques, procedures, knowledge and ideas about their use. The production set is a cultural subsystem and therefore the definition emphasizes the technology and organization of personnel involved in its use rather than the resource or resources procured. All subsistence activities may be grouped into a relatively small number of production sets based on similarities in technology, personnel and organization.

Production sets differ from one another in tools, facilities, techniques and/or procedures, as well as in personnel and organization. Therefore, the interaction of production sets with the environment will also vary with the production set. The hunting of big game and the collecting of small seeds require different technologies, organization and personnel, and the technology, personnel and organization of one cannot be used successfully in carrying out the other. The procurement of all small hard seeds by individual women using seed beaters and finely woven baskets for collecting and millingstones for processing are considered a single production set, whereas the procurement of bighorn sheep by groups of men using projectile weapons and cutting implements is another production set. The procurement and processing activities of a given society may be grouped into a relatively small number of production sets based on similarities in technology, personnel and organization. Production sets are not equal in productivity nor are they of equal concern to the population. There is a tendency for one production set to be the focus of activity in the sense that it is the one in which the greatest manipulation of ideas, technology, organization, procedures, techniques and environment take place. That production set is designated the subsistence focus. Because the manipulations are consciously made, the members of the society have been made aware of possibilities of change within the subsistence focus and the resistance to creativity is minimized. In the context of the subsistence focus, innovations are more freely expressed and more readily accepted than in other production sets. The process of focusing is thus a dynamic force within the cultural system which can provide impetus to and direction for change within the subsistence system. Theoretically, the subsistence focus will generally exhibit more numerous procurement activities and greater complexity of organization, procedures and technology, and greater productivity than other production systems. However, this argument does not consider the practical problem of measuring relative productivity and relative complexity of the technology and organization of the different production sets. Consequently, the subsistence focus is defined in terms of scheduling and organization. Because the greatest intensity of interest and activity is found in the subsistence focus, a higher priority is given its scheduling in the seasonal round and it becomes the dominant or core production set. It is the production set about which others are organized.

Focusing, in this context, may be viewed as the process in which a group of individuals direct their interests and energies toward a production set and its application to the environment. This results in the acceptance of innovations within the production set but resistance to change from outside the subsistence focus. The subsistence focus thus has an internal dynamic that interacts with environmental and demographic forces. Changes in the subsistence system may be viewed as the result of the interaction of these dynamic systems. This interaction between this cultural system and environment is at the center of the following analyses.

In summary, a production set consists of the manufacture and use of a set of artifacts, facilities, and procedures by individuals, or organized groups, in the procurement and processing of a resource or group of resources. There is a tendency for a population to manipulate one production set more than others and that production set is known as the subsistence focus. The subsistence focus is identified by its dominant position in the organization of subsistence activities and tends to have relatively complex technology, organization and procedures, and to include a relatively large number of procurement and processing activities. Innovations tend to occur more readily within the subsistence focus than within other production sets.

Subsistence foci function within the context of cultural, demographic and environmental forces. It is the relationship among these forces that results in changes in subsistence systems. The concept of subsistence focus together with other related concepts may aid in understanding these interactions. The interactions between the subsistence system and its environment are at the center of the following analyses.

THE CULTURAL OVERVIEW

The broader overview of the cultural adaptation to the early Holocene environmental of the far west is important background for the following discussions and analyses. The early cultures of the Mojave Desert (or our discussion about them) are better understood when placed in this broader context.

A widespread, distinctive, early cultural tradition has long been recognized in the far west (Daugherty 1962; Warren 1967; Bedwell 1973; Carlson 1983). In more recent years the terms "Western Pluvial Lakes Tradition" and "Stemmed Points Tradition" have been applied to this early cultural tradition or some portion of it. Most sites of the Stemmed Point tradition could be subsumed within the definition of the "Western Pluvial Lakes Tradition", which is more restricted geographically. Bedwell, who coined the term "Western Pluvial Lakes Tradition," visualized environmental conditions of increasing temperature and aridity as the Wisconsin ice masses withdrew. With the gradual withdrawal of the ice mass, the pluvial lakes systems in the western Great Basin became important to the economy of the inhabitants of that area about 9,000 years ago, "and there occurred a unique and persisting pattern of events significant enough to be called the western pluvial lakes tradition" (Bedwell 1973:170).

The artifact assemblage of the Western Pluvial Lakes Tradition is characterized by long-stemmed narrow-shouldered, lanceolate and leaf-shaped points which exhibit regional and temporal variations (e.g., Lake Mojave, Lind Coulee, Parman, Cougar Mountain, Haskett); larger lanceolate and ovate knives; crescent-shaped bifaces of unknown use; large and moderate-sized, well formed domed-ovate or hemispherical scrapers; small beaked gravers made on irregular flakes and broken tools, as well as a number of other scraper types and utilized flakes.

Bedwell argued that this cultural tradition extended over an area from Fort Rock Valley in southern Oregon south through northeastern California and western Nevada into the deserts of southeastern California:

> Here was an environment which was generally similar throughout. There were certainly area differences, but the region's numerous lakes made possible a similar environmental adaptation by the inhabitants. So once an economic adaptation had been made which specialized in the exploitation of a lake, marsh and grassland environment, groups could travel north and south along the Cascade-Sierra Nevada Uplift and never leave the lacustrine environment which the hundreds of viable lakes at that time provided. (Bedwell 1973:170).

Bedwell (1973:171) specifically excludes sites associated with pluvial lakes of the eastern Great Basin and with the Columbia-Snake drainage system to the north (sites that are included in the Stemmed Points tradition by Carlson [1983]). Bedwell (1973:170-171) is also unclear whether man is adapting to the lake environments or the environment created by the presence of a plentiful supply of water--"lakes, marshes and grasses."

Hester (1973:66-67) lists 21 sites and localities (some containing several sites) of the Western Pluvial Lakes Tradition, adding sites in eastern Nevada, Utah and central and southern California to those listed by Bedwell. However, Hester continues to argue for a lacustrine adaptation:

> The settlement pattern data reveal that sites of the Western Pluvial Lakes Tradition were situated along the shores of ancient lake systems, and this implies a predilection toward the utilization of lacustrine resources at an early time level. (1973:124).
>
> The Western Pluvial Lakes Tradition of 9000-6000 B.C., represented by a specialized tool kit and a lacustrine adaptation. (1973:127).

The assertion that these early people were adapted to lacustrine resources is clear, but the evidence supporting it is not. As Aikens (1983:244) states:

> Archaeological sites in open locations have left only a very thin record of what the earliest lakeshore occupations were like. Large stone points found on sites of the early San Dieguito complex or the Western Pluvial Lakes Tradition suggest the hunting of relatively large game animals more that the taking of fishes, small mammals, waterfowl, and many kinds of vegetable foods that are characteristic of marshlands. The earliest peoples may have been primarily hunters, as suggested by Warren (1967). Or it may be that definitive gathering implements such as bone or shell fishhooks, wooden fish spears, basketry traps, and spun-fiber fish nets and other indicators such as fish and bird bones and edible plant remains have long since decomposed in exposed open sites where they were once used and discarded

The association of early sites and pluvial lakes is probably exaggerated by the "non-random sampling procedures" of early archaeologists. Fifty years ago, the Campbells (1935) stated the bias that many archaeologists were to implicitly accept for the next decades, in their search for ancient man in the desert west:

> In order to prove that a site has great age, it should be a pure site; that is, the artifacts should represent one period only, and it should be situated where the geology of the region points to antiquity. For this reason we have sought man's ancient remains along extinct river channels and about the strand lines of playas and fossil lakes, indicated by beaches, terraces, spits, and wave-cut cliffs--mute testimony to a past day of moister climate. We have not been disappointed in our search for locations by geological indication...

The sites associated with the pluvial lakes and major water courses should not be segregated from contemporary sites with similar tool assemblages simply because the latter are not associated with pluvial lakes. It may be argued for some areas that the sites on pluvial lakes, while constituting the main body of site distribution data, in fact represent only a portion of the activities of the economic round. An examination of a wide range of sites of the same or similar technological tradition, regardless of their ecological setting, provides a better understanding of the subsistence systems of the early occupants of the far west. A review of selected sites of the Stemmed Point tradition (Carlson 1983) provides this broader view of the technology of this early period and how it articulates with the environment in the subsistence activities "recorded" at these sites.

The Lind Coulee site in eastern Washington exhibits many similarities of artifact assemblage with the sites associated with pluvial lakes in southern California (Daugherty 1956). These similarities are found in several types of scrapers, including the domed-ovate forms, beaked gravers, lanceolate biface knives, long-stemmed sloping-shouldered points, bifacially flaked crescents of unknown use, and rare handstones. The majority of the types reported from Lind Coulee are found in the surface sites at Lake Mojave. However, the Lind Coulee site was deeply buried and contained faunal remains and other evidence missing from the Lake Mojave sites. The cultural remains at the Lind Coulee site were over 2 feet thick, located within an 8 foot thick strata (Bed D) "of evenly bedded, firmly compacted water-laid sand" (Daugherty 1956:234).

The environment of the Lind Coulee site at time of occupation was

> ...a series of lakes and ponds with shifting connecting channels draining to the southwest into a large lake. It is the author's opinion that the site represents sedimentation in a small lake or pond near an occupied area which was flooded occasionally and habitation interrupted with later reoccupation at low water (Enbysk 1956:269-70).

Moody (1978) reinvestigated the Lind Coulee site in the early 1970s, analyzing the microstratigraphy, paleoecology, and tephrochronology. She placed the site chronologically at between 8600 and 9000 years ago based on a series of radiocarbon dates and concluded:

> The Lind Coulee site, then, was a spring habitation site near a supply of large herbivores. The site was occupied as part of the economic seasonal round of peoples living in the Columbia Basin 9,000 years ago (Moody 1978:217).

The faunal remains at the Lind Coulee site contain small numbers (one to five) of elements of Green Wing Teal (*Anas crecca*), a young bird of uncertain identification, a large goose (?), deer, fox, skunk, and rabbit (?), pocket gopher, muskrat, badger, and unidentified rodents and carnivores. Bison, however, is represented by over 45 bones and teeth. In addition, unidentified eggshells were recovered from the site (Enbysk 1956:270).

Many of the bison remains are parts of the skull and jaws, vertebra column, and lower legs and feet (Enbysk 1956:270), suggesting that the animals were butchered at the site or very close by and long bones of the upper legs were removed with the meat to other site locations. The faunal remains and sedimentary data strongly suggest that this site was a hunting camp where bison were taken seasonally during a time when the water was lower than the site area, and that the site was occupied by a small number of individuals at any one time.

If the Lind Coulee site was a hunting camp where the primary game was bison, then the artifact assemblage at Lind Coulee may serve as a partial checklist of stone tools used by peoples of the Stemmed Point tradition while occupying such sites. Most of the tools probably functioned in the taking and/or processing of the bison. However, other tools are also present in smaller numbers. A serrated bone point may have been a specialized tool for taking fish or game other than bison. The handstones and nether stones (Daugherty's palettes) appear to have been used to process ochre rather than seeds because all of them retain yellow or red ochre stains. Another related feature of the site was the occupation zone. The red ochre also occurred on at least one of the isolated boulders in Bed D as fillings in the outermost vesicles, as if processing of red ochre was an activity conducted by the group of hunters while they waited for game.

D.G. Rice (1972) presented an analysis and synthesis of a series of three early components from deeply stratified sites located on the lower Snake River in southeastern Washington: Windust Cave, Marmes Rockshelter, and the Granite Point site. On the basis of these components Rice argues for the existence of a Windust Phase. This cultural unit is dated between circa 6,000 and 8,000 years B.C. on the basis of ten radiocarbon dates at Marmes Rockshelter (Rice 1972:31). Rice continues, stating that during the "time of deposition of Windust Phase components the climate was cooler and moister than any other time throughout the last 10,000 years" (1972:26). The plant cover probably varied from mostly grassland with scattered stands of forest in protected areas to forested regions with areas of open grassland.

The artifacts of the Windust Phase include a large number of projectile points (229 specimens representing 23% of the classifiable stone artifacts and 25% of the classifiable chipped stone artifacts) that exhibit a high degree of variability and include forms that are very similar to those from nearby Lind Coulee and distant Lake Mojave. The Windust Phase artifact assemblage contains many more categories of artifacts than does the Lind Coulee site. However, the large domed and keeled scrapers and the flaked stone crescents that are characteristic of both Lind Coulee and Lake Mojave are not present. There are eight manos and four millingstones, all from the Marmes Rockshelter. One mano and an unworked pebble exhibit red ochre stains. The greater variety of artifacts in the Windust components is not only due to the greater numbers of items, but also to greater variety of activities conducted at the Windust components. These components are located adjacent to the Snake River and the multiple resources of that environmental zone. It seems highly probable that these sites are essentially base camps in which multiple activities took place.

Nearly all of the faunal remains attributable to the Windust Phase came from the Marmes Rockshelter. Only deer (*Odocoileus*) is tentatively identified at Windust Cave, and a small sample, including elk (*Cervus canadensis*), beaver (*Castor canadensis*), and river mussel (*Margaritifera falcata*) is reported from the Granite Point component. At the Marmes Rockshelter, bird and fish bones were found in small numbers, the fish including chub and sucker, but no salmonids. In the Windust component of Marmes Rockshelter, 73% (82) of the identifiable bone fragments are large mammals (deer, *Odocoileus* spp., 19.6% [22]; antelope, *Antilocapra americana*, 12.5% [14]; elk, *Cervus canadensis*, 4.5% [5]; indeterminate large mammals 36.6% [41]); medium-sized mammals (*Sylvilagus* 1.8% [2]; *Lepus* 2.7% [3]; *Canis cf. latrans* 1.8% [2]; *Ondatra zibethica* 1.8% [2]; indeterminate medium sized mammals 2.7% [3]); and small mammals (*Marmota flaviventris* 0.9% [1]; *Thomomys talpoides* 2.7% [3]; *Neotoma cinerea* 2.7% [3]; *peromyscus maniculatus* 0.9% [1]; indeterminate small mammals 8.9% [10]). Rice (1972:157-159) notes that the mammal bones were characteristically broken up for marrow and badly fragmented. The majority of bones found were postcranial elements, suggesting that game animals were transported to the habitation sites from surrounding areas. The Windust sites are presumably the kind of site that served as a base camp for the hunters that occupied Lind Coulee.

Another example of a possible base camp located in the river valley is the Five Mile Rapids site on the Columbia River, near The Dalles, Oregon. The Five Mile Rapids site is deeply stratified with the earliest occupation dating to approximately 9,000 years B.C. (Cressman 1960:66). Dates of 7835 ± 220 B.C. and 5726 ± 100 B.C. were obtained from composite samples from Strata I and II respectively. A third date of 5726 ± 100 B.C. was obtained from a 20 cm level within Stratum III, creating an inversion of the two later dates. The artifact assemblages from these deposits include a range of projectile points that are similar to those of Lind Coulee and the Windust components; large leaf-shaped knives, gravers and numerous scraper forms are also apparently rare or absent. Also present are handstones and nether stones used in the grinding of red and yellow ochre: large quantities of ochre are found in the midden (Cressman 1960:43-58).

The early occupation at the Five Mile Rapids site also contains considerable quantities of faunal remains. Salmon bones are missing from the earliest occupation, but occur suddenly a short time later and are very numerous (over 125,000 salmon vertebrae, mostly from Stratum II). Bird bones are common, birds with a strong liking for fish the most abundant. The minimum numbers of individuals for cormorants, bald eagles and gulls are all over 100, whereas minimum numbers of individuals for duck and geese are one and nine respectively. The cervid and marmot are the two most commonly occurring mammals: small mammals such as rabbit and beaver are less frequently represented (Cressman 1960:76-77). Cressman (1960:69) notes that small mammals are part of the food supply, "but the larger animals were not much in evidence." However, a rich bone and antler industry is present, which seems to indicate that considerable numbers of elk and deer were taken, probably from hunting camps in the hinterland.

Other sites in the northwest Plateau of approximately the same age and containing similar artifact assemblages may represent other economic activities conducted during a yearly round. The Goldendale site (Warren, Bryan, and Tuohy 1963), although lacking faunal remains, contained projectile points, ovate knives, domed ovate scrapers, small manos and flat millingstones that are very similar to those from Lind Coulee and the Windust components. A comparison of the range and relative frequencies of artifact types at these sites suggest functional differences that would be characteristic of different economic activities. The components of the Windust Phase and the Five Mile Rapids site appear to be base camps at which multiple tasks were conducted, but with hunting sites where bison was the primary game taken. The other small game probably represent animals taken while waiting for the bison. The Goldendale site appears to be a site at which the edge ground cobble was the primary tool, presumably used in processing plant resources. However, the tool assemblage shares a number of types with the Lind Coulee site, including projectile points, ovate knives or points, and domed scrapers, as well as a number of other types of scrapers. These tools were almost certainly used in hunting activities at the Lind Coulee site, so it may be argued that hunting was also conducted to some degree from the Goldendale site.

These data and others from the sites of the Columbia and Snake drainage can be used to support a model of a forager-collector subsistence pattern similar to that proposed by Warren, Bryan and Tuohy (1963). In this model, populations move seasonally from a residential base camp in the major river valley, where resources are both varied and relatively plentiful, to more specialized sites in the hinterland, at localities where resources are less varied and may be available for relatively short periods of time. The activities conducted included collecting of local plant resources in season, limited fishing, and collecting of freshwater shellfish, but in nearly all sites a major activity is hunting of large game. The data in fact seem to indicate that the primary economic activity was hunting of artiodactyls. It is our contention that this subsistence pattern, adapted to local environmental conditions, is found throughout much of the "desert west" during the early Holocene and is associated with most sites of the Stemmed Point tradition identified by Carlson (1983).

In the Fort Rock Basin of southern Oregon, the two earliest occupation units defined by Bedwell (1970, 1973) contain a range of artifact types that is remarkably similar to those of the Lind Coulee, Goldendale and Windust components. The earliest occupation unit, represented only at Fort Rock Cave, is firmly dated at 9,000 years B.C., and may be as old as 11,000 B.C. (Bedwell 1973, Aikens 1983). The second occupation, represented at several of the Connelly Caves and Fort Rock Cave, is dated between 8,000 and 11,000 years. The artifact assemblages include projectile points (Lake Mojave, Windust, Lind Coulee, Haskett and Cougar Mountain types), ovate knives, a variety of moderately large scrapers, which includes the ovate-dome or hemispherical type, gravers, and crescents. Also present are hammerstones, choppers, and two manos.

The faunal remains from the earliest occupation of Fort Rock Cave are limited to lagomorphs and a few mountain sheep (*Ovis canadensis*). The early material from the Connelly Caves, however, contains 20 genera of birds, 12 of which require significant amounts of open water for survival (Grayson 1979:437). Sage grouse (*Centrocercus urophasianus*), however, was the most abundant single species (MNI=61) with several species of ducks (*Anus sp.*) somewhat less common (MNI=46). The mammals include a broad range of species with lagomorphs (*Sylvilagus idahoensis* [MNI=23], *S. nutallii* [MNI=32], and *Lepus spp.* [MNI=80]) being most abundant; woodrat (*Neotoma cinerea* [MNI=23]) well represented, and elk (*Cervus canadensis* [MNI=11]), black-tailed deer (*Odocoileus* cf. *hemionus* [MNI= [illegible]) and bison (*Bison* cf. *bison* [MNI=151]) occuring in moderate numbers (Grayson 1979:438-445). There are also a few elements of fish from these early levels (Grayson 1979:436, Bedwell 1970:248-259).

The Connelly Caves are located less than 2 km from Paulina Marsh. Presumably, during the early period of occupation, this body of water was a lake with a shoreline considerably closer to the occupation sites than it is today. The wide variety of tools and fauna at these sites suggest that they were base camps at which a wide spectrum of economic activities were pursued. The use of lake resources is seen in the occurrence of water birds and fish. However, hunting of large mammals was important, as indicated by the relatively large number of individuals represented in the faunal remains. We would argue that even at the site that served as a basis for the formulation of Bedwell's Western Pluvial Lakes Tradition, the faunal remains point to a more generalized hunting and collecting subsistence than postulated by Bedwell (1970) and Hester (1973).

Another site that provides subsistence data for this early horizon is Smith Creek Cave in eastern Nevada. This cave also contains an assemblage of artifact types similar to Fort Rock Cave and Lake Mojave (Bryan 1979). The artifacts derived from a gray ash stratum, called the Mount Moriah Occupation Zones by Bryan, are dated from nearly 10,000 years B.C. to about 8,000 years B.C. on the basis of 13 radiocarbon dates. This component contains 18 basal fragments of Cougar Mountain and/or Haskett point types. All but two of these exhibit reworking and/or use-wear as scrapers or gravers. The scrapers appear similar to those at other early sites discussed here, including Bryan's domed "core" scrapers and a series of heavily used end-scrapers. On the bases of use-wear and association with much animal hair, Bryan argues that the end-scrapers were used in processing hides. In addition to these tools there were a large number of flaked microtools which included small gravers, concave scrapers, denticulate scrapers, and retouched flakes.

The fauna of the Mount Moriah Occupation Zones includes unidentified fish, reptiles and birds, as well as rabbits (*Sylvilagus sp.*, *Lepus sp.*), marmot (*Marmota flaviventris*), small rodents (*Thomomys sp.*, *Peromycus sp.*, *Microtus sp.*), mountain lion (*Felis concolor*), and mountain sheep (*Ovis canadensis*) (Miller 1979:314). Large quantities of pulverized mammal bone fragments were also found in the Mount Moriah Occupation Zones. Many had been altered by man during the butchering and processing of the meat. Almost all the "recognizable artiodactyl bones are long bones. A few skull, rib and vertebral fragments are the only exceptions. Preliminary butchering at the kill site apparently eliminated most vertebrae and almost all foot bones" (Bryan 1979:218). In addition, a considerable quantity of hair recovered from the Mount Moriah Occupation zone was identified as coming from rodents, lagomorphs, Bovidea, and Camelidae, with Cervidae being represented by the largest quantity (Bryan 1979:185).

The Mount Moriah Occupational Zone of the Smith Creek Cave appears to represent the remains of a series of hunting parties that made periodic trips to the vicinity of the cave in search of large game. The most common animal in the remains is the mountain sheep, although other large mammals are represented. This site has a more specialized tool assemblage than the base camps of the Windust Phase, Five Mile Rapids or Fort Rock and Connelly Caves.

The similarity in artifact assemblages that characterize the sites discussed above is also characteristic of many sites in which faunal remains are not preserved. These sites include the numerous surface sites associated with the shore features of many of the pluvial lakes in the western Great Basin (Hester 1973:66-67), as well as a number of sites elsewhere in California (Moratto 1984:90-113). Although the faunal assemblages of these sites are either lacking or very small, it is postulated that the artifact assemblages represent similar subsistence activities which varied due to the application of essentially the same technology to a variety of environments.

The sites of the Western Pluvial Lakes Tradition that contain faunal remains vary from residential bases at Five Mile Rapids (Cressman 1960), Windust Cave, Marmes Rockshelter and Granite Point (Rice 1972), and Fort Rock and Connelly Caves (Bedwell 1970, 1973), to small hunting sites at Lind Coulee (Daugherty 1956, Moody 1978) and Smith Creek Cave (Bryan 1979). These sites exhibit an underlying similarity of hunting and animal processing tools and faunal remains. The tool assemblages consistently include a morphologically similar series of points, ovate knives, scrapers, and engraving tools, in addition to less formal flake-based cutting and scraping tools. Deer and marmot were the most common animals represented in the faunal remains at Five Mile Rapids (excluding salmon) and a rich bone and antler industry supports the interpretation that artiodactyls were of major importance to the subsistence system. At Marmes Rockshelter (from which came nearly all of the faunal remains of the Windust Phase), deer, elk and antelope together comprised 82% of the mammal bones. At Fort Rock and Connelly Caves, lagomorphs, sage grouse and ducks were the most commonly recovered fauna. However, bison, black-tailed deer and elk were all well-represented. The bones from Smith Creek Cave were badly fragmented, but artiodactyl remains were apparently the most common, with mountain sheep probably the most plentiful. Bison was by far the most common animal represented in the Lind Coulee fauna.

Small animals were taken at all of these sites. Lagomorphs were generally the most frequently represented, but rodents and fish were important in one or more sites. These small animals require procurement and processing technologies that are often different from those of the larger artiodactyls. These animals are also generally represented by a greater variety of bones in the middens, indicating that the whole carcass was brought back to the camp from the place of procurement. Consequently, these animals are overrepresented, relative to the artiodactyls whose whole carcasses are rarely brought back to the site.

Handstones and millingstones may have been used to process hard seeds, but there is good evidence that their primary function at some sites may have been the preparation of pigments. The millingstones and handstones very often exhibit ochre stains, and at the Lind Coulee and Five Mile Rapids sites, large quantities of pigment were found in the deposits. Millingstones may not always be a clear indication of seed processing.

It is postulated that artiodactyl hunting is the subsistence focus of the Western Pluvial Lakes Tradition. The bases for making this postulate are: (1) the prominence of artiodactyl remains wherever faunal data are found in the Western Pluvial Lakes sites; (2) the large percentage of the artifact assemblage comprised of hunting and animal processing tools; and (3) great variability within the hunting tool types.

In the central Mojave Desert, the Lake Mojave Complex is the local variant of the Western Pluvial Lakes Tradition. At Pleistocene Lake Mojave this cultural unit is dated between circa 8,320 ± 160 and circa 6,000 B.C. (Ore and Warren 1971; Warren and Ore 1978) and 6,520 ± 370 B.C. (AA 648) for Component 1 of the Henwood site in Nelson Wash. Both Lake Mojave and Pinto points have been recovered from deposits at Rogers Ridge, dated to 6230 ± 150 B.C. (Beta 13463) and 6460 ± 140 B.C. (Beta 12840). The latter dates suggest that the chronological range of the Lake Mojave and Pinto points overlap at about 6,000 B.C., supporting the interpretation that the Pinto Basin Complex developed directly out of the Lake

Mojave Complex and together they represent a single cultural tradition. This interpretation is also supported by: (1) preference for basalt and other macrocrystalline material for bifacial tools that set apart the Lake Mojave and Pinto assemblages from the later cultural complexes of the central Mojave; (2) similar coarse lithic reduction techniques that are distinct from those of later assemblages; ard (3) a preponderance of hunting and animal processing tools, morphologically very similar to the assemblage of the Western Pluvial Lakes Tradition, exhibited by both Lake Mojave and Pinto Basin complexes.

What distinguishes the Pinto Basin from the Lake Mojave complex is the addition of the Pinto point series and the gradual disappearance of the Lake Mojave points and crescents. The available data suggest that the Lake Mojave-Pinto Basin assemblages are best considered a single cultural development, which persisted from about 8500 years B.C. to the mid-Holocene, from a period of ample water and rich resources to one of extreme aridity and poor resources.

The Lake Mojave Complex is the Mojave Desert expression of the Western Pluvial Lakes Tradition and it is postulated that the Lake Mojave Complex exhibited an economic system with a focus on hunting artiodactyls, and that the Lake Mojave Complex evolves into the Pinto Basin Complex without interruption, together representing a single tradition that persisted in the Mojave Desert from late Pleistocene to mid-Holocene.

THE ENVIRONMENTAL SETTING IN THE MOJAVE DESERT: EARLY TO MID-HOLOCENE

Changes in the environmental conditions of the late Pleistocene and early Holocene undoubtedly created stresses in the Lake Mojave-Pinto subsistence systems. During the late Pleistocene and early Holocene, the many basins of the Mojave Desert contained lakes that overflowed through major and minor channels into adjacent basins, forming strings of lakes across long distances. The Owens, Amargosa, and Mojave rivers at one time formed a single integrated drainage system terminating at Lake Manley in Death Valley. This more abundant water must have supported numerous marshes along the stream courses and at favorable locations on lakeshore margins, causing the distribution of vegetation to be considerably different from that of today.

The trend toward warmer and effectively drier conditions that mark the transition from Pleistocene to Holocene apparently began as early as 14,000 years B.C. in the Mojave Desert (Spaulding et al. 1984:24). During the late Pleistocene, the first changes in vegetation that have been recognized occurred in the driest habitats and at the lowest elevations within a particular zone. Woodlands changed to desert scrub at lower elevations and from subalpine conifer woodland to pinyon-juniper woodland at higher elevations (Cole 1982; Spaulding 1983). As Spaulding and others (1984) note, the upward shift of ecotones occurred at some sites as early as about 14,000 years B.C., some 6,000 years before the final removal of the woodland from the desert. These changes began at the close of the full glacial episode and did not terminate at most sites until the mid-Holocene. Major changes in vegetational type, for example woodland to desert scrub, was abrupt in many localities but occurred at different times in different places.

Spaulding and others (1984) argue that the climate of the terminal Pleistocene and early Holocene was characterized by increasing temperatures and effectively wetter conditions than at present. By about 9,750 years B.C., the average annual temperatures probably were within 1° C of present values. Pinyon pine, Utah juniper, and prickly pear, all thermophiles, had replaced the subalpine conifer and steppe shrub species at the packrat midden sites of the Elena Range in the eastern Mojave. Against this backdrop of a marked increased in thermal regimes of the later Wisconsin, Spaulding and others (1984:25-26) marshall evidence for continued, and even increased, effective moisture, and suggest that there is justification for viewing the terminal Pleistocene as a time when the precipitation of the Mojave Desert was greater during both the summer half-year and the winter half-year than it is today. Spaulding and others (1984:30) present a brief sketch of the late Wisconsin and early Holocene climates:

> After about 16,000 years B.P., temperatures (summer temperatures in particular) increased rapidly, resulting in radical alteration of seasonal precipitation regimes. By about 12,000 to 9,000 years B.P., increased precipitation during both the winter and summer half-years may have caused average annual precipitation to be more than 100 percent greater than present precipitation. This hypothesis represents a significant change from an earlier estimate of 10 to 20 percent relative increase in annual precipitation for the latest Wisconsin compared to the present (Spaulding, 1983, Table 10).... Because average annual temperatures approached those of the present at this time (Kutzback and Otto-Bleisner, 1982), a

> substantial relative increase in precipitation is required to maintain high stands in southern Great Basin paleolakes and to support woodland in the lower Colorado River Valley.

The increase in precipitation proposed here does not, however, prevent the beginnings of desertification at an early date. In another study of packrat middens, Spaulding (1983:263) presented evidence for the occurrence of "xerophitic, shrub-dominated vegetation below 1000 m altitude during the last part of the Late Wisconsin" in the central Mojave Desert. At a site near Ash Meadows, in the north central Mojave Desert, desert scrub is dated between 12,850 and 8,050 B.C., while at the Marble Mountains in the southern Mojave the desert scrub is dated between 8,550 and 8,050 B.C. These dates suggest that the lower desert may well have contained wide areas of desert scrub vegetation during the early Holocene. Contemporary with this desert scrub was a widespread woodland in the Mojave, Sonoran and Chihuahuan deserts (Spaulding et al. 1983:289). Packrat nest macrofossils record juniper and juniper-pinyon communities up to 1600 to 2000 m elevations above the desert scrub vegetation:

> Species that were common in the glacial age woodlands south of about latitude 36 N include evergreen oak (e.g., *Quercus terbinella*, *Q. dunnii*); succulents such as yucca, bear grass and agave (*Yucca* spp., *Nolina* spp., *Agave* spp.); and certain warm-desert elements such as barrel cactus (*Echinocactus polycephalus*), brittlebrush (*Encelia* spp.), gopher tortoise (*Gopherus agassizi*), and chuckwalla (*Sauromalus obesus*). Above this woodland zone and throughout the present Great Basin Desert north of latitude 37 N, macrofossil and pollen records suggest a full-glacial vegetation dominated by montane and subalpine conifers. In this region bristlecone and limber pine (*Pinus longaeva* and *P. flexilis*) were widely distributed above about 1800 m elevation. (Spaulding et al. 1983:289).

