

**AN INVENTORY AND EVALUATION OF THE
CAVE RESOURCES TO BE IMPACTED BY THE
NEW MELONES RESERVOIR PROJECT
CALAVERAS AND TOULUMNE COUNTIES,
CALIFORNIA**

ASSEMBLED BY:
J. Michael McEachern
Mark A. Grady

Final Report Submitted to the Sacramento District Office
of the U.S. Army Corps of Engineers
in Compliance with Contract DACW05-77-C00038

Archaeology Research Program
Department of Anthropology
Southern Methodist University
January 1978

Principal Investigator: Mark A. Grady

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ABSTRACT

In April 1977, the Sacramento District Office of the U.S. Army Corps of Engineers contracted with the Archaeology Research Program of Southern Methodist University to implement an evaluation of the cave resources to be impacted by the future New Melones Reservoir. Located in Calaveras and Tuolumne Counties, California, the reservoir is projected to inundate a considerable amount of cavernicolous karst terrain. In addition, numerous caves are known to exist in the adjacent areas to be set aside for recreational and similar purposes.

The field phase, most of which was completed in April and May, first emphasized the study of known caves of archaeological value. The preliminary results of this study were published in June (McEachern and Grady, 1977). The remainder of the field work was directed toward an interdisciplinary inventory and evaluation of the other known caves within the project area. Following the field work, the data were synthesized by a core of research specialists assisted by consultants familiar with particular aspects of speleology. This report represents the results of the study.

In all, 87 caves were investigated. Although evaluations stressed geological, paleontological, taphonomic, biological, archaeological, and historical importance, esthetic values and recreational potential were also considered. Significance was assessed on the basis of National Register of Historic Places and National Registry of Natural Landmarks guidelines. From these data, mitigation recommendations were provided.

Due to the exceedingly valuable nature of the cave resource base, particularly from a biological perspective, it was concluded that adequate mitigation could not be implemented within the time schedule currently being followed for project completion. Thus, it was recommended that actual impoundment in the karst area not occur until such mitigation can be completed—2½ years from the time ameliorative study can be initiated.

PROJECT DEVELOPMENT

As originally envisioned in the proposal, this study was to be an interdisciplinary endeavor emphasizing the evaluation of archaeological, geological, paleontological, and biological resources in the caves to be affected by the reservoir project. It was proposed that a series of specialists in the various disciplines be employed under the direction of an archaeologist to implement this research. These people would be assisted by others with caving backgrounds and research back-up capabilities. However, due to the constrained time frame imposed by the scheduling of the study, only a few specialists were able to spend all of the time in the field specified by the contract and supporting documentation. To compensate for this problem, a number of different individuals with the same expertise were employed to complete the field work as required. These specialists were aided by others competent in cave access logistics. In addition, personnel were employed to coordinate aspects of the research at Southern Methodist University that related to the synthesis of documentary information, assembly of the report, and revision of the draft versions.

A centralized location for implementing the field research was established in Angels Camp, California, some ten miles from the study area. This location served not only as a field residence but also as a coordination center for the field work. The research crews departed from and returned to this point during the field phase of the study.

Prior to the initiation of the field study a set of cave recording forms were developed which emphasized documentation of the attributes required to ascertain significance in terms of the National Register of Historic Places and the National Registry of Natural Landmarks. These forms were used to record every cave investigated by the crew. As per the contract specifications, those caves of known or suspected archaeological importance—thirteen in all—were visited first. In cases where technical aid was required for ascent or descent, those knowledgeable in caving provided the expertise to gain access to the cave interiors. Whenever permission was available, minimal collections were made of the biota and paleontological materials in order to identify the specimens and determine their importance. Other materials generally were not collected. In every case, efforts were made to minimize any disturbance to the cave environment.

The cultural data collected by the field crews (informant data and first-hand observational information) were partially synthesized in the field. They were then transported to Dallas where they were integrated with the available background information and organized for use in the preliminary report (McEachern and Grady, 1977).

Following the completion of the major archaeological phase of the fieldwork, emphasis was shifted to visiting other known caves within the project boundary and to an intensive survey for unrecorded caves in selected localities below the gross pool level. Collections from non-archaeological caves were primarily limited to biological resources, and generally consisted of invertebrate biota and vertebrate remains. In a number of cases, (caves 025 and 054) fossil breccias representing exhumed cave fissure fills were collected to determine the possibility of extracting significant vertebrate faunas from them. In a few instances (caves 009 and 050) matrix samples were collected for further analysis. In all cases collections were limited to materials that could not be examined *in situ*.

During and following the completion of fieldwork, the collections were broken down and mailed or transported to specialists throughout the United States and Canada for identification.

The previously compiled information, field observations, and reports from specialists were synthesized in draft form at Amalgamated Digroes in Austin, Texas. Further synthesis, final editing, typing and duplication of the draft report were done at the Archaeology Research Program facilities in Dallas, Texas. Revisions of the draft were also completed in Dallas, and the final report printed in Albuquerque, New Mexico.

PERSONNEL

The following persons have contributed to the project in some significant fashion:

Mr. Kimball Banks: Research Assistant, background in archaeological research, Southern Methodist University, Dallas, Texas.

Ms. Nancy Boice: Research Assistant, background in archaeological research and caves, Austin, Texas.

Mr. Tom Briggs: Biology Specialist, background in biospeleology in the project area (harvestmen), California State University, San Francisco, California.

Mr. Donald Broussard: Field Assistant, background in archaeological research and caves, Austin, Texas.

Dr. Kenneth Christiansen: Biology Specialist, background in biospeleology (springtails), Grinnell College, Grinnell, Iowa.

Mr. Dave Cowan: Field Assistant, background in caves of the project area, Sacramento, California.

Mr. Billy Davidson: Paleontology Specialist, background in paleontology and caves, Austin, Texas.

Dr. Jonathan Davis: Geology Specialist, background in geology and archaeology of the Sierra Nevada and cave research, Nevada Archaeological Survey, Reno, Nevada.

Dr. William R. Elliott: Biology Specialist, background in biospeleology (mites), Texas Tech University, Lubbock, Texas.

Dr. R. G. Fennah: Biology Specialist (leaf hoppers), British Museum of Natural History, London, England.

Dr. Willis J. Gertsch: Biology Specialist, background in biospeleology (spiders), American Museum of Natural History, New York, New York.

Dr. Mark Grady: Principal Investigator, background in cave archaeology, Southern Methodist University, Dallas, Texas.

Mr. Andrew Grubbs: Field Assistant, background in cave biology, Austin, Texas.

Ms. Carol Heathington: Research Assistant, background in archaeological research, Southern Methodist University, Dallas, Texas.

Mr. Bruce Hanson: Paleontology Specialist, background in paleontology and taphonomy, University of California, Berkeley, California.

Mr. David Lawler: Paleontology Specialist, background in paleontology, University of California, Berkeley, California.

Mr. Michael McEachern: Project Director, background in cave archaeology, Amalgamated Digroes, Austin, Texas.

Mr. Samuel McCloud: Paleontology Specialist, background in paleontology, University of California, Berkeley, California.

Mr. Charles M. Mobley: Research Assistant, background in archaeological research, Southern Methodist University, Dallas, Texas.

Dr. William B. Muchmore: Biology Specialist, background in biospeleology (pseudoscorpions), University of Rochester, Rochester, New York.

Mr. Jens Munthe: Paleontology Specialist, background in paleontology and caves, University of California, Berkeley, California.

Dr. Stuart Peck: Biology Specialist, background in biospeleology (beetles), Carleton University, Ottawa, Ontario, Canada.

Mr. James Reddell: Biology Specialist, background in biospeleology (japygids), Texas Tech University, Lubbock, Texas.

Dr. Barry Roth: Biology Specialist, background in spelean malacology, California Academy of Science, San Francisco, California.

Dr. George A. Schultz: Biology Specialist, background in biospeleology (isopods), Hampden-Sydney College, Hampden-Sydney, Virginia.

Mr. Chester Shaw: Research Assistant, background in archaeological research, Southern Methodist University, Dallas, Texas.

Dr. William A. Shear: Biology Specialist, background in biospeleology (millipedes), Hampden-Sydney College, Hampden-Sydney, Virginia.

Mr. Peter Sprouse: Draftsman, background in caves and cave mapping, Austin, Texas.

Mr. Ralph Squire: Cave Specialist, background in caves of the project area, Head of the New Melones Dam National Speleological Society Task Force, Hughson, California.

Dr. Andrew Weaver: Biology Specialist, background in biospeleology (centipedes), College of Wooster, Wooster, Ohio.

Mr. Steve Winterath: Field Assistant, background in caves of the project area, Sacramento, California.

Dr. Pedro Wygodzinsky: Biology Specialist, background in biospeleology (mites), American Museum of Natural History, New York, New York.

In addition, the survey benefitted from the generous advice of professionals such as Mr. Raymond DeSassure (speleologist), Dr. Richard E. Graham (biologist), Mr. Louis A. Payen (archaeologist), Dr. Ernest L. Lundelius, Jr. (paleontologist), Mr. Arthur B. Busbe III (paleontologist), and Mr. George Fuller (geologist).

Finally, mention should be made of the cavers and friends who volunteered their weekends to make the survey of the rugged Stanislaus canyon possible: Jane Armstrong, Sandy Powers, Jon Mulder, John Thom, Bob Spring, Dan Edler, and Mickey Smith.

THE SOCIETY UPON THE STANISLAUS

*I reside at Table Mountain, and my name is Truthful James;
I am not up to small deceit or any sinful games;
And I'll tell in simple language what I know about the row
That broke up our Society upon the Stanislaw.*

*But first I would remark, that it is not a proper plan
For any scientific gent to whale his fellow-man,
And, if a member don't agree with his peculiar whim
To lay for that same member for to "put a head" on him.*

*Now nothing could be finer or more beautiful to see
Than the first six months' proceedings of that same Society,
Till Brown of Calaveras brought a lot of fossil bones
That he found within a tunnel near the tenement of Jones.*

*Then Brown he read a paper, and he reconstructed there,
From those same bones, an animal that was extremely rare;
And Jones then asked the Chair for a suspension of the rules,
Till he could prove that those same bones was one of his lost mules.*

*Then Brown he smiled a bitter smile, and said he was at fault
It seemed he had been trespassing on Jones' family vault;
He was a most sarcastic man, this quiet Mr. Brown,
And on several occasions he had cleaned out the town.*

*Now I hold it is not decent for a scientific gent
To say another is an ass,—at least, to all intent;
Nor should the individual who happens to be meant
Reply by heaving rocks at him, to any great extent.*

*Then Abner Dean of Angel's raised a point of order, when
A chunk of old red sandstone took him in the abdomen,
And he smiled a kind of sickly smile, and curled up on the floor,
And the subsequent proceedings interested him no more.*

*For, in less time than I write it, every member did engage
In a warfare with the remnants of a palaeozoic age;
And the way they heaved those fossils in their anger was a sin,
Till the skull of an old mammoth caved the head of Thompson in.*

*And this is all I have to say of these improper games,
For I live at Table Mountain, and my name is Truthful James;
And I've told in simple language what I know about the row
That broke up our Society upon the Stanislaw.*

BRET HARTE
1836-1902

METHOD AND TECHNIQUES

CAVE INVENTORY

The cave inventory was based on both extensive and intensive survey of the present project area as well as nearby recreational lands proposed to be acquired. Extensive coverage was directed toward the visitation of all known limestone caves within both the present project boundary and the projected additional lands. The intensive survey was limited to limestone areas located below gross pool level as well as a zone extending 3 m above that level. This phase attempted to locate previously unknown or unrecorded caves which would be adversely affected by the filling of the New Melones Reservoir.

An open ended inventory approach was used for recording cave data. The five page form included 32 major headings which were considered important for determining cave values. As the survey progressed, this form was refined to compensate for previously unrecognized data potential.

The most effective field coverage procedure proved to be the use of crews of three to four cavers with expertise in mapping, biological collecting, and field archaeology to locate and record the caves. Usually biological collections would be made and a survey form would be filled out. If the cave appeared to contain significant scientific resources, additional field trips would be made which included vertebrate paleontological experts, geological specialists, and other relevant personnel.

In some cases caves proved to be difficult or impossible to locate. Despite detailed locational information from an informant, the survey was unable to locate Cave 071 although three field searches were made. Similarly, repeated visits to the area with four different people who had previously been to Cave 049 failed to relocate the entrance with certainty.

SURVEY METHODS

It was apparent through field investigations and discussions with Ralph Squire, Dave Cowan, Mark Dubois and Corps personnel that no comprehensive cave survey of that portion of the Stanislaus River Canyon to be inundated by the New Melones Lake had been completed. Because there seemed to be a distinct possibility that other caves might exist that had not been described, a systematic survey of the area was initiated. Some survey personnel were selected for these duties, but because of their knowledge of the region, volunteers also were solicited from among the local cavers.

Due to time limitations, the area subject to intensive systematic survey was restricted to the marble below 335 m (gross pool level being 332 m). While it was deemed desirable to survey the area using persons spaced out at consistent intervals along the canyon slope, the rugged nature of the terrain precluded this approach. Often there were only a few routes along the canyon wall that were negotiable without resorting to technical climbing. The character of the terrain also made it difficult for the surveyors to see cave entrances above or below them.

To combat these problems while making the survey as systematic as possible, members of the survey party used portable citizen band radios and whistles to maintain continuous communication. A spotter placed on one side of the canyon with a radio and binoculars located possible cave entrances and directed members of the team on the other side to these sites.

As previously noted, the caves were usually visited by a party of three or more people who would examine the cave, fill out the form, draw a sketch map of the site, or survey the cave with a compass and tape if warranted. Large caves or those containing significant cultural or natural phenomena sometimes required one or more additional follow-up trips for specialists' examinations and completion of recording.

COLLECTIONS

While the emphasis of the cave investigations were on observing features *in situ* and describing them at the locality, it occasionally proved necessary to make some collections for purposes of identification. The collections were primarily of indigenous invertebrates. Specimens were preserved in isopropyl alcohol and then shipped to various taxonomic specialists for keying out. Other biological collections included identifiable recent or sub-recent microvertebrate remains. These also required study using comparative assemblages for proper identification. Additional collections included fossil vertebrate materials from Caves 043, 045, and 054, as well as fossil-bearing breccias occurring in fissures on the karst surface at the entrances to Caves 023 and 030. In several cases (Caves 023, 025, and 050) matrix samples were collected from both caves and the surface for evaluative physical and chemical analysis. Those analyses that have been completed are reported in the Appendix as a part of the cave descriptions.

The original plan did not call for the collection of any cultural materials, but in two cases the recovery of artifacts proved to be desirable. A single bone tool, similar to those found at Potter Creek Cave in Shasta County, California, was removed from Cave 025 to be examined by a specialist familiar with the Potter Creek Cave artifacts. A second item, which turned out to be a steatite bowl fragment, was removed from Cave 010 to be cleaned and examined to determine if it had been culturally modified.

GEOLOGICAL STUDY

The project geologist, Dr. Jonathan Davis, concentrated on the geology of the caves, their deposits, and their geologic relation to the area. Field time was spent in visiting and examining significant caves in the project area and studying the local surface geology. Methods consisted of standard geological reconnaissance procedures, including the use of published field guides (Wright and Schweickert, 1977); topographic maps at scales of 1:24,000, 1:62,500, and 1:250,000; black-and-white aerial mapping

photographs at an approximate scale of 1:30,000; color oblique stereo air photos (COSA photos; Hall, 1966); and high-altitude aerial photographs in color infrared at a scale of 1:250,000. It was not possible given the evaluative scope of the project, which was limited to inspection and examination without excavation, to develop a detailed understanding of cave genesis or sediment characteristics. Nor could actual geologic mapping be done (an error in indexing at EROS Data Center delayed the arrival of the requisite aerial photos until the report preparation phase of the survey).

PALEONTOLOGICAL STUDY

Informed cavers generally provided the initial preliminary inventory and assessment of the real or potential paleontological significance of the 87 caves considered in this study. The evaluative fieldwork was done by a team of vertebrate paleontologists from the University of California, Berkeley (J. Munthe, B. Hanson, S. McLoud, D. Lawler). These experts spent most of their time visiting localities identified as important by the survey teams. With few exceptions, identifications were made in the field and the faunal materials were not removed.

TAPHONOMIC STUDY

In addition to standard biological study procedures, an effort was made to identify the role of extant vertebrates in the cave ecosystem by direct observation and collection of recent remains found in animal middens and related contexts in caves. The collection of these vertebrate materials was primarily the responsibility of Michael McEachern and Bruce Hansen, while Billy Davidson undertook the task of identifying most of the bones that comprised the collections.

BIOLOGICAL STUDY

Biological study was oriented primarily toward the identification of invertebrate taxa found in the project area caves. It had been recognized from the beginning of the survey that knowledge of the extent of regional cave fauna was incomplete. Thus, the survey assessment strategy emphasized the collection of specimens for taxonomic purposes from all caves where they were observed as opposed to implementing detailed observations of communities in selected caves. Mr. Andy Grubbs, Mr. Thomas Briggs, and Mr. Dave Cowan undertook the responsibility of making biological collections. As previously explained,

standard collection, recording, and preservational procedures were employed.

Identification of the collections were made by zoo-speleological specialists throughout North America. These individuals are listed in the personnel section of the report.

CULTURAL STUDY

Evaluation of prehistoric and historic resources formed the emphasis of initial survey fieldwork and was carried through the remainder of the field phase. The people responsible for most of the archaeological field evaluations were Michael McEachern, Nancy Boice, and Donald Broussard. Additional examinations of significant archaeological sites were made by Mark Grady and Jonathan Davis.

The cultural resource study provided the framework within which the other studies were integrated; most of this information was treated in detail in the preliminary report (McEachern and Grady, 1977).

IN-HOUSE STUDY

During the field phase of the study and the preliminary stages of data analysis and synthesis, a team of archaeological researchers based in Dallas abstracted much of the documentary data and collated available information for later use. They were also involved in completing many of the administrative and logistic tasks required at the institution coordinating such research. Kimball Banks and Charles Mobley were responsible for this work, under the direction of Mark Grady.

Following the fieldwork, those specialists authoring the report developed their respective sections at their home bases. These data were then assembled in first draft stage in Austin by Jonathan Davis, Mark Grady, and Michael McEachern. These individuals, with the assistance of Andrew Grubbs and Dr. William Elliott, synthesized the biological information in addition to integrating fully generated sections provided by the other authors.

The first draft was then revised in final draft form by Mark Grady and Michael McEachern at Southern Methodist University in Dallas. This version was forwarded for review by the Sacramento Office of the U.S. Army Corps of Engineers.

During the Corps review, work continued on manuscript refinement by Michael McEachern, Chester Shaw, and Carol Heathington under the direction of the Principal Investigator. Carol Heathington and Mark Grady then implemented the revisions requested by the Corps once their review comments had been returned.

ENVIRONMENTAL SUMMARY

The oldest lithology present in the western slope of the central Sierra Nevada is a sequence of recrystallized sedimentary deposits comprising the Calaveras Formation. This formation is located in a belt of metamorphosed and deformed rock to the west of the granitic core of the Sierra Nevada and east of the Melones Fault Zone. Here, both calcareous and aluminous sediments have been tilted and folded, as well as cut by large and small-scale faults. Indeed, this deformation has occurred to such an extent that few fossils have survived.

Of the rocks present in the Calaveras Formation, only the soluble, cave-containing marble is of concern. This marble has been isolated by erosional processes into a series of boudinlike pods, the walls of which are nearly vertical.

Relatively limited in extent, the major outcrops of Calaveras Formation marble straddle the Stanislaus River between Parrotts Ferry and Camp Nine (fig. 1). The Stanislaus River has downcut through some of this marble, exposing cliffs as much as 250 m high. The outcrops along the current river drainage encompass an area of 44 sq km (11,000 acres). This represents about half of all the known marble of the formation, with lesser outcrops having been mapped to the north and south of the Stanislaus drainage basin (figs. 2-3).

Uplift and erosion following the emplacement of the Mesozoic batholithic complex in the Sierra Nevada, resulted in the exposure of the Calaveras Formation by Eocene times. Auriferous gravels were then deposited upon a surface of low relief cross-cutting the steeply dipping

structures of the formation. It is not known when solution began creating the caves of the area, but this may have occurred during the Eocene.

The auriferous gravels and the earlier rocks were buried by later Tertiary volcanic flows, including the Valley Springs Formation, rocks correlated with the Mehrten Formation, and the Table Mountain Member of the Stanislaus Formation, the latter of which is about 9 million years old (Slemmons, 1966). The accumulation of the volcanic rocks took place over at least 25 million years, during which time the unconformable top of the Calaveras Formation was buried no deeper than about 500 meters.

The Table Mountain Latite Member in the project area is a classic example of topographic reversal. The latite first flowed down a wide sinuous stream channel. The resulting hard, impervious rock has subsequently resisted erosion while the surrounding terrain has been eroded so that the flow became elevated as a flat-topped mountain. The Stanislaus River now has cut some 350 m below the Table Mountain Latite through the marble of the Calaveras Formation. Although no terraces or other chronologic clues are preserved in the drainage of the Stanislaus, the inner canyon is so steep-walled and V-shaped that it seems likely that it has been cut since the mid-Pleistocene. It is certainly younger than the 9 million year-old Table Mountain Latite by at least the amount of time needed to invert the topography.

The present vegetation in the area includes a complex mosaic of plant communities which reflects soil chemistry, slope, climate, and successional biotic stages. No thorough



FIGURE 2. Survey terrain near Duck Bar, looking North.



FIGURE 3. Looking North to Table Mountain; Calaveras Formation Marble in foreground.

synecological study of the area has been made, but the vegetation may be grossly divided into 4 communities (cf. Daubermire, 1968; Daubermire and Daubermire, 1968), each of which include dozens of actual associations (U.S. Department of the Army, 1976). These are the Foothill Woodland Community (blue oak, digger pine, and grasses), the Chaparral Community (chamise, manzanita, toyon, and buck-brush), the Yellow Pine Forest Community (ponderosa pine and black oak) and a generalized riparian community (Oregon ash, willow, alder, and laurel). Over all, this vegetation can be classified as Upper Sonoran and Transition Zone (Storer and Usinger, 1964).

The extant wildlife of the area is typical of the foothills region, with deer and quail presently the most significant game animals. In terms of the caves, the more important mammalian fauna currently recognized are porcupines, ringtail cats, skunks, raccoons, wood rats, and bats (Briggs and Gpc, 1975). The unique cave-adapted fauna from the area are assumed to have been unimportant from an overall man-land perspective.

Little paleoenvironmental information concerning the history and development of the flora and fauna in the area is available. Although considerable work has been done in the Great Basin and on the eastern slopes of the Sierra Nevada (e.g. Curry, 1969; LaMarche, 1973; Martin and

Mehring, 1965; Mehring, 1967), its applicability to the project area has not been demonstrated. Nonetheless, these researchers, as well as others, have argued that important shifts in biotic community relationships occurred as a result of climatic changes during the Pleistocene and early Holocene—a premise that might have important ramifications with respect to the potentially early use of the Stanislaus River canyon by humans. However, it should be recognized that almost all of the Holocene research that has been completed in the west indicates that climatic change was insignificant during the time that human populations are known to have occupied the area (e.g. Elston, 1976; Fowler, 1972; Harper and Ander, 1972). The actual effect of climatic factors on the caves and their use by man therefore remains equivocal until regional investigations take place.

However, recent and well-known changes in the natural environment were caused by the introduction of exotic plant and animal species during and after the Gold Rush period of the middle 1800's. Considerable modification of the landscape was also associated with the mining, ranching, and urban development that began at this time. The implications of these impacts must also await future regional research.

CULTURAL SUMMARY

The time period in which man utilized the Central Sierra Nevada foothills is very poorly documented. Although some evidence for man's presence in the Sierras—in the form of artifacts associated with auriferous gravels—might date back to early postglacial times, there is no solid evidence for this premise. On the basis of diagnostic artifact types cross-dated to the Central Valley sequence, the earliest known occupation of the Central Sierra Nevadas dates to the Middle Horizon (2000 B.C. to A.D. 300). The Martis Complex, defined for the Lake Tahoe region, has been bracketed tentatively between the above dates (Elston, 1971; Davis and Elston, 1972). Firmer cross-dating is available for excavations done in the open sites in Amador, Calaveras and Tuolumne Counties. These studies indicate that the locality was most likely occupied late in the Middle Horizon and that occupation continued through the Late Horizon (A.D. 300 to the protohistoric period). Use of the mortuary caves seems to have begun during Early Horizon times and continued until the end of the Late Horizon, perhaps 3000 B.C. to 600 A.D. (McEachern, 1975).

Although the culture history of the study region generally follows that of the Central Valley of California, at least some cultural lag has been proposed (which presumes that the impetus for cultural "change" came from the valley). This suggests that the recognized time frames for this development in the Sierra foothills might not be accurate. At any rate, the use of caves by prehistoric inhabitants of the region during this time spans the range of functions from calcite quarrying through occupation to specialized use as mortuary chambers. As such, their unique position within the overall settlement-subsistence system of the region makes them of critical importance in understanding that system.

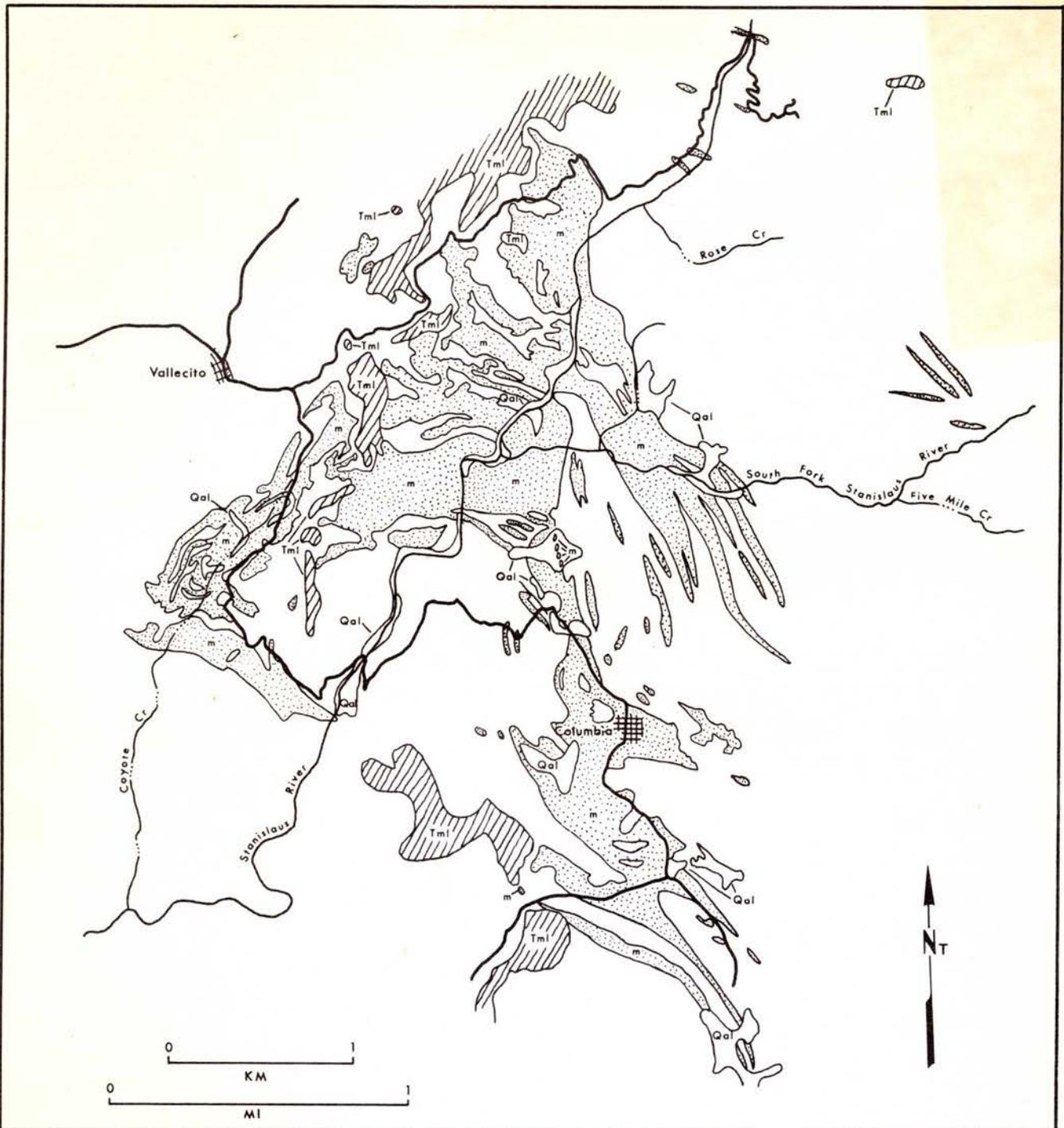
It has been proposed that considerable change characterized the populations in the central Sierra Nevada during the late prehistoric and protohistoric periods. One sugges-

tion is that Penutian-speaking peoples moved into the Central Valley at the end of the Late Horizon and forced the indigenous populations into the foothills. This demographic shift supposedly resulted in the end of the use of caves as burial chambers and possibly signaled the end of aboriginal exploitation of all caves. A related proposition holds that later change, based on Euro-American penetration of the valley, forced the ethnographic Miwok, Maidu, and Washo into more constrained territories, and resulted in shifts in settlement-subsistence behavior. This premise also has relevance to the cave archaeology in the project area since the Miwok, and to some extent the Maidu, are said to have avoided caves for superstitious reasons.

Throughout this chronology, the Indians seemingly practiced a hunting and gathering subsistence economy. The "discovery" of the acorn exploitation subsistence system may well have allowed for the first intensive occupation of the central Sierra Nevada foothills—a pattern that might not have been perfected until 1500 B.C. or later. The demographic implications of this proposition are important in terms of the differential use of caves in the project area.

With the advent of the Gold Rush, people swarmed into the region from all over the world, and the pattern of cave use changed. Some of the burial caves became objects of scientific curiosity. Other caves were sporadically worked for gold by geologically unenlightened miners, or used for shelter or storage. Some of the more spectacular systems were developed into commercial tourist attractions.

Historic exploitation of caves declined with the collapse of the ore mining industry, and present use is primarily limited to recreation by those seeking the challenge and solitude of the subterranean wilderness. Interest in this activity is such that two caves in the region have continued to be successfully operated as commercial enterprises.



SIMPLIFIED GEOLOGIC MAP OF COLUMBIA AREA

Calaveras and Tuolumne Cos., California
after Aune [1965] & Gpc [1973]

- Qal QUATERNARY ALLUVIUM
- Tml TABLE MOUNTAIN MEMBER,
STANISLAUS FORMATION, 9m.y.
- m MARBLE, CALAVERAS COMPLEX,
LATE PALEOZOIC
- OTHER ROCKS

SPROUSE 1977

FIGURE 4. Geology of Mother Lode Area.

PREVIOUS GEOLOGICAL STUDIES

The geology of the Sierra Nevada has been seriously studied since the 1850's. Numerous articles and monographs have been written and a voluminous bibliography exists, to which the publications by Bateman and Wahrhaftig (1966) and Slemmons (1966) are excellent introductions.

Much of the early research involved geologic mapping. The project area was mapped at small scale by Turner and Ransome (1897) and later partially remapped by Ransome (1898) and Lindgren (1911). More recently the region has

been mapped at a scale of 1:250,000 by Strand and Koenig (1965). A geologic map of an approximate scale of 1:30,000 has been prepared by Aune (1965) and Besse and Rogers (1975), but comparisons of the latter map with vertical aerial photographs indicates that it is somewhat generalized. Figures 5 and 6 are based on this map.

Almost all of the remaining studies emphasize the exploitive potential of the regional geology of Calaveras County. Since 1970, road logs and area descriptions, again

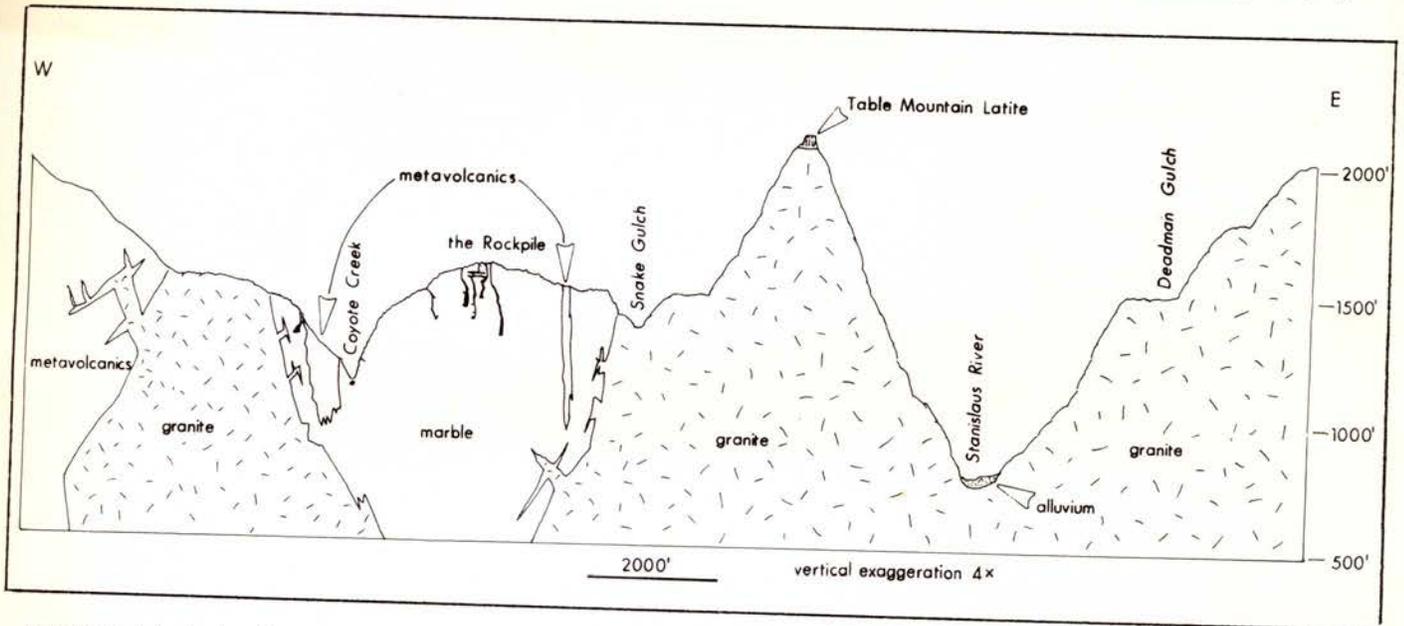


FIGURE 5. Extended profile of Mother Lode region geology.

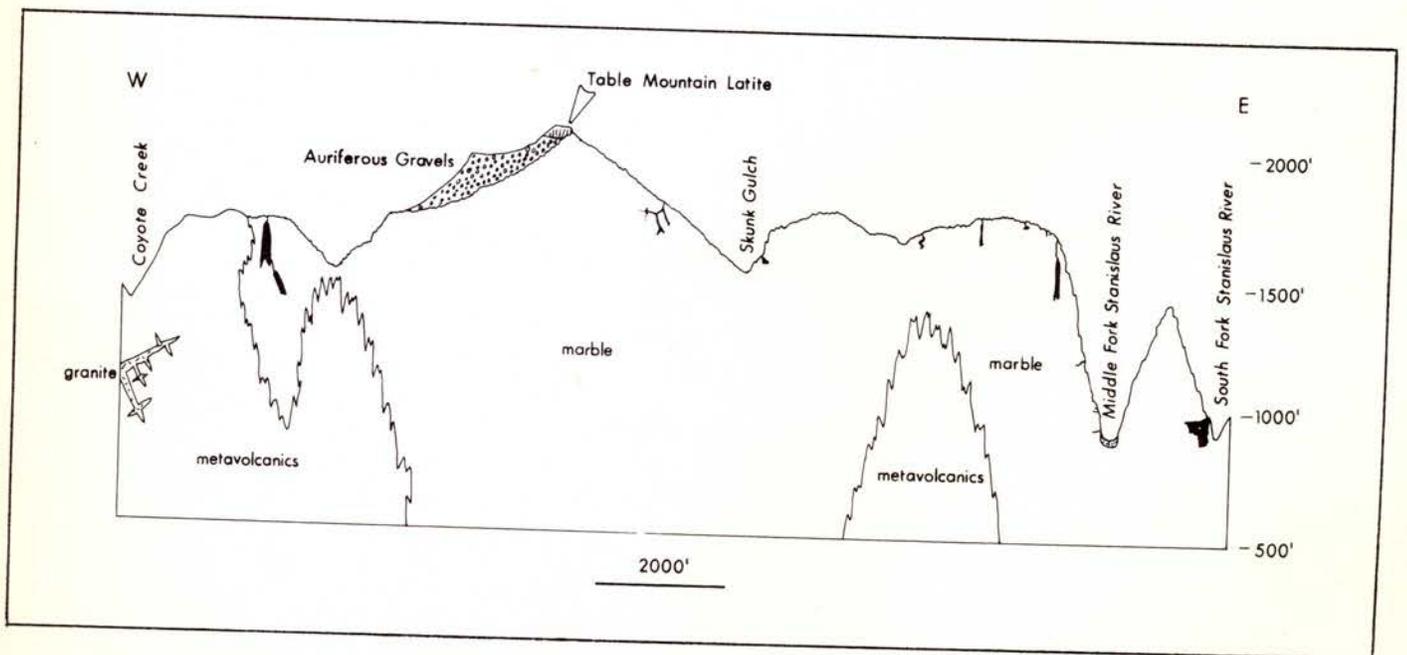


FIGURE 6. Extended profile of Mother Lode region geology.

emphasizing economic potential, have been produced. Among them are the publications of Besse and Rogers (1975), Wright (1975), and Wright and Schwieckert (1977).

The project area, in specific, contains the type locality for the rock "latite", west of Parrotts Ferry (Ransome, 1898). A Tertiary plant regime, the Table Mountain Flora, was identified nearby (Condit, 1944).

No thorough study of speleogenesis in the Calaveras Formation karst has been published, but a few works are relevant to this inquiry. Besse and Rogers (1975) and Halliday (1960; 1962) discuss the formation of caves on the western slopes of the Sierra Nevada in general, hypothesizing that these caves were formed during the Tertiary by phreatic solutioning and opened to the surface by Quaternary downcutting. Short (1970) described the geology of Moaning Cave, adjacent to the project boundary. Implicit in his text is a hypothesis that the cave formed through vadose processes during the Quaternary. Goodman (1964) and Lange (1962; 1963; 1964; 1968), in a series of articles concerning the geometry of cave formation, mention a number of specific caves from in or near the project area, but they do not discuss the genesis of the systems as a whole. Moore and Nicholas (1964) comment on several caves in the region and Davis and Moore (1965) report on two geophysical studies in three caves in the project area.



FIGURE 7. Breccia inculted in surface karst on "Rockpile."

PREVIOUS PALEONTOLOGICAL STUDIES

NORTHERN CALIFORNIA

Paleontological studies of northern California caves began in 1879 when E. D. Cope described "The Cave Bear of California" from Potter Creek Cave in Shasta County. In subsequent years a number of California cave faunas were studied in considerable detail (Munthe, 1975).

The earliest systematic investigations were done by the cave survey established by the University of California's Department of Anthropology in 1901. Mercer's Cave, near Murphys in Calaveras County, was the first site to receive the survey's attention. A number of other caves near Murphys were also examined by F. W. Putnam, J. C. Merriam, and W. J. Sinclair in 1901 and 1902, but evidently they found little of paleontological interest. The materials in Mercer's Cave were the only data they reported on during that time (Merriam, 1906; Sinclair, 1904). The sloth *Megalonyx* was recovered from Mercer's Cave and described by Sinclair (1905), but it was not directly associated with human remains found in the cave, so paleontological studies were abandoned in 1902.

