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On the Nature and Antiquity of the Manix Lake Industry

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THE antiquity of human occupation in the New World undoubtedly is one of the major unresolved culture-historical problems in North American prehistory. On the one hand, a dominant position with a long history in American archaeology (cf. Wilmsen 1965) holds that human beings arrived in the New World at the close of the Pleistocene, no longer than 12,000 years ago, and that Clovis sites represent the oldest occupation in the Americas (Haynes 1970; Martin 1973; Waters 1985). On the other hand, a less widely accepted school of thought sees a variety of evidence for human occupation in the Americas well back into the Pleistocene, with dates ranging from 19,000 B.P. at Meadowcroft Rockshelter, Pennsylvania (Stuckenrath et al. 1984), to 32,000 B.P. at Boquiero do Sitio da Pedra in Brazil (Guidon and Delibrias 1986), and to at least 220,000 B.P. at Calico Hills in the California desert (Bischoff et al. 1981).

Unfortunately, much of the debate between these two positions is characterized by preliminary research reports, hasty examinations of sites, a near absence of published data, and unsystematic and incomplete analyses. This is particularly true when the debate is over claims for early occupation in southern California, a region that has produced more purportedly early material than any other part of North America (cf. Moratto 1984). The purpose of this paper is to present recent data bearing on one of these claims, the Manix Lake Industry (Simpson 1958, 1960, 1964).

THE MANIX LAKE INDUSTRY

Prehistoric Manix Lake existed in what is now the valley of the Mojave River east of Barstow, California (Fig. 1). Although this region is now extremely arid, geomorphic and stratigraphic evidence clearly shows that the river fed a large, permanent lake in the Manix Basin for much of the late Pleistocene (Jefferson 1985). The lake attained a maximum level of approximately 1,780 ft. (543 m.), and drained before ca. 17,000 B.P. (Dorn et al. 1986; Meek 1988). During extensive surface surveys around the ancient shorelines of this basin, particularly the 1,780-foot shoreline, Simpson (1958, 1960, 1964) found a variety of artifacts which she grouped together as the Manix Lake Industry. She assigned these artifacts a late Pleistocene age coincident with the maximum lake stand, thought at the time of her research to date between 12,000 and 25,000 B.P.

The Manix Lake Industry is characterized by large, roughly worked bifaces, as well as by a few simple types of unifacially retouched flakes, hammerstones, "Clactonian" flakes, and discs. Specimens identified as Manix Lake implements principally are found in the eastern Calico Mountains adjacent to the Coyote Lake embayment of the Manix Basin, on desert pavement surfaces composed of volcanics and raw nodules of chert, chalcedony, and jasper. Although Simpson noted that debris from lithic procurement and initial tool production occurred on these sites, she explicitly argued that this debris is distinct from the material she identified as

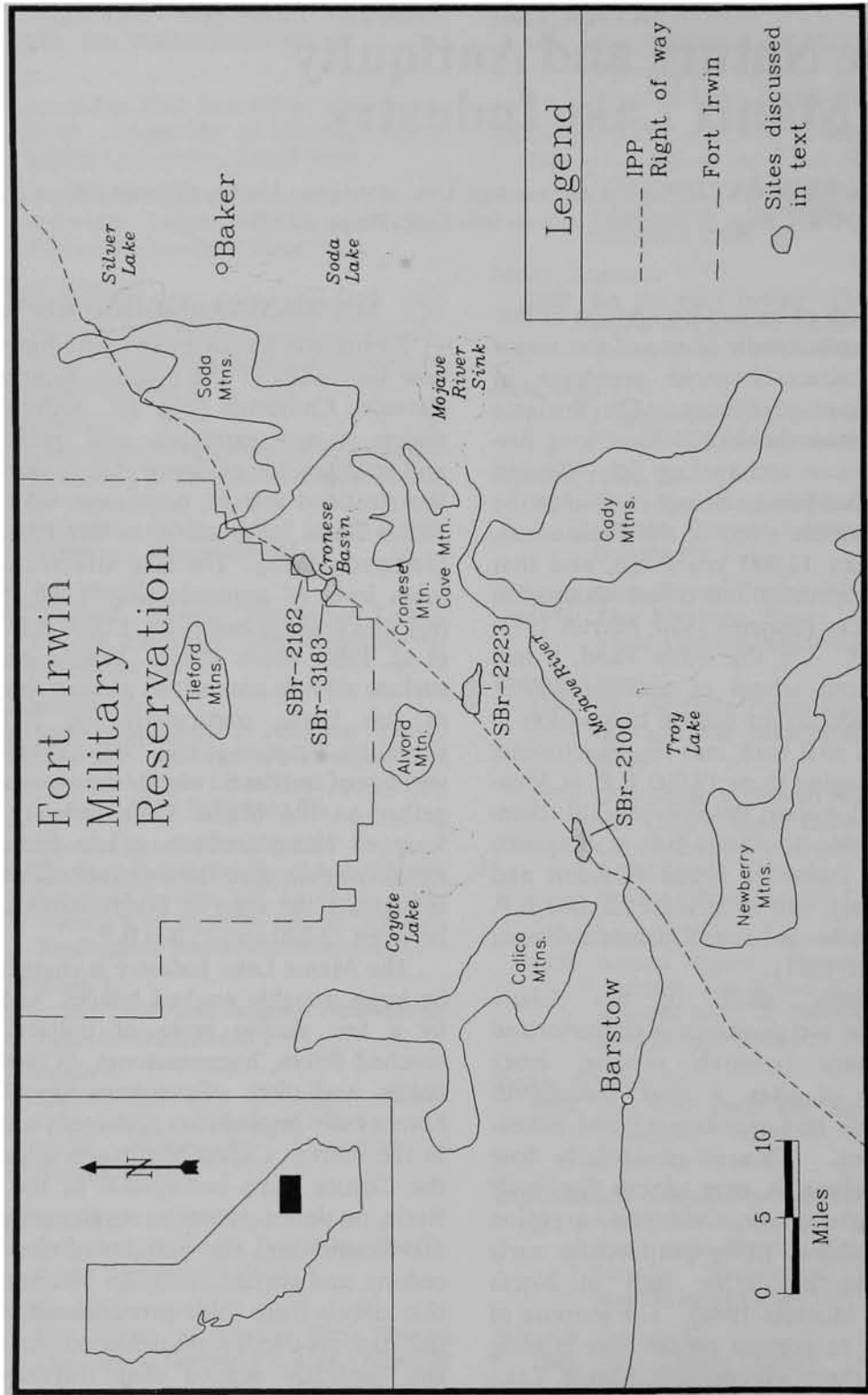


Fig. 1. Map showing the study area within the Mojave Desert.

part of the Manix Lake Industry.

