A SEARCH STRATEGY FOR EVIDENCE OF EARLY MAN IN AMERICA: A PRELIMINARY ASSESSMENT OF THE MANIX TYPE SECTION, CENTRAL MOJAVE DESERT, CALIFORNIA

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ABSTRACT

Testing of the hypothesis that the New World may have been occupied by hunters and gatherers prior to Clovis times will require the use of systematic site search strategies which should be based on the geoarchaeological potentials of various types of microdepositional environments to yield artifacts in proper stratigraphic context. Coastal marine terraces and lake basins have significant potential to yield evidence relevant to the early man hypothesis. The geology, geomorphology, stratigraphy, and paleontology of the Pleistocene Lake Manix basin of the central Mojave Desert suggest it has significant geoarchaeological research potential. The interdigitating lacustrine, fluvial, and alluvial sediments of the Manix Formation are sediments of appropriate ages for research pertaining to early New World archaeology. The beds have yielded a rich vertebrate and invertebrate Rancholabrean fauna, elements of which are datable by radiocarbon and uranium series techniques. A layer of tephra provides a laterally extensive time marker. Paleoenvironmental studies suggest that lake edge habitats would have been attractive to early human populations. Examination of the Manix sediments resulted in the discovery of a chalcedony artifact with a prominent bulb of force, force rays, and compression rings on its ventral surface. Its dorsal surface exhibits evidence of a hinge flake removal, a step termination, and localized unifacial edge flaking. The artifact was discovered *in situ* in a thin layer of alluvium 5.0 m below a layer of volcanic ash which has been chemically correlated with the Long Canyon ash of the southern Sierra Nevada dated at 185,000 ± 15,000 B.P.

The search for evidence of early human populations in the New World should be undertaken systematically with well-reasoned strategies. Such strategies should serve to constrain the foci of investigation by considering the data requirements of convincing evidence and the relative potential of various geomorphic contexts for satisfying those requirements. In order to be conclusive, an early site must yield either human fossil evidence or indisputable artifacts and/or features. Site stratigraphic context should be unambiguous and datable by at least one, and preferably several, chronometric techniques. Evidence will not be regarded as compelling and conclusive if any of these three major requirements are not met.

Early sites, especially open-air sites, will not be easy to find in the New World. Sediments of an appropriate age and character must be located either as outcrops, in stratigraphic profiles, or as buried landforms by remote sensing. Each candidate location should be carefully evaluated regarding its total geoarchaeological potential. Among the questions which should be asked are: (1) Is the sedimentary context or its contents datable by one or more analytical techniques? (2) Was it deposited under high or low energy conditions and could it yield an unambiguous archaeological record if one is present? (3) Does the sedimentary sequence suggest paleoenvironmental conditions attractive for human occupation? (4) Does the sedimentary context have the potential to yield osteological evidence as well as evidence of material culture? (5) Does the sequence have the potential to yield proxy evidence of various sorts regarding paleoenvironmental conditions? Perhaps the best way to approach the matter of targeting sediments which might have good geoarchaeological potential is though a consideration of basic landscape types and their depositional microenvironments.

The type and amount of deposition which can occur in a particular context is influenced primarily by local topography, effective geomorphic processes, the size and character of the available sediment supply, and the type and amount of local ground cover. Sediments can be deposited either aerially over large surfaces (e.g., tephra layers, lacustrine deposits, and aeolian dune fields), linearly (e.g., coastal and river terraces), or at point sources (e.g., at springs and in caves) (Butzer 1982). Because successive sedimentary units differentially record effective landscape processes, depositional microenvironments can be characterized through the study of sedimentary facies which record specifiable events and processes. Butzer (1982) has characterized ten basic types of microdepositional environments: spring, karst, cave, seacost, floodplain, fluvial delta, aeolian, slope, volcanic, and lakeshore/marsh. By assessing the depositional processes and sedimentary products of each it should be possible to assess relative geoarchaeological potentials.

Springs often provide attractive habitats for hunting, gathering, and settlement. Spring deposits can effectively seal and preserve archaeological evidence, including fossil evidence of man himself. However, the point source character of springs makes the targeting of their location on Pleistocene landscapes very difficult.