Potter Creek Cave, in Shasta County, was excavated during 1902 and 1903 by E. L. Furlong and W. J. Sinclair. This excavation was a major paleontological undertaking and resulted in a number of publications concerning the cave's Pleistocene vertebrate fauna (Sinclair, 1903; 1904; 1905; Sinclair and Furlong, 1904; Miller, 1911; Kellogg, 1912; Hutchison, 1967). Although careful stratigraphic control was allegedly maintained during the excavation (Merriam, 1906), the information has subsequently been lost and it is now impossible to place the collection from Potter Creek within a stratigraphic framework.

Merriam and Furlong next turned their attention to Samwel Cave, also in Shasta County. The studies of Samwel were even more extensive than those at Potter Creek and considerably more complex, since three separate deposits within the cave were removed. Carried out from 1903 through 1906, the data recovered provided the basis, as in the case of Potter Creek Cave, for several publications (Furlong, 1904; 1905; 1906; Sinclair and Furlong, 1904; Miller, 1911; Kellogg, 1912). Additional excavations on a far smaller scale were conducted at Samwel in the late 1950's, resulting in minor additions to the fauna (R. Graham, 1959; S. Graham, 1967). These newer specimens were found in different parts of the cave than the specimens collected in 1903-1905 and add no new information on the stratigraphic relations of the earlier finds.

Hawver Cave, near Auburn, in Eldorado County, was partially excavated by E. L. Furlong in 1906. He wrote a preliminary note on the Pleistocene fauna in 1907, but did not continue the excavations at that time. The discoverer of the cave, Dr. J. C. Hawver, continued digging on his own, and subsequently donated his collection to the University of California. His materials, together with Furlong's provide the data for papers on the human remains (Merriam, 1909), the birds (Miller, 1911) and the mammals (Stock, 1918). The cave was subsequently completely destroyed by quarrying, and the data base is no longer available for further research.

PALEONTOLOGICAL WORK IN THE PROJECT VICINITY

As indicated above, the only Mother Lode caves to receive an appreciable amount of attention by paleontologists have been Mercer's Cave and Hawver Cave. Two caves near the study area, however, have been shown to have some paleontological importance. O'Neill Cave, north of the project area, was visited by William H. Corey of the University of California's Department of Paleontology in 1929. Although Corey reportedly recovered some fossil material (Cliff, 1929), no record of this collection remains at the Department of Paleontology and nothing further was published concerning the deposit. The status of any fossil materials which may have existed in O'Neill Cave is unclear, though the cave is well known locally today.

An unnamed cave immediately south of the project area in Stoney Gulch has produced some fossil material. A well preserved Pleistocene tapir mandible from this cave was donated to the University of California Museum of Paleontology by K. Howard in 1968. The cave has never been visited by a paleontologist and the extent of its fossil deposit is entirely unknown.

R. Graham (1960:90) described a mandible from a fossil ringtail that may have been recovered from a cave just outside the project boundary. The specimen, which is apparently Pleistocene in age, was not complete enough for determination of species, but was similar to the ringtails which are found in the area today.

Halliday (1962) notes that paleontological materials were recovered from Cave 043, but adds that these data were destroyed in a fire before research on them could be completed.

PREVIOUS BIOLOGICAL STUDIES

The earliest descriptions of cave-adapted animals in the region came from commercial caves such as Alabaster Cave in Eldorado County, Crystal Stanislaus (Mobley) Cave, and Cave City Cave in Calaveras County, and McNamee's (Quarry) Cave in Tuolumne County, where human access was prevalent enough that these fauna were observed. Emphasizing taxonomy, the first scientific description of a species collected from a California cave was Cooper's (1868) paper on the Yate's snail (*Ammonitella yatesii*) from Cave City Cave. Packard (1888) collected a ground beetle (*Anillus explanatus*) and harvestman (*Usifila Banksula californica*) from the Alabaster Cave. Since that time the cave has been partly destroyed by quarrying and the latter species is now believed to be extinct (Briggs, 1974:2).

Systematic collection of cave life in the Mother Lode did not begin until the late 1940s and 1950s when the Stanford Grotto of the National Speleological Society became interested in the area (e.g. Berry, 1955; Smith, 1957). Danehy compiled a list of animals from California caves in the Monthly Report of the Stanford Grotto in 1951 and 1952 with over half of the species collected by that caving group.

Following the demise of the Stanford Grotto in the 1950s, biological collecting and related research were carried on by the Western Speleological Survey and later by Cave Research Associates. Richard E. Graham of Cave Research Associates conducted intensive biological investigations of caves in the region, including some within the project boundaries. The studies resulted in several publications including one by Graham on crane flies (1966), and two descriptions of pseudoscorpions by William B.

Muchmore (1969a; b).

Cave Research Associates' work in the area waned in the mid-1960s and there followed a hiatus in which little published material appeared. In 1968, Mark Grady of the Mother Lode Grotto collected several amphipods from Crystal Palace Cave in Tuolumne County. Aquatic invertebrate collections were also made in Bower Cave by Paul Hara, and later by Steve Shimek and Bill Kruse. An amphipod form was obtained from Pinnacle Point Cave by John Holsinger during the same period. The finds were described by Holsinger in a paper on the western species of *Stygobromus* (1974).

More recently work has been done in the area on harvestmen by Thomas Briggs, of the San Francisco Bay Chapter of the National Speleological Society and the California Academy of Science, which has resulted in the description of several new species (Briggs and Hom, 1967; Briggs, 1974). Briggs has recently been involved in transplanting cave fauna from Cave 054 to a mine tunnel in an attempt to save a number of species from extinction as a result of impact from the New Melones Lake Project.

In general biological studies in western caves have lagged behind studies of eastern cave fauna. This can primarily be attributed to the lack of larger, more spectacular vertebrate cave-adapted fauna (i.e. blind fish, salamanders, etc.) known in the east. On the other hand the absence of these large predators may well have allowed the development of a complex and diversified invertebrate fauna, the significance of which has only been recognized in the last few years.

PREVIOUS ARCHAEOLOGICAL STUDIES

REGIONAL ARCHAEOLOGICAL BACKGROUND

Effective penetration of the Sierra Nevada foothills did not occur until the discovery of gold and the California Gold Rush. Stories of rich ore deposits stimulated a tremendous population influx into the area to search the hillsides for gold. Often this search led to the discovery of caves. Vertical caves were often entered on knotted ropes and flimsy ladders, and miners-turned-cave-explorers were surprised to find that many of them were littered with human bone and artifacts from some previous time period.

In several caves bones were found securely cemented in the flowstone, a situation which seemed to suggest great antiquity. J. B. Trask, the State Mineralogist, was one of the first to comment on their age:

I will not attempt to speculate on these remains, or in the age in which they were deposited, but the situation or peculiarities attendant, to say the least, is strongly presumptive of high antiquity. *Daily Alta California*, December 7, 1851.

Interest in Mother Lode caves continued and in 1881 Henry G. Hanks, then the State Mineralogist, conducted what was probably the first careful excavation of one—Cave of the Catacombs. Human remains were abundant, but no artifactual materials were recovered (Hanks, 1884).

In 1866, J. D. Whitney, the State Geologist reported a skull which started a controversy which lasted nearly twenty years. It was unearthed by mining operations near Angels Camp in a deposit attributed to a much earlier age. He claimed that the Calaveras Skull, similar to that of a modern Indian, indicated that the course of the evolution of man in the new world must have been different than in the old world. The popular press claimed that it was a hoax played on Whitney.

The controversy was settled at the turn of the century when W. H. Holmes of the Smithsonian Institute visited the area. He analyzed calcareous breccia cemented to the cranium which indicated that the Calaveras Skull had come not from the gold-bearing deposit, but from one of the caves in the area (McEachern, 1975).

However, it was not until the turn of the century that long-term scientific archaeological interest was directed towards California caves. Between 1901 and 1908 the Anthropology Department of the University of California under the direction of F. W. Putnam and J. C. Merriam conducted the first systematic archaeological survey of the California caves. Summaries of some of the results of this survey can be found in Munthe (1975) and Heizer (1948 and 1952) and in scientific journals of the time.

These early studies were focused on caves in northern California, but several caves in the Mother Lode Region were also investigated. The most important of these were Hawver Cave in Eldorado County and Mercer Cave in Calaveras County (Flood, 1887-89; Furlong, 1907; Stock, 1918).

At the time of the discovery of Mercer Cave, the remains of an extinct ground sloth, *Megalonyx*, were found in the entrance room. Human bone was also noted. The cave had

been visited by Holmes from the Smithsonian Institution in 1900 and it seems likely that he mentioned the possible association of human remains with extinct fauna to the Berkeley scientists. Consequently, during the summer of 1901 Merriam and Putnam investigated several caves around Murphys, including Mercer Cave. The sloth material turned out to be separated from the human remains and differentially preserved, which clearly demonstrated that they had been deposited at divergent times (Munthe, 1975).

In late 1906 a deposit of fossil bone was found in a cave near the town of Auburn and reported to Merriam by J. C. Hawver. Named Hawver Cave, investigation disclosed an extensive deposit of vertebrate remains including human bone (Furlong, 1907; Stock, 1918). The archaeological deposit was described by J. C. Merriam. Some human bone was clearly mixed with the other vertebrate remains but it was unclear to Merriam whether the material was actually contemporaneous (Merriam, 1909).

Activity at the cave continued after Merriam lost interest. N. C. Nelson from the Department of Anthropology at the University of California worked on a map of the cave which was never completed. A. L. Kroeber visited the site in 1910 and sketched the cave at that time (Wallace and Lathrap, 1952: 134).

By 1910 Merriam had become involved in other interests, and the cave survey was not destined to continue without his guidance. Hawver Cave was the last to be investigated. The cave was later destroyed by quarrying, without the benefit of further research.

Archaeological investigations in the caves of the Mother Lode were briefly renewed following the discovery of O'Neill Cave, Cave of the Catacombs and Moaning Cave.

Wallace and Lathrap (1952) examined the collections from Hawver and described artifacts which had been found with the human bone. The general similarity between the Hawver Cave projectile points and those diagnostic of the Early Horizon of the Central Valley were noted (Wallace and Lathrap 1952:137).

Of the caves studied by Wallace, the most interesting was Moaning Cave, located a short distance from the project boundary. The cave is essentially a greatly enlarged fissure developed in marble. It has both a ceiling entrance and a side entrance. The ceiling entrance opens above a ledge in the top of the main room. The side entrance is formed as a vertical fissure which connects high on the eastern side of the main room. The dimensions of the room vary greatly, but narrow down at the floor, which was originally composed of a large cone of surface deposit.

The cave had been discovered by miners in the area as early as 1851. A number of newspaper articles were written about it during that time. One of the articles contained a description of the deposit by J. B. Trask, the State Mineralogist.

A large mound occupies the center of this room, 50 feet in height and 70 feet in diameter composed of loose stones and earth that has washed in from the top and contains gold... in this chamber the most interesting feature of the whole presents itself, which was the appearance of portions of a human skeleton.

On a large flat rock, on one side of this room, lay a portion of the skull. The skull was not entire—the entire base was wanting. All that remained was the os frontis, the parietal bones, and part of the occiput. One of the company, Mr. Phillips, attempted to pick it up, in doing which it crumbled and fell to pieces. (*Daily Alta California* December 7, 1851, cf. Wallace 1951b:30).

By the time Wallace began his investigation of the cave, the top of the cone of debris described by Trask had been leveled by Addison Carley when he commercialized the cave in 1922. Carley was convinced that there were other chambers in the cave which had been buried as a result of the 1906 San Francisco earthquake (Carley, personal communication). In searching for the lower sections, Carley had also dug a number of holes in the deposit.

Wallace, with the help of Donald W. Lathrap, excavated in the southeastern area of the deposit, encompassing a pit dug previously by Carley. Wallace reported two distinct strata. The upper stratum was described as "unconsolidated grey gravel liberally sprinkled with larger rocks." (1951b:33). The lower stratum was composed of red clay and angular limestone slabs and was covered by an unbroken layer of flowstone two to four inches thick.

Scattered human bone, fauna, and artifacts were found throughout the latter stratum. Some human bone was also discovered in the grey gravel stratum, as well as faunal remains and artifactual materials.

Wallace equated the artifacts from the red clay stratum with the Middle Horizon of the Sacramento Valley and concluded that the material there was a result of burials being thrown or lowered into the cave from the ceiling entrance. The material found in the gravel layer, however, was considered to be of different origin, possibly trash washed into the cave from a village site above the cave.

Shortly after Wallace completed his excavations, additional investigations were conducted in the cave by Phil C. Orr of the Santa Barbara Museum of Natural History (Orr, 1952). Orr excavated a trench in the northwest area of the room. The deposit in Orr's trench, like Wallace's displayed complex stratigraphy. Although human bone and faunal remains were recovered by Orr, no cultural materials were found.

The lack of artifacts convinced Orr that the deposit in his trench was older than the material which had been found by Wallace. Seeking proof of this, Orr attempted to date the deposit by means of the growth rate of speleothems. The amount of flowstone deposited on some material left in the cave when the spiral staircase was built were used as a basis to determine how much flowstone accumulated in a single year, assuming a constant rate of deposition. By dividing this figure into the total thickness of the flowstone layers in the archaeological deposit, an age estimate of 12,000 to 50,000 years was obtained for the deposit excavated by Orr. On the other hand, Wallace's trench was estimated to be about 2,900 years old based on the total thickness of the flowstone layers present at that location.

Orr's assumption of a constant rate of deposition, however, is untenable considering the large number of factors which could effect the deposition rate. A human femur with 86 mm of flowstone covering was collected from an area of the deposit interpreted by Orr (1952:15) as being slightly younger in age than the material excavated by Wallace. The specimen was later radiocarbon dated as

1400 ± 250 years old (Broecker, Olson and Orr 1960:94).

Of the caves investigated by the University of California Archaeological Survey, the most significant was Winslow Cave, near the town of Murphys. Exploratory investigations were first conducted in the cave in 1950 by C. M. Meighan with the help of W. C. Gonsalves, M. A. Baumhoff and D. M. Pendergast (Gonsalves, 1955). The cave yielded a considerable amount of human bone, representing a range of sexes and ages. All of the skeletal material was disarticulated, suggesting that the interments were of a secondary nature.

Artifactual recovery was also extensive, and the analysis of these materials led Gonsalves to speculate about the chronological placement of the site in terms of the known culture history of the region and the Central Valley.

The excavations at Winslow Cave were not extensive enough to reconstruct the entire history of human utilization. An attempt to fit the material from Winslow Cave into a local culture sequence is difficult and unreliable because knowledge of the archaeological situation of the Sierra foothills is extremely limited at the moment. However, of the cultural pattern that is known for this area, nearby Moaning Cave can be said to be most similar to Winslow Cave on the basis of artifact types recovered and similar use of a limestone cavern as a mortuary chamber. The small number of similarities of Winslow Cave's with those of Moaning Cave is probably due to the small number of artifacts recovered from the latter. Aside from these conclusions, it can be said that Winslow Cave is a Middle Central California Horizon site with several Early Horizon hold-overs. (Gonsalves 1955:38)

It should be noted that Gonsalves lumped all of the artifacts in his analysis of the collection, ignoring any stratigraphic relationships which may have existed. The possibility of temporal distinctions being made within the assemblages was thus not pursued.

In 1958 the Department of Anthropology of Sacramento State College expanded a study of nearby rockshelters to include the limestone caves prevalent in the central Sierra Nevada foothills following the discovery of artifacts in Pinnacle Point Cave (McEachern and Ralph, 1964; Payen and Johnson, 1965). Cave Research Associates, an organizational outgrowth of the Stanford Grotto, also provided aid for the State College investigations.

A significant offshoot of the study undertaken by Sacramento State College was the excavation of Pinnacle Point Cave under the direction of Louis A. Payen and Jerald J. Johnson. Summaries of aspects of this excavation are presented in several different papers (Payen n.d.; Payen and Johnson, 1965; McEachern and Ralph, 1964; Ralph and McEachern, 1964; McEachern, 1968) and some of the artifacts have been dealt with by Payen (1964), Beck (1970), and Pritchard (n.d.). A complete report, however, has not yet appeared.

In conjunction with the Sacramento State College study of the limestone caves of the Mother Lode, Michael McEachern conducted an extensive investigation of limestone outcrops occurring in the region. In addition to the survey, known mortuary caves were reexamined and a more intensive survey was conducted of the upper portion of the San Domingo Creek drainage north of Murphys, California.

The San Domingo Creek survey (McEachern n.d.) attempted to locate open sites which might be correlated with known mortuary caves. The upper portion of the drainage was selected because there was little evidence of placer mining, and mortuary caves were known to occur on both sides of the relatively narrow valley (e.g., Mercer's Cave, Winslow Cave, and Papke Cave). A large open midden site was located between the three caves which was considered ideal for exploring the relationship between open sites and mortuary caves.

Additional studies of Moaning Cave were also made by Mark Grady and Michael McEachern during this time. Grady (n.d.) examined the gray gravel stratum which was described by Wallace and deduced that it was residual cave earth formed by the impurities left behind when limestone undergoes solutioning. McEachern and Grady (1967) questioned Wallace's assumption that the ceiling entrance to the cave was the one used in prehistoric times. They found that:

All of the evidence points to the side entrance as the one used by the Indians. Its location and slope would not necessitate entry into the cave at all. Deposition of burials could have easily taken place without entering the darkness of the cave. Logically speaking, then, the process of interment in Moaning Cave was simplified by the use of the side entrance. (McEachern and Grady, 1967:4).

Between 1963 and 1968 an intensive survey of the natural limestone caves of the region was conducted under the direction of McEachern (1964, 1968, 1975; Grady, 1969). Several hundred caves and fissures in the scattered outcrops of limestone were investigated, although only a few were identified which contained cultural remains. Additional cave sites were examined and recorded between 1971 and 1973. The results of this survey were summarized by McEachern:

Twenty-five caves which contain some evidence of aboriginal use are now known in the region. Seventeen of the caves are vertically oriented chambers with deposits of scattered human bones and artifacts and apparently were used in prehistoric times as natural mortuary chambers. Four are occupation sites, three are calcite quarries, and one contains a single obsidian flake well within the area of total darkness (McEachern, 1975:136).

One of the most recent investigations involving mortuary caves was conducted by Judy Rose in 1971. The study focused on the Winslow Locality, a relatively small area which included three mortuary caves (Mercer, Papke and Winslow Burial Pit) in addition to several open sites.

Attempting to establish the relationship between mortuary caves and open sites, Rose implemented intensive survey, surface collection and test excavations at several sites, including Papke Cave.

Papke Cave is a vertical limestone fissure which drops 11 m to the floor. A distinct cone of debris was located directly below the entrance which contained sparse amounts of human bone.

Rose's excavations focused on the cone of debris. Approximately 80% of the cultural deposit in the cave was excavated, with most of the bone and the cultural materials

being recovered from between 40 and 70 cm below the surface. Based on the map of the cave presented in her report the total depth of excavation appears to have reached 1.6 m below the surface.

Although Rose implemented detailed and valuable analyses of the artifacts and human remains recovered from Papke Cave, returns were sparse, and results consequently of limited applicability. The evidence suggested that there were some cultural, and perhaps genetic ties with the open site occupants. Rose concludes that the cave was used for a short period of time, and tentatively dates the cave interments at A.D. 300 (terminal Middle Horizon) based on correlations with diagnostic Central Valley artifacts.

In addition to the excavation at Papke Cave, Rose also analyzed material from Winslow Cave which had been unsystematically removed by the landowners.

The material from Winslow Burial Pit turned out to be of little interpretative value due to the lack of stratigraphic control, the paucity of records, and the large screen size used in recovering artifacts. A number of new ornament and bead types were added to the mortuary cave inventory, but these additions did not significantly change the overall interpretation of the assemblage.

It is clear from the preceding regional synthesis that the greatest share of cave-related archaeological research has been directed toward the study of mortuary caves. However, a number of endogene caves in marble have been documented as having other uses. The most significant, Kentucky House Cave, evidently had indications of extended occupation over a long time period, but it has been destroyed by quarrying operations of the Calaveras Cement Company (McEachern 1968:37).

The three known quarry caves (including 047, 048, and 077, all located within the project area) exhibit evidence of calcite mining. The sites are identified by the presence of cobble hammerstones, quarry faces, and blanks. The heavy vandalism present in a number of other caves may mask indications of prehistoric quarrying which may have been present.

The presence of calcite artifacts in Early and Middle Horizon sites in the Central Valley provides indirect evidence for the existence of calcite quarries in the caves of the Sierra Nevada foothills. This was pointed out by Payen and Johnson in 1965 before any such quarry site had been located. The presence of calcite quarry caves in the Mother Lode Region indicates an interrelationship between the Mother Lode Region and the Central Valley either directly or through trade. Since calcite artifacts are known to be used only in Early and Middle Horizon times, there may be a close correlation between quarry caves and mortuary caves (McEachern, 1975:137).

Previous Archaeological Work Involving Caves Within the New Melones Project Boundary

In 1968, Payen, Scott, and McEachern conducted an archaeological reconnaissance of the area to be inundated by the New Melones Lake and some of the adjacent land. They investigated a number of caves, the most important being Cave 077.

Flowstone in the upper section of the cavern appears to have been broken away in prehistoric times. A stream cobble hammerstone was found on the surface. Excavation and screening of the deposit in the quarry area disclosed an additional cobble hammerstone and numerous fragments of broken flowstone which seem to support the contention that this cave was indeed a prehistoric calcite quarry. (Payen, Scott, and McEachern, 1969:11).

In addition to the archaeological material, some mineralized vertebrate remains, presumably of Pleistocene age, were found in Cave 077 (Payen, Scott, and McEachern, 1969:15).

Other caves investigated by these researchers include Crystal Palace and Cave 054. A human cranium fragment was collected from the former and an obsidian flake discovered in the latter. The significance of McNamees Cave was also noted (1969:9).

Although Payen, Scott, and McEachern's survey was primarily of an exploratory nature, a number of recommendations were made, one of which was related to caves.

Consideration should also be given to the speleological-paleontological aspects of the reservoir's limestone caverns. Further exploration for and of these caverns would certainly disclose additional sites of scientific value (Payen, Scott and McEachern, 1969:16).

Later survey of the reservoir area was conducted by Roland Gage, who again noted the importance of McNamees Cave and recommended that mitigation should include excavation of selected ossuary and habitation caves (Gage, 1969).

Patti Johnson then conducted limited excavations on a number of open midden sites within the New Melones project area (Johnson, 1973). She described the results of the excavation of eight sites and constructed a tentative chronology which included additional sites investigated by Ann Peak (1973). Johnson also discussed some of the problems in trying to relate mortuary caves to the open midden sites.

Although open midden deposits along with bed-rock mortars constitute the majority of sites within the Project area, other features of the landscape were also utilized. . . The endogene caves—Pinnacle Point, Moaning, Papke, and other vertical limestone solution caverns above or in the general vicinity of the Project present an enigmatic situation in view of their possible relationships to the open sites. It is certain they served a specialized use for disposal of the dead (Payen, 1964); they contain both skeletal remains and a sometimes substantial array of artifacts. Unlike artifact assemblages from the open sites which display strong affinities with the hill region, especially an orientation towards the Washo and Southern Miwok territories, those from the mortuary caves demonstrate a close resemblance to the Central Valley tradition. Pinnacle Point Cave, located above but in close proximity to the reservoir take-line, contained shell beads and ornaments and projectile points distinctly diagnostic of the Middle Horizon in the Valley. From all of the caves investigated it appears that their use spans a limited period from the Middle Horizon to some time in Phase 1 (Payen,

Scott, McEachern, 1969). Thus far no component other than that of Cal-S347 is of such antiquity although the lower stratum of Cal-S323 does appear to be at least terminal Middle Horizon to early Phase 1. From what is presently known of the New Melones regions and environs it seems the mortuary caves were utilized by groups either in the lower foothills or in the Valley proper who traveled to the area. If habitation in the mid-elevations during the Middle Horizon was as infrequent as it now appears, then access to the burial caves would probably be unhindered by intervening populations. As evidenced by the greater number of later archaeological components, an increase and expansion of peoples permanently inhabiting the lower and middle hill region by their presence may have effectively restricted access to the limestone region, thus eventually bringing about a cessation of the use of the caves during the Phase 1 period. A source analysis on the mortuary cave artifacts of obsidian and on those of various open sites in the New Melones area and Central Valley might greatly clarify the problem of cultural affiliation (Johnson, 1973: 111-112).

The most recent archaeological studies of the New Melones Lake Project were conducted by Michael J. Moratto (1976) and Roberta Greenwood (1977). Moratto implemented an intensive survey for the prehistoric resources on all of the lands within the project boundary, while Greenwood was responsible for the historic resources inventory. Moratto's survey in particular was well planned, organized, and executed, but the rugged canyon terrain of the upper arm of the project area created logistic problems which lessened the comprehensive nature of both endeavors. The information in the Moratto report documenting intensity of survey coverage (Part 6, Map X) indicates that the majority of the karst area was not investigated, a fact made clear in the text. Those data dealing with caves, however, are incomplete and in some cases inaccurate. Of the caves shown on Map X, eight are incorrectly plotted. Locational information previously developed by the New Melones Task Force was considerably more accurate.

Moratto (1976:146) concludes that due to the extreme relief in the area the prospects of finding prehistoric sites are remote. In light of the fact that known prehistoric and historic non-cave sites had been previously located along the river in this area (Squire, 1972), such a position has little support. Greenwood, on the other hand, does not address the issue of historic use of caves, although historic resources in the karst localities are considered.

In evaluating the work on caves in the project area, Moratto (1976:168) concluded:

It should be stressed that it is quite possible—indeed probable—that some cave sites remain undiscovered in the New Melones Project locale. The caves tend to occur in extremely rugged karst topography; some large chambers are connected to the surface by very small vertical cracks and fissures; and the typically dense chaparral cover in the limestone belt may obscure any number of cave apertures. Thus, while we sought out archaeological caves as conscientiously as we searched for other types of sites, there were field conditions which significantly

affected our success in discovering caves.

For these reasons, it is emphasized that further studies of the Stanislaus River caves should be conducted and that this work should be done by multidisciplinary teams composed of specialists in geology, paleontology, speleology, cartography, zoology, photography, and archaeology. The purposes of the studies should be: (1) to discover additional caves which may have eluded detection in the past; (2) to properly investigate the known endogene archaeological caves; and (3) to develop proposals for the enlightened management of the natural and cultural resources of the caves.

Despite his failure to implement surface survey of the areas containing caves, Moratto's research is of the highest professional quality. Most of the better known works on

the archaeology of caves in the project region were summarized. More importantly, however, Moratto recognized the specialized problems that caves presented for his investigations. His recommendation that such work be undertaken by an interdisciplinary team of cave specialists is a responsible conclusion.

In large part stimulated by the Moratto report and recommendations, the Corps of Engineers contracted with the Archaeology Research Program to implement the cave research study discussed herein. The preliminary report of this study (McEachern and Grady, 1977) emphasized the archaeological aspects of the project. As previously discussed, 13 caves of archaeological significance were described and evaluated in that report. Mitigative recommendations were suggested, pending the final results of the overall survey, which was still in the field phase at the time the preliminary report was completed.

RESEARCH FRAMEWORK

The data gathered by this survey, in conjunction with information synthesized during the field work, resulted in the development of a set of research frameworks designed in part to direct future work in the project area. Each framework accounts for the available information within the context of a generalized explanatory model. Considering both description and process, these frameworks act as low level guides for the evaluations and recommendations that follow. It is emphasized that these directions of inquiry are not developed to constrain future research in the area. Nor are they designed to supercede or pre-empt management considerations of a non-research nature. However, they do function as useful integrative tools for providing profitable mitigative research direction.

GEOLOGY RESEARCH FRAMEWORK

Emphasis here is placed upon a set of proposed geological processes which resulted in the current regional landscape and the order in which these processes took place. Caves had a key role in this evolution, and the stratigraphic data obtained within them are important to paleontology and archaeology as well as geology.

The formation of caves and their deposits is often considered as resulting from a combination of processes occurring above the water table (vadose processes) and below the water table (phreatic processes) (Davis, 1930; Bretz, 1942; Davies, 1960). Phreatic processes primarily consist of subaqueous matrix solutioning which follows pre-existing geological structures and includes limited deposition of clay and *in situ* collapse of blocks. Vadose processes include solutioning and corrosion by flowing water, formation of speleothems, and differential deposition of sediments based on load and water movement. These processes are succinctly discussed in Moore and Nicholas (1964).

A third karst and cave formation mechanism, which is actually a subset of the vadose category, has been defined herein as "pedovadose". This speleogenetic process takes place when sediment-filled fissures, called "cutters" or "grikes" by Jennings (1971), Fellows (1965), and others, are enlarged by solutioning, but remain filled with soil. These sediments slowly slump downward in the grikes. Solution is enhanced by the high carbon-dioxide content of the soil

atmosphere and by the lack of permeability of the soil material, which concentrates the soil-water flow at the rock/soil interface. A pedovadose solution fissure becomes a cave when the plug of soil material slumps to a considerable extent, is flushed out, or collapses into a previously opened phreatic/vadose cavity below. (Table 1).

Once cave formation processes have developed a subterranean cavity a variety of depositional events may take place. Although fine clay may settle in water-filled (phreatic) caves, most cave deposition is a vadose phenomenon and can be generally categorized under collapse, stream-flow, and carbonate deposition (speleothem growth). Collapse produces breakdown when the collapsed material is rock; blocks of breakdown may be up to tens of meters in size and fill large volumes of space in cave systems. Collapsed soil material generally forms soil cones analogous to talus cones and is often the matrix of large breakdown blocks. Such collapsed sediment may be composed of pedovadose residuum.

Streams in caves deposit sediment in a fashion similar to that manifested above ground; it tends to be fairly well sorted and bedded and is found in familiar forms such as bars and meanders. Pedovadose deposits or other collapsed sediments that fall into streams may be redeposited as alluvium in caves.

Carbonate accumulation, or speleothem growth, is a result of the decrease of solubility of carbonate in vadose water once the water comes in contact with the cave atmosphere. The resulting flowstone is one of the main attractions to caves and can occur as extensive deposits within solution cavities.

Two models have been proposed previously to account for the genesis of the caves of the region; unfortunately, neither considers all of the observed facts. Halliday (1962) and Besse and Rogers (1975) proposed that most of the caves in the Mother Lode were formed during the Pliocene under phreatic conditions. They argue that most of these caves accumulated fine-grained phreatic fills and were subsequently drained. Collapse material and carbonate sediments were then deposited in them during the Quaternary.

Short (1970) does not actually propose a speleogenetic model, but one is implicit in his discussion of Moaning Cave, a commercial cave adjacent to the study area. No mention of phreatic processes was made. Solutioning was inferred as vadose, structurally controlled, and occurring

TABLE 1. Cave Formation Processes

Process	Result
Vadose (above water table)	Collapse, stream activity (corrasion/deposition), speleothem deposition.
Pedovadose (in soil, above water table)	Solution in grikes at soil/rock interface; solutioned material deposited within grikes or below grike/cavity intersection.
Phreatic (below water table)	Solution along planes of permeability; residuum concentrated as settled fill; may occur at depth.

in the Pleistocene. It is difficult, however, to account for features such as the flat ceiling in Moaning Cave itself, the apparently phreatic nature of Cave 054, the two horizontal passages crossing the rock structure at Cave 058, the horizontal development of Cave 025, or the collapsed sinks at Cave 043 and Cave 009 without invoking phreatic solutioning as an important agent in the formation of Mother Lode caves.

Halliday's model (which is borrowed by Besse and Rogers), involves phreatic solutioning but fails to explain adequately the preponderance of vertical shafts in Calaveras Formation marble, such as Caves 016, 073, 045, and 010. Neither model refers to sources or processes of sediment deposition other than breakdown and carbonate. Thus, key attributes of project area speleogenesis remain unexplained in both sources.

Following but elaborating upon Halliday, the following model of cave formation and sediment deposition is proposed for the Mother Lode karst in general and New Melones in specific:

Speleogenesis

- (1) Phreatic solution at depth produced a uniform low density of sealed caverns through the marble (see Stage 1 in Davies 1960). The age of the beginning of this event is not known, but it may be continuing beneath the current water table.
- (2) During the Eocene the marble was exposed at the surface, and grikes at least 10 m deep formed. Examples may be seen near Columbia, where they have been exposed by mining. Caves may have existed at this time, and vadose and epiphreatic solutioning may have been taking place. Collapse, streamflow, and carbonate deposition may also have occurred at that time but positive evidence is lacking. However, if phreatic solutioning had not begun before the Eocene, there might have been cavities for grike fills to collapse into, hence few caves.
- (3) The Eocene landscape became buried beneath a thick pile of volcanic and pyroclastic rocks, and remained buried until the Pliocene. As previously noted, phreatic solutioning may have taken place throughout this 25 million year period.
- (4) Some time after the eruption of the Table Mountain Latite (9 million years ago), erosion again exposed the marble and cut a mature alluvial surface about 750 feet above the present Stanislaus River (figs. 4, 5, and 6). Epiphreatic and pedovadose solutioning intersecting pre-existing phreatic chambers (and perhaps the roots of Eocene grikes) at this time created the existing cave systems of the region. Pedovadose sediments, then, collapsed into many of the phreatic systems and were redeposited as phreatic fills. This took place from the late Pliocene through the late Pleistocene.
- (5) The Stanislaus River and its tributaries subsequently entrenched to their present depth, probably during the early Holocene. This action created 250 m of canyon relief while opening the roots of grike systems at the Rockpile and Skunk Gulch. Grike fills collapsed into the breached roots and into emptied phreatic chambers. At the same time lower elevation phreatic caves such as

054 and 025 were drained and breached directly by the downcutting of the river. (fig. 6).

Deposition began in low elevation caves where adequate mantling and carbonate-charged water was most abundant. Higher precipitation during pluvial stages may have influenced the growth of speleothems and the filling and erosion of cave sediment deposits.

- (6) Postglacial decline in precipitation then stabilized the overall accumulation of surficial and other deposits in most of the caves in the region. (figs. 5 and 6).

This model implies that there should be a well-stratified depositional record, largely of collapse sediment and redeposited collapse sediment, spanning the Quaternary, in the New Melones caves.

There may also be a record of the Eocene preserved at high elevations, whereas caves at low elevations (e.g., 054 and 025) may contain deposits dating to the late Quaternary

Stratigraphy

Although the sediments in Mother Lode caves are too complex stratigraphically to be adequately deciphered without detailed study, they were divided in the field into *surface fills* and *breccias*. Breccias are cemented, reddish, and usually contain cobbles and boulders of marble as clasts. Breccia is often found adhering to the walls and is manifested as sediment-filled fissures exposed in cross-section by the present ground surface (fig. 7). It is old enough that its present morphology does not correspond to its depositional morphology. Breccia includes alluvium as well as collapse sediment.

Surface fills are unconsolidated, often brown or black, deposits which are related to the modern depositional systems in the cave. The morphology of these deposits is still that of deposition although they may be truncated by very recent erosion or digging. Most surface fills are collapse sediments (soil cones).

Based on paleontological and archaeological evidence, most surface fills are of Holocene age; they contain only extant fauna and comprise the matrix for most of the cultural deposits. On the other hand, breccia is probably of several ages. At least some deposits are Pleistocene, although others could be earlier. Breccias are separated in geologic time from the surface fills by one or more episodes of erosion and cementation and have been completely concealed by flowstone. Entire rooms in cave 054 and cave 043 are eroded from partially flowstone-covered alluvial "breccia", and these deposits obviously fill earlier, larger chambers in the marble. More precise age and stratigraphic assignment for such cave deposits must await more complete study of the project area.

Cave deposits in the Stanislaus karst area generally include flowstone, alluvium, and collapse matrices. Flowstone is often well stratified, though the stratigraphy may be discontinuous and difficult to detect. Alluvium is well-layered and its stratification is almost always readily recognized (fig. 8). Collapse sediments in the region, however, have sometimes been presumed to be without recognizable stratification (e.g. Gonzales, 1955:32). Such is not generally the case. This misconception has led to some archaeological and paleontological deposits being

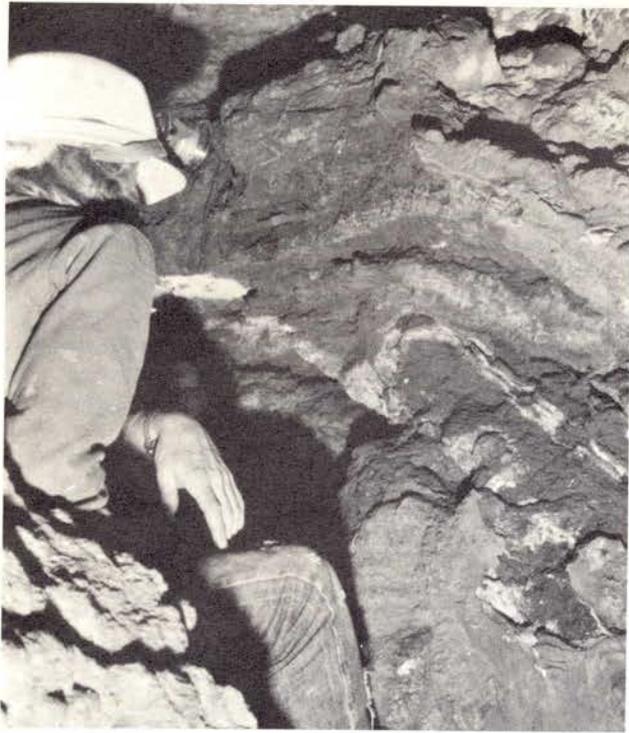


FIGURE 8. Stratigraphic deposits, Cave 016.

excavated without stratigraphic control

In such deposits these strata are often dipping at the angle of repose and may be identified—in the absence of changes in sediment lithology—by the orientation of rocks, bones, artifacts, and other constituents. The caves within the project area are therefore of considerable significance, both from the perspective of the caves themselves and what they contain in the form of depositional materials. Thus, the interpretive opportunities inherent within the geological data base not only for clarifying questions of regional geologic history and speleogenesis but also for shedding light on paleoenvironmental conditions relevant to paleontological and archaeological research are manifold.

PALEONTOLOGICAL RESEARCH FRAMEWORK

Although as previously summarized, a considerable amount of paleontological research has been implemented within the state, these studies have been primarily directed toward taxonomic ends. This approach has also characterized most of the investigations done by the New Melones Reservoir cave inventory personnel, but the field work indicated the potential for implementing further research along at least two profitable avenues of inquiry.

The first concerns paleoenvironmental reconstruction. It is generally recognized that lower orders of fauna, because of their limited climatic tolerances, are particularly good indicators of environmental conditions. Microtine rodents, for example, are sensitive to subtle changes in the ecology, and their presence or absence in paleontological deposits can be used to document the nature of the paleoenvironmental setting (fig. 9). Floral materials should also be a part of the paleoenvironmental record, and the identifiable

remains of these plants will provide an associated but independent source of similar information.

Aspects of the geological research proposed as a part of the mitigative study are also directed toward the reconstruction of Eocene and later environmental conditions. To the extent that these data overlap in time, they should operate as mutually exclusive checks on the results. At the same time, the combined conclusions should elucidate the environmental history of the region in general and the Stanislaus River drainage in particular.

Such information is not only important to the interpretation of geological and paleontological phenomena but is critical for clarifying some of the most important issues outlined for the archaeology (McEachern and Grady, 1977:39-40); Moratto, 1976:502-04). Thus, the importance of paleontology in contributing to the interdisciplinary considerations of paleoenvironment cannot be minimized.

The second avenue of inquiry concerns an ecological theory advanced to account for the environmental configurations characteristic of the California Basin. In essence this theory proposes that the area circumscribed by the mountain ranges bounding central and northern California was isolated from the intrusion of plant and animal forms that characterized much of the rest of the western United States. Acting as a barrier, the mountains forced the allopatric evolution of species and environmental mosaics that are somewhat distinct from adjacent regions (Hinds, 1952).

If this postulate is accurate, it should be manifested in a paleontological assemblage and configuration that is not only somewhat unique to the state but is more similar to other assemblages in the basin than those found elsewhere. Such attributes should be reflected in the contextual relationships among individuals and groups of individuals in the fossil record as well as in the morphological structure of the taxa themselves.