These data suggest that from early in the Holocene the biotic communities of the lower Mojave Desert contained elements characteristic of modern arid environments. These desert plants seem to have existed in associations different from today's vegetation Zones, and the modern plant communities developed as a result of increasing temperatures and aridity from early in the Holocene.

The transition from the "pluvial" to arid conditions in the early Holocene was the most severe and dramatic environmental change in the California desert during post-Pleistocene times. Rivers and lakes dried up, vegetation and distribution of vegetation changed as did the animal population. A new arid environment was created to which the human population had to adapt or from which it had to withdraw to more desirable neighboring areas.

EARLY HOLOCENE CULTURAL ADAPTATION

The early Holocene was marked by a general trend toward increasing aridity and many desert species were present in the lower desert prior to 8,000 years B.C. (Spaulding et al. 1983:289). The lakes and streams system of the central Mojave Desert may be viewed as forming a linear oasis that stretched through the lower basins durng the early Holocene. The relatively dense resources along this oasis must have attracted game which passed along game trails between feeding areas and watering places. The distribution of sites of the Lake Mojave period appears to be associated with these bodies of water, with relatively few sites elsewhere. Although there is obviously a bias in the sampling, no known Lake Mojave period site has been found elsewhere, except, perhaps, at lithic source areas. The human population of the early Holocene in the Mojave Desert appears to have been adapted to the riparian, marsh and lakeshore environments on the basin floors. It is important, however, to realize that these basins are found from relatively high elevation down to below sea level on the floor of Death Valley.

The occupation of the Nelson Wash sites occurred during the Lake Mojave and early Pinto periods. Occupation in Nelson Wash is dated to 6500 B.C. by radiocarbon, and perhaps began as early as 8000 B.C. It endured to at least 4000 B.C. with periodic occupation taking place perhaps as late as 2000 B.C. During this period envirionmental conditions probably fluctuated considerably, but changes of short duration cannot be recognized in the available archaeological and paleoenvironmental record. The long term trend is clearly toward increased aridity and environmental deterioration. Increased aridity resulted in declining quantities of riparian, marsh and lake shore resources, including large game.

The subsistence focus model (Warren et al. 1986) predicts a two stage response to continued resource reduction. The first stage response is an attempt to increase productivity through: (1) manipulation of the technology of the subsistence focus and its application to the environment; and (2) intensification of the procurement activities of the subsistence focus. If productivity continues to decrease, the second stage response takes the form of diversification of the general subsistence base. New emphasis is placed on manipulation and experimentation of the technology of non-focus production sets and their application, together with intensification of the more productive procurement activities.

An alternative to the second stage response is that the population declines to the point where the cultural systems can support the population or the cultural systems can no longer function, cultural disintegration sets in, and the culture, if not the population, becomes extinct.

The hypotheses presented below have been deduced from the subsistence focus model and are designed to be tested by archaeological data. Although archaeological data from elsewhere in the central Mojave are used, the Nelson Wash sites provide the bulk of the data. Tests of some of the hypotheses derived from the subsistence focus model are dependent on adequate paleonenvironmental data, which are not currently available. Tests of other hypotheses are dependent upon archaeological data and are discussed below.

Increased aridity resulted in a decrease in the productivity of the artiodactyl production set. This statement contains two parts, only one of which can be tested with available data. It is assumed that the artiodactyl population in the vicinity of Nelson Wash decreased with increasing aridity. Neither the decrease in artiodactyl population nor its correlation with increasing aridity can be tested at this time. The second part of the statement, that productivity decreased, should be reflected in the faunal remains of the archaeological sites and a hypothesis can be constructed to test the productivity of artiodactyl hunting relative to other resources.

Hypothesis 1: The productivity of artiodactyls relative to other animals decreased during the occupation of the Nelson Wash sites.

Expectations: The quantity of artiodactyl remains will decrease, relatively to other faunal remains, through time at the Nelson Wash site.

At this time faunal remains from early occupations in the central Mojave Desert are reported from only seven components at three sites. These components are Locus A of the Awl site (4-SBr-4562), Locus 1 of Rogers Ridge (4-SBr-5250), and Components 1-4 and Locus H at the Henwood site (4-SBr-4966). The data available from these sites are presented in Table 10-1.

Table 10-1: Faunal Remains from Early Components in the Central Mojave Desert (by element count).

	Awl (SBr-4562)	Rogers Ridge (SBr-5250)		Henwood (SBr-4966)			
	Locus A	Loc. 1	Cmp3	Cmp1	Cmp4	Cmp2	Loc. H
	#/%	#/%	#/%	#/%	#/%	#/%	#/%
Artiodac.	399/43	41/3	8/5	12/3	1/2	2/.3	0/0
Lagomorpha	104/11	124/10	18/10	92/24	25/37	83/12	17/32
Rodentia	2/.2	36/3	33/19	102/26	0/0	11/2	30/57
Rod/Lag.	413/45	967/81	109/63	174/45	40/59	125/18	6/11
Tortoise	1/.1	0/0	6/3	8/2	2/3	433/64	0/0
Lizards & Snakes	2/.2	25/2	0/0	2/.5	0/0	12/2	0/0
Aves & other	0/0	2/.2	0/0	7/2	0/0	5/.8	0/0
Total	921	1195	174	397	68	671	53

These components may be placed in three groups based on similarity in age (Table 10-2), and the reduction in the number of artiodactyl bones becomes apparent. However, these sites are also located in different geological settings that may have resulted in somewhat different availability of artiodactyls, especially bighorn sheep. The Awl site is at the west end of Drinkwater Basin in an area of rugged hills and steep canyons, an environment ideal for bighorn sheep. The Rogers Ridge site is located in Tiefort Basin, relatively close to Tiefort Mountain and adjacent rugged areas. This would have been a good site for bighorn sheep, but not as ideal as the area near the Awl site. The Henwood site is located along a wash in a relatively open basin with a number of small rugged hills nearby. Of the three, the Henwood site is probably in the poorest environment for bighorn sheep. When evaluating the quantity of artiodactyl bone in these archaeological sites, their location relative to the best habitat for bighorn sheep must be considered.

Table 10-2: Faunal Remains from Early Components by Temporal Units.

	8000-7000 B.C.[1]	6500-6000 B.C.[2]	5500-5000 B.C.[3]
	No./%	No./%	No./%
Artiodac.	400/40.4	61/3.5	2/0.3
Lagomorph	129/13.0	234/13.3	100/13.8
Rodent	2/0.2	171/9.7	41/5.7
Rod./Lag.	453/45.8	1250/70.8	131/18.1
Tortoise	3/0.3	14/0.8	433/59.8
Lizard and Snake	2/0.2	27/1.5	12/1.7
Aves & Other	0/0	9/0.5	5/0.7
Total	989/	1766/	724/

[1]Locus A, Awl Site (SBr-4562); Component 4, Henwood site (SBr-4966)
[2]Locus 1, Rogers Ridge, Components 1 and 3, Henwood site (SBr-4562)
[3]Component 2, and Locus H, Henwood site (SBr-4562)

There are several factors that require comment before these figures can be interpreted. First, the element counts of rodents are increased by burrow deaths in Components 1 and 3 and Locus H at the Henwood site, probably indicating that the rodent count is generally somewhat too high.

Second, artiodactyls are represented by highly fragmented bones, generally less than an inch in length, suggesting that they were smashed in order to obtain marrow or processed for the removal of "grease." Even articular ends of bones are extremely rare (Douglas 1986). The processing of these bones, together with the fact that much artiodactyl bone is left at the kill site, results in a small number of indentifiable artiodactyl bones at residential sites. Small animals are more often brought intact to the occupation site so that relatively more bones are deposited per individual killed. Artiodactyl bones are, therefore, probably under-represented in these sites.

Also, the Nelson Wash sites probably were not sites from which bighorn sheep could be easily hunted, further reducing the expected quantity of artiodactyl bone.

Third, whole tortoises were apparently brought to the sites and cooked in the shell. The carapace was then broken open to remove the meat, resulting in a large number of easily identified carapace fragments, as well as most other skeletal parts. The tortoise is, therefore, probably overrepresented where it occurs in the faunal assemblages.

The faunal data presented above suggests that the artiodactyl resources were reduced during the Lake Mojave occupation in the central Mojave, especially between about 7500 and 6500 B.C. The dominant number of artiodactyl bones at the Awl site certainly suggests that hunting artiodactyls was a major economic pursuit by the early Lake Mojave peoples. In components from circa 6500-6000 B.C., the artiodactyl bones become scarce and lagomorphs and rodents become more plentiful. In the final period of occupation, circa 5500-5000 B.C., reptiles, especially in the form of the tortoise, become the most common animals in the faunal assemblage. The evidence is rather clear that the number of artiodactyl bones drops significantly as the remains of smaller animals increase significantly, so it appears that the artiodactyl resources were declining even during the 1000 years between the circa 7400 B.C. occupation of the Awl site and the circa 6400 B.C. occupation of the Henwood site.

It follows from the subsistence focus model that if the artiodactyl population decreased as aridity increased, the first stage response would be increased manipulation of, and experimentation with, the technology of the subsistence focus (i.e. artiodactyl production set) and the application and intensification of its procurement activities. This manipulation and experimentation would result in greater variability of form in the technological assemblage, and intensification of procurement activities might postpone a decrease in productivity. Ideally, the initiation of the first stage response to decreasing artiodactyl population would be indicated by a rapid increase in variability of forms in the technological assemblage of the artiodactyl production set (subsistence focus), followed by a decrease in artiodactyl remains in the midden. If artiodactyl production continues to decrease or remains at a low level, then the subsistence focus will weaken or distintegrate and the technological assemblage will decrease in number of items, although not necessarily in variability.

The first stage response consists of three events that occur in chronological order: (1) increase in variability of technology, together with intensification of procurement activities; followed by (2) a decrease in productivity of artiodactyl resources; which, in turn, is followed by (3) a decrease in quantity of tools of the artiodactyl production set. The rapidity with which these changes take place are dependent upon a number of variables, but especially the speed at which the resource (artiodactyls) is diminishing. It is conceivable that a rapid, persistent reduction in the artiodactyl population could result in such rapid cultural change that the three events would appear to be simultaneous. Slow geological deposition could also cause the sequence to accumulate as a single unit and appear as a point in time. Under such conditions archaeological assemblages from the three events will be inseparably mixed in a single component.

Hypothesis 2: Technological variability increases within the artiodactyl production system as the artiodactyl resources decline in the Lake Mojave-early Pinto periods.

Expectations: The primary artiodactyl procurement tool, recovered archaeologically, is the projectile point. Therefore, during the Lake Mojave-early Pinto periods there should be an increased variability within the projectile point category. This variability should take two forms: (1) an increase in projectile point types; and (2) projectile point types should have weaker attribute association in later sites than in earlier sites.

It is not possible to adequately test Hypothesis 2 with the data now available, but the following is a presentation of this limited data. The evidence from those assemblages containing faunal remains is presented in Table 10-3. No conclusion can be drawn from such incomplete data. However, if the projectile point frequencies from all sites are arranged by temporal units, this larger sample suggests some patterning (Table 10-4, 10-5).

The data in Table 10-4 are too incomplete to be useful. The data in Tables 10-4 and 10-5 do make some interesting observations possible, but it is apparent that any measurement of complexity or variability will be misleading because of the small numbers of projectile points present in many of the samples. Table 10-5 provides the distribution of point types by site/locus and gross chronologic periods that appear to conform to the periods represented by the faunal samples shown in Table 10-3. The early (8000-7000 B.C.) period is not represented because the Awl site (4-SBr-4562A) material is too incomplete to use,

Table 10-3: Distribution of Projectile Point Types Among Sites with Faunal Remains.

Site/Locus	No. of Proj. Pts.	Classifiable Points	No. of Types of Points
8000-7000 B.C.			
SBr-4562 A	8[1]	7	3[2]
SBr-4966 Cmp. 1	10	3	2
Total	18	10	5
5500-5000 B.C.			
SBr-4966 Cmp. 2	0	0	0
SBr-4966 H	8	6	4
Total	8	6	4

[1]This number includes projectile points reported by Jenkins and Warren (1985) and unpublished data supplied by Far Western Anthropological Research Group (FWARG) from the buried midden at SBr-4562.
[2]This number is based on visual examination of the five points recovered by FWARG and may change with more analysis.

and Component 4 of SBr-4966 yielded only three artifacts, none of which was a projectile point. Locus 4-SBr-4966C and site 4-SBr-5267 have been omitted from these calucations because they appear to represent long periods of occupation as indicated by the range of projectile points in both and the large standard deviation of the obsidian hydration measurements.

The number of points relative to other chipped stone tools decrease in the later period as shown in the point:tool ratio in Table 10-5. The point:tool ratio is highly variable within each period, suggesting that the different activities at these sites affected this ratio. This is probably especially true of SBr-4968, where an unusually large number of unifaces are present.

Table 10-4: Distribution of Classifiable Projectile Points.

T	4	4	4	4	4	4	4	4	4	5	4	4	4	4	4	4	4
Y	9	9	9	9	9	9	9	9	9	2	9	9	9	9	9	9	9
P	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6
E	8	7	6	3	6	6	6	6	6	7	6	6	9	6	6	5	6
			CI		B	I	A	C	H		F	G		C2	E		D
1a	x		x	x	x		x			x							
1b		x		x	x		x			x							
1c				x			x	x									
2		x	x		x	x			x		x						
3e							x		x	x							
3d							x	x					x				
3c								x									
3b									x			x					
3a										x	x	x					
4			x					x									
5				x	x					x							
6								x									
7										x							
8										x							
9				x				x	x	x							
10					x										x		
11						x											
12					x	x											
13							x	x	x								
14				x								x					
15	x						x										
16					x		x	x									
17							x	x		x							
Tot.	2	2	2	7	6	3	10	10	5	9	1	3	1	0	0	1	0

The type:point ratio theoretically indicates the relative variability in the point assemblage. With large samples the closer the ratio is to 1:1, the more variable the assemblage. However, a small sample will appear to be highly variable because the small number of points will skew the ratio

Table 10-5: Chronological Distribution of Projectile Points.

Site/Locus	# of Proj. P.	# of Class. P	# of Proj. Types[1]	# of Tools	Proj. P: Tool
<u>8000-7000 B.C.</u>					
SBr-4562 A	8	7	3	--	---
SBr-4966 Cmp. 4	0	0	0	3	---
Total	8	7	3	3	---
Types:Points ratio 7/3 = 1:2.3					
<u>6600-5800 B.C.</u>					
SBr-4968	6	5	2	164	1:27.3
SBr-4967	2	2	2	24	1:12
SBr-4966 Cmp. 1	10	3	2	57	1:5.7
SBr-4963	17	7	7	129	1:7.6
SBr-4966 Cmp. 3	3	0	0	14	1:4.7
SBr-4966 B	14	10	6	479	1:34.2
SBr-4966 I	5	3	3	76	1:15.2
SBr-4966 A	36	27	10	635	1:17.6
Total	93	57	17	1578	1:16.9
Types:Points ratio 57/17 = 1:3.3					
<u>5700-4500 B.C.</u>					
SBr-4966 H	8	6	5	130	1:16.3
SBr-4966 F	1	1	1	34	1:34
SBr-4966 G	4	3	3	97	1:24.3
SBr-4969	2	1	1	43	1:22.5
SBr-4966 Cmp. 2	0	0	0	64	---
SBr-4966 E	0	0	0	14	---
SBr-4965	7	1	1	28	1:4.0
SBr-4966 D	0	0	0	39	---
Total	22	12	9	449	1:20.4
Types:Points ratio 12/9 = 1:1.3					

[1]Number of projectile point types is determined by counting types as listed in Table 10-4, not by summing number of types in sites of each period.

toward the lower number. The pattern of "the larger the sample the larger the ratio," in the Nelson Wash data seems, therefore, to be a reflection of the small samples. Another possible, but unlikely, interpretation is that the ratio represents the breakdown of the tradition of projectile point manufacture, where there is little to guide the flintknapper in the making of projectile point forms. Finally, the problem could be the lack of chronological control. Because the single data for each assemblage is the calculated mean, the date could represent a long period of light occupation at the sites, resulting in a small number of points dating from very different periods of time. Because these assemblages are primarily surface manifestations, there is no way of determining the length of time for the occupation except through the standard deviation on the obsidian hydration readings. These, unfortunately, are also probably unreliable. There is nothing in these data to either support or disprove Hypothesis 2.

Hypothesis 3: A significant decrease in artiodactyl bone relative to small animal bone occurs earlier than a significant decrease in variability of projectile points and number of projectile points relative to other flaked stone tools.

Expectations: This hypothesis is a test of the postulate that the subsistence focus will tend to remain important even though its productivity is lessened due to decreasing resources. If this postulate is supported, there will be a lag time between the decrease in artiodactyl remains and the decrease in the number of projectile points. During this lag time, variability within the projectile points will be maintained or increased over the variability of projectile points in earlier components.

The significant decrease in artiodactyl bone appears to have occurred prior to 6500 B.C. If this is the case, there is a decrease of the large projectile points long after that decrease in artiodactyl remains. Unfortunately, there are too few projectile points from the early period to determine if the number of point types have increased or decreased. There are some interesting changes that do occur during the period of 6600-5800 B.C. It is during this period that the notched and shouldered Pinto point becomes increasingly popular and the nearly shoulderless Lake Mojave points essentially go out of existence. This change is significant because it may represent a shift in the hunting tools from a thrusting spear to the atlatl and dart.

During the 5700-4500 B.C. period, artiodactyl bones become scarce to nonexistent in the faunal assemblage, suggesting a permanent depletion of that resource at these sites. This may be reflected in the artifact assemblage by the slight reduction in the number of points relative to other tools and perhaps by the more impressive reduction of the number of Group 1 unifaces that occurs over the period of time represented here (See Table 9-32).

Tools used in the processing of artiodactyls should reflect the decrease in productivity of the artiodactyl production system. The functional relationship between the decrease in productivity and changes in processing tools is difficult to demonstrate, however, because: (1) the pressure for change is on the procurement, not the processing activities; (2) the scraping and cutting tools used in processing artiodactyls may also have functioned as processing tools for smaller animals; and (3) a morphological or technological type may have multiple functions, or functions may change without change in morphology. A sample of morphological and technological types were analyzed to determine their use. If the use-wear of this sample is consistent within morphological and technological types, the types can be tentatively assigned to function identified by the use-wear. The validity of these tentative tool functions is then tested by examination of associated fauna. If there is a co-occurrence of appropriate fauna with the tools, the validity of the assigned function is supported.

The uniface:flaked tool ratio does not change significantly between the 6600-5800 B.C. (1:3.1) and the 5700-4500 B.C. (1:3.7) periods (Table 10-6). Since the use-wear analysis (Bamforth, Chapter 5 this volume) indicates that the most common use for unifaces (except Type 16, gravers) was processing animal resources, it seems reasonable to assume that the change to more dependence on lagomorphs and rodents is not reflected in this statistic. However, the domed and keeled scrapers (Types 1 and 2) exhibit a pronounced reduction in relative frequency during the latter of the two periods. The Types 1 and 2 ratio to flaked tools increased from 1:34.6 to 1:77.5 while the ratio of Types 1 and 2 unifaces to other unifaces climbed from 1:7.6 to 1:21.7. This decrease in relative frequency of domed and keeled unifaces appears to correspond with the continued drop in the frequency of artiodactyl remains.

Table 10-6: Chronological Distribution of Domed and Keeled Unifaces (Group 1 unifaces).

Site/Locus	# of Unifaces	# of Types 1 & 2	# of Other Flaked Tools	Uniface: Flaked Tool Ratio
<u>8000-7000 B.C.</u>				
SBr-4562 A	?	?	?	?
SBr-4966 Cmp. 4	2	0	1	1:0.5
Total	2	0	1	
<u>6600-5800 B.C.</u>				
SBr-4968	75	15	95	1:1.3
SBr-4967	14	1	12	1:0.9
SBr-4966 Cmp. 1	22	2	45	1:2.0
SBr-4963	32	2	114	1:3.6
SBr-4966 Cmp. 3	8	0	9	1:1.1
SBr-4966 B	103	17	390	1:3.8
SBr-4966 I	9	0	72	1:8.0
SBr-4966 A	142	10	529	1:3.7
Total	405	47	1266	1:3.1

Types 1&2: flaked tools = 1624/47 = 1:34.6
Types 1&2: other unifaces = 358/47 = 1:7.6
Types 1&2: comprise 2.4% of the flaked stone tools (1266/47 = 2.4%)
Types 1&2: comprise 8.6% of the unifaces (405/47 = 8.6%)

Site/Locus	# of Unifaces	# of Types 1 & 2	# of Other Flaked Tools	Uniface: Flaked Tool Ratio
<u>5700-4500 B.C.</u>				
SBr-4966 H	33	1	105	1:3.2
SBr-4966 F	10	0	25	1:2.5
SBr-4966 G	45	2	56	1:1.2
SBr-4969	20	1	25	1:1.3
SBr-4966 Cmp. 2	13	0	51	1:3.9
SBr-4966 E	4	0	10	1:2.5
SBr-4965	3	0	32	1:10.7
SBr-4966 D	8	2	31	1:3.9
Total	136	6	335	1:2.5

Types 1&2: flaked tools = 465/6 = 1:77.5
Types 1&2: other unifaces = 130/6 = 1:21.7
Types 1&2: comprise 1.8% of the flaked stone tools (6/335 = 1.8%)
Types 1&2: comprise 4.4% of the unifaces (6/136 = 4.4%)

Although all the expected data have not been forthcoming, the available data do suggest that there was a reduction in the artiodactyl population, but that the hunting technology continued to be greatly manipulated and used for a long period of time. Bamforth's (Chapter 5, this volume) use-wear analysis of tools from the Henwood site further supports this interpretation. Skinning, butchering and hide preparation, together with the working of wood and bone or antler, were identified for Components 1 and 2 of the Henwood site. This broad spectrum of tool-use suggests that a wide range of animal resource processing took place at the Henwood site. The proximity of the Henwood site to a very large basalt lithic source with lesser deposits of chalcedony suggests that the tools recovered from the Henwood site probably include those being replaced by newly manufactured implements. This is certainly the case with the biface "knives" and points which are made predominately from basalt. However, it is not clearly the case with the uniface tools, which are made from a wide range of cryptocrystalline materials. Whether on the Henwood site or elsewhere,
the majority of the tools examined appears to have been used in the processing of animal resources.

The decrease in projectile points relative to other chipped stone tools signals the end of the first stage response to the decreasing productivity. The second stage response is the general diversification of the subsistence base. This response probably begins before the first stage ends and is marked by increasing manipulation of items and ideas associated with production sets other than the subsistence focus. This is based on the postulate that if productivity of the subsistence focus continues to decrease in spite of the manipulation and experimentation with its technology, energy and time will be redirected to other production systems. This results in increased manipulation and experimentation with the technologies of other production sets and intensification of other procurement activities, in turn leading to greater diversification of the subsistence system. This leads us to the next set of hypotheses:

Hypothesis 4: As the projectile point variability increases and/or as the number of projectile points decrease relative to other flaked stone tools, the quantity of small animal bones will increase relative to the quantity of artiodactyl bones.

Hypothesis 5: As the number of projectile points decrease relative to other flaked stone tools, the number of species represented by faunal remains will increase.

These hypotheses assume that: (1) the increased number of small animal bones relative to increased manipulation of the artiodactyl production set and/or the decrease in artiodactyl bones represents increased intensification of small animal procurement; and (2) increasing numbers of species found in conjunction with decreasing use of artiodactyl procurement tools represents increasing breadth of the application of a production set or sets other than the artiodactyl production set.

The projectile point variability cannot be dealt with because of the small samples from the various sites. Changes in the number of projectile points relative to other flaked stone tools can be partially dealt with. We cannot record the point:other flaked stone ratio at the Awl site prior to 7000 B.C., but following 7000 B.C. there are some changes that appear to fit the predicted pattern.

The reduction of artiodactyl bones apparently took place early in the sequence, perhaps by 7000 B.C. After 6600 B.C., the quantity of small animal bone increases and the ratio of projectile points to other flaked stone tools is set at 1:16.9, although it varies from 1:4.7 to 1:34 (Table 10-7). After about 5700 B.C., the ratio of points to other flaked stone increases to 1:20 +, which it maintains until the end of the occupation. During post-5700 B.C. periods, artiodactyl remains virtually disappear and tortoise becomes a major dietary item; other reptiles and birds are either added or increased, suggesting an increase in species may be indicated.

The predicted changes in the faunal assemblages appear to be present in the data. However, there are a number of possible explanations for these patterns of change. The co-occurrence of the changes in artifacts and faunal remains are required to support the hypotheses deducted from the subsistence focus model. The data presently available do not adequately test this model, but on the other hand, none of these data disprove the subsistence focus model.

Table 10-7: Projectile Point Frequency and Faunal Variation.

Site/Locus	Proj. Pt.: Flkd Tool Ratio	Fauna Classes % of Artio	Lago	Rodent	Tortoise
8000-7000 B.C.					
SBr-4562 A	---	43	11	0.2	0.1
SBr-4966 Cmp. 4	---	5	10	1	3
Total	---				
Types:Points ratio 7/3 = 1:2.3					
6600-5800 B.C.					
SBr-4968	1:27.3				
SBr-4967	1:12				
SBr-4966 Cmp. 1	1:5.7	3	24	26	2
SBr-4963	1:7.6				
SBr-4966 Cmp. 3	1:4.7	2	37	00	3
SBr-4966 B	1:34.2				
SBr-4966 I	1:15.2				
SBr-4966 A	1:17.6				
Total	1:16.9				
Types:Points ratio 57/17 = 1:3.3					
5700-4500 B.C.					
SBr-4966 H	1:16.3	00	32	57	00
SBr-4966 F	1:34				
SBr-4966 G	1:24.3				
SBr-4969	1:22.5				
Total	1:20.2				
Types:Points ratio 11/8 = 1:1.4					
Class 4 sites					
SBr-4966 Cmp. 2	---	.3	12	2	64
SBr-4966 E	---				
SBr-4965	1:4.0				
SBr-4966 D	---				
Total	1:20.7				
Types:Points ratio 1/1 = 1:1					

[1]Number of projectile point types is determined by counting types as listed in Table 10-4, not by summing number of types in sites of each period.

With the uncertainty of the validity of these hypotheses, we now turn to the next set of hypotheses which addresses the problem of changing settlement patterns.

Subsistence Systems and Settlement Patterns in the Central Mojave

It is postulated that during the Lake Mojave period, the subsistence strategy was one of foraging (cf. Binford 1980) in which groups consisting of small numbers of households were adapted to the resources of the riparian, lake margin and marsh zones of the valley floors. Local vegetable resources and small game animals were important in the diet, but the movement of the groups was determined by the availability of larger game (e.g. artiodactyls). These groups moved from site to site within the zones of the valley floor, collecting vegetable resources, taking small animals and hunting larger game. When artiodactyls became scarce at one locality they moved on to the next site. This model assumes that ecological zones more than one-half day's journey above the valley bottoms were seldom used and that hunting of artiodactyls was possible because the artiodactyls were drawn to the water and vegetation of these zones, although they were not limited to them.

As aridity increased, the marsh, riparian and lakeshore vegetation communities were reduced in area and became increasingly patchy. As this occurred the artiodactyl population of the valley floors was probably reduced, although they continued to be attracted from the higher elevations by the now scattered watering places on the valley floors. Artiodactyl hunting was still productive because the decreasing number of watering places made it easier to locate the game. Although hunting may have remained productive in the valley bottoms, the plant resources decreased and movement to localities away from valley bottoms may have occurred in order to acquire plant resources. It is predicted that man adapted to the reduced productivity of the valley bottom resources by manipulation and experimentation within the artiodactyl production system and by intensification of artiodactyl hunting. This did not necessarily result in increased productivity, but is thought to have maintained the importance of artiodactyl hunting as a source of food.

A settlement pattern, to a large degree, reflects the optimal distribution of organizations of individuals for conducting subsistence activities. Change in subsistence systems should, therefore, be reflected by changes in settlement patterns. If the changes in subsistence systems postulated above are valid, predictions regarding changes in settlement patterns may be made.

At first glance the variability in the size (area) of the Nelson Wash sites suggests differences in population through time; however, the size of the sites (which varies from 404,000 m^2 for 4-SBr-4966 to 4,700 m^2 for 4-SBr-4967) is more apparent than real. Site 4-SBr-4967 is a single locus of cultural debris on the surface. All other sites except 4-SBR-4963 (which was heavily impacted by an Army bivouac) are composites of loci, with 4-SBr-4966 containing the largest number of both surface and subsurface loci. Furthermore, much of the area between such loci exhibits little evidence of occupation or use on the surface. The locus, therefore, becomes the unit of comparison, but even at this level, smaller concentrations are recorded. For example Locus C of 4-SBr-4966 included eight concentrations varying in size from 75 to 1950 m^2 with 43,150 m^2 remaining in areas of low to moderate artifact density. While it is not possible to identify a spatial unit that represents the space occupied by a social unit, it is clear that such spatial units remained small throughout the occupation of the Nelson Wash sites and presumably the social units also remained small. The evidence at this point remains inconclusive.

In the forager model proposed here for the late Pleistocene and early Holocene, small groups containing several hunters and their families moved as a unit through the valley bottom zones hunting and collecting available resources. Particularly productive localities were used more frequently and for longer periods of time than others, creating extensive sites such as those found on the shoreline of Lake Mojave. Theoretically, the sites of this period should include large field camps resulting from repeated use, small field camps resulting from limited use, and small specialized sites or "locations" (Binford 1980) where single, or a very limited number of activities were conducted (e.g. lithic reduction sites or butchering locations). The quantity of debris on all site types will vary greatly and is dependent upon the intensity and duration of use (e.g. the number of people using the site and the total amount of time the site was occupied), but the diversity of functional tool types for both large and small field camps should be greater than that of specialized sites and locations. The internal variability of the field camps will be greater than the internal variability of the specialized sites. However, the variability between or among specialized sites should be greater than between or among field camps. Unfortunately, the sizes of the samples from nearly all of the sites/loci from Nelson Wash are so small that this approach cannot be used in their analysis.

As the valley bottom resources became increasingly patchy, field camps decreased in number and tended to be associated with the more productive patches. During this period of increased aridity, occupation sites were located near watering places where artiodactyls were more easily hunted and plant resources plentiful. As a result of this adaptation, the population may have remained in the valley bottom occupation sites for longer periods each year. Also, the diversification of resources procured may have led to the establisment of seasonally occupied procurement and processing sites away from the major occupation sites in the valley bottom. A transition from basic foraging to strategic collecting may have occurred at this time, with residential bases developing at favored hunting and collecting patches in the valley bottom and smaller specialized field camps elsewhere in the valley and at higher elevations. Specialized sites (locations) were probably associated with occupation of both the low-lying residential bases and higher elevation field camps.

With continued increasing aridity, the remaining resources, reduced to a few limited areas about isolated springs, were no longer sufficient to support the subsistence system. It was during this period that the artiodactyl hunting focus weakened or disintegrated. The decreased productivity of traditional valley bottom resources was in part compensated for by diversification of resources used and intensification of procurement of the more abundant resources. The population of the central Mojave also must have decreased at this time. This led to the procurement of dispersed resources away from the valley bottom and the dispersal of the human population in small groups across the patchy desert environment. Residential bases were abandoned or became less used field camps so that during the period of greatest aridity, the settlement pattern became one of a series of small field camps or family camps associated with seasonally available resources and specialized sites or locations resulting from specialized activities.