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Karst topographies in limestone and dolomite can be weathered into cavities which may serve as natural traps for bone and artifacts. Rarely, however, were such contexts conducive to habitation. Like springs, the entrances to karst cavities are idiosyncratic in their location and, therefore, difficult to target on Pleistocene landscapes. Caves and rock shelters were sometimes suitable for human habitation. Many caves, however, are relatively young. Old caves, more likely than not, have been flushed and early sediments partially or completely removed, sometimes more than once (Butzer 1988). Stratigraphic relationships in caves are often complex and difficult to interpret. Like other point source depositional contexts, caves are difficult to target.

The potential of finding unambiguous evidence of early man increases dramatically in linear and aerial depositional environments. Coastal landforms, especially marine terraces, afford excellent environments for human subsistence and settlement. Wave processes and eustatic sea level changes, however, can in some cases cause significant reworking of sediments and artifacts. Nonetheless, coastal terraces can be considered to have excellent potential to yield acceptable early man evidence. Because they occur over long stretches of the present coastline and are readily accessible, marine terraces are probably the largest of the potential landscape target types. Unfortunately, in California many marine terraces have been extensively developed and are unavailable for detailed inspection.

River floodplain terraces may be suitable for subsistence and settlement only on a seasonal basis. Geomorphically such contexts are inherently unstable and periodic pulses of erosion can easily scour out much of an archaeological record. Nonetheless, sealed evidence may be recovered in quiet overbank deposits. Sediments situated on the inside curves of stream meanders have especially significant potential to yield undisturbed cultural evidence. Overall, floodplain terrace can be considered as having moderate to good potential for finding early sites.

Human settlement on deltaic deposits is usually discrete and localized to shorelines and the banks of distributary channels. Deltas are geomorphically active and targeting past habitation foci would be difficult. For these reasons deltas are regarded as having only moderate site targeting potential.

In aeolian dune fields attractive subsistence foci may be found in places where groundwater conditions promote the development of biologically diverse habitats. Deflationary aeolian processes, however, tend to coalesce cultural evidence, producing ambiguous archaeological records. Because of targeting difficulties and stratigraphic complexities aeolian contexts are assessed as having low to moderate potential of yielding acceptable early man evidence.

Depositional processes on hill and mountain foot slopes and in swales, can, in some cases, preserve portions of archaeological sites. However, serious stratigraphic problems can occur when upslope sites are redeposited down onto foot slopes. Serious post-depositional disturbances can result from selective winnowing, transport, and coalescing of assemblages. In cold environments cryoturbative processes on hill slopes can significantly distort stratigraphic relationships through frost heaving.

A variety of different archaeological contexts can be generated by volcanic activity. Sites in the immediate vicinity of an explosive volcanic crater are usually destroyed and hillslope sites nearby are rapidly buried by lava and airborne pyroclastics. Pyroclastic tephra ejected by an eruption can travel great distances and become incorporated into the sedimentary profiles of river terraces, deltas, and lakes. In such contexts, tephra can effectively bury and preserve archaeological records. Because tephra blankets represent particular geologic events they can serve as laterally extensive time horizons. With regard to the search for early man in the New World, volcanic deposits are regarded as having moderate potential.

Pleistocene lakeshore and marsh depositional environments probably have the highest potential to yield unam biguous early man evidence and ancillary paleoenvironmental evidence. Lacustrine settings provide some of the most biologically diverse and productive environments available and would have been attractive foci for human subsistence and settlement. Sedimentary deposition can often provide good preservation of archaeological materials. Acidic marsh deposits, for example, can readily preserve organic materials.

If people were in the Western Hemisphere prior to 12,000 years ago they were probably here in very small numbers. The archaeological visibility of their presence will undoubtedly be minimal at best. It is generally recognized that site frequency deceases exponentially as one goes back through time in the Quaternary. Two large-scale inventories, one in South Africa and one in Spain, document this nicely. Sampson (1985) recorded almost 15,000 surface sites spanning the last 600,000+ years in an exhaustive survey in South Africa. He found 7,200 sites dating within the last 1,500 years, 4,900 sites between 1,500 B.P. and 8,000 B.P., 1,250 sites dating to an interval of about 4,000 at the time of the Pleistocene-Holocene transition, 968 sites for the last 100,000 years of the Pleistocene, and only 517 sites for the previous 500,000+ years. Butzer (1988) reported a similar pattern for identified surface and buried sites in Cantabrian Spain. Per thousand year interval, 25.7 sites were recorded at about 8,000 B.P., 9.5 at 13,500 B.P., 8.8 at 19,500 B.P., 1.4 at 28,000 B.P. and only 0.2 at 75,000 B.P. Such ratios suggest that very early sites in the New World will be rarely encountered. Butzer (1988), in fact, has suggested that compared to the Paleoindian record already documented we could probably expect to find less than a dozen pre-12,000 year old sites (Butzer 1988).