Simpson's discussion of the Manix Lake Industry can be divided into two hypothetical arguments. The first is the argument that Manix Lake implements represent the level of technology extant in North America during the period when they were made, that is, that these implements were deposited around Manix Lake as finished pieces. The second is the argument that these implements represent a late Pleistocene occupation.

The first position is supported principally by the following: (1) the occurrence of the artifacts as isolates rather than in direct association with the abundant manufacturing debris found elsewhere on the sites with them; (2) the degree of refinement of the artifacts identified as Manix Lake implements; and (3) the existence of edge damage interpreted as evidence of use on some of the artifacts.

The second position is supported by the following: (1) the fact that the implements are embedded in desert pavements; (2) the typological crudeness of the implements and their formal similarity to Old World artifacts known to be of Pleistocene age; (3) the lack of projectile points on the sites that produce Manix Lake implements; and (4) the apparent association of Manix Lake implements with the high stand of the lake, which is known to date from the late Pleistocene.

Like other purported pre-Clovis occupations in the New World, the Manix Lake Industry has not been accepted by most archaeologists. Glennan (1976; also see Wallace 1962) provided the most explicit objections to both the dating and the interpretation of the Manix Lake material, arguing that (1) the Manix Lake assemblages are typologically crude because they are quarry and workshop debris rather than formed artifacts; (2) the collecting procedures used in the Manix Lake surveys se-

lected only the most finished artifacts, creating a biased view of the material on the sites surveyed; (3) artifacts typologically identical to those found as isolates and designated ancient are commonly associated directly with their primary reduction debris; (4) embeddedness in a desert pavement is no guarantee of great antiquity; and (5) the Manix Lake artifacts are not associated with the high stand of the lake but with the desert pavements containing the stone from which they were made.

Glennan supported these arguments by an analysis of new collections from the eastern edge of the Calico Mountains. Simpson (1976) found the argument unconvincing.

DATING MANIX LAKE IMPLEMENTS

One of the major problems with assigning a Pleistocene age to the Manix Lake Industry is the complete absence of direct chronological information on Manix Lake implements. As the preceding section discusses, analyses to date have relied entirely on inferential links between surface artifacts whose age is unknown and geomorphic features whose age is known. Recent work using cation-ratio dating, however, provides direct chronometric data on Manix Lake implements. Although a full report on this work is forthcoming (Whitley and Dorn, unpublished data), its chronological results are directly relevant here.

Cation-ratio dating is a new method of dating surface artifacts recovered from arid regions (Dorn 1983; Dorn and Whitley 1984; Dorn et al. 1986; Harrington and Whitney 1987). This method is based on changes over time in the chemical constituents of rock varnish, an accretion on rock surfaces that is composed of clay minerals, oxides of manganese and iron, and minor and trace elements including organic carbon. The minor elements that accumulate in this varnish have different susceptibilities to leaching by

meteoric water. Over time, moisture leaches away certain of these elements (cations) at a faster rate than others.

Thus, there is a progressive change in the ratio of the more mobile cations (e.g., potassium [K] and calcium [Ca]) to more stable cations (e.g., titanium [Ti]) over time.

By itself, a cation ratio (such as $[K+Ca]/Ti$) provides relative dates for varnished surfaces: higher ratios indicate younger ages. However, the ratios can also be calibrated by an absolute chronology. By measuring the cation ratio in varnish on geomorphic surfaces of known age, the age of the surfaces and the cation ratios can then be plotted against one another to construct a least-squares regression, called a cation-leaching curve, which describes the rate at which unstable cations are leached over time. The age of varnish whose antiquity is unknown can then be determined by plotting its cation ratio on this curve, thereby providing a minimum age for the underlying surface. Changes in cation ratios can also be calibrated by extracting the organic content of the lowest (i.e., oldest) levels of the varnish on a surface and obtaining both a radiocarbon date on this material and a cation-ratio reading. Such dates can also be plotted against cation ratios to construct a curve, and are especially useful where no previous dates on geomorphic surfaces are available. Unfortunately, however, there is not enough carbon in varnish on artifacts for even an accelerator radiocarbon date (Dorn et al. 1986).

The cation-leaching curve for the central Mojave Desert (Fig. 2) uses both of these methods and was constructed using cation ratios from youthful potassium-argon-dated basalt flows in the Cima volcanic field, the radiocarbon-dated high stand of Silver Lake (Warren and Ore 1971), and modern aeolian fallout, assigned an age of 100 B.P. based on estimates of the rate of varnish initiation in

the Mojave Desert (Dorn and Whitley 1984). Six radiocarbon analyses were obtained on the organic components of varnish after the curve was constructed, and the additional ^{14}C /cation-ratio calibration points corroborated the initial results.

The curve used to derive the dates employed in later sections of this paper differs slightly from the one depicted in Figure 2, and these dates therefore vary slightly from those reported elsewhere (Bamforth et al. 1986; Dorn et al. 1986). This is because recent tests at the University of Arizona tandem accelerator (Ronald Dorn, unpublished data on file at Arizona State University; Dorn et al. 1987) indicate that ^{14}C dates derived from desert varnish average approximately 10% younger than the age of the underlying varnish surface. This discrepancy apparently results from (1) a slight delay between the exposure of a surface to the varnishing process and the onset of that process; and (2) the fact that even using only organic material from the lowest levels of the varnish for Tandem Accelerator Mass Spectrometry (TAMS) analysis includes material deposited over a period of time after the varnish began to form. To correct for this, the ages derived from the TAMS analyses were increased by 10% and a new calibration curve was derived. The equation for this curve is $Y = 12.21 - 1.90X$, where Y equals the cation ratio and X equals the \log_{10} of the absolute age. Although some past applications of this technique have derived dates with fairly large error margins (i.e., Dorn and Whitley 1983, 1984), the dates for the core/flake sequences discussed here have a mean error margin of 11.0% (median = 8.0%).