The late Pleistocene - early Holocene environmental changes can be summarized in three periods: (1) Late Pleistocene; (2) Early Holocene; and (3) Middle Holocene, each characterized by different environmental conditions. The Late Pleistocene period (9000 to 6000 B.C.) was the wettest period under consideration. The central Mojave Desert (Figure 10-1) was crossed by the Mojave River as it flowed through the Manix Basin and filled Lake Mojave on its way to Lake Manley in Death Valley. In the surrounding uplands, other streams and lakes formed tributaries to the Mojave River. A considerable quantity of surface water was present in the central Mojave at this time, and it must have supported rich natural resources.

During the Early Holocene (circa 6000 to 4500 B.C.), the Mojave Desert became increasingly dry and dramatic environmental changes occurred. The flow of streams was reduced and there was an inadequate water supply to maintain overflow levels of some lakes, creating a series of stream termini in the form of saline lakes and/or swampy sinks. The increasing salinity and actual drying of lakes below stream termini greatly reduced the productivity of the lower streams.

The Middle Holocene (circa 4500 to 2000 B.C.) was a period of arid climate during which the stream channels and lake beds were dry. Some springs dried up or became too saline for use, further reducing the available fresh water in the central Mojave Desert. Fresh water was available only at springs and seeps and in high mountain ranges (not found in the central Mojave Desert) where lower temperatures and greater precipitation may have provided conditions for limited stream flow. By the middle part of this period the central Mojave Desert must have experienced a virtual elimination of riparian, marsh and lakeshore resources.

The settlement pattern for Nelson Wash, viewed as part of a central Mojave settlement system, is deduced from this model of changing environment and subsistence focus. If the model of change is valid it should be reflected in a change in site locations which correlate with the changes in the availability of water.

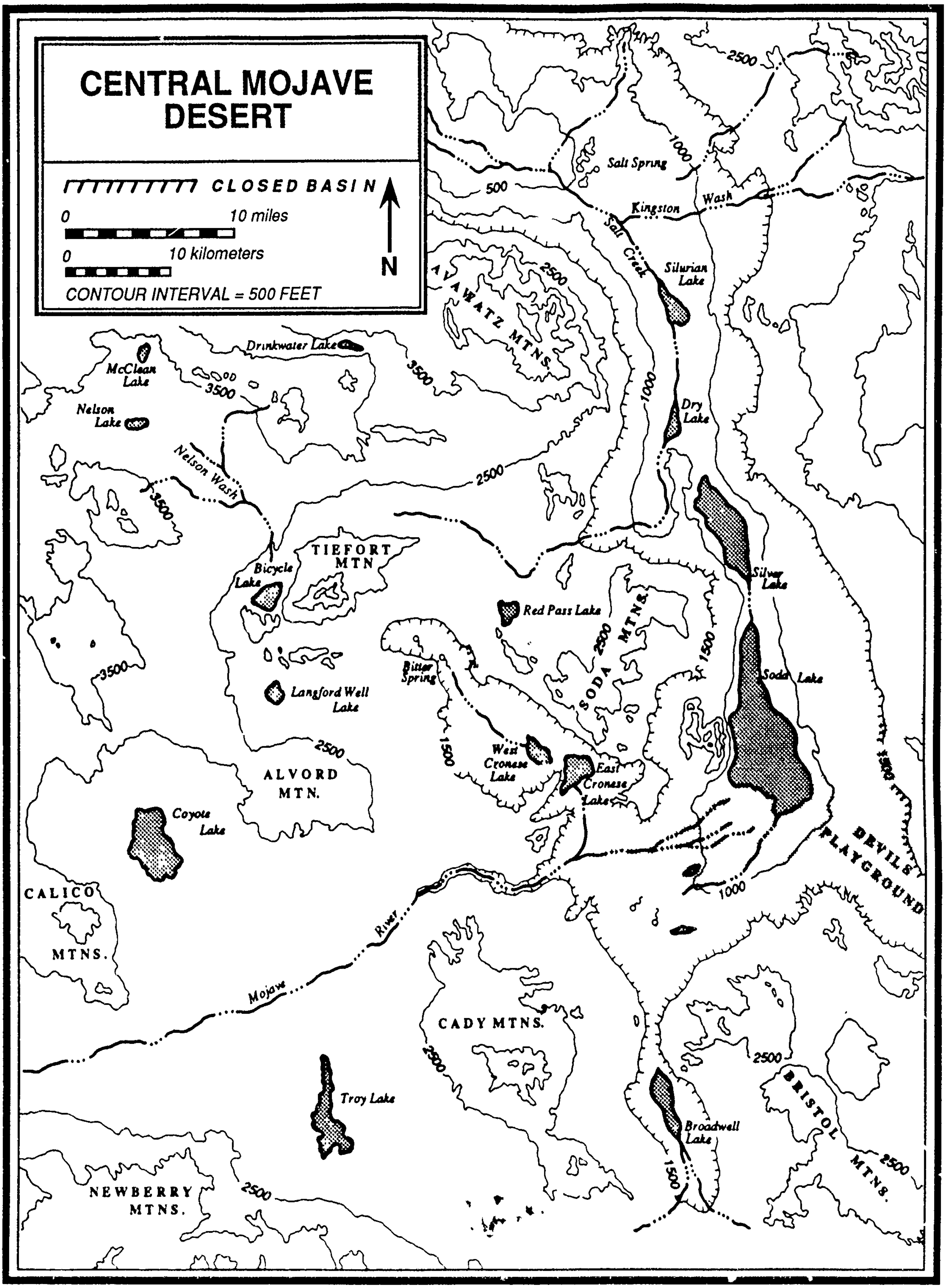

FIGURE 10-1. MAP OF THE CENTRAL MOJAVE DESERT

Late Pleistocene Settlement Patterns in the Central Mojave Desert

A series of radiocarbon dates on shell and tufa deposits at Lake Mojave suggest that Lake Mojave ceased to overflow about 7000 B.C. (Ore and Warren 1971). Although a lake may have been present in the basin until after 6300 years B.C., Lake Mojave would have become increasingly saline and less productive after the overlow ceased. The human occupation of the beachline probably ended shortly after the overflow ceased at about 7000 years B.C. A single radiocarbon date of 8320 ± 160 B.C. is applicable to occupation of one of the Lake Mojave sites (Ore and Warren 1971:2559, Warren and Ore 1978).

If this data for the abandonment of the Lake Mojave beachlines is correct, sites characterized by the Lake Mojave artifact complex should date to the Late Pleistocene (9000-7000 B.C.). This interpretation is supported by the fact that only two Pinto points are known from the 24 sites recorded on Lake Mojave beaches (Campbell n.d.). The Lake Mojave complex is also found in sites located along stream channels and other lakeshores that date between 9000 and 7000 B.C. or shortly thereafter (Figure 10-2). Sites containing the Lake Mojave complex found at Nelson Wash include the buried Component 1 at the Henwood site (SBr-4966), which contained two Lake Mojave points and one fluted point as well as a variety of uniface tools and bifaces characteristic of the Lake Mojave complex, and is dated to only 6520 ± 370 years B.C. Other sites that contain this assemblage and date before 6000 B.C. include the Class 1 sites from Nelson Wash (4-SBr-4963, 4966 Cmp.1, -4966 Cmp.3, -4966 Cmp.4, -4966 B, -4966 I, -4967, -4968).

Survey investigation at Nelson Lake identified three sites at 935 meters and above which contain Lake Mojave points but no Pinto points (Robarchek et al. 1983; Skinner 1984). Sites 4-SBr-5255 and -5262 are small camps in which a small number of tools is reported from the surface, including two Lake Mojave points from 4-SBr-5262 and one Silver Lake point from 4-SBr-5255. Site 4-SBr-5407 is a larger campsite with three Lake Mojave and three Silver Lake points and many artifacts on the surface. No other classifiable points were recovered from these three sites.

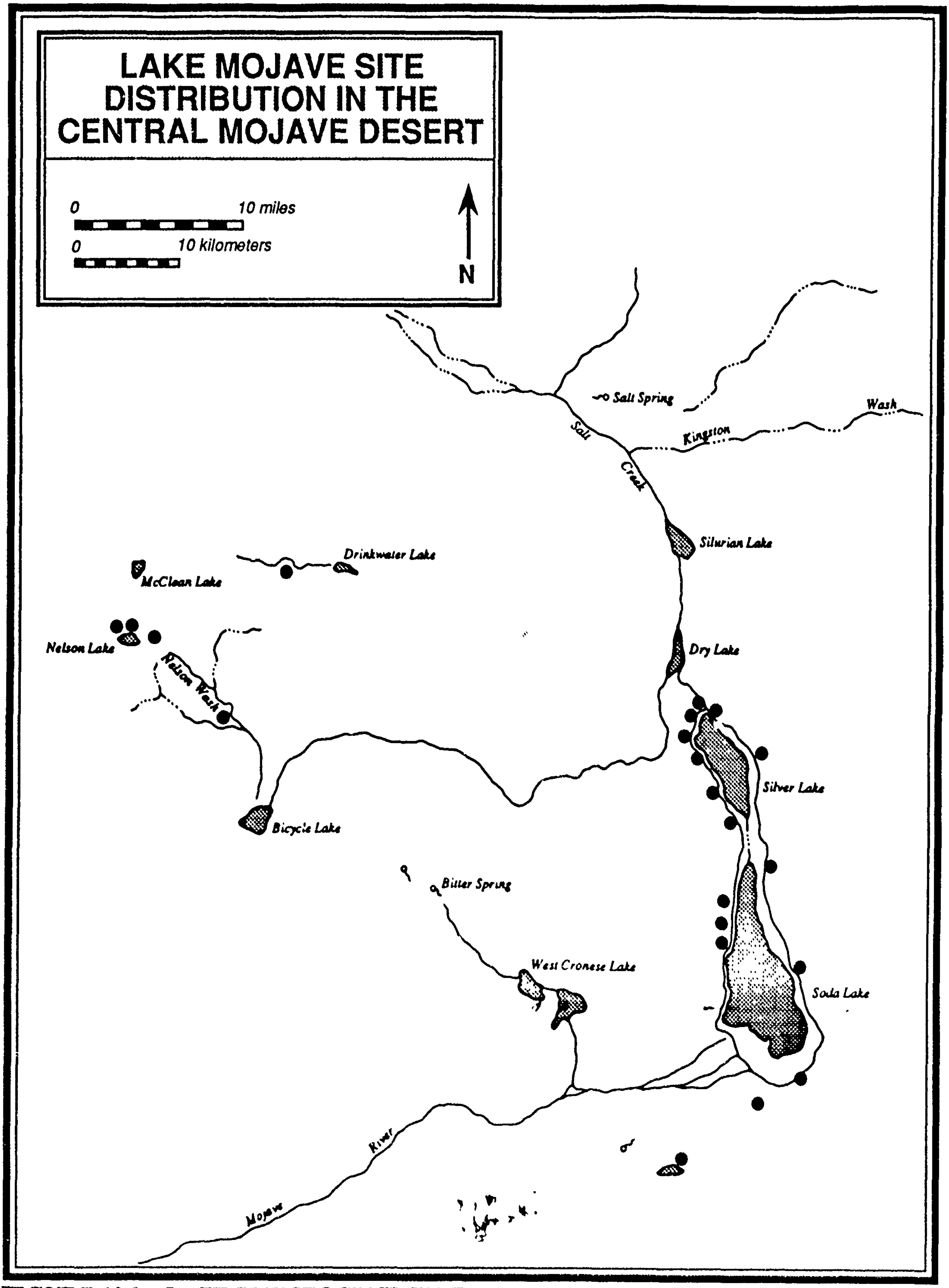

FIGURE 10-2. LATE PLEISTOCENE SETTLEMENT PATTERN

At the east end of Nelson Lake is located a large site (4-SBr-2356) consisting of two important subdivisions or loci. There is a storm beach in and upon which are found cultural debris (Robarcheck et al 1983:72) and a series of gravel cusps developed along the eastern shore. These two areas were grouped together and numbered M-110 by Rogers. The second locus was the sand dunes on a terrace behind the storm beach which Rogers designated M-110A. The gravel cusps developed along the eastern shore and exhibit a symmetry with individual cusps being up to 10 m long with points of the arcuate gravel bars oriented toward the shoreline. Rogers collected a large number of artifacts from both of his loci. Regarding M-110, Rogers states:

> On the talus and in recent wave terraces of gravel 150 ft. out from the site is a great amount of dacite knife material. Knives are very large and some square butted. Some metates [are] present on upper terrace (Rogers n.d.).

The gravel bars are believed to have been formed during a period when the lake did not overflow and water was about 2 m deep (Bachhuber 1984:595). In his concluding comments Bachhuber states:

> Geological data do not permit the establishment of an absolute chronology but it is believed here that the Nelson Lake subpluvial phase occurred about 8000-9000 B.C.

Skinner and Ferraro (in Skinner 1984:234), writing later, report that "artifacts were present in the cusps and this suggests that the lake filled to a high enough level to rework the beaches." If the gravel in these bars, including the stone artifacts, is derived only from the storm beach and the water level was last high enough to rework the storm beach at the end of the Pleistocene (8000-9000 B.C.), then the artifacts contained in the gravel bars would date from this early period. However, several late point types (crude Elko series) have been recovered from the gravel bars and the sand dunes indicating that all those assumptions do not hold and man occupied this site for at least brief periods of time during the mid Holocene. Even though there appears to be a relatively late occupation, Pinto points are rare, missing from 4-SBr-2356, suggesting that there is a Lake Mojave period assemblage dating from early in the occupation of this site.

Finally, the Awl site (4-SBr-4562), located on the drainage channel at the west end of the Drinkwater Basin, has two meters of deposit containing Pinto and Silver Lake points. Recently, however, it has been shown to contain an early occupation that is dated by two radiocarbon assays of 7460 ± 115 and 7520 ± 115 years B.C. Points from this dated level include Silver Lake points and apparently one Pinto point (Basgall personal communication 1988).

<u>The Early Holocene Settlement Pattern in the Central Mojave Desert</u>

After the water level of Lake Mojave had receded, in the Early Holocene (7000 to 4500 B.C.), the occupation of the Lake Mojave terraces ended and the population became concentrated along the upper stream channels, where water was fresh and near springs. Archaeological assemblages from Tiefort Basin, Nelson Wash, Nelson Lake and the Awl site appear to date from this period (Figure 10-3).

A small lake was once contained in Tiefort Basin, but a channel eventually cut to the southeast, lowered the water level, and left a low lying, perhaps swampy area with the basalt-capped Rogers Ridge near its center. A spring on the northwest end of Rogers Ridge attracted human occupation. The Rogers Ridge site (4-SBr-5250) is divided into two loci. The Spring Locus (Locus 1) produced a date of 6460 ± 140 and 6230 ± 150 years B.C. associated with both Pinto and short-stemmed Lake Mojave points (Silver Lake points) (Jenkins 1986).

Locus 2 at Rogers Ridge was further subdivided into the Silver Lake and Embayment artifact clusters. The Silver Lake cluster contained a charcoal-stained feature that produced dates of 5960 ± 420 and 6460 ± 210 B.C. Lake Mojave and leaf-shaped points were recovered from the surface of the area, but no points were found in association with the feature. The Embayment cluster contained a charcoal-stained feature 50 cm deep with a cobble lens dated at 3100 ± 230 years B.C. A Pinto point was found at 20-30 cm depth, above the cobble lens. For geological reasons, however, this date is believed to be too young (Jenkins 1986).

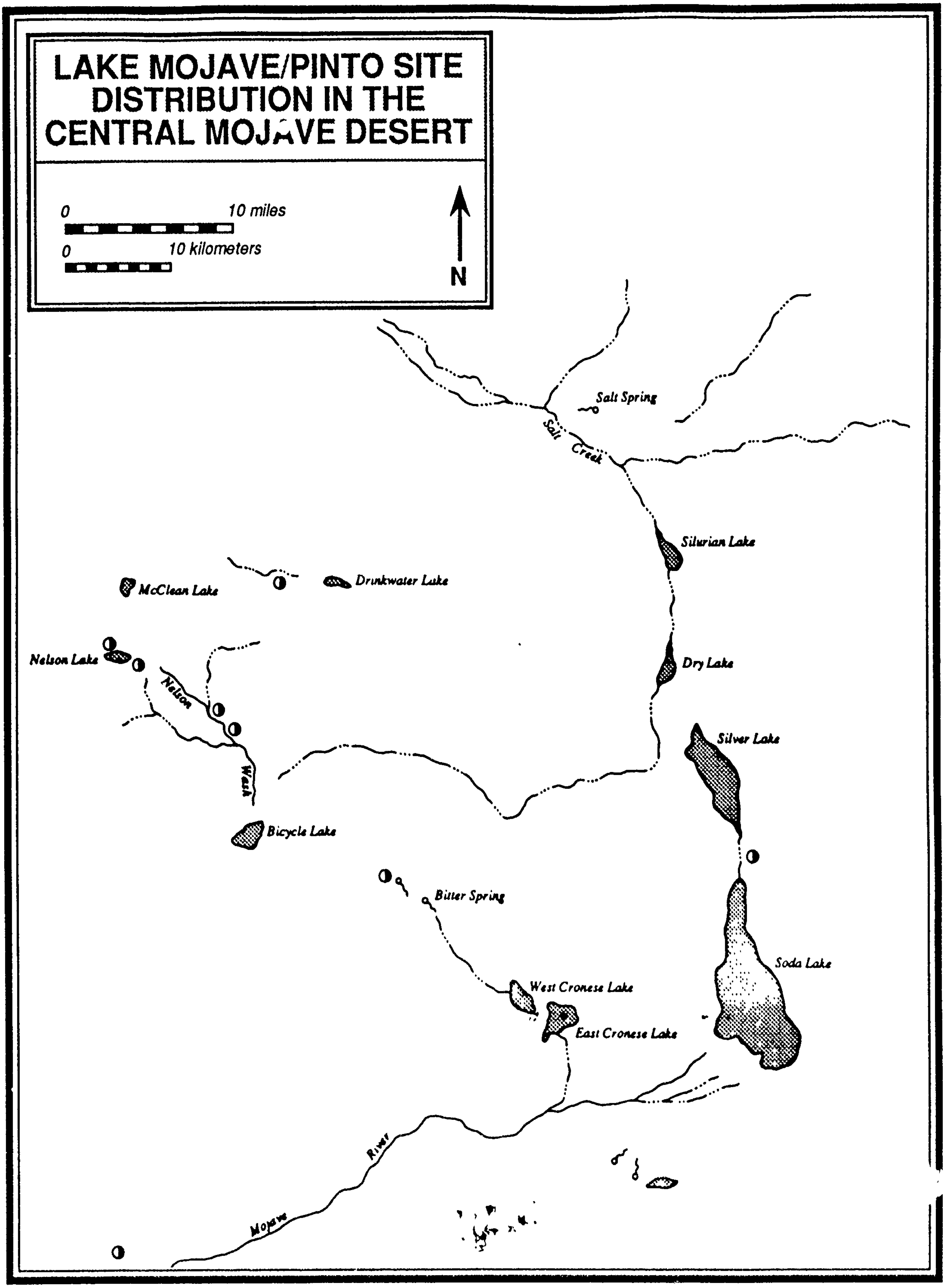

FIGURE 10-3. EARLY HOLOCENE SETTLEMENT PATTERN

Among the Nelson Wash sites the buried 4-SBr-4966 Cmp. 2 is dated at 5200 ± 290 and 5450 ± 280 years B.C., but no projectile points were recovered from this component. Locus H, a surface component with artifacts exposed by erosion and a hearth excavated into the caliche underlying the artifacts, was dated to 5210 ± 290 years B.C. (obtained from charcoal in the hearth). This probably dates the earliest occupation of the site. The projectile points from Locus H consist of one Silver Lake, two Pinto and a single lanceolate form. Other loci at the Henwood site containing both Pinto and Lake Mojave points are 4-SBr-4966 A and -4966 C, dated by obsidian at between 6200 and 6400 year B.C. Site 4-SBr-4969 produced a small tool assemblage which included a single Pinto point, the only classifiable point recovered from the site.

At Nelson Lake, a small campsite just northwest of the playa (4-SBr-5042) contains a single Pinto point, whereas the upper levels of 4-SBr-2356 at the east end of the playa have produced several points suggesting Pinto period and later occupation. The Pinto points from both sites are surface finds and occur with Lake Mojave and/or Silver Lake points.

One variation in artifact assemblage, which appears to date from late in the Early Holocene period (circa 6000 to 4500 B.C.), is characterized by Pinto points and the absence of Lake Mojave points. The Black Mountain site near Newberry Spring falls in this category, as does Locus H of the Henwood site; the last occupation of the Awl site might also belong in this category. Sites with this assemblage of points are rare in the central Mojave Desert, but farther south this assemblage is characteristic of the Pinto Basin sites (Campbell and Campbell 1935). The Pinto Basin sites are found along the margins of an ancient stream channel in an environmental setting similar to that of Nelson Wash. Nearly all of them lack Lake Mojave points, but millingstones are present, as are nearly all of the types of flaked stone biface "knives" and preforms, uniface "scrapers", and a heavy predominance of Pinto points.

A second variation in artifact assemblages which lacks projectile points altogether also dates from approximately 5500 to 4500 years B.C. Component 2 of the Henwood site, dated at 5200 ± 290 B.C. and 5450 ± 280 B.C., produced no projectile points, but the assemblage contained bifacially flaked ovate "knives" and preforms, and flake-based uniface scraping tools, millingstone and mano fragments, and cores. Loci at SBr-4966 that appear to have assemblages that are very similar to that of Component 2 include 4966 E (the surface materials that overlay Component 2) and 4966 D, which may date to slightly later than 5000 B.C. The Early Holocene period (7000 to 5000 B.C.) exhibits more variability among the artifact assemblages so far recovered than do the earlier periods. This seems to be a time of cultural change, with the addition of Pinto points and an increase in millingstones, followed by the disappearance of Lake Mojave points and crescents. This cultural pattern apparently persisted in the upper drainages until at least 5000 B.C. Dates for Rogers Ridge suggest that occupation may have occurred at the spring until 2000 B.C., but no artifact assemblage can be identified for the period between 5000 and 2000 B.C. at that site.

The Middle Holocene Settlement Pattern

Middle Holocene climate was arid; streams and some springs dried, leaving fresh water available at only a few springs (Figure 10-4). Site identification for this period is tenuous. There are no radiocarbon dates for either prehistoric occupation of the drying up of the streams and springs, although the arid conditions were certainly severe by 5000 years B.C. Two components in the central Mojave Desert containing Pinto points but not Lake Mojave series have been identified and may date from this period. These are located at low elevations near Salt Spring, at the southern end of Death Valley, and at Fossil Spring, on the southern edge of the Mojave River Valley where it enters the basin of Soda Playa.

Salt Spring is currently flowing, but as the name indicates, the water is salty and has been reported as undrinkable in historic times. Rogers (n.d.) recorded eighteen detached camps or occupation areas within the Salt Spring site. A major portion of the occupation has been attributed to the Pinto and Gypsum periods on the basis of time-sensitive projectile points (Warren 1980a). In most loci the Pinto points are mixed with later Elko and Gypsum points; however, at one locus, M-35-0, there appears to be an unmixed Pinto assemblage. This locus yielded 125 Pinto points and 71 other points of nondiagnostic forms (Rogers n.d.; Warren

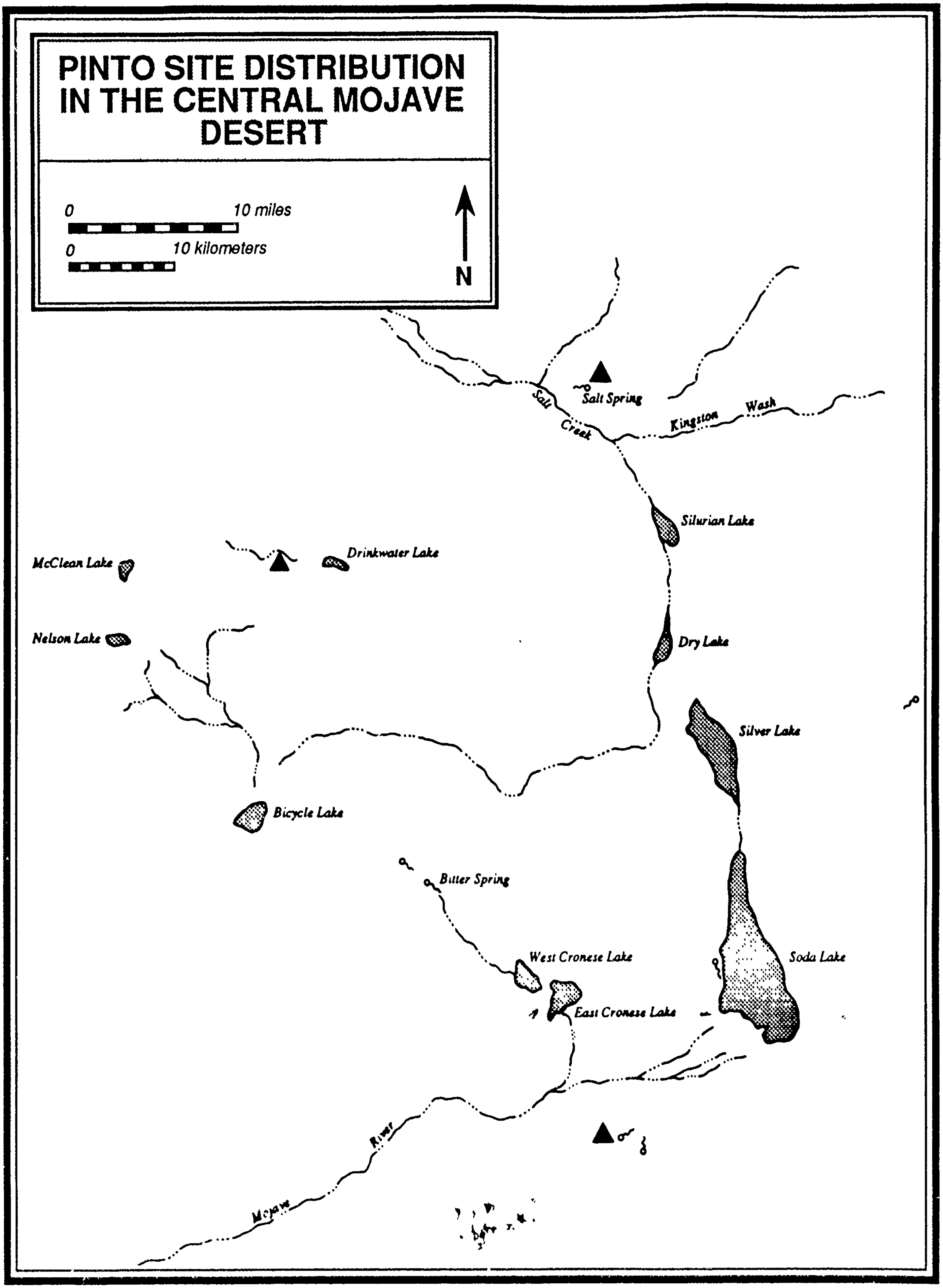

FIGURE 10-4. MIDDLE HOLOCENE SETTLEMENT PATTERN

1980a).

The Fossil Spring site produced nearly the same range of points, but with a much smaller total number. In the Campbell collection from the Fossil Spring site there are 15 Pinto points, nine leaf-shaped and two nondiagnostic forms, but no Lake Mojave, Silver Lake, Elko series or Gypsum points (Campbell n.d.). Rogers' collection from a wider area in the same locality (about one square mile) includes several Elko series points and a single fluted point, in addition to seven Pinto points (Rogers n.d.).

Spring sites from the middle to late Holocene period are rare, so far impossible to date, and may also exhibit "assemblages" containing artifacts from several different periods. At none of these sites can the Pinto points be dated. Regardless of whether or not these sites are representative of the Pinto period after the drying of the streams and lakes, the population of the central Mojave must have been significantly smaller during the middle Holocene period than it was during the earlier period discussed above.

<u>Summary of Changing Settlement Patterns in the Early Holocene Central Mojave</u>

Although there are a few data available on the settlement pattern of the Mojave Desert during the Late Pleistocene-Early Holocene (9000 to 4500 B.C.), a number of tentative observations can be made when the data are organized chronologically and spatially. It appears that during the Late Pleistocene period (circa 9000 to 7000 B.C.), the settlements of the central Mojave Desert were concentrated about larger freshwater lakes and along the Mojave River and its tributaries. The 24 sites reported on the shoreline of Pleistocene Lake Mojave were probably occupied primarily during this period, although only one dated site, at 8320 B.C., has been reported (Warren and Ore 1978; Ore and Warren 1971). Other components of considerable age include the early occupation at the Awl site, with dates of 7460 ± 115 and 7520 ± 115 years B.C. (Mark Basgall, personal communication 1986; Matt Hall, personal communication 1986), and possibly Component 1 at the Henwood site in Nelson Wash, dated at 6520 ± 160 years

B.C. The distribution of other sites dated by obsidian hydration and by typological cross-dating indicate a widespread association of sites characterized by the Lake Mojave cultural complex with streams and lakeshores. There are no known occupation sites from this period located away from the lake and stream shores, except perhaps some lithic resource sites.

After about 7000 B.C., the settlement pattern became more restricted as the depleted water supply no longer maintained overflow levels of the desert lakes. The resources of the lake margins were depleted by receding or fluctuating water tables and increasing salinity. At this time, the sites on the margin of Lake Mojave and the lower reaches of the Mojave River system were abandoned, but further upstream sites located adjacent to stream channels and small freshwater lakes were still occupied. Components containing both Lake Mojave points and Pinto points at Rogers Ridge have been dated at 6460 $\pm$ 140 and 6230 $\pm$ 150 years B.C.; whereas at the Henwood site the surface of Locus H, containing both Silver Lake point and Pinto points, is dated at $\leq$ 5190 $\pm$ 290 years B.C. Component 2, lacking points entirely, is dated at 5200 $\pm$ 290 and 5450 $\pm$ 280 years B.C. Sites containing Pinto and Lake Mojave points appear to date to the Early Holocene period and exhibit a settlement pattern characterized by a "restricted" occupation of upstream locations along shorelines of freshwater lakes and streams.

The Middle Holocene period (4500 to 2000 B.C.) is marked by the absence of lakes and flowing streams in the central Mojave Desert. The only sources of water in the central Mojave at this time were springs and seeps. No sites can be unquestionably dated to this period and sites that do appear to date from this period are very few in number. The smaller lakes and tributary streams of the Mojave River, and most of the Mojave River, could no longer support the populations of the earlier periods. The Middle Holocene human population apparently concentrated about the springs, the only sources of water in the central Mojave Desert.

Changing Subsistence Strategy: Conclusions

The artifact assemblage from the Late Pleistocene (9000 to 7000 B.C.) in the Mojave Desert is the Lake Mojave complex. This complex is found on sites associated with the high lakestands of Lake Mojave and on the margins of Nelson Lake, Nelson Wash, in Death Valley (Wallace 1962), and at the Awl site. Lake Mojave and/or Silver Lake points, together with leaf-shaped points, crescents, spiked gravers, leaf-shaped biface cutting tools, domed keeled, concave and ovoid side scrapers, are characteristic of these early assemblages. Millingstones and handstones occur rarely on these sites.

The postulate that the subsistence focus was artiodactyl hunting is supported by: (1) the faunal remains from the Awl site, virtually the only faunal remains recovered from a site dated to this period; and (2) an emphasis on heavy projectile points and animal processing tools in the assemblages from sites of this period. The association of occupation sites of the Late Pleistocene period with ancient stream and lake shores suggests an adaptation to the riparian and marsh environments, but one that emphasized hunting artiodactyls that were presumably numerous in and/or near these environmental zones. Although no analytical study of assemblage composition has been made on sites other than those in Nelson Wash, the components identified with the Late Pleistocene period appear to be a homogenous group, with possible specialized lithic resource and reduction sites being the only exception, although they vary considerably in size, that appear to contain the same range of artifact types. This may simply reflect the bias of the archaeological sample, but it may also represent a forager subsistence strategy (Binford 1980) adapted to a set of similar environmental zones, namely riparian, marsh and lakeshore. The sites, in this case, would represent the repetition of similar subsistence activities, with artiodactyl hunting always playing a major role.