Cave studies are admirably suited for considering this problem. As is pointed out in Harris (1976) and elsewhere in this study, caves may well be repositories for elements of the paleontological record that do not exist under other circumstances. More importantly, however, most of the caves in the study region that have been identified as having paleontological significance are vertical in nature. Thus it is presumed that these caves operated as natural traps, collecting the range of fauna that inhabited the



FIGURE 9. Fossil mandible, Cave 016.

vicinity. Horizontal caves, on the other hand, are presumed to have been used as dens for animals in those instances where such caves contain paleontological deposits. The remains in such inhabited caves will reflect the bias inherent within the behavioral patterns of the occupant animals rather than a more representative indication of the extant species that were in the community. Therefore, paleontological deposits in vertical caves in the study region are presumed to contain a relatively unbiased sample of the variability and density of fauna within the locality in the past—an important prerequisite for identifying the characteristics of extinct faunal communities as required to evaluate the isolationism model.

BIOLOGICAL RESEARCH FRAMEWORK

The general biological diversity characteristic of the study region has been recognized by environmental researchers for many years (fig. 10). This also extends to the biospeleology. Although almost no research has been directed toward the nature of cave adapted flora, those few studies available have not identified truly troglomorphic plant taxa in California (Briggs and Gpc, 1975; Graham, 1969). Indeed, the photosynthetic requirements of all plants, with the exception of certain saprophytes, would prevent the development of truly cave related varieties. Although the possibility exists that the twilight zones of caves in the study region would support unique plant taxa, this consideration has not been investigated.

Cavernicolous invertebrate fauna, however, are well known for the caves within the Calaveras Formation. Previous zoospeleological research suggests that the distribution of the cave bearing geologic formations—manifested as relatively isolated pods each containing a number of caves—are significant from several perspectives. Such caves provide excellent laboratories for the study of cave-related faunal evolutionary parallelism and divergence. In addition, the clustering of caves in otherwise relatively similar environmental settings facilitates the controlled study of zoospeleological community development and interaction among cave systems as well as individual caves.

These factors are only a few that make the Stanislaus karst region an extremely significant zoospeleological resource base. Nowhere in the west, aside from the Shasta cave region, do circumstances exist supporting the development and maintenance of such a rich and varied cave adapted biota (Graham, personal communication).



FIGURE 10. Snail, Cave 051.

The New Melones cave investigations yielded an impressive amount of faunal data. Not only were many new taxa identified, but the ranges of others were extended considerably. Information concerning the densities and distributions of these fauna has shed some light on the dynamics of cave ecosystems, and the research proposed for the future within the project area should yield similar knowledge of a more refined nature.

One of the current debates within ecology in general and biospeleology in specific is whether species diversity or specificity is a better measure of adaptive stability (e.g. Poulson and Kane, 1977). In other words, does an ecosystem composed of a few taxa exploiting a limited number of relatively extensive niches indicate a more long-term successful adaptive strategy than a situation characterized by a greater number of more specialized fauna.

Zoospeleological data gathered by the New Melones cave research personnel suggest that this dichotomy is not particularly clear-cut in the study region. Much of the problem rests with the vagaries of faunal sampling, the identification of troglomorphic as opposed to troglomorphic or epigean taxa, and recognition of the nature of regional cave ecosystemic relationships.

Many of the specimens studied as a part of the survey were immature and could not be classified accurately. There was no conclusive indication that the information obtained was representative of the range of existing cave adapted fauna. Only in some cases (e.g. certain pseudoscorpions, springtails, and harvestmen) was it convincingly determined that specimens were troglomorphic. In addition, the interactive characteristics of cave faunal communities are only poorly understood for the region.

The proximity of caves and cave systems is an obviously critical factor in reducing taxonomic diversity. It should be no surprise that the taxa of equivalent classificatory levels are most similar within proximal cave systems. This is particularly true of troglomorphic isopods, pseudoscorpions, and harvestmen. Yet particular taxa (e.g. *Microcreagris grahmi*) can also be widely dispersed throughout the study region.

Some evidence exists suggesting that the troglomorphic taxa operating at the lowest levels of the trophic pyramid are the most generalized in terms of nutrient intake while at the same time evidencing few signs of interspecific competition. Isopods and springtails, for example, show a relatively high correlation between phylogenetic proximity and spatial proximity. Yet few evidently competing species exist in the same cave locality. Pseudoscorpions, however, are much more widely distributed. It is unclear whether this distribution is a factor of a more generalized subsistence strategy or reflects an evolutionarily later, but more specialized adaptation to the exploitation of certain speleofauna. The data suggest that other cavernicolous invertebrates, such as centipedes, may not be particularly cave adapted as a taxonomic class although epigean specimens are documented in caves of the study region. If the truly troglomorphic fauna upon which cavernicolous predators might depend were too few and occupied too generalized a niche to support such predation, the previously outlined pattern would be expected to exist.

Much of the community and subcommunity level of complexity seems to relate to the nature of energy input. Those caves characterized by the highest diversity and density of invertebrate fauna are vertical in nature and

functioned as natural traps for both plant materials and animals. Such a situation should result in a combined high-payoff/high-risk food input ratio and a low payoff/low-risk food input ration, both of which would support different faunal communities. The high payoff/high-risk subcommunity subsists upon the occasional trapped animal, which provides many calories per gram per time per area of energy in exchange for low dependability. Such subcommunities are expected to include a small number of specialized troglobites. This subcommunity in the study region is evidently largely composed of epigeal taxa, possibly reflecting the fact that the risk is too high to support the development of such specialized troglobites.

The low payoff/low-risk subcommunity depends upon a more constant input of vegetative materials which provide less overall energy but a consistent supply. Although this subcommunity in the study region may not be exemplified by a particularly complex group of taxa, certainly the majority of the troglobites fall within the low payoff/low risk category.

Horizontal caves in general support a much less complex group of fauna. These fauna are generally localized within the twilight zone of the cave, and include a relatively high percentage of epigeal types. Here the community structure is also ineluctably related to energy input. The faunal assemblage is greatest in horizontal caves such as 043, where the organic debris introduced by terrestrial vertebrates provides a consistent subsistence base, or at locations such as 054, where the entrance room is sloping and acts to funnel in low payoff types of food.

Neither diversification nor specialization, then, seems to be mutually exclusive in terms of indicating stable cavernicolous ecosystems. Although the greatest numbers of troglobites in the study area are associated with low-risk energy input situations, they evidently consist of a few taxa highly adapted for subsisting on a wide range of low-calorie organic materials. Predatory troglobites seem to be adapted to ingestion of a range of fauna which include epigeal forms as well as cave adapted exploiters of vegetative debris. Other cave fauna are made up largely of epigeal or troglomorphic taxa which are diversified to the point of being able to utilize high energy food resources in caves as well as elsewhere.

Although a considerable range of vertebrate fauna was identified as utilizing caves, none could be argued as cave adapted. Undoubtedly the fecal material and other residue introduced by some of these denizens in part support a troglobitic invertebrate population. Bats are only sporadic users of any one cave system (with the exception of a possible nursery in Crystal Stanislaus Cave). They thus represent a relatively unimportant element of the project-specific cave taxa. None of the fauna known to frequent the caves in the project area are currently on the Rare or Endangered Species lists, although some may be eligible for inclusion on these rosters.

ARCHAEOLOGICAL RESEARCH FRAMEWORK

The archaeology of the Mother Lode region is considerably better understood than the data base for the other

disciplines comprising this survey. This should not be taken as an indication that culture history and culture process in the central Sierra Nevada foothills is well controlled; indeed, the information available concerning prehistoric and protohistoric human activities is slight in comparison with the knowledge available from other parts of the California basin. Nonetheless, the archaeological studies done to date in the project area (cf. Greenwood, 1977; Johnson, 1973; Moratto, 1976) have provided some basic information and pointed out a number of avenues of constructive research. As made clear in the preliminary report (McEachern and Grady, 1977:38-39), it is inappropriate to consider the data potential of archaeological resources in caves exclusive of their surface counterparts. Thus, the archaeological research framework is directed primarily toward the elucidation of aspects of the investigative strategies defined by Moratto (1976:502-09). Although more fully documented in the preliminary report, the framework is summarized here.

All of the previous research suggests that the prehistoric and protohistoric use of caves was essentially specialized in nature. No occupation caves were positively identified by the survey, with the possible exception of Cave 025. In other words, the aboriginal use of caves constituted only a part of the range of behavior exhibited by the extinct user cultures.

It is also evident that most of these uses were only secondarily related to subsistence-settlement requirements. Mortuary caves, for example, were of very specific socioreligious import. Limited numbers of vertical caves functioned in this capacity, and only selected members of the user community were interred—often with abundant and elaborate funerary offerings. Similarly, calcite quarry caves were exploited as procurement sites for raw materials for what seems to be exclusively nonutilitarian end products. Thus, most of the cave usage was evidently related to socioeconomic concerns. This premise, when evaluated in conjunction with more general questions of regional archaeological process, should provide important information about cultural behavior other than that related to subsistence practices.

The diachronic and synchronic elements of human use of caves are also viable research concerns. Most of the information currently available, albeit circumstantial, suggests that the mortuary and calcite quarry caves were utilized for relatively limited periods of time. It is also possible that such resources were exploited either directly or indirectly by populations other than those inhabiting the region. These questions also can be profitably addressed within the context of future research.

The postindustrial use of caves is yet a third element to be considered during the mitigative phase. Again, the survey data suggest that historic use was limited and specialized. In the project area, storage and some short-term occupation have been documented. However the fact that in some instances, considerable time and effort were put into developing trails to some of these caves indicates that they were of more value to early Anglos than is currently recognized.

CAVE AREAS WITHIN THE NEW MELONES LAKE PROJECT

The cavernicolous geology to be affected by the New Melones Lake is limited to the upper arm of the Stanislaus River and Coyote Creek, in those regions of soluble limestone terrain. For the purposes of the report, that portion of the Stanislaus karst area included in the project boundaries can be divided into four sub-areas. The Stanislaus River Canyon includes caves which will be directly impacted by flooding as well as caves which will be indirectly impacted by recreational development and increased visitation. The three areas to be primarily affected by other impacts consist of the Coyote Creek, Grapevine Gulch, and Skunk Gulch Recreation Areas.

STANISLAUS RIVER CANYON

The Stanislaus River Canyon includes the area above the projected pool level to the top of the canyon on both sides of the river. Here, more than a river mile of nearly continuous radically foliated marble cliffs form a 200 m deep chasm. Vegetation is sparse, as much of the terrain is exposed limestone, but the most predominant flora consists of digger pine and chaparral.

Much of the canyon subarea will be inundated. Because of the nature of the topography, recreational use will be largely limited to boaters; no developmental facilities are planned for the canyon slopes.

Forty-four caves were recorded in the canyon by the survey project, 8 of which are archaeological sites. This count includes caves along the South Fork of the river, with Cave 054 being the most important.

COYOTE CREEK

The Coyote Creek Recreation Area is located on the Calaveras side of the upper arm of the Stanislaus River. As currently projected, the parcel includes approximately 476 acres. Vegetation consists of blue oak interspersed with chaparral, with riparian vegetation supported along the creek. The landscape is broken by a great fold in the Calaveras Formation limestone outcrop and the down-cutting of the steep-sided Coyote Creek Canyon. The creek flows under two natural travertine bridges.

The Lake Area Master Plan suggests that this parcel be developed for picnicing, hiking, caving, and interpretive education for a maximum day load of 500 persons. Planned facilities include a self-guiding interpretive nature trail leading to the natural bridges and an informal picnic area along Coyote Creek. Restrooms will be constructed at the parking lot and by the creek.

The recreation area is rich in cave resources, including 19 known caves. The two natural bridges, high in esthetic

value, will have unrestricted access. One of the caves, 010, is an extremely valuable archaeological and paleontological site that is recommended to be gated. The area also includes the "rockpile", a unique localized zone of well developed karst with a high cave density that was only partly investigated during this study.

SKUNK GULCH

The Skunk Gulch Recreation Area (426 acres) is located on the Calaveras side of the upper arm of the Stanislaus River and is bordered on the north by the Grapevine Gulch Recreation Area. Karst outcrops, part of a large marble block, become increasingly exposed in this area as they eventually drop sharply into the Stanislaus River Canyon. The upland hills here are vegetated with blue oaks and digger pine, while Skunk Gulch itself is lined with dense riparian vegetation.

Skunk Gulch will be developed for camping, picnicing, hiking, caving, and interpretive study for a maximum day load of 100 persons and an overnight load of 200 persons. Facilities include two small campgrounds, a boat access campsite, a picnic area, an interpretive hiking trail, parking lots, and restrooms.

Fifteen known caves occur in the recreation area boundaries. One famous archaeological cave, 018, is of major scientific value and is recommended to be gated and minimally developed. Cave 045 contains an exceedingly important paleontological deposit. Cave 027 is one of the better "sport" caves of the vicinity and may see heavy recreational use.

GRAPEVINE GULCH

Grapevine Gulch Recreational Area is located one mile upstream from the confluence of the main and south fork of the Stanislaus River in Calaveras County. Encompassing 491 acres, the area consists of zones of Calaveras Formation marble interfingering with schist. Vegetation includes scattered blue oak, digger pine, and ponderosa pine with some open grassland and limestone outcrops. The gulch areas are more densely vegetated with blue oak, black oak, and manzanita.

Designed for a maximum day load of 80 persons, the area will emphasize camping, hiking, and caving. Grapevine Gulch will be one of the last to be developed but will eventually have facilities for limited overnight and day use, including a hiking trail, campsites, parking lots, and a restroom.

The area includes 9 known caves, many of which already receive heavy use as recreational caves.

SIGNIFICANCE

The concept of significance within the realm of resource management has assumed a central role both in the justifying of any form of land use decision-making and in focusing the direction of management research undertaken as a result of that decision-making. Although the guidelines utilized for assigning significance are numerous, in all cases two broad categories must be considered: research values and public values. As should be evident, these values are not mutually exclusive. Nor are they consistently applicable. However, the management theorists who have spent time developing the concept generally agree upon the fact that significant resources must be evaluated from not only the perspective of research data potential, but also from the possibility of use and appreciation by all or selected elements of the public for more than scientific ends.

Given the dynamic nature of scientific research, it should be evident that any resource base that is the subject of research will have a myriad of recognizable values. Thus research significance is best supported by explicitly justifying scientific study in terms of a broad-based substantive avenue of inquiry that makes responsible use of the recognized data potential. The research frameworks and significance discussions in this report follow this lead.

Public values are more difficult to define—in part because scientists have not yet developed a sophisticated approach to considering this perspective. Yet some provisions must be made for recognizing the public importance of cave resources in terms of general lay interest, educational potential, ethnic value, etc. These considerations are developed within the cave areas, site-specific significance, and mitigation and recommendations sections.

GEOLOGICAL SIGNIFICANCE

The caves within the New Melones Reservoir area and their contents are geologically significant for a number of reasons. One of the most critical is that they may well comprise the only stratigraphic record of the Quaternary (and perhaps the Pliocene) in the area. The contextual data incorporated in such subterranean deposits are expected to provide a relatively undisturbed and consistent indication of the depositional history and the mechanisms responsible for the extant geomorphology of the upper Stanislaus River drainage.

To the extent that these data can be correlated with speleothem growth analysis, independent evidence can be brought to bear on stratigraphic interpretations. Considerable research has recently been devoted to the dating of depositional events in caves based on uranium-thorium analysis. Such studies have proven to be very promising as a means of clarifying cave-related geological developments that are regional in scope.

Speleothems may also be of value in interpreting paleotemperature. Using oxygen-isotope analysis, scientists are having considerable success in deriving projections of past climatic conditions based on the growth characteristics of dated speleothems in conjunction with assessment of

unstable oxygen decomposition rates (c.f., Harman, 1971a, 1971b; Howard and Howard, 1972). The feasibility of applying these studies to formations in caves of the New Melones area remains unknown and is therefore of potential significance. If it is possible to obtain information relating to regional paleoclimate from speleothems, paleoenvironmental reconstruction would be considerably enhanced.

The value of cave deposits is made even more important by the geological development of the Stanislaus River drainage. The river has left no relict terraces in its down-cutting through the Calaveras Formation. This, coupled with the fact that hydraulic mining, dredging, and other forms of ore recovery have destroyed any evident context within upland Quaternary deposits, indicates that the caves may have the only remaining intact record of regional geological development. They also may have the only locally available biological indicators of past environments. Indeed, late Quaternary surface deposits within the direct impact zone are so poorly preserved that Moratto (1976: 457) has suggested that paleoenvironmental data be collected outside the project area to provide an undisturbed base for environmental reconstruction.

The geological significance of the caves in the region is also related to speleogenesis. Although little has been written about the evolution of California caves in general and central Sierra Nevada foothill caves in specific, it is evident that the origin and evolution of many karst features within the study region cannot be explained by recourse to the uncritical use of traditional mechanisms of limestone or marble solutioning. As previously hypothesized, the predominantly vertical nature of Mother Lode caves and their relationship to surface features requires study on a regionally-specific level. Only then can the complexities of cave development within the Calaveras Formation begin to be understood.

PALEONTOLOGICAL SIGNIFICANCE

The significance of caves for vertebrate paleontology has been recognized since 1823 with William Buckland's classic work *Reliquiae Diluvianae; or observation on the organic remains contained in caves, fissures, and diluvial gravel, and other geological phenomena attesting the action of a Universal Deluge* (Boylan, 1967). Cave deposits are of particular value in containing data useful to interpret past animal life in comparison with open sites. The dichotomy has been recently discussed by Harris from the perspective of responsible cave resource management.

Were caves merely equivalent to open sites, little attention would be given to them due to their relative rarity. To the contrary, however, there are features of caves that make them unique among fossil sites. Caves open to the surface are possible in areas where erosion rather than deposition is the dominant geological process. Under such conditions, a cave may be the only source of fossils for a region...

Despite the advantages of possible occurrences where no other fossils occur, despite the possible advantages in dating, and despite the possibilities of preservation of kinds of structures unknown from open sites, the biggest value of cave fossil biotas is in their differences in makeup from those in open sites...

Caves... often represent a larger segment of a contemporary biota than do open sites, though the concomitant disadvantage of having separate communities intermixed in the fill makes study difficult...

In short fossil cave faunas often give data obtainable in no other way and from no other place (1975: 19-20).

The importance of cave faunas in developing an understanding of Pleistocene life cannot be overemphasized. This is true worldwide (Sutcliffe, 1976), but it is particularly accurate for northern California. The faunas of Potter Creek Cave, Samwel Cave, and Hawver Cave have provided very nearly all that is known about the late Pleistocene animals of northern California. Isolated finds of large mammals such as *Bison* and *Mammuthus* are relatively frequent in the state, and attract considerable local attention. But it is the less spectacular cave discoveries, usually consisting almost entirely of animals of small and medium size, which provide the best approximations of the range of Pleistocene fauna.

Unfortunately, paleontological studies of the aforementioned caves were completed long ago and cannot be repeated. Hawver Cave has been destroyed, and recent inspections of Potter Creek and Samwel Caves by J. Munthe indicate that these sites can no longer be utilized feasibly in detailed faunal studies. Extensive excavations made between 1902 and 1905, as well as subsequent digging by amateurs, has either completely removed the deposits (as in the Pleistocene Room of Samwel Cave) or destroyed the stratigraphic context of the known fossil-bearing strata (as in Furlong's Pit of Samwel Cave and Potter Creek Cave). Not only do these circumstances preclude the addition of new taxa to the cave faunas (techniques current in 1900-1910 failed to recover many of the small mammal fossils), but they leave fundamental questions unanswered. For instance, was man contemporaneous with Pleistocene animals in California? Despite the fact that this concern was the primary purpose of California's first cave survey (Munthe, 1975), seventy years of research has failed to produce conclusive evidence for either position (Payen and Taylor, 1976). Also, how old are the Pleistocene cave faunas? Radiometric dating was not developed at the time of the original studies, and only one radiocarbon date on fossil bone from a northern California cave has so far been published (Payen and Taylor, 1976). The value of even this single date is reduced by the uncertain stratigraphic context of the specimen relative to the published faunas from the cave. Dating of expendable material in the large collections of fossil bone from Samwel, Potter Creek, and Hawver Caves is now impossible due to the organic preservatives which were applied to the specimens many years ago.

It is clear, then, that the previously described Pleistocene cave faunas of northern California have not yet provided (and may never be able to provide) the types of information necessary to modern paleofaunal studies. New Pleistocene vertebrate deposits in northern California caves must be

examined to: (1) facilitate comparisons with the major Pleistocene faunas of southern California (cf. Rancho La Brea and McKittrick); (2) expand the inventory of northern California late Pleistocene animals; (3) analyze the paleoecology of these animals, and (4) determine whether or not man was contemporary with any extinct taxa in California.

Only two areas in northern California could potentially produce the data required for studies such as those described above. One is the outcrops of McCloud and Hosselkus Limestones immediately north of Shasta Lake in Shasta County (Munthe and Hirschfeld, 1973). Potter Creek and Samwel Caves are located here as well as a number of other small caves. Preliminary field studies indicate that of approximately a dozen known caves in this region, only one or two contain potentially significant fossil deposits (J. Munthe, n.d.). Therefore, although the paleontological value of Shasta area caves is imperfectly known, they appear to offer far less paleontological potential than the much more numerous caves within the second area—the marble outcrops of the Calaveras Limestone, an important part of which falls within the boundaries of the present survey.

In fact, certain caves within the project area appear to represent one of the last opportunities to recover vital information from late Pleistocene faunas of the caves of northern California concerning their age, composition, paleoecology, and possible association with man. This resource has continued to be damaged by land use practices since the gold mining period of the last century. Important elements of the remaining data base will be destroyed by flooding and/or increased human activity when recreation areas are established and developed and cave locations become more widely known. It is therefore necessary to complete detailed paleontological studies of the caves to be impacted in the project area that contain these resources *before* that impact takes place.

TAPHONOMIC SIGNIFICANCE

The animal remains which are presently accumulating or have recently been brought into the caves of the project area are a significant and fragile part of the natural history resource. These remains and their physical, geological, and biological context provide the most direct and objective information available concerning the relationships between the living fauna, the preservable record of that fauna, and the natural agents which assemble and alter the depositional record. An adequate understanding of these relationships, in turn, is prerequisite to paleoecologic interpretation of the fossil faunas and to unravelling the cultural or ecological meaning of faunal remains associated with evidences of human activity.

The studies of the mechanisms and features of recent bone accumulations as well as interpretation of the modes of accumulation of buried assemblages fall within the realm of *taphonomy*, the science which concerns itself with all aspects of the transition from living to buried assemblages or organisms. Investigations of contemporary accumulations provide the factual basis for the science because the processes of accumulation and the responsible agents can be directly observed or readily inferred from evidence which is not usually associated with long buried

assemblages (e.g., scat, tracks, vegetational elements, and ephemeral physical features). Links can then be established between known histories of bone accumulation and features which are observable in paleontological deposits.

By comparing the relative representation of different species whose remains appear in the recent bone assemblages with the known relative abundance of species in the living fauna of the area, two goals can be achieved. Data on contemporary animal ethology can be examined, and this information can be assessed and applied to the interpretation of comparable fossil assemblages.

The variety and abundance of recent and fossil bone accumulations in caves of the project area offer unique opportunities for a comprehensive comparative study in which taphonomic models could be established and tested. The initial survey has revealed numerous recent accumulations which fall in three broad categories: those in which the represented animals walked or fell into a cave, those in which they were carried to the site by collectors such as packrats or porcupines, and those in which the inhabitants actually used or occupied the cave and died *in situ*. Assemblages in each of these categories may have been produced by any of several specific agents and subsequently modified by further biological or physical alterations. Each of the resulting kinds of assemblages will carry different kinds of interpretive information. Only a broad-based comparative study of these varied recent assemblage types can show to what extent comparable fossil assemblages can be recognized and used for paleoecologic interpretation. No other karst terrain duplicates the combination of physical and biological conditions now prevailing in the project area. Nor does any other region approximate as closely those which affected the fossil accumulations. Recent taphonomic studies done in this area would therefore be far more useful for paleoecologic studies of the project area fossil faunas than any that might be done elsewhere.

Although conclusions derived from such research will emphasize applicability to local paleontological, and less directly to archaeological investigations, they would not be of only local importance. If the results of the study allow the most significant depositional factors operating on the taphonomic record to be isolated, the conclusions should be relevant to any area in which the same or similar factors operate. Should similar patterns appear in assemblages with somewhat varied histories, broader generalizations with wider applicability could be derived.

Thus taphonomic research is particularly significant and merits responsible study in the project region for several reasons: The importance and feasibility of detailed paleoecologic studies of terrestrial fossil assemblages and the usefulness of taphonomy in these studies have been realized only within the last few years, and only within the last decade have more than a handful of workers actively pursued such studies. Important contributions to cave taphonomy have been stimulated by renewed investigations of early man sites in Africa (Brain, 1967; 1974; *in press*; Sutcliffe, 1970). However, conclusions drawn from these studies are largely applicable to North American small mammal assemblages. Secondly, few other areas of North America offer the diversity of vertebrate species (Simpson, 1964) and cave types and settings preserving the taphonomic remains of these taxa than the cave resources which occur within the project area.

BIOLOGICAL SIGNIFICANCE

The importance of biological organisms in cave systems is one of the more widely recognized values among those familiar with caves. However, aside from the spectacular nature of certain cave adapted fauna such as blind and depigmented fish and crustaceans—which then become objects of some public interest—cave ecosystems are not commonly recognized as being a significant element of the overall environment.

A considerable amount of research on biospeleology has been implemented, and a body of literature is available that indicates the scientific significance of caves as natural zoological laboratories. Among environmental scientists, cave research of this nature has assumed importance because cave ecosystems function as simplified models for more common terrestrial components of the environment—particularly the basic soil-related subsystems. Biospeleological studies can monitor and control, for example, the rates and kinds of food supplied to cavernicoles and observe the effects of such manipulations on community structure. Because these communities are relatively simple and easily observed in their natural habitats, the documentation of normal behavior is facilitated. Caves are often accessible year-round and the effects of seasonal change on the ecosystem can be recorded under somewhat controlled circumstances. Questions concerning long-term community stability and change can also be effectively evaluated in caves where the spatial distribution of the populations is somewhat restricted and the communities can be relocated and examined over long periods of time.

Such research has led to the understanding of some basic questions posed in biological and ecological theory. Information has been collected about such processes as population fluctuation that is not associated with environmental variation or other forms of external influence. The largely closed nature of cave communities has illuminated factors of coevolution among interacting species—particularly prey-predator relationships. And the adaptive changes manifested in the biology of cave fauna—not only the reduction and simplification of optical and pigment physiology, but also the correlated development of other sensory organs, appendage attenuation, and cave-specific bioenergetic and reproductive patterns—have shed considerable "light" on the relationships between natural selection and genetic plasticity in the evolution of many lower forms of animal life.

A certain amount of this research has taken place in California caves, and sporadic studies have occurred in selected caves in the central Sierra Nevada foothills, as noted in previous sections of this report. Those studies indicate that the region is a particularly appropriate natural laboratory for such research. The caves are numerous, display similar speleogenesis, and are distributed in broadly equivalent ecological zones. Thus the potential for comparative study is high. Yet many of these cave systems exhibit diversity as well. Located in isolated marble outcrops, biospeleological communities are influenced by a certain level of spatial discontinuity. Cave configurations (e.g., horizontal and vertical entrance attributes) are differentially distributed throughout the region, and are developed at all elevations where the marble has been exposed.

The significance of the region from a biospeleological perspective, then, relates in large part to the fact that the caves are numerous, yet somewhat variable in nature. They are distributed over a range of physiographic settings, and many are isolated by intervening nonsoluble rock. Thus, the study of cave biota can benefit from the fact that comparative research can take place in distinct but similar cave ecosystems. Research can also emphasize a controlled range of differences in caves, producing information on biological variability correlated with these differences. The fact that cave adapted fauna exist in the caves and can be profitably studied has been demonstrated. Such study, however, has yet to tap the potential afforded by the region.

The research completed by the survey personnel is in itself a powerful indicator of the importance of cave-related fauna within the project area. Few areas of the world are known to support the numbers and varieties of cavernicolous invertebrates recorded as a part of this study. Their significance is increased by the fact that the fauna are relatively localized and thus can be considered somewhat unique in terms of the potential for their existing in similar relationships outside of the Mother Lode karst region. The region is truly a critical area for biospeleological research, and the terrain to be impacted by the New Melones Reservoir is currently of the most importance in understanding the biospeleology. For the reservoir impact will not only result in the disturbance or destruction of a relatively large portion of this region but also will inundate the locality now recognized as having the most potential in the western United States for biospeleological research. This potential is manifested by an impressive assemblage of invertebrate fauna that span the adaptive range from true troglobites to troglloxenes (figs. 11 and 12). Although some local fauna demonstrate genetic ties with taxa in other parts of the world, many are unique to the region and locality, and the community mosaic created by these forms is not duplicated elsewhere. Thus the potential for the cave adapted fauna of the project area to provide information on local, regional, and world-wide questions of ecological subsystemic interaction, microevolutionary process, and adaptive parallelism and divergence is unexcelled.

CULTURAL SIGNIFICANCE

It has long been recognized that caves and rockshelters provide one of the most complete cultural inventories available to archaeological researchers. The preservational characteristics of these sites are such that perishable materials generally not available in open sites can be recovered. These data not only expand the available knowledge concerning adaptive patterns reflective of particular groups but also provide a comprehensive record of human use of the area through time.

As stated by Moratto (1976:501), regional cultural significance cannot be viewed within the confines of the Stanislaus River drainage. Responsible and comprehensive understanding of culture history and process in the central Sierra Nevada foothills requires that the caves of archaeological significance be studied from such a perspective. The following discussion of cultural significance, then, stresses the caves in this region in relation to current understanding of New World prehistory in general, the archaeology of the central Sierra Nevada foothills and the central valley, and the project area in specific. In light of this perspective, several regional research questions have been identified, most of which have been proposed by Moratto in relationship to the archaeology of the region (1976:502-09).

The cave inventory within the Stanislaus River karst area has the potential for shedding light on a debate that has plagued New World archaeology for 70 years. A bone artifact located in Cave 025 (Fig. 13) is very similar to the artifacts found in Potter Creek Cave, Shasta County, by George Putnam. Putnam declared that the items were in definite association with extinct megafauna, thus proving that man was present in California during the Late Pleistocene. Krieger (cf. 1964) and Bryan (1965) supported Putnam's position, arguing that the artifacts were components of a preprojectile point horizon. Other investigators believe the objects to be of natural origin. The cave was again studied in 1965. Radiocarbon dates obtained subsequent to that investigation suggested that the bone material recovered in 1903 was at least 8000 years old



FIGURE 11. Pseudoscorpion, Cave 045.



FIGURE 12. Pseudoscorpion and Harvestman, Cave 051.



FIGURE 13. Bone tool, Cave 025.

(Payen and Taylor, 1976). Payen also reexamined the associated bone specimens and concluded that they were not the result of human work. Cultural items recovered from demonstrated archaeological strata near the cave entrance were originally assigned a tentative date of between 1000 B.C. and A.D. 300 (Payen, 1970). They were later dated from 2050 to 3250 B.P. (Payen and Taylor, 1976). Thus, the 1965 study does not provide unequivocal evidence supporting or disconfirming man-Pleistocene faunal associations.

The debate has resurfaced due to the reputed discovery of a bone industry preceding the earliest known lithic assemblages in Alaska (Cook, personal communication). If such an assemblage was identified in the New Melones Project area, it would provide the basis for a series of critical reassessments of early California prehistory as well as the antiquity of man in the New World.

The cave resources within the project area provide an important opportunity to study the relationships between culture and environment in the region as well. Information currently available suggests that the caves are time capsules of paleoenvironmental information which, in conjunction with correlable archaeological remains, will provide a wealth of information concerning extinct man-land relationships. It is already evident that the prehistoric peoples were adapted to an environmental context of impressive diversity. This diversity, as identifiable from cave deposits, can be assessed in terms of abundant recent to subrecent microbiotic remains, which will indicate much about subsistence patterns and protoenvironments; fine-grained sediment fills, which are important for interpreting extinct climatic and hydrologic conditions; and calcite formations, which are sensitive indicators of chronology, paleoclimate,

and paleotemperature.

Chronological questions can also be addressed by recourse to the New Melones cave data. The cultural chronology that is used for the New Melones Reservoir region, based on the excavation of open sites, only extends back in time for approximately 1500 years (Middle Horizon). Explanations for the lack of earlier material in the region have been proposed by Johnson (1973), Moratto (1976), and Moratto and Riley (1974). These models suggest that the foothills of the Sierras were largely uninhabited during the early time periods identified from archaeological sites in the Central Valley of California. On the other hand, since the history of human occupation in the High Sierras is known to extend back in time for at least 8,000 years based on radiocarbon dates (Elston, 1971), possibly man was exploiting the foothills at an equally early date. It may well be that this data gap is a result of the effects of biophysical processes which have obscured earlier open sites. It may also be a manifestation of the tendency of some California archaeologists to direct their research toward sites or portions of sites that have well-developed middens. Resolution of this question might be achieved in the study of archaeological caves in the New Melones Reservoir area. Not only could such caves preserve occupational deposits of considerable antiquity, but careful analysis of the calcite from known prehistoric quarries in the project area might prove that they were the sources of calcite artifacts dating to cultural periods in the Central Valley that predate 300 A.D.

Both Moratto (1976) and King (1972) have discussed the archaeological evidence for sociopolitical organization in California. In particular, the evolution of political differentiation as distinguished in the archaeological record has been modelled and proposed for testing in the state. The specialized use of certain caves in the project area would



FIGURE 14. Abalone shell ornament, Cave 010.



FIGURE 15. Steatite bowl fragment, Cave 010.

provide important evidence to evaluate these propositions. The high curate value and particular significance of calcite as a luxury good has considerable relevance to such models. In addition, the selection of certain caves within and immediately adjacent to the project area for mortuary chambers provides an empirical data base of critical significance to the testing of such models and hypotheses.

Prehistoric demography is also an issue isolated by Moratto as worthy of investigation within the context of archaeological research in the project area. If indeed there was an increase in population size during the late prehistoric periods, this should be represented in the use of caves both as shelters and mortuary chambers. Population intrusion should also be demonstrable in a radical shift in cave use practices, or abrupt termination of such usage.

The role of caves in prehistoric exchange networks, a third issue posed for consideration by Moratto (1976) is relevant as well. There is no question that the caves in general and the mortuary chambers in specific have an artifact assemblage of somewhat unique composition (figs. 14 and 15). The high frequencies of exotic ornaments in burial caves have important implications for clarifying such exchange networks. The obviously central role that was held by calcite in this network requires inclusion of the caves within such a research framework.

Moratto also makes a case for directing research toward the evaluation of the nature of Basin-Sierra cultural affiliation. Again, the specialized nature of cave usage within the Sierran settlement-subsistence pattern makes the archaeological caves in the project area an important component of study directed toward the solution of this problem.

Additional research questions outlined by Moratto, such as the study of human skeletal remains, should include data derived from caves. The mortuary chambers in par-



FIGURE 16. Nail scatter, Cave 059.

ticular may well provide the most complete skeletal populations available in the Stanislaus River karst area.

The historical significance of the caves within the impact zones cannot be discounted, although it does not assume the complexity of aboriginal use of this resource base. Short-term habitation and specialized storage has been demonstrated for selected caves within the gross pool level (fig. 16). Others may have been mined during the gold rush period (fig. 17). Some caves were evidently of enough importance to nineteenth century individuals that they went to considerable trouble to construct spur trails to these sites (primarily Caves 046 and 047).

In summary, the regional significance of the archaeological caves in the project region, although broad in scope, relates primarily to the range of the data available within them and to their relatively unique character with respect to context of the overall central California cultural system. There is little question that almost all of these sites

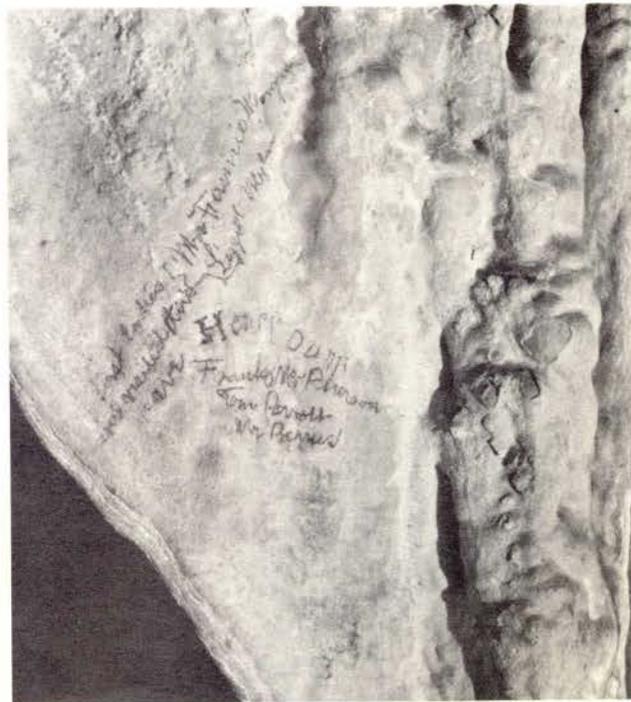


FIGURE 17. Historic signatures, Cave 010.

were key components of a specialized and poorly understood element of this system. Most were the focus of socio-ritualistic activities which may well have served as the nexus of organizational centralization and redistribution of wealth. The fact that such propositions can be explicitly tested within the context of the New Melones Reservoir region is of major importance.

Consideration of the role of caves within the Stanislaus River drainage is also a key to understanding local adaptation. For one thing, the area to be directly and indirectly impacted by the dam construction and water impoundment includes a high percentage of the karst terrain present within a three county radius. Thus the cave resources within the drainages assume critical status in that a greater percentage of cave-related resources will be affected by reservoir completion than other natural and cultural manifestations within the region.

It is also important to note that the characteristics of the caves in the gross pool zone differ from those above this zone. Such situations have significant implications within the project area in terms of the cultural materials. Most of the caves to be impacted by the gross pool are more recent in origin than those above the gross pool. Few of the former caves are vertical in nature, and several display more solutional complexity than those above the zone to be permanently inundated. On the other hand, the caves slated for preservation and other forms of management are generally remnants of older cave systems that developed higher in the canyons. Many are vertical, and solutional events may have been quite different.

These differences have important implications for the distribution and varieties of cultural remains in such caves. Cave-related occupations most directly associated with riparian exploitation practices in the project area will most likely all be inundated. Most of the shelters will be flooded.

On the other hand, the localities selected for preservation emphasize vertical cave systems of a less complex nature. Whereas shelters are less in evidence, burial caves make up a disproportionately high percentage of the resource base. Thus the impact of the project on the caves will not be reflective of the range of archaeological caves in the New Melones Reservoir area. Rather some aspects of the total cultural system will be primarily or completely lost as a result of the project. Others will be overemphasized in terms of their providing a representative sample of the range of settlement-subsistence variability extant within the central Sierra Nevada foothills.

Locality-specific significance cannot be discounted. From a functional perspective, the caves of archaeological importance fall into five broad categories: quarry caves, prehistoric "occupation" caves, historic occupation caves, historic storage caves, and mortuary caves. Significance at this level is discussed within the description of each site.

OVERALL SIGNIFICANCE

In the previous section the significance of various cave resources was established in terms of their individual research potential. However, it should be noted that the occurrence of many types of resource significance within a single area is in itself important and unusual. The value of individual resources is increased considerably when they occur together, particularly when they can be related in interdisciplinary fashion. The potential of the area for supporting integrated speleological research makes the overall significance of the study area cave resources much greater than simply the sum of individual values.

NATIONAL REGISTER OF HISTORIC PLACES ELIGIBILITY

The foregoing discussion of significance is designed in part to provide the information necessary to determine archaeological site eligibility to the National Register of Historic Places. Fifteen caves have been assessed with respect to the eligibility criteria defined in 36 CFR 800 and other relevant regulations and guidelines. All have been determined eligible to the National Register (Table 2).