Dramatic population growth in the very late Pleistocene is the principal reason for the substantial increases in site visibility during the latter part of the record. Such growth was facilitated by improved extractive efficiencies supported by technologies which included micro-blades and pressure-flaked projectile points. Earlier populations were probably small and in steady-state equilibria with their local environments.

Butzer (1988) has pointed out that, to some degree, success or failure in the search for early sites will depend on the expectations archaeologists have about the character of such a record. If the New World was populated significantly earlier than 12,000 years ago, it is probable that early migrants brought with them relatively simple technologies derived from middle or lower Paleolithic traditions in Asia. Much of the Asian Paleolithic record has low archaeological visibility. Lithic assemblages tend to be small with few formal tools of limited diversity (Aigner 1981; Aikens and Higuchi 1982; White and O'Connell 1982; Wu and Olson 1985; Chang and Pei 1986; Larichev et al. 1987). Tool types are generalized and usually include choppers, chopping tools, crude bifaces, trihedral picks, and utilized flakes. Prepared core techniques and blade technologies did not appear in Asia until about 21,000 years ago (Aikens and Higuchi 1982). Pressure flaking appeared about 14,000 years ago and microblades shortly thereafter.

Like their Asian predecessors, it is likely that early populations in the New World had relatively simple technologies which were essentially limited to processing activities, as opposed to hunting. Given the probable constraints of such technologies, it is likely that human populations responded to marginal environments in much the same way as lower and middle Paleolithic populations did in the Old World (Butzer 1988). Relatively moist environments with high resource predictability and reliability were undoubtedly favored and arid and semi-arid environments with low resource predictability and reliability were avoided. Because climate patterns are cyclic, human settlement and subsistence patterns would have responded in kind. Large regions of North America were probably not conducive to human habitation for lengthy periods of time during warm dry cycles. Regions which afforded high resource predictability and reliability during cool moist times and deteriorated only moderately during warm dry times were probably exploited more than other types of areas. It is in such regions that archaeologists have the best chance of detecting the possible presence of early man.

Patterns recognized in the spatial and temporal distribution of middle and late Pleistocene archaeological sites in South Africa may be relevant to the search for early man in the New World. Butzer (1988) noted that almost all South African open-air sites dating from approximately 300,000 to 13,000 years ago were tied to former lakes, springs, or flood plains. He further noted, however, that settlement patterns were discontinuous both in space and time. There were repeated intervals of tens of thousands of years during which the interior of South Africa was essentially unutilized and uninhabited except for sporadic hunting forays in some peripheral areas. Evidence of subsistence and settlement was limited to moist climatic periods when water and biotic resources were dependable and predictable. Not all moist periods, however, were accompanied by human settlement.

Warm dry periods diminished plant productivity and this in turn severely impacted herd grazing herbivores. Stores of body fat are significantly reduced in game animals during severe drought and this condition can render them an unsuitable food source. When fat-starved humans eat such super lean meat they crave more and soon begin consuming protein to excess. This pattern has the effect of speeding up the metabolic rate which can produce diarrhea, dehydration, and death in only a week or two (Speth 1987). Because of such factors the actual resource capacity of a drought-prone environment was actually less than a species inventory might suggest.