Although the details of the method (Dorn 1983; Dorn et al. 1986) and its application here are discussed extensively elsewhere (Bamforth et al. 1986), it is useful to summarize the reasons for accepting the

Years Before Present

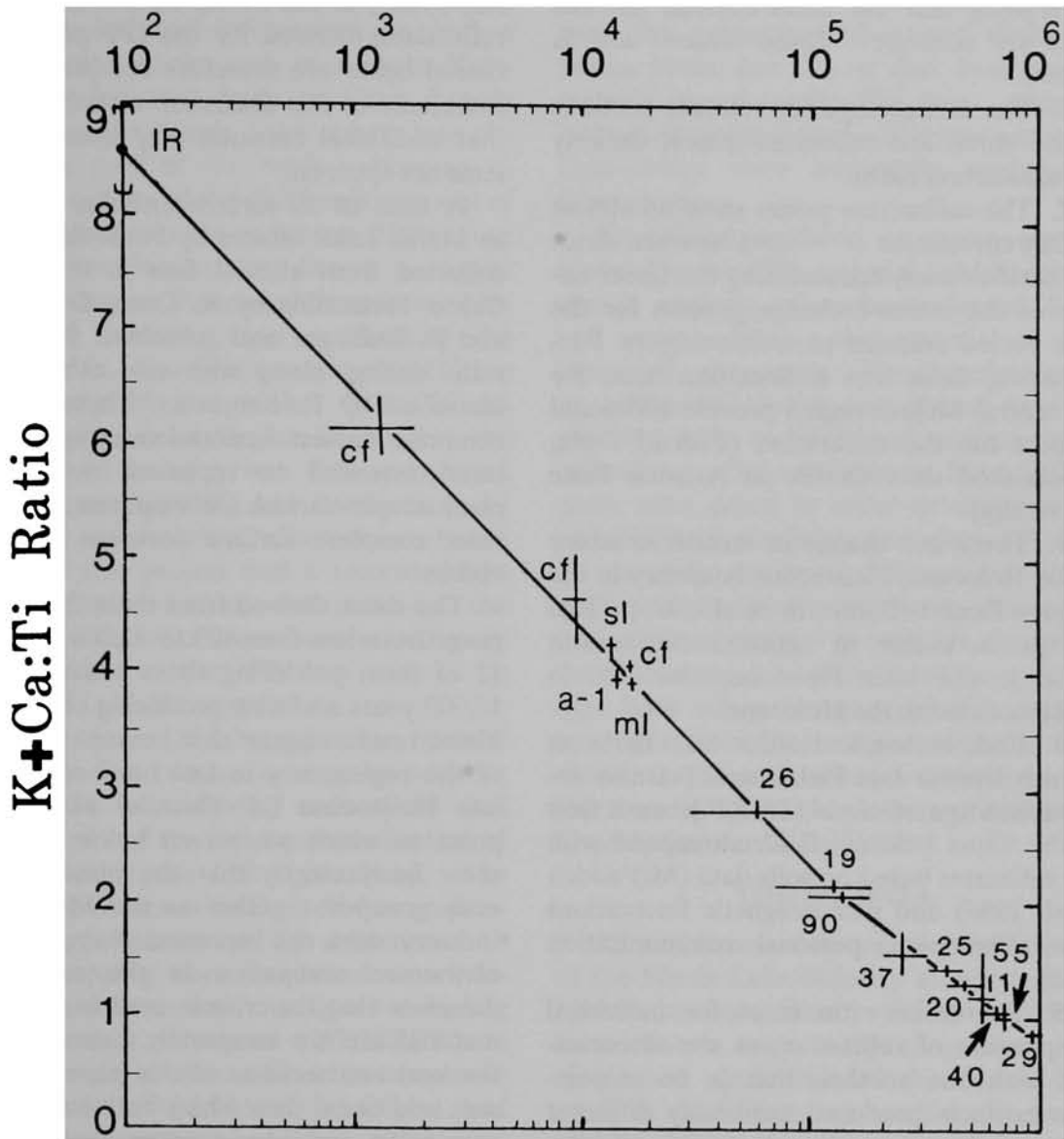


Fig. 2. Initial cation-leaching curve for the east-central Mojave Desert, California. Numbers refer to K-Ar dates and letters refer to TAMS radiocarbon dates listed in Dorn et al. (1987:Table 1). The horizontal bars represent, respectively, two standard deviations of the age-uncertainties and of the mean varnish cation-ratios for each calibration point. The error of the initial varnish ratio is represented as one standard error and is indicated by brackets on the left margin of the graph (see Dorn et al. 1987). The lines represent the first estimates of the semilog least-squares regressions indicating the probable rate of cation leaching in the east-central Mojave Desert (see text for a more recent estimate).

present calibration of the leaching curve constructed for the Mojave Basin and hence for arguing that the dates derived for this study are accurate. These reasons are as follows:

1. The archaeologically relevant portions of the curve are calibrated almost entirely by radiocarbon dates.

2. The calibration points show an almost perfect correlation ($r = -.99$) between dates and cation-ratios, documenting the linear nature of the cation-exchange process for the time period relevant to archaeologists. Furthermore, three new radiocarbon dates for the central Mojave region provide additional support for the calibration (Ronald Dorn, unpublished data on file at Arizona State University).

3. There is a change in varnish structure at the Holocene/Pleistocene boundary in the Mojave Desert (Bamforth et al. 1986). This change is visible in artifacts cation-ratio dated to the later Pleistocene but not in artifacts dated to the Holocene.

4. Radiocarbon and cation-ratio dates on varnish from a late-Pleistocene (varnish radiocarbon age of ca. 14,600 B.P.) basalt flow in the Cima volcanic field correspond with age estimates based on soils data (McFadden et al. 1986) and paleomagnetic fluctuations (D. Champion, personal communication 1986).

5. The cation-ratio dates for individual components of refitted cores are all consistent with one another; that is, no conjoinable artifacts produced noticeably different ages.

There are simply no data currently available to contradict this evidence, although Dorn et al. (1986) noted several theoretically possible complications with the method. The major reason for treating the dates presented here as tentative is the experimental nature of the method, a problem that can be solved only by additional independent veri-

fication, such as that by Harrington and Whitney (1987) in New Mexico and Glazovskiy (1985) in the Soviet Union. The cation-ratio dates derived for the IPP project discussed below are therefore accepted for the remainder of this discussion with the caution that additional research may uncover problems not apparent.