The assemblage of the Early Holocene period (7000 to 4500 B.C.) shares most of the artifact types found in the preceding period; crescents appear less frequently and the Pinto point series is added to the assemblage. The Lake Mojave, Silver Lake and leaf-shaped points continue into, if not through, this period. The areas of marsh, stream and lakeshore and associated resources decrease during this period and are limited largely to locations upstream from the sinks of the Mojave River and it tributaries. The human settlements appear to become more restricted, exhibit an apparent association with the decreasing areas of riparian, marsh and lacustrine resources, and suggest a continuation of the forager subsistence strategy from the Late

Pleistocene period. The limited faunal evidence available suggests a decrease in productivity of artiodactyl hunting and presumably in artiodactyl population. Cultural adjustments appear in the occurrence of new projectile point types and the decreasing frequency of domed and keeled scrapers with a corresponding increase in flake scrapers, which suggests the manipulation of the subsistence focus. Other adjustments are possibly indicated by the apparent increase in the occurrence of millingstones, and associated seed collecting and processing.

In the later part of the Early Holocene period (5500 to 4500 B.C.) and in the Middle Holocene (4500 to 2000 B.C.) components are more variable in content than earlier. Some components lack projectile points, others have characteristic Pinto points, but lack Lake Mojave points. Domed and keeled scrapers are essentially gone from these assemblages, and millingstones and handstones appear to be more numerous. The taking of artiodactyls appears to have been reduced to a negligible quantity and a major change in subsistence strategy, from forager to collector (Binford 1980), may have occurred at this time. The increasing aridity reduced the size and number of areas of riparian, marsh and lakeshore resources, making such areas increasingly scarce and more widely separated by non-productive zones. Human groups now had to travel greater distances to find desired resources and to different locations for different resources. A seasonal round of activities was developed in which hunting of artiodactyls continued but in a lesser role, becoming one of several logistically organized activities requiring planning and coordination.

The change to the collector strategy results in specialization of sites in which different subsistence acitivities begin to occur in different resource patches during different seasons of the year. Component 2 and Locus H of the Henwood site (4-SBr-4966), site 4-SBr-4965, and possibly site 4-SBr-4501 in No Name West Basin (Kelly and Warren 1984:240-250), are examples of this variety of sites. All of these sites are small but their artifact assemblages are quite variable. Site 4-SBr-4965 was a surface site and contained no faunal remains; however, one non-diagnostic point and six fragments were recovered. Artiodactyl bones are absent in the small sample of faunal remains from Locus H, but two Pinto points, a Silver Lake point, and three non-diagnostic points were recovered. At SBr-4501 and Component 2, there were a negligible number of artiodactyl bones but no projectile points. This suggests that hunting of artiodactyls was rare or was conducted primarily from other sites, perhaps located at higher elevations or at springs where the artiodactyls came regularly to drink. The faunal remains from these sites suggest that increased effort was put into collecting small animal resources with unspecialized and/or perishable tools, e.g., rabbit clubs, hooked sticks, nets, etc. However, each site contained a somewhat different faunal assemblage. Fauna from Locus H is limited to lagomorphs and rodents; Component 2 has a heavy emphasis on tortoise (64%) and secondarily lagomorphs (12%); and SBr-4501 has an emphasis on lagomorphs (55%), but reptiles make up a large part of the balance (tortoise 7%, snake and lizard 26%).

Millingstones and/or manos are also reported from Component 2 and Locus H, suggesting that processing of seeds was conducted at these sites. Millingstones were also reported rom SBr-4501, but they were isolated from other cultural materials and probably are not part of the tool assemblage discussed above.

During the Middle Holocene period (4500 to 2000 B.C.) there is a lack of dated sites and cultural assemblages. However, there are several undated occupations associated with springs, e.g. Fossil Spring and Salt Spring, that appear to be the final phase of the Lake Mojave-Pinto Basin cultural development. Artifact assemblages from these sites are surface collections and contain a mixture of different points, including Pinto points (Warren 1980a). If these spring sites date from the Middle Holocene period they have undergone some changes. Crescents, Lake Mojave points, Silver Lake points, spiked gravers and most of the domed and keeled scrapers have all dropped from the assemblage. Pinto points are present and later point types, e.g. Elko and Humboldt series, may be added at the end of this period. At some sites projectile points appear to make up an even higher percentage of assemblage than in earlier periods. Projectile points may also be absent from some sites, but if they are we have no means of placing such sites without dating them by other means. Millingstones and handstones appear to become relatively more numerous during this phase, but they may not occur at all components.

If the spring sites do date from this period they probably represent a continued occupation from earlier times. The lack of dated sites for this period makes it impossible to discuss the subsistence strategy. Whatever the strategy may have been, it appears to have been relatively unsuccessful since the number of sites appears to continue to decrease. The continued dry conditions limited the amount of water, making it a critical element in controlling the number and distribution of both artiodactyl and human populations. Both man and artiodactyl were tethered to springs and perhaps the decrease in human population made it possible for men to continue hunting artiodactyl as an important element in the seasonal round of collector strategy.

The increasing aridity of the early to middle Holocene undoubtedly resulted in a decreasing artiodactyl population as well as decreasing resources associated with the dwindling lakes, streams and marshes. The decrease in artiodactyls is reflected in the decreasing number of artiodactyl bone in the archaological sites. The artifacts used for hunting artiodactyls appear to continue but reflect a number of morphological changes, even as the productivity of artiodactyl hunting declines. Other adjustments were apparently attempted late in the sequence, as reflected in the apparent increase in use of millingstones and the taking of small animals. However, the human population does not seem to have successfully adapted to the arid conditions of these early times. The environmental conditions of the Middle Holocene in the central Mojave Desert were certainly very much like they were in historic times. It is abundantly clear that the human population of the Early and Middle Holocene periods had a different settlement pattern until sometime between 4000 to 2000 B.C.: a settlement pattern that clearly indicates an adaptation to resources that are scarce or absent in the modern desert. It now appears that the adaptation to the desert that characterizes later peoples of the region was not developed until possibly as late as 2000 B.C. In fact, the attempt by the early inhabitants of the central Mojave Desert to preserve the way of the hunter may have contributed to declining populations and near abandonment of the desert during the arid Middle Holocene.

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APPENDIX A

Confidential Appendix - Archaeological Site Locations

Fort Irwin, California

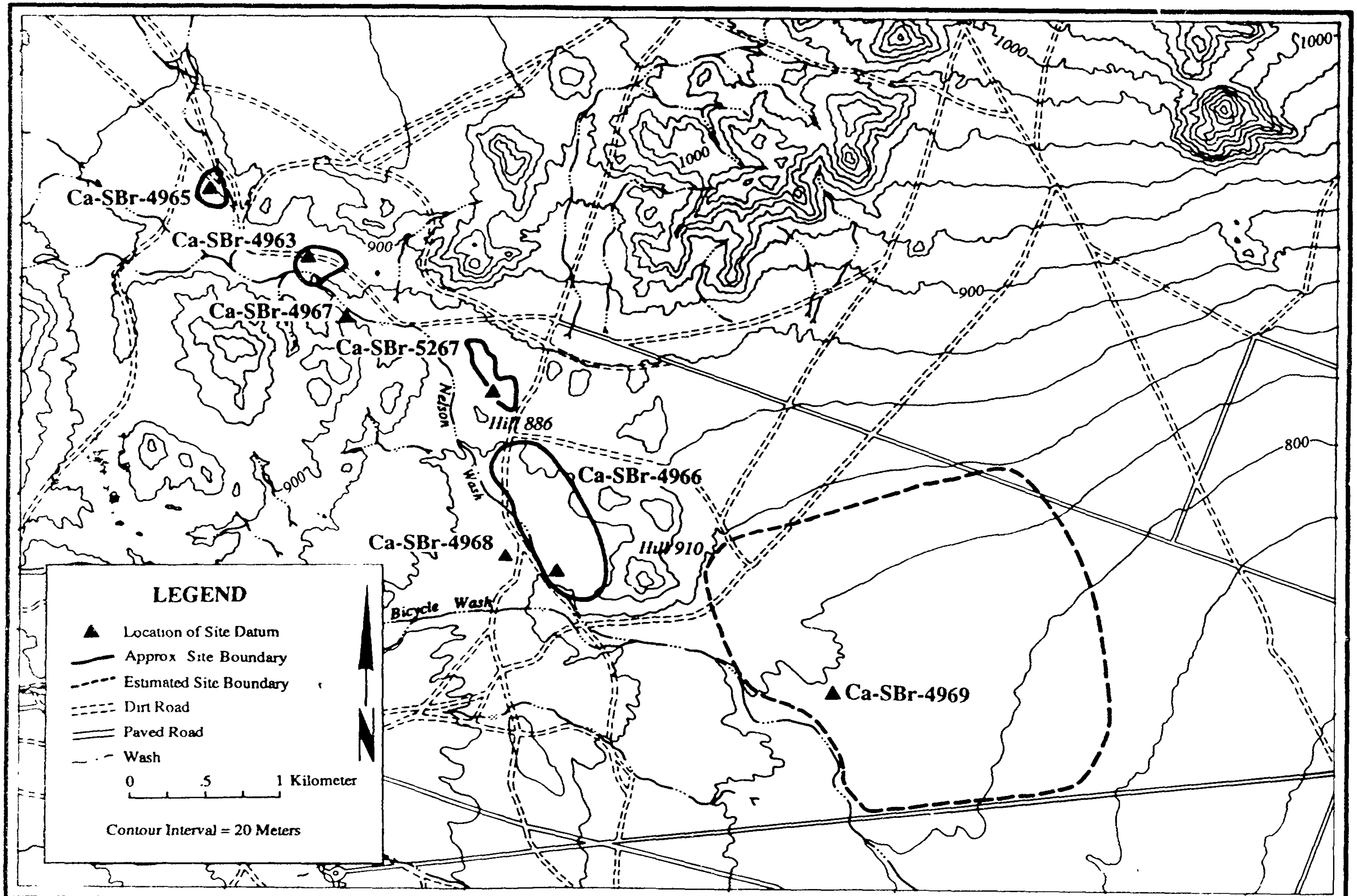

FIGURE A1. NELSON WASH STUDY AREA

APPENDIX B

Bachhuber: Pollen Analysis of Site SBr-4966 (KD-26)

Fort Irwin, California

in KOH, concentrated HF, and acetolysis solution. Glacial acetic acid and t-butyl alcohol were used as washing agents. The complete processing procedure should remove all silicate minerals, calcium carbonate and most organic material, leaving a concentrate of pollen, spores and certain algae.

The pollen concentrate was transferred to 2 dram shell vials and mixed with silicone fluid (30,000 cs) as the mounting medium. The mixture was then placed on a standard glass slide and covered with a 22 x 40 mm coverslip. The entire area under the coverslip was scanned at 260x using a Zeiss microscope with differential interference contrast capabilities. Identification of certain pollen grains required a magnification of 450x and 1000x.

Pollen Analysis

The pollen analytical data is submitted in two appendices. Appendix A includes sample location information on the 30 sediment samples and a brief sedimentologic description of each sample. Appendix B contains pollen frequency diagrams. In both appendices the pollen samples are listed as Pollen Sample #1 through Pollen Sample #30. There is no geographic or stratigraphic order to the pollen sample numbers. Samples were collected more or less at random with only samples #25, #26, #27 and #28 occurring in stratigraphic sequence.

As indicated in appendix A, the majority of sediment samples submitted for processing were fine to coarse-grained sand but almost all samples had a relatively high clay fraction as matrix. Many of the samples also had high relative percentages of calcium carbonate as grain coatings or interstitial cement. The calcium carbonate content was determined by the samples relative reaction with dilute HCl. The Munsell color of the sample is based on color of the dry sediment prior to processing. The term "float" is an indication of the relative amount of organic debris (mainly rootlets) which surfaced during the initial swirl/decant process.

The pollen frequency diagrams of Appendix B list a total of seven pollen taxa for the 30 samples.

The seven taxa are:

Pine - *Pinus*
Chenopod - family Chenopodiaceae, e.g. *Atriplex*
Ephedra - *Ephedra*, Mormon tea
Grass - family Poaceae
Short spine - family Compositae, spines less than 1 micron in height
High spine - family Compositae, spines more than 1 micron in height
Unknown - grains that have a reasonable amount of surface sculpturing and pollen wall morphology preserved but could not be identified.
Unidentifiable - obvious palynomorphs but virtually all surface and pollen wall morphology has been destroyed by corrosion

With the exception of taxum "Unidentifiable" pollen grains were identified and tabulated. Pollen frequencies were determined and the data was plotted using Microsoft Chart. Owing to occasionally large numbers of "Unidentifiable" this taxum was tabulated and included in the total pollen sum (Σ). However, a relative indication of "Unidentifiable" abundance is noted on the pollen frequency diagrams.

Of the 30 sediment samples processed for pollen content, 8 samples contained no palynomorphs or the observed palynomorphs were judged to be contamination, 7 samples had fewer than 50n identified grains, 4 samples had less than 100 identified grains and 11 samples had over 100 identified grains. The generally low pollen densities and the restricted diversity of pollen taxa is the result of poor preservation of pollen grains. This is verified by the moderate to high corrosion of virtually all of the pollen grains identified in the 30 samples.

Discussion.

The sediment samples submitted for pollen analysis were typically fine to coarse-grained sane with varying pebble and cobble content. Coarse-grained sediment of this type, even though they may have high silt and clay matrix, are not likely to have high pollen grain diversity and density. As a result, it is surprising that many of the samples contained as much pollen as they did. The coarse-grained nature of the sediment automatically creates certain problems. The high permeability of the sediment allows rapid water infiltration. This results in translocation of clay and the movement of pollen grains to lower stratigraphic levels. A true stratigraphic relationship in terms of the pollen, therefore, is not maintained through time. A more serious problem is that the infiltrating surface water is generally highly oxygenated. Oxygenated water causes rapid corrosion and eventually the complete destruction of pollen grains. Degradation of the various pollen taxa, however, is not uniform. Some pollen types are more resistant to corrosion than others and some pollen types can be easily identified even at advanced staged of degradation. These factors contribute to a significant bias when analyzing the pollen spectrum. The more resistant pollen types are preserved or identified, artificially increasing their pollen percentages; whereas, the less-resistant types are totally removed from the pollen spectrum with no record of their having been present. All of the pollen samples examined in this study were characterized by high corrosion and therefore, none of the samples should be considered representative of the pollen rain at the time of deposition of the sediment. it then follows that none of the samples are representative of the total vegetational complex at any particular time.

Three pollen taxa (Chenopod, High Spine and Low Spine) occur with the highest percentages in those samples that have identifiable pollen. The High Spine and Low Spine Compositae have highly resistant pollen walls and are easily identified even when highly corroded. The Chenopod taxum is characterized by more easily corroded pollen but even at advanced stages of degradation, the pollen can still be identified. The high frequencies of Compositae and Chenopodiaceae pollen are, therefore, a function of the relative preservation and easy identification of the pollen at the exclusion of most other pollen types. Nonetheless, the occurrence of Compositae and Chenopodiaceae pollen is an indication that these plant groups did exist at the time of deposition of the sediment. In addition, they most likely were a significant component of the actual vegetational complex.

Pine is the next most abundant taxum in terms of frequency and occurrence. Similar to the Compositae, pine also has a resistant and easily identifiable pollen grain. In a few samples, pine has a frequency of up to 10%. Under normal preservational conditions, 10% pine pollen would be considered paleoenvironmentally significant and speculations as to color and/or more mesic conditions than the present could be made. In view of the artificial "concentration" of pine by preservation factors, however, this speculation should not be made.

The only other pollen taxa identified were *Ephedra* and Grass. Grass is easily corroded and in most cases will be completely removed from the pollen spectrum under moderately adverse corrosional conditions. The very few grains encountered exhibited an advanced stage of degradation but owing to the simple pollen morphology of grass (a single pore), a number of grains were positively identified. Because of corrosion, grass mist be highly under-represented in the pollen spectra. In contrast, *Ephedra* has a more resistant pollen wall but it too is under-represented. *Ephedra* pollen grains are easily crumpled and thus assume an unidentifiable condition.

Sediment samples were collected from the three major stratigraphic units identified at site 4SBR-4966. The units are the result of three distinct pedogenic or depositional events. The oldest unit consists of fluvial sediment which was deposited by a permanent or quasi-permanent stream flowing through Nelson Wash. It is believed that this sedimentary sequence is of Wisconsin age. The fluvial sediment is typically capped by a buried geosol. The geosol, referred to a AS-3 in the geologic report, is a buried B-horizon which developed after deposition of the fluvial sequence. The geosol, in turn, is truncated or unconformably overlain by a complex sequence of aggrading fan and colluvial deposits. The fan and colluvial deposits mark the time of occupation of the area by early man.

Unfortunately the stratigraphic location of many of the sediment samples used for pollen analysis is unknown by the author of this report. Even with this restriction a number of general statements can be made as to the pollen spectra of the various stratigraphic units. Samples #25, #26, #27 and #28 were collected by the author in stratigraphic sequence from the older fluvial sediments. This sequence, however, had no or very few observed palynomorphs. Samples #12, #24 and #29 were collected from the buried geosol. These samples also had no or very few observed palynomorphs. This is to be expected because the pedogenic process is not conducive to the preservation of pollen. The remaining samples represent the older fluvial sediment and the post-geosol alluvium and colluvium. It would be desirable to know the actual stratigraphic location of these samples but in reality it somewhat of a moot point. The pollen spectra of the remaining samples, whether of fluvial or alluvial origin, are similar. The pollen frequency diagrams are characterized by high Chenopodiaceae and Compositae percentages. The similarity in pollen spectra suggests that there may not have been any significant difference in vegetational composition or climate between the time of deposition of the fluvial sediment and the alluvial sequence. Further, the pollen spectra suggest that there may not have been a significant vegetational and climatic difference over the present arid environment. The main point that is being made here is that the pollen record from 4-SBr-4966 is not reliable enough to make any paleoenvironental interpretation. Climate may have been cooler and more mesic during the recent geologic past but pollen can not be used to make this inference.

In summary, it is obvious that the pollen data from site 4-SBr-4966 leaves much to be desired (like No Name West). Surprising high numbers of pollen were extracted from many of the coarse-grained sediment submitted for analysis. The pollen grains, however, exhibited a high degree of corrosion and only the more resistant or easily recognizable grains were identified. Since most pollen taxa were completely removed by corrosion or are drastically under-represented, the more resistant grains become grossly over-represented. The pollen frequency diagrams, therefore, are not representative of the pollen rain, vegetational composition or climate during the time of deposition of the sediment.

APPENDIX B

Pollen sample #1
Site information: S1454E2018.4, 30-40 cm, feature 18
pebbly, silty sand, 10YR7/1, minor float, high HCL reaction.
AS66

Pollen sample #2
Site information: S1504.9E2007.2, 42-50 cm, nonlocus
Gravelly, silty sand, 10YR7/2, medium float, moderate HCI reaction
AS7a

Pollen sample #3
Site information: S1599.6E2138.2, 10-30 cm
Pebbly, silty sand, 10YR7/2, minor float, moderate HCI reaction
AS2

Pollen sample #4
Site information: SV6, 10-30 cm, locus E, feature 4
Medium-coarse sand, 10YR6/2, minor float, slight HCI reaction
AS66

Pollen sample #5
Site information: S1439E2009.8, 10-30 cm
Pebbly, silty sand, 10YR6/4, medium float, high HCI reaction

Pollen sample #6
Site information: S1681E2087, 40-50 cm, feature 15
Silty, medium-coarse sand, 10YR7/2, minor float, slight HCI reaction.
AS2

Pollen sample #7
Site information: S1445E2011, 60-70 cm, feature 10
Pebbly, medium-coarse sand, 10YR5/2, minor float, black suspension,
No HCI reaction
AS76

Pollen sample #8
Site information: S1463E4566(?), 20-30 cm, feature 10
Silty, coarse sand, 10YR7/2, minor float, No HCI reaction
AS66

Pollen sample #9
Site information: S1459E2011, 40-50 cm, feature 21

Pebbly, medium-coarse sand, 10YR7/1, minor float, high HCI reaction
AS7A

Pollen sample 10
Site information: S1460E2011, 28.5-30 cm, feature 12
Medium-coarse sand, 10YR7/1, minor float, no HCI reaction
AS6a/AS66

Pollen sample #11
Site information: SV19, FIR 11, 40-50 cm
Medium-coarse sand, 10YR7/3, moderate float, high HCI reaction

Pollen sample #12
Site information: Trench 10, 105m(?), 260 cm, B-horizon
Sandy, pebbly gravel, 10YR7/2, minor float, slight HCI reaction

Pollen sample #13
Site information: Trench 10, 105m, 120 cm
Sandy, pebbly gravel, 10YR7/4, very minor float, minor suspension,
No HCI reaction.

Pollen sample #14
Site information: Trench 9, 270 cm, 480 cm BD(?)
Silt to fine sand, 10YR7/2, very minor float, high HCI reaction.

Pollen sample #15
Site information: S1580E2069, 30-40 cm, feature 6, seg B
Pebbly, silty sand, 10YR5/3, minor float, black suspension,
No HCI reaction.

Pollen sample #16
Site information: S1460E1994, 30-40 cm, locus 0, feature 13
Pebbly, silty sand, 10YR5/3, heavy float, no HCI reaction.

Pollen sample #17
Site information: SV9, FTR5, 40-50 cm
Pebbly, silty sand, 10YR7/4, minor float, slight HCI reaction.

Pollen sample #18
Site information: S1455E2013, 60-80 cm, "the gray stain"
Pebbly, silty fine sand, 10YR5/1, minor float, black suspension,
Slight HCl reaction.

Pollen sample #19

Site information: SV6, 20-30 cm, locus E, feature 4
Pebbly, silty sand, 10YR6/4, minor float, moderate HCI reaction.

Pollen sample #20
Site information: S1455E2011, 70-80 cm
Pebbly, silty sand, 10YR5/1, minor float, no HCI reaction

Pollen sample #21
Site information: S1539.9E1956.6, 50-61 cm, feature 2, seg B
Pebbly, silty sand, 10YR5/1, minor float, slight HCI reaction.

Pollen sample #22
Site information: S1595.6E2073, 30-40 cm, feature 20
Pebbly sand, 10YR6/4, minor float, no HCI reaction.

Pollen sample #23
Site information: Locus by pod(?), 41-46 cm
Silty sand, 10YR7/4, minor float, slight HCI reaction.

Pollen sample #24
Site information: Trench 10, 5 m west T/S 1797, 2 m, B-horizon
Pebbly, silty sand, 7.5YR6/6, minor float, minor suspension,
No HCI reaction.

Pollen sample #25
Site information: stratigraphic sequence in fluvial sediments, 20 cm
Fine sand, 10YR8/3, minor float, no HCI reaction.

Pollen sample #26
Site information: stratigraphic section - 35 cm
Silty, fine sand, 10YR7/3, minor float, no HCI reaction.

Pollen sample #27
Site information: stratigraphic section - 55 cm
Silty, fine sand, 10YR7/1, minor float, no HCI reaction.

Pollen sample #28
Site information: stratigraphic section - 70-75 cm
Silty, fine sand, 10YR7/1, minor float, no HCI reaction.

Pollen sample #29
Site information: trench 10, 8 m west T/S9/0, 80 cm, B-horizon

Medium-coarse sand, 7.5YR5/6, minor float, no HCI reaction.

Pollen sample #30
Site information: south end trench 7, caliche, backhole spoil
Fine sand, 10YR8/4, minor float, high HCI reaction.

Pollen sample #14
No palynomorphs observed

Pollen sample #24
Pollen sum = 10 grains. 4 pine, 6 short spine. All grains are contamination.

Pollen sample #26
No palynomorphs observed

Pollen sample #27
No palynomorphs observed

Pollen sample #28
Pollen sum = 3 grains. 3 short spine. All grains are contamination.

Pollen sample #29
Pollen sum = 15 grains. 2 pine, 1 high spine, 2 short spine,
1 *Artemisia*, 2 Chenopod, 1 grass, 6 unknown. All grains are contamination.

APPENDIX C
Jackson: Analysis of Obsidian Hydration on Archaeological Specimens from the Fort Irwin Archaeological Project

February 12, 1984

Ms. Elizabeth Skinner
Wirth Environmental Services
Fort Irwin Archaeological Project
P.O. Box 1298
Barstow, CA 92311

Dear Elizabeth:

Enclosed please find xerox copies of data sheets presenting the results of x-ray fluorescence analysis of 118 obsidian specimens from six archaeological sites (CA-SBr-4562, n=2; CA-SBr-4963, n=17; CA-SBr-4966, n=85; CA-SBr-4968, n=1 and CA-SBr-5267, n=7) in the Fort Irwin Archaeological Project, San Bernardino County, California. This total includes 115 artifacts from six sites (detailed above), one Elko Corner-notched projectile point (Cat. no M117A) from the San Diego Museum of Man in San Diego, and two obsidian nodules from the Goldstone source, San Bernardino County. The analyses were conducted pursuant to letter requests dated December 10, 1983 and December 19, 1984 under Wirth Environmental Services Contract CX 8000-10034, BOA Order No. 8015-1-0034 and CX 8000-1-0034, BOA Order No. 8017-1-0034 (for the Elko Corner-notched point), under Sonoma State University Academic Foundation, Inc. Account 6081-A1, Job X85-1.

Laboratory investigations were conducted at the Department of Geology and Geophysics, University of California, Berkeley, on a Spectrace$_{tm}$ 440 (United Scientific Corporation) energy dispersive x-ray fluorescence machine equipped with a 572 power supply (50 kV, 1 mA), 534-1 pulsed tube control, 513 pulse processor (amplifier), 588 bias/protection module, Tracor Norther 1221 100 mHz analog to digital converter 9ADC), Tracor Northern 2000 computer based analyzer, an Rh x-ray turbe and a Si(Li) solid state detector with 142 eV resolution (FWHM) at 5.9 keV in a 30 mm_2 area. The x-ray tube was operated at 30.0 kV, 40 mA pulsed, with a .04 mm Rh primary beam filter in an air path at 200 seconds livetime. All trace element values on the enclosed data sheets are expressed in parts per million (ppm) by weight, and these were compared directly to values for known obsidian sources that appear in Jack and Carmichael (1969: 27-28), Jack (1976: 203-204), Bacon et al. (1981: 10225-10228, 10234) and Hughes (1985: Figure 3). The $\pm$ character associated with each trace element concentration value on the data sheets represents counting error uncertainty at 200 seconds livetime (see Hughes 1983:26).

Comparison of diagnostic trace element values (Rb, Sr, Y and Zr) for these 115 artifacts with values for known obsidian sources supports the following source ascriptions. These can be summarized, by site, as follows:

Eighty-five specimens were analyzed from SBr-4966 (catalogue prefix: 178-). Of this total, three (Cat. nos. 3173, 6126 and 6892) match the trace element profile of the Queen obsidian source, cone (Cat. no 5144) is most similar to the elemental configuration of obsidian from the vicinity of Obsidian Butte, Nevada, while two specimens (Cat. nos. 2999 and 3100) were too small to yield reliable quantitative measurements (i.e. the ± value is 3-4 times greater than those accompanying the majority of the specimens analyzed). The remaining 79 specimens match the trace element configuration of obsidian from Coso Hot Springs. However, thirteen specimens in this latter group (Cat. nos. 2329, 2968, 3019, 3064, 3108, 3310, 6459, 6622, 7391, 701, 7664, 7711, and 8002) generated trace element concentration values rather different from the remainder of the group. Specifically, these 13 artifacts possess Zr concentrations ca. 20 - >50 ppm less than those reported for Coso obsidian by Jack and Carmichael (1969: 27; nos. 27 and 28) and Jack (1976: 204), but they closely match concentration values recently reported for Sample Group 6 obsidian by Bacon et al. (1981: cf. 10227, nos. 24/6 and 25/6; 10234, Table 3). Since neither robert Jack nor I visited this locality, we have no source standards for comparison; however, the diagnostic Rb, Sr, Y and Zr ppm values indicate a close match with this group of 13 artifacts, although Zr ppm values are somewhat higher than those reported for source standards.

Seventeen artifacts were analyzed from SBr-4963 (catalogue prefix: 174-). All 17 match the elemental fingerprint of Coso Hot Springs obsidian but, as with SBr-4966, 12 of these (Cat. nos. 55, 63, 121-1, 121-2, 127-1, 127-2, 133, 134, 141, 173, 354 and 410) possess trace element concentrations similar to Sample Group 6 obsidian identified by Bacon et al. (1981).

Seven specimens were analyzed from SBr-5267 (catalogue prefix: 440-). Six of these match the Coso Hot Springs trace element configuration, and one (Cat. no 202) matches the profile of Coso Hot Springs Sample Group 6.

Three specimens were submitted from SBr-4965 (catalogue prefix: 176-). One of them (Cat. no. 76) matched the Coso Hot Springs fingerprint, but the other two represent "unknown" sources. Specimen 168 has Rb, Sr and Zr ppm values similar to glasses from the vicinity of Obsidian Butte, Nevada (Hughes, unpublished data), but the other (Cat. no 7) does not.

A single specimen was analyzed from SBr-4968 (catalogue prefix: 180-). This artifact (Cat. no. 68) matches the Coso Hot Springs trace element profile.

Two specimens were submitted for re-analysis from SBr-4562 (catalogue prefix: 24); one of them (cat. no. 934-2) matches the Coso Hot Springs elemental profile, while the other (cat. no. 934-1) possesses Rb, Sr and Zr ppm values similar to those from the Casa Diablo obsidian source. However, the Rb ppm value for 934-1 is nearly 50 ppm greater than values observed on Casa Diablo source standards (cf. Jack 1976: 203), so it may be that, despite superficial similarity, this specimen nay have been fashioned from obsidian from an "unknown" source.

I have also included trace element measurement data on small obsidian nodules from the Goldstone locality (catalogue designations: GOLD A and B). As you can see by inspection of Rb, Sr, and Zr ppm values, this glass is quite unique for the Fort Irwin study area. What is from the vicinity of Obsidian Butte, Nevada, while two specimens (Cat. nos. 2999 and 3100) were too small to yield reliable quantitative measurements (i.e. the ± value is 3-4 times greater than those accompanying the majority of the specimens analyzed). The remaining 79 specimens match the trace element configuration of obsidian from Coso Hot Springs. However, thirteen specimens in this latter group (Cat. nos. 2329, 2968, 3019, 3064, 3108, 3310, 6459, 6622, 7391, 701, 7664, 7711, and 8002) generated trace element concentration values rather different from the remainder of the group. Specifically, these 13 artifacts possess Zr concentrations ca. 20 - >50 ppm less than those reported for Coso obsidian by Jack and Carmichael (1969: 27; nos. 27 and 28) and Jack (1976: 204), but they closely match concentration values recently reported for Sample Group 6 obsidian by Bacon et al. (1981: cf. 10227, nos. 24/6 and 25/6; 10234, Table 3). Since neither robert Jack nor I visited this locality, we have no source standards for comparison; however, the diagnostic Rb, Sr, Y and Zr ppm values indicate a close match with this group of 13 artifacts, although Zr ppm values are somewhat higher than those reported for source standards.

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A single specimen was analyzed from SBr-4968 (catalogue prefix: 180-). This artifact (Cat. no. 68) matches the Coso Hot Springs trace element profile.