In order to cope with low yield unpredictable resources unspecialized hunter-gathers sometimes respond with increased mobility in enlarged operational areas (Dyson-Hudson and Smith 1978). Yellen (1976) has documented the response of Kalahari Bushman to poor environmental conditions. In a highly productive environment the radius of their hunting/foraging territory is about 15 km and has an area of about 700 square kilometers. In a poor environment the radius increases to about 75 km and the area to about 17,500 square kilometers. Such a response can be maladaptive because bands get spread so thinly across the landscape that they cannot attain a complete knowledge of the resources of their own operational areas (Yellen 1976). Up-to-date information regarding water, plant, and animal resources is critical to hunter-gatherers. If bands become spread thinly across the landscape in response to deteriorating environmental conditions it becomes increasingly difficult if not impossible to adequately monitor resources and maintain information exchange networks with other bands. Peripheral bands have the additional difficulty of maintaining mate exchange networks necessary to maintain biological viability (Butzer 1988).

The archaeological visibility of early populations will be low and probably a function of paleohabitat persistence. In order to target likely areas it will be necessary to focus on places which afforded both potable water and food resources for long periods of time during much if not all of the late and middle Pleistocene. With regard to lakes, the most attractive to early populations were probably those which had their water levels stabilized by overflow outlets. Lakes which remained fresh even during periods of climatic change would have been particularly attractive. Those fed by allogenic streams bringing water from high mountains outside the immediate area would have offered the best potential for persistent fresh water conditions, especially if they also had hydrologic export of salts through groundwater movement and/or leaching (Smith 1985). Lakes which existed in low slope basins were probably particularly attractive because they were conducive to the development and maintenance of biologically rich marsh habitats. Lakes in high slope basins, on the other hand, were probably not as attractive because changes in the water budget would cause dramatic changes in lake levels, either drowning or drying marsh plants.

It is necessary to determine which geomorphic contexts held persistently fresh water lakes with minimal water level fluctuation despite high frequency climatic changes. Such contexts would have afforded relatively stable and reliable habitats which remained attractive enough for long periods of time that an archaeologically visible record might be generated.

Lake-edge marsh habitats characteristically exhibit significant biological diversity. Floral and faunal resources can be readily exploited with relatively simple technology. In addition to edible plants, fish, water birds (and bird eggs), shellfish, insects, and small animals are available. Terrestrial mammals are drawn to lakes for water and evidently can in some cases be driven into boggy marshes to be mired down.

During Quaternary pluvial periods (times of greater effective moisture than the present) most of the more than 120 closed basins of the American Great Basin held lakes (Smith and Street-Perrott 1983). These lakes responded to climatically-driven hydrologic budget changes. At least 110 of the pluvial lakes have been documented to some degree (Snyder et al. 1964; Smith and Street-Perrott 1983). It is unlikely, however, that all of these were attractive to human populations. The most attractive lakes would have been those which remained fresh and had their water levels stabilized by overflow. Stabilized lake levels are also basic requirements for persistent marsh conditions. Of the 110 documented lakes only 53 spilled via overflow outlets (Snyder et al. 1964) and of that number 17 were closed basin lakes which spilled only during their maximum late Pleistocene stands. These lakes were probably saline for most of their histories (Smith 1985), leaving 36 pluvial lakes as high priority candidate foci for Pleistocene human habitation.

Small volume lakes respond much more rapidly to hydrologic changes than large, deep water lakes. Hence they are more likely to record high frequency climatic variations than large volume lakes. Because of their size, however, small lakes are susceptible to drying and would not have been as reliable as larger lakes as water reservoirs during dry times.

If we eliminate from consideration those lakes not fed by allogenic streams and less than 50 mi^2 the list of candidate lakes drops from 36 to 15. Nine of the 15 are in California, 3 are in Nevada, and 3 straddle the California-Nevada state line. Of those in California, four lakes (Lake Owens, Long Valley, Searles and Panamint) are part of the Owens River drainage system, two are in the Mojave River system, (Lakes Harper and Manix), and one is in the Amargosa River drainage (Lake Tecopa). The remaining two lakes (Lake Truckee and an unnamed lake in Eagle Valley, northwest of Honey Lake) are part of the Lake Lahontan basin.

Of the three Nevada lakes, Lakes Crescent and Ruby are in the northern part of the state while Lake Hot Creek is in the southern part of the state. Lakes Tahoe, White Mountains, and Pahrump straddle the California-Nevada state line.