TABLE 2. Cave Sites Eligible for the National Register of Historic Places

003 (Ca-Cal-646)	024 (Ca-Tuo-770)	048 (Ca-Tuo-773)
005 (Ca-Tuo-769)	025 (Ca-Cal-648)	056 (Ca-Tuo-774)
007 (Ca-Cal-647)	032 (Ca-Cal-649)	059 (Ca-Tuo-775)
010 (Cal-S-435)	046 (Ca-Tuo-771)	069 (Ca-Tuo-776)
018 (Cal-S-9)	047 (Ca-Tuo-772)	077 (Cal-S-18)

NATIONAL REGISTRY OF NATURAL LANDMARKS ELIGIBILITY

One of the few comparative bases available to governmental agencies for evaluating the importance of natural resources is the approach taken to determine the eligibility of natural features and areas to the National Registry of Natural Landmarks. As presented in 38 CFR Part 171, the National Park Service has developed a set of natural history themes and criteria within which landmark status is assessed. The following discussion considers the recognized natural resource values of the Mother Lode karst in general and the project area terrain in specific with reference to National Registry specifications.

No discussion of impact area qualification to the National Registry would be adequate without considering the larger karst system of which the project area caves are a part. As noted in the introductory environmental summary, the karst exposed along the Stanislaus River is the largest of the outcrops of Calaveras Formation marble and is the best and most representative example of the karst island development in an otherwise insoluble lithologic region. The Stanislaus Karst Area can be defined as that area of Calaveras Formation marble that is overlain by Table Mountain to the north (immediately north of the project area) and extends south in a band several miles wide to a point just south of the historic town of Columbia (fig. 4). This area corresponds with the boundaries defined by Squire (1972) for the Stanislaus cave country with the addition of Table Mountain. The Stanislaus Karst Area is unique in that it is an example of an older karst that was first covered by volcanic ash and Table Mountain Latite, then reexposed by the downcutting of the Stanislaus River, and is now in the process of renewed karst development.

The region is further unusual in that its parent material is marble, whereas most karst forms in limestone. The foliation of this marble dips steeply instead of lying flat as is most commonly encountered.

These morphological factors have resulted in the development of rather unusual cave speleogens, and polished marble walls.

And finally, Table Mountain itself is a widely recognized classic example of topographic reversal as a geologic process (Sheldon, 1966).

The National Registry eligibility evaluation is based on the relationship of the area to one or more of 35 natural history themes. These themes are crosscut by a series of criteria to be considered under each theme.

Of the 35 themes listed, at least 11 are pertinent to the Stanislaus Karst Area:

LANDFORMS OF THE PRESENT

1. Plains, plateaus, mesas
2. Mountain systems
3. Works of volcanism
4. Sculpture of the land
5. River systems and lakes
6. Caves and springs

GEOLOGICAL HISTORY OF THE EARTH

7. Mississippian-Triassic

8. Permian-Cretaceous
9. Paleocene-Eocene
10. Oligocene-Recent

AQUATIC ECOSYSTEMS

11. Underground Ecosystems

1. Plains, Plateaus and Mesas

The area under consideration is a gently dipping plateau on which are situated the historic towns of Columbia, Vallecito, Altaville, and Angels Camp. The surface of the plateau is rolling, with portions having been dissected by the Stanislaus river and its tributaries. This plateau is related to earlier Tertiary plains, the latter of which were removed through denudation and drainage system downcutting (Lindgren, 1911). However, the extant plain seems to have been modified considerably during the Quaternary as well.

2. Mountain Systems

The Westward-dipping plateau mentioned above is a part of the great tilted block of the Sierra Nevada, one of the great mountain systems in the world. Perhaps the most striking feature of the Sierra Nevada is its structural unity; it forms an enormous, 400-mile-long single tilted block. Most drainage systems, such as the Stanislaus River, run directly down its west side in roughly parallel courses. The pre-Cenozoic rocks of the project area—granite, marble, and schist—reflect the building of earlier mountain ranges and island arcs, and illustrate great changes in the plate tectonic pattern of the earth's crust (Schwiekert and Wright, 1975).

3. Works of Volcanism

Table Mountain is a lava flow which, approximately 9 million years ago, flowed down an Eocene river channel. It is an excellent example of the mobility of lava because it issued from vents in the Dardanelles Cone area, some 40 miles to the northeast (Ransome, 1894; Slemmons, 1966). Table Mountain, at a site adjacent to the project area, is the type locality for the rock "latite" (Ransome, 1898).

4. Sculpture of the Land

Two aspects of the region exemplify the sculpture of the land by erosion: Table Mountain and the overall Stanislaus Karst Area. Table Mountain is now the highest point in the region of concern. Yet it was in the lowest portion, a river bed, when it was deposited. Since its emplacement, erosion has removed most of the softer rocks from around the harder latite, resulting in the present topographic inversion of the lava. Shelton (1966:334) presents Table Mountain as a classic example of such general erosional processes.

The karst topography in the project area is also an unusual example of sculpture of the land in having been solutioned primarily by mildly acidic rainwater. Most areas of karst are developed on flat-lying sedimentary rocks, and the sculpture at New Melones is extremely unusual, if not unique, in that the solutional features—caves, grikes,

fissures, etc.—have developed in vertically-dipping marble.

5. River Systems and Lakes

Three river systems are represented in the project area. The modern Stanislaus River is a perennial mountain stream with boulders common in its bed load, located in the bottom of a steep V-shaped canyon. The Table Mountain Latite followed an older (9 million years) channel, called the "Cataract Channel" by Lindgren (1911). Lindgren also recognized a yet earlier river in the area which he called the Calaveras River. This he inferred from channel deposits of the gold-bearing Auriferous Gravels which underlie the Table Mountain Latite in places.

6. Caves and Springs

The project area occupies one of the largest areas of karst terrain in California. Caves and similar subterranean solutional features are common, and are exceedingly important from numerous perspectives. This entire report is devoted to a more thorough discussion of the caves of the region and their significance.

7. Late Paleozoic Time (Mississippian-Triassic)

Although the sequence is not precisely known, the Calaveras Complex is late Paleozoic in age; the marble of the caves and the surrounding metavolcanic rocks were originally deposited as sediment and extrusive rocks during this time. The Calaveras Complex and its structures allow considerable inference about the distribution of land masses and of plate tectonics during this period.

8. Mesozoic Time (Permian-Cretaceous)

The deformation, metamorphism, and intrusion of the Calaveras Complex occurred during more than one orogenic episode of the Mesozoic. The events of this time changed the limestone to marble and thus determined many of the unusual qualities of the caves. The great granitic batholiths of the Sierra Nevada were also emplaced during the Mesozoic.

9. Paleocene-Eocene

The surface upon which the gold-bearing auriferous gravels lie is of Eocene age, as was the Calaveras River. The geometry of this surface and of the gravels allowed Lindgren (1911) to determine the course of the river. Grikes formed in the marble of the Calaveras Formation at this time, and cave deposits may have begun to form.

10. Oligocene-Recent

The present landscape developed during this period of time; the Eocene erosion surface was buried in volcanic rocks, including the Table Mountain Latite. Volcanism waned, and the Sierra Nevada structural block was tilted to the west and uplifted. The Stanislaus River flowed down the west side of the block, cutting through the Table Mountain Latite and uncovering the marble of the Calaveras Formation beneath. Much of the fill in the caves dates to this time period, and most of the inner, steep-walled canyon of the Stanislaus was formed by the end of the period.

11. Underground Ecosystems

The biological portions of this report document a unique series of faunas inhabiting the caves and fissures of the New Melones area. These probably comprise more than one isolated ecosystem. The nature of the distribution of these faunas raises several questions about speciation (more than one species of a genus in the same fauna), since their ecology is little known. The presence of aquatic

isopods in the cave faunas of the Stanislaus Karst Area indicates the likely presence of underground aquatic ecosystems as well, but these are basically unknown at present.

NATIONAL LANDMARK CRITERIA

In discussing National Landmark criteria a series of ten examples of the kinds of areas which could qualify for National Landmark designation have been given in the code of Federal Regulations. All of the examples, with the exception of number five, are in part descriptive of the Stanislaus Karst Area and are discussed below.

1. Outstanding geological formations or features significantly illustrating geologic processes:

The project area contains the following features which are illustrative of a range of geologic processes:

Calaveras Complex rocks	Metamorphism, deformation
Granitic Intrusives	Intrusion, orogeny
Eocene erosion surface and Auriferous Gravels	Erosional plantation, concentration of minerals by placer processes, fluvial processes
Valley Springs Formation	Violent volcanic eruptions and ashfalls, blanketing of a pre-existing terrain by tuff.
Table Mountain Latite	Flow of lava through a river channel to areas far from the source, topographic inversion
Mother Lode Karst	Weathering of rock by solution, preservation of fossils cave fills, creation of cave formations, invasion of caves by streams
Stanislaus River Canyon	Downcutting of rivers through rock, alluvial transport of very large particles during seasonal high flow, movement of deposits on canyon slopes through gravity

2. Significant fossil evidence of the development of life on earth.

The Stanislaus Karst Area is a major Pleistocene locality comparable to the caves of the Shasta karst region, the Rancho La Brea tar pits, and other Quaternary fossil localities. More significantly, the Stanislaus Karst has not been extensively studied by paleontologists and remains almost intact. Evaluation of the stratigraphic record and the geomorphology of the region indicate that both Eocene and Pliocene fissure fills containing fossil fauna may exist there. While none of the fissure fills examined in the study could be definitely identified as Pliocene or earlier, the possibility that such material may exist locally cannot be dismissed. No pre-Pleistocene cave faunas have yet been found in North America and identification of such deposits would be of international significance.

3. An ecological community significantly illustrating characteristics of a physiographic province or a biome.

The nature of the regional karst terrain as manifested

by isolated marble pods of the Calaveras Formation is a classic example of this criterion. The variability and density of the cave-related fauna both within the study region and in adjoining localities attests to the fact that these biota exemplify the successful adaptation to a particular habitat—in this case, caves. The limited research that has occurred to date demonstrates that the cave life studied as a part of this project is characteristic of cavernicolous invertebrate communities, and likely is comparable to no other region aside from the Shasta area karst from this perspective.

4. A biota of relative stability maintaining itself under prevailing natural conditions, such as a climatic climax community.

The preliminary taxonomic research that has resulted from this study indicates that much of the cave-adapted fauna may have been a part of a stable climax community. Although some of the taxa have genetic associations ranging throughout the world, most of the troglophiles show successional associations with other forms endemic to the localized karst outcrops in the region. Since these outcrops were separated during the Eocene, the long-term nature of the cave ecosystems is strongly supported.

6. A habitat supporting a vanishing, rare, or restricted species.

The cavernicolous invertebrates are both rare and restricted. In many instances, only one species—described for the study area—is known. Taxa are not only restricted within the karst terrain of the Calaveras Formation, but many are confined to single cave systems. And not only are these species rare and restricted, but they are exceedingly sensitive to environmental disruption. Thus the necessity for managing and protecting such a fragile ecosystem is paramount.

7. A relict flora or fauna persisting from an earlier period.

The likelihood of cavernicolous invertebrate community survival from as early as the Eocene has been previously noted as a likely possibility. Future research can clarify the nature and implications of relict cave-adapted taxa, but considerable evidence exists in support of this contention.

8. ... a vantage point for observing concentrated populations, such as a constricted migration route.

One of the most important aspects of truly troglomorphic biota is that they are contained within essentially closed ecological systems—caves. The fact that these systems are spatially extremely limited makes them not only a valuable natural laboratory but also means that minor disruptions of the ecosystem can have catastrophic results. In this case, a number of concentrated cavernicolous populations exist in the area, each with its unique community configuration. They represent phenomenal potential for investigating in microcosm the ramifications of community evolution, stability, and change.

9. A site containing significant evidence illustrating important scientific discoveries.

During the tour of the southern mines when J. D. Whitney acquired the infamous Calaveras skull, he stopped and visited Cave 018. W. H. Holmes later demonstrated that the skull had actually come from a cave (possibly 018). Holmes' work, of international import, demonstrated the need for rigorous controls in the study of natural history and illustrated the use of careful analytical methods in exposing a scientific hoax.

10. Examples of the scenic grandeur of our natural heritage.

While parts of the scenic quality of the Stanislaus Karst Area have been degraded by marble quarrying, the bulk of the karst remains unspoiled. Spectacular marble cliffs tower above the rugged canyon, with Table Mountain superimposed over the rest of the landscape (fig. 3).

In conclusion it should be noted that the Stanislaus Karst Area possesses an impressive range of resource values, any one of which could make it eligible for the National Registry. The fact that so many values are concentrated within this study area suggests that it should be nominated to the National Registry of Natural Landmarks. This recommendation represents the professional opinion of the assemblers of this report. It is further concluded that the region circumscribed in the previous discussion qualifies for National Registry status despite the development of the New Melones Reservoir, and this perspective should be maintained when further determinations of eligibility are made.

IMPACTS OF THE PROJECT ON THE RESOURCES

The potential and realized impacts of the development of the New Melones Reservoir and associated recreational areas has been considered according to a number of approaches. These consist of cost or benefit of impact, source of impact, and the values subject to impact. The cost or benefit of impact varies with the impact source and the value being considered. Very few positive impacts are noted; the project will have almost exclusively negative effect upon the resource base. Sources of impact are divided into direct impacts (partial, periodic or permanent flooding), direct and indirect impacts (increased development and surface modification of the project area), and indirect impacts (increased visitation to the caves). Values considered are geological, paleontological, taphonomic, biological, archaeological (includes historic), esthetic, and recreational (Tables 3 through 10).

VALUES TO BE IMPACTED

1. Archaeological. For the purposes of this particular discussion, archaeology consists of all manifestations of past human activities in and directly associated with caves. These include the archaeological record in cave deposits (mortuary cave matrices, discarded quarrying materials, historic artifacts, grinding surfaces, structures, etc.), evidence on other parts of the cave surface (smoke blackening, quarry faces, historic signatures, etc.), and cultural materials in the cave entrance area (artifacts, organic deposition, etc.). Because most of the value of archaeological remains lies in their physical and structural (stratigraphic) relations to each other, even the reorientation of cultural materials can be as destructive as their breakage or removal from the cave.

2. The geological value of caves is derived from the record of the earth's history that is contained in them. Speleogens (features sculpted into the parent rock of the cave) provide clues to geomorphological origin and development in terms of physical processes operating on land forms. Speleothems (depositional features in caves) contain paleoclimatic information of considerable value. Cave sediments are ultimately derived from the surface and reflect past surface conditions. And finally, the overall geological study of particular caves yields significant data about how that underground system itself formed.

3. Paleontological and taphonomic values are incorporated primarily within surface-derived deposits that contain a record of extinct and extant animal activities. These values may be reflected in the form of primarily deposited osteological materials, coprolites, and regurgitative remains. Since much of this evidence is present on the surfaces of cave floors, the same contextual concerns must be advanced in evaluating these values as in considering impact on archaeological remains.

4. Biological values are some of the most significant and poorly understood considerations to be made in impact assessment. A surprising amount of biota inhabit caves, ranging from completely cave-adapted life (troglobites)

through partially adapted forms (troglaphiles) to largely epigeal taxa (trogloxenes). Yet all are a part of the complex and often fragile life-support network that maintains the cave ecosystem. Many of these forms are small and inconspicuous and are dependent for their survival upon often innocuous materials (such as fecal remains, vegetative litter, etc.) that are strategically located within the caves. The system can be easily disturbed or destroyed by physically modifying the habitat, leaving toxic substances in caves, and—in the case of some troglabites and troglaphiles—simple overvisitation of that location.

5. Although esthetic values are difficult to objectively define or quantify, most cave users agree that cave esthetics are related to the beauty and appeal of their natural contents, and the interest of their archaeological and historical record. Conversely, intentional or premeditated damage to these values—in the form of breakage, defacement, littering, and removal—can be universally recognized as having a deleterious impact (Figs. 18, 19 and 21).

6. Recreational values are also somewhat difficult to develop. In addition, recreational potential must often be considered in conjunction with a casually related reduction in some or all of the previously discussed values. In most cases recreational potential also merges with esthetic values. In most cases recreational potential also merges with esthetic values. For this discussion, recreational values are considered to relate to accessibility, challenge,

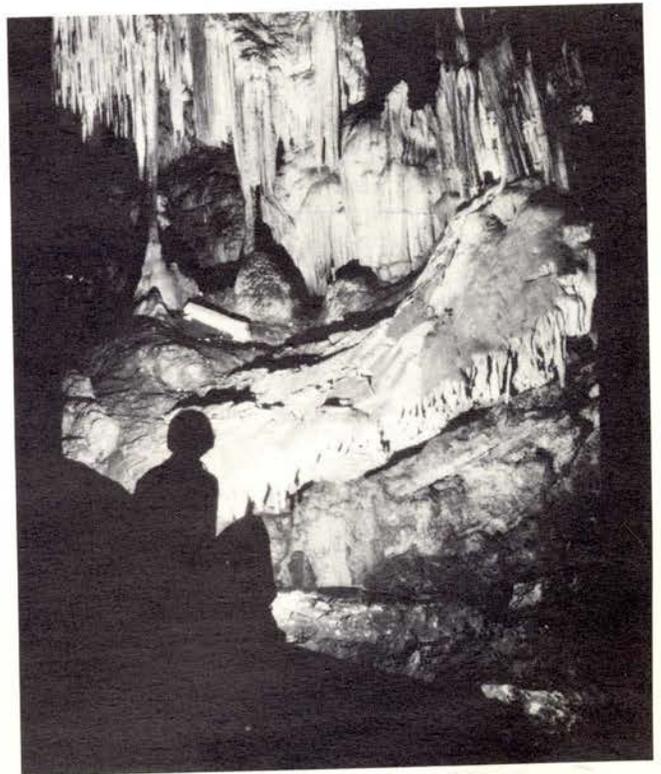


FIGURE 18. Formations (esthetics), Cave 043.

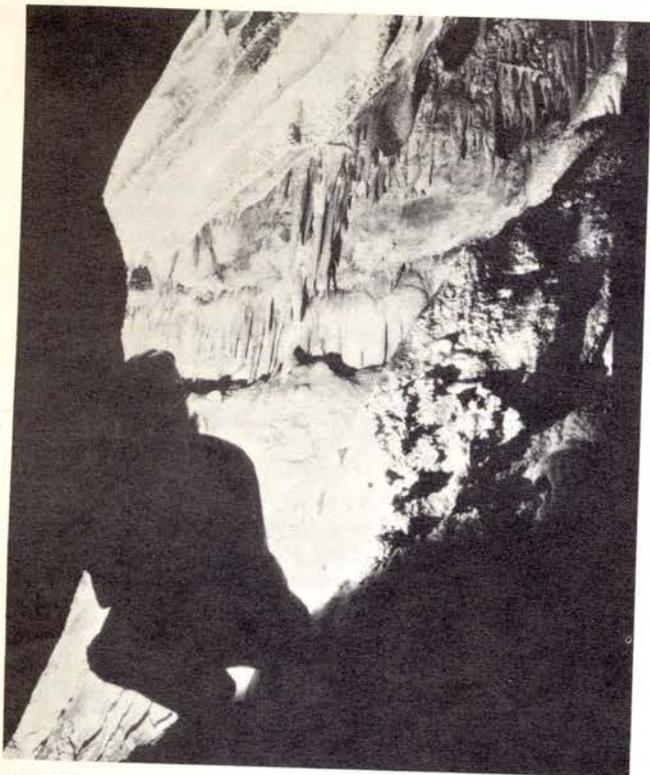


FIGURE 19. Formations, Cave 050.

size, diversity of features, and other such attributes. Recreational value is adversely affected by the consequent reduction of most of the aforementioned values (an interesting conundrum in itself), as well as the problem of hazard within the cave system (fig. 20).

Ranking of Values

For each of the values considered, it was necessary to rank the caves on the basis of site-specific significance. Initially this was done on a subjective level to produce a tentative list representing the range of significance for each value. Once the range was established, a five point rating scale was constructed identifying, in more detail, the criteria for the ranking. The most significant caves for a particular value were assigned a numerical rating of five; the least significant caves a rating of one. Caves not considered significant for a specific value were not rated.

On the basis of these numerical ratings, the tentative cave ranking list was then reordered to reflect the final evaluative criteria. These criteria and the cave rankings are presented below.

GEOLOGICAL RANKING CRITERIA

5. Great diversity and complexity in the geological record, with sediments of differing ages, multiple false floors and/or breccias, speleogens, numerous speleothems, association with paleontological and/or archaeological materials.
4. Diverse geological record including breccias or false floors which may or may not be associated with Quater-



FIGURE 20. Hazards (exposure), Cave 027.

nary biotic remains.

3. Geological record includes at least two stratigraphic units, or associated with other lines of evidence such as archaeological or paleontological materials.
2. Geological record limited to single stratigraphic unit without speleothems or other types of associated materials.
1. Potentially significant geological record.

PALEONTOLOGICAL RANKING CRITERIA

5. Demonstrable extinct fauna, complete integrity, large deposits with full range of taxa.
4. Demonstrable extinct faunal deposit, extensive deposits, some disturbance.



FIGURE 21. Vandalism, Cave 054.

3. Demonstrable extinct fauna, disturbed deposit of more limited areal extent, more restricted range of species identified.
2. Likely or confirmed presence of extinct fauna with unknown significance.
1. Potential for the presence of extinct fauna in intrusive sediments or breccia.

TAPHONOMIC RANKING CRITERIA (Based on identified or potential vertebrate species diversity)

5. 8 or more taxa
4. 6-7 taxa
3. 4-5 taxa
2. 2-3 taxa
1. 1 taxon or potential presence.

BIOLOGICAL RANKING CRITERIA (Based upon invertebrate species diversity)

5. 8 or more species
4. 6-7 species
3. 4-5 species
2. 2-3 species
1. 1 species or potential presence

ARCHAEOLOGICAL RANKING CRITERIA

5. Relatively great quantity of material, high research potential, little disturbance, relatively good preservation, uniqueness.
4. Smaller quantity of material yet relatively greater range of types, increased disturbance.
3. Deposits generally indicating more than one activity, additional disturbance.
2. Indentifiable deposits indicating single activities, generally quite disturbed.
1. Potentially significant, cultural material of value likely present.

ESTHETIC RANKING CRITERIA

5. Relatively pristine, large numbers of speleothems, great variety of formations.
4. Some breakage of speleothems present, relatively fewer formations, less variety of speleothems.
3. Considerable vandalism.
2. Only pockets of unvandalized formations remaining.
1. Completely vandalized.

RECREATIONAL RANKING CRITERIA

5. Easy access, greatest range of caving activities, relatively great length.
4. More limited caving potential, more difficult access.
3. Restricted range of caving activities with emphasis upon one aspect of caving, variable access.
2. Easy access, relatively restricted range of caving activities available.
1. Small caves with very limited range of caving activities available.

TABLE 3. Geological Ranking (Most important caves at top of list).

	Cave	Value	Cave	Value	
1.	016	5	23.	027	2
2.	025	5	24.	028	2
3.	043	5	25.	037	2
4.	051	5	26.	046	2
5.	054	5	27.	048	2
6.	009	4	28.	055	2
7.	010	3	29.	060	2
8.	011	3	30.	064	2
9.	022	3	31.	067	2
10.	030	3	32.	069	2
11.	040	3	33.	073	2
12.	045	3	34.	074	2
13.	047	3	35.	002	1
14.	050	3	36.	018	1
15.	058	3	37.	020	1
16.	065	3	38.	034	1
17.	066	3	39.	035	1
18.	077	3	40.	052	1
19.	003	2	41.	068	1
20.	005	2	42.	072	1
21.	023	2	43.	085	1
22.	024	2			

TABLE 4. Paleontological Ranking (Most important caves at top of list).

	Cave	Value	Cave	Value	
1.	045	5	11.	028	2
2.	043	4	12.	077	2
3.	051	4	13.	002	1
4.	010	3	14.	006	1
5.	023	3	15.	009	1
6.	025	3	16.	034	1
7.	030	3	17.	035	1
8.	054	3	18.	037	1
9.	018	2	19.	064	1
10.	022	2	20.	066	1

TABLE 5. Taphonomic Ranking (Most important caves at top of list).

	Cave	Value	Cave	Value	Cave	Value		
1.	010	5	18.	011	2	35.	013	1
2.	030	5	19.	022	2	36.	033	1
3.	051	5	20.	023	2	37.	037	1
4.	054	5	21.	025	2	38.	045	1
5.	002	4	22.	040	2	39.	048	1
6.	066	4	23.	041	2	40.	052	1
7.	077	4	24.	043	2	41.	055	1
8.	009	3	25.	046	2	42.	060	1
9.	015	3	26.	047	2	43.	061	1
10.	016	3	27.	058	2	44.	068	1
11.	018	3	28.	063	2	45.	071	1
12.	021	3	29.	065	2	46.	074	1
13.	028	3	30.	067	2	47.	075	1
14.	034	3	31.	072	2	48.	076	1
15.	035	3	32.	086	2	49.	079	1
16.	050	3	33.	003	1	50.	082	1
17.	005	2	34.	012	1	51.	083	1

TABLE 6. Biological Ranking (Most important caves at top of list).

Cave	Value	Cave	Value
1. 006	5	22. 035	4
2. 009	5	23. 041	4
3. 010	5	24. 045	4
4. 011	5	25. 065	4
5. 015	5	26. 025	3
6. 016	5	17. 027	3
7. 017	5	28. 077	3
8. 022	5	29. 003	2
9. 023	5	30. 037	2
10. 029	5	31. 086	2
11. 030	5	32. 020	1
12. 034	5	33. 021	1
13. 043	5	34. 028	1
14. 050	5	35. 035	1
15. 051	5	36. 055	1
16. 054	5	37. 060	1
17. 058	5	38. 061	1
18. 072	5	39. 063	1
19. 073	5	40. 067	1
20. 079	5	41. 075	1
21. 018	4		

TABLE 7. Esthetic Ranking (Most important caves at top of list).

Cave	Value	Cave	Value
1. 027	4	9. 045	3
2. 043	4	10. 054	3
3. 050	4	11. 058	3
4. 064	4	12. 073	3
5. 066	4	13. 051	2
6. 077	4	14. 052	1
7. 025	3	15. 085	1
8. 028	3		

TABLE 8. Recreational Ranking (Most important caves at top of list).

Cave	Value	Cave	Value
1. 025	5	12. 051	3
2. 043	5	13. 058	3
3. 054	5	14. 073	3
4. 027	5	15. 002	2
5. 052	5	16. 018	2
6. 085	4	17. 064	2
7. 006	3	18. 066	2
8. 010	3	19. 077	2
9. 016	3	20. 037	1
10. 045	3	21. 041	1
11. 050	3		

TABLE 9. Archaeological Ranking (Most important caves at top of list).

Cave	Value	Cave	Value
1. 010	5	9. 003	1
2. 018	5	10. 007	1
3. 025	5	11. 024	1
4. 005	3	12. 032	1
5. 046	3	13. 077	1
6. 047	3	14. 056	1
7. 048	3	15. 069	1
8. 059	2		

Multiple Value Ranking

Since most of the caves under consideration had more than a single value, it was also necessary to rank the caves on the basis of multiple values. This was accomplished by integrating the seven ranked value lists within a single table (Table 10). The values were listed across the top and the caves were listed in numerical order down the side. The numerical rating for each value for each cave was then entered, and totalled on the right side of the table. The caves were then reordered on the basis of this total weighted value in order to determine the overall ranking on a multi-value basis (Table 11). When two caves had the same cumulative rank, priority was placed on that cave that included the greatest range of values and/or was threatened by direct impact as opposed to less serious effects.

TABLE 10. Multivalue Ranking.

Cave	Geol.	Paleo.	Taph.	Arch.	Bio.	Esth.	Rec.	Total Weighted Value
001								
002	1	1	4				2	8
003	2		1	1	2			6
004			2	3				7
005	2		4		5		3	13
006		1						1
007				1				1
008	4	1	3		5			13
009	3	3	5	5			3	24
010	3		2		5			10
011	3		1					1
012			1					1
013								
014								
015			3		5			8
016	5		3		5		3	16
017					5			5
018	1	2	3	5	4		2	17
019								
020	1							2
021			3		1			4
022	3	2	2		5			12
023	2	3	2		5			12
024	2			1				3
025	5	3	2	5	3	3	5	26
026								
027	2				3	4	4	13
028	2	2	3		1	3		11
029					5			5
030	3	3	5		5			16
031								
032				1				1
033			1					1
034	1	1	3		5			10
035	1	1	3		4			9
036				1				1
037	2	1	1		2		1	7
038								
039								
040	3		2		1			6
041			2		4		1	7
042								
043	5	4	2		5	4	5	25

Cave	Geol.	Paleo.	Taph.	Arch.	Bio.	Esth.	Rec.	Total Weighted Value
044								
045	3	5	1		4	3	3	19
046	2		2			3		7
047	3		2			3		8
048	2		1			3		6
049								
050	3		3		5	4	3	18
051	5	4	5		5	2	3	24
052	1		1			1	4	7
053								
054	5	3	5		5	3	5	26
055	2		1		1			4
056				1				1
057								
058	3		2		5	3	3	16
059				2				2
060	2		1		1			4
061			1		1			2
062								
063	2	1	2		1	4	2	3
064	3		2		4			9
065	3		2			4	2	9
066	3	1				4	2	10
067	2		2					4
068	1		1					2
069	2			1				3
070					1			1
071			1					1
072	1		2		5			8
073	2				5	3	3	13
074	2		1					3
075			1		1			2
076			1					1
077	3	2	4		3	4	2	18
078								
079			1		5			6
080								
081								
082			1					1
083			1					1
084								
085	1					1	4	6
086		2						4
087								

TABLE 11. Overall Ranking (Most important caves at top of list).

Cave	Total Weighted Value	Cave	Total Weighted Value
1. 054	26	45. 067	4
2. 025	26	46. 086	4
3. 043	25	47. 024	3
4. 010	24	48. 063	3
5. 051	24	49. 069	3
6. 045	19	50. 074	3
7. 077	18	51. 020	2
8. 050	18	52. 059	2
9. 018	17	53. 061	2
10. 016	16	54. 068	2
11. 030	16	55. 075	2
12. 058	16	56. 007	1
13. 006	13	57. 012	1
14. 009	13	58. 013	1
15. 027	13	59. 032	1
16. 073	13	60. 033	1
17. 023	12	61. 036	1
18. 022	12	62. 056	1
19. 028	11	63. 070	1
20. 034	10	64. 071	1
21. 066	10	65. 076	1
22. 011	10	66. 082	1
23. 064	9	67. 083	1
24. 065	9	68. 001	0
25. 035	9	69. 004	0
26. 002	8	70. 008	0
27. 047	8	71. 014	0
28. 015	8	72. 019	0
29. 072	8	73. 026	0
30. 005	7	74. 031	0
31. 041	7	75. 038	0
32. 037	7	76. 039	0
33. 046	7	77. 042	0
34. 052	7	78. 044	0
35. 003	6	79. 049	0
36. 040	6	80. 053	0
37. 048	6	81. 057	0
38. 079	6	82. 062	0
39. 085	6	83. 078	0
40. 017	5	84. 080	0
41. 029	5	85. 081	0
42. 021	4	86. 084	0
43. 055	4	87. 087	0
44. 060	4		

Observations on Value Ranking

As previously noted, the definition of values within the context of this study was somewhat of a subjective endeavor. Those values ultimately isolated as important were derived from a project-specific assessment of cave component significance as perceived by the investigators. There is no suggestion that these values are universal in their applicability. Nor is the position taken that this approach necessarily is better than some other ranking

procedure. It proved applicable to this study, however, because the assemblers believed that no one value was generally more important than the next with respect to assigning significance to caves and their contents. This was true within value categories as well as between them. For instance, species diversity was used as the most important criterion for assigning biological and taphonomic ranks to caves. This index was deemed appropriate because there is a demonstrable relationship between high species diversity and biotic community complexity. To the extent that the criteria emphasized research potential, more biospeleological problems can be studied in a complex community system than can be evaluated in one of a simpler nature. And since one organism was deemed no more worthy of research than another, such an approach is eminently defensible.

It should also be evident that ranking criteria within values are not consistently employed. This again relates to the significant elements within the project with reference to value rankings as determined by the investigators. As an example, the caves of greater archaeological significance indicated a specialized but limited use, while displaying considerable contextual integrity. Those of lesser archaeological value exhibited evidence for a broader range of activities but contained smaller deposits and were much more seriously disturbed.

SOURCES OF IMPACT

Direct impact will result in the total destruction of essentially all of the values previously described for the caves below the gross pool level. Land modification activities associated with inundation will introduce debris and pollutants into the caves and may well modify surface features critical to maintenance of the cave ecosystem (drainage, nutrient input, etc.).

Actual flooding of the caves essentially will signal the loss of the total resource base. Some limited value could be derived from the recreational value of cave diving, but this is not construed as a significant factor. Useful information could be made available from long-term studies of the nature of the destructive impact on the resource base. This, however, would be of value only for managing and planning other such reservoir projects.

Both direct and indirect impacts are realized with the development of the reservoir and its associated facilities. Obviously actual land modification in the construction and maintenance of these facilities will result in losses identical to some of those suffered by caves in the direct impact zone. Caves may be affected by the introduction of deleterious substances into the underground ecosystem. Surfacing of areas may alter drainage patterns, thus changing the subterranean solutioning, depositional, and climatic equilibrium. And waste materials introduced into the ground in the form of drain effluent, sewage and other such disposal could seriously degrade the caves.

The positive effects of this activity should ideally result in the enlightened management of those caves maintained outside of the gross pool levels. Obviously a compromise in light of the fact that construction will have a negative impact on some cave values, such development should also bring monitoring and other forms of control to certain

TABLE 12. Effects of Management Actions on Cave Values.

	Actions							
	Direct Impact	Direct/Indirect			Indirect Impacts			
	A	B	C	D	E	F	G	H
Esthetics	X	X	X			X	X	X
Recreation		X	0	0	0	0	X	0
Geology	X	X	X	X	X	X	X	
Archaeology (History)		X	X	X	X	X	X	
Paleontology [Taphonomy]		X	X		X		X	X
Biology	X	X	X	X	X	X	X	X

— Visitation Effects—
 X—negative impact
 0—follows from value

A: Pre-project Activities
 B: Flooding
 C: Facility Construction
 D: Entrance Disturbance
 E: Floor Compaction

F: Deposit Mixing
 G: Cave Content,
 Breakage, Re-
 moval, Death
 H: "Pollution"

caves that already are being seriously misused. This is particularly true of those caves recommended for partial public use and development.

Indirect impact is largely related to increased user pressure placed upon the caves in and adjacent to the recreational areas. Obviously this will result in disturbance to the entrance areas, compaction of floor deposits, mixing of cave contents, killing, breaking, and removing of objects, organisms, and substances in caves and introduction of destructive and unesthetic materials into subterranean systems. The benefit to be gained is obviously the recreational use of the caves in or near the project area. In some cases, these benefits also may be reflected in control of currently overused caves in accordance with a management strategy designed at least to minimize the loss of the resource while maximizing public gain.

The effects of these activities are presented as a matrix in Table 12. It should again be noted that, although proper management may minimize some of the recognized adverse impacts of direct and indirect impacts on caves, these impacts cannot be completely eliminated. Even careful visitation results in degradation—a problem which must be solved on a cave-specific basis.

GEOLOGICAL IMPACTS

Flooding of the terrain below the 1,088 ft contour level will probably destroy the Quaternary sedimentary deposits in the caves below gross pool. These contain possibly the only record of the geologic history of the Stanislaus River older than the gravel bars along the present channel; loss of this cave record will erase forever the history of the upper Stanislaus River and any possibility of deriving useful hydrologic, climatologic, or environmental inferences from that history.

Inundation also will disrupt the stratigraphic context of the speleothems and may cause recrystallization, thus destroying the paleoclimatic and absolute age records

contained in these speleothems (cf. Harmon, 1971a; 1971b; Howard and Howard, 1972). Destruction of the archaeological and paleontological record of the caves in the reservoir will have severe geological impact as well, for archaeological and paleontological materials are important tools in geologic dating.

Flooding of the Stanislaus River canyon will alter substantially characteristics of the marble in which the caves lie and will make impossible any studies of hydrology as related to cave formation, water-supply questions, or similar avenues of inquiry. Flooding will also obscure, first with water, and then with reservoir sediments, the bedrock geology of the canyon bottom, where it is particularly well exposed. This may prevent better understanding of mineral deposits related to caves, and of regional geological history in general.

Increased human visitation of the caves at about the 1,088 ft level will have less geological impact. Breakage of speleothems and disturbance of deposits in caves in the indirect impact are the two major negative effects upon the geological record that are anticipated to occur.

PALEONTOLOGICAL IMPACTS

Inundation, even if periodic, must be regarded as effectively destroying the paleontological data base. Undisturbed stratigraphic relationships are crucial to effective paleontological study and most factors related to inundation disturb these relationships in some fashion. Prolonged wetting causes settling and eventually slumping of the type of unconsolidated clastic sediments encountered in the deposits of the project area. Further, pedoturbation and silting accompany inundation. While silting may only mask the surface of fossil deposits, making them difficult to locate, pedoturbation of unconsolidated sediments quickly and thoroughly destroys original stratigraphy. Both of these factors are particularly common features of the upstream margins of reservoir basins due to the prompt settling of sediment loads under the essentially deltaic hydrodynamic conditions. Caves 025 and 054, because of

their location with respect to the projected water levels of the New Melones Reservoir, are particularly vulnerable to this type of impact, and their paleontological resources will be irreparably damaged by inundation.

Recreational visitation will disturb the paleontological resource most seriously in those cases where unconsolidated surface fills are present. Some fills have already been severely degraded by heavy visitation in a number of project area caves such as Cave 025 and 043. Increased activity of this type related to development of recreation areas may result in some disturbance of additional surface deposits, but this is considered to be a less significant impact because few of these surface fills possess paleontological value (with the notable exception of Cave 045).

However, active destruction of fossil deposits by excavations undertaken by amateurs constitutes a very serious impact problem. More than a century of such disturbance has seriously damaged the cultural and paleontological resources of caves both inside and outside the present project boundaries. It is clear that increased visitation of the project area caves due to the reservoir and the development of recreational areas will accelerate such destruction, although the precise nature of these destructive events is difficult to predict. Attempts to restrict access, such as gating, should be partially effective in preventing damage to caves in the indirect impact zone. Adequate mitigation, then, requires systematically investigating portions of the directly threatened deposits and implementing conservation-oriented study to those requiring such action prior to an increase in visitation. These factors are considered in depth in the mitigation recommendations.

TAPHONOMIC IMPACTS

As recent bone accumulations are invariably on or very near exposed surfaces, they often will be altered, obscured, or destroyed either by inundation or increased visitation. Wave and current action, which would result from flooding, will destroy much of the evidence bearing on agents of accumulation and will selectively remove or displace certain skeletal elements, further biasing the samples. Burial by water-borne sediment would render them inaccessible or useless for the type of study proposed. Visitors also may break, move, or selectively remove skeletal elements, altering the natural assemblages in an unknown and incorrecable manner.

BIOLOGICAL IMPACTS

The effect of the reservoir on the cave adapted fauna will be one of the most harmful results of this project. The zoospeleological system, a unique and ongoing community, may be partially relocated and extensively studied by biologists, but the completion of the New Melones Reservoir Project will certainly mean the destruction of a number of cave ecosystems and considerable damage to others. Currently the nature of this adverse impact can only be suggested.

As in previous discussions, it is useful to divide impacts into those that are direct and those that are more or less indirect. Direct impacts for this project will involve one

primary effect—actual inundation.

Flooding itself can be confidently predicted to destroy all of the ecosystem as it currently exists in those caves to be wholly or partially inundated. There are possibilities that components of the ecosystem will remain in partially inundated caves. It is even possible, for example, that aquatic-adapted troglobites and troglaphiles that might exist in the project area, such as those identified in Pinnacle Point and Crystal Palace caves, might become successfully adapted to benthic conditions when the reservoir is filled. But the likelihood of the latter is remote, and if the former occurs, the resultant community relationships may bear little similarity to those that preceded it.

Other forms of land modification related to the reservoir, including recreational facilities development and access road construction, will result in significant impacts. These impacts include the introduction of pollutants into the cave ecosystem, the alteration of groundwater input, and the removal of portions or all of the ecosystem food supply. As indicated by Poulson and Kane (1977), all of these activities are deleterious.