A total of 20 surface artifacts identified as Manix Lake bifaces by F. Budinger were collected from alluvial fans in the eastern Calico Mountains by R. Dorn, D. Whitley, and F. Budinger and submitted for cation-ratio dating, along with one other biface identified by R. Simpson. These artifacts comprise a select, nonrandom sample of material intended to represent a range of macroscopic varnish development, from almost complete surface coverage to barely visible.

The dates derived from these 21 artifacts range from less than 400 to 32,000 B.P., with 12 of them producing dates within the last 10,000 years and nine producing older dates. These results suggest that human occupation of the region may in fact have occurred in late Pleistocene (cf. Dorn et al. 1986), a point to which we return below, but they show fairly clearly that the material presently grouped together as the Manix Lake Industry does not represent a single period of human occupation in the region and therefore that the criteria used to group this material are not temporally meaningful. In the next two sections of this paper, we present additional data which both support this conclusion and also account for those aspects of the distribution of "Manix Lake" material that have been argued to indicate their great age.

THE IPP PROJECT

One of the major problems in evaluating the various interpretations of the Manix Lake Industry is the general absence of

detailed supporting data. Simpson's various discussions offered summaries with little supporting evidence, while Glennan's (1976) discussion included information on only a small portion of the area of interest. However, a substantial body of data directly relevant to the Manix Lake debate was obtained as part of the work performed to mitigate impacts of the California segment of the Intermountain Power Project (IPP). Four quarry sites located on desert pavement quarries between Baker and Barstow were investigated, including two overlooking the Manix Basin. One of these, CA-SBr-2100, is immediately adjacent to the Calico Mountains and is one of the localities where the Manix Lake Industry was first recognized. Bamforth et al. (1986) and Bamforth (n.d.) presented a complete discussion of the results of this project and a reconstruction of prehistoric human activities on the project sites; our concern here is with only those aspects of the IPP data relevant to the Manix Lake Industry debate.

Three aspects of this project are relevant here. The first two are a mapping program covering the full extent of each of the sites investigated and the subsequent collection of artifacts within the IPP right-of-way. The third is the information derived from cation-ratio dating of portions of this collection.

The mapping work was based on a two-dimensional systematic, unaligned sampling procedure (e.g., Cochran 1977:277-278) in which one unit 40 m. in diameter was placed within each 200-yd. block in a grid laid down over each site, providing a 3.76% sample of the area investigated. All cultural material within each sample unit was mapped. This sampling procedure was used on three of the four quarries studied for the project: CA-SBr-2100, CA-SBr-2223, and half of CA-SBr-3183. The fourth site (CA-SBr-2162) and the other half of CA-SBr-3183 were surveyed completely, but the data from

these areas were not used due to possible bias introduced by the use of different field methods. The major foci of our attention were the generally well-defined clusters of flakes, cores, and bifaces that dominate the material found on the IPP sites. Although isolates were recorded, collections within the right-of-way were essentially confined to these clusters.

Traditional methods of dating are not useful for the IPP material, which consists almost entirely of surface-collected flakes and cores. Nor is this material in itself temporally diagnostic. We therefore relied on cation-ratio dating (see above) to obtain absolute dates on individual artifacts in the collection. Only specimens from refitted cores were dated in order to eliminate the possibility of obtaining extremely old dates on naturally produced flakes. All of the artifact clusters collected during the project were refitted insofar as possible, and dates were obtained for all refits whose constituents bore adequate amounts of varnish; a total of 167 artifacts from 66 refits were dated. These dates were summarized in Dorn et al. (1986) and were discussed in detail in Bamforth et al. (1986).

THE IPP DATA

As was discussed above, the identification of the Manix Lake Industry as evidence of a Pleistocene occupation in the Mojave Desert rests on two major supporting ideas: the typological similarities of the Manix Lake artifacts to Pleistocene artifacts from the Old World and the occurrence of those artifacts as isolates embedded in desert pavements around the high stand of Pleistocene Lake Manix. We have presented data above which indicate that technologically crude bifaces are not temporally diagnostic in the Manix Lake region, a point which is true for all of North America (cf. Stanford 1982:205).

The material collected and dated for the

IPP project, mainly cores and unmodified flakes, generally is not typologically part of the Manix Lake Industry, although many of the artifacts located during the site-mapping phase of the project might be classified as belonging to it. The remainder of this section therefore examines the second supporting idea just noted, the embeddedness and isolation of the Manix Lake implements and their association with the shoreline of the maximum stand.

Embeddedness in Desert Pavement

The material collected during the IPP project was embedded to various depths in the desert pavement. The depth of embedding (or artifact burial) was recorded for the artifacts in most of the clusters collected. This information unfortunately cannot be linked to individual artifacts because of time constraints in the field, but it can be evaluated on a cluster-by-cluster basis. Artifact burial data are available for 36 of 49 clusters that produced dated, refitted cores. Degree of burial was assessed in five categories: surface, 1% to 25% of the artifact buried, 26% to 50% buried, 51% to 75% buried, and greater than 75% buried.

Visual inspection of the frequency distributions of the degree of burial of the flakes within the 36 clusters showed that they fall generally into four groups, or classes. Representative examples of these four classes are presented in Figure 3. Class 1 is comprised of those clusters with most of the artifacts on the surface and rapidly diminishing frequencies of artifacts more deeply buried. Clusters with most artifacts buried from 1% to 25% are in Class 2. Class 3 includes clusters with artifact frequencies increasing from the surface to greater than 25 percent burial. Class 4 is a miscellaneous group whose members all have a high proportion of artifacts buried more than 50 percent. If artifacts tend to become embedded in the

surface over time, we should tend to see older dates associated with clusters more deeply buried. Class 1 clusters, with the highest proportion of surface artifacts, should therefore tend to be youngest, and Class 4 clusters, with the highest proportion of deeply buried artifacts, should be oldest.

Table 1 presents the mean ages of dated artifacts from clusters in each of these four classes, along with the maximum and minimum ages obtained for any cluster. (These maximum and minimum figures refer to the oldest and youngest ages obtained from individual refitted cores within each class, and not to the errors associated with the dates on any single refit.) It is obvious that there is no particular relationship between the four classes of clusters and the mean age of refitted artifacts from them.