Two specimens were submitted for re-analysis from SBr-4562 (catalogue prefix: 24); one of them (cat. no. 934-2) matches the Coso Hot Springs elemental profile, while the other (cat. no. 934-1) possesses Rb, Sr and Zr ppm values similar to those from the Casa Diablo obsidian source. However, the Rb ppm value for 934-1 is nearly 50 ppm greater than values observed on Casa Diablo source standards (cf. Jack 1976: 203), so it may be that, despite superficial similarity, this specimen nay have been fashioned from obsidian from an "unknown" source.

I have also included trace element measurement data on small obsidian nodules from the Goldstone locality (catalogue designations: GOLD A and B). As you can see by inspection of Rb, Sr, and Zr ppm values, this glass is quite unique for the Fort Irwin study area. What is equally clear is that - probably because of their diminutive size - these nodules were not employed to fashion any of the tools submitted in your archaeological samples from Fort Irwin.

Finally, the Elko Corner-notched projectile point from the San Diego Museum of Man collections (catalogue no. M117A) was fashioned from obsidian of the Coso Hot Springs geochemical type. I will forward a copy of the data sheet for this specimen later this week.

One final note. In preparing this summary, I encountered three examples of catalogue number duplication from SBr-4966 (catalogue numbers 178-3064, 178-3310 and 178-3488). Since this did not come to my attention until after the x-ray fluorescence analyses had been completed, you will notice that each of these three specimens appears twice on the enclosed data output sheets. I suspect a cataloging duplication primarily because two of the three (3064 and 3310) yielded different acriptions; once each for Coso and Sample Group 6. If you discover the duplication, please let me know and I will re-run them at no charge to resolve the issue.

I hope this information will help in your analysis of these site materials. Please contact me if I can be of further assistance.

Sincerely,

Richard E. Hughes, Ph.D
Senior Research Archaeologist
Anthropological Studies Center
Sonoma State University
Rohnert Park, CA 94928

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	CaSO	Fe	TH	RB	SR	Y	ZR	NB
W-1[illegible]E	7.65	14.68 +- 1.86	0.05 +- 0.05	23.99 +- 2.03	190.72 +- 3.72	22.99 +- [illegible]	108.13 +- 3.14	[illegible] +- [illegible]
174-141	9.05	33.33 +- 1.88	29.05 +- 3.72	197.07 +- 3.27	9.80 +- 1.75	44.18 +- 2.67	164.57 +- 2.67	31.[illegible] +- [illegible]
178 4214	6.04	34.29 +- 2.26	28.98 +- 4.63	272.62 +- 4.29	5.44 +- 2.01	60.50 +- 3.28	148.92 +- 3.20	38.17 +- 2.43
174-173	8.99	28.90 +- 1.80	32.21 +- 3.65	214.68 +- 3.26	8.31 +- 1.69	45.57 +- 2.61	165.31 +- 2.79	30.17 +- 1.99
178-7791	6.31	33.69 +- 2.39	36.57 +- 4.74	272.59 +- 4.43	3.65 +- 2.06	50.68 +- 3.35	146.69 +- 3.30	38.60 +- 2.50
178-7435	3.32	50.58 +- 4.36	44.39 +- 8.33	280.62 +- 7.21	6.24 +- 3.73	49.65 +- 5.65	132.08 +- 5.37	34.96 +- 4.16
178-6984	4.52	48.04 +- 4.37	44.50 +- 8.51	228.33 +- 6.85	5.11 +- 3.82	50.52 +- 5.67	142.99 +- [illegible]	33.74 +- [illegible]
178 3486	4.55	42.55 +- 4.47	28.09 +- 6.60	266.78 +- 7.16	8.39 +- 3.82	[illegible] +- 5.66	[illegible] +- 5.42	[illegible] +- 4.18
178 7971	3.56	42.14 +- 5.61	28.98 +- 10.28	191.23 +- 7.71	12.95 +- 5.06	25.20 +- 6.51	121.76 +- 6.53	23.[illegible] +- 4.98
178-6309	4.38	42.71 +- 3.49	28.04 +- 6.88	238.07 +- 5.86	8.90 +- 3.18	56.56 +- 4.68	148.98 +- 4.73	34.04 +- 3.50
178-6892	2.70	46.70 +- 6.35	29.39 +- 11.99	182.21 +- 8.65	32.92 +- 6.23	27.36 +- 7.35	127.60 +- 7.45	22.51 +- 5.47
178-6465	4.58	52.39 +- 5.10	26.35 +- 10.06	246.81 +- 8.11	9.70 +- 4.64	54.69 +- 6.60	134.49 +- 6.40	29.65 +- 4.83
178-3205	3.20	45.62 +- 5.48	24.71 +- 10.11	220.55 +- 7.93	8.17 +- 4.62	45.82 +- 6.52	131.7[illegible] +- 6.42	32.32 +- 4.70
178-6615	2.76	47.36 +- 6.07	48.53 +- 10.95	238.25 +- 8.52	8.60 +- 4.81	47.52 +- 6.09	[illegible] +- 6.68	[illegible] +- 5.13
178-3451	2.57	59.57 +- 5.86	41.67 +- 10.74	233.40 +- 8.45	0.05 +- 0.05	44.22 +- 6.84	112.97 +- 6.25	23.64 +- 5.04
178-3310	2.39	53.25 +- 6.87	21.11 +- 12.38	272.91 +- 9.83	0.05 +- 0.05	49.29 +- 7.79	133.00 +- 7.23	35.60 +- 5.65
178 5515	9.61	37.86 +- 2.27	38.72 +- 4.58	271.90 +- 4.29	4.96 +- 1.97	54.76 +- 3.24	144.07 +- 3.19	36.30 +- 2.42
178-4905	8.65	33.07 +- 2.08	31.59 +- 4.20	235.57 +- 3.85	9.31 +- 1.91	50.17 +- 3.01	156.10 +- 3.11	33.12 +- 2.27
178-3910	9.22	35.38 +- 2.07	36.31 +- 4.17	281.49 +- 3.99	6.74 +- 1.82	56.79 +- 3.01	148.01 +- 2.96	35.54 +- 2.33
178-3064	6.15	43.86 +- 4.02	12.65 +- 7.89	243.36 +- 6.61	7.26 +- 3.53	43.86 +- 5.36	124.74 +- 5.08	40.56 +- [illegible]
178-3246	8.30	37.43 +- 3.34	48.07 +- 6.62	274.46 +- 5.97	4.69 +- 2.99	54.66 +- 4.36	[illegible] +- 4.44	33.34 +- 3.42
178-6387	4.12	39.27 +- 4.56	41.88 +- 8.99	234.99 +- 7.16	6.13 +- 4.09	45.48 +- 5.36	140.56 +- 5.91	35.80 +- 4.36
178-7265	4.49	50.09 +- 4.77	45.17 +- 8.98	333.16 +- 8.10	0.05 +- 0.05	62.90 +- 6.13	120.44 +- 5.44	45.70 +- 4.43
178-4543	8.65	37.16 +- 2.12	34.64 +- 4.25	280.65 +- 4.07	7.01 +- 1.84	56.25 +- 3.08	145.12 +- 3.00	36.45 +- 2.26
178-3492	3.98	46.02 +- 4.63	30.24 +- 8.45	239.04 +- 6.91	4.39 +- 3.71	44.36 +- 5.61	119.01 +- 5.20	30.32 +- 4.22
178-6876	4.19	49.38 +- 3.96	44.23 +- 7.76	266.34 +- 6.60	7.39 +- 3.50	54.89 +- 5.19	144.09 +- 5.14	37.70 +- 3.83
174-257	5.03	34.85 +- 3.01	30.79 +- 5.70	238.20 +- 5.04	3.08 +- 2.44	57.06 +- 3.98	137.65 +- 3.88	36.79 +- 2.97

	CHSQ	PB	TH	RB	SR	Y	ZR	NB
W-1-H	8.4	13.3 +- 1.9	0.0 +- 0.0	23.3 +- 2.0	190.0 +- 3.7	18.4 +- 2.7	111.7 +- 3.2	16.6 +- 2.3
178-7625	5.7	42.6 +- 2.9	37.9 +- 5.8	301.4 +- 5.4	11.9 +- 2.5	48.5 +- 4.1	147.0 +- 3.9	38.3 +- 3.0
178-6622	11.9	38.3 +- 3.1	35.1 +- 6.7	213.4 +- 5.4	5.9 +- 3.8	42.2 +- 4.3	120.9 +- 4.3	32.0 +- 3.2
178-3016	6.1	40.4 +- 3.2	35.1 +- 6.6	249.9 +- 5.6	8.3 +- 3.1	49.9 +- 4.5	144.3 +- 4.5	32.5 +- 3.3
178-8107	5.7	40.1 +- 3.7	41.2 +- 7.5	257.2 +- 6.3	12.3 +- 3.3	53.1 +- 5.0	135.6 +- 4.8	36.5 +- 3.7
178-3108	4.9	33.1 +- 3.1	46.9 +- 6.6	209.6 +- 5.3	38.6 +- 3.5	34.1 +- 4.3	155.5 +- 4.6	21.7 +- 3.2
178-8111	32.8	40.7 +- 2.3	37.1 +- 4.7	256.6 +- 4.2	3.8 +- 3.0	57.1 +- 3.3	138.8 +- 3.2	38.3 +- 2.4
178-8002	3.3	46.7 +- 8.4	45.9 +- 14.3	184.6 +- 9.9	0.0 +- 0.8	33.9 +- 8.6	101.2 +- 8.2	22.9 +- 6.5
178-2128	11.4	38.1 +- 1.9	39.2 +- 3.9	269.7 +- 3.6	6.6 +- 1.7	62.6 +- 2.8	144.9 +- 2.7	38.9 +- 2.0
178-2968	8.1	38.4 +- 3.1	21.8 +- 6.3	210.3 +- 5.2	4.8 +- 2.8	43.8 +- 4.3	106.2 +- 4.0	32.0 +- 3.2
178-3509	5.6	37.4 +- 3.2	31.0 +- 6.3	253.0 +- 5.4	4.9 +- 2.7	59.4 +- 4.3	134.1 +- 4.1	35.7 +- 3.2
178-2999	2.0	54.1 +- 8.3	39.8 +- 14.1	176.0 +- 10.0	34.5 +- 7.2	24.4 +- 8.5	112.8 +- 8.5	20.5 +- 6.3
178-2172	11.6	36.6 +- 2.1	39.4 +- 4.2	257.9 +- 3.9	8.7 +- 1.8	50.6 +- 3.0	138.3 +- 2.9	34.9 +- 2.2
178-6561	10.4	32.5 +- 1.9	26.6 +- 3.9	221.8 +- 3.6	6.4 +- 1.7	44.8 +- 2.8	118.2 +- 2.7	32.9 +- 2.1
178-6976	3.7	44.4 +- 4.8	33.5 +- 8.9	253.8 +- 7.4	6.6 +- 4.0	50.9 +- 5.9	151.5 +- 5.8	33.6 +- 4.3
178-7711	2.5	58.8 +- 8.1	26.4 +- 14.1	217.2 +- 10.5	0.8 +- 0.0	27.6 +- 8.6	93.9 +- 7.8	26.5 +- 6.4
178-1903	10.3	35.9 +- 1.9	38.4 +- 3.9	273.7 +- 3.6	4.9 +- 1.6	56.8 +- 2.7	146.1 +- 2.7	39.0 +- 2.0
178-3247	4.2	56.9 +- 5.3	34.0 +- 10.6	267.9 +- 8.6	0.0 +- 0.0	50.0 +- 6.9	121.8 +- 6.4	29.8 +- 5.0
178-3019	2.4	41.6 +- 5.7	33.1 +- 10.3	197.1 +- 7.6	39.4 +- 5.2	30.1 +- 6.3	141.7 +- 6.7	23.0 +- 4.8
943-1	8.8	35.5 +- 2.1	35.0 +- 4.4	208.8 +- 3.8	78.6 +- 2.8	26.5 +- 2.9	219.7 +- 3.6	26.2 +- 2.2
943-2	7.1	41.9 +- 2.7	38.0 +- 5.5	270.2 +- 5.0	3.0 +- 2.3	53.5 +- 3.8	139.3 +- 3.7	35.8 +- 2.8
GOLD-A	5.4	34.6 +- 3.0	19.5 +- 5.4	160.7 +- 4.5	86.8 +- 3.7	26.3 +- 3.6	111.8 +- 3.8	20.2 +- 2.8
GOLD-B	10.6	39.4 +- 2.3	22.6 +- 4.2	158.4 +- 3.6	85.2 +- 2.9	31.4 +- 2.9	111.8 +- 3.0	19.7 +- 2.2

	CHSQ	PB	TH	RB	SR	Y	ZR	NB
178-3488	3.8	42.4 +- 3.3	28.8 +- 6.2	250.3 +- 5.5	3.5 +- 2.8	46.1 +- 4.3	123.0 +- 4.1	31.4 +- 3.2
178-2329	7.5	35.6 +- 2.1	29.7 +- 4.2	198.9 +- 3.5	8.2 +- 1.9	46.7 +- 2.9	158.3 +- 3.1	31.3 +- 2.2
178-5952	2.9	59.1 +- 7.4	35.3 +- 13.5	231.0 +- 10.2	0.0 +- 0.0	35.5 +- 8.3	105.0 +- 7.7	21.2 +- 6.2
178-7405	10.2	40.7 +- 3.0	36.0 +- 6.2	242.5 +- 5.2	4.3 +- 2.6	54.6 +- 4.1	121.9 +- 3.9	33.0 +- 3.0
178-3364	10.2	41.4 +- 3.1	43.1 +- 6.1	253.7 +- 5.3	9.0 +- 2.7	53.8 +- 4.2	133.5 +- 4.1	35.8 +- 3.1
178-7501	3.6	48.5 +- 5.2	24.5 +- 9.5	218.4 +- 7.6	11.5 +- 4.2	43.3 +- 6.3	122.2 +- 6.0	31.4 +- 4.7
178-3064	5.0	46.7 +- 3.2	24.9 +- 6.3	207.2 +- 5.0	18.6 +- 3.1	38.2 +- 4.2	150.4 +- 4.4	32.0 +- 3.2
178-6305	17.7	36.4 +- 2.3	37.7 +- 4.6	269.3 +- 4.3	9.7 +- 2.0	50.8 +- 3.2	133.4 +- 3.2	32.7 +- 2.4
178-7292	9.2	37.5 +- 2.2	36.5 +- 4.7	291.3 +- 4.2	6.4 +- 2.0	61.9 +- 3.2	146.8 +- 3.1	39.0 +- 2.4
178-3478	12.9	41.5 +- 3.5	31.7 +- 7.1	279.3 +- 6.1	0.0 +- 0.0	47.9 +- 4.8	137.4 +- 4.6	33.8 +- 3.5
178-6879	5.1	44.0 +- 3.1	41.2 +- 6.4	251.8 +- 5.4	8.0 +- 2.9	53.9 +- 4.3	147.7 +- 4.3	33.0 +- 3.2
178-6098	5.9	41.3 +- 3.2	39.9 +- 6.5	236.3 +- 5.5	7.2 +- 2.9	52.3 +- 4.3	143.5 +- 4.3	32.6 +- 3.2
178-6867	8.2	36.8 +- 2.5	32.5 +- 5.1	256.9 +- 4.6	3.0 +- 2.2	54.3 +- 3.6	139.7 +- 3.4	34.1 +- 2.6
178-2412	4.4	38.4 +- 4.2	30.6 +- 7.7	253.4 +- 6.6	6.6 +- 3.4	46.8 +- 5.2	130.2 +- 5.0	36.8 +- 3.9
178-3355	12.3	36.9 +- 2.1	38.5 +- 4.4	271.8 +- 4.1	10.8 +- 1.9	55.1 +- 3.1	146.6 +- 3.0	39.3 +- 2.3
178-3310	18.7	36.2 +- 3.2	31.3 +- 6.2	216.0 +- 5.2	3.7 +- 2.7	41.2 +- 4.2	107.8 +- 3.9	34.9 +- 3.1
178-6126	2.5	45.5 +- 6.4	38.5 +- 11.3	161.7 +- 7.9	15.0 +- 5.4	36.7 +- 6.9	132.0 +- 7.1	18.5 +- 5.3
178-6731	4.1	43.9 +- 3.6	47.1 +- 7.1	242.1 +- 5.9	10.1 +- 3.2	52.3 +- 4.8	147.5 +- 4.8	35.0 +- 3.5
178-3173	2.0	49.3 +- 7.2	22.3 +- 12.5	188.6 +- 8.9	27.9 +- 6.2	28.4 +- 7.6	139.6 +- 7.8	0.0 +- 0.0
178-6643	7.5	41.5 +- 2.6	37.2 +- 5.5	281.4 +- 4.9	9.3 +- 2.4	60.0 +- 3.8	145.4 +- 3.6	40.0 +- 2.7

	CHSQ	PB	TH	RB	SR	Y	ZR	NB
174-35	14.3	38.3 +- 1.9	35.4 +- 3.9	249.6 +- 3.6	6.0 +- 1.7	54.9 +- 2.8	136.8 +- 2.7	39.0 +- 2.0
440-490	13.0	33.6 +- 1.8	32.6 +- 3.7	232.7 +- 3.4	1.6 +- 1.6	48.6 +- 2.7	122.0 +- 2.6	37.6 +- 2.0
174-133	12.3	33.5 +- 2.0	33.1 +- 4.2	198.1 +- 3.7	6.4 +- 1.9	44.7 +- 3.0	157.0 +- 3.2	31.9 +- 2.3
174-127-1	17.1	31.0 +- 1.9	35.7 +- 3.9	204.6 +- 3.4	9.6 +- 1.8	45.0 +- 2.8	158.6 +- 3.0	30.7 +- 2.1
174-127-2	20.1	30.4 +- 1.7	27.3 +- 3.5	187.5 +- 3.1	4.7 +- 1.6	43.0 +- 2.5	151.8 +- 2.7	31.4 +- 1.9
440-247	16.0	34.7 +- 1.9	33.3 +- 3.7	239.9 +- 3.5	2.4 +- 1.6	47.8 +- 2.7	116.3 +- 2.5	37.2 +- 2.0
174-121-1	8.8	31.6 +- 2.1	34.5 +- 4.4	205.3 +- 3.8	8.3 +- 2.0	50.7 +- 3.1	159.8 +- 3.3	29.9 +- 2.3
174-121-2	13.4	33.3 +- 1.9	26.0 +- 3.9	199.8 +- 3.5	7.8 +- 1.8	45.0 +- 2.8	162.1 +- 3.0	30.4 +- 2.2
174-39	11.3	36.0 +- 2.2	34.1 +- 4.6	253.2 +- 4.2	7.4 +- 2.0	54.1 +- 3.2	139.9 +- 3.2	33.3 +- 2.4
174-77	7.5	35.1 +- 2.0	36.7 +- 4.1	280.1 +- 3.9	6.6 +- 1.7	58.6 +- 2.9	152.2 +- 2.9	38.7 +- 2.2
176-7	9.4	28.6 +- 1.9	21.0 +- 3.8	203.4 +- 3.5	132.7 +- 2.9	35.2 +- 2.7	167.2 +- 3.1	27.4 +- 2.1
440-571	15.2	36.4 +- 2.3	27.8 +- 4.7	229.0 +- 4.2	1.8 +- 2.0	52.0 +- 3.3	114.8 +- 3.1	33.6 +- 2.5
174-63	7.3	36.9 +- 2.0	33.8 +- 4.0	209.3 +- 3.6	9.7 +- 1.8	49.1 +- 2.9	161.8 +- 3.1	30.3 +- 2.2
440-198	6.8	35.8 +- 2.2	35.7 +- 4.4	238.4 +- 4.0	8.0 +- 2.0	50.8 +- 3.1	163.6 +- 3.3	34.9 +- 2.3
174-55	7.7	31.1 +- 1.9	27.7 +- 3.8	196.1 +- 3.4	6.0 +- 1.8	45.3 +- 2.8	160.5 +- 3.0	27.9 +- 2.1
174-410	8.7	26.9 +- 1.7	31.3 +- 3.6	201.9 +- 3.2	7.8 +- 1.6	46.2 +- 2.6	164.1 +- 2.8	32.9 +- 2.0
174-354	16.3	31.1 +- 1.7	27.1 +- 3.6	205.6 +- 3.2	10.8 +- 1.7	44.5 +- 2.6	163.8 +- 2.8	30.6 +- 2.0

	CHSQ	PB	TH	RB	SR	Y	ZR	NB
W-1 B	8.9	16.5 +- 1.8	0.0 +- 0.0	21.3 +- 2.0	188.5 +- 3.7	24.2 +- 2.7	115.5 +- 3.1	12.9 +- 2.2
178-1499	10.4	31.2 +- 2.[illegible]	33.0 +- 4.4	224.2 +- 3.9	0.0 +- 0.0	49.8 +- 3.0	116.5 +- 2.9	34.1 +- 2.3
176-76	10.6	34.8 +- 2.2	23.7 +- 4.4	266.3 +- 4.3	6.8 +- 1.9	54.0 +- 3.2	143.4 +- 3.2	34.4 +- 2.4
174-134	9.2	31.0 +- 1.9	30.9 +- 4.1	195.9 +- 3.5	7.1 +- 1.8	45.7 +- 2.9	159.0 +- 3.1	32.3 +- 2.2
178-4114	14.1	38.2 +- 2.1	34.6 +- 4.2	257.7 +- 4.0	10.2 +- 1.8	45.6 +- 3.0	135.8 +- 3.0	34.0 +- 2.2
180-68	18.9	35.2 +- 2.1	26.4 +- 4.1	226.4 +- 3.8	3.6 +- 1.7	41.4 +- 2.9	113.7 +- 2.8	28.0 +- 2.2
178-1907	9.2	35.8 +- 1.9	31.2 +- 3.8	265.5 +- 3.6	7.5 +- 1.7	54.8 +- 2.8	141.5 +- 2.7	40.8 +- 2.0
170-945	7.9	39.7 +- 2.2	34.7 +- 4.5	254.6 +- 4.2	7.2 +- 1.9	57.5 +- 3.2	144.1 +- 3.2	30.4 +- 2.4
440-202	8.7	27.8 +- 1.9	30.3 +- 3.9	200.5 +- 3.4	43.5 +- 2.1	36.8 +- 2.7	156.5 +- 3.0	23.6 +- 2.0
178-5505	10.8	35.9 +- 1.9	32.3 +- 3.8	256.2 +- 3.6	8.0 +- 1.6	48.8 +- 2.8	141.2 +- 2.8	35.1 +- 2.1
440-1	8.3	35.8 +- 1.9	29.8 +- 3.8	240.2 +- 3.6	3.1 +- 1.7	49.9 +- 2.7	128.3 +- 2.7	34.4 +- 2.1
178-3712	9.1	34.7 +- 1.9	32.5 +- 3.9	244.0 +- 3.6	8.4 +- 1.7	48.8 +- 2.8	134.9 +- 2.8	35.3 +- 2.1
440-192	11.0	31.1 +- 2.0	28.7 +- 4.0	243.4 +- 3.7	7.1 +- 1.[illegible]	47.5 +- 2.9	148.1 +- 2.9	30.5 +- 2.1
178-7788	9.[illegible]	35.8 +- 1.8	42.7 +- 3.8	266.8 +- 3.6	6.0 +- 1.6	55.7 +- 2.8	149.9 +- 2.7	36.6 +- 2.0
174-24	9.2	35.2 +- 1.9	41.8 +- 3.8	260.3 +- 3.6	5.9 +- 1.6	54.3 +- 2.7	148.4 +- 2.7	36.8 +- 2.0
178-4240	12.7	36.4 +- 1.7	37.1 +- 3.6	265.7 +- 3.4	6.6 +- 1.5	61.2 +- 2.6	143.1 +- 2.5	38.1 +- 1.9
178-3541	9.3	36.6 +- 1.9	33.5 +- 3.8	278.0 +- 3.6	3.6 +- 1.6	57.3 +- 2.7	145.0 +- 2.6	39.7 +- 2.0
178-5382	9.6	33.3 +- 2.0	37.1 +- 4.0	230.1 +- 3.6	2.6 +- 1.7	51.0 +- 2.8	122.6 +- 2.7	32.5 +- 2.1
178-5144	12.3	36.1 +- 1.9	40.5 +- 3.9	213.6 +- 3.4	81.8 +- 2.4	28.0 +- 2.5	222.7 +- 3.2	27.2 +- 2.0
176-148	11.6	45.1 +- 2.2	22.2 +- 4.0	187.6 +- 3.5	103.7 +- 2.8	32.2 +- 2.7	113.3 +- 2.8	23.6 +- 2.1

ANALYSIS OF OBSIDIAN HYDRATION ON ARCHAEOLOGICAL SPECIMENS FROM THE FORT IRWIN ARCHAEOLOGICAL PROJECT

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METHODS

Selected obsidian specimens recovered during archaeological investigations at Fort Irwin were submitted by Wirth Environmental Services, Inc. for obsidian hydration analysis during late 1983 and 1984. The prepared obsidian hydration slides are curated at the University of California, Davis Obsidian Hydration Laboratory under specimen accession numbers UCD 3152-3202, 3547-3548, and 3789-3814.

During the initial phase of preparation, an appropriate section of each artifact is selected for examination. The location of this section is determined by the morphology, purity, and potential of each location for yielding valuable archaeological data. Two parallel cuts are made into the edge of each specimen, using a 0.4 mm-thick, diamond impregnated, lapidary saw blade, powered by a motor turning at approximately 3600 rpm. The cuts isolate a wedge which is approximately one millimeter thick. The wedge is then removed from the artifact and freshly cut, exposed faces of the wedge are ground in a slurry of 600 grade, optical-quality corundum abrasive on flat plate glass. Initial grinding is designed to remove the saw nicks from the faces of the artifact potentially containing an hydration layer. The obsidian wedge is then affixed to a flat microscope specimen slide with Lakeside cement, and ground to a final thickness of 30-50 microns. The end product is an extremely thin cross-section of the outer faces of the artifact. The slide is mounted on a petrographic microscope fitted with cross-polarizing filter and quartz I-IV/gypsum filter. The filter maximizes the visual contrast between the hydrated and unaltered layers, and provides a valuable confirmation that an optical aberration is not being misconstrued as an hydration layer. The edge of the obsidian thin-section is scanned under a magnification of 500X or 1250X. When a clearly defined and representative hydration band is identified, the section is centered in optical field to minimize any parallax effect from the filar screw micrometer eyepiece, which is used to measure the thickness of the hydration band to 1/10th of a micron. A minimum of eight readings are taken (four each from two sides of the thin-section), and the resulting values are entered into a computer program designed to calculate the mean and standard deviation for each edge of the specimen, based on four readings each. The program then performs a two-tailed, difference of means t-test on readings values (sets of micron readings) represent the same or different hydration thicknesses. Significantly different readings on the same specimen may reflect aspects of the artifact's history.

The raw data derived from the obsidian hydration analysis is presented in appended data tables.

EXPLANATION OF OBSIDIAN HYDRATION CATALOGUE INFORMATION AND PROCEDURES

CATALOGUE DATA

The OHL# denotes the Obsidian Hydration Laboratory Number, assigned to each specimen. Correspondence or questions concerning specific hydration specimens should refer to the OHL# if possible, as data are stored according to this number.

CATALOG# refers to the designation assigned to each artifact by the archaeologist or agency submitting the artifact(s) for obsidian hydration analysis.

DESCRIPTION

The artifacts submitted of obsidian hydration analysis are briefly described in the DESCRIPTION column. The NAME of each item is first listed, further described by an adjective. Projectile point types are named only when type designations are unambiguous, but are otherwise described in terms of a major morphological attribute such as "corner-notched" for "side-notched".

HYDRATION DATA

The Edge 1+2 column lists the separate mean values of the two examined edges, four readings being obtained for each edge. The standard deviation of the readings from each edge are also listed, but have been rounded to the nearest tenth micron. While there is a recognized inherent reading error of 0.2 microns, the standard deviation lists the actual deviation of readings.

A difference of means t-test is performed on the data from the two edges of each specimen, to test the hypotheses that the two edges contain significantly different hydration thicknesses ($p > 3.707$). It is assumed that readings are taken randomly along each edge, though this is often prevented by physical circumstances. Variance co-readings from both faces of each artifact are pooled in the t-test determination, and the hypothesis is confirmed at the .01 level under six degrees of freedom. A critical values table for t-distributions indicates the strength or distance of test results from confirmation of the hypothesis. This distance has been used as a basis for determining the manner of further data manipulation and reporting. For instance, if the 'p' value resulting from the t-test exceeds 0.1, the two edges are regarded as representing the same period of manufacture. These decisions are reported in two locations: 1) directly beneath the results of the t-test, described in terms of whether or not the edges are the same (edges=), different, or undetermined (diff.or=?), and 2) right and adjacent to the t-test results, described in terms of whether the values represent one hydration band or two different bands.

If it is determined that only hydration thickness is represented, all eight readings are averaged and a standard deviation for the group derived and reported.

COMMENTS

Comments pertain to qualities of the thin section and hydration 'rind' or band. In some instances hydration can be observed on only one fact of an artifact, listed a "ONE EDGE OLY". Hydration data are manipulated and reported accordingly. Other comments list the general quality and clarity of the examined edges (GOOD, FAIR, POOR). The comment "RECUT" indicates that more than one thin section was prepared for some reason. Still other comments refer to specific qualities of the hydration bands, such as "HIGHLY VARIABLE", "IRREGULAR", or "DISCONTINOUS". In certain instances, it is possible to obtain hydration readings from three different edges of an artifact, and when this possibility is encountered, readings are taken from the two most dissimilar edges, and a comment to the effect that three edges may ? is made. Particularly small difficult specimens are also noted. The boundary between hydrated and unaltered obsidian layer (diffusion front) is sometimes unclear and noted as "DIFFUS.FRONT VAGUE".

OBSIDIAN SOURCE

The geographic/geologic origin of the obsidian under study is listed in the last column of the catalogue. Source information is normally listed only if the specimens have been subjected to chemical or trace element analysis. In unusual circumstances, source information may be listed if replicable, tested means of source determination are employed.