As previously iterated, increased visitation will constitute the most predictable indirect impact on the cave fauna. These activities will result in the destruction of portions or all of cave habitats, the alteration of food input sources, and the introduction of foreign substances into the ecosystem, among other factors. All of these can have destructive results with respect to speleofauna. Even well-intentioned efforts to protect such fauna can be detrimental. For instance, if concern for protective cave gating does not include taking into account bat access, detrital input, etc., these conservation efforts can result in the modification of critical components of the biological data base.

ARCHAEOLOGICAL (HISTORIC) IMPACTS

The impact of the project on the cultural resources within caves will take two major forms—partial, periodic, or permanent inundation or disturbance at the hands of visitors attracted to the reservoir. Both forms are discussed separately below.

The question of the impact of inundation on archaeological remains is an issue of considerable debate at present. Although some study has been directed toward that problem, no substantive conclusions have yet been reached. All available information, however, points to the fact that archaeological materials are deleteriously affected by flooding of any sort (cf. Jewell, 1962; Lenihan, 1974). In the absence of positive information to the contrary, it is concluded that loss of research potential will occur with any inundation, and mitigation in the form of adequate data study must precede flooding of the sites.

Visitor impact on archaeological caves is another class of problems. In certain cases this is already occurring, and the cumulative effect has been considerable damage to the archaeological resource base. Such damage will undoubtedly increase with the additional traffic resulting from the development and promotion of the New Melones Reservoir. The most responsible way to ameliorate the effect of this form of impact is to direct traffic away from archaeological caves and to prevent access to those caves of highest archaeological sensitivity.

As all of the caves are located well outside of the dam construction locality, the direct impact envisioned for those caves below gross pool level is water impoundment. Thus impact will occur from south to north, and the caves farthest downstream are to be flooded the earliest.

Impact priority with respect to archaeological caves above the flood pool level is most appropriately evaluated in terms of visitor carrying capacity and recreation area developmental scheduling. Although the Skunk Gulch Recreation Area (which contains Cave 018) is slated to be

developed before the Coyote Creek Recreation Area (which includes Cave 010), the latter site currently is receiving more visitation and is more amenable to damage. Furthermore, Coyote Creek is scheduled to receive more intensive use. Therefore, protective mitigation should be provided for Cave 010 before Cave 018 is considered. Although Cave 077 is not within a recreation area, gating is recommended because once the water is impounded, the cave will become quite visible to boaters and others.

MITIGATION OF IMPACTS

Mitigation means "alleviating" or "lessening" of the severity. It is the purpose of this section to discuss means by which the negative impacts outlined in the previous section may be mitigated. It should be made clear that the following discussion is generated within an ethical perspective emphasizing the conservation of as much of the resource base as possible. Thus, only the resources in imminent danger of destruction by the impacts of the New Melones project will be intensively studied. Obviously, this limits comprehensive mitigative study to those caves in the area to be flooded. Although lesser forms of impact amelioration are recommended for cave systems that will be effected outside of the gross pool zone, these are closely related to locality-specific considerations. In all cases, mitigative action is recommended to accomplish no more than necessary to responsibly alleviate or lessen the predicted impact of the project on the data base, given an appropriate investigative framework to which that data base can be applied.

MITIGATIVE ACTIONS

The discussion of mitigative actions in part follows Moratto (1976:479-82). A full range of mitigative alternatives are first presented. Then the most feasible of these are developed for more detailed consideration.

Project Abandonment

Obviously the most ideal solution to the threat of adverse impact upon the resource base is to alleviate the threat—in this situation, abandon the project. It is equally as obvious that the nature of the New Melones project is such that this alternative is not feasible.

Project Redesign

All direct impact on the cave resources could be alleviated by redesign of the project to prevent water impoundment above the south fork confluence with the main fork of the Stanislaus River. However, this alternative has been considered elsewhere, and has been determined unrealistic for reasons other than those that apply to cave resources.

Modified Impoundment Scheduling

As developed in detail by Moratto (1976:481), it would be exceedingly difficult if not impossible to implement an adequate program of archaeological mitigation given the current schedule for dam construction completion (1978) and reservoir filling (immediately thereafter). This consideration applies even more to the diverse and relatively long-term studies needed in caves in order to achieve minimally acceptable mitigation of the currently recognized resource base. As discussed in the next chapter, biological investigations alone will require that at least two years be allocated to intersystem and intrasystem habitat/community relationships in the threatened caves. Such a

study could likely not be initiated before 1978, and, since the most significant biological cave will be inundated, data collection alone could not be completed under the present timetable. In addition, a prolonged period of time to experiment with transplanting of cave adapted fauna could greatly increase the chances of success for this form of mitigation, thus possibly preventing the extinction of certain of the unique species endangered by project completion. This alternative, considering the feasibility of all mitigative actions available, is deemed the most appropriate.

Project Completion as Planned

The current schedule calls for dam closure in November 1978 with impoundment to begin immediately. Although it is *conceivable* that data *recovery* of the geological, paleontological, and archaeological resources in the direct impact caves could be adequately accomplished within six months or less, the biological mitigation could not. Considering the details of mitigative scheduling for the cave resources (in those caves where multiple resource values exist, biological mitigation must precede any other forms of direct impact investigations since the latter generally modify or destroy speleofaunal habitats), the total projected data recovery phase of the program of cave resource amelioration would require between 2 and 2½ years to complete. Even if the project could be launched this year, it would not be completed before scheduled impoundment as it is now planned. Such factors are developed in more detail in the following section of the report. Suffice it to state here that this alternative is quite unrealistic in comparison with the previous one.

MITIGATIVE METHODS

As previously noted, a series of approaches to mitigation must be taken, given the variations in impact on the cave system. Some are more easily categorized than others, and some are more generally applicable as methods than others.

Data Study

Data study consists of data collection or recovery, analysis, synthesis, and publication. It is the sole feasible option available for those caves to be inundated periodically or completely. Although only data recovery must precede inundation, adequate mitigation has not been achieved without completion of all phases of the data study package. Data study is in part particular to the relevant fields—in this case, archaeology, history, biology, paleontology, taphonomy, and geology—but it is proposed as an integrated program with respect to the New Melones investigations, for much of the information generated by one study is relevant to another.

Collection and Stabilization

These methods are designed to lessen indirect impacts such as visitor entry. They include such activities as collecting fragile materials from the surfaces of sensitive cave areas; limited excavations to remove data in prime impact locations; covering deposits with sterile fill, rocks, and other protective materials; enhancing biotic habitats in inobtrusive areas; and developing minimally destructive routes through caves. Again, these procedures are specific to the particular values that exist within those caves most amenable to visitor impact.

Gating

Cave gating has been recommended as a mitigative method in indirectly impacted caves of high scientific value. Installation of gates at the entrances or within caves to restrict human access has been tried with variable success many times. As a result, a corpus of information is available on cave gating (e.g. Hunt and Stitt, 1975). One of the major concerns with proper cave gating is the fact that they must be developed to allow unrestricted access of cave biota, natural food materials, and similar elements (cf. Horst, 1972; Poulson, 1972; Welbourn, 1976). They must also be planned in such a fashion that rescue operations are not hindered and that, in some instances, research equipment can be passed through.

Experience has also demonstrated that cave gates are often violated. This means that such gates must be regularly and frequently inspected and repaired as necessary. Only will such persistence be effective in protecting the gated cave. In light of this fact, gating recommendations have been limited to those sites where the gates are deemed to be effective without being an attraction in and of themselves.

Alternative Methods of Access Restriction

A number of mitigative recommendations other than the above have been suggested for selected caves. These include monitoring, avoidance of publicity, electronic surveillance, and similar procedures. Since examples of these procedures having been actually implemented are rare, their effectiveness can only be surmised at this point.

Limited Development

Three caves—018, 052, and 085—are recommended for limited development. In the case of Cave 018, this should consist of collection and stabilization of the archaeological and taphonomic deposits as per the previous discussion, the installation of a gate, and—if deemed appropriate—placement of a permanent means of safely negotiating the entrance drop, before public access is allowed. Monitoring of the cave users, possibly by means of electronic surveillance, is also recommended. These actions should be combined with the dissemination of information in the form of conservation-oriented signs explaining the archaeology, history, and other values of the cave.

Caves 052 and 085 are slated for development as per the New Melones Master Plan. It is recommended that a strong conservation-oriented educational facility be included within the development process and that the caves be monitored to insure adequate control of vandalism.

Post-Project Evaluation

Although the details of this suggestion are not developed within this report, it is recommended that, following the filling of the reservoir, a multidisciplinary group of individuals familiar with caves monitor the long-term effects of flooding and other forms of direct and indirect impact on the cave resource base. Such a study might consider the nature of changes in cave sediments, formations, remaining cultural and biological deposits, and extant animal life in the caves for a reasonable period following impact by the project. Such a study could provide exceedingly important information for management agencies concerned with the modification of karst terrain within the region at least.

MITIGATION OF GEOLOGICAL VALUES

Essentially, any steps that may be taken to reduce disturbance of cave deposits, fossils, artifacts, and speleothems constitute mitigation of adverse impact to the geological record. In the event that disturbance cannot be avoided, data study is necessary.

In all directly impacted caves, stratigraphic relations among deposits must be recorded. This can often be accomplished by detailed study of the walls of excavations made in archaeological and paleontological deposits. Test excavations or borings to collect these data should be made in deposits which are not investigated otherwise. The wall and ceiling deposits in Cave 054 are of special significance with regard to the latter consideration.

Detailed three dimensional cave mapping with tape and transit will also be necessary to establish relationships among deposits. This mapping will provide precise controls for archaeological and paleontological excavation as well.

Samples of cave sediments should be studied granulometrically, mineralogically, and petrographically so that environmental conditions and geological processes and facies changes can be documented. Soil monoliths (Fryxell and Daugherty, 1968) from selected proximal exposures should be taken to document the undisturbed appearance of the sediments.

Speleothems should be collected and studied for clues to age and environment (Harmon, 1971a; 1971b; Broecker, Olson, and Orr, 1960); it may be possible to reconstruct Lake Quaternary climatic fluctuations from speleothems alone. A search for unusual minerals also should be made. If such minerals are found, they should be identified and their genesis deciphered.

Indirect impact studies of the geology should emphasize the understanding of the project area in relation to the region. Important clues to the meaning of deposits and fossils can be obtained from mapping the geology exposed on the surface around the caves. This can best be achieved through detailed study of aerial photographs. The determination of spatial relationships among the karst structures will aid in the interpretation of karst solutioning and cave formation processes and the prediction of volumes of fill and the genesis of cave sediments. This work would be done most appropriately in connection with regional mapping beyond the reservoir but certainly must be done in the flooded area. Mapping should be accompanied by selected petrographic study of the rocks to be flooded.

Detailed mapping of the "Rockpile" is also recommended. The rockpile is so small, topographically complex, and rich in caves that a comprehensive map is needed simply to complete the cave inventory. In addition, appropriate management of this area will depend upon such a study, which was beyond the scope of the survey contractual agreement.

MITIGATION OF PALEONTOLOGICAL VALUES

The caves of paleontological significance in the direct impact zone must be intensively studied prior to inundation. Collection of adequate samples of the deposits involved, careful recording of all pertinent associated information, analysis, publication of findings, and permanent storage in an appropriate repository such that the material is available for future study constitute adequate mitigation in this case.

It is possible to estimate the amount of material which must be excavated in order to obtain fossil samples large enough for paleoecological and faunal studies (e.g. Wolff, 1975; Voorhies, 1969). Unfortunately, such estimates are difficult to apply in the case of the project cave deposits because time did not permit the establishment of specimen densities by collection and preparation of even small bulk sediment samples. Nevertheless, it is clear that removal of considerable amounts of certain deposits will be necessary in order to adequately sample the fossil vertebrate fauna.

Paleontological considerations in the indirect impact areas is less clear-cut. Depending upon the circumstances specific to the cave system in question, a combination of minimal paleontological examination, deposit stabilization, gating, and visitation discouragement should be implemented. In most cases the caves in the indirect impact zone have other values than paleontological, and mitigative measures need to be based on the most effective and responsible means for amelioration of the combined resources values.

MITIGATION OF TAPHONOMIC VALUES

Constraints on the mitigation options for recent bone accumulations are imposed by the vulnerability of these accumulations to loss by flooding or increased visitation, the impracticality of protecting such accumulations from most of these hazards, and, especially, the need to use information derived from the recent accumulations to guide excavation and aid interpretation of paleontological and archaeological sites.

Because of the great variety of cave types and settings, a large number of observations will be needed to control the depositional variables required to complete taphonomic research. A range of localities in varied settings should receive qualitative field investigation, including observations on physical settings, evidence bearing on identification of agents responsible for bone accumulation and modification, and the nature of sediments and other matrices associated with the bones. Of those deposits which are attributable to predators or bone collectors such as packrats or porcupines, one-third of the localities should be selected for quantitative analysis of bone breakage,

nature of skeletal element bias, and relative representation of species. This will require collecting, screen washing, and classifying about 1,000 identifiable (probably 3,000 total, mostly small vertebrate) bones or fragments from each of the collection sites. Several natural trap accumulations should receive detailed excavation and data collection in the field.

Taphonomy, because of the surficial nature of its data base, is one study area in which considerable mitigation of the effects of human visitation to the caves above the reservoir is warranted. It is proposed to investigate intensively each of the relevant caves within the direct impact zone of the reservoir area, plus each of the taphonomically significant caves above the reservoir that stand to be seriously disturbed by indirect impact.

MITIGATION OF BIOLOGICAL VALUES

Although zoospeleological research is a relatively well-developed science, few guidelines exist for couching this research in an overall management framework. Available publications that consider this issue (cf. Poulson, 1976; Poulson and Kane, 1977), do not discuss implementation procedures and other such pragmatics. The following recommendations have been largely formulated through discussions with Dr. Richard E. Graham, undoubtedly the most knowledgeable individual about the biospeleology of the region.

It should be evident that the mitigation of threatened cavernicolous invertebrates is an exceedingly complex endeavor. Unlike archaeological and paleontological data, the biological resource base is an ongoing dynamic system, the relationships of which must be understood as a part of the mitigation procedure. In those caves where protective mitigation cannot be operationalized, data study of a relatively long-term nature must be implemented in order that an adequate amount of information can be collected concerning the components and processes that make up the threatened ecological system.

Although some form of protection or avoidance amelioration is most highly recommended for the treatment of all of the cave biology in the project area, this is not a realistic proposal. A number of caves containing significant biota can be mitigated by these means, but sites to be inundated by the reservoir will require salvage research.

Of highest priority is the mitigation of the fauna to be affected by the direct impact of the project. This impact will consist of partial or periodic inundation and will most certainly result in permanent damage to or total destruction of the entire ecosystem.

Further study is recommended in three partially related stages. The first concerns a sampling study of the nature of certain cave ecosystems outside of the project area. This is recommended for two reasons. The first is that the project environment is the only area within the central Sierra Nevada foothills that has had such a comprehensive inventory made of the zoospeleological resources. Thus the importance of these data with respect to the region is undoubtedly somewhat inflated. New taxa in particular may take on much more added importance because of the fact that they simply have not been identified in caves adjacent to the proposed New Melones Reservoir. Systematic investigation of selected localities outside of the

project boundary will place the importance of the zoospeleological information from the impact zones in proper perspective and will undoubtedly reduce their significance in a number of instances.

The second reason for such a study relates to the potential for transferring components of cave ecosystems to settings not threatened by reservoir development, thus mitigating against project impacts in a long-term fashion. Assuming that these components are in relatively delicate balance with other elements of the ecosystem, such as food input, temperature, humidity, elevation, light, and habitat availability, careful study must be made of those settings before they can even be identified as appropriate for such a transfer. For not only must the setting used for faunal introduction be amenable to the perpetuation of the transferred components, but it must not threaten the balance of any ecosystem that may already be present in the locality. Although no biologist or ecologist would claim to control all the information necessary to predict with certainty the success or failure of faunal transfer in specific circumstances, the value of such an approach cannot be dismissed. Despite the comments recorded by Godfrey (1977:50), empirical evidence has yet to be provided that proper selection of environmental settings (not necessarily caves) with the criteria necessary for perpetuation of relocated cave fauna will result in either the demise of the introduced fauna or the serious disruption of indigenous assemblages.

Thus an extra-project investigation of proximal cave systems and other karst settings would not only mediate against the currently biased perspective with regard to the significance of the resource base in the project area, but also would provide information on the potential for transferring components of the invertebrate assemblage to unthreatened localities where they can be preserved for long-term study and appreciation. From a management perspective, transfer sites located on properties to be managed by the BLM after reservoir completion would be preferred. However, if no such sites exist on these lands, adjacent Forest Service holdings, and even private property should be considered.

If locations amenable to transfer can be located, this procedure is recommended as a stage in the mitigation process. Described by Briggs (1975), procedural details will have to be refined to apply to forms other than harvestmen.

The third stage is the mitigative study of the threatened cave-adapted communities. This is proposed in two phases. The first will consist of an intensive investigation of a number of threatened caves within the project area that have already been identified as containing significant biota. The goals of this phase would be to gather information on the similarities and differences among fauna within different cave systems. These data would provide representative information concerning the range of invertebrate faunal densities, distributions, and relational processes for the project area. They would also place the directly threatened caves in proper perspective with respect to the unique elements that require research emphasis prior to inundation.

Phase 2 would consist of an intensive study of a selected cave or caves containing an integrated cave adapted faunal community. The results of such a study would yield information about the successional dynamics of a single ecosystem through time—research that would be necessary

to complement the intersystemic information gathered in the previous phase—and would document specific micro-environmental data that will be ultimately lost to science.

The implementation of these investigations is projected to require a minimum of two years. During the first seasonal round, two investigators would make at least bi-monthly visits to a select number of caves within the project area in order to study the biota therein. A minimum of one year is mandatory in that faunal community dynamics are integrally related to seasonal change, and the full seasonal round must be used to observe the range of community variation within different caves.

The second year would be spent in observing in more detail the intra-community interaction in a limited number of directly threatened cave ecosystems. This is projected to require a minimum of weekly visits to the caves by two researchers. Again, such observations must take place over the full suite of seasons.

In concert with the conservation theme of this report, as many of the biologically significant caves in the indirect impact zone should be avoided or protected as possible. When this is not feasible, (see the following section), additional zoospeleological research will have to be implemented to mitigate these indirect impacts. In some cases this will require in-depth study of ecosystems to be affected by increased visitation. In others, preservational measures such as habitat-enhancement in inaccessible areas, access restriction, etc. can be implemented. Such study can best be done as a part of the mitigation of the direct impact zone, in that the same research personnel can then deal with all biological mitigation in all the caves.

Some of the methods for effecting this mitigation have already been noted. They include the use of two biological researchers for a period of two years. In addition, the extra-project survey will require a team of 3 to 4 qualified individuals for a total period of twelve months. These individuals, in consort with the impact zone biologists, can also implement the mitigation recommended for the indirect impact localities identified in the cave prioritization section.

MITIGATION OF ARCHAEOLOGICAL (HISTORICAL) VALUES

As previously discussed (McEachern and Grady, 1977:75), the approach taken to consider cultural mitigation follows that of Moratto (1976:485-91). Since the argument is developed in detail in those publications, it will only be summarized here.

The Moratto archaeological study procedures were developed for open sites in the direct impact zone. They included appropriate methods and techniques to be implemented in the excavation, analysis, synthesis, publication, and curation of archaeological remains and data to be impacted by the reservoir proper. Cave deposits, however, cannot be studied in a directly comparable fashion. The logistics involved, which include reduction of large breakdown blocks, hand excavation in cramped quarters, dry screening through fine mesh, wet screening, transportation of the deposit from the site to the screening locations, flotation, and detailed recording procedures, increase the specialized data recovery requirements considerably. Analysis, synthesis, and publication, however, are essentially the same.

Sites within the indirect impact area will vary with the circumstances related to specific cave systems. Gating of some caves is recommended. Limited stabilization is suggested for a few cases. Cave 018 is recommended for development of a minimal nature, in part as a means to protect the archaeological deposit and the historical signatures within the cave.

It should be reemphasized that the archaeological aspects of mitigation will be most valuable if integrated with the archaeological and historic research conducted on open sites within the reservoir area. To the extent that the archaeological research can be implemented in conjunction with the studies proposed by other disciplines within this report, this should be done as well.

MITIGATION RECOMMENDATIONS

Recommendations regarding the implementation of multiple value mitigation strategies on a cave-by-cave basis are often complex. This discussion emphasizes the types of mitigation to be pursued and the sample of the data base concluded to be adequate given the recognized potential of the resources at sites where some ameliorative action is required.

A crucial aspect of mitigative recommendations, the question of sampling adequacy cannot be considered in any depth here. Literature available on the topic is too voluminous to synthesize. Suffice it to observe that sampling strategies must relate to the problems emphasized in the research. Similarly, the sampling rate (percentage) must be based on obtaining an amount of data sufficient to address the research problem while at the same time selecting for those elements of the data base that are as representative in its *in situ* composition as possible. There are few guidelines for determining sampling rates; one of the only generally applicable procedures relates to the complexity of the data base. The more complex the data base (as reflected in intra-disciplinary and inter-disciplinary potential), the larger the percentage necessary to adequately examine the universe being sampled. This procedure is followed in instances where data study is necessary.

Cave Specific Recommendations

The following sites, listed in numerical order, are recommended for mitigation. Table 12 summarizes these data with respect to direct and indirect impacts, as well as on the basis of cave values.

Cave 002: The faunal bone on the surface of the cave floor should be collected in those areas where visitor impact will be great.

Cave 003: As this site is below gross pool level, data study is recommended. With recognized archaeological, geological, and taphonomic importance, the nature of the cave and its deposit suggests that a 30% sample of the data base should be adequate.

Cave 005: Determined to have archaeological, historical, taphonomic and geological value, a minimum of 30% of the combined data base is suggested for investigation. Although the data base here appears to be of less complexity than some others, the fact that the cave will be completely flooded warrants such a recommendation.

Cave 006: Minimal taphonomic collection is recom-

mended for this cave, as it is within the recreational area.

Cave 007: The black staining on the ceiling should be analyzed and the deposit in front of the cave entrance should be investigated for archaeological data. A 30% sample is recommended.

Cave 009: Likely to be one of the more heavily visited sites in the indirect impact area, this cave contains important geological, paleontological, taphonomic, and biological data. Stabilization is recommended prior to recreational area development.

Cave 010: This site is deemed to be one of the more important archaeological caves in the project area. It also has historic value, as well as taphonomic significance and paleontological potential. Since it is of a hazardous vertical nature, and is receiving a considerable amount of visitation at this point in time, gating, monitoring and stabilization are strongly recommended.

Cave 011: Although in the indirect impact area, mitigation in the form of taphonomic collection is recommended for this cave. As the site is known to have fluctuating bad air levels, and requires direct aid for safe access, collecting trips should be made with extreme caution.

Cave 012: Some taphonomic mitigation is recommended for this cave as it is in the direct impact zone.

Cave 015: Within the boundaries of one of the recreation areas, taphonomic collections are suggested for this cave, as it is concluded that some surface bone deposits will be damaged by increased visitation.

Cave 018: This cave is not only one of the better known sites in the project bounds, but has considerable archaeological, historic, taphonomic, and paleontological potential. In order to protect these values, it is strongly recommended, since the cave is within one of the recreational areas, that it be stabilized and minimally developed for ease of visitor access as has been discussed previously. Gating and monitoring are also deemed necessary.

Cave 020: Within the direct impact area, this cave will require geological mitigation.

Cave 022: Of some taphonomic significance, this cave will be subjected to indirect impacts—primarily increased visitation. As some of the taphonomic deposits will be damaged by such activities, limited collections are recommended to be made.

Cave 023: Collection is suggested for this site. Although it will not be flooded, it contains an extremely significant taphonomic and paleontological deposit, the latter of which will be impacted by increased caver use.

Cave 024: Due to the geological, archaeological and historical significance of this cave, and the fact that it is to be inundated, comprehensive data study is recommended. Complete recovery of the deposit has been proposed, since it is quite small.

Cave 025: One of the most significant archaeological caves in the project area, Cave 025 exhibits considerable geological, paleontological and taphonomic importance as well. Since it is also below gross pool projections, the site will require intensive interdisciplinary investigations. The known research potential, the need for a large "one-shot" sample of the data base, and the estimated point of data replicability suggests that the generally recommended sample rate of 10 to 20% is inadequate, and a sample of at least 50% of the data base is considered necessary to acquire an adequately representative percentage of the natural and cultural record at the cave.

Cave 030: This cave is located within one of the areas of heaviest anticipated indirect impact. Since it has some paleontological and taphonomic importance, selected collection is suggested.

Cave 032: Located below gross pool, data study is recommended for this cave, in light of its archaeological and historic importance. Investigation of no more than 20% of the deposit is proposed as adequate.

Cave 034: The cave is within the indirect impact area, but is not projected to receive much visitor pressure. Thus only limited surface collection of the taphonomic materials in the main caver use areas is recommended.

Cave 035: Recommendations for this cave are identical to those for Cave 034, as the circumstances are the same.

Cave 037: In the indirect impact area, Cave 037 should be gated, due to its dangerous vertical entrance and the predicted increased use of the locality.

Cave 043: To be disturbed only by indirect impact in the form of increased caver use, the recognized taphonomic values in this cave should be mitigated by surface collection at specific locations subject to human traffic. Due to the vertical nature of the entrance, gating is also recommended.

Cave 045: This site is undoubtedly the most significant paleontological and taphonomic site in the project area, and possibly of the region. Since it is also in pristine condition, it is critical that as much of the data base be preserved as possible. It must be gated, and exceedingly careful stabilization must take place in order to recover the contextual information available in those parts of the cave that will receive what little indirect impact the site is projected to receive. In addition, information dissemination concerning the cave location and characteristics should be strongly discouraged.

Cave 046: This cave will be inundated when water impoundment takes place. Since it has recognized archaeological, historical, and taphonomic importance, data study is recommended. The depositional history at the site might be of some complexity, and a 30% sample of the site should be investigated.

Cave 047: Although below the currently estimated gross pool level, this cave does not require extensive data study. The limited significance—archaeological and taphonomic—exhibited within the largely undifferentiated deposit suggests that investigation of 30% of the site matrix should be adequate.

Cave 048: Data study is the only feasible mitigation suggestion at this site as well, since it also falls below gross pool level. Although little deposit is present in the cave, it is of archaeological and taphonomic importance, and should be investigated. Therefore 100% of the deposit is recommended for examination, as well as the examination of other relevant aspects of the cave itself.

Cave 050: Although this cave has a vertical entrance, the opening is so small that the likelihood of accidentally falling into the cave is essentially nonexistent, and thus gating is not recommended. Given the fact that it does have recreational and esthetic importance, taphonomic collection in those localities of heaviest caver traffic constitute the only mitigative recommendation.

Cave 051: In addition to the recommendations forwarded in the concluding chapter of this report, Cave 051 should be gated and stabilized. It is currently an extremely popular cave, and the important paleontological, taphonomic and

biological data base is being continually degraded. As a part of the indirect impact area, this degradation can then be controlled and stemmed to some degree.

Cave 052: Recommended in the Master Plan for development, the survey results support this suggestion. It is further recommended that this development be accompanied by strong conservation and educational displays and other similar exhibits. All taphonomically significant materials should be collected. In addition, pre-development investigations of all known biota should be made.

Cave 054: In terms of multiple cave values, 054 is the most significant cave in the project area. Unfortunately, it is also to be inundated. The cave is exceedingly important from geological, paleontological, taphonomic, biological, esthetic, and recreational perspectives. It is recommended that long-term speleofaunal research take place in the cave, followed by intensive examination of the cave deposits by geologists, paleontologists, and taphonomists with speleological expertise. Thus, in addition to the biological research, some 50 cu m of deposit are recommended to be excavated for geological, paleontological, and taphonomic data study.

Cave 055: Geological recording and taphonomic collection is recommended, since this cave will be inundated.

Cave 056: This cave will be flooded as a result of water impoundment. Insofar as it contains archaeological, historic and geological values, data study is recommended. The data potential is not extensive, the deposit being small. Thus mapping and excavation of the entire deposit should be implemented.

Cave 059: Located below gross pool, Cave 059 requires adequate data study to be mitigated. With historic values and archaeological potential, it is recommended that these materials be mapped and collected. In addition a sample of the deposit—20%—is recommended for excavation to determine if subsurface information of value is present.

Cave 060: Taphonomic collections alone are suggested as a mitigative measure for this cave. It is located in the indirect impact area, and will suffer from increased caver traffic.

Cave 063: Similar to 060, the same recommendations are proposed for Cave 063.

Cave 064: Of high esthetic value, this site is located in the indirect impact area, and should be protected. Due to the nature of the cave entrance, gating would be difficult to accomplish. Thus alternative means of protective mitigation are recommended. These consist of active efforts to discourage visitation except to highly qualified and conscientious caver groups.

Cave 065: Due to its accessibility, this cave should be subjected to some limited taphonomic collection.

Cave 066: This cave also has a dangerous vertical entrance, gating would be difficult to accomplish. Thus alternative means of protective mitigation are recommended. These consist of active efforts to discourage visitation except to highly qualified and conscientious caver groups.

Cave 065: Due to its accessibility, this cave should be subjected to some limited taphonomic collection.

Cave 066: This cave also has a dangerous vertical entrance, which cannot be negotiated without technical equipment. Thus gating is recommended, as it is in the increased visitor impact area.

Cave 067: In the direct impact zone, this cave will

require minimal geological, paleontological, and taphonomic testing.

Cave 068: Geological and taphonomic data studies are recommended for this cave. It is below gross pool, and collections of pertinent information in the form of osteological materials and selected geological samples will be necessary.

Cave 069: To be inundated, this cave has archaeological and geological significance. Thus data study in the form of investigation of 30% of the data base is proposed as necessary for adequate mitigation.

Cave 071: Also below gross pool, collection of taphonomic information will constitute the necessary data study in this case.

Cave 074: Data study in the form of geologic and taphonomic sampling is recommended for 074. It falls within the direct impact area, and will be flooded.

Cave 076: This cave will be impacted only by an estimated increased caver use load. Consequently, selected taphonomic collection alone will be necessary for mitigation.

Cave 077: This site is of high esthetic and archaeological value. It also contains important paleontological materials. The cave has a dangerous vertical drop beyond the entrance, thus gating is recommended. In addition, vegetation should be encouraged to grow in the entrance, as it will be visible from the proposed gross pool level (though the cave itself will not be inundated). It is suggested as well that visitation be discouraged.

Cave 078: Additional efforts should be made to locate the cave and implement responsible management actions.

Cave 079: Given that the cave is likely to be heavily impacted by recreational cavers, some taphonomic mitigation should be implemented.

Cave 084: As this cave was not visited, it should be relocated and properly mitigated.

Cave 085: Essentially a segment of Cave 052, the same mitigative recommendations put forth for that site apply to 085.

Cave 086: To be inundated, this cave will require minimal taphonomic mitigation.

Additional Mitigative Factors

It should be emphasized that, in all cases, these recommendations are based on currently available land modification plans. Changes in these plans may have important effects on the mitigation deemed appropriate to certain cave systems.

It should also be stressed that the mitigation plans may not adequately mitigate the long-term effects of the project on the caves within the indirect impact areas. They are considered to be effective measures only insofar as (1) they reflect accurately the nature of indirect impact, and (2) they are responsibly carried through and maintained.

And lastly, as noted in the preliminary report (McEachern and Grady, 1977), data study must be integrated with a well-developed management/research plan. Only if this is done will maximum use be made of the data base to be lost as a result of cave inundating and other project-related disruptive influences. This study does not claim to have achieved such a goal. As an evaluative survey, its principal contribution is in identifying significant resources and in elucidating viable directions of research and responsible management actions to be taken in achieving adequate mitigation. More exacting plans, based on this study in part, must be formulated before actual mitigation can be initiated.

SCHEDULING AND PRIORITIZATION

An essential aspect of the mitigation process concerns the correlation of ameliorative priorities with the realities of project implementation scheduling. Although this has no bearing on the ranking of caves in terms of their research or public values, it is a critical consideration with respect to when and how the effect of the project on these values is ameliorated. The most evident prioritization considerations relate to the timing and form of impact. As the caves to be flooded will receive the earliest and most severe impact, they generally are considered separately from those above gross pool level.

Prioritization is also influenced by the mitigation needs in cave systems with multiple values. Multidisciplinary data study is such that often the information relevant to one discipline must be recovered before the investigations for a second can be implemented.

And finally, the nature of current use of the caves, which often is irrelevant to the project goals or effects, must be considered. Such factors are primarily related to inappropriate use of caves today.

CAVE PRIORITIZATION

Tables 3 through 11 (in the Impacts Section) summarize the ranking of caves assessed by the survey on the basis of values alone. These rankings are first broken down in terms of direct versus indirect impacts (Table 13).

Direct Impact Priorities

Any study of the resources to be directly impacted must consider such factors as vegetation clearing operations, inundation scheduling, current cave use, and multiple value mitigation needs. At this point in time no formalized plans exist for clearing of the area above Parrott's Ferry, which includes the whole of the impacted karst terrain. Thus, for the sake of this discussion, pre-inundation modification of the survey area is not of concern.

Inundation impact will obviously affect those caves at the lowest elevations below gross pool the soonest. In general, the caves the farthest downstream, closer to the gross pool elevation will be impacted the earliest, since inundation will obviously occur at the dam site first and move upstream.

TABLE 13. Priority Listing of Caves Based on All Values and Stratified by Impact (Most important caves at beginning of list).

DIRECT IMPACT				
1. 054	8. 055	15. 061	22. 070	29. 039
2. 025	9. 067	16. 068	23. 071	30. 044
3. 047	10. 086	17. 012	24. 082	31. 084
4. 005	11. 024	18. 013	25. 083	
5. 046	12. 074	19. 032	26. 014	
6. 003	13. 020	20. 033	27. 019	
7. 048	14. 059	21. 056	28. 038	

INDIRECT IMPACT

1. 043	13. 027	25. 015	37. 063	49. 049
2. 010	14. 073	26. 072	38. 069	50. 053
3. 051	15. 023	27. 041	39. 075	51. 057
4. 045	16. 022	28. 037	40. 007	52. 062
5. 077	17. 028	29. 052	41. 036	53. 078
6. 050	18. 034	30. 040	42. 076	54. 080
7. 018	19. 066	31. 079	43. 001	55. 081
8. 016	20. 011	32. 085	44. 004	56. 087
9. 030	21. 064	33. 017	45. 008	
10. 058	22. 065	34. 029	46. 026	
11. 006	23. 035	35. 021	47. 031	
12. 009	24. 002	36. 060	48. 042	

However, this situation is influenced by two additional elements—adequate data recovery time and multiple value mitigation procedures. Mitigative actions must take into consideration the sensitivity of the various forms of data to be collected on the basis of the effect of data study of one value on others. Since excavation of caves would obviously be disruptive to the cave ecology, biological mitigation must be essentially completed before any in-depth geological, paleontological, or archaeological investigations could take place. Taphonomic studies, requiring undisturbed surface contextual information, would also have to be implemented before extensive excavations could be initiated. Thus the following general data study priorities must be recognized:

1. biological
2. taphonomic
3. archaeological, paleontological, and geological

There is obviously room for some overlap in that non-disruptive study of several types can proceed in conjunction with long-term biological investigations or taphonomic collection activities. Generally speaking, however, in cases such as Cave 054, no disturbance of the deposits can be made before the biological data recovery has been completed.

Scheduling of data study must also be based upon projected mitigation time. It should be evident that mitigation should start at sites such as Caves 025 and 054 before others are mitigated. Even through some sites will be flooded before the water reaches either cave, the time required to implement adequate data study at these sites is considerably longer than at all others slated for such mitigation.

Current use of caves within the canyon area is also of prioritization concern. In this case, the two most significant caves to be directly impacted are also being most rapidly degraded by uncontrolled visitation. Both Caves 025 and 054 are constantly being entered by river boating parties, most of which are unaware of and/or unconcerned about

the importance of preserving the natural and cultural integrity of the resource base.

Indirect Impact Priorities

These priorities, in addition to some considered previously, include such factors as the sequence of planned recreational area development, projections of cave user pressure, ease of management control, and the nature of visitation safety.

It should be evident that the real goal of indirect impact mitigation in this situation is to preserve the resource base while allowing reasonable recreational use to be made of the caves. A major concern, therefore, is the developmental schedule for the various recreational areas. Those scheduled for earliest development should also be subject to the earliest mitigation.

Mitigative actions within each recreational area should then be implemented sequentially with respect to the projected extent of cave user impact on the resource base. Well-known or highly visible caves should be protected or otherwise mitigated before more obscure examples. This is particularly critical when gating is recommended. Properly placed, maintained, and monitored, cave gates can virtually eliminate deleterious human impacts. If selective use is ultimately planned, stabilization, biospeleological habitat enhancement, caver route establishment, carrying capacity determination, level of caver proficiency, and other such mitigative measures should be completed before further public access is granted. Additional restrictions can be placed upon caves (or sections of caves) of high scientific value that will be degraded by additional visitation; these sites can be gated and unauthorized access prohibited.

These factors, again, are crosscut by a number of other relevant considerations. In cases where multiple values must be mitigated by such methods as stabilization, the same conditions that hold for data study will hold for stabilization. Thus in Cave 009, for example, biological study must precede taphonomic stabilization, which must in turn precede paleontological investigation. Such stabilization must be completed before user pressure increases to any great extent.

An additional variable relates to current caver use of scientifically significant sites within the indirect impact areas. Caves such as 010 and 051 are now receiving so much irresponsible visitation that the scientific values are being destroyed at a relatively rapid rate. Thus some management control must be exercised over unauthorized entry into these caves irrespective of recreational area development sequencing.

Indirect impact mitigation in the form of minimal development must also be initiated early in the recreational area developmental process. Caves 052 and 085 will require less actual preparation but will require more monitoring and control than that expected for Cave 018.

As discussed previously, a thorough survey of "the Rockpile" is recommended for the initial phase of the Coyote Creek mitigation sequence. Due to the complexity of the karst terrain, literally hundreds of caves of unknown significance or hazard are located in this outcrop. Systematic locating and plotting of all entrances on aerial photographs followed by a cave-by-cave evaluation must take place before further mitigative recommendations of any constructive nature can be proposed for that locality.

DIRECT IMPACT SCHEDULING

Tables 14 through 22 present the priority listing of caves based on the various values previously assigned. These rankings are further separated with respect to presence in the direct versus indirect impact areas.

The discipline-specific prioritization synthesized in Table 4 in turn provided the framework for developing Table 13—the ranking of caves in terms of mitigation activity scheduling within the direct impact area. In addition to cave values, inundation timing and current visitor impact were taken into account.

INDIRECT IMPACT SCHEDULING

Tables 6 through 12 also constituted the framework for the generation of Table 14. Here cave values are combined with the planned recreational area development sequence, mitigation activity scheduling and projected caver impact factors.

SCHEDULING CONFLICTS

As currently proposed, dam closure and initiation of water impoundment are scheduled for November, 1978. Relevant recreational area development will begin with Coyote Creek and Skunk Gulch, both of which will be completed in September of 1980. Grapevine Gulch will be developed between 1990 and 2020. Although the mitigation recommendations for the recreational areas can be implemented within currently scheduled completion dates, it is evident that adequate mitigation cannot be accomplished within the time frame projected for inundation of the caves at or below the gross pool level.

One cave—054—is the focus of conflict. With one of the most complex cave-adapted invertebrate cavernicolous communities known in the western United States, adequate mitigation will require a minimum of two years of research simply to gather the data required to ameliorate the project impacts on the speleofauna. As previously discussed, a full seasonal round of intraregional research must be implemented in order to provide an adequate perspective on the nature of cave ecosystems that will not be inundated as well as those that will be flooded. Such research must obviously include Cave 054. Following that phase, more detailed direct impact investigations must be undertaken at those caves threatened by water impoundment. The latter studies will emphasize aspects of the biotic communities that are unique to particular cave ecosystems and that will be lost when inundation occurs. This phase must also include Cave 054, for without the perspective provided by placing 054 in a regional framework, the unique elements of the zoospeleology of that cave cannot be identified and isolated for more intensive investigation. In addition, important geological, paleontological, and taphonomic data exist in the cave. Three to six months following the completion of the zoospeleological data recovery are estimated as necessary to collect information relevant to the former disciplines before any inundation could occur.