Other aspects of the data suggest that the major factors controlling the degree of burial of artifacts in a cluster are the degree of slope and nature of the surface on which the artifacts were deposited. Table 2 shows the frequencies of the four classes of clusters for these two variables. Slope was evaluated in the field and dichotomized into level/gentle and moderate/steep. Surface type was also evaluated in the field and was divided into armored pavement, semi-armored pavement, and nonpavement. The sample of clusters is too small in many of the categories for detailed analysis, but it is clear that the overall tendency is for more deeply buried clusters to be found on steeper slopes and more loosely compacted surfaces. Slopewash (Sharon 1962), pavement redistribution processes caused by upthrust (Springer 1958), and the accumulation of desert loess (Mabbutt 1979; McFadden et al. 1986) probably are responsible for this pattern.

Controlling for local depositional conditions should show chronological relationships if they exist. Within each combination of conditions, Simpson's hypothesis implies that

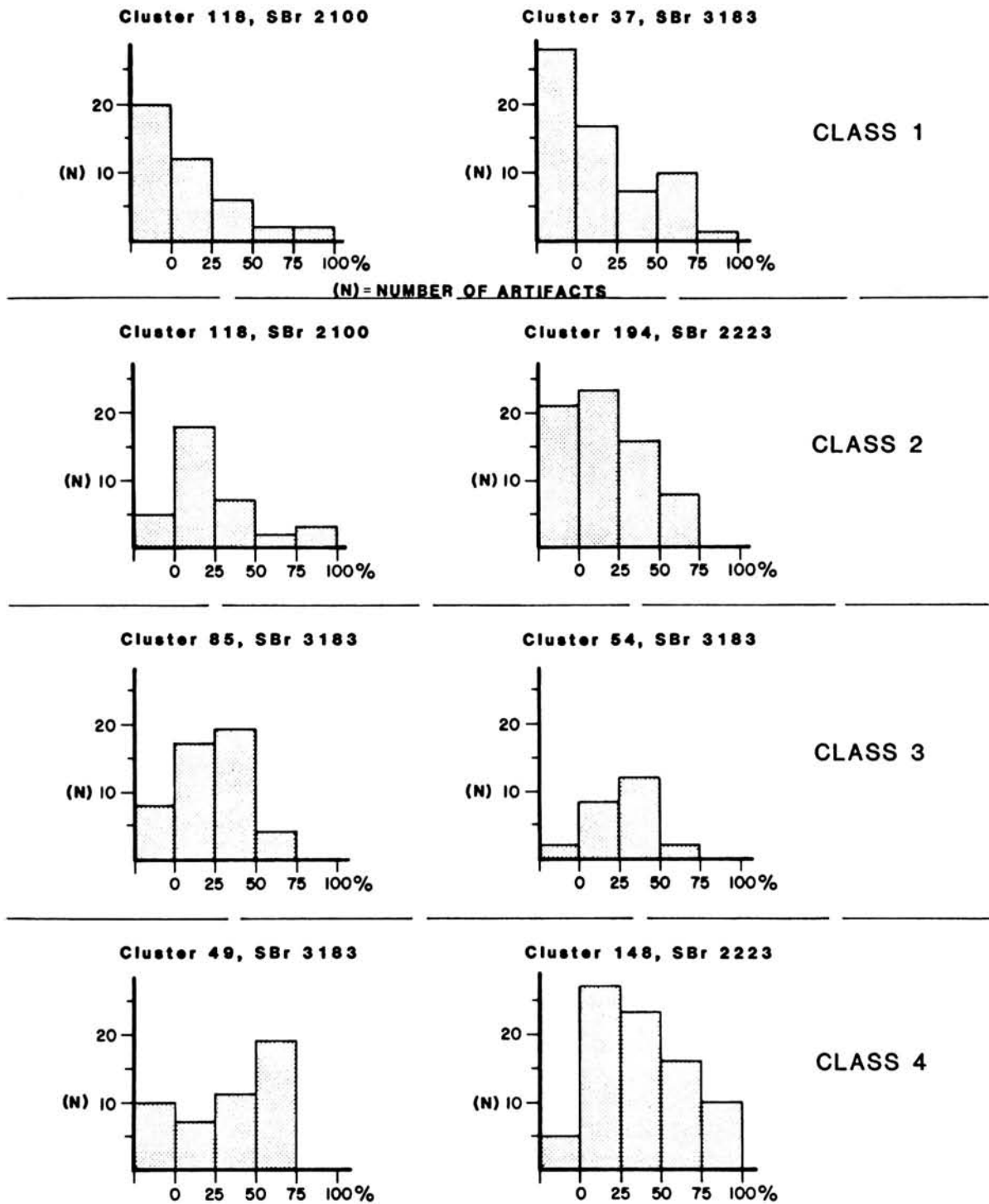


Fig. 3. Examples of artifact clusters on the IPP sites classed by overall degree of embeddedness in the desert pavement, where N equals the number of artifacts.

Table 1
MEAN AGES IN YEARS B.P. OF ARTIFACTS
BY DEPTH OF EMBEDDING

| Depth Class ^a | N | Mean Age | Maximum Age | Minimum Age |
|--------------------------|----|----------|-------------|-------------|
| 1 | 10 | 4,321 | 11,815 | 492 |
| 2 | 17 | 1,612 | 8,756 | 298 |
| 3 | 8 | 5,592 | 21,643 | 375 |
| 4 | 15 | 3,964 | 18,445 | 565 |

^a Class 1: most artifacts on the surface; Class 2: 1% to 25% burial of most artifacts; Class 3: 25% to 50% burial of most artifacts; Class 4: 50% or greater burial of most artifacts.

Table 2
FREQUENCY OF COLLECTED CLUSTERS BY DEPTH OF EMBEDDING
AND LOCAL DEPOSITIONAL CONDITIONS

| Depth Class ^a | Local Depositional Conditions | | | | Total |
|--------------------------|-------------------------------|-------------------|--------------------|-------------|-----------|
| | Armored | Semi-armored Flat | Semi-armored Slope | Nonpavement | |
| 1 | 1 | 3 | 1 | 1 | 6 |
| 2 | 2 | 10 | 0 | 2 | 14 |
| 3 | 0 | 3 | 3 | 2 | 8 |
| 4 | 0 | 1 | 3 | 4 | 8 |
| Total | 3 | 17 | 7 | 9 | 36 |

^a Class 1: most artifacts on the surface; Class 2: 1% to 25% burial of most artifacts; Class 3: 25% to 50% burial of most artifacts; Class 4: 50% or greater burial of most artifacts.