In almost all of the closed basins of the Great Basin, alluviation which occurred during the Pleistocene to Holocene effectively buried the sealed earlier sediments and with them possible evidence of pre-12,000 B.P. cultures. Only two of the 15 basins, the Lake Manix basin and the Lake Tecopa basin, recently have experienced significant downcutting modern drainages. In each of these cases the lowering of base level initiated significant erosional dissection. The lacustrine, fluviatile, and alluvial sediments of the Manix basin were recently examined and assessed for geoarchaeological potential.

During most of the Pliocene, much of the area which is today the Mojave Desert was a west-sloping upland. Drainage was to the Pacific and continental deposition was primarily in basins aligned approximately east-west. The uplift of the San Gabriel Mountains caused a shift to internal drainage and deposition early in the Pleistocene (Woodburn 1975; Ponti 1985; Meisling and Weldon 1989). In this sense, tectonic events created the ancestral Mojave River drainage basin.

Tectonic displacements along the San Andreas fault zone produced successive gains and losses in mountain mass in the headwaters region of the ancestral Mojave River drainage during early and middle Pleistocene times (Meisling and Weldon 1989). These fluctuations in drainage basin size are reflected broadly in downstream sedimentary records, including those of the Manix basin (Meek 1990).

The Mojave River drainage is a closed hydrologic system. The overall drainage basin has an area of approximately 9,500 km^2. Ninety-five percent of its area lies within the Mojave Desert, where it is one of the largest watersheds. It extends from the northwestern San Bernardino Mountains northeastward into the central portion of San Bernardino County. More specifically, it is located between latitudes 34° north and 35° 30' north and longitudes 115° 30' and 119° west. The Mojave River is the only major stream in the drainage basin and the main source of aquifer recharge. The headwaters region is an area of approximately 560 km^2 in the Transverse Ranges. Under modern conditions the Mojave River terminates at the playas of Soda Lake and Silver Lake over 200 km away from its headwaters region in the San Bernardino Mountains.

Hydrologic studies have, for convenience, divided the overall drainage basin into a headwaters region, the Upper, Middle, and Lower Mojave Valleys, and Harper Lake. (See, for example, Thompson 1929; Kunkle 1962; California Department of Water Resources 1967; Hardt 1971). Except for its headwaters region which accounts for only five percent of the total drainage basin area, the basin is an alluvial plain which slopes gently to the northeast within the Mojave Desert.

During the middle and late Pleistocene, the Manix basin episodically impounded water of the Mojave River, creating various stands of Lake Manix. This lake, the southern-most of the more than 110 "pluvial" lakes in the Great Basin, was climatically sensitive. The Manix formation, a complex stratigraphic sequence of interdigitated lacustrine, fluviatile, and alluvial deposits, has preserved a relatively high-fidelity sedimentary record of paleoclimatic and paleohydrologic changes. Hydrologic responses in the Manix basin were primarily a function of rainfall and snowmelt in the headwaters region of the Mojave River (Meek 1990).

Evidence suggests that a major deep lake occupied the Manix basin during Illinoisan times. This lake may have been stabilized by a spillway on the south rim of Afton Canyon (Meek 1990).

Recent investigations by Meek (1990) indicate that during the late Pleistocene major lake stands occurred in the Manix basin between 31,000 and 29,000 years B.P., 21,000 and 17,500 years B.P., and 14,700 and 13,700 years B.P. The maximum filling of the lake was to an elevation of 543 m and was stabilized by overflow into the Coyote sub-basin. Rapid incision of Afton Canyon and drainage of the lake occurred between 13,800 and 13,000 years B.P. (Meek 1990).

The Lake Manix basin, as defined by Meek (1990:81), has an area of 236 km^2. It consists of three sub-basins, two of which are still topographically intact and one which was breached by rapid fluvial incision and through which the present channel of the Mojave River flows. The Afton sub-basin is the largest with a surface area of approximately 104 km^2 (Meek 1990:81). This sub-basin was rapidly incised sometime between 13,800 and 13,300 B.P. The Coyote sub- basin is the northernmost of the three sub-basins. It is still topographically intact and has a surface area of approximately 100 km^2. The Troy sub-basin to the south is quite small. It has a total surface area of only 32 km^2.

The lowest member of the Manix formation (member A) is a wedge-shaped conglomerate of volcanic and metavolcanic rocks and sand shed under torrential conditions from the Cady Mountains on the southeast side of the basin (Jefferson 1985).