It must be concluded that the data required for adequate mitigation of the direct impact area cannot be recovered in less than a full 27 months. If mitigative data recovery could start immediately, it would not be completed until after the closure date. Thus the scheduling for impoundment such that Cave 054 is in any way directly impacted must be extended until such time as adequate data relevant to all recognized values in the cave can be collected.

TABLE 14. List of Caves Ranked in Terms of Geological Significance and Stratified by Impact (Most important caves at beginning of list).

DIRECT IMPACT				
1. 025	4. 003	7. 046	10. 067	13. 020
2. 054	5. 005	8. 048	11. 069	14. 068
3. 047	6. 024	9. 055	12. 074	
INDIRECT IMPACT				
1. 016	7. 022	13. 065	19. 037	25. 034
2. 043	8. 030	14. 066	20. 060	26. 035
3. 051	9. 040	15. 077	21. 064	27. 052
4. 009	10. 045	16. 023	22. 073	28. 072
5. 010	11. 050	17. 027	23. 002	29. 085
6. 011	12. 058	18. 028	24. 018	

TABLE 15. List of Caves Ranked in Terms of Paleontological Significance or Potential Significance and Stratified by Impact (Most important caves at beginning of list).

DIRECT IMPACT		INDIRECT IMPACT		
1. 025		1. 045	7. 018	13. 009
2. 054		2. 043	8. 022	14. 034
		3. 051	9. 028	15. 035
		4. 010	10. 077	16. 037
		5. 023	11. 002	17. 064
		6. 030	12. 006	18. 066

TABLE 16. List of Caves Ranked in Terms of Taphonomic Significance and Stratified by Impact (Most important caves at beginning of list).

DIRECT IMPACT				
1. 054	5. 047	9. 012	13. 055	17. 074
2. 005	6. 067	10. 013	14. 061	18. 082
3. 025	7. 086	11. 033	15. 068	19. 083
4. 046	8. 003	12. 048	16. 071	

INDIRECT IMPACT				
1. 010	8. 015	15. 050	22. 058	28. 052
2. 030	9. 016	16. 011	23. 063	29. 060
3. 051	10. 018	17. 022	24. 065	30. 075
4. 002	11. 021	18. 023	25. 072	31. 076
5. 006	12. 028	19. 040	26. 037	32. 079
6. 077	13. 034	20. 041	27. 045	
7. 009	14. 035	21. 043		

TABLE 17. List of Caves Ranked in Terms of Archaeological Significance and Stratified by Impact (Most important caves at beginning of list).

DIRECT IMPACT		INDIRECT IMPACT	
1. 025	7. 003	1. 010	
2. 005	8. 032	2. 018	
3. 046	9. 056	3. 007	
4. 047	10. 069	4. 077	
5. 048	11. 024		
6. 059			

TABLE 18. List of Caves Ranked in Terms of Biological Significance and Stratified by Impact (Most important caves at beginning of list).

DIRECT IMPACT		INDIRECT IMPACT		
1. 054	5. 020	1. 006	12. 034	23. 045
2. 025	6. 055	2. 009	13. 043	24. 065
3. 003	7. 061	3. 010	14. 050	25. 027
4. 086	8. 067	4. 011	15. 051	26. 077
		5. 015	16. 058	27. 037
		6. 016	17. 072	28. 021
		7. 017	18. 073	29. 028
		8. 022	19. 079	30. 040
		9. 023	20. 018	31. 060
		10. 029	21. 035	32. 063
		11. 030	22. 041	33. 075

TABLE 19. List of Caves Ranked in Terms of Esthetic Significance and Stratified by Impact (Most important caves at beginning of list).

DIRECT IMPACT		INDIRECT IMPACT		
1. 025		1. 027	6. 077	11. 051
2. 054		2. 043	7. 028	12. 052
		3. 050	8. 045	13. 085
		4. 064	9. 058	
		5. 066	10. 073	

TABLE 20. List of Caves Ranked in Terms of Recreational Significance and Stratified by Impact (Most important caves at beginning of list).

Horizontal Caves		Vertical Caves	
DIRECT IMPACT	INDIRECT IMPACT	DIRECT IMPACT	INDIRECT IMPACT
1. 025	1. 043		1. 006
2. 054	2. 027		2. 010
	3. 052		3. 016
	4. 085		4. 045
			5. 050
			6. 051
			7. 058
			8. 073
			9. 002
			10. 018
			11. 064
			12. 066
			13. 077
			14. 037
			15. 041

ANCILLARY MITIGATION SCHEDULING

As proposed in the Mitigation section, some studies of the direct and indirect impact areas are most efficiently coordinated. Biological mitigation should encompass selected caves in the recreational areas as well as those below gross pool in order to maximize the information available on speleofaunal community variability. Once these data are available, the intensive investigation of Cave 054 can be most comprehensively implemented.

Similarly, the mitigation of the Coyote Creek and Skunk Gulch Recreation Areas must co-occur with the mitigation of the direct impact zone caves. Given the fact that these facilities will be completed about the time normal reservoir holding capacity is reached, the recommended gating of

caves, development of Caves 052, 085, and 018, and the survey of the Rockpile at least must be completed by the beginning of facility use.

If some form of postinundation monitoring of the directly impacted caves is approved, this action must begin at the time initial flooding occurs. It is presumed that the greatest changes will occur shortly after inundation. From 1 to 5 years is recommended for the implementation of such evaluative research.

TABLE 21. List of Caves in Direct Impact Area Ranked in Terms of Mitigation Scheduling (Sites to be considered earliest at beginning of list).

1. 054	4. 047	7. 032	10. 068	13. 003
2. 025	5. 074	8. 046	11. 059	
3. 005	6. 024	9. 048	12. 069	

TABLE 22. List of Caves in Indirect Impact Area Ranked in Terms of Mitigation Scheduling within Recreational Areas (Sites to be considered earliest at beginning of list).

<i>Coyote Creek</i>					
1. 010			4. "Rockpile" survey		
2. 051			5. 015		
3. 052, 085			6. 050		
<i>Skunk Gulch</i>					
1. 045		4. 002		7. 037	
2. 018		5. 006		8. 034	
3. 023		6. 011		9. 035	
<i>Grapevine Gulch</i>					
1. 043		3. 066		5. 022	
2. 009		4. 030		6. 060	

MITIGATIVE COST ESTIMATION

Both approaches for estimating costs for the various disciplines involved in the cave research and the mitigation procedures themselves vary considerably. As a consequence, costs differ to a great extent, and funding justification is not strictly comparable among any of the disciplines except possibly paleontology and archaeology. Nonetheless, the following funding approaches are deemed reasonable, given the value of the data base and the level determined adequate for responsible mitigation. Support for funding determination is provided on a discipline-specific basis in the following discussion. Actual costs have been deleted from this chapter as per the Corps of Engineers request.

GEOLOGY AND RELATED STUDIES

Realistic cost estimates for geological mitigation of the New Melones caves are difficult to determine because no similar project has been undertaken in the U.S. However, the following funding projections are based on current geological research costs and are in accordance with previous mitigation recommendations.

Site-Specific Costs:

Stratigraphic drawing of deposits is estimated to require 5 person days/5 sq m, or a minimum of 1 person day per site. One person day costs approximately \$100.

Boring equipment rental and staff time for operation will require approximately \$250/day; 1 day will be spent at most sites.

Granulometric determinations, if done in bulk, cost approximately \$35 each.

Mineralogical determinations, if done as a part of the granulometric tests, will also cost \$35 each. In addition, samples will be run on selected calcite artifacts at \$50 each.

Petrographic thin section analysis costs approximately \$25.

Soil monolith collection requires some 4 person days in the field and approximately \$250 for materials and analysis for a cost per monolith of \$200.

Establishment of three-dimensional mapping-provenience control takes approximately 3 person days per 10 cu m, or a minimum of 3 days per site; 3 person days costs \$275.

Isotopic determinations, based on the average commercial cost of radiocarbon and potassium-argon dating, costs \$300 per sample.

Analysis of data (excluding isotopic analysis) and report writing is projected to cost approximately as much as field work in studies of this sort. This translates into an expense of ca. \$715/ cu m of deposit.

Caves to be studied geologically will either be inundated or contain deposits which are expected to be heavily impacted by increased caver use. Cost estimates are based on the figures provided above as they apply to individual caves.

Those caves which are considered highly significant are recommended for intensive mitigation and will require the implementation of the full range of geological study procedures. Large-scale investigations such as soil monolith analysis and three-dimensional mapping are emphasized at these caves.

Caves which were used prehistorically as calcite quarries will require in-depth mineralogical and petrographic analysis. In addition a number of calcite artifacts will be analyzed to determine source areas through trace element correlation.

All of the caves recommended for geological mitigation contain formations which may be radio-isotope dated. Such chronometric information is of obvious importance.

Geologic Mapping of the Direct Impact area:

10 person days to map the area from aerial photos (\$975).

3 person days to transfer the information from photos to map base with zoom transfer scope (\$300).

20 person days to field check the aerially-derived map for the zone to be flooded; geologist and assistant (\$3,300).

100 thin sections and petrographic descriptions at \$25/specimen.

Planimetric analysis of the map; 5 mandays (\$490).

Large-Scale Mapping of the Rock Pile:

Custom low-altitude aerial photos (\$1,000).

Plane Table checking to establish ground control; 10 person days (\$865).

Photogrammetry from custom aerial photos; 5 person/days (\$500).

Drafting and transferring information, printing (\$1,000).

Manufacture and placement of permanent markers at prominent cave entrances; 2 person/days; \$125 plus \$200 supplies.

PALEONTOLOGY

The basic cost estimates for the data study of paleontological resources are derived from recent excavations at Fresenhaun Cave, Texas (Graham, 1976). While it would have been desirable to base the estimates on California localities, the relevant cave faunas were excavated in the earlier part of this century, and most notes subsequently have been lost.

Developing cost estimates based on only one locality is open to a number of errors. Such factors as density of bone, nature of matrix, quality of preservation, and other variables cannot be carefully controlled. Detailed records of deposit differentiation, volumes of deposit studied, and person hours spent in various phases of paleontological research, for purposes of cost accounting, are not normally kept. Cost estimates for the Fresenhaun material, then, were based on information gathered from the final report and interviews conducted with individuals involved with the recovery and preparation of the data. Despite the possible errors inherent in such an approach, the figures

developed in this report are deemed reasonably accurate estimates of the actual costs involved in adequate study of the New Melones cave materials.

Although cave excavations for archaeological and paleontological resources are similar in most respects, some important differences exist. Current standards for the retrieval of cultural data do not always require extremely fine screening. On the other hand, paleontologists seeking paleocological information utilize 1.5 mm mesh to recover the microvertebrates that are necessary for meaningful environmental reconstruction. This, plus the amount of time needed to prepare and preserve individual specimens, costs somewhat more per unit of volume than does archaeology in most cases. For Fresenhaun Cave approximately 50 person days were required for the excavation of 8.2 cu m of the project while at least 380 person days were necessary for preparation, analysis, and report writing. Thus, the estimated cost per cubic meter is \$2,378.63. It should be noted that Fresenhaun Cave is a vertical cave and the above figure is comparable to cost estimates that were utilized in the preliminary report and in the following section for mortuary caves. No figures were available for developing paleontological costs for the study of horizontal caves comparable to those present in the New Melones area (although paleontologists were consulted at the University of Texas at Austin, Southern Methodist University, and the University of California, Berkeley). However, it is reasonable to assume that the differences determined for archaeological data in horizontal and vertical caves are directly comparable to the paleontological situation. Based on this assumption, the cost of excavating, analysis, and report preparation for paleontological resources in a horizontal cave is computed at \$1,679.31 per cu meter. About \$1,000/per cu m is required for analysis and reporting of paleontological data if this expense is to be considered separately, as in the case of paleontological analysis of specimens recovered during archaeological excavations.

TAPHONOMY

The activities involved in taphonomic mitigation largely consist of the collection of extant animal remains, with particular attention being paid to their contextual relationships. Such activity requires point provenience mapping in some cases, as well as sample collection, often from a matrix context. After field recording, samples are analyzed (identified, tabulated, and, in the case of matrix samples, submitted to heavy liquid or similar solutioning to break down the matrix), and the data are synthesized according to various research needs. Because taphonomy involves the study of patterns of deposition of bone within a single cave as well as among caves, it will be necessary to take more than one sample from some caves. One hundred sample collections are estimated to be sufficient for adequate mitigation, as indicated in the discussion on mitigation recommendations.

Cost estimates for taphonomy are derived from the experience gained by Bruce Hanson of the University of California, Berkeley:

To collect one sample requires 4 person hours or 0.5 person day.

Screening of one sample requires 1 person hour or 0.125 person day.

Each sample yields about 3,000 specimens; separation of bone from sediment requires about 5 seconds per specimen, or 4.2 person hours per sample.

Identification, weighing and measuring of each specimen requires 1 minute, or 6.25 person days per sample.

Statistical analysis, report writing and curation, requires about 3 person days per sample.

The total time per sample is thus estimated to be 10 person/days at a cost of \$875.

BIOLOGY

The cost estimates for biological mitigation are more difficult to derive and support than others, in large part because fully funded research of this calibre has rarely been attempted. In addition, carefully costed examples of biospeleological studies were not available to the authors during the time that the project was being synthesized. However, the following cost estimates are similar to those recommended by Dr. Richard Graham although they have been modified to suit project-specific mitigation needs as defined by the three-stage mitigation program previously described. The wages for two research biologists with expertise in speleofaunal study are estimated at \$1,700/mo./person. These individuals, over a 24-month period, will implement the intensive research on selected caves in the project area. Four biological survey/transplant personnel, with estimated rates of pay of \$560/mo./person, will study caves outside the research area, assist the research biologists and effect the faunal transplants if a suitable site is located.

Operational costs are projected to cover the expense of field and laboratory supplies of an expendable nature (live traps, photographic materials, notebooks, lighting equipment) at an estimated cost of \$5,000. Per diem and transportation expenses are estimated to be approximately \$20,000 for the field phase. Analysis and report preparation costs, including the involvement of the research biologists for 6 months plus expenses, will require \$30,000.

ARCHAEOLOGY

The following discussion of mitigation funding follows that of Moratto (1976:477-500). Developed in depth in the preliminary report (McEachern and Grady, 1977), these data will only be summarized here. In light of the fact that the archaeological cave resources are an integral part of the prehistoric data base (in most cases), it is argued that the Moratto mitigation framework is not only an appropriate set of guidelines, but also that the cave research discussed herein must be integrated with the prehistoric mitigation procedures outlined in the aforementioned references.

Moratto (1976:485-491) has developed estimates of the costs involved in the investigation of surface archaeological data in the New Melones area. Using accurate records kept of the number of person/hours that were

involved and the volume of midden processed from 10 separate open sites, Moratto was able to develop well-supported cost estimates for studying a cubic meter of midden. This figure (K), a constant, was then multiplied by the area excavated (A) and the estimated depth (D) to determine the cost (C) involved in studying an individual site. Some quantities, such as depth, were often determined visually (V). This formula ($C=KAD$ or $C=KV$ with $V=AD$) provided a rapid method for determining cost estimates for cultural deposits once the value of K was determined for the type of site involved.

Whereas the Moratto estimates were developed for open sites, cave deposits cannot be studied in any directly comparable fashion. The more complicated logistics increase the data recovery cost per cubic meter substantially. The shelter cave costs for data recovery have been derived from scaled estimates of time and effort devoted to the archaeological study of the outer reaches of Samwel Cave in Shasta County (L. Payen, personal communication). The mortuary cave costs were derived in part from adjusted estimates based on the study of Pinnacle Point Cave and Papke Cave (Payen, 1964; Rose, 1971). These latter estimates are higher due to the fact that logistic problems are increased even more within the confines of a vertical cave of some considerable depth.

Based on the above information, an average expenditure of 2,750 person days is made in the excavation of 275 cu m of deposit in shelter sites. Approximately 196 person days are spent in the excavation of 14 cu m of deposit in vertical cave sites. This translates into 10 person days per cu m and 14 person days per cu m, respectively—increases of 12% and 17% over the Moratto average.

The data study factors and estimates developed by Moratto also are applicable to the cave resources with some exceptions. However, the costs of such specialized investigations as chemical analyses of deposit constituents and trace-element analysis are assumed to be covered by the contingency technical analysis figures computed by Moratto (1976:490).

Thus, the cost per cubic meter of rockshelter study, at an increase of 12% over the Moratto field phase estimate, yields a cost per cubic meter of \$1,368.60. Mortuary cave study, at an equivalent increase of 17%, will cost \$1,938.90 per cubic meter.

The percentages of total data study recommended for the adequate mitigation of each site are used to derive the cost estimates. Those sites to be indirectly impacted have mitigation costs developed that are in large part specific to the sites themselves.

ANCILLARY COST ESTIMATES

Ancillary costs refer to those expenses outlined in previous sections of the report in relation to mitigative procedures other than data study. These include cave gating, surface collection, deposit stabilization, and recreational development.

The cost of cave gating varies with the size of the entrance, the nature of the cave, and other such considerations. Allowances must be made for biotic movement, the entry and exit of equipment, and the location of the cave entrance, among other factors. Available data on cave gates (Hunt and Stitt, 1975; NSS, 1975; knowledge of the coassembler), indicates that approximately \$2,500.00 will be required to design, construct, and install an adequate cave gate (exclusive of installation labor). It should be noted that gate design and installation must be supervised by those with the speleological background to produce the desired result in the form of an adequate barrier compatible with the nature of the cave itself. It should also be noted that gates must be inspected periodically and maintained in order to have any long-term positive effect.

The caves recommended for gating by this study are fewer than those identified in the Master Plan. The assemblers are of the opinion that only the caves that will be demonstrably impacted by increased visitation should be gated. In other situations, gates can become an attractive nuisance, and thus more of a liability than a deterrent to cave damage. It is also becoming increasingly evident that effective cave gating requires regular monitoring and maintenance—actions which are not particularly feasible for some caves in the indirect impact areas. Thus, at this point in time, the restriction of cave location information is considered to be a more responsible approach for mitigation of the impacts of increased visitation on most of the caves in the recreation areas.

As previously indicated, surface collection as a mitigative action is exclusively directed toward caves of taphonomic value. Extensive procedures in the indirect impact zone caves will be restricted to those locations within caves where increased visitation will have the most effect.

It must be reemphasized that these estimates reflect the actual implementation of mitigation procedures. They do not include the expense involved in "gearing up" to implement mitigation. Such expenses would cover the funding for developing an integrated multidisciplinary research design, working out logistic contingencies, locating and hiring personnel, and similar such activities.

SUMMARY AND CONCLUDING CONSIDERATIONS

This report assesses the significance of the caves known to be present in the area to be directly and indirectly impacted by the New Melones Lake. In all, 87 caves are evaluated (Table 23). National Register of Historic Places and National Registry of Landmarks eligibility is considered, project impact on the sites is evaluated, and mitigation recommendations are provided. A case is made for the caves being an exceedingly important component of the cultural and natural systems within the project area, and it is argued that responsible mitigation against data loss through project development must be implemented.

In closing, it is believed that four additional considerations must be aired within the context of this report. The first three have to do with cave acquisition.

Crystal Stanislaus Cave, a large and relatively complex system, is supposedly located immediately outside of the indirect impact zone at the extreme north end of the reservoir (there is some likelihood that the lower entrance to this cave is actually within the take line controlled by the U.S. Army Corps of Engineers). The cave is of particular importance because it supports one of the few myotis bat nurseries in the region. In addition to its high speleological and biological importance, it has an interesting history of use by a hermit named Mobley, who developed a tourist trail to the cave and ran guided trips through it during the 1800's (Halliday, 1962; Squire, 1972). The upper entrance room is relatively large and has considerable potential for containing evidence of aboriginal use as well as the previously documented historic utilization. It is recommended strongly that this cave be included within the area managed as part of the lake and that steps be taken to protect it from damage which will inevitably result from the increased traffic to that part of the river.

McNamee's Cave has long been recognized as one of the more important mortuary caves in the area. Preliminary archaeological investigations were made in the cave by the University of California at Berkeley, indicating that substantial deposits of human bone and prehistoric artifacts were present (Halliday, 1962; McEachern, 1968:56). The site is also suspected to be of great biological importance (Briggs, 1974). It is located below the confluence of the North and South Forks of the Stanislaus River slightly above the current zone of Corps of Engineers control. The cave is privately owned at this time, and the owners have blasted the entrance closed to prevent access. Nonetheless,

it is suspected, based on first-hand observations, that the archaeological deposit was not destroyed by this action and that the cave is eminently worthy of acquisition and proper preservation as a part of the land management program associated with the reservoir.

A third cave of exceptional biological and paleontological value is Cave 051, which is located only a few meters beyond the northern boundary of the Skunk Gulch Recreation Area. There is no question that this cave will suffer impact as a direct result of the development of the recreation area, and it is strongly recommended that the property including this site be acquired so that proper management of the cave can be implemented. Further information is provided in the Cave Descriptions section.

The final considerations are meant to reemphasize a number of points that have been made throughout the report. One of these has to do with mitigative study integration. Although the National Environmental Policy Act and subsequent legislation based in part on this law indicates that evaluative (and, by extension, mitigative) investigations of threatened resources should be implemented as multidisciplinary research endeavors, this only rarely occurs. Much of the research done to date on the New Melones Project, however, has been completed in a multidisciplinary spirit (e.g. Moratto 1976) or as interdisciplinary fact (e.g. this report). It is urged that this approach be continued, especially with regard to further open site and cave cultural resource studies, and with cave cultural, paleontological, and taphonomic investigations. There is no question that the results of such an approach yield a product that is far more valuable than the sum of its individual parts.

The interdisciplinary studies of the New Melones resources should not stop once direct and indirect impact mitigation has been completed. One of the most valuable management tools that could result from the construction of the dam and reservoir would be the results derived from continued monitoring and quantitative evaluation of the actual effects of flooding, increased visitation, and other such factors on the natural and cultural values of the area. With virtually no empirical evidence documenting the positive or negative aspects of such actions, an actual study of this calibre could result in exceedingly useful management guidelines.

TABLE 23. Status of Caves in the Direct and Indirect Impact Areas.

Cave	Area	Relation of Pool Level	Present Condition	Nature of Project Impact	Previous Mitigation
		27 ± 2m(89 ± 6ft) above RPL			
001	Canyon	7 ± 2m(22 ± 6ft) above GPL	no vandalism	indirect	
002	Skunk Gulch	193 ± 1m(632 ± 3ft) above GPL	no vandalism	indirect	
		36m(118ft) below GPL			
003	Canyon	15m(36ft) below RPL	no vandalism*	inundation	
004	Skunk Gulch	144 ± 3m(472 ± 10ft) above GPL	no vandalism	indirect	

TABLE 23. Status of Caves in the Direct and Indirect Impact Areas (continued).

Cave	Area	Relation to Pool Level	Present Condition	Nature of Project Impact	Previous Mitigation
005	Canyon	52m(168ft) below GPL 31m(100ft) below RPL	No vandalism*	inundation	
006	Skunk Gulch	144±3m(472±10ft) above GPL	no vandalism	indirect	
007	Canyon	34m(112ft) above GPL	no vandalism*	indirect	
008	Canyon	218m(712ft) above GPL	no vandalism	indirect	
007	Canyon	34m(112ft) above GPL	no vandalism*	indirect	
010	Coyote Creek	131m(430ft) above GPL	disturbed deposit*	indirect	Note 1
011	Skunk Gulch	147±6m(482±20ft) above GPL	some usage	indirect	
012	Canyon	18m(59ft) above RPL 24m(8ft) below GPL	no vandalism	ind/inund.	
013	Canyon	51±3m(169±10ft) below GPL 31±3m(101±10ft) below RPL	excavated by mining	inundation	
014	Canyon	42±3m(173±10ft) below GPL 21±3m(70±10ft) below RPL	no vandalism	inundation	
015	Coyote Creek	144±12m(472±40ft) above GPL	no vandalism	indirect	
016	Coyote Creek	143±6m(472±20ft) above GPL	heavy usage	indirect	
017	Coyote Creek	144±12m(472±40ft) above GPL	no vandalism	indirect	
018	Skunk Gulch	168m(552ft) above GPL	heavy usage*	indirect	Note 2
019	Canyon	34m(111ft) below RPL	excavated by mining	inundation	
020	Canyon	41m(133ft) below GPL 20m(66ft) below RPL	no vandalism	inundation	
021	Canyon	95±3m(312±10ft) above GPL	heavy usage	indirect	
022	Grapevine Gulch	266m(872ft) above GPL	vandalism	indirect	
023	Skunk Gulch	186±8m(612±25ft) above GPL	no vandalism	indirect	
024	Canyon	51m(168ft) below GPL 31m(101ft) below RPL	no vandalism*	inundation	
025	Canyon	25±1.5m(83±5ft) below GPL 5±1.5m(16±5ft) below RPL	heavy usage*	inundation	
026	Coyote Creek	126m(412ft) above GPL	mod. usage	indirect	
027	Skunk Gulch	217±3m(712±10ft) above GPL	no vandalism	indirect	
028	Grapevine Gulch	240m(787ft) above GPL	heavy usage	indirect	
029	Coyote Creek	144±11m(472±40ft) above GPL	no vandalism	indirect	
030	Grapevine Gulch	272m(892ft) above GPL	heavy usage	indirect	
031	Canyon	110±3m(362±10ft) above GPL	no vandalism	indirect	
032	Canyon	56m(183ft) below GPL 35m(116ft) below RPL	vandalism, trash*	inundation	
033	Canyon	35±1.5m(996±5ft) below RPL	excavated by mining	inundation	
034	Skunk Gulch	183±25m(602±25ft) above GPL	no vandalism	indirect	
035	Skunk Gulch	187±3m(612±10ft) above GPL	no vandalism	indirect	
036	Canyon	28m(92ft) above GPL	no vandalism	indirect	
037	Skunk Gulch	180±3m(592±10ft) above GPL 17m(48ft) below GPL	no vandalism	indirect	
038	Canyon	69m(228ft) above RPL	no vandalism	ind./inund.	
039	Canyon	20m(66ft) below RPL	no vandalism	inundation	
140	Grapevine Gulch	251±9m(822±30ft) above GPL	heavy usage	indirect	
041	Skunk Gulch	199m(652ft) above GPL	heavy usage	indirect	
042	Coyote Creek	126m(412ft) above GPL	mod. usage	indirect	
043	Canyon	254±3m(832±10ft) above GPL	heavy usage	indirect	Note 3
044	Canyon	34±2m(111±6ft) below RPL	no vandalism	inundation	Note 4

TABLE 23. Status of Caves in the Direct and Indirect Impact Areas (continued).

045	Skunk Gulch	186 ± 8m(612 ± 25ft) above GPL	no vandalism	indirect
046	Canyon	17m(53ft) below RPL	no vandalism*	inundation
047	Canyon	6m(21ft) below RPL	no vandalism*	inundation
048	Canyon	8m(28ft) above RPL 13m(39ft) below GPL	vandalism*	inundation
049	Coyote Creek	126m(412ft) above GPL	vandalism	indirect
050	Coyote Creek	145 ± 6m(472 ± 20ft) above GPL	mod. usage	indirect
051	Coyote Creek	92m(302ft) above GPL	mod. usage	indirect
052	Coyote Creek	4 ± 3m(12 ± 10ft) above GPL	heavy usage	indirect
053	Coyote Creek	35 ± 6m(115 ± 20ft) above GPL	no vandalism	indirect
054	Canyon	4m(12ft) below RPL	heavy usage	inundation
055	Canyon	1m(3ft) below GPL	no vandalism	ind./inund. Note 5
056	Canyon	45m(156ft) below GPL	mod. usage*	ind./inund.
057	Coyote Creek	126m(412ft) above GPL	no vandalism	indirect
058	Coyote Creek	143 ± 6m(472 ± 20ft) above GPL	heavy usage	indirect
059	Coyote Creek	28m(93ft) below RPL	no vandalism*	inundation
060	Grapevine Gulch	34 ± 2m(112 ± 6ft) above GPL	no vandalism	indirect
061	Canyon	25m(81ft) below RPL	no vandalims	inundation
062	Coyote Creek	144 ± 12m(472 ± 40ft) above GPL	no vandalism	indirect
063	Canyon	34m(112ft) above GPL	no vandalism	indirect
064	Skunk Gulch	205 ± 3m(672 ± 10ft) above GPL	mod. usage	indirect
065	Grapevine Gulch	214m(702ft) above GPL	heavy usage	indirect
066	Grapevine Gulch	257 ± 5m(842 ± 15ft) above GPL	heavy usage	indirect
067	Canyon	13m(43ft) below RPL	no vandalism	inundation
068	Canyon	12 ± 3m(41ft) below RPL	no vandalism	inundation
069	Canyon	20 ± 3m(66 ± 10ft) below RPL	vandalism*	inundation
070	Canyon	12m(41ft) below RPL	no vandalism	inundation
071	Canyon	2 ± 3m(6 ± 10ft) below RPL	mod. usage	inundation
072	Coyote Creek	2540m(8332ft) above GPL	mod. usage	indirect
073	Coyote Creek	144 ± 3m(472 ± 10ft) above GPL	vandalism	indirect
074	Canyon	31 ± 3m(101 ± 10ft) below RPL	no usage	inundation
075	Canyon	95 ± 3m(312 ± 10ft) above GPL	deposit disturbed	indirect
076	Canyon	6 ± 6m(20 ± 20ft) above GPL	no vandalism	indirect
077	South Fork	19m(62ft) above GPL	heavy usage*	indirect
078	Canyon	119m(392ft) above GPL	no vandalism	indirect
079	Coyote Creek	144 ± 12m(472 ± 40ft) above GPL	no vandalism	indirect
080	Canyon	141 ± 1m(462 ± 3ft) above GPL	no vandalism	indirect
081	Skunk Gulch	133 ± 1m(437 ± 3ft) above GPL	no vandalism	indirect
082	Canyon	20m(65ft) below GPL even 1021 ft RPL	no vandalism	ind./inund.
083	Canyon	55m(182ft) below RPL	no vandalism	inundation
084	Canyon	6m(21ft) below RPL	no vandalism	ind./inund.
085	Coyote Creek	22 ± 3m(72 ± 10ft) above GPL	heavy usage	indirect
086	Canyon	6 ± 1m(21 ± 3ft) below RPL	no vandalism	inundation
087	South Fork			
087	South Fork	6 ± 6m(21 ± 20ft) above GPL	no vandalism	indirect

Note 1: Cal. St. Stanislaus visit

Note 2: 1951 Santa Barbara Mus. Testing
1967 McEachern Collections

Note 3: Paleontological collections reputedly
made here

Note 4: Fossil *Bassariscus* discovered here
(Graham, 1960).

Note 5: Gated
Site of harvestmen studies

Note 6: Archaeological studies implemented here
(Payen, et al., 1969).

* National Register quality site

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APPENDIX — CAVE DESCRIPTIONS

The following descriptions are based largely on field observations made by the survey team and recorded on specially designed cave survey forms. In the few cases where caves could not be located by the team, the descriptions are based on published references and information obtained from persons familiar with the caves.

The larger and more complex caves were studied in greater detail, with emphasis placed on those located below gross pool level. Repeated trips were made to several of the most important caves. The specialists concentrated their time and effort on these sites, as reflected in the cave descriptions.

Considerable confusion resulted from efforts to correlate cave names and locational information. Not only were certain caves known by more than one name, but the same name was occasionally applied to more than one cave. In part to alleviate this problem and in part to prevent sensitive information concerning cave locations and other values from too easily falling into the wrong hands, each cave was assigned a number. When archaeological sites were identified, permanent California State University at Sacramento site numbers were also used. In accordance with this concern, cave descriptions were purposefully developed in nonspecific fashion as well. Such information is available to responsible individuals and agencies demonstrating a legitimate reason for acquiring these data.

The elevations of caves located well above or well below the currently projected gross pool level of the reservoir were generally taken directly from the USGS Columbia 7.5 minute topographic map. In the case of caves located near the gross pool level, a survey line was run from the entrance of the cave to the river level to determine elevation more accurately. An altimeter was used to check the elevation of river level on the Middle Fork at Duck Bar.

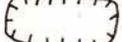
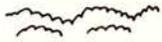
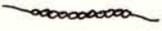
While sketches were made of all caves on the cave record form, the more complex caves required survey mapping to accurately determine their extent and configurations. A total of 29 caves were mapped using a compass, clinometer, and fiber tape.

The following format was employed to describe the caves for this report. Only those categories relevant to the data collected within the cave are provided although all observations were made for all caves.

- Cave Number
- Location
- Elevation
- Height above Base Level
- Relation to Gross Pool Level
- Description
- Speleogens
- Speleothems
- Hazards
- Vandalism
- Sediments and Stratigraphy

- Biological Observations
- Biological Identifications
- Paleontological Observations
- Paleontological Identifications
- Archaeological Observations
- Archaeological Identifications
- Significance
- National Register Eligibility
- Mitigation

CAVE MAP SYMBOLS

-  Passage outlines
-  Lower level passage
-  Upper level passage
-  Sharp drop in floor level
-  Slope, down in splayed direction
-  Pit
-  Ceiling lowers, down in hachured direction
-  Ceiling height
-  Water
-  Columns (floor plan)
-  Columns (profile)
-  Stalactite
-  Stalagmite
-  Flowstone
-  Breccia
-  Bedrock (floor)
-  Bedrock
-  Clay, silt floor
-  Dirt, sand floor
-  Breakdown
-  Talus

Cave Descriptions

CAVE 001

Location: Stanislaus River Canyon, Calaveras County

Elevation: 338 ± 2 m (1110 ± 6 ft)

Height above Base Level: 61 ± 2 m (200 ± 6 ft)

Relation to Pool Level: The cave is located 27 ± 1 m (89 ± 6 ft) above recreation pool level and 7 ± 2 m (22 ± 6 ft) above gross pool level.

Description: The round, 50 cm diameter cave entrance is situated beneath a rock overhang on a steep cliff face. The cave is a small solution tube that drops vertically for 3 m into a small crawlway 4 m in length.

Speleothems: Cave coral is present.

Sediments and Stratigraphy: No sediments were noted inside the cave, but remnants of river deposited alluvium were noted outside the cave entrance on the cliff face.

Mitigation: No further study is required for this cave.

CAVE 002

Location: Skunk Gulch, Calaveras County

Elevation: 524 ± 1 m ($1720 \pm$ ft)

Height above Base Level: 258 m (845 ft)

Relation to Pool Level: The cave is located 193 ± 1 m (632 ± 3 ft) above gross pool level.

Description: A tight entrance of 50 by 75 cm opens into a 15 cm drop that bells out into a small "L" shaped room 4 m in length and 1.5 m in width.

Speleogens: The cave exhibits joint pockets and scallops.

Speleothems: Flowstone and stalactites were noted.

Hazards: Cave 002 has a 16 m drop that cannot be executed without technical assistance.

Sediments and Stratigraphy: The cave has a deposit of brownish-red clay. The sediments are covering flowstone, indicating recent deposition.

Biological Observations: Small animal dung occurs around the cave entrance. Recent vertebrate bones occur on the surface of the deposit in the bottom of the cave.

Biological Identifications:

- 1 Young California Rock Squirrel: *Citellus beecheyi*
- 4 Adult Valley Pocket Gopher: *Thomomys bottae*
- 1 Pocket Gopher: *Perognathus californicus*
- 1 Old Adult Deer Mouse: *Peromyscus maniculatus*
- 1 Adult Dusky-Footed Packrat: *Neotoma fuscipes*
- 1 California Vole: *Microtus californicus*
- 2 Adult Bush Rabbits: *Sylvilagus cf. bachmani*

Significance: The cave is presently a natural trap and is of value in terms of taphonomic research potential. There is reason to believe that the cave may have also been a natural trap in the past and significant vertebrate fossils may be present below the recent deposits.

Mitigation: Although some taphonomic collection is appropriate for this cave, no other mitigative work is recommended at this time.

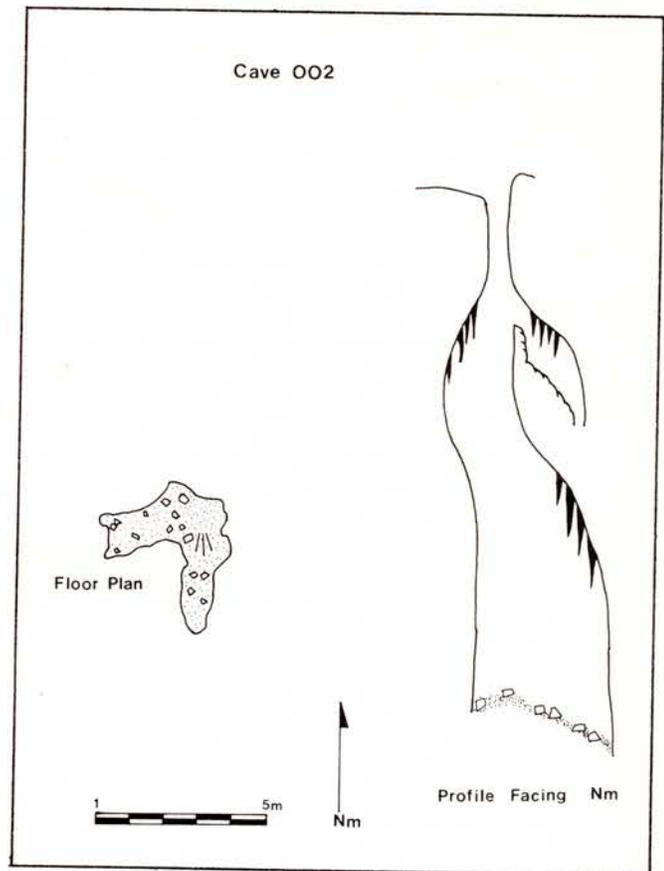
CAVE 003 (Ca-Cal-646)

Location: Stanislaus Canyon, Calaveras County

Elevation: 236 m (970 ft)

Height above Base Level: 6 m (20 ft)

Relation to Pool Level: The cave is 36 m (118 ft) below



gross pool level and 15 m (50 ft) below recreation pool level.

Description: The entrance is 2.5 m wide and 4 m high. The entrance room is 2 m in height and 2 m in length and has a breakdown-covered floor. Below a false floor in the rear of the entrance room a small crawlway passage 50 cm in height continues for a distance of 2 meters.

Speleogens: The cave has formed along a joint in the marble and evidence of its origin is seen in joint pockets.

Speleothems: Cave 003 contains cave coral, a false flowstone floor, and stalactites averaging 2.5 cm in length.

Sediments and Stratigraphy: The floor of the entrance room consists of angular breakdown blocks averaging 2 by 2 meters. A false floor occurs 1 m above the present floor level at the rear of the entrance room. The fill in the crawlway passage exhibits angular breakdown averaging 3 by 2 cm which is derived from the false floor and ceiling. Small pebbles and gravels are also deposited in the crawlway.

Biological Observations: A dark stain occurs on the ceiling in the rear of the crawlway passage which appears to be guano-like excrement.

Biological Identifications:

- Snails: *Monadenia mormonum mormonum*
- Unidentified Small Bird
- Unidentified Rodent

Archaeological Observations: Random patches of black stain occur on the ceiling and walls in the entrance room

and on the ceiling in the crawlway. This may be aboriginal soot blackening but could also occur from natural causes such as staining by magnesium dioxide.

Significance: The deposit in this cave may contain evidence of prehistoric occupation, possibly of considerable antiquity. Some important taphonomic data may also be present. The cave is of considerable geological significance as well based on the stratigraphic complexity of the site.

National Register Eligibility: Yes

Mitigation: Archaeological mitigation, limited excavation of the deposit and chemical analysis of the ceiling blackening is recommended. Taphonomic collection and geological study are also suggested.

CAVE 004

Location: Skunk Gulch, Calaveras County

Elevation: 479 ± 6 m (1570 ± 20 ft)

Height above Base Level: 223 ± 6 m (730 ± 20 ft)

Relation to Pool Level: The cave is located 147 ± 6 m (482 ± 20 ft) above gross pool level.