Table 3
MEAN AGES IN YEARS B.P. OF DATED ARTIFACTS
BY DEPTH OF EMBEDDING AND LOCAL DEPOSITIONAL CONDITIONS

| Depth Class ^a | Local Depositional Conditions | | | |
|--------------------------|-------------------------------|-------------------|--------------------|-------------|
| | Armored | Semi-armored Flat | Semi-armored Slope | Nonpavement |
| 1 | 6,259 | 3,686 | 2,810 | 808 |
| 2 | 1,625 | 1,278 | — | 3,985 |
| 3 | — | 8,298 | 585 | 8,530 |
| 4 | — | 1,694 | 3,989 | 3,645 |

^a Class 1: most artifacts on the surface; Class 2: 1% to 25% burial of most artifacts; Class 3: 25% to 50% burial of most artifacts; Class 4: 50% or greater burial of most artifacts.

the four classes of clusters should show increasing age. As shown in Table 2, there is no apparent relationship between depth class (or degree of embeddness) and depositional conditions. The cation-ratio dates cannot be taken as direct estimates of the age of the entire cluster from which they

came because several clusters have produced as many as four dated refits separated by several thousand years. However, if there is a strong relationship between age and artifact burial, at least a general association between the classes of clusters defined here and increasing age should be apparent. No

such association is evident in Table 3. Furthermore, even the Class 4 clusters (those with the highest proportion of deeply buried artifacts) are commonly associated with Holocene dates.

The IPP data thus indicate that local depositional conditions and not age are the major factors conditioning the degree to which artifacts are incorporated into the desert pavements at the sites investigated: even relatively deeply embedded artifacts can be of Holocene age. Embeddedness in a desert pavement therefore does not provide a reliable basis for drawing chronological inferences (cf. Glennan 1976).

Distribution of Isolates

Simpson (1960) repeatedly has asserted that some of the best evidence for the hypothesis that the Manix Lake artifacts indicate habitation areas rather than quarry activity is that they are not associated with nearby workshops. However, none of the participants in the Manix Lake debate has ever reported the full distribution of isolates. During the IPP project, many isolates were recorded and mapped. These data suggest that the significance of the distribution of isolates on desert pavement sites cannot be evaluated unless post-depositional processes are taken into account. Given that discrete clusters of primary production debris are the dominant type of remains found on such sites, it is particularly critical to consider what happens to such clusters when they are exposed on the surface for extended periods of time.

Experimental research by Bowers et al. (1983) indicates that surface clusters of flakes tend to disperse over time as the cumulative result of small, random movements of the individual artifacts they contain. Clusters on the IPP sites typically contain from 10 to 200 artifacts dispersed over areas of 5-15 m.² The experimental

results of Bowers et al. (1983) indicate clearly that clusters of this size and density could readily disperse to the point where they would be unrecognizable within a few thousand years, even given a very conservative rate of artifact movement.

Larger objects, such as cores and bifaces, should move more readily on steeper slopes than on more gentle ones, while smaller objects such as unmodified flakes should move relatively easily on all slopes (cf. Carson and Kirkby 1972). If the isolates on the IPP sites are the remnants of dispersed clusters, then intact clusters, isolated cores and bifaces, and isolated flakes should show distinct distributions. Clusters should show the most restricted distribution, being largely confined to the intact pavements towards the centers of the sites. Isolated cores and bifaces should be more dispersed across the site areas, and isolated flakes should be the most dispersed of all. This prediction was tested for the three IPP sites on which sample units were placed: CA-SBr-2100, CA-SBr-2223, and CA-SBr-3183. The last of these three sites is on flatter terrain than the other two, and the distributions of clusters, cores and bifaces, and flakes on it should be more alike than on the other two, which show a considerable degree of topographic relief.

The data support these predictions. The degree of artifact and cluster dispersion on CA-SBr-2100, CA-SBr-2223, and CA-SBr-3183 can be assessed quantitatively, but the nature of the available data affects the methods that can be used for such an assessment. A simple way of measuring the degree of dispersion of a set of entities (e.g., clusters, cores, bifaces, or flakes) across an area that has been sampled is to compute the ratio of the variance of the number of observations of like items per sample unit to the mean number of observations per sample unit, thus deriving a statis-

tic known as the Coefficient of Dispersion (Greig-Smith 1983:61-62; see Thomas [1975] for an archaeological application). The variance of a uniformly dispersed set of observations will be zero, while the variance of a clumped distribution will be relatively high, and the variance/mean ratio will therefore be lower for uniformly dispersed than for clumped distributions.

However, analyses based on the variance of a nonnormal distribution can be seriously misleading, and this is a particular problem for the data at issue here. The distributions of observations of all classes of material per sample unit are extremely right-skewed (Fig. 4), and such a degree of skew artificially inflates the variance. Furthermore, because the values of observations within classes vary considerably, the degree to which the variance is inflated differs between classes. Comparisons between classes of material using the variance are therefore meaningless in this case.

However, the essential meaning of the Coefficient of Dispersion, although not its strict probabilistic interpretation, can be captured for comparative purposes by using statistics which are more resistant to distortion. For this analysis, we can substitute the interquartile distance (Hartwig and Dearing 1979:21) for the variance and the median for the mean and take the ratio of these nonparametric alternatives. Again, this adaptation of the Coefficient of Dispersion is simply a convenient device for comparing the relative degree of dispersion of the different classes of material on the three sites.

Table 4 presents the results of this analysis, which clearly conform to the patterns predicted above. First, the degree of dispersion of clusters is similar to that of cores and bifaces on all three sites, and on the only site where a difference between the two is visible (CA-SBr-2100), the latter are more dispersed than the former. Further-

more, on CA-SBr-2100 and CA-SBr-2223, isolated flakes are dispersed noticeably more than either of the other classes of material. On CA-SBr-3183 all three classes of material show essentially identical degrees of dispersion, indicating that the substantially lower and more continuous slope in the sampled area of this last site has reduced the degree of artifact movement.