Member B consists of fluvial sands and conglomerates rich in granodoioritic clasts shed from the north, presumably from older alluvial deposits southeast of Alvord Mountain (Byers 1960; Jefferson 1985). These alluvial deposits coalesced with those of member A on the east side of the Manix basin (Jefferson 1968, 1985).

Under positive water budget conditions, the Afton sub-basin impounded the flow of the ancestral Mojave River, forming Lake Manix. As the water level rose, lacustrine sediments of lower member C interdigitated with and prograded over the alluvial deposits of Members A and B (Jefferson 1985). Jefferson (1985) has suggested that the earliest lacustrine sediments were deposited during marine oxygen-isotope stage 8 (279,000 to 244,000 years ago). During the early shallow water phase of this lake stand, lithoid tufa was deposited on the uppermost rocks of members A and B suggesting that near-shore waters were warm and wave-agitated. Well-sorted sands were deposited and subsequently oxidized atop the tufa-encrusted clasts, suggesting beach conditions.

Subsequent xeric conditions during marine oxygen-isotope stage 7 (Jefferson 1985) caused this early stand of Lake Manix to contract. There is no evidence that the lake became saline or was reduced to an ephemeral playa/sabkha. Some of the lacustrine clay layers became slightly oxidized, presumably due to sub-aerial exposure. The lacustrine deposits of lower member C were subsequently overlain by the fluviatile sands and gravels of upper member B. Cross-bedding suggests these latter deposits flowed into the basin from the north.

A second major episode of lacustrine transgression began approximately 190,000 years ago (Jefferson 1985). Again, lithoid tufa and beach sands provide evidence of the early, shallow water phase of the transgression. Jefferson (1985) has dated the thick lacustrine sequence deposited by this major transgression to marine oxygen-isotope stages 6 through 4 (from approximately 188,000 to 58,000 years ago). Three thin oxidized sand layers in the upper portion of the lake sediments are thought by Jefferson (1985) to represent times of sub-aerial exposure during the sub-stages of marine oxygen-isotope stage 5 (128,000 to 72,000 years ago).

The deposition of deltaic sediments by the Mojave River (Member D of the Manix formation) acted to constrain the late Pleistocene lake to the central and eastern portion of the basin (Hagar 1966; Groat 1967).

Lake Manix had three stands which occurred during the very late Pleistocene (Meek 1990). Meek (1990) has dated these at 31, 000 to 29,000 years B.P., 21,000 to 17,500 years B.P., and 14,700 to 13,700 years B.P. Lake Manix drained, apparently catastrophically, sometime between 13,800 and 13,300 years ago (Meek 1990) as a result of the down-cutting of Afton Canyon. As Lake Manix drained, the Lake Mojave basin 25 km to the east filled. The oldest analytical dates from Lake Mojave are 14,500 and 13,000 B.P.

The cutting of Afton Canyon lowered the local base-level by approximately 160 m (Meek 1990). This entrenched the Mojave River close to its present course and initiated the erosional dissection of the Manix formation beds in the vicinity of an entrenched meander (informally known as the "Big Bend"). Members B, C, and D of the Manix formation are fossiliferous. Jefferson (1964, 1985) has named the diverse assemblage of invertebrate and vertebrate fossils the Camp Cady local fauna. Both extinct and non-local extant species are represented. Fossil taxa suggest that the climate and biogeography of the Manix basin during the middle and late Pleistocene was significantly different from what it is today. Invertebrate fossils include four species of ostracodes, nine species of snails, and one species of freshwater mussel. Only one species of fish has been identified in the Manix deposits, the Tui or Mohave chub.

A rich assemblage of avifauna has been recovered. Approximately two-thirds of the extant species today prefer or subsist exclusively on small fish. These include the Arctic loon, eared grebe, western grebe, American white pelican, double-crested cormorant, common merganser, golden eagle, bald eagle, and gull. The great horned owl is the only bird in the Camp Cady fauna which feeds exclusively on small terrestrial mammals. The rest of the extant avifauna feed on aquatic and freshwater invertebrates. They include the tundra swan, Canada goose, green-wing teal, mallard, ruddy duck, and sandpiper. Extinct species include a cormorant, a stork, a flamingo, a small flamingo, and a gull. The habitat requirements, food preferences, and nesting habits of the Manix avifauna suggest that Lake Manix was fresh to only moderately saline and that marsh habitats included sandy beaches and reedy marshes.