Description: The 1.8 by .8 m entrance drops to two separate passages. The lower passage drops 7 m through a fissure to a 2 m long and 35 cm wide fill of earth and rubble. The upper passage, which is very narrow, drops 20 m to a fissure 3 m long and 40 cm wide. Bad air was encountered 20 m below the entrance. A ledge could be seen 3 m lower.

Hazards: Bad air.

Speleogens: The cave is a slightly enlarged fissure.

Speleothems: Flowstone and popcorn were noted.

Sediments and Stratigraphy: Earth and rubble were noted on sloping ledges.

Mitigation: The cave is dangerous due to bad air. However, the entrance is so small that only slightly built people are able to enter it. No active mitigation is recommended at this time.

CAVE 005 (Ca-Tuo-769)

Location: Stanislaus River Canyon, Tuolumne County

Elevation: 280 ± 6 m (920 ± 20 ft)

Height above Base Level: 80 ± 6 m (25 ± 20 ft)

Relation to Pool Level: The cave is located 52 m (168 ft) below gross pool level and 31 m (100 ft) below recreation pool level.

Description: The cave consists of a series of four prominent entrances located at the base of a cliff. The largest is 4 m high and 4 m wide, and the smallest is 215 cm high and 50 cm wide. All lead from 2 to 5 m into the cliff face to a series of upward sloping passages which tend to be less than 50 cm in diameter. These passages generally follow the bedding. These passages appear to be interconnected but are too small for human access. They were explored for a distance of about 10 m above the cave floor.

Speleogens: Evidence of the origin of the cave includes pendants, joint pockets, and a slight tendency toward maze development.

Speleothems: Those noted are flowstone, draperies, false floors, and popcorn. Speleothem growth seems to have significantly decreased the volume of the cave.

Vandalism: Graffiti is present at one location. A few broken formations found in a constricted passage appear to be the results of human penetration as opposed to intentional vandalism.

Sediments and Stratigraphy: The fill present in the small entrance chambers of the cave consists of sand and silts representing recent flood deposits from the South Fork. The fill is a continuous extension of a flat terrace in front of the cave. Older, redder sediments are found in the upper passages, which consist of small patches of matrix cemented in place by overlying flowstone. The bedding of the matrix is sloping, indicating that it had been deposited from above.

Biological Observations: Current habitation by rodents and carnivores is evidenced by recent scat. Some high wall stains may indicate bats, but none were noted.

Biological Identifications:

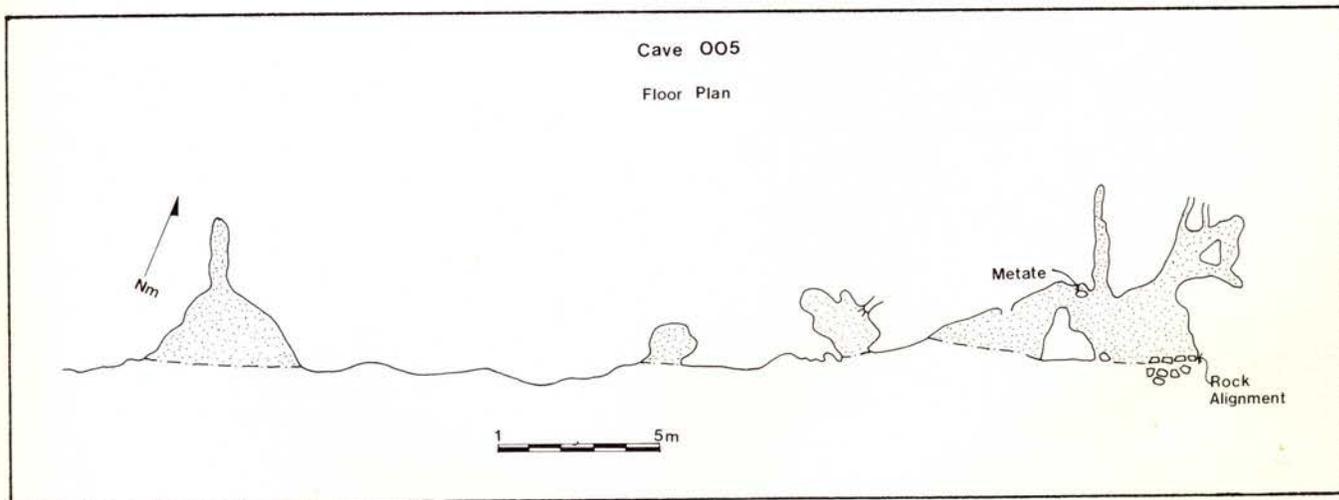
Spotted Skunk: *Spilogale gracilis*

Unidentified Rodent

Paleontological Observations: The sandy floor of this stream-level cave complex contained a paucity of recent small mammal bones, but includes one carnivore mandible. There were no fossils noted.

Archaeological Observations: The spacious entrances and flat floors make this cave ideal for habitation. A dry-laid rock alignment composed of local marble is present in the easternmost entrance. This may be the remnant of a historic or prehistoric wall (see map of Cave 005). A metate was found *in situ* on the floor of this same entrance.

Significance: The site is filled with soil material of recent origin and could be expected to be inundated during



exceptionally high flood levels. Archaeological information which could reasonably be expected or occur in the cave would primarily be from the protohistoric and historic period. Taphonomic data may also be present.

National Register Eligibility: Yes

Mitigation: Partial excavation of the deposit and detailed mapping of surface features are recommended. A minimum of 30% of the combined archaeological, historical, geological, and taphonomic data base is recommended for adequate sampling.

CAVE 006

Location: Skunk Gulch, Calaveras County

Elevation: 473 ± 3 m (1560 ± 10 ft)

Height above Base Level: 155 ± 3 m (510 ± 10 ft)

Relation to Pool Level: The cave is located 144 ± 3 m (472 ± 10 ft) above gross pool level.

Description: The entrance, measuring .8 m in width and 1.7 m in height, leads to a tight squeeze followed by an elongated tube passage extending vertically for 10 meters. This is followed by a meter-wide fissure 12 m in length. The bottom of the fissure is only .4 m wide and is filled with sediment. The cave continues vertically for another 10 m through a circular tube 1.5 m in diameter and ends at the bottom of this passage.

Speleogens: Joint pockets are present.

Speleothems: Stalactites, cave coral and flowstone were noted.

Hazards: The entrance is a vertical passage 10 cm in depth.

Sediments and Stratigraphy: The floor of the fissure is reddish-brown dirt and clay with some small breakdown blocks.

Biological Observations: At the bottom of the main drop there were recent animal remains which supplied food for a relatively diverse invertebrate fauna. Mites, springtails, and harvestmen were particularly abundant.

Biological Identifications:

Isopod: *Brackenridgia heroldi*

Beetle: Pselaphidae sp. #2

Collembola: *Sinella sexoculata*

Spiders: *Liocranoides*

Harvestmen: *Banksula n. sp.* near *melones*

Mites: Unidentified

Pseudoscorpion: *Neochthonius sp.*

Snails: *Monadenia mormonum mormonum*

Kingsnake: *Lampropeltis getulus*

1 Adult California Rock Squirrel: *Citellus beecheyi*

1 Adult Deer Mouse: *Peromyscus cf. maniculatus*

1 Adult Dusky-Footed Packrat: *Neotoma fuscipes*

3 Adult California Voles: *Microtus californicus*

1 Adult Bush Rabbit: *Sylvilagus cf. bachmani*

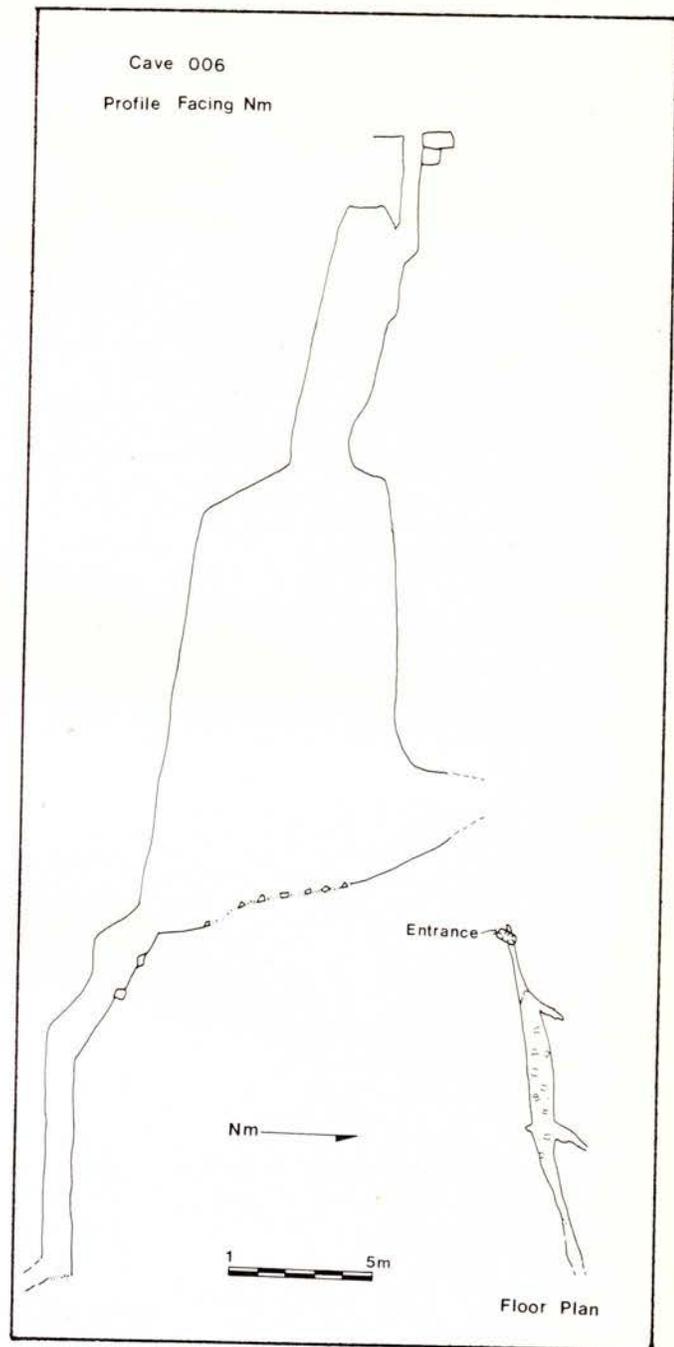
Significance: The cave is presently a natural trap and is of considerable taphonomic value. Paleontological material may be present below recent sediments. A new species of harvestmen was recovered from the cave which is only known in the project area.

Mitigation: Some taphonomic collecting is appropriate for this cave.

CAVE 007 (Ca-Cal-647)

Location: Stanislaus Canyon, Calaveras County

Elevation: 365 ± 10 m (1200 ± 30 ft)



Height above Base Level: 97 m (320 ft)

Relation to Pool Level: The entrance is 34 m (112 ft) above gross pool level.

Description: The prominent 3 m high and 8 m wide entrance extends into the cliff face for 3 meters.

Speleothems: The entire cave is covered with flowstone and stalactites are present in the ceiling.

Vandalism: Stalactites have been broken and "FI" has been scratched in the wall.

Sediments and Stratigraphy: The floor of the shelter is entirely covered with flowstone and rubble derived from flowstone. In places the flowstone has weathered away revealing more flowstone underneath.

Archaeological Observations: The relatively flat floor

appears to have been cleared of rubble, which was moved to the front of the cave. The ceiling is blackened, possibly as a result of campfires. The ends of broken stalactites are not blackened, indicating the staining took place sometime before at least some of the historic vandalism occurred.

National Register Eligibility: Yes

Significance: The rubble in front of the cave entrance may be culturally significant from an aboriginal perspective.

Mitigation: The black staining should be analyzed and the rubble in front of the entrance should be carefully investigated for archaeological data, since the site will be so accessible after water impoundment occurs.

CAVE 008

Location: Stanislaus River Canyon, Calaveras County

Elevation: 549 m (1800 ft)

Height above Base Level: 261 m (855 ft)

Relation to Pool Level: The cave is located 218 m (712 ft) above gross pool level.

Description: This cave was not entered. It has been described by Squire (1972) as a large crack emitting a huge volume of air. However, a tight restriction 5 ft below the opening makes access to the cave impossible.

Mitigation: No further study is recommended for this cave.

CAVE 009

Location: Grapevine Gulch, Calaveras County

Elevation: 604±6 m (1980±20 ft)

Height above Base Level: 330±6 m (1080±20 ft)

Relation to Pool Level: The cave is 272 m (892 ft) above gross pool level.

Description: The entrances of the cave are located in a sink with a 3 by 3 m entrance narrowing down to a breakdown-floored crawlway, which opens into a wide room. A crawlway passage leads from there under a small false floor into another low room 3 by 10 meters. Another crawl under another false floor leads into a terminal room which has a large flowstone ledge on the left wall.

Speleogens: Joint pockets were noted.

Speleothems: The cave is highly decorated with false floors, stalactites, stalagmites, columns, flowstone shelves, draperies, cave coral, and soda straws.

Vandalism: Many of the formations in the entrance room are broken.

Sediments and Stratigraphy: The entrance room is floored with breakdown and flowstone; the rest of the cave is floored with recent black dirt. Older breccia is found on some of the walls and under the false floor.

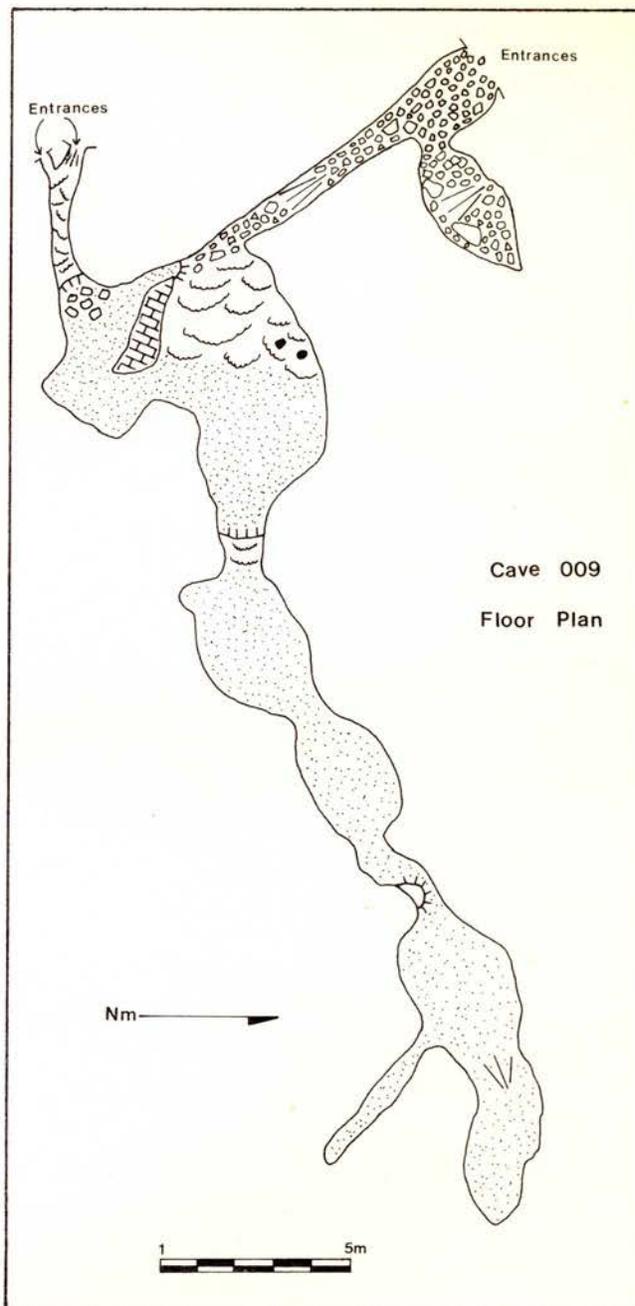
Biological Observations: The invertebrate fauna of the cave include pseudoscorpions, isopods, beetles, epigeal millipedes and several species of spiders, collembola, and flies. California newts and bats were also noted. During one visit to this cave a large number of flies were present although they were absent on subsequent visits. Fauna was concentrated at the end of the cave where there was a fresh deposit of bat guano and the humidity was higher.

Biological Identifications:

Isopod: *Brackenridgia heroldi*

Millipedes: *Paeromopus sp.*

Mites: Unidentified



Cave 009
Floor Plan

Collembola: *Tomocerus celsus*

Spiders: *Liocranoides sp.*

Blabomma, n. sp. "A" blind

Flies: Unidentified

Lizard: Unidentified

Snake: Unidentified

Bird: Unidentified—sparrow size

Rodent: Unidentified

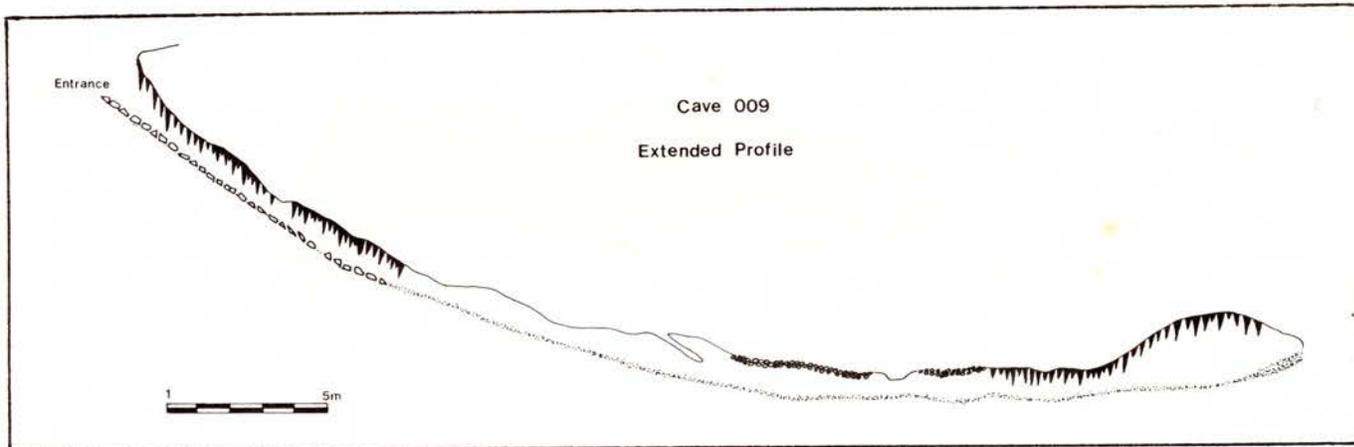
Pocket Gopher: *Thomomys sp.*

White-Footed Mouse: *Peromyscus sp.*

Packrat: *Neotoma sp.*

Dusky-Footed Packrat: *Neotoma fuscipes*

Significance: This cave may contain important breccia deposits providing insight to questions of paleoenvironment and geological processes. Taphonomic and zoospeleological significance is also exemplified in the extant bone material and the cave-related invertebrate fauna, which includes a new species of spider.



Mitigation: As this cave will receive a considerable amount of visitor impact once the surrounding recreation area is developed, geological, taphonomic, and biological studies of a limited nature are recommended.

CAVE 010 (Cal-S-435)

Location: Coyote Creek, Calaveras County

Elevation: 436 ± 6 m (1520 ± 20 ft)

Height above Base Level: 128 m (420 ft)

Relation to Pool Level: The cave is located 131 m (430 ft) above gross pool level.

Description: The 1 m wide and 1.5 m long entrance slopes steeply downward to the northeast for a distance of 12 m to a 5.5 m deep pit, which contains human bone and artifacts. A passage continuing across the pit for a distance of 5 m leads to a 7 m long by 1 m wide passage at right angles with the entrance slope. A passage trending south from the 5.5 m pit provides access to a 10 m deep pit leading to the lower cave. The lower cave is made up of a maze of steeply dipping fissures reaching a depth of 34 meters.

Speleogens: Only a few joint pockets were noted. The cave consists almost entirely of joint-controlled fissure passages along 3 or 4 steeply plunging fractures.

Speleothems: The speleothems noted include flowstone, stalactites, draperies, and a few stalagmites.

Hazards: The vertical nature of the cave, coupled with abundant loose rock and fragile hand and footholds, make this cave dangerous even for experienced and properly equipped cavers.

Vandalism: Abundant evidence of uninformed excavation or looting is present in the lower cave. Some human bone has been scattered around and displaced. About 2 m of deposit has been disturbed and a screen for sieving out artifacts was removed from the cave by the project crew.

Sediments and Stratigraphy: The most obvious fills in the upper part of the cave are reddish silts with abundant nuts, leaves, snails, and small rodent bones. In the lower cave fills include limestone blocks averaging cobble size. Abundant human bone and cultural material is present in some of these fills; small mammal remains are found in others. The red color of sediments are seemingly derived from "Terra Rossa" soils at the surface. Only fills above flowstones were noted in the upper cave. Deposits in lower parts are generally fissure fills but several are below the uppermost flowstone. None of the fills has much calcium carbonate cement. The archaeological deposits are well stratified with the top ca. 10 cm culturally sterile.

Biological Observations: The cave contains a sizeable temporary colony of medium-sized bats. A party decomposed rat (species undetermined) was collected and submitted to the Vector Control for plague testing.

Biological Identifications:

Beetle: Tenebrionidae undetermined sp. #1
Eleodes or related genus

Spider: *Liocranoides* sp.

Achaearanea fresno

Snail: *Monadenia mormonum mormonum*

Unidentified bird—dove size

Unidentified bat—*Myotis* size

1 Adult Pocket Gopher: *Thomomys* sp.

Packrat: *Neotoma* sp.

1 Adult Dusky Footed Packrat: *Neotoma fuscipes*

Vole: *Microtus* sp.

1 Adult California Vole: *Microtus californicus*

1 Adult Bush Rabbit: *Sylvilagus* cf. *bachmani*

Paleontological Observations: The soil and mortuary fills near the bottom of Cave 010 do not appear to constitute a paleontological resource at this time. Not only are they quite recent in origin but little bone other than human occurs in them.

Several unconsolidated fills in the upper horizontal level of the cave contain abundant vertebrate remains. Although of no great antiquity, these fills show considerable taxonomic diversity, and the bone concentration is high.

Breccias not directly associated with the mortuary fills near the bottom of the cave also contain a considerable amount of vertebrate material. The exact extent of these deposits is unknown, but they are probably adequate to produce a significant fauna.

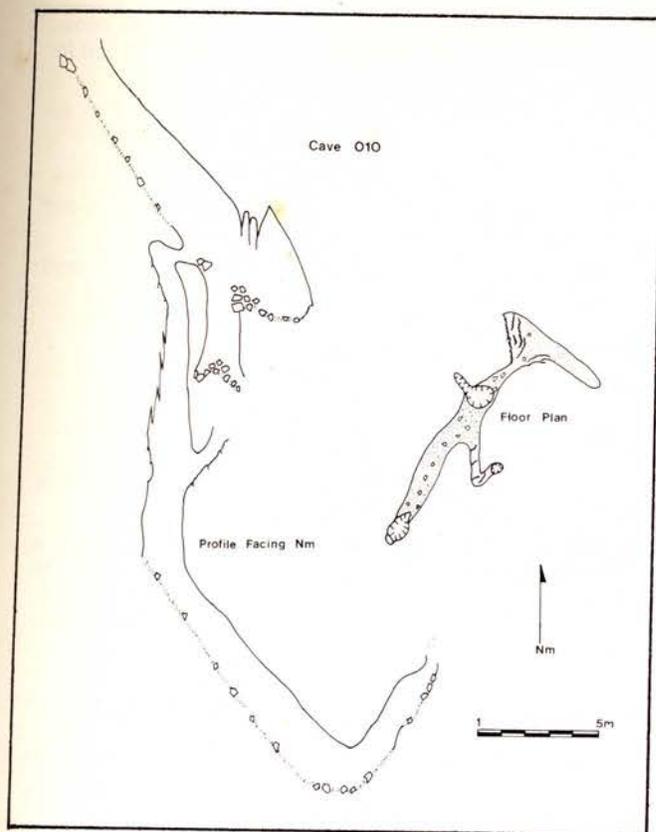
Archaeological Observations: Human bone and artifacts were found at the bottom of the 5 m pit in a deposit consisting almost entirely of cobble-sized pieces of limestone without matrix. The deposit is 14 m below the surface and extends into a narrow sloping crawlway. In the lower cave the deposit was observed issuing from a fissure passage at a depth of 28 m and was spread to the bottom of the cave (34 m) as a debris cone. In the upper cave the following historic signatures (Fig. 19) and graffiti were also noted on a wall past the 5 m pit:

Henry Dunn Tom Parrot

Frank McPherson Mr. Barrus

First ladies to visit this cave Mrs. Farmio (?) Morgan and Liggot Mylar.

A note present in a cave register at the bottom of the cave indicated that some archaeological investigation of this site had been undertaken by California State University at Stanislaus.



Archaeological Identifications:

One basal sherd from a steatite vessel was collected. Two *Haliotis* sp. shell pendants (Fig. 17) were recorded, one still strung. These indicate a Middle or Late Horizon mortuary cave phase (Elsasser, 1950; McEachern and Grady, 1977:32-35).

Significance: This cave has one of the largest archaeological deposits of any known mortuary cave. The presence of well-preserved human bone as well as artifacts (some of a perishable nature) in good context makes the site exceedingly valuable for the study of many archaeological research questions. It may also be of considerable paleontological and taphonomic value.

National Register Eligibility: Yes

Mitigation: Preservation is strongly recommended. The cave should be gated and access to the lower sections strictly limited to researchers with legitimate reasons to require entry. The deposit should also be stabilized and its extent accurately mapped.

CAVE 011

Location: Skunk Gulch, Calaveras County

Elevation: 479 ± 6 m (1570 ± 20 ft)

Height above Base Level: 223 ± 6 m (730 ± 20 ft)

Relation to Pool Level: The cave is located 147 ± 6 m (482 ± 20 ft) above gross pool level.

Description: The 2 by 1 m cave entrance drops vertically to a ledge at the top of a dirt slope. The slope continues for 15 m to a small room. A passage over the dirt slope is 3 to 5 m in diameter and continues for 4 m before pinching out. The small room at the base of the slope is well decorated and contains a false floor. The cave continues down to another small room containing a second false floor. A dirt

filled fissure leads to a mud plug at the end of the cave. Speleothems: Stalactites, stalagmites, columns, soda straws, rimstone dams, false floors, and flowstone occur in the cave.

Sediments and Stratigraphy: The deposit consists of reddish-brown dirt. A cemented breccia is present under the false floors.

Biological Observations: A number of invertebrates were noted in the cave.

Biological Identifications:

Pseudoscorpion: *Neochthonius* sp.

Harvestmen: *Banksula* n. sp. near *melones*

Spider: *Achaearanea fresno*

Licdrandides sp.

Blabomma, n. sp. "A" blind

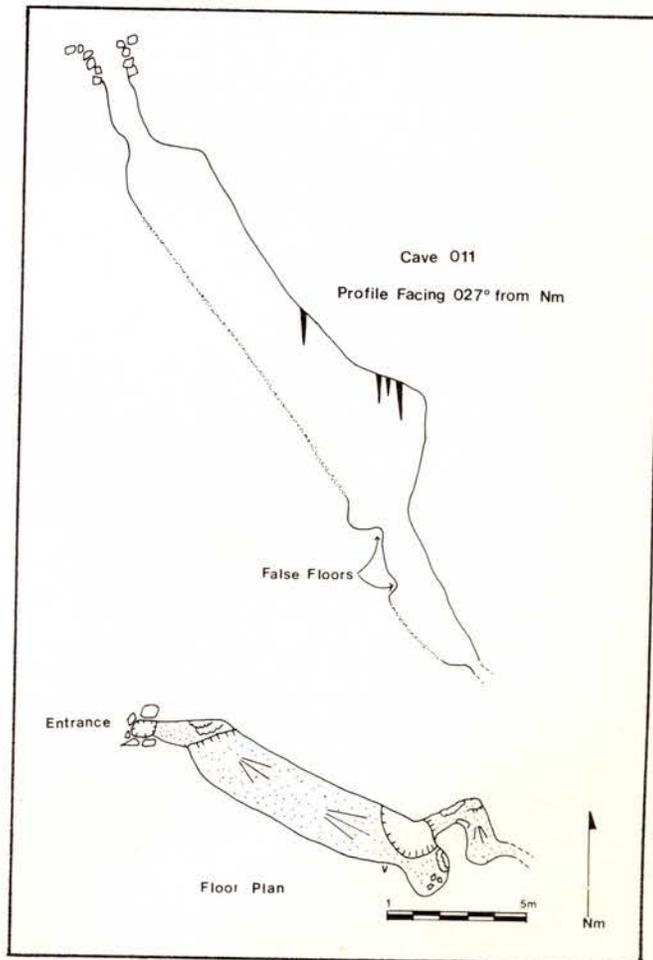
Collembola: *Entomobrya californica*

Sinella n. sp.

Paleontological Observations: Recent mammal bone was observed in the dirt. Snail shells were noted in the cemented breccia below the false floors.

Significance: New species of collembola, harvestmen, and spiders which may have restricted ranges are found in the cave. Breccia deposits also may provide important clues to the geological record present in the area.

Mitigation: Some taphonomic collection might be appropriate for this cave. Unnecessary entry should not be promoted.



CAVE 012

Location: Stanislaus River Canyon, Tuolumne County

Elevation: 329 m (1080 ft)

Height above Base Level: 73 m (240 ft)

Relation to Pool Level: The cave is located 18 m (59 ft) above recreation pool level and 2.4 m (8 ft) below gross pool level.

Description: The entrance is 1 m in height and 50 cm in length. This passage widens to a room 4 m in length and 2 m in width.

Speleogens: Solution pockets are present in the cave.

Speleothems: Several stalactites 2 cm in length were noted.

Sediments and Stratigraphy: Cave sediments consist of a brownish clay covering the floor of the cave.

Biological Observations: A turkey vulture, *Cathartes aura*, was nesting in the back of the cave.

Paleontological Observations: Recent mammal bones were noted in the cave sediments.

Significance: The cave is presently being used by turkey vultures and the undisturbed deposit would provide important data for taphonomic studies on vertebrate assemblages associated with vulture middens.

Mitigation: Investigations to determine the constituent assemblage of the vulture deposit is suggested.

CAVE 013

Location: Stanislaus River Canyon, Calaveras County

Elevation: 280 ± 3 m ($920 \pm$ ft)

Height above Base Level: 6 m (20 ft)

Relation to Pool Level: This cave is 51 ± 3 m (168 ± 10 ft) below gross pool level and 31 ± 3 m (101 ± 10 ft) below recreation pool level.

Description: Cave 013 is unusual since it is a fissure that was historically excavated. The entrance is 1 m in height and 2 m in width and leads down a 30° slope for 3 m to a room 5 m in length, 1.5 m in width, and 2 m in height. A tight fissure leads off this room for about 5 m to 2 small skylights.

Speleogens: The cave exhibits joint pockets and tight fissures filled with clay.

Vandalism: Trash has been dumped into the cave through constricted fissures.

Sediments and Stratigraphy: The floor of the cave is sand and gravel which probably washed in after the fissure was excavated. The fissures are filled with sediments.

Biological Observations: Two swallows are nesting in the fissure entrance.

Mitigation: No mitigation is recommended for this cave.

CAVE 014

Location: Stanislaus River Canyon, Tuolumne County

Elevation: 290 ± 3 m (951 ± 10 ft)

Height above Base Level: 16 ± 3 m (52 ± 10 ft)

Relation to Pool Level: The cave is located 42 ± 3 m (173 ± 10 ft) below gross pool level and 21 ± 3 m (70 ± 10 ft) below recreation pool level.

Description: The entrance is 1.5 m in height and 15 m in width. It extends into the cliff for 2 m to a point where the

passages divide and continue for 2 m before they rejoin. a small passage leads upward for 2 m which is too tight for human access.

Speleogens: A 10 cm wide stream meander is cut into the flood and the walls in the back passage are polished.

Speleothems: Stalactites and cave coral are present.

Sediments and Stratigraphy: The cave exhibits a rubble and earth floor.

Biological Observations: Small carnivore dung was noted on the cave floor.

CAVE 015

Location: Coyote Creek, Calaveras County

Elevation: 476 ± 12 m (1560 ± 40 ft)

Height above Base Level: 155 ± 12 m (510 ± 40 ft)

Relation to Pool Level: The cave is located 144 ± 12 m (472 ± 40 ft) above gross pool level.

Description: The small 0.4 by 0.8 m entrance leads down a small solution tube that opens into a climbable drop of about 4 m. This in turn leads into an irregular shaped room 3.5 m in length and 2 m in width. A small crawlway leads off the room for 3 m before pinching out.

Speleogens: Joint pockets occur in the cave.

Speleothems: Cave coral is present.

Sediments and Stratigraphy: The cave is floored with breakdown and rubble.

Biological Observations: One big-eared bat was seen near the entrance. The configuration of the cave provides a high input of food from the surface which is combined with a rocky substrata and ample moisture, producing very good conditions for speleofauna. Small, recent vertebrate microfauna were observed.

Biological Identifications:

Isopod: *Brackenridgia heroldi*

Millipede: Unidentified

Centipede: *Arenophilus sp.*

Oabius sp. cf. patonius

Pseudoscorpion: *Apochthonius n.sp.*

Neochthonius sp.

Spiders: *Calisoga theveneti*

Telema gracilis

Archoleptoneta schusteri

Psilochorus, n. sp.

Collembola: *Tomocerus wilkey*

Mite: Unidentified

Beetle: *Catopocerus pusio*

Leiodidae

Snail: *Pristiloma subrupicola spelaeum*

Significance: The cave contains a rich invertebrate fauna including a new species of pseudoscorpion which may have restricted range.

Mitigation: Some taphonomic study may need to be implemented in this cave. Visitation should be discouraged.

Cave 016

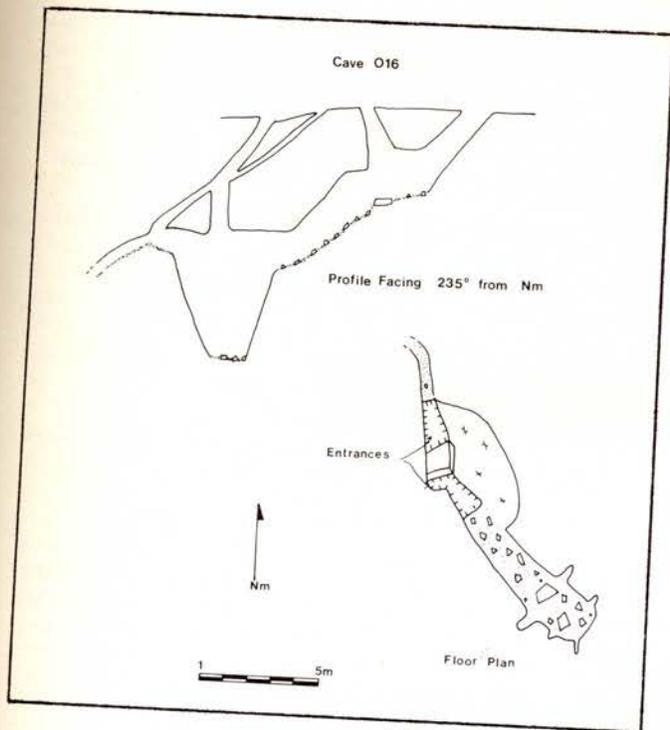
Location: Coyote Creek, Calaveras County

Elevation: 475 ± 6 m (1560 ± 20 ft)

Height above Base Level: 155 ± 6 m (510 ± 20 ft)

Relation to Pool Level: The cave is located 143 ± 6 m (472 ± 20 ft) above gross pool level.

Description: This cave occurs in the 'Rockpile', a karst area



of oak parkland. The cave entrance measuring 1.75 m in length and .75 m in width occurs on the edge of a large karst outcrop. A vertical fissure cave, it begins with a corkscrew drop of about 14 m in length, then continues with a straight drop to the floor 20 m below. The walls of the drop are decorated with flowstone and draperies; plugs of sediment are perched at various places. The room at the bottom measures 5.5 m in length and 2 m in width. This joins another small room 4 m in length and 1.5 m in width that is heavily decorated with flowstone.

Speleogens: Pendants and a bedrock column were noted.

Speleothems: Flowstone, serrated draperies, stalactites and stalagmites decorated the walls of the drops, and the room at the bottom of the drop.

Hazards: The cave drops vertically 34 m from the entrance. It is located on the side of a karst outcrop and is highly visible.

Vandalism: Litter was noted on the surface near the cave entrance and on the floor of the cave. Mud has been tracked on the flowstone formations and names have been scratched on the walls.

Sediments and Stratigraphy: The floor of the cave is reddish-brown soil with some flowstone and bedrock breakdown also on the floor. Cemented to the walls at the bottom of the drop are several layers of flowstone intercalated with red loam soil.

Biological Observations: The cave is particularly rich in fauna. Vertebrate life includes epigenous arboreal salamanders and a frog. Invertebrate fauna were also recorded.

Biological Identifications:

Millipede: *Trichopolydesmidae* perhaps *Bidentogon*

Centipede: *Oabius* sp. cf. *patonius*

Spiders: *Telema gracilis*

Liocranoides sp.

Erigoninae

Harvestmen: *Banksula grahami*

Collembola: *Sinella* n.sp.

Tomocerus wilkey
Pseudoscorpion: *Aphrastochthonius* n.sp.
Neochthonius sp.
Microcreagris grahami

Snail: *Monadenia mormonum mormonum*

2 Adult California Rock Squirrels: *Citellus beecheyi*

1 Adult Western Grey Squirrel: *Sciurus griseus*

1 Adult Valley Pocket Gopher: *Thomomys bottae*

1 Pocket Mouse: *Perognathus* sp.

2 Adult Bush Rabbits: *Sylvilagus* cf. *bachmani*

Paleontological Observations: Small, recent mammal bones and snail shells are present in the reddish-brown dirt floor. A mandible (*Citellus* sp.) cemented under a flowstone floor was also observed, (Fig. 10).

Significance: The cave has an extensive biota including rare or restricted species. Two new species of pseudoscorpions were identified. The vertebrate remains indicate that the cave is functioning as a natural trap, and bones found beneath a thick layer of flowstone indicate that the cave was also a trap in the geological past. A section of alternating flowstone and clastic fills are an important part of the geological record as well.

Mitigation: Access should be managed and visitation discouraged. No other active mitigation is recommended at this time.

CAVE 017

Location: Coyote Creek, Calaveras County

Elevation: 476 ± 12 m (1560 ± 40 ft)

Height above Base Level: 155 ± 12 m (510 ± 40 ft)

Relation to Pool Level: The cave is located 144 ± 12 m (472 ± 40 ft) above gross pool level.

Description: A solution tube 0.4 m in diameter slopes down into an enlarged joint system. The primary joint is 1.5 m in width and 14 m in length. A room 1 m in width and 2 m in length occurs 5 m below the ground surface. The far end of the crack has intersected the surface, forming a second entrance through large breakdown blocks.

Speleogens: This cave formed along a fissure.

Speleothems: Cave coral is present.

Sediments and Stratigraphy: Reddish-brown dirt and breakdown occur on the floor of the small room.

Biological Observations: A bat colony is present in this cave.

Biological Identifications:

Centipede: *Oabius patonius*(?)

Pseudoscorpions: *Apoichthonius* n.sp.

Spiders: *Telema gracilis*

Liocranoides sp.

Blabomma sp.