These patterns thus conform to the expectations discussed above for the effects of post-depositional dispersion of previously discrete artifact clusters over time. The occurrence of an artifact as an isolate may or may not indicate that it is older than an artifact that occurs in a nearby, well-defined cluster, but the data presented here strongly suggest that it cannot be taken as evidence that such an artifact is of Pleistocene age. The likelihood that isolates on the IPP sites were once part of clusters that have dispersed over time fits well with Glennan's (1976) observation that artifacts typologically identical to isolates also occur as parts of clusters.

Association with the Shoreline

The third major point of contention in the Manix Lake Industry debate discussed here is whether the artifacts included in the industry are associated with the 1,780-ft. shoreline of Manix Lake or with the desert pavement that produced the material from which they are made and that is only coincidentally above that shoreline. The latter position, taken by Glennan (1976), clearly implies that the density of artifacts should be much higher on the pavements than off them, with proximity to the 1,780-ft. shoreline having no effect on this relationship. Conversely, if artifacts are associated with the shoreline, they should be evenly distributed on and off the pavements above the 1,780-ft. level. If isolates are the dispersed remnants of clusters, and the clusters are

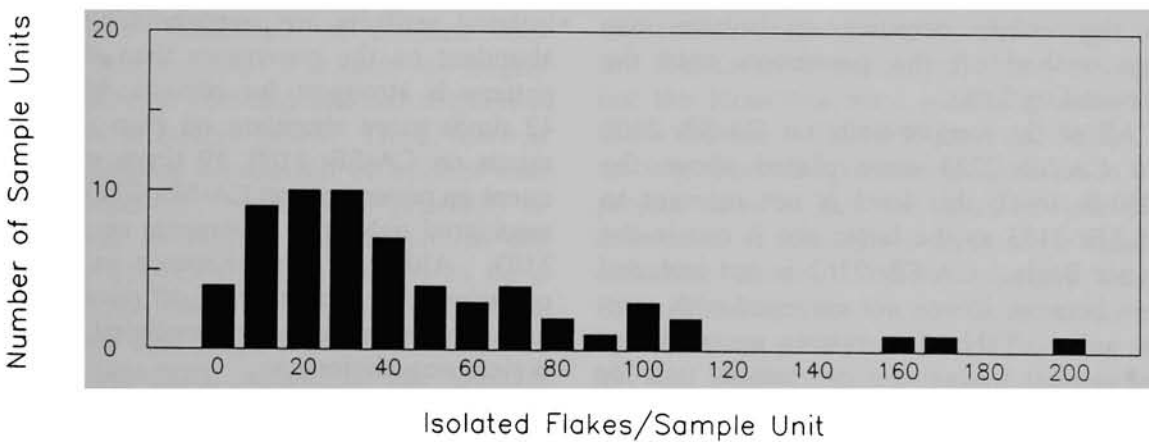
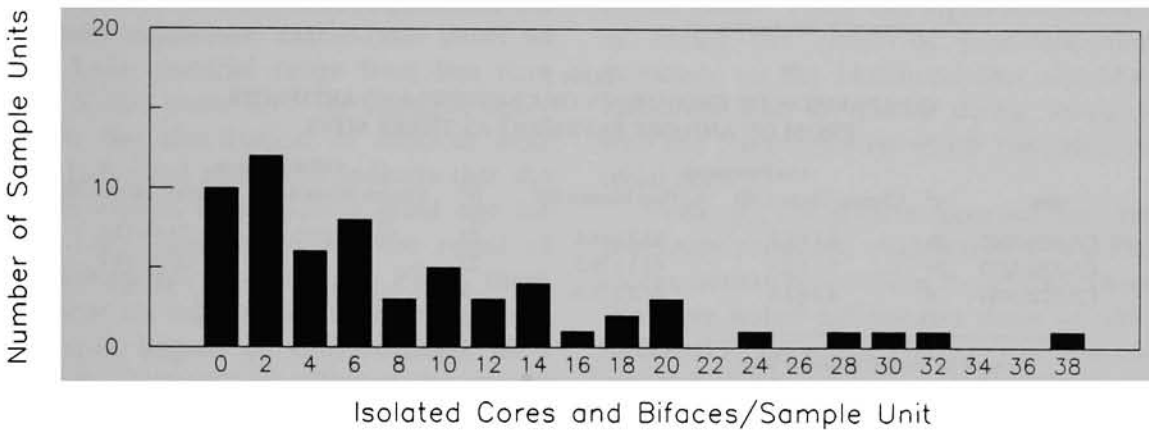
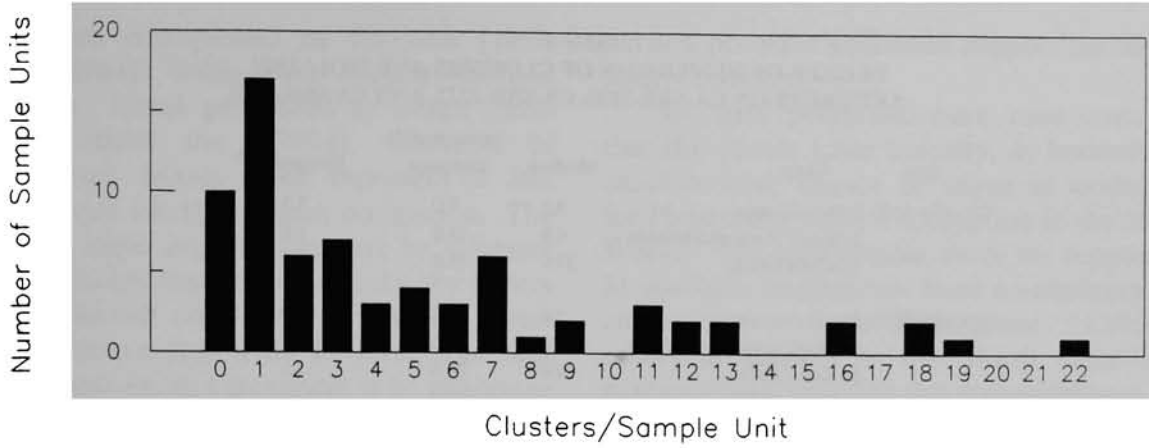


Fig. 4. Frequency distributions of numbers of intact clusters, isolated cores and bifaces, and isolated flakes per sample unit on CA-SBr-2100.