U.C. DAVIS OBSIDIAN HYDRATION CATALOGUE
CA-SBR-4966

SUBMITTED BY: WIRTH ENVIRONMENTAL SERVICES — FEBRUARY 1984

O.H.L. TECHNICIAN: R.J. JACKSON — MAGNIFICATION - 500/1250 — RESULTS (microns) ON 8 READINGS, 4 PER EDGE

CATALOGUE DATA		PROVENIENCE	DESCRIPTION	HYDRATION DATA			COMMENTS	OBSIDIAN
ohl#	catalog #	unit, level	name,type	edge 1+2	t-test	MEAN-all	quality, problems	SOURCE
3152	178-2128	S1380E1865 SURFACE	FLAKE INTERIOR	12.4 +-.3 12.3 +-.3	p>.5 edges =	ONE BAND 12.3 +-.3	VARIABLE DIFFUS. FRONT VAGUE	COSO
3153	178-2172	S1410E1760 SURFACE	FLAKE INTERIOR	5.7 +-.3 5.6 +-.3	p>.5 edges =	ONE BAND 5.6 +-.3		COSO
3154	178-2172	S1650E2000 SURFACE	FLAKE INTERIOR	9.1 +-.1 13.4 +-.3	p<.001 different	2 BANDS (edge 1+2)	VARIABLE	COSO
3155	178-2412	S1440E2010 SURFACE	FLAKE INTERIOR	11.0 +-.5 11.0 +-.1	p>.9 edges =	ONE BAND 11.0 +-.3		COSO
3156	178-2874	S1520E1779 0-10 cm	FLAKE INTERIOR	13.6 +-.4 13.7 +-.7	p>.5 edges =	ONE BAND 13.6 +-.5	VARIABLE	COSO
3157	178-2968	S1715E2060 10-20 cm	FLAKE INTERIOR	13.4 +-.6 13.4 +-.3	p>.9 edges =	ONE BAND 13.4 +-.4	VARIABLE	?
3158	178-2999	S1685E2076 50-60 cm	FLAKE INTERIOR	9.8 +-.3 9.6 +-.4	p>.4 edges =	ONE BAND 9.7 +-.4		?
3159	178-3016	S1686E2085 40-50 cm	FLAKE INTERIOR	10.9 +-.3 11.0 +-.4	p>.5 edges =	ONE BAND 10.9 +-.3	VARIABLE	COSO
3160	178-3019	S1686E2085 50-60 cm	FLAKE INTERIOR	9.4 +-.2 9.5 +-.3	p>.5 edges =	ONE BAND 9.4 +-.3		?
3161	178-3064-2	S1674E2121 40-50 cm	FLAKE INTERIOR	8.2 +-.2 8.3 +-.4	p>.5 edges =	ONE BAND 8.2 +-.3		?
3162	178-3100	S1670E2080 100-110 cm	FLAKE INTERIOR	9.0 +-.2 9.3 +-.2	p<.05 diff.or=?	2 BANDS? 9.1 +-.2	VARIABLE	?
3163	178-3100-1	S1605E2080 30-40 cm	FLAKE INTERIOR	9.0 +-.2 8.9 +-.2	p>.4 edges =	ONE BAND 8.9 +-.2	ONE EDGE ONLY	?
3164	178-3173	S1604E2085 90-100 cm	FLAKE INTERIOR	10.8 +-.8 10.8 +-.6	p>.9 edges =	ONE BAND 10.8 +-.7	VARIABLE	QUEEN
3165	178-3247	S1670E2100 10-20 cm	FLAKE INTERIOR	13.0 +-.2 12.3 +-.4	p<.02 diff.or=?	2 BANDS? 12.7 +-.5	VARIABLE	COSO
3166	178-3263	S1630E2110 20-30 cm	FLAKE INTERIOR	12.8 +-.5 13.5 +-.3	p<.05 diff.or=?	2 BANDS? 13.1 +-.5	VARIABLE	COSO
3167	178-3264	S1630E2110 30-40 cm	FLAKE DECORT.	11.1 +-.0 11.2 +-.5	p>.5 edges =	ONE BAND 11.2 +-.7	VARIABLE	COSO
3168	178-3315-7	S1630E2100 50-60 cm	FLAKE INTERIOR	15.1 +-.4 14.8 +-.6	p>.4 edges =	ONE BAND 14.9 +-.5	VARIABLE	COSO

U.C. DAVIS OBSIDIAN HYDRATION CATALOGUE

CA-SBR-4966

SUBMITTED BY: WIRTH ENVIRONMENTAL SERVICES — FEBRUARY 1984

O.H.L. TECHNICIAN: R.J. JACKSON — MAGNIFICATION - 500/1250 — RESULTS (microns) ON 8 READINGS, 4 PER EDGE

CATALOGUE DATA ohl#	catalog #	PROVENIENCE unit, level	DESCRIPTION name,type	HYDRATION DATA edge 1+2	t-test	MEAN-all	COMMENTS quality, problems	OBSIDIAN SOURCE
3169	170-3364	S1604E2120	FLAKE	14.3 +-.3	p(.01	2 BANDS		COSO
		50-60 cm	INTERIOR	12.5 +-.7	different	(edge 1+2)	VARIABLE	
3170	170-3470-1	S1632E2100	FLAKE	8.9 +-.3	p).5	ONE BAND		COSO
		20-30 cm	INTERIOR	8.8 +-.3	edges =	8.9 +-.3		
3171	170-3400.5	S1632E2100	FLAKE	20.0 +-.2	p).5	ONE BAND		COSO
		50-60 cm	INTERIOR	19.9 +-.5	edges =	20.0 +-.3		
3172	170-3509	S1620E2099	FLAKE	11.5 +-.2	p).9	ONE BAND		COSO
		40-50 cm	INTERIOR	11.5 +-.6	edges =	11.5 +-.4	VARIABLE	
3173	170-3310-9	S1630E2100	FLAKE	18.0 +-.5	p).2	ONE BAND		COSO
		40-50 cm	INTERIOR	18.7 +-.1	edges =	18.3 +-.9	VARIABLE	
3174	170-3355	S1604E2120	FLAKE	13.4 +-.2	p(.001	2 BANDS		COSO
		10-20 cm	INTERIOR	10.9 +-.6	different	(edge 1+2)		
3175	170-1903	S1965E1995	FLAKE	13.7 +-.8	p).5	ONE BAND		COSO
		SURFACE	INTERIOR	13.6 +-.1	edges =	13.7 +-.9	VARIABLE	
3176	170-5952	SV 17 EAST	FLAKE	15.8 +-.4	p(.1	2 BANDS?		?
		10-20 cm	INTERIOR	16.9 +-.8	edges =	16.3 +-.9	VARIABLE	
3177	170-6090	S1690E2085	FLAKE	11.4 +-.2	p(.001	2 BANDS		COSO
		20-30 cm	INTERIOR	8.2 +-.2	different	(edge 1+2)	VARIABLE	
3178	170-6126	S1390E2223	FLAKE	10.4 +-.7	p).5	ONE BAND	VARIABLE	QUEEN
		80-90 cm	INTERIOR	10.5 +-.5	edges =	10.5 +-.6	ONE EDGE ONLY	
3179	170-6156	S1634E2100	FLAKE	17.3 +-.6	p).5	ONE BAND		COSO
		50-60 cm	INTERIOR	17.5 +-.3	edges =	17.4 +-.5	VARIABLE	
3180	170-6303-2	S1681E2087	FLAKE	8.9 +-.4	p(.1	2 BANDS?		COSO
		10-20 cm	INTERIOR	10.7 +-.4	edges =	9.8 +-.4	VARIABLE	
3181	170-6422	S1683E2083	FLAKE	7.6 +-.4	p).2	ONE BAND		COSO
		60-70 cm	INTERIOR	7.4 +-.1	edges =	7.5 +-.3		
3182	170-6459	S1683E2085	FLAKE	11.2 +-.4	p).2	ONE BAND		?
		30-40 cm	INTERIOR	10.9 +-.2	edges =	11.0 +-.3		
3183	170-6489	S1685E2083	FLAKE	11.5 +-.4	p).2	ONE BAND		COSO
		20-30 cm	INTERIOR	11.2 +-.4	edges =	11.4 +-.4		
3184	170-6561	S1682E2083	FLAKE	20.0 +-.6	p).1	ONE BAND		COSO
		30-40 cm	DECORT.	20.7 +-.6	edges =	20.3 +-.7		
3185	170-6622	S1679E2087	FLAKE	15.8 +-.4	p).2	ONE BAND		?
		20-30 cm	INTERIOR	16.0 +-.2	edges =	15.9 +-.3		

U.C. DAVIS OBSIDIAN HYDRATION CATALOGUE

CA-SBR-4966

SUBMITTED BY: WIRTH ENVIRONMENTAL SERVICES FEBRUARY 1984

O.H.L. TECHNICIAN: R.J. JACKSON MAGNIFICATION - 500/1250 RESULTS (microns) ON 8 READINGS, 4 PER EDGE

CATALOGUE DATA ohl0	catalog 0	PROVENIENCE unit, level	DESCRIPTION name,type	HYDRATION DATA edge 1+2	t-test	MEAN-all	COMMENTS quality, problems	OBSIDIAN SOURCE
3186	178-6643	S1679E2097	FLAKE	12.2 +-.3	p).2	ONE BAND		COSO
		30-40 cm	INTERIOR	11.9 +-.4	edges =	12.0 +-.3		
3187	178-6731	S1678E2085	FLAKE	11.6 +-.9	p).5	ONE BAND		COSO
		10-20 cm	INTERIOR	12.0 +-.8	edges =	11.8 +-.8	VARIABLE	
3188	178-6743	S1679E2095	FLAKE	9.6 +-.7	p).5	ONE BAND		COSO
		30-40 cm	INTERIOR	9.3 +-.6	edges =	9.5 +-.6	VARIABLE	
3189	178-6812	S1680E2089	FLAKE	11.1 +-.5	p).9	ONE BAND		COSO
		30-40 cm	INTERIOR	11.1 +-.3	edges =	11.1 +-.4		
3190	178-6867	S1695E2097	FLAKE	12.6 +-.3	p).2	ONE BAND		COSO
		60-70 cm	INTERIOR	12.2 +-.7	edges =	12.4 +-.6	ONE EDGE ONLY	
3191	178-6879	S1681E2089	FLAKE	9.8 +-.4	p(.001	2 BANDS		COSO
		30-40 cm	INTERIOR	14.8 +-.6	different	(edge 1+2)		
3192	178-6976	S1679E2085	FLAKE	0.0	p).9		RECUT	COSO
		30-40 cm	INTERIOR	0.0			UNREADABLE	
3193	178-7292	S1570E2117	FLAKE	12.2 +-.3	p).5	ONE BAND		COSO
		40-50 cm	INTERIOR	12.3 +-.0	edges =	12.3 +-.7		
3194	178-7381	S1570E215	FLAKE	19.5 +-.9	p).2	ONE BAND		COSO
		40-50 cm	INTERIOR	20.1 +-.9	edges =	19.8 +-.9		
3195	178-7405	S1568E2113	FLAKE	12.0 +-.6	p(.001	2 BANDS		COSO
		30-40 cm	INTERIOR	5.8 +-.3	different	(edge 1+2)	VARIABLE	
3196	178-7501	S1630E2090	[illegible]AKE	9.5 +-.1	p).2	ONE BAND		?
		30-40 cm	INTERIOR	9.8 +-.4	edges =	9.7 +-.3		
3197	178-7625	S1574E2113	FLAKE	12.0 +-.4	p).5	ONE BAND		?
		50-60 cm	INTERIOR	12.2 +-.7	edges =	12.1 +-.5		
3198	178-7664	S1460E2013	FLAKE	13.0 +-.5	p(.01	2 BANDS		?
		10-20 cm	INTERIOR	11.5 +-.3	different	(edge 1+2)		
3199	178-7711	S1460E2013	FLAKE	9.3 +-.2	p).9	ONE BAND		?
		50-60 cm	INTERIOR	9.3 +-.2	edges =	9.3 +-.2	ONE EDGE ONLY	
3200	178-8002	S1459E2013	FLAKE	7.6 +-.4	p).5	ONE BAND		?
		20-30 cm	INTERIOR	7.7 +-.3	edges =	7.6 +-.3		
3201	178-8107	S1630E2105	FLAKE	11.4 +-.2	p).2	ONE BAND		COSO
		40-50 cm	INTERIOR	11.1 +-.4	edges =	11.2 +-.3		
3202	178-8111-2	S16[illegible]E2105	FLAKE	15.5 +-.5	p).2	ONE BAND		COSO
		50-60 cm	INTERIOR	15.9 +-.6	edges =	15.7 +-.5	VARIABLE	

U.C. DAVIS OBSIDIAN HYDRATION CATALOGUE

CA-SBR-4966

SUBMITTED BY: WIRTH ENVIRONMENTAL SERVICES JUNE 1984

O.H.L. TECHNICIAN: R.J. JACKSON MAGNIFICATION - 500/1250 RESULTS (microns) ON 8 READINGS, 4 PER EDGE

CATALOGUE DATA		PROVENIENCE	DESCRIPTION	HYDRATION DATA			COMMENTS	OBSIDIAN
ohl0	catalog #	unit, level	name, type	edge 1+2	t-test	MEAN-all	quality, problems	SOURCE
3792	170-6876	S1681E2009	FLAKE	10.0 +-.7	p).5	ONE BAND		COSO
		20-30 cm	INTERIOR	9.9 +-.2	edges =	10.0 +-.5	VARIABLE	
3793	170-6892	S1681E2009	FLAKE	8.4 +-.8	p).4	ONE BAND		QUEEN
		30-40 cm	INTERIOR	8.0 +-.5	edges =	8.2 +-.6	VARIABLE	
3794	170-6904	S1679E2005	FLAKE	14.7 +-.1	p).9	ONE BAND		COSO
		30-40 cm	INTERIOR	14.7 +-.1	edges =	14.7 +-.1	ISOLATED	
3795	170-6867	S1680E2007	FLAKE	15.2 +-.6	p).5	ONE BAND		COSO
		60-70 cm	INTERIOR	15.0 +-.4	edges =	15.1 +-.5		
3796	170-6309	S1681E2007	FLAKE	12.1 +-.7	p).5	ONE BAND		COSO
		20-30 cm	INTERIOR	12.3 +-.8	edges =	12.2 +-.7	VARIABLE	
3797	170-6387	S1681E2005	FLAKE	12.8 +-.3	p(.1	2 BANDS?		COSO
		40-50 cm	INTERIOR	13.4 +-.4	edges =	13.1 +-.4	VARIABLE	
3798	170-3205	S1682E2005	FLAKE	11.1 +-.3	p).5	ONE BAND		COSO
		30-40 cm	INTERIOR	11.0 +-.3	edges =	11.0 +-.2	ISOLATED	
3799	170-6465	S1683E2005	FLAKE	15.1 +-.5	p(.001	2 BANDS		COSO
		50-60 cm	INTERIOR	13.1 +-.3	different	(edge 1+2)		
3800	'70-6126	S1390E2323.5 S1044E2321	FLAKE	17.0 +-.3	p).9	ONE BAND	DIFFUS. FRONT VAGUE	COSO
		80-90 cm	INTERIOR	17.0 +-.3	edges =	17.0 +-.3	ISOLATED	
3801	170-7791	TRENCH B-2	FLAKE	11.5 +-.4	p).2	ONE BAND		COSO
		35 cm	INTERIOR	11.2 +-.3	edges =	11.4 +-.4		
3802	170-7265	S1571E2115	FLAKE	10.9 +-.3	p(.01	2 BANDS		COSO
		50-60 cm	INTERIOR	12.4 +-.6	different	(edge 1+2)	VARIABLE	
3803	170-7451	S1570E2115	FLAKE	12.3 +-.2	p).4	ONE BAND		COSO
		30-40 cm	INTERIOR	12.2 +-.2	edges =	12.2 +-.2		
3804	170-7391	S1570E2115	FLAKE	8.9 +-.3	p).2	ONE BAND		COSO
		40-50 cm	INTERIOR	9.1 +-.3	edges =	9.0 +-.3		
3805	170-7435	S1572E2111	FLAKE	13.2 +-.1	p).1	ONE BAND		COSO
		50-60 cm	INTERIOR	13.1 +-.1	edges =	13.2 +-.1	ISOLATED	
3806	170-3310	S1630E2100	FLAKE	11.7 +-.5	p).1	ONE BAND		COSO
		40-50 cm	INTERIOR	6.0 +-.0	edges =	8.9 +-.5	VARIABLE	
3807	170-4905	S1482E2019	FLAKE	0.0	p).9		UNREADABLE	COSO
		SURFACE	INTERIOR	0.0			DIFFUS. FRONT VAGUE	
3808	170-3064	S1574E2121	FLAKE	10.3 +-.2	p(.1	2 BANDS?		COSO
		[illegible] cm	INTERIOR	10.7 +-.3	edges =	10.5 +-.3	VARIABLE	

U.C. DAVIS OBSIDIAN HYDRATION CATALOGUE

CA-SBR-4966

SUBMITTED BY: WIRTH ENVIRONMENTAL SERVICES — JUNE 1984

O.H.L. TECHNICIAN: R.J. JACKSON — MAGNIFICATION - 500/1250 — RESULTS (microns) ON 8 READINGS, 4 PER EDGE

CATALOGUE DATA		PROVENIENCE	DESCRIPTION	HYDRATION DATA			COMMENTS	OBSIDIAN
ohl#	catalog #	unit, level	name,type	edge 1+2	t-test	MEAN-all	quality, problems	SOURCE
3809	178-5515	SH96 E1136 SURFACE	FLAKE INTERIOR	16.1 +-.2 15.9 +-.5	p>.4 edges =	ONE BAND 16.0 +-.4	 VARIABLE	COSO
3810	178-3910	SH97 E1985 SURFACE	FLAKE INTERIOR	12.4 +-.3 12.4 +-.2	p>.9 edges =	ONE BAND 12.4 +-.2		COSO
3811	178-3492	S1632E2100 60-70 cm	FLAKE INTERIOR	18.5 +-.2 18.6 +-.1	p>.4 edges =	ONE BAND 18.5 +-.2	DIFFUS. FRONT VAGUE VARIABLE	COSO
3812	178-3246	S1670E2100 0-10 cm	FLAKE INTERIOR	10.7 +-.5 13.0 +-.1	p<.001 different	2 BANDS (edge 1+2)		FLAKE
3813	178-4543	TS 1499 SURFACE	CORNER-NOTCH FRAGMENT	5.6 +-.4 5.9 +-.6	p>.4 edges =	ONE BAND 5.7 +-.5	DIFFUS. FRONT VAGUE ISOLATED	COSO
3814	178-3488	S1632E2100 50-60 cm	FLAKE INTERIOR	7.4 +-.4 10.1 +-.6	p<.001 different	2 BANDS (edge 1+2)		COSO

U.C. DAVIS OBSIDIAN HYDRATION CATALOGUE

CA-SBR-4562 (AWL)

SUBMITTED BY: WIRTH ENVIRONMENTAL SERVICES — JUNE 1984

O.H.L. TECHNICIAN: R.J. JACKSON — MAGNIFICATION - 500/1250 — RESULTS (microns) ON 8 READINGS, 4 PER EDGE

CATALOGUE DATA ohl#	catalog #	PROVENIENCE unit, level	DESCRIPTION name, type	HYDRATION DATA edge 1+2	t-test	MEAN-all	COMMENTS quality, problems	OBSIDIAN SOURCE
3815	24-944		PROJ. POINT	15.4 +-.4	p(.001	2 BANDS		COSO
			SILVER LAKE	17.8 +-.4	different	(edge 1+2)		
3816	24-924		BIFACE	9.3 +-.3	p(.001	2 BANDS		COSO
			FRAGMENT	7.9 +-.3	different	(edge 1+2)		
3817	24-930		PROJ. POINT	14.5 +-.1	p(.001	2 BANDS	VARIABLE	COSO
			LITTLE LAKE	13.3 +-.2	different	(edge 1+2)	DISCONTINUOUS	
3818	24-949		PROJ. POINT	11.4 +-.3	p).9	ONE BAND	VARIABLE	COSO
			ELKO SERIES	11.4 +-.3	edges =	11.4 +-.3	ISOLATED	
3819	24-9		BIFACE	10.0 +-.6	p(.01	2 BANDS		COSO
			FRAGMENT	8.0 +-.4	different	(edge 1+2)	VARIABLE	
3820	24-922		PROJ. POINT	15.3 +-.6	p).4	ONE BAND		COSO
			STEMMED	15.6 +-.4	edges =	15.5 +-.5	VARIABLE	
3821	24-939		BIFACE	12.5 +-.4	p(.05	2 BANDS?		COSO
			FRAGMENT	12.0 +-.1	diff.or=?	12.3 +-.4		
3547	24-943-1		FLAKE	7.3 +-.1	p(.001	2 BANDS		
			INTERIOR	9.2 +-.1	different	(edge 1+2)		
3548	24-943-2		FLAKE	10.9 +-.4	p).2	ONE BAND		
			INTERIOR	11.4 +-.6	edges =	11.1 +-.5		

U.C. DAVIS OBSIDIAN HYDRATION CATALOGUE

CA-SBR-4963

JUNE 1984

SUBMITTED BY: WIRTH ENVIRONMENTAL SERVICES
O.H.L. TECHNICIAN: R.J. JACKSON   MAGNIFICATION - 500/1250   RESULTS (microns) ON 8 READINGS, 4 PER EDGE

CATALOGUE DATA		PROVENIENCE	DESCRIPTION	HYDRATION DATA			COMMENTS	OBSIDIAN
ohl#	catalog #	unit, level	name,type	edge 1+2	t-test	MEAN-all	quality, problems	SOURCE
3789	174-141	S255 E235 SURFACE	FLAKE INTERIOR	14.9 +-.5 14.9 +-.7	p).9 edges =	ONE BAND 14.9 +-.5		COSO
3790	174-173	S215 E255 SURFACE	FLAKE INTERIOR	14.4 +-.4 4.4 +-.1	p(.001 different (edge 1+2)	2 BANDS		COSO
3791	174-257	S230 E265 SURFACE	FLAKE INTERIOR	18.1 +-.6 15.4 +-.3	p(.001 different (edge 1+2)	2 BANDS		COSO

Fort Irwin Archaeological Project
Wirth Environmental Services
P.O. Box 1298
Barstow, California 92311

January 7, 1985

Attn: Ms. Elizabeth Skinner, Dr. Claude Warren, Mr. Dennis Jenkins

Dear Colleagues,

Enclosed is the second series of data from the Fort Irwin Project obsidian hydration analysis. I hope that the study provides you with useful data.

I will leave all interpretation to you, as you are far more familiar with the archaeological context than I. A few words of cautio on interpreting the result are i order, however. As I have stated previously, few researchers that have examined Coso obsidian hydration, particularly surface specimens, have discussed the problem of possible rate acceleration or variability. Coso is a "fast" obsidian, so old specimens can exhibit greater variation in band width as a result of differences in hydration environment than "slow" obsidians, and individual specimens can exhibit greater individual variation as well. For instance, if there is an inherent variation in band with any obsidian (say 10% for the sake of argument), then 10% variation on slow obsidian may be within, or close to, the inherent optical error factor of the analysis process ($\pm$0.2 microns), whereas 10% of 15-20 microns is a significant variation. As you have observed, standard variations of one micron or more is not uncommon for the Fort Irwin obsidian.

In addition, the lack of hydration should not be interpreted as late prehistoric specimens, simply as a lack of observed hydration. There are many factors that destroy or obscure hydration (e.g. windblasting, patination).

As requested, I cut some of the submitted specimens in two locations. In two instances (specimens 498-265 and 498-82-2) no hydration was observed on either cut. Sorry.

The enclosed material includes two BOA numbers, and I have written separate bills for these. However, the methods descriptions cover both projects although the data sheets are printed separately.

I hope that these data help you to address the problem of site dating. If I can be of any further assistance, do no hesitate to call.

Sincerely,

Robert Jackson
Department of Anthropology
University of California, Davis 95616

(916) 666-1754 (home)

CAT No.	CHSQ	Pb	Th	Rb	Sr	Y	Zr	Nb
178-6156	16.6	36.8 +- 2.2	35.2 +- 4.5	245.6 +- 4.0	4.5 +- 1.9	46.4 +- 3.1	118.3 +- 2.9	35.5 +- 2.3
178-2874	15.3	46.4 +- 3.8	38.4 +- 7.2	251.1 +- 6.2	4.3 +- 3.2	49.5 +- 4.9	138.5 +- 4.7	39.2 +- 3.6
178-3263	11.0	42.7 +- 3.7	37.3 +- 7.2	262.0 +- 6.0	10.0 +- 3.2	62.8 +- 4.8	149.7 +- 4.7	38.9 +- 3.5
178-6422	3.7	49.3 +- 4.8	47.1 +- 9.2	242.3 +- 7.3	11.5 +- 4.1	50.0 +- 5.9	147.0 +- 5.8	28.2 +- 4.4
178-7664	2.6	64.5 +- 8.1	36.7 +- 13.7	208.0 +- 10.0	0.0 +- 0.0	38.8 +- 8.5	102.7 +- 7.7	26.6 +- 6.3
178-6489	7.8	39.8 +- 3.1	37.0 +- 6.3	240.0 +- 5.4	9.1 +- 2.8	56.6 +- 4.3	134.7 +- 4.2	35.6 +- 3.2
178-6459	2.6	54.8 +- 6.7	35.1 +- 12.1	206.3 +- 9.0	10.3 +- 5.4	35.4 +- 7.5	119.7 +- 7.2	32.5 +- 5.7
178-6743	4.8	38.3 +- 3.0	30.5 +- 5.9	231.9 +- 5.0	9.5 +- 2.6	47.6 +- 4.1	151.1 +- 4.1	34.8 +- 3.0
178-3315	15.8	40.0 +- 3.5	38.8 +- 7.0	261.8 +- 5.9	8.8 +- 3.0	53.8 +- 4.6	127.7 +- 4.4	35.3 +- 3.4
178-6812	4.7	44.9 +- 3.9	37.7 +- 7.2	269.6 +- 6.2	0.0 +- 0.0	51.9 +- 4.9	119.2 +- 4.5	36.5 +- 3.6
178-3264	13.4	32.3 +- 2.1	32.6 +- 4.4	236.1 +- 4.0	4.8 +- 1.9	54.1 +- 3.1	122.1 +- 3.0	36.1 +- 2.4
178-3100	1.9	52.8 +- 10.3	35.1 +- 17.4	164.0 +- 11.6	0.0 +- 0.0	36.3 +- 10.2	95.2 +- 9.3	26.1 +- 7.6
178-7381	15.5	37.1 +- 2.7	24.0 +- 5.1	232.3 +- 4.5	4.9 +- 2.3	44.8 +- 3.6	115.5 +- 3.4	31.3 +- 2.7

ANALYSIS OF OBSIDIAN HYDRATION OF ARCHAEOLOGICAL SPECIMENS FROM FORT IRWIN

BY

R.J. JACKSON
DEPARTMENT OF ANTHROPOLOGY
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METHODS

Selected obsidian specimens recovered during archaeological investigations at Fort Irwin were submitted by Wirth Environmental Services, for obsidian hydration analysis during 1983 1984. The prepared obsidian hydration slides are curated at the University of California, Davis Obsidian Hydration Laboratory under specimen accession numbers UCD 3152-3202, 3547-3548, 3789-3821, 4002-4023, 4205-4224, 4269 4285, and 4293-4129.

An appropriate section of each artifact is selected for examination during the initial phase of preparation. The location of this section is determined by the morphology, purity, and potential of a location for yielding valuable archaeological data. Two parallel cuts are made into the edge of each specimen, using a 0.4 mm-thick, diamond impregnated, lapidary saw blade, powered by a motor turning at approximately 3600 rpm. The cuts isolate a wedge which is approximately one millimeter thick. The wedge is then removed from the artifact and the freshly cut, exposed faces of the wedge are ground in a slurry of 600 grade, optical-quality corundum abrasive on flat plate glass, Initial grinding is designed to remove the saw nicks from the faces of the artifact that potentially contains an hydration band. The obsidian wedge is then affixed to a microscope slide with Lakeside cement, and ground to a final thickness of 30-50 microns. The end product is an extremely thin cross-section of the outer faces of the artifact. The end product is an extremely thin cross-section of the outer faces of the artifact. The slide is mounted on a petrographic microscope fitted with a cross-polarizing filter and a quartz I-IV /gypsum filter. The filter maximizes the visual contrast between the hydrated and unaltered layers, and provides alternative means of assuring that an optical aberration is not misconstrued as an hydration lay. The edge of the obsidian thin-section is scanned under a magnification of 500X or 1250X. When a clearly defined and representative hydration band is identified, the section is centered in the optical field to minimize any parallax effect from the filar screw micrometer eyepiece, which is used to measure the thickness of the hydration band to 1/10th of a micron. A minimum of either readings are taken (four each from two sides of the thin-section), and the resulting values are entered into a computer program designed to calculate the mean and standard deviation for each edge of the specimen, based on four readings each. The program then performs a two-tailed, difference of means t-test on readings from two sides to statistically test the hypothesis that that the two surfaces (sets of micron readings) represent a single hydration band. The hypothesis is confirmed when a "p" value smaller than 0.1 at the 0.01 significance level under six degrees of freedom is obtained.

The results of the obsidian hydration analysis is presented in the appended U.C. Davis Obsidian Hydration Catalogue.

EXPLANATION OF OBSIDIAN HYDRATION CATALOGUE INFORMATION

ACCESSION DATA

The OHL# is the Obsidian Hydration Laboratory Number assigned to each obsidian specimen. Correspondence or questions concerning specific hydration specimens should refer to the OHL#. The CATALOG# refers to the original reference number of designation assigned to each artifact.

DESCRIPTION

Artifacts submitted for obsidian hydration analysis are briefly described in the DESCRIPTION column. The first category (**NAME**) represents a gross morphological or functional description for each item. Each obsidian artifact is also briefly described (**TYPE**) in greater detail. For instance, projectile point are often described in terms some prominent attribute (e.g., corner-notched, side-notched). The purpose of the type column is to describe artifacts' forms, not their temporal associations. Obsidian flakes are described in terms of gross dorsal face characteristics (e.g., decortication, interior). Edge modification on obsidian flakes is also noted when it is observed.

HYDRATION DATA

The band one column can serve either of two purposes. The first purpose is to list the mean value and standard deviation of four measurements recorded for an artifact surface that exhibits distinctly different hydration values than another set of four measurements on some other artifact surface, as determined by a difference of means t-test. Alternatively, the **BAND ONE** column lists the mean and standard deviation for all either hydration measurements if the two sets of four measurements are not significantly different (i.e., the measurements represent a single hydration band). The sole purpose of the **BAND TWO** column is to list the mean and standard deviation of a second hydration band, when present. In other words, if no value is listed in the **BAND TWO** column, the specimen exhibits a single hydration band, which is listed in the **BAND ONE** column. Standard deviation figures are rounded to the nearest tenth micron, and represent the actual variation in readings. There is a generally accepted measurement error of 0.2 microns on each hydration measurement, but this error factor is independent of the standard deviation.

COMMENTS

All Obsidian hydration thin sections are not "textbook" examples. **COMMENTS** are designed to supplement the hydration measurements by identifying specimens that represent some problem in measurement, or that exhibit some unusual optical properties. Definitions for the abbreviations used in the **COMMENTS** column are listed on the following page.

OBSIDIAN SOURCE

The geographic origin of the analyzed obsidian is listed when specimens have been subjected to some replicable means of source identification (e.g., x-ray fluorescence spectroscopy, neutron activation, visual identification in some instances).

ABBREVIATIONS AND DEFINITIONS USED IN THE COMMENTS COLUMN

BRE - (BREak). The thin section cut was made across a broken edge of the artifact. Resulting hydration measurements may reveal when the artifact was broken, relative to its age of manufacture.

BUR - (BURned?). The optical nature of the hydration band suggests that the artifact was exposed to extreme heat or burning in the past. The range of burning effects are poorly understood, but burning can obscure the diffusion front of a hydration band and possibly affect an interpretation of its thickness.

DES - (DEStroyed). The artifact was destroyed in the process of thin section preparation. Usually this occurs only with very small specimens, such as unmodified pressure flakes.

DFV - (Diffusion Front Vague). The diffusion front is vague and poorly defined. This can result in less precise measurements than are obtained with a well-defined diffusion front. The technician is forced to interpret the hydration band termination because it is often presented as either a thick, dark line or a gradation in color between the hydrated and unhydrated obsidian, under cross-polarized, filtered light.

DIS - (DIScontinuous). A discontinuous or interrupted hydration band was observed on more than one surface of the thin section.

HV - (Highly Variable). The hydration band exhibits variable thickness along continuous surfaces. This variability can occur with very well-defined bands as well as those with irregular or vague diffusion fronts.

IRR - (IRRegular). The surfaces of the thin section (outer surfaces of the artifact) are uneven and measurement is difficult.

ISO - (ISOlated). Measurement was made on a small, isolated hydration band that is discontinuous. Such measurements are usually relied upon only when preparation of no more than one thin section is possible.

NVH - (No Visible Hydration). No hydration band was observed. This does not assure that hydration is absent, only that none was observed.

OSO - (One Surface Only). Hydration was observed on only one surface of the thin section. In such instances eight measurements were obtained on the one surface.

PAT - (PATinated). This description is usually used when there is a problem in measuring the hydration band, and refers to the unmagnified surface of the artifact, possibly indicating a source of the measurement problem.

REC - (RECut). More than one thin section was obtained from the artifact. Multiple thin sections are made if preparation quality of the first thin section is poor or the resolution of the hydration band is low and poor preparation is suspected, or if additional information on an artifact's history is desired.