The mammals of the Camp Cady local fauna include herbivores, omnivores, and carnivores. Herbivores far outnumber carnivores in a ratio of 63:1. Herbivores include three taxa of ground sloths, two species of horses, one large and one small, mammoth, two species of camels, two species of llamas, pronghorn, bison (identified as *Bison bison antiquus*), and mountain sheep. Carnivores include coyote, dire wolf, mountain lion, and scimitar cat. Omnivorous feeders include black bear and short-faced bear.

During the microstratigraphic analysis of the upper members of the Manix formation a 2.5 cm thick layer of alluvium containing water-rounded clasts of chalcedony and jasper was encountered. One chalcedony specimen, found *in situ*, was identified as being artifactual. This specimen weighs 31.1 grams and measures 44.86 cm by 33.66 cm by 23.05 cm. On its ventral surface are a prominent bulb of force, a small eraillure scar, and hackles or force rays. The dorsal surface exhibits unifacial edge flaking as well as evidence of a previous step termination and a previous hinge termination. The stratigraphic position of this putative artifact 5 m below the 185,000 year Long Canyon ash layer suggest an age of 230,000 to 240,000 B.P.

In conclusion, the Manix basin of southern California's Mojave Desert appears to have high geoarchaeological potential. Stratigraphic analyses have documented a complex history of alluvial, lacustrine, and fluvial deposition. During both the middle and late Pleistocene, the valley was the terminal basin of the Mojave River, a major allogenic stream with headwaters in the San Bernardino Mountains. Lakes were impounded during both Illinoisan and Wisconsin times. Stratigraphic, sedimentological, and paleontological studies all suggest that lake stands were persistent for long periods and that lake-margin habitats would have been attractive to human occupation. Water conditions evidently remained potable during all Pleistocene lake stands. A diverse Rancholabrean fauna has been documented, suggestion a high standing biomass.

Geoarchaeological investigations are continuing with special attention to locating additional artifacts both in the stratigraphic profile and in projected lake-edge areas above the 434 m high stand. In many respects the Bassett Point locality would seem to offer more potential than the Calico site which is located 19.5 km to the west. At Calico the fact that the artifacts have been recovered from moderate to high energy alluvial sediments has retarded their acceptance. Many archaeologists feel alluviation and other types of fluvial activity can create artifact-like "geofacts." The experts in fluvial dynamics and rock breakage tell us otherwise but the myth persists, especially here in America. Admittedly, the Bassett Point artifacts are also in alluvium but it is a relatively low energy distal fan facies which is interdigitated with lake deposits. Some of the objections which have faced Calico will not apply here. Additionally, it is significant that the Manix deposits are becoming well-dated by both radiocarbon and uranium-thorium techniques. The deposits are quite fossiliferous with Rancholabrean fauna and this holds open the possibility of finding early man himself, and/or evidence of his subsistence activities, perhaps through the discovery of butchering marks on mammal bones.

REFERENCES CITED

Aigner, J.S.
1981 *Archaeological Remains in Pleistocene China.* C.H. Beck, Munich.

Aikens, C.M. and T. Higuchi
1982 *Prehistory of Japan.* Academic Press, New York.

Butzer, K.W.
1982 *Archaeology as Human Ecology: Method and Theory for a Contextual Approach.* Cambridge University Press, New York.
1988 A Marginality Model to Explain Major Spatial and Temporal Gaps in the Old and New World Pleistocene Settlement Records. *Geoarchaeology* 3:193-203.

Byers, F.M., Jr.
1960 *Geology of the Alvord Mountain Quadrangle, San Bernardino County, California.* U.S. Geological Survey Bulletin 1089-A.

California Department of Water Resources
1967 *Mojave River Ground-Water Basins Investigations.* California Department of Water Resources Bulletin 84.

Chang, T. and G. Pei
1986 Upper Paleolithic Cultural Traditions in North China. *Advances in World Archaeology* 5:339-364.