Uloborus diversus

Harvestmen: *Hesperonemastoma modestum* (epigeal)

Sitalcina sierra (epigeal)

Collembola: *Tomocerus wilkey*

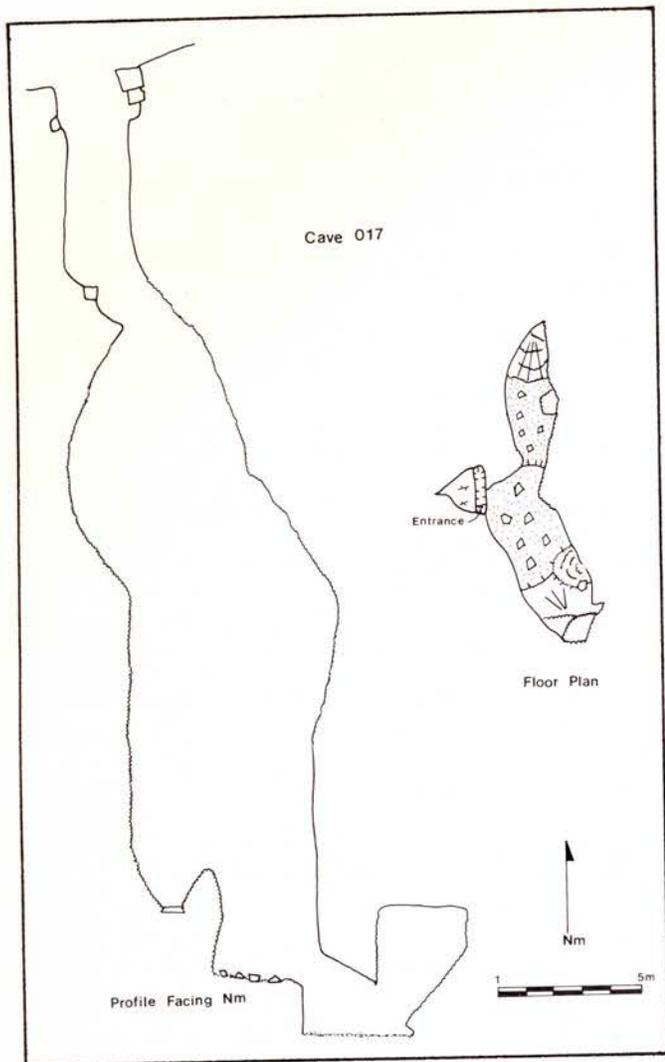
Tomocerus celsus

Snail: *Monadenia mormonum mormonum*

Pristiloma subrupicola spelaeum

Significance: This is one of the few caves in the area to support a substantial, though transitory, bat colony. A new species of pseudoscorpion was collected.

Mitigation: Access to this cave should be restricted in light of the significance of the fauna.



CAVE 018 (Cal-S-9)

Location: Skunk Gulch, Calaveras County

Elevation: 500 ± 5 m (1640 ± 20 ft)

Height above Base Level: 244 ± 5 m (800 ± 20 ft)

Relation to Pool Level: The cave is 168 m (552 ft) above gross pool level.

Description: Cave 018 is entered through a vertical fissure 1.5 m wide and 2 m long which drops 9 m to the top of a talus cone. The talus cone slopes steeply to the east, covering the floor of a 10 m long by 6 m wide room. A small passage west of the entrance drop terminates after 7 meters. Another passage is located 2 m above the floor on the north wall of the entrance room. The passage goes north for 8 m into a small room containing historic signatures.

Speleogens: The speleogens noted are limited to joint pockets and a horizontal ceiling in a small chamber off the entrance room.

Speleothems: These include flowstone, popcorn, draperies, stalactites, and small stalagmites.

Hazards: The 9 m deep entrance drop could be hazardous for casual, improperly equipped visitors.

Vandalism: Approximately 10% of the formations have

been broken, but much of this can be attributed to the early mining period. Graffiti is also present in the cave.

Sediments and Stratigraphy: The sediments consist of subangular rubble and brown to slightly red fine sediments which were introduced into the cave from the entrance. These surface-derived sediments overlie flowstone in many locations.

Biological Observations: Invertebrate fauna noted included millipedes, spiders, collembola, and harvestmen. A fluorescent millipede skeleton was recorded.

Biological Identifications:

Millipedes: Spirobolidae

Collembola: Unidentified

Spiders: *Liodranoides* sp. (3 immature individuals)

Harvestmen: *Banksula* sp. (1 adult, 2 juvenile individuals)

1 Adult Pocket Gopher: *Thomomys bottae*

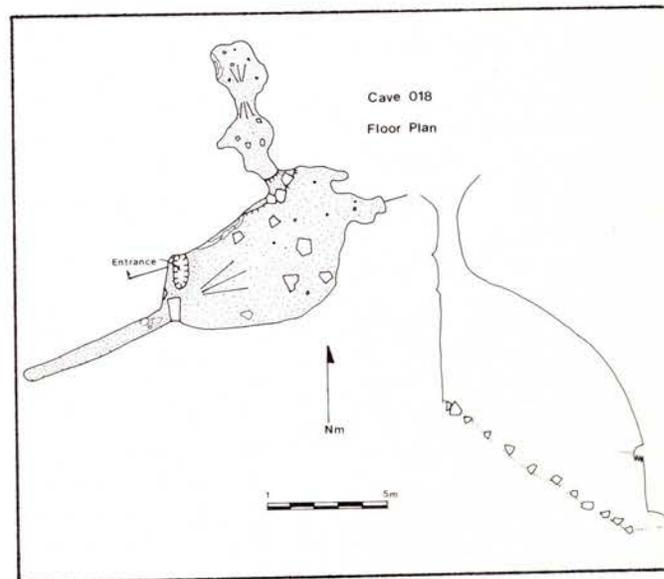
1 California Vole: *Perognathus californicus*

1 Dusky-Footed Packrat: *Neotoma fuscipes*

1 Rabbit: *Lagomorpha* sp.

Paleontological Observations: A large number of recent rodent bones were found in the upper northwestern chamber of the cave. This material occurs in unconsolidated breccia and soil that has fallen from the chamber roof. This layer is several inches deep; no consolidated layer was found beneath. Much of the walls and roof are also composed of this weathering breccia, which contains no observable fossils. The northern end of the main chamber has a semiconsolidated breccia floor. Some recent as well as weathered fossil material was found on the surface in this location. A few large clumps of the consolidated floor breccia were screened, producing fossil rodent bones and larger bone fragments.

Archaeological Observations: The surface of the deposit contains rolled seamed cans and machine-made bottles with screw tops dating circa 1930-1940. A depression on the east side of the entrance room is probably the remains of a test pit excavated by Phil C. Orr of the Santa Barbara Museum of Natural History in 1951 in search of human bones and artifacts. There are presently no surface indications of the extensive deposit of prehistoric human bone known to occur at this site. Human skeletal material was collected from the cave in 1967 by McEachern (1968)



which included several specimens covered with flowstone and represented at least three adults and a small child.

Numerous signatures and initials from the early mining period are present in the cave; several were recorded during the present project:

Woodman	Rowhard	GA Thomas	R Taylor
Nov 1853	Nov 1853		1853

Significance: This cave is particularly significant because (1) it contains prehistoric remains which document the use of the cave by an extinct culture; (2) it has considerable paleontological potential; (3) it was investigated by J. D. Whitney during the trip in which he acquired the famous Calaveras Skull; (4) it was visited by a large number of people after its discovery. Prehistoric and historic materials are present in the cave which were sealed by later historic fill noted by Whitney in 1867.

National Register Eligibility: Yes

Mitigation: Preservation and development of the site is recommended by gating, stabilization, placement of educational signs in the cave, restricting access by use of a permit system and managing the site by daily recreation area personnel patrol or by electronic surveillance.

CAVE 019

Location: Stanislaus River Canyon, Calaveras County

Elevation: 277 m (910 ft)

Height above Base Level: 11 m (34 ft)

Relation to Pool Level: The caves are located 34 m (111 ft) below recreation pool level.

Description: These caves are a series of small fissures which have been exposed by mining. The largest measures 2.5 to 3 m in length and 1 m in width and 1 to 1.5 m in height.

Mitigation: No further action is recommended at this site.

CAVE 020

Location: Stanislaus River Canyon, Calaveras County

Elevation: 291±6 m (955±20 ft)

Height above Base Level: 10 m (30 ft)

Relation to Pool Level: The cave is located 41 m (133 ft) below gross pool level and 20 m (66 ft) below recreation pool level.

Description: A 0.9 m by 0.3 m entrance in breakdown leads straight down for 3 m to a horizontal fissure 1 m wide and 4 m long.

Speleothems: Stalactites, flowstone, and popcorn decorate the cave.

Sediments and Stratigraphy: The floor is composed of angular rubble mixed with fine sediments.

Biological Observations: Snail shells and medium size mammal dung are present on the floor.

Biological Identifications:

Snails: *Monadenia mormonum mormonum*

Significance: This cave is of geological significance as it contains deposits which may contribute to the understanding of past environmental conditions and geological processes active in the area.

Mitigation: As this cave will be inundated, geological study is recommended.

CAVE 021

Location: Stanislaus River Canyon, Calaveras County

Elevation: 427±3 m (1400±10 ft)

Height above Base Level: 160±3 m (525±10 ft)

Relation to Pool Level: The cave is located 95±3 m (312±10 ft) above gross pool level.

Description: This cave is situated high on a cliff overlooking the Stanislaus River. The impressive entrance measures 14 m in height and 4 m in width; the cave is 3 m in depth.

Speleothems: Flowstone is present.

Sediments and Stratigraphy: The reddish-brown dirt floor is covered by vulture dung.

Biological Observations: Two young turkey vultures were nesting in the cave.

Biological Identifications:

Snails: *Monadenia mormonum mormonum*

1 Adult Turkey Vulture: *Cathartes aura*

14 Valley Pocket Gophers: *Thomomys bottae*

3 Adult Dusky-Footed Packrats: *Neotoma fuscipes*

7 Adult California Voles: *Microtus californicus*

Significance: The cave is presently being used as a vulture nest and the undisturbed deposit has a rich collection of microfaunal remains.

Mitigation: No active mitigation is recommended at this time.

CAVE 022

Location: Grapevine Gulch, Calaveras County

Elevation: 597±6 m (1960±20 ft)

Height above Base Level: 323±6 m (1,050±20 ft)

Relation to Pool Level: The cave is 266 m (872 ft) above gross pool level.

Description: This cave is a series of short drops entered through a 0.9 by 0.3 m fissure. An adjacent smaller fissure 0.5 by 0.2 m connects below the entrance drop. A series of small chimneys and drops end about 20 m from the surface in small dirt-filled rooms.

Speleogens: The cave is developed along a fissure. Most of the bedrock is obscured by flowstone.

Speleothems: The cave is highly decorated with draperies, stalactites, stalagmites, columns, and coral.

Hazards: Vertical drops and rockfall are potential hazards to the unwary visitor.

Sediments and Stratigraphy: A top layer of recent black soil is underlain by an older black breccia; both cover even older black deposit, which in turn covers an even older flowstone.

Biological Observations: Invertebrate fauna were uncommon. A solitary bat was observed roosting in the bottom of the cave on 17 September 1977.

Biological Identifications:

Spiders: *Uloborus diversus*

Achaearanea fresno

Chasmocephalon shantzi

Mite: Unidentified

Collembola: *Cicyrtoma (ptenothrix) marmorata*

Snails: *Monadenia mormonum mormonum*

Paleontological Observations: A small exposure of breccia with snail shells and some bone occurs below thin flow-

stone near the floor of the lowest level of this cave. The low apparent bone concentration and limited extent of this deposit suggest that it would not produce a large sample of fossil vertebrates.

Significance: Because this cave is the highest in elevation of those known to contain microfossils, it is considered to be of particular paleoecological significance. The sediments in the cave are an important part of the regional geological history.

Mitigation: Some taphonomic collection of surface materials is recommended, and visitation to the cave should not be encouraged.

CAVE 023

Location: Skunk Gulch, Calaveras County

Elevation: 517 ± 8 m ($1,700 \pm 25$ ft)

Height above Base Level: 258 ± 8 m (845 ± 25 ft)

Relation to Pool Level: The cave is located 186 ± 8 m (612 ± 25 ft) above gross pool level.

Description: The small entrance measures 0.7 by 0.5 m and opens into a vertical drop of 7 m in depth. The drop leads to a room 5 m in length and 7 m in width. Several small fissure passages extend off in various directions but are too small for human entry.

Speleogens: The cave is developed in an enlarged fissure.

Speleothems: Cave coral occurs in the cave.

Vandalism: Names and dates have been inscribed in the cave ranging from 1902 to 1970.

Sediments and Stratigraphy: The floor of the room is of relatively recently derived brown soil.

Biological Observations: The invertebrate fauna of this cave is noteworthy in that it probably contains an undescribed centipede taxon.

Biological Identifications:

Isopod: *Brackenridgia heroldi*

Centipede: *Taiyuna* sp.

Pseudoscorpion: *Neochthonius* sp.

Spiders: *Liocranoides* sp.

Cybaeus sp.

Chasmocephalon shantzi

Snail: *Helminthoglypta cypreophila*

1 Adult Striped Skunk: *Mephitis mephitis*

1 Adult Brush Rabbit: *Sylvilagus* cf. *bachmani*

Paleontological Observations: Although no fossils have been found within the cave itself, three fissures containing richly fossiliferous breccia have been located south and west of the cave entrance, near the base of the small conical hill which is solutioned out by the cave. One of these fissure fills is rather extensive; about 1 m wide and 10 m in length at its exposed surface. The breccia is stratified, intercalated with flowstone layers, and has a total stratigraphic thickness of 3 to 4 meters. The deposit could yield a significant sequence of fossil faunas spanning a considerable period of time. The geomorphologic context suggests that the entire deposit is of some antiquity (probably Pleistocene), being in an area which is no longer accumulating sediment and, in fact, has undergone enough erosion to expose the deposit in cross-section.

Significance: The fossil breccias could yield an important sequence of fossil fauna spanning a considerable period of

time. Geomorphologic context suggest that the entire deposit is of some antiquity.

Mitigation: Some taphonomic and paleontological study of surface material is recommended, due to anticipated visitor impact.

CAVE 024 (Ca-Cal-770)

Location: Stanislaus River Canyon, Tuolumne County

Elevation: 280 ± 3 m (920 ± 9 ft)

Height above Base Level: 5 m (16 ft)

Relation to Pool Level: The cave is 51 m (168 ft) below gross pool and 31 m (101 ft) below recreational pool.

Description: A 5 m wide and 6 m high entrance opens into two small rooms which end in flowstone. A small connecting room on the north side can be entered through a second smaller entrance. The ceiling of the cave is blackened.

Speleogens: Limited to joint pockets.

Speleothems: Flowstone, soda straws, rimstone pools and a canopy were noted.

Sediments and Stratigraphy: Limited areas of river derived sand are overlying older flowstones.

Archaeological Observations: The black ceiling may be a result of smoke blackening.

Significance: The cave may have been occupied or otherwise utilized prehistorically.

National Register Eligibility: Yes.

Mitigation: Archaeological investigation, including excavation and analysis of blackening material, and geological mitigation are recommended for this cave as it will be inundated. Total recovery of the deposit is suggested since it is quite small.

CAVE 025 (Ca-Cal-648)

Location: Stanislaus River Canyon, Calaveras County

Elevation: 305 ± 1.5 m ($1,005 \pm 5$ ft)

Height above Base Level: 30 ± 10 m (100 ± 32 ft)

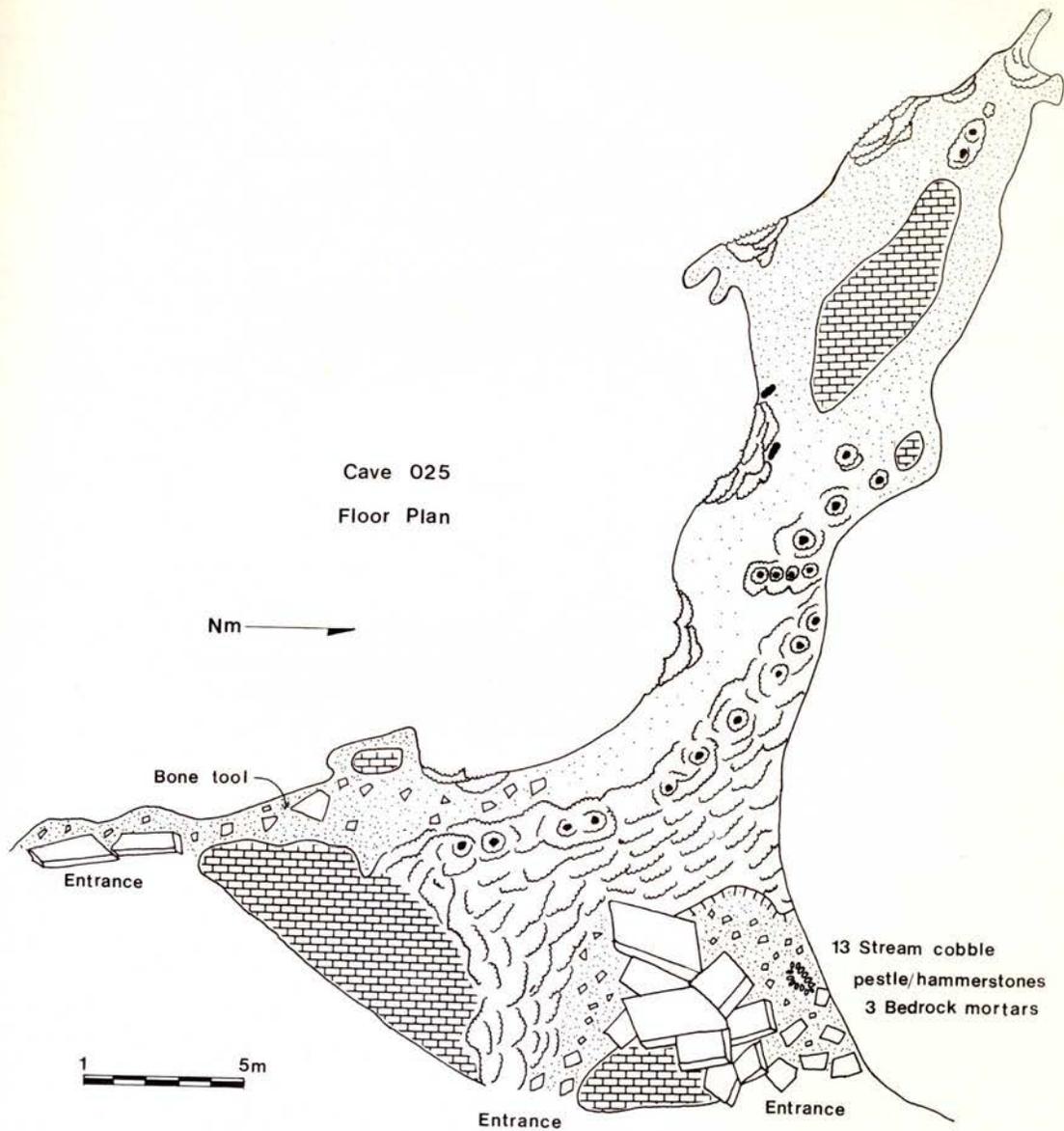
Relation to Pool Level: The cave is 25 ± 1.5 m (83 ± 5 ft) below gross pool level and 5 ± 1.5 m (16 ± 5 ft) below recreational pool level.

Description: A 2 x 2 m entrance leads into an entrance chamber with breakdown blocks up to 3 x 3 m square on the west side of the chamber and on the floor. Smaller breakdown and angular pieces of rubble with finer sediments between them are present on the east side of the floor. A massive flowstone slope dominates the north end of the entrance chamber. Below the flowstone slope a 1 m high and 3 m wide opening leads to a chamber of equal height and width which is 5 m long. The roof of the chamber is composed of breccia.

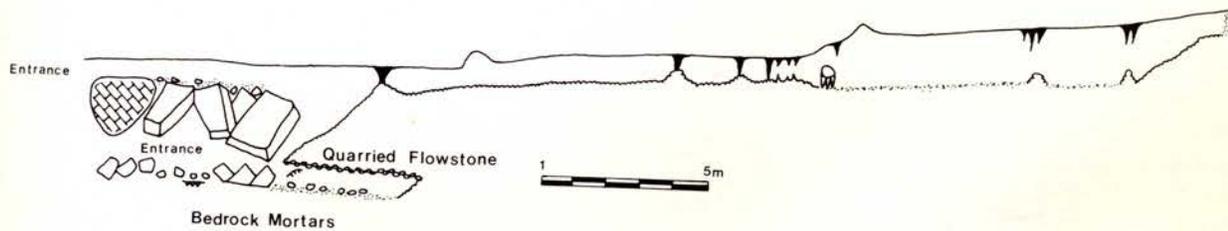
Above the flowstone slope a crawlway leads north through a passage profusely decorated with columns, stalactites, stalagmites, and rimstone pools to the rear portion of the cave. The back chamber is divided into two separate interconnected passageways by a bedrock partition. Fine sediments interbedded with flowstone are present in the rear chamber and have an estimated depth of 2 meters. While the chamber is not as profusely decorated as the crawlway, several shield formations are present.

Returning to the top of the flowstone slope in the

Cave 025
Floor Plan



Cave 025
Profile Facing 205° Nm



entrance chamber a southward trending passage leads to another entrance.

The total measured passage length for the cave is 84 m while the vertical relief is about 4 meters. The distance from the main entrance of the cave to the rear of the cave is about 30 meters.

Speleogens: Massive breakdown in the entrance of the cave has destroyed any evidence of speleogenesis at the drip line. In the rear portion of the cave pendants and joint pockets are present. The cave is a good example of horizontal development in vertical bedrock.

Speleothems: Formations noted in the cave include cave coral, flowstone, false floors, stalactites, stalagmites, draperies, columns, shields, and rimstone dams. Stalagmites suitable for dating by the uranium-thorium method are present.

Vandalism: Graffiti is present at several places on the walls of the cave, and about half the stalactites have been broken. The observed effects of cave visitation as opposed to intentional vandalism are churning and compaction of the deposits and accidental breakage of speleothems in the crawlways.

Sediments and Stratigraphy: The entrance room has breccia fill around major blocks of breakdown. Flowstone to the south of the main entrance and above is interbedded with scats and plant micro-fossils. In the rear chamber beyond the crawlway the floor is composed of reddish sediments with false floors above. One exposure is about 30 cm of flowstone laminae interbedded with 3 to 3 mm of clastic strata.

In the entrance speleothems and cementation overlie all but a few centimeters of scat-incalated surface sediments. In the rear chamber false floors indicate that erosion has taken place. Exposures show interbedding of flowstone and clastics, but the present floor is younger than the aforementioned flowstone surface.

Biological Observations: Although the biological specialists inventoried this cave rather extensively, no significant invertebrate fauna were located at that time.

Biological Identifications:

Spider: *Psocoptera* sp.

Achaearanea fresno

1 Adult Ringtail: *Bassaricus astutus*

Paleontological Observations: Nearly all the walls, floors, and ceilings in Cave 025 are surfaced with what is evidently quite recent flowstone. Few deposits of unconsolidated fill are present and these are quite small. All surface fills which were examined contained small vertebrate bone and several of these, in protected alcoves off the larger passages, contained concentrated accumulations with very abundant bone. None of these surface deposits, however, was large enough to yield a diverse vertebrate fauna. Inspection of clastic fills interbedded with flowstones, where these were exposed in cross-section, demonstrated that small vertebrate remains are present in some of these capped fills. The surface deposits containing bone have little if any paleontological value, being either very small or highly disturbed by modern human activity, but the extensive vertebrate-bearing fills capped by flowstones represent a potentially significant paleontological resource.

Archaeological Observations: A basalt chopper was recorded near the main entrance. A group of 12 stream cobble pestles and/or hammerstones were arranged in a ring on the floor of the entrance room around at least three shallow bedrock mortars. The arrangement of these artifacts has likely been the result of recent visitors. A shallow

deposit of small rubble and fine sediments is present around the bedrock mortars and additional mortar holes are probably present. One hammerstone/pestle is lying on a breakdown block at the entrance of the cave.

An isolated bedrock mortar is located deeper in the cave on a ledge of flowstone. A pestle was found *in situ* within it although it may have been placed there historically.

In a small chamber below a flowstone slope at the rear of the entrance is a block of flowstone from which pieces have been removed on one side. Calcite debris from below this face seems to indicate that calcite was mined there, most likely during pre-historic times.

Archaeological Identifications:

A bone item (Fig. 16) similar to specimens obtained from Potter Creek Cave was recovered from the side entrance (Merriam, 1906). At the former site these "artifacts" were found in association with middle or late Pleistocene fauna and may be indicative of a pre-projectile point stage (cf. Krieger, 1964).

Significance: Cave 025 is considered one of the two most significant caves to be directly affected by the reservoir. It is significant in that both artifacts and environmentally sensitive data occur in the same context. The archaeological significance is related to important local and regional problems such as the origin and use of certain types of bone tools and the use of horizontal caves during the Early, Middle, and Late Horizons. Paleontological/taphonomic significance is based on the presence of climatically-sensitive faunal remains.

National Register Eligibility: Yes

Mitigation: Cave 025 is unlike any other site which has been studied in the Mother Lode region and no similar sites are known to exist in the area. Adequate mitigation for this site requires extensive excavation by a multidisciplinary team capable of handling the unique research problems posed by this site.

CAVE 026

Location: Coyote Creek, Calaveras County

Elevation: 457 m (1500' ft)

Height above Base Level: 137 m (450 ft)

Relation to Pool Level: The cave is located 126 m (412 ft) above gross pool level.

Description: The cave was not visited during this project; however, an unsuccessful attempt was made to locate it. It has been described by Squire (1972) as a small cave located in the "rockpile" on the Mitchell property.

Mitigation: No active mitigation for this particular site is recommended at this time.

CAVE 027

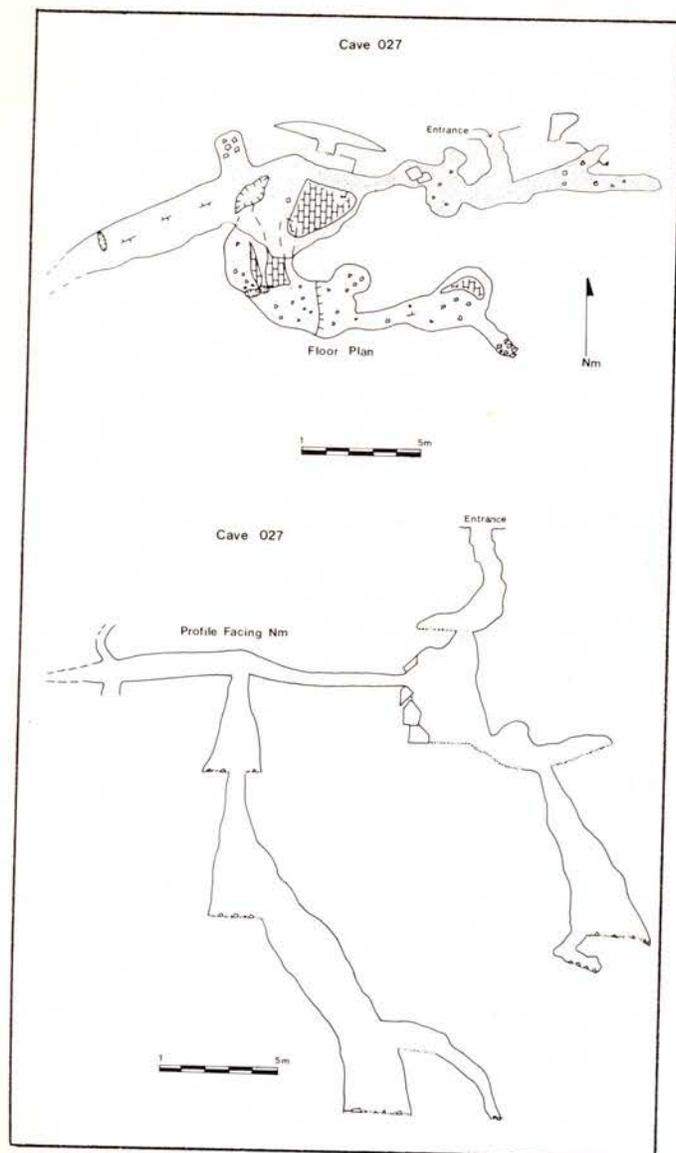
Location: Skunk Gulch, Calaveras County

Elevation: 549±3 m (1800±10 ft)

Height above Base Level: 293±3 m (960±10 ft)

Relation to Pool Level: The cave is located 217±3 m (712±10 ft) above gross pool level.

Description: The entrance, measuring 1 m in height and 0.45 m in width, opens into a series of 2 short drops (about 6 m deep) which connect 2 small rooms. Leading off the second small room is a crawlway 7 m in length that intersects with another climbable drop of about 10 meters. This climb leads to another drop of about 10 meters. Below is another small room with yet another drop, which opens into a large room at the bottom of the cave. This lower



room measures 4 m in length and 2.5 m in width with a ceiling height of about 3 meters. Runoff flows into the cave during heavy rains, and has scoured out plunge pool basins at the bottoms of the drops.

Speleogens: The cave exhibits features of phreatic and vadose formation such as pendants, scallops, a stream meander, and elliptical passages.

Speleothems: The cave is not well decorated with formations, but does exhibit stalactites, soda straws, draperies, and cave coral. Several small columns are present, which measure 10-20 cm in height.

Hazards: The cave should not be entered by inexperienced climbers.

Vandalism: Only a few broken stalactites were noted. Initials have been inscribed on a wall close to the bottom room of the cave.

Sediments and Stratigraphy: The cave is essentially scoured of sediments. Some surface sediments occur in the passages closest to the surface. Gravels are present on the floors of some of the deeper rooms. One false floor occurs with cemented gravels underneath. Some cemented gravel is present in cracks near the ceiling in the lower room.

Biological Observations: Two epigeal taxa—one ant and one spider—were noted in the cave.

Paleontological Observations: Small recent vertebrate microfaunal remains are present in the surface-derived sediments. The deposit is shallow, being only about 2 cm in depth.

Significance: The cave is unusual in that it is the only cave found in the project area which was formed primarily by vadose processes.

Mitigation: No active mitigation is recommended at this time.

CAVE 028

Location: Grapevine Gulch, Calaveras County

Elevation: 517 ± 6 m (1875 ± 20 ft)

Height above Base Level: 297 ± 6 m (975 ± 20 ft)

Relation to Pool Level: This cave is located 240 m (787 ft) above gross pool level.

Description: The entrance is located in the bottom of a sinkhole 4 by 7 m and 4 m deep. It is 4 m in width and 1 m in height, and leads into the side of a chamber almost 20 m long. Two crawlways from this room each terminate after a few meters. Solution domes in the ceiling extend almost to the surface.

Speleogens: The cave has developed horizontally across vertical bedding planes. Joint pockets and domes form the ceiling.

Speleothems: There are stalactites, flowstone, popcorn, and recrystallized flowstone in the cave.

Sediments and Stratigraphy: Large breakdown fragments slope into the main chamber from the entrance. Away from the entrance the debris consists of a horizontal layer of fine, dark sediment with small rock fragments. Breccia cemented on the ceiling of the entrance seems to be of earlier origin than the dark fine sediment.

Biological Observations: A swallow nest was seen. A salamander of unknown taxon was collected from this cave (Danehy, 1952; cf. Halliday, 1962:48).

Biological Identifications:

Snails: *Monadenia mormonum mormonum*

3 Adult Rock Squirrels: *Citellus beecheyi*

1 Young Adult Deer Mouse: *Peromyscus maniculatus*

1 Old Adult, 2 Young Adult Dusky-Footed Packrats: *Neotoma fuscipes*

Paleontological Observations: Although no sub-recent or fossil remains were identified, it is speculated that deep floor sediments may contain paleontological material.

Significance: The cave contains breccia from pre-Holocene periods which is an important part of the geological record and it is likely that deep floor sediments contain valuable paleontological material.

Mitigation: No active mitigation measures are recommended at this time.

CAVE 029

Location: Coyote Creek, Calaveras County

Elevation: 476 ± 14 m (1560 ± 40 ft)

Height above Base Level: 155 ± 12 m (510 ± 40 ft)

Relation to Pool Level: The cave is located 144 ± 12 m (472 ± 40 ft) above gross pool level.

Description: The 0.5 to 0.25 m entrance leads to a narrow

fissure with a dirt floor. There are rock and breakdown plugs on each end, where there were once external openings.

Speleogens: There are joints in the walls and ceiling.

Speleothems: Cave coral is present.

Sediments and Stratigraphy: Brown, recent, organic sediments occur at the bottom of the narrow fissure.

Biological Observations: Small mammal dung is present.

Biological Identifications:

Centipede: *Nadabius sp.*

Spiders: *Telema gracilis*

Chasmocephalon shantzi

Pseudoscorpion: *Parca sp.*

Collembola: *Tomocerus celsus*

Mite: *Rhagioia sp.*, near *cavernarum*

Paleontological Observations: Small, recent, vertebrate microfauna is present in the brown sediment.

Significance: The cave is of some zoospeleological value.

Mitigation: No active mitigation is recommended at this time.

CAVE 030

Location: Coyote Creek, Calaveras County

Elevation: 476 ± 6 m (1980 ± 20 ft)

Height above Base Level: 329 ± 6 m (1080 ± 20 ft)

Relation to Pool Level: The cave is located 272 m (892 ft) above gross pool level.

Description: A small fissure 1.3 by .3 m wide opens into a slanting drop which is easily down-climbed for 10 meters. A room 3 m in length continues into a small passage for 3 m before pinching out.

Speleogens: The cave is developed along a fissure.

Speleothems: Small stalactites, coral and small false floors are present.

Sediments and Stratigraphy: The terminal room contains recent dirt while some older breccia was noted cemented to the walls. On the surface near the cave entrance breccia over flowstone was observed.

Biological Observations: A single bat was noted.

Biological Identifications:

Centipede: *Tosibius sp.*

Millipede: *Pamreopus sp.*

Pseudoscorpion: *Neochthonius sp.*

Spiders: *Liocranoides sp.*

Telema gracilis

Psilochorus sp.

Chasmocephalon shantzi

Archoleptoneta schusteri

Mite: Trombiculidae

Collembola: *Tomocerus wilkey*

Beetle: *Pselaphidae, sp. #3*

Snails: *Mondenia mormonum mormonum*

1 Adult Pocket Gopher: *Thomomys sp.*

1 Adult California Pocket Mouse: *Perognathus cf. californicus*

1 Adult Deer Mouse: *Peromyscus cf. maniculatus*

1 Deer Mouse: *Peromyscus sp.*

1 Packrat: *Neotoma sp.*

1 Adult Dusky-Footed Packrat: *Neotoma fuscipes*

1 California Vole: *Microtus cf. californicus*

1 Rabbit: *Sylvilagus sp.*

Paleontological Observations: Two small fissures outside

the entrance to this cave, about three meters north of the entrance contain abundant, well-preserved remains of small mammals. The geomorphologic context of these fissures suggests they are rather old (Pleistocene?) having been formed and filled at an earlier stage in the development of Cave 030. A sample of breccia from one of the fissures disaggregated completely in acetic acid, leaving a rich concentrate of bones and teeth. These occurrences may yield paleontologically significant fossil assemblages of small mammals despite their limited extent.

Significance: The fossil bone found within a stratigraphic context in this cave is an important part of the data base required to answer the questions posed within the research discussions. The significance of the taphonomic data base should not be ignored.

Mitigation: Some limited taphonomic and paleontological surface collection is appropriate here; no other active mitigation recommendations are advanced at this time.

CAVE 031

Location: Stanislaus River Canyon, Calaveras County

Elevation: 442 ± 3 m (1450 ± 10 ft)

Height above Base Level: 145 ± 3 m (475 ± 10 ft)

Relation to Pool Level: The cave is located 110 ± 3 m (362 ± 10 ft) above gross pool level.

Description: A 1 m wide and 1.5 m tall entrance occurs at the base of a steep cliff in thick, brushy vegetation. The entrance leads upward in a tight chimney of about 5 cm in width for 7 meters. No side passages are present.

Mitigation: No further study is recommended for this cave.

CAVE 032 (Ca-Cal-649)

Location: Stanislaus River Canyon, Calaveras County

Elevation: 276 ± 2 m (905 ± 6 ft)

Height above Base Level: 2 ± 2 m (6 ± 6 ft)

Relation to Pool Level: The cave is 56 m (183 ft) below gross pool and 35 m (116 ft) below recreation pool level.

Description: The $1\frac{1}{2}$ m by 1 m primary entrance is followed by 6 m of horizontal cave which averages $1\frac{1}{4}$ m wide. Then the passage slopes steeply up for four meters to a smaller entrance. A third entrance to the right of the main entrance drops into the main passage near the primary entrance.

Speleogens: A stream meander noticeable in the main passage has been modified by further phreatic solutioning. Joint pockets were observed in the ceiling.

Vandalism: Graffiti and trash are present.

Sediments and Stratigraphy: The river has recently deposited sand and rock in the cave, partially from the higher entrances.

Archaeological Observations: There is abundant evidence of contemporary use, including a firepit, which obscures historic or prehistoric manifestations.

Significance: The location of the entrance only 2 m above the river suggests aboriginal use of the cave on a short-term basis. Miners may also have used or excavated this cave (Squire, n.d.).

National Register Eligibility: Yes

Mitigation: A testing/excavation program should evaluate the extent of historic or prehistoric use and provide adequate mitigation.

CAVE 033

Location: Stanislaus River Canyon, Calaveras County
Elevation: 276 ± 1.5 m (90 ± 5 ft)
Height above Base Level: 1.5 ± 1.5 m (5 ± 5 ft)
Relation to Pool Level: The cave is located 35 ± 1.5 m (996 ± 5 ft) below recreation pool level.
Description: The pit has an entrance 3 by 2 m and is 4 m deep. It appears to be a mined fissure.
Sediments and Stratigraphy: Sand and gravels are overlain by colluvium.
Biological Observations: Two epigeal salamanders were observed at the bottom of the pit.
Mitigation: No further study is recommended for this cave.

CAVE 034

Location: Skunk Gulch, Calaveras County
Elevation: 518 ± 8 m (1690 ± 25 ft)
Height above Base Level: 248 ± 8 m (815 ± 25 ft)
Relation to Pool Level: The cave is located 183 ± 25 m (602 ± 25 ft) above gross pool level.
Description: The 0.8 by 0.3 m entrance leads down a small vertical fissure for 7 meters. The drop is easily climbable, and leads to a small room 3 m in length and 2.5 m in width. A constricted fissure too tight for human passage leads into what looks like another small room.
Speleothems: Cave coral is present.
Sediments and Stratigraphy: Geologically recent brown soil covers the floor of the small room.
Biological Observations: Snail shells were common.
Biological Identifications:
Isopod: *Brackenridgia heroldi*
Spiders: *Psilochorus* n. sp.
Blabomma sp.
Pseudoscorpion: *Microcreagris* sp. (epigeal)
Snail: *Monadenia mormonum mormonum*
Helminthoglypta cypreophila
Pristiloma subrupicola spelaeum
Paleontological Observations: This pit contained an immature deer skull. No fossil bones were found.
Significance: The cave is a natural trap, possibly for extinct as well as recent fauna. A new species of spider, possibly with a restricted range, was included in the invertebrate fauna.

Mitigation: Some taphonomic surface collection is recommended here. Visitation should be discouraged.

CAVE 035

Location: Skunk Gulch, Calaveras County
Elevation: 518 ± 3 m (1700 ± 10 ft)
Height above Base Level: 215 ± 3 m (825 ± 10 ft)
Relation to Pool Level: The cave is located 187 ± 3 m (612 ± 10 ft) above gross pool level.
Description: The small entrance, measuring 0.8 by 0.5 m, drops vertically for 4 m into a small room 2 m in width and 4 m in length. A small passage leads west for 3 m.
Speleothems: The cave exhibits small stalactites in solution pockets, cave coral and resolutioned flowstone.
Sediments and Stratigraphy: A rich organic soil layer covers a dark brown sediment below the vertical entrance.

Biological Observations: Invertebrate fauna includes diplura, harvestmen, and pseudoscorpions. A nearly vertical pit, this cave contains a recent, disarticulated skeleton of a young deer.

Biological Identifications:

Pseudoscorpion: *Neochthonius troglodytes*
Cheliferidae

Spiders: *Chasmocephalon shantzi*

Harvestmen: *Ortholasma rugosum*

Dipluran: Unidentified

Snails: *Monadenia mormonum mormonum*

Significance: Data from this cave and other natural traps in the project area would provide an invaluable basis for the paleoecological interpretation of extinct and extant faunal assemblages.