THR - (THRee). Three different hydration bands are, or may be, present.

UNR - (UNReadable). The optical quality of the hydration band is so poor that accurate measurement is not possible. Poor thin section preparation is not a cause.

U.C. DAVIS OBSIDIAN HYDRATION CATALOGUE

CA-SBR-4963,4966

SUBMITTED BY: WIRTH ENVIRONMENTAL SERVICES — MAY 1984

O.H.L. TECHNICIAN: R.J. JACKSON — MAGNIFICATION - 500 or 1250

ACCESSION DATA ohl#	catalog #	PROVENIENCE unit	level (cm)	DESCRIPTION name - type	HYDRATION (microns) band 1	band 2	COMMENTS (see text)	OBSIDIAN SOURCE
3789	174-141	S255 E2	SURFACE	FLAKE -INTERIOR	14.9+-.5	--------	--------	COSO
3790	174-173	S215 E2	SURFACE	FLAKE -INTERIOR	14.4+-.4	4.4+-.1	--------	COSO
3791	174-257	S230 E2	SURFACE	FLAKE -INTERIOR	18.1+-.6	15.4+-.3	--------	COSO
3792	178-6876	S1681E2	20-30	FLAKE -INTERIOR	10.0+-.5	--------	HV	COSO
3793	178-6892	S1681E2	30-40	FLAKE -INTERIOR	8.2+-.6	--------	HV	COSO
3794	178-6984	S1679E2	30-40	FLAKE -INTERIOR	14.7+-.1	--------	ISO	COSO
3795	178-6867	S1685E2	60-70	FLAKE -INTERIOR	15.1+-.5	--------	--------	COSO
3796	178-6309	S1681E2	20-30	FLAKE -INTERIOR	12.2+-.7	--------	HV	COSO
3797	178-6387	S1681E2	40-50	FLAKE -INTERIOR	13.1+-.4	--------	HV	COSO
3798	178-3205	S1682E2	30-40	FLAKE -INTERIOR	11.0+-.2	--------	ISO	COSO
3799	178-6465	S1683E2	50-60	FLAKE -INTERIOR	15.1+-.5	13.1+-.3	--------	COSO
3800	178-6126	S1544E2	80-90	FLAKE -INTERIOR	17.0+-.3	--------	ISO DFV	COSO
3801	178-7791	TRENCH	35	FLAKE -INTERIOR	11.4+-.4	--------	--------	COSO
3802	178-7265	SV-21	50-60	FLAKE -INTERIOR	10.9+-.3	12.4+-.6	HV	COSO
3803	178-7451	S157 E2	30-40	FLAKE -INTERIOR	12.2+-.2	--------	--------	COSO
3804	178-7391	S1570E2	40-50	FLAKE -INTERIOR	9.0+-.3	--------	--------	COSO
3805	178-7435	S1572E2	50-60	FLAKE -INTERIOR	13.2+-.1	--------	ISO	COSO
3806	178-3310	S1630E2	40-50	FLAKE -INTERIOR	8.9+-.5	--------	HV	COSO
3807	178-4905	[illegible]	SURFACE	FLAKE -INTERIOR	0.0+-.0	--------	DFV UNR	COSO
3808	178-3064	S1574E2	40-50	FLAKE -INTERIOR	10.5+-.3	--------	HV	COSO
3809	178-5515	[illegible]	SURFACE	FLAKE -INTERIOR	16.0+-.4	--------	HV	COSO
3810	178-3910	[illegible]	SURFACE	FLAKE -INTERIOR	12.4+-.2	--------	--------	COSO
3811	178-3492	S1632E2	60-70	FLAKE -INTERIOR	18.5+-.2	--------	HV DFV	COSO
3812	178-3246	S1670E2	0-10	FLAKE -INTERIOR	10.7+-.5	13.0+-.1	--------	FLAKE
3813	178-4543	[illegible]	SURFACE	CORNER-FRAGMENT	5.7+-.5	--------	ISO DFV	COSO
3814	178-3488	S1632E2	50-60	FLAKE -INTERIOR	7.4+-.4	10.1+-.6	--------	COSO
3815	24-944			POINT -SILVER LAKE	15.4+-.4	17.8+-.4	--------	COSO
3816	24-924			BIFACE-FRAGMENT	9.3+-.3	7.9+-.3	--------	COSO
3817	24-930			POINT -LITTLE LAKE	14.5+-.1	13.3+-.2	DIS HV	COSO
3818	24-949			POINT -ELKO SERIES	11.4+-.3	--------	ISO HV	COSO
3819	24-9			BIFACE-FRAGMENT	10.0+-.6	8.0+-.4	HV	COSO
3820	24-922			POINT -STEMMED	15.5+-.5	--------	HV	COSO
3821	24-939			BIFACE-FRAGMENT	12.3+-.4	--------	--------	COSO

U.C. DAVIS OBSIDIAN HYDRATION CATALOGUE
FORT IRWIN

SUBMITTED BY: WIRTH ENVIRONMENTAL SERVICES — AUGUST 1984
O.H.L. TECHNICIAN: R.J. JACKSON — MAGNIFICATION - 500 or 1250

ACCESSION DATA		PROVENIENCE		DESCRIPTION	HYDRATION (microns)		COMMENTS	OBSIDIAN
ohl#	catalog #	unit/level (cm)		name - type	band 1	band 2	(see text)	SOURCE
4002	174-24			POINT -STEMMED	16.9+-.6	--------	HV	
4003	714-134	S25.5/E	SURFACE	UNIFAC-FRAGMENT	17.1+-.3	15.4+-.6	--------	
4004	176-76	S160/E2	SURFACE	BIFACE-FRAGMENT	10.8+-.3	--------	DFV	
4005	176-168	S170/E2	SURFACE	FLAKE -DECORT.	0.0+-.0	--------	DFV UNR	
4006	1768-945	S1725E1	SURFACE	BIFACE-FRAGMENT	13.1+-.6	--------	HV	
4007	178-1499	S1716E1	SURFACE	BIFACE-FRAGMENT	27.7+-.7	16.6+-.3	--------	
4008	178-1907	S1960E1	SURFACE	BIFACE-FRAGMENT	14.7+-.3	--------	HV	
4009	178-2154	S1375E1	SURFACE	POINT -SIDE-NTCH	0.0+-.0	--------	UNR	NOT OBSID?
4010	178-2547	S1430E1	SURFACE	BIFACE-FRAGMENT	0.0+-.0	--------	--------	NOT OBSID?
4011	178-3541	S1960E1	SURFACE	BIFACE-FRAGMENT	12.2+-.5	--------	HV	
4012	178-3712	S1426E1	SURFACE	FLAKE -EDGE-MODIF.	14.0+-.2	11.9+-.3	--------	
4013	178-4114	S1461E1	SURFACE	FLAKE -EDGE-MODIF.	12.9+-.4	--------	--------	
4014	178-4240	S1797E2	SURFACE	FLAKE -INTERIOR	7.9+-.3	--------	DIS	
4015	178-5144	S1733E1	SURFACE	BIFACE-FRAGMENT	8.7+-.2	12.8+-.4	HV DFV	
4016	178-5382	S1458E1	SURFACE	BIFACE-FRAGMENT	13.4+-.2	10.0+-.5	--------	
4017	178-5585	S1102E1	SURFACE	BIFACE-FRAGMENT	19.3+-.8	--------	--------	
4018	178-7788	S1642E2	47	FLAKE -EDGE-MODIF.	13.1+-.5	--------	--------	
4019	180-68	S212/E2	SURFACE	FLAKE -EDGE-MODIF.	28.3+-.6	--------	HV DFV	
4020	440-1	S949/E1	SURFACE	POINT -STEMMED	6.6+-.4	2.3+-.1	--------	
4021	440-33	S1018E1	SURFACE	POINT -STEMMED	0.0+-.0	--------	UNR	NOT OBSID?
4022	440-192	S791/E8	SURFACE	BIFACE-FRAGMENT	14.1+-.3	--------	--------	
4023	440-202	S760/E8	SURFACE	POINT -STEMMED	8.9+-.4	--------	HV DIS	

U.C. DAVIS OBSIDIAN HYDRATION CATALOGUE
CA-SBR-4963

SUBMITTED BY: WIRTH ENVIRONMENTAL SERVICES — DECEMBER 1984
O.H.L. TECHNICIAN: R.J. JACKSON — MAGNIFICATION - 500 or 1250

ACCESSION DATA ohl#	catalog #	PROVENIENCE unit/level (cm)		DESCRIPTION name - type	HYDRATION (microns) band 1	band 2	COMMENTS (see text)		OBSIDIAN SOURCE
4269	174-35	K-1	SURFACE	FLAKE -INTERIOR	11.3+-.8	--------	HV		
4270	174-39	K-5	SURFACE	FLAKE -INTERIOR	12.9+-.2	15.7+-.5	HV		
4271	174-55	K-15	SURFACE	FLAKE -INTERIOR	14.7+-.5	6.9+-.4		PAT	
4272	174-63	K-22	SURFACE	FLAKE -INTERIOR	13.5+-.2	--------	ISO		
4273	174-77	N11	SURFACE	FLAKE -EDGE-MODIF.	15.4+-.3	--------	--------		
4274	174-121-1	S250E24	SURFACE	FLAKE -INTERIOR	14.8+-.3	21.0+-.7	HV	PAT	
4275	174-121-2	S250E24	SURFACE	FLAKE -EDGE-MODIF.	15.3+-.3	--------		PAT	
4276	174-127-1	S250E23	SURFACE	FLAKE -EDGE-MODIF.	16.5+-.3	--------	ISO		
4277	174-127-2	S250E23	SURFACE	FLAKE -INTERIOR	14.2+-.4	16.5+-.2		PAT	
4278	174-133	S255E24	SURFACE	FLAKE -INTERIOR	15.5+-.2	--------	ISO	PAT	
4279	174-354	P2	SURFACE	FLAKE -INTERIOR	12.7+-.4	--------		PAT	
4280	174-410	Z11	SURFACE	FLAKE -EDGE-MODIF.	14.8+-.3	--------	ISO	PAT	
4281	176-7	GS-27	SURFACE	FLAKE -EDGE-MODIF.	7.6+-.2	10.5+-.4		PAT	
4282	440-198	H-8	SURFACE	FLAKE -INTERIOR	14.7+-.3	--------	--------		
4283	440-247	I-21	SURFACE	FLAKE -INTERIOR	21.6+-.0	19.4+-.5	HV	PAT	
4284	440-490	S715E89	SURFACE	FLAKE -INTERIOR	27.2+-.8	--------	HV	PAT	
4285	440-571	S750E86	SURFACE	FLAKE -INTERIOR	10.3+-.4	12.5+-.4	--------		

U.C. DAVIS OBSIDIAN HYDRATION CATALOGUE
FORT IRWIN

SUBMITTED BY: WIRTH ENVIRONMENTAL SERVICES — DECEMBER 1984
O.H.L. TECHNICIAN: R.J. JACKSON — MAGNIFICATION - 500 or 1250

ACCESSION DATA ohl#	catalog #	PROVENIENCE unit/level (cm)		DESCRIPTION name - type	HYDRATION (microns) band 1	band 2	COMMENTS (see text)	OBSIDIAN SOURCE
4205	499-339	M130	10-20	FLAKE -INTERIOR	10.1+-.2	--------	1SO	
4206	499-275	M130	40-50	FLAKE -INTERIOR	10.5+-.3	--------	--------	
4207	296-58	M130A	30-50	FLAKE -INTERIOR	9.6+-.2	8.1+-.3	HV DIS	
4208	498-59	LOCUS 2	SURFACE	POINT -SILVER LAKE	12.3+-.5	--------	HV	
4209	498-59	LOCUS 2	SURFACE	POINT -SILVER LAKE	11.8+-.2	--------	1SO	
4210	498-486	LOCUS 2	SURFACE	BIFACE-FRAGMENT	14.9+-.0	--------	HV	
4211	498-487	LOCUS 2	SURFACE	FLAKE -INTERIOR	17.6+-.4	--------	--------	
4212	498-489	LOC 2,T	21-31	FLAKE -INTERIOR	23.8+-.1	--------	HV	
4213	498-148	LOCUS 2	SURFACE	POINT -LITTLE LAKE	8.5+-.5	--------	HV	
4214	498-265	LOCUS 2	SURFACE	POINT -SILVER LAKE	0.0+-.0	--------	NVH WP	
4215	498-265	LOCUS 2	SURFACE	POINT -SILVER LAKE	0.0+-.0	--------	NVH WP	
4216	498-82-1	LOCUS 2	SURFACE	BIFACE	11.4+-.1	--------	HV DIS	
4217	498-82-1	LOCUS 2	SURFACE	BIFACE	12.8+-.4	--------	1SO HV	
4218	498-82-2	LOCUS 2	SURFACE	BIFACE-FRAGMENT	0.0+-.0	--------	NVH WP	
4219	498-82-2	LOCUS 2	SURFACE	BIFACE-FRAGMENT	0.0+-.0	--------	NVH WP	
4220	498-82-3	LOCUS 2	SURFACE	FLAKE -EDGE-MODIF.	0.0+-.0	--------	NVH WP	
4221	498-274	LOCUS 2	SURFACE	FLAKE -INTERIOR	15.4+-.6	--------	--------	
4222	294-242	LOCUS 1	70-80	FLAKE -INTERIOR	15.0+-.9	--------	1SO HV	
4223	294-301	LOCUS 2	50-60	FLAKE -INTERIOR	15.4+-.7	--------	HV	
4224	294-318	LOC2,FE	SURFACE	FLAKE -INTERIOR	13.9+-.9	--------	HV	

U.C. DAVIS OBSIDIAN HYDRATION CATALOGUE
M117A

SUBMITTED BY: WIRTH ENVIRONMENTAL SERVICES — JANUARY 1984
O.H.L. TECHNICIAN: R.J. JACKSON — MAGNIFICATION - 500 or 1250

ACCESSION DATA ohl#	catalog #	PROVENIENCE unit/level (cm)		DESCRIPTION name - type	HYDRATION (microns) band 1	band 2	COMMENTS (see text)	OBSIDIAN SOURCE
4293	M117A			POINT -ELKO C-N.	7.6+-.1	--------	1SO	

APPENDIX D

Warren: Distribution of Nelson Wash Artifact Types by Site, Locus and Component

Fort Irwin, California

Artifacts of unknown provenience

Proj. pt.	3d	17
number	2	1

Total=3

Bifcomp	18a
number	1

Total=1

Bifbase	8A	22A
number	1	1

Total=2

Biftip	1.3
number	1

Total=1

Unifaces	8.1	14.3
number	2	1

Total=2

4-SBr-496c

Locus A Artifact Complex

Locus A Projectile Point Classes

Proj. pt.	1a	1b	1c	2	3d	3e	13	15	16	17	18	19
ng	2	4	1	-	1	-	-	1	-	-	-	3
sc	1	3	2	1	5	2	1	-	-	2	1	5
ex	-	-	-	-	-	-	-	-	1	-	-	-
total	3	7	3	1	6	2	1	1	1	2	1	8

ng total=12
sc total=23
ex total= 1
Proj. pt Total=36

Locus A Complete Biface Classes

Bifcomp.	1A	1B	2A
ng	2	2	3
sc	1	-	1
ex	-	-	-
total	3	2	4

Bifcomp.	3A	3B	3C	4A	4B	6A	7A	7B	7C
ng	3	1	1	2	-	4	2	1	1
sc	2	2	2	2	-	2	-	-	2
ex	-	-	-	-	1	-	-	-	-
total	5	3	3	4	1	6	2	1	3

Bifcomp.	8A	8B	8C	9A	10A	11A	11B	11C	12A	12B
ng	3	1	2	1	1	3	1	2	2	1
sc	5	1	-	-	-	1	1	-	2	-
ex	-	-	-	-	-	1	-	-	-	-
total	8	2	2	1	1	5	2	2	4	1

Bifcomp.	13A	16A	16B	16C	17B	18A	19A	19B	99.9	0.0
ng	-	1	2	-	2	-	2	1	[illegible]	[illegible]
sc	1	-	-	1	2	1	-	1	6	[illegible]
ex	-	-	-	-	-	-	-	-	-	-
total	1	1	2	1	4	1	2	2	10	9

ng total=56
sc total=40
ex total= [illegible]
Bifcomp. Total=96

Locus A Biface Base Classes

Bifbase	1A	1B	2A	3A	3B	5A	5B	6A	6B	7B
ng	4	1	-	2	1	6	1	5	1	1
sc	15	6	3	5	-	5	1	6	1	1
ex	--	-	-	-	-	--	-	1	-	-
total	19	7	3	7	1	11	2	12	2	2

Bifbase	8A	8B	9A	12A	16A	16B	16C	18A	18B	18C
ng	1	-	-	1	1	3	1	11	1	14
sc	2	3	1	-	1	2	-	8	-	8
ex	-	-	-	-	-	-	-	1	-	2
total	3	3	1	1	2	5	1	20	1	24

Bifbase	19A	19B	22A	22B	23A	24A	24B	25A	99.9	0.0
ng	12	-	1	1	3	2	2	4	8	4
sc	19	1	1	-	2	4	3	4	8	15
ex	1	-	-	-	-	-	-	-	1	1
total	32	1	2	1	5	6	5	8	17	20

ng total= 82
sc total=125
ex total= 7
Bifbase Total=214

Locus A Biface Tip Classes

Biftip	1.1	1.11	1.2	1.3	1.4	1.5	1.6	1.7
ng	5	4	2	3	5	4	4	4
sc	1	3	4	10	6	1	5	5
ex	-	-	-	2	-	-	-	-
total	6	7	6	15	11	5	9	9

Biftip	2.1	2.2	2.3	2.4	2.5	3.0	4.0	5.0	6.0	99.9
ng	4	2	6	1	4	3	5	2	4	1
sc	2	4	4	3	9	1	4	2	-	1
ex	-	-	--	-	1	-	3	-	-	-
total	6	6	10	4	14	4	12	4	4	2

ng total=64
sc total=65
ex total= 6
Biftip total=134

Locua A Uniface Classes

Uniface	1.0	2.1	2.2	3.1	3.2
ng	1	2	3	1	2
sc	-	-	4	-	1
ex	-	-	-	1	-
total	1	2	7	2	3

Uniface	4.0	5.3	5.6	6.0	7.1	7.2	7.3	8.1
ng	1	-	-	1	2	1	2	2
sc	-	1	1	-	-	1	5	1
ex	-	-	-	-	-	-	-	-
total	1	1	1	1	2	2	7	3

Uniface	9.0	10.2	11.0	12.2	13.1	13.2	13.3	13.4
ng	-	-	1	-	1	2	-	2
sc	2	2	-	1	-	2	2	7
ex	1	1	-	-	-	-	-	-
total	3	3	1	1	1	4	2	[illegible]

Uniface	13.5	13.6	14.1	14.2	14.3	15.2	15.3	15.4
ng	1	1	1	3	3	-	2	-
sc	2	3	8	22	8	1	1	1
ex	-	-	1	2	-	-	-	
total	3	4	10	27	11	1	3	1

Uniface	15.1	16.2	16.3	17.0	18.0	20.0	22.3
ng	-	-	-	4	-	1	1
sc	1	4	-	6	5	2	-
ex	-	-	1	--	-	-	-
total	1	4	1	10	5	3	1

ng total=41
sc total=94
ex total= 7
Uniface Total=142

Locus A Core Classes

Cores	1	2	3	5	6	7
ng	-	3	1	1	1	3
sc	3	7	2	-	1	6
ex	1	-	-	-	-	-
total	4	10	3	1	2	9

ng total= 9
sc total=19
ex total= 1
Core Total=29

	Biface midsections	Amorph. bifaces
ng	15	1
sc	21	10
ex	-	-
total	36	11

ng total=16
sc total=31
ex total= 0
Misc. biface total= 47

Locus B Artifact Complex

Proj. pt.	1a	1b	2	5	10	12	18	19
ng	1	-	4	1	1	1	1	1
sc	1	1	-	-	-	-	-	2
ex	-	-	-	-	-	-	-	-
total	2	1	4	1	1	1	1	3

ng total=10
sc total= 4
ex total= 0
Total=14

Bifcomp.	1A	2A	2B	3A	3B
ng	6	9	1	5	1
sc	-	-	-	2	-
ex	-	-	-	-	1
total	6	9	1	7	2

Bifcomp.	4A	4B	5A	5B	6A	7B
ng	3	3	2	1	2	1
sc	1	-	-	-	1	-
ex	-	-	-	-	-	-
total	4	3	2	1	3	1

Bifcomp.	8A	8C	10A	11A	11B	12A	12B	13A
ng	1	1	1	1	2	3	3	1
sc	-	-	-	1	-	1	-	-
ex	-	-	-	-	-	-	-	-
total	1	1	1	2	2	4	3	1

Bifcomp.	15A	16B	16C	17A	17B	19A	21A	99.9	0.0
ng	-	1	2	3	3	3	-	5	-
sc	1	-	-	1	-		1	-	1
ex	-	-	-	-	-	-	-	-	-
total	1	1	2	4	3	3	1	5	

ng total=64
sc total=10
ex total= 1
Total=75

Bifbase	1A	1B	2A	3A	3B	5A	5B	6A	6B	8B
ng	13	2	3	.	1	10	–	–	1	4
sc	8	1	1	1	2	3	3	1	–	1
ex	–	–	–	–	–	–	–	1	–	–
total	21	3	4	2	3	13	3	2	1	5

Bifbase	12A	16A	16B	16C	18A	18B	18C	19A	19B
ng	2	1	3	–	12	5	11	8	2
sc	–	–	1	1	9	2	4	9	–
ex	–	–	2	–	2	–	–	–	–
total	2	1	6	1	23	7	15	17	2

Bifbase	20B	21A	22A	22B	23A	24A	24B	25A	99.8	0.0
ng	1	3	4	1	2	1	4	3	12	2
sc	–	3	3	1	2	1	–	1	3	1
ex	–	–	–	–	–	–	–	–	–	–
total	1	6	7	2	4	2	4	4	15	[illegible]

ng total=11[illegible]
sc total= 62
ex total= 5
Total=179

Biftip	1.1	1.11	1.2	1.3	1.4	1.5	1.6
ng	1	3	–	6	5	1	6
sc	–	1	1	3	1	–	4
ex	–	–	–	–	–	–	–
total	1	4	1	9	6	1	10

Biftip	1.7	2.1	2.2	2.3	2.4	2.5	3.0	4.0	6.0	90.0
ng	3	3	3	3	3	12	3	1	1	1
sc	2	1	1	2	4	8	–	1	–	–
ex	–	–	–	–	–	–	–	–	1	–
total	5	4	4	5	7	20	3	2	2	1

ng total=59
sc total=29
ex total= 1
Total=85

Uniface	1.0	2.1	2.2
ng	1	1	6
sc	-	5	3
ex	-	-	1
total	1	6	10

Uniface	3.2	4.0	5.1	5.2	5.3	5.4	5.5
ng	1	1	1	2	2	1	4
sc	1	-	-	-	-	-	-
ex	-	-	-	-	-	-	-
total	2	1	1	2	2	1	4

Uniface	6.0	7.1	7.2	8.1	9.0	10.2	12.2
ng	1	2	1	6	2	1	1
sc	-	1	-	1	1	-	1
ex	-	-	-	-	1	-	-
total	1	3	1	7	4	1	2

Uniface	13.1	13.2	13.3	13.4	13.5	13.6	14.1
ng	-	-	-	-	1	4	2
sc	2	1	1	1	3	-	3
ex	-	1	-	-	-	1	-
total	2	2	1	1	4	5	5

Uniface	14.2	14.3	15.2	16.1	17.0	18.0	20.0	22.0
ng	2	7	1	-	5	2	1	-
sc	1	5	-	1	2	3	1	1
ex	1	1	-	-	-	-	-	-
total	4	13	1	1	7	5	2	1

ng total=59
sc total=38
ex total= 6
Total=103

Cores	1	2	3	4	6	7
ng	3	4	5	1	2	7
sc	2	3	2	-	-	6
ex	-	1	-	-	-	-
total	5	8	7	1	2	13

ng total=22
sc total=13
ex total= 1
Total=36

	Biface midsections	Amorph bifaces
ng	16	7
sc	8	5
ex	-	1
total	24	13

nq total=23
sc total=13
ex total= 1
Total=37

Locus C Artifact Complex

Proj. pt.	1c	2	3c	3d	4	5	9	15	16	17	18	19
ng	1	2	1	1	–	1	1	–	1	1	1	4
sc												
c1	–	–	–	–	–	1	–	–	–	–	–	–
c2	–	–	–	–	–	–	–	–	–	–	–	–
c3–6	–	–	–	–	–	–	–	1	–	–	1	–
cb	–	–	–	–	–	–	–	–	–	–	1	–
c other	–	–	–	–	1	–	–	–	–	–	–	1
ex	–	–	–	–	–	–	–	–	–	–	–	2
total	1	2	1	1	1	2	1	1	1	1	3	7

ng=14
sc= 6
ex= 2
Total=22

Bifcomp.	1A	1B	2A	3A	3B	4B
ng	1	1	2	3	4	1
sc						
c1	–	–	–	–	–	–
c2	–	–	–	–	–	–
c3–6	–	–	–	1	–	–
cb	1	–	1	1	–	–
c other	–	–	–	–	–	–
ex	–	–	–	–	–	–
total	2	1	3	5	4	1

Bifcomp.	5A	5B	6A	7A	7B	7C	8A	8B
ng	4	2	8	1	1	2	5	3
sc								
c1	–	–	–	–	–	–	–	–
c2	–	–	1	–	–	–	–	–
c3–6	–	–	–	1	–	–	2	–
cb	1	–	1	–	–	–	–	–
c other	1	–	–	–	–	–	–	–
ex	–	–	–	–	–	–	–	–
total	6	2	10	2	1	2	7	3

Bifcomp.	11A	11B	11C	12A	12B	15A	16A
ng	-	1	1	3	-	1	2
sc							
c1	-	-	-	-	-	-	-
c2	-	-	-	-	-	-	-
c3-6	1	1	-	1	1	-	-
cb	2	-	-	1	-	-	-
c other	-	-	-	-	-	-	-
ex	-	-	-	-	-	-	-
total	3	2	1	5	1	1	2

Bifcomp.	16B	16C	17B	18A	18B	19A	21A	99.9	0.0
ng	1	-	1	1	1	2	1	6	7
sc									
c1	-	-	-	-	-	-	-	-	-
c2	-	-	-	-	-	-	-	-	1
c3-6	-	-	-	-	-	-	-	-	1
cb	-	1	-	-	-	1	-	1	1
c other	-	-	-	-	-	-	1	-	-
ex	-	-	-	-	-	-	-	-	-
total	1	1	1	1	1	3	2	7	10

ng=66
sc=25
ex= 0
Total=91

Bifbase	1A	2A	3A	3B	5A	5B	6A	6B	7C	8A	8B
ng	16	8	6	1	12	1	3	1	1	3	1
sc											
c1	-	-	-	-	1	-	1	-	-	-	-
c2	6	-	-	-	1	-	-	-	-	-	1
c3-6	3	-	-	-	2	-	-	-	-	-	-
cb	3	1	1	-	4	-	-	1	-	2	-
c other	-	-	-	-	-	-	-	-	-	-	-
ex	-	-	-	-	-	-	-	1	-	-	-
total	28	9	7	1	20	1	4	3	1	5	2

Bifbase	12A	16A	16B	16C	18A	18B	18C	19A	19B
ng	1	1	4	2	19	6	22	20	1
sc									
c1	-	-	1	1	3	-	-	1	-
c2	-	-	1	1	1	-	-	2	-
c3-6	-	-	-	-	1	-	-	4	-
cb	-	-	-	-	5	-	5	5	-
c other	-	-	-	-	-	-	-	2	-
ex	-	-	-	-	-	-	-	1	-
total	1	1	6	4	29	6	27	35	1

Bifbase	21A	22A	22B	23A	24A	24B	25A	99.8	0.0
ng	3	3	2	6	2	3	4	10	7
sc									
c1	1	-	-	-	-	-	-	-	1
c2	-	-	1	-	-	-	-	2	1
c3-6	-	1	-	-	-	-	-	1	-
cb	-	-	-	1	-	-	2	1	2
c other	-	-	-	-	-	-	-	1	-
ex	-	-	-	-	-	-	-	-	-
total	4	4	3	7	2	3	6	15	11

ng=169
sc= 75
ex= 2
Total=246

Biftip	1.1	1.11	1.2	1.3	1.4	1.5
ng	2	1	5	4	4	1
sc						
c1	-	-	-	-	-	-
c2	1	1	1	1	1	-
c3-6	1	1	1	1	1	-
cb	-	-	-	3	2	1
c other	-	-	-	-	-	1
ex	-	-	-	-	-	-
total	4	3	7	9	8	3

Biftip	1.6	1.7	2.1	2.2	2.3	2.4	2.5	3.0	5.0	99.9
ng	4	3	1	4	4	3	15	2	2	1
sc										
c1	-	-	-	-	-	-	-	-	-	-
c2	1	-	-	-	-	-	-	-	-	-
c3-6	1	-	-	2	-	-	1	-	-	1
cb	2	2	-	-	-	2	5	-	-	2
c other	-	-	-	-	-	-	-	-	-	-
ex	-	-	-	-	-	-	-	-	-	-
total	8	5	1	6	4	5	21	2	2	4

ng=36
sc=36
ex= 0
Total=92

Uniface	1.0	2.2	3.2	4.0	5.2
ng	1	6	1	1	1
sc					
c1	-	-	-	-	1
c2	-	-	-	-	-
c3-6	-	-	-	-	-
cb	-	-	-	-	-
c other	-	-	-	-	-
ex	-	-	-	-	-
total	1	6	1	1	2

Uniface	5.6	7.1	7.2	8.1	8.2	9.0	10.1
ng	1	2	1	1	1	2	1
sc							
c1	-	-	-	-	-	-	-
c2	-	-	-	-	-	-	-
c3-6	-	-	-	-	-	-	-
cb	-	1	-	-	-	-	-
c other	-	-	-	-	-	-	-
ex	-	-	-	-	-	-	-
total	1	3	1	1	1	2	1

Uniface	10.2	12.1	13.2	13.4	13.5	13.6
ng	3	1	-	1	1	2
sc						
c1	-	-	-	-	-	
c2	-	-	-	-	-	-
c3-6	-	-	-	-	-	-
cb	-	-	-	-	-	-
c other	-	-	2	-	-	-
ex	-	-	-	-	-	-
total	3	1	2	1	1	2