Dyson-Hudson, R. and E.A. Smith
1978 Human Territoriality: An Ecological Reassessment. *American Anthropologist* 80:21-41.

Groat, C.G.
1967 *Geology and Hydrology of the Troy Playa Area, San Bernardino County, California.* Unpublished Master's thesis, University of Massachusetts, Amherst.

Hagar, D.J.
1966 *Geomorphology of the Coyote Valley, San Bernardino County, California.* Unpublished Ph.D. dissertation, University of Massachusetts, Amherst.

Hardt, W.F.
1971 *Hydrologic Analysis of the Mojave River Basin, California, Using Electric Analog Model.* U.S. Geological Survey Open-File Report 7208-08.

Jefferson, G.T.
1968 *The Camp Cady Local Fauna from Pleistocene Lake Manix, Mojave Desert.* Unpublished Master's thesis, University of California, Riverside.
1985 Stratigraphy and Geologic History of the Pleistocene Manix Formation, Central Mojave Desert, California. In *Cajon Pass to Manix Lake; Geologic Investigations Along Interstate 15*, compiled by R.E. Reynolds, pp. 157-169. San Bernardino County Museum, Redlands, California.

Kunkel, F.
1962 *Reconnaissance of Ground Water in the Western Part of the Mojave Desert Region, California.* U.S. Geological Survey Hydrological Investigations Atlas HA-31.

Larichev, V., U. Khol'ushkin, and I. Laricheva
1987 Lower and Middle Paleolithic of Northern Asia: Achievements, Problems and Perspectives. *Journal of World Prehistory* 1:103-125.

Meek, N.
1990 *Late Quaternary Geochronology and Geomorphology of the Manix Basin, San Bernardino County, California.* Unpublished Ph.D. dissertation, University of California, Los Angeles.

Meisling, K.E. and R.J. Weldon
1989 Late Cenozoic Tectonics of the Northwestern San Bernardino Mountains, Southern California. *Geological Society of America* 101:106-128.

Ponti, D.J.
1985 The Quaternary Alluvial Sequence of the Antelope Valley, California. *Geological Society of America Special Paper* 203, pp. 79-96.

Sampson, C.G.
1985 Atlas of Stone Age Settlement in the Central and Upper Seacow Valley. *National Museum, Broemfontein Memior* 20:1-116.

Smith, G.I.
1985 Possible Impacts on Early Man of Late Quaternary Lake Fluctuations in the Great Basin. *Woman, Poet, Scientist: Essays in New World Anthropology Honoring Dr. Emma Louise Davis*, compiled and edited by the Great Basin Foundation, pp. 118-125. Ballina Press, Los Altos, California.

Smith, G.I. and F.A. Street-Perrot
1983 Pluvial Lakes of the Western United States. In *Late Quaternary Environments of the United States, Vol. 1: The Late Pleistocene*, edited by H.E. Wright, Jr., pp. 190-214. University of Minnesota Press, Minneapolis.

Snyder, C.T., G. Hardman, and F.Z. Zdenek
1964 Pleistocene Lakes in the Great Basin. U.S. Geological Survey Miscellaneous Geological Investigations Map I-416. Scale 1:1,000,000.

Speth, J.D.
1987 Early Hominid Subsistence Strategies in Seasonal Habitats. *Journal of Archaeological Sciences* 14:13-29.

Thompson, D.G.
1929 *The Mojave Desert Region; A Geographic, Geologic, and Hydrologic Reconnaissance.* U.S. Geological Survey Water-Supply Paper 578.

White, J.P. and J.F. O'Connell
1982 *Prehistory of Australia, New Guinea and Sahul.* Academic Press, Sydney.

Woodburn, M.O.
1975 *Cenozoic Stratigraphy of the Transverse Ranges and Adjacent Areas, Southern California..* Geological Society of America Special Paper 162.

Wu, R. and J.W. Olson, editors
1985 *Paleoanthropology and Paleolithic Archaeology in the People's Republic of China.* Academic Press, New York.

Yellen, J.E.
1976 Settlement Patterns of the !Kung: An Archaeological Perspective. In *Kalihari Hunter-Gathers* edited by R.B. Lee and I. DeVore, pp. 47-72. Harvard University Press, Cambridge, Massachusetts.