Table 4
DEGREE OF DISPERSION OF CLUSTERS AND ISOLATED
ARTIFACTS ON CA-SBR-2100, CA-SBR-2223, AND CA-SBR-3183

| Site | Class | Median | Interquartile | Dispersion ^a |
|-------------|----------------------------|--------|---------------|-------------------------|
| | | | Distance | |
| CA-SBr-2100 | Intact clusters | 3.0 | 7.0 | 2.3 |
| | Isolated cores and bifaces | 6.0 | 11.0 | 1.8 |
| | Isolated flakes | 37.0 | 45.0 | 1.2 |
| CA-SBr-2223 | Intact clusters | 3.0 | 6.0 | 2.0 |
| | Isolated cores and bifaces | 2.0 | 4.0 | 2.0 |
| | Isolated flakes | 24.0 | 36.0 | 1.1 |
| CA-SBr-3183 | Intact clusters | 2.0 | 4.0 | 2.0 |
| | Isolated cores and bifaces | 2.0 | 4.0 | 2.0 |
| | Isolated flakes | 10.5 | 22.0 | 2.1 |

^a interquartile distance/median

Table 5
COMPARISON OF FREQUENCY OF CLUSTERS AND ARTIFACTS
FROM ON AND OFF PAVEMENT AT THREE SITES

| Site | N ^a | On Pavement | | N ^a | Off Pavement | |
|-------------|----------------|-------------------|--------------------|----------------|-------------------|--------------------|
| | | Cluster Mean ± SD | Artifact Mean ± SD | | Cluster Mean ± SD | Artifact Mean ± SD |
| CA-SBr-2100 | 28 | 8.4 ± 5.7 | 81.7 ± 64.6 | 17 | 0.2 ± 0.5 | 21.4 ± 13.8 |
| CA-SBr-2223 | 24 | 5.9 ± 3.9 | 43.1 ± 39.5 | 22 | 0.3 ± 0.7 | 21.4 ± 24.9 |
| CA-SBr-3183 | 8 | 4.0 ± 2.6 | 24.8 ± 18.3 | 9 | 0.0 ± 0.0 | 3.0 ± 4.9 |

^a N equals the number of sample units.

directly associated with the pavements, the relationship between pavements and cluster densities should be somewhat stronger than for the isolate densities, as isolates may have washed off the pavements onto the surrounding flats.

All of the sample units on CA-SBr-2100 and CA-SBr-2223 were placed above the 1,780-ft. level; this level is not relevant to CA-SBr-3183 as the latter site is not in the Manix Basin. CA-SBr-2162 is not included here because it was not surveyed with sample units. Table 5 compares mean cluster and artifact frequencies per sample unit for units on and off the pavements. Unfortunately, whether or not a unit was on a pavement was not recorded in every instance; the units included in Table 5 are

only those for which this information was clearly indicated. The pattern shown by these data is obvious: both clusters and isolated artifacts are overwhelmingly more abundant on the pavements than off. This pattern is strongest for clusters, which are 42 times more abundant on than off pavements on CA-SBr-2100, 19 times more frequent on pavements on CA-SBr-2223, and are associated only with pavements on CA-SBr-3183. Although the difference in the frequencies of isolates on and off pavements is not as pronounced, as we predicted above, it is clear nonetheless.

SUMMARY AND CONCLUSIONS

Two basic hypotheses can be defined in the debate over the Manix Lake Industry.

The first, championed by Simpson (1958, 1960, 1964), holds that certain isolated artifacts found embedded in desert pavements above the 1,780-ft. shoreline of Pleistocene Manix Lake represent a late Pleistocene lakeside human occupation. The second, most explicitly framed by Glennan (1976), holds that these artifacts are quarry debris found on desert pavements fortuitously above the 1,780 ft. level, and that embeddedness in a pavement is no guarantee of great antiquity.

Cation-ratio dating of supposed Manix Lake implements shows no evidence that the criteria used to identify such implements are temporally significant: cation-ratio dates on Manix Lake material range from less than 400 to 32,000 years B.P. In addition, other data on the distribution of artifacts near Manix Lake and elsewhere indicate that the patterns argued to support a great age for Manix Lake implements are the result of post-depositional processes. First, these data show no relationship between age and the overall degree of embeddedness of a cluster in the pavement. Rather, the overall degree of embeddedness of the clusters seems to be a function of the degree of slope and the development of the pavement on the surface of which they were found. Second, the distribution of artifacts conforms to that expected if isolates are largely the products of post-depositional dispersion of clusters of quarry debris. Third, there is an unambiguous association of isolates with desert pavements regardless of proximity to the 1,780-ft. shoreline. These patterns are found on CA-SBr-2100, purported to be a major Manix Lake Industry site, CA-SBr-2223, which also overlooks the Manix Basin, and CA-SBr-3183, which is not directly associated with any Pleistocene lake. The existence of essentially identical patterns on both a supposed Manix Lake Industry site and on the two sites included here for com-

parison provides additional support for these interpretations.

The data presented here thus indicate that the Manix Lake Industry, as heretofore characterized, cannot be taken as evidence for Pleistocene human occupation in the New World. The cation-ratio dates on supposed Manix Lake implements show no tendency to cluster in the Late Pleistocene. Critical points in support of the Manix Lake hypothesis have included the embeddedness of Manix Lake implements in desert pavements, their occurrence as isolates, and their apparent association with the high stand of Manix Lake. These can all be accounted for as either the result of post-depositional processes or the likelihood that the Manix Lake material is quarry debris associated with the pavements on which raw lithic material occurs.

Ironically, the studies reported here have seemingly produced evidence of a late Pleistocene human presence in the Mojave Desert. We have noted cation-ratio dates as old as 32,000 B.P. on rough bifaces from the eastern Calico Mountains, and the IPP project produced four refitted cores dated by the cation-ratio method from 14,000 to 22,000 B.P. (see Bamforth et al. 1986:101-105; Dorn et al. 1986). However, "Manix Lake" implements (bifaces apparently dating from the Pleistocene) and bifaces dated throughout the Holocene were identified using the same criteria. The IPP material differs in no way from the Holocene material in the project sites: like the rest of the IPP collection, it clearly is early-stage quarry reduction debris. We provisionally accept these dates because, as we discussed earlier, there are no good reasons for rejecting any of the Mojave River Valley cation-ratio dates. We believe that the irony of this situation simply emphasizes the distinction between chronological inferences drawn from direct chronometric information and chrono-

logical inferences drawn without the benefit of such information. We hope that our analysis has demonstrated how cautious archaeologists must be when working in the latter situation.

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