Uniface	14.1	14.2	14.3	16.2	17.0	18.0	19.0	20.0
ng	2	3	2	1	3	-	1	1
sc								
c1	1	-	-	-	-	1	-	-
c2	-	1	-	-	-	1	-	-
c3-6	1	2	1	-	-	2	-	-
cb	-	-	-	-	-	-	-	-
c other	1	4	-	-	-	-	-	-
ex	-	-	-	-	1	-	-	-
total	5	10	3	1	4	4	1	1

ng=40
sc=19
ex= 1
Total=60

Cores	1	2	3	4	5	7	8
ng	2	1	2	1	-	7	2
sc							
c1	-	1	-	-	-	-	-
c2	-	-	-	-	-	-	-
c3-6	-	1	-	-	1	-	-
cb	-	-	-	-	-	-	-
c other	-	1	-	-	-	1	-
ex	-	-	-	-	-	-	-
total	2	4	2	1	1	8	2

ng=15
sc= 5
ex= 0
Total=20

	Biface midsections	Amorph bifaces
ng	14	2
sc		
c1	1	-
c2	3	4
c3-6	4	-
cb	4	-
c other	1	2
ex	-	-
total	27	8

ng=16
sc=19
ex= 0
Total=35

Locus D Artifact Complex

Projectile Points

Total=0

Bifcomp.	2A	3A
ng	-	-
sc	1	1
ex	-	-
total	1	1

ng total=0
sc total=2
ex total=0
Total=2

Bifbase	1A	18A	18B	18C	22A	23A	24A	25A	99.8	0.0
ng	-	-	1	1	-	1	-	-	1	1
sc	1	2	-	4	1	1	1	1	-	-
ex	-	-	-	-	-	-	-	-	-	-
total	1	2	1	5	1	2	1	1	1	1

ng total= 5
sc total=11
ex total= 0
Total=16

Biftip	1.3	2.5	3.0	5.0	99.9
ng	-	1	1	-	1
sc	-	-	1	1	-
ex	1	-	-	-	-
total	1	1	2	1	1

ng total= 3
sc total= 2
ex total= 1
Total= 6

Uniface	2.2	7.3	8.1	12.2	14.1	14.2	18.0
ng	1	-	-	-	-	-	-
sc	1	1	1	1	1	1	1
ex	-	-	-	-	-	-	-
total	2	1	1	1	1	1	1

ng total= 1
sc total= 7
ex total= 0
Total= 8

Cores	2	6	9
ng	-	-	-
sc	2	1	1
ex	-	-	-
total	2	1	1

ng total= 0
sc total= 4
ex total= 0
Total= 4

	Biface midsections	Amorph. bifaces
ng	-	1
sc	3	2
ex	1	-
total	4	3

ng total= 1
sc total= 5
ex total= 1
Total= 7

Site 48Br4966 Locus E Artifact Complex

Projectile points

Projectile Points Total=0

Bifcomp.	1A	3B	7C	16A	18A
ng	-	-	-	-	-
sc	-	-	-	-	-
comp2 (ex)	1	1	1	1	1
other ex.	-	-	-	-	-
Total	1	1	1	1	1

ng= 0
sc= 0
cmp2 (ex)= 5
other ex.= 0
Total= 5

Bifbase	1A	1B	2A	6B	8A	8B
ng	-	-	-	-	-	-
sc	1	-	-	1	-	-
comp2 (ex)	1	1	1	-	1	1
other ex.	-	-	1	-	-	-
Total	2	1	2	1	1	1

Bifbase	18A	18B	18C	19A	22A	22B	23A	24A	99.8	0.0
ng	-	-	-	-	-	-	-	-	-	-
sc	1	1	-	-	-	1	-	-	-	-
comp2 (ex)	-	-	4	3	1	-	-	2	3	2
other ex.	-	-	1	-	-	-	1	-	1	2
Total	1	1	5	3	1	1	1	2	4	4

ng= 0
sc= 5
cmp2 (ex)=20
other ex.= 6
Total=31

Biftip	1.2	1.3
ng	-	-
sc	-	-
comp2 (ex)	-	2
other ex.	1	1
Total	1	3

Biftip	1.4	1.6	1.7	2.2	2.4	2.5	4.0	6.0	99.9
ng	1	-	-	-	-	-	-	-	-
sc	-	1	-	-	-	1	-	-	1
comp2 (ex)	1	-	-	1	1	3	3	1	4
other ex.	-	-	1	-	-	1	1	-	-
Total	2	1	1	1	1	5	4	1	5

ng= 1
sc= 3
cmp2 (ex)=16
other ex.= 5
Total=25

Uniface	7.3	12.1	12.2	13.6	14.1	14.2	14.3	15.4	18.0
ng	-	-	-	-	-	-	-	1	-
sc	-	-	-	1	1	-	-	-	1
comp2 (ex)	1	1	2	2	2	2	1	-	2
other ex.	-	-	-	1	-	-	1	-	-
Total	1	1	2	4	3	2	2	1	3

ng= 1
sc= 3
cmp2 (ex)=13
other ex.= 2
Total=19

Cores	1	2	7
ng	-	-	1
sc	-	1	-
comp2 (ex)	2	1	7
other ex.	-	2	1
Total	2	4	9

ng= 1
sc= 1
cmp2 (ex)=10
other ex.= 3
Total=15

	Biface midsections	Amorph. bifaces
ng	-	1
sc	-	-
comp2 (ex)	4	6
other ex.	-	3
total	4	10

ng= 1
sc= 0
cmp2 (ex)=10
other ex.= 3

Locus G Artifact Complex

Proj. pt.	1a	3a	3b	4	12	14	17	18	19
ng	-	-	1	-	-	1	-	-	-
sc	-	1	-	-	-	-	-	-	1
cmpl (ex)	2	-	-	1	-	-	-	1	6
other ex.	-	1	-	-	1	-	1	-	1
total	2	2	1	1	1	1	1	1	8

ng= 2
sc= 2
cmpl (ex)=10
other ex.= 4
Total=18

Bifcomp.	2A	2B	3C	4A	5A	6A
ng	2	1	-	1	-	-
sc	-	-	-	-	-	1
cmpl (ex)	-	-	1	-	2	-
other ex.	-	-	-	-	1	-
total	2	1	1	1	3	1

Bifcomp.	8A	13A	15A	16B	17B	18A	19B	99.9	0.0
ng	1	1	-	-	-	-	1	1	1
sc	-	-	-	-	-	-	-	-	-
cmpl (ex)	-	-	1	1	1	1	-	-	-
other ex.	-	-	-	1	-	-	-	1	-
total	1	1	1	2	1	1	1	2	1

ng= 9
sc= 1
cmpl (ex)= 7
other ex.= 3
Total=20

Bifbase	1A	1B	3A	5A	6A	8A	16B	16C	18A	18B	18C
ng	4	1	3	1	1	-	-	1	2	5	3
sc	-	1	-	-	-	-	-	-	-	-	2
cmpl (ex)	2	-	-	1	-	1	-	-	1	2	-
other ex.	-	-	-	1	-	-	1	-	-	-	1
total	6	2	3	3	1	1	1	1	3	7	6

Bifbase	19A	19B	21A	22B	23A	24A	25A	99.8	0.0
ng	1	1	1	1	6	1	1	2	1
sc	-	-	-	-	-	-	-	1	-
cmpl (ex)	1	-	-	1	-	-	-	1	2
other ex.	2	-	-	-	-	1	-	-	-
total	4	1	1	2	6	2	1	4	3

ng=36
sc= 6
cmpl (ex)=12
other ex.= 6
Total=59

Biftip	1.1	1.2	1.4	1.5
ng	1	-	4	-
sc	-	-	-	-
cmpl (ex)	1	2	1	-
other ex.	-	-	-	1
total	2	2	5	1

Biftip	1.6	1.7	2.1	2.2	2.4	3.0	4.0	5.0	99.9
ng	1	2	4	2	1	2	-	-	1
sc	-	-	-	-	-	-	-	-	1
cmpl (ex)	-	-	1	-	1	-	1	4	-
other ex.	-	-	1	1	-	1	-	-	-
total	1	2	6	3	2	3	1	4	2

ng=18
sc= 1
cmpl (ex)=11
other ex.= 4
Total=34

Uniface	2.1	2.2	3.2	4.0	5.1	5.3	5.4
ng	-	-	1	-	3	1	-
sc	1	-	-	-	-	-	1
cmpl (ex)	-	1	-	1	-	-	-
other ex.	-	-	-	-	1	-	-
total	1	1	1	1	4	1	

Uniface	6.0	7.2	7.3	9.0	10.2	12.2	13.4	[illegible]
ng	–	–	–	–	1	–	–	–
sc	–	–	–	–	–		–	
cmpl (ex)	1	1	1	1	–		–	–
other ex.	–	–	–	–	–	1	–	–
total	1	1	1	1	1	2	1	1

Uniface	13.6	14.1	14.2	14.3	15.1	16.2	17.0	19.1
ng	2	1	1	2	–	–	2	–
sc	–	–	–	1	–	–	–	–
cmpl (ex)	2	1	5	4	–	1	–	2
other ex.	–	–	–	1	1	–	–	–
total	4	2	6	8	1	1	2	2

ng=15
sc= 4
cmpl (ex)=22
other ex.= 4
Total=45

Cores	1	2	3	6	7
ng	2	1	–	1	2
sc	–	–	1	–	–
cmpl (ex)	–	1	–	–	–
other ex.	–	–	–	–	–
total	2	2	1	1	2

ng= 6
sc= 1
cmpl (ex)= 1
other ex.= 0
Grand Total= 8

	Biface midsections	Amorph. bifaces
ng	4	3
sc	2	–
cmpl (ex)	–	5
ex	1	–
total	7	8

ng= 7
sc= 2
cmpl (ex)= 5
other ex.= 1
Total=15

Locus H Artifact Complex

Proj. pt.	2	3b	3e	9	13	19
ng	1	1	1	1	1	2
sc	-	-	-	1	-	-
ex	-	-	-	-	-	-
total	1	1	1	2	1	2

ng= 7
sc= 1
ex= 0
Total= 8

Bifcomp.	1A	2B	4A
ng	1	1	-
sc	-	-	1
ex	-	-	-
total	1	1	1

Bifcomp.	7A	7B	7C	8C	11A	12A	16B	17B	19B	99.9
ng	1	1	1	1	-	1	-	1	1	-
sc	-	-	1	-	1	-	1	-	-	6
ex	-	-	-	-	-	-	-	-	-	-
total	1	1	2	1	1	1	1	1	1	6

ng= 9
sc=10
ex= 0
Total=19

Bifbase	1A	3A	5A	6A	16A	16B	16C	18A
ng	3	2	1	1	1	-	1	2
sc	-	-	-	-	-	1	-	2
ex	-	-	-	-	-	-	-	-
total	3	2	1	1	1	1	1	4

Bifbase	18B	18C	19A	19B	20B	21A	22A	23A	99.8	0.0
ng	5	5	2	1	1	1	2	3	5	-
sc	1	2	1	-	-	-	-	-	3	4
ex	-	-	1	-	-	-	-	-	-	-
total	6	7	4	1	1	1	2	3	8	4

ng=[illegible]
sc=14
ex= 1
Total=51

Biftip	1.11	1.2	1.3
ng	1	-	3
sc	-	1	-
ex	-	-	-
total	1	1	3

Biftip	1.4	1.6	2.4	2.5	3.0	4.0	99.9
ng	2	1	-	2	-	3	1
sc	-	-	3	-	1	-	-
ex	-	-	-	-	-	-	-
total	2	1	3	2	1	3	1

ng=13
sc= 5
ex= 0
Total=18

Uniface	2.2	4.0	7.2	7.3	9.0	10.2
ng	1	2	1	1	2	1
sc	-	-	1	1	-	-
ex	-	-	-	-	-	1
total	1	2	2	2	2	2

Uniface	13.4	13.5	13.6	14.2	14.3	16.1	16.3	18.0
ng	-	1	3	1	7	-	1	-
sc	2	-	-	2	1	1	-	3
ex	-	-	-	-	-	-	-	-
total	2	1	3	3	8	1	1	3

ng=21
sc=11
ex= 1
Total=33

Cores	1	2	6	7
ng	2	2	2	4
sc	1	2	1	1
ex	-	-	-	-
total	3	4	3	5

ng=10
sc= 5
ex= 0
Total=13

	Biface midsections	Amorph. bifaces
ng	2	2
sc	2	3
ex	-	-
total	4	5

ng= 4
sc= 5
ex= 0

Total= 9

Locus I Artifact Complex

Proj. pt.	2	11	12	19
ng	-	1	1	1
sc	1	-	-	1
ex	-	-	-	-
total	1	1	1	2

ng= 3
sc= 2
ex= 0
Total= 5

Bifcomp.	3B	5A	6A	7C	13A	16B	0.0
ng	1	-	2	-	1	-	3
sc	-	1	1	1	-	1	-
ex	-	-	-	-	-	-	1
total	1	1	3	1	1	1	4

ng= 7
sc= 4
ex= 1
Total=12

Bifbase	1A	2A	3A	5A	8A
ng	3	-	3	1	-
sc	1	1	-	-	2
ex	-	-	-	-	-
total	4	1	3	1	2

Bifbase	18A	18C	19A	22A	22B	25A	99.6	0.0
ng	1	-	5	-	1	-	-	1
sc	-	1	2	1	-	1	1	-
ex	-	-	-	-	-	-	-	2
total	1	1	7	1	1	1	1	3

ng=15
sc=10
ex= 2
Total=27

Biftip	1.11	1.3	1.4
ng	1	-	2
sc	-	2	1
ex	-	-	-
total	1	2	3

Biftip	1.5	1.6	1.7	2.1	2.3	2.4	2.5	4.0
ng	1	1	-	1	1	1	4	-
sc	-	1	-	-	-	-	-	2
ex	-	-	1	-	-	-	-	-
total	1	2	1	1	1	1	4	2

ng=12
sc= 6
ex= 1
Total=19

Uniface	7.2	10.2	11.0	13.3	14.2	16.1	17.0
ng	1	1	-	-	-	-	-
sc	-	-	1	1	2	1	1
ex	1	-	-	-	-	-	-
total	2	1	1	1	2	1	1

ng= 2
sc= 6
ex= 1
Total= 9

Cores	2	7	9
ng	1	1	1
sc	-	-	-
ex	-	1	-
total	1	2	1

ng= 3
sc= 0
ex= 1
Total= 4

	Biface midsections	Amorph. bifaces	
ng	1	1	ng= 2
sc	2	4	sc= 6
ex	1	-	ex= 1
total	4	5	Total= 9

Site 48Br-4966
Non Locus Artifact Assemblage

Proj. pt.	1a	1b	2	3b	6	13	16	18	19
cmp 3 (ex)	-	-	-	-	-	-	-	1	2
cmp 4 (ex)	-	-	-	-	-	-	-	-	-
other ex.	-	-	-	-	-	-	-	-	1
noloc surf.	3	3	1	1	1	1	2	2	3
Total	3	3	1	1	1	1	2	3	6

Total=21

Bifcomp.	1A	1B	2A	2B	3A	3B	4A	4B
cmp3 (ex)	-	-	-	-	-	-	-	-
cmp4 (ex)	-	-	-	-	-	-	-	-
other ex.	1	-	-	-	1	-	-	-
noloc surf.	4	1	3	2	5	3	1	1
Total	5	1	3	2	6	3	1	1

Bifcomp.	5A	7A	7C	8A	8C	9A	11A	15A
cmp3 (ex)	-	-	-	-	-	-	-	-
cmp4 (ex)	-	-	-	-	-	-	-	-
other ex.	-	-	-	-	-	-	-	-
noloc surf.	1	2	1	2	1	1	1	1
Total	1	2	1	2	1	1	1	1

Bifcomp.	16A	16B	16C	17A	18A	18B	19A	19B	99.9	0.0
cmp3 (ex)	-	-	-	1	-	-	-	-	-	-
cmp4 (ex)	-	-	-	-	-	-	-	-	-	-
other ex.	-	-	-	-	-	1	-	-	-	1
noloc surf.	1	1	1	-	3	1	1	2	1	2
Total	1	1	1	1	3	2	1	2	1	3

Total=46

Bifbase	1A	2A	3B	5A	8A
cmp3 (ex)	-	-	-	-	-
cmp4 (ex)	-	-	-	-	-
other ex.	1	-	-	-	-
noloc surf.	3	2	1	5	1
Total	3	2	1	5	1

Bifbase	16A	16B	16C	18A	18B	18C	19A
cmp3 (ex)	-	-	1	1	-	-	1
cmp4 (ex)	-	-	-	-	-	-	-
other ex.	-	-	-	1	-	-	-
noloc surf.	1	3	-	25	8	24	13
Total	1	3	1	27	8	24	14

Bifbase	21A	22A	22B	23A	24A	24B	25A	99.8	0.0
cmp3 (ex)	-	-	-	-	-	-	-	-	-
cmp4 (ex)	-	-	-	-	-	-	-	-	-
other ex.	-	-	-	-	-	-	-	-	-
noloc surf.	3	5	6	3	5	1	5	6	4
Total	3	5	6	3	5	1	5	6	4

Total=130

Biftip	1.1	1.2	1.3	1.4	1.5
cmp3 (ex)	-	1	-	-	-
cmp4 (ex)	-	-	-	-	-
other ex.	-	-	2	-	-
noloc surf.	1	-	4	3	2
Total	1	1	6	3	2

Biftip	1.6	1.7	2.1	2.2	2.3	2.4	2.5	3.0	4.0	6.0
cmp3 (ex)	-	-	-	-	-	-	-	1	-	-
cmp4 (ex)	-	-	-	1	-	-	-	-	-	-
other ex.	1	-	-	-	-	-	-	-	-	1
noloc surf.	3	2	2	3	1	6	10	-	5	1
Total	4	2	2	4	1	6	10	1	5	2

Total=51

Uniface	1.0	2.1	2.2	3.0
cmp3 (ex)	-	-	-	1
cmp4 (ex)	-	-	-	-
other ex.	-	-	1	-
noloc surf.	1	2	4	-
Total	1	2	5	1

Uniface	4.0	5.1	5.3	5.4	5.5	5.6	7.1
cmp3 (ex)	-	-	-	-	-	-	-
cmp4 (ex)	-	-	-	-	-	-	-
other ex	-	1	-	-	-	-	-
noloc surf.	5	-	1	1	1	2	2
Total	5	1	1	1	1	2	2

Uniface	7.2	7.3	8.1	8.2	10.2	12.2	13.1
cmp3 (ex)	1	-	-	1	-	-	-
cmp4 (ex)	-	-	-	-	-	-	-
other ex.	-	-	-	-	-	-	-
noloc surf.	3	1	1	-	2	2	2
Total	4	1	1	1	2	2	2

Uniface	13.4	13.5	14.1	14.2	14.3	16.1	16.3	17.0
cmp3 (ex)	-	-	-	1	4	-	-	-
cmp4 (ex)	-	1	-	-	1	-	-	-
other ex.	-	-	-	1	-	-	-	-
noloc surf.	2	4	1	2	5	1	1	3
Total	2	5	1	4	10	1	1	3

Total=62

Cores	1	2	3	4	5	7	9
cmp3 (ex)	-	1	-	-	-	3	-
cmp4 (ex)	-	-	-	-	-	-	-
other ex.	-	-	-	-	-	1	-
noloc surf.	2	10	5	3	1	12	1
Total	2	11	5	3	1	16	1

Total=39

	Amorph. bifaces	Biface midsections
cmp3	-	-
cmp4	-	-
other ex.	-	-
noloc surf.	1	18
Total	1	18

Site 4-SBr-4963 Non Grid Artifact Complex

Proj. pts.	1a	1b	2	5	9	14	16	18	19
ng	4	-	2	1	-	-	2	1	1
sc	1	2	-	-	1	1	1	-	-
ex	-	-	-	-	-	-	-	-	-
total	5	2	2	1	1	1	3	1	1

Total ng=11
sc= 6
ex= 0
Grand Total 17

Bifcomp.	4B	7B	7C	8A	8B	12A	16A	99.9	0.0
ng	-	2	1	1	1	-	1	1	1
sc	1	-	1	-	-	1	-	-	1
ex	-	-	-	-	-	-	-	-	-
total	1	2	2	1	1	1	1	1	2

Total ng=8
sc=4
ex=0
Grand Total=12

Bifbase	1A	3A	5A	5B	6A	6B	16A	18A
ng	3	-	1	1	1	2	1	3
sc	3	1	-	-	2	-	-	3
ex	-	-	-	-	-	-	-	-
total	6	1	1	1	3	2	1	6

Bifbase	18B	18C	19A	21A	22A	23A	24B	0.0
ng	-	1	3	-	1	2	1	2
sc	1	-	4	1	-	1	-	1
ex	-	-	1	-	-	-	-	-
total	1	1	8	1	1	3	1	3

ng=22
sc=17
ex= 1
Total=40

Biftips	1.1	1.11	1.2
ng	-	4	1
sc	1	-	1
ex	-	-	-
total	1	4	2

Biftips	1.3	1.5	1.6	1.7	2.2	2.5	3.0	4.0	5.0	9.9
ng	3	2	3	-	1	-	1	-	-	1
sc	4	1	-	1	-	2	-	2	1	2
ex	-	-	-	-	-	-	-	-	-	-
total	7	3	3	1	1	2	1	2	1	3

ng=16
sc=15
ex= 0
Total=31

Unifaces	2.1	4.0
ng	1	1
sc	1	-
ex	-	-
total	2	1

Unifaces	5.2	5.4	6.0	7.1	10.2	12.2	13.3	13.4
ng	1	1	1	1	-	-	-	-
sc	-	-	-	-	1	1	1	3
ex	-	-	-	-	-	-	-	-
total	1	1	1	1	1	1	1	3

Unifaces	13.5	13.6	14.2	14.3	16.1	16.3	17.0	18.0
ng	1	2	1	1	-	-	1	-
sc	-	-	6	4	1	1	-	1
ex	-	-	-	-	-	-	-	-
total	1	2	7	5	1	1	1	1

Total ng=12
sc=20
ex= 0
Grand Total=32

Cores	1	2	3	4	7
ng	1	-	3	1	2
sc	2	2	-	-	1
ex	-	-	-	-	-
total	3	2	3	1	3

Total ng= 7
sc= 5
ex= 0
Grand Total=12

	Amorph. Bifaces	Biface Midsections
ng	1	4
sc	2	7
ex	-	-
total	3	11

Total ng= 5
sc= 9
ex= 0
Grand Total=14

Site 4-SBr-4965 Artifact Complex

Proj.pts	10	19
ng	1	2
sc	-	4
ex	-	-
total	1	6

Total ng= 3
sc= 4
ex= 0
Grand total= 7

Bifcom	1B
ng	1
sc	-
ex	-
total	1

Total ng= 1
sc= 0
ex= 0
Grand total= 1

Bifbase	1A	5A	8A	18C	19A	25A	0.0
ng	1	-	2	-	1	-	-
sc	-	2	1	4	1	1	1
ex	-	-	-	-	-	-	-
total	1	2	3	4	2	1	1

Total ng= 4
sc=10
ex= 0
Grand Total=14

Biftips	1.5	1.6	99.9
ng	1	-	1
sc	-	3	-
ex	-	-	-
total	1	3	1

Total ng= 2
sc= 3
ex= 0
Grand Total= 5

Unifaces	14.2	18.0
ng	-	-
sc	2	1
ex	-	-
total	2	1

Total ng= 0
sc= 3
ex= 0
Grand Total= 3

Cores	2	7
ng	2	2
sc	-	-
ex	-	-
total	2	2

Total ng= 4
sc= 0
ex= 0
Grand Total= 4

	Amorph. Bifaces	Bilface Midsections
ng	1	0
sc	3	1
ex	-	-
total	4	1

Total ng= 1
sc= 4
ex= 0

Grand Total= 5

4-SBr-4967 Artifact Complex
[All artifacts from 4-SBr-4967 are from non grid collection]

Proj. pts	1b	2
number	1	1

Total=2

Bif.Comp.	1A	2A	19A
number	1	1	1

Total=3

Bifbase	5A	21A	24B
number	1	1	1

Total=3

Biftips	2.4
number	1

Total=1

Unifaces	2.2	4.0	9.0	10.2	13.3	14.2	17.0	18.0
number	1	1	1	4	1	3	1	2

Total=14

Cores -- none Total=0

Amorph Bifaces: 1
Biface Midsections: 2

4-SBr-4968 Artifact Complex

Proj. pts.	1a	15	19
ng	2	-	-
scH	2	1	1
scL	-	-	-
total	4	1	1

Total ng= 2
scH= 4
scL= 0
Grand Total= 6

Bifcom.	2A	3A	7A	8C	10A	14A	18B	19A	19B	21A	99.9	0.0
ng	1	-	-	-	-	2	-	1	1	1	-	1
scH	2	1	1	1	1	-	-	1	-	-	1	-
scL	-	-	-	-	-	-	1	-	-	-	-	-
total	3	1	1	1	1	2	1	2	1	1	1	1

Total ng= 7
scH= 8
scL= 1
Grand Total=16

Bifbase	1A	6B	12A	16B	18A	18B	18C	19A
ng	-	-	-	-	1	-	-	-
scH	3	1	-	1	1	1	2	2
scL	-	-	1	-	-	-	1	1
total	3	1	1	1	2	1	3	3

Bifbase	21A	22A	23A	24A	99.9	0.0
ng	-	-	-	-	-	2
scH	1	-	1	1	1	1
scL	-	1	-	-	1	2
total	2	1	1	1	1	3

Total ng= 2
scH=16
scL= 6
Grand Total= 24

Biftips	1.2	1.4	1.6	1.7	2.3	2.4	2.5	5.0	6.0	99.9
ng	-	-	-	-	-	-	-	-	-	-
scH	1	3	1	1	1	-	-	-	1	2
scL	-	-	2	2	-	1	1	1	-	-
total	1	3	3	3	1	1	1	1	1	2

Total ng= 0
scH=10
scL= 7
Grand Total=17

Unifaces	1.0	2.1	2.2	3.0	4.0	5.2	5.3	5.6	6.0
ng	1	3	2	-	-	-	-	-	-
scH	1	-	2	-	-	2	1	1	1
scL	4	1	1	1	1	2	-	-	-
total	6	4	5	1	1	4	1	1	1

Unifaces	7.1	7.2	8.1	9.0	10.1	10.2	11.0	12.1	12.2
ng	1	-	2	-	1	-	-	-	-
scH	2	1	1	-	-	1	-	1	1
scl	-	-	-	1	-	1	2	-	1
total	3	1	3	1	1	2	2	1	2

Unifaces	13.1	13.2	13.4	13.6	14.1	14.2	14.3	15.1
ng	1	-	-	1	-	-	2	1
scH	-	-	2	4	1	6	-	-
scL	-	1	2	1	-	2	4	-
total	1	1	4	6	1	8	6	1

Unifaces	16.1	18.0	19.0	20.0	23.0
ng	-	1	-	-	-
scH	2	-	2	1	-
scL	-	-	-	-	1
ex	-	-	-	-	-
total	2	1	2	1	1

Total ng=16
scH=33
scL=26
Grand Total=75

Cores	1	2	3	4	5	7	8
ng	-	2	1	1	1	2	3
scH	1	6	3	-	1	3	-
scL	2	4	-	-	-	2	-
total	3	12	4	1	2	7	3

Total ng=10
scH=14
scL= 8
Grand Total=32

	Amorph. bifaces	Biface midsections
ng	-	-
scH	-	3
scL	-	2
ex	-	-
total	-	5

4-SBr-4969 Non Locus Artifact Complex

Proj. pts.	3D	19
ng	1	1
sc	-	-
ex	-	-
total	1	1

Total ng= 2
sc= 0
ex= 0
Grand Total= 2

Bifcom.	15A	18B	20A	21A	99.9
ng	-	1	1	-	-
sc	2	-	-	1	1
ex	-	-	-	-	-
total	2	1	1	1	1

Total ng= 2
sc= 4
ex= 0
Grand Total= 6

Bifbase	5A	16B	18A	18B	19A	19B	20B	21A	99.8
ng	1	1	1	-	-	1	-	1	1
sc	-	-	-	1	1	-	1	1	-
ex	-	-	-	-	-	-	-	-	-
total	1	1	1	1	1	1	1	2	1

Total ng= 6
sc= 4
ex= 0
Grand Total=10

Biftips	2.5	3.0
ng	1	2
sc	1	1
ex	-	-
total	2	3

Total ng= 3
sc= 2
ex= 0
Grand Total= 5

Unifaces	2.2	4.0	5.6	7.1
ng	1	1	1	-
sc	-	-	-	1
ex	-	-	-	-
total	1	1	1	1

Unifaces	7.3	13.1	13.4	13.6	14.1	14.2	17.0	18.0
ng	1	1	4	-	2	1	1	2
sc	-	-	1	1	1	1	-	-
ex	-	-	-	-	-	-	-	-
total	1	1	5	1	3	2	1	2

Total ng=15
sc= 5
ex= 0
Grand Total=20

Cores	1	2	3	4	5	6	7	8
ng	1	7	7	3	3	1	6	1
sc	-	6	3	2	2	-	5	2
ex	-	-	-	-	-	-	-	-
total	1	13	10	5	5	1	11	3

Total ng=29
sc=20
ex= 0
Grand Total=49

	Amorph. Biface	Biface Midsections
ng	1	0
sc	0	1
ex	0	0
total	1	1

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Proj pts.	1a	1b	3a	3e	5	7	9	8	17	18	19
ng	-	-	1	2	1	-	-	1	2	1	3
sc	2	1	-	-	-	1	1	-	-	2	-
ex	-	-	-	-	-	-	-	-	-	-	-
total	2	1	1	2	1	1	1	1	2	3	3

Total ng=11
sc= 7
Grand Total=18

Bifcom.	1A	2A	3A	3B	3C	4A	5A	6A	7A	7C
ng	1	3	4	1	1	2	1	2	-	4
sc	-	-	-	-	-	-	-	1	1	1
total	1	3	4	1	1	2	1	3	1	5

Bifcom.	8A	8B	8C	9A	10A	11A	11B	12A	15A	16A
ng	3	1	1	1	1	2	1	3	1	1
sc	-	2	-	-	-	2	-	-	2	1
total	3	3	1	1	1	4	1	3	3	2

Bifcom.	16B	17A	17B	18B	19B	20A	99.9	0.0
ng	2	1	-	1	-	1	5	3
sc	-	1	1	-	1	-	2	1
total	2	2	1	1	1	1	7	4

Total ng=47
sc=16
Grand Total=63

Bifbase	1A	2A	3A	5A	5B	6A
ng	10	3	6	7	2	-
sc	4	-	1	-	-	2
total	14	3	7	7	2	2

Bifbase	8A	8B	16A	16B	18A	18B
ng	1	3	1	1	6	2
sc	1	1	-	1	2	2
total	2	4	1	2	8	4

Bifbase	18C	19A	19B	21A	22A	23A	24A	25A	99.9	0.0
ng	9	16	1	2	3	1	2	1	6	4
sc	2	8	-	-	1	-	-	-	3	4
total	11	24	1	2	4	1	2	1	9	8

Total ng= 87
sc= 32
Grand Total=119

Biftips	1.1	1.11	1.2	1.3	1.4	1.5	1.6
ng	-	-	2	-	2	1	4
sc	1	1	-	5	3	1	-
total	1	1	2	5	5	2	4

Biftips	1.7	2.1	2.3	2.4	2.5	3.0	4.0	6.0	99.9
ng	2	2	3	2	6	2	3	-	2
sc	2	1	-	-	1	1	2	1	1
total	4	3	3	2	7	3	5	1	3

Total ng=31
sc=20
Grand Total=51

Unifaces	1.0	2.1	2.2
ng	1	1	6
sc	-	-	4
total	1	1	10

Unifaces	3.1	3.2	4.0	5.5	5.6	6.0
ng	-	5	3	2	1	1
sc	1	2	1	-	-	-
total	1	7	4	2	1	1

Unifaces	7.1	7.2	7.3	8.1	9.0	10.2	11.0
ng	1	1	5	-	2	3	-
sc	2	2	1	3	-	2	1
total	3	3	6	3	2	5	1

Unifaces	12.1	12.2	13.1	13.2	13.4	13.5	13.6
ng	1	-	1	1	2	3	-
sc	-	1	-	1	1	-	2
total	1	1	1	2	3	3	2

Unifaces	14.1	14.2	14.3	16.1	16.2	17.0	18.0	21.0
ng	1	-	5	-	1	1	1	-
sc	2	9	4	1	1	3	2	1
total	3	9	9	1	2	4	3	1

Total ng=49
sc=47
Grand Total=96

Cores	1	2	4	6	7
ng	4	10	2	1	6
sc	-	4	-	-	2
total	4	14	2	1	8

Total ng=23
sc= 6
Grand Total=29

	Amorph Biface	Biface Midsections
ng	6	18
sc	8	11
total	14	29

Total ng=24
sc=19
Grand Total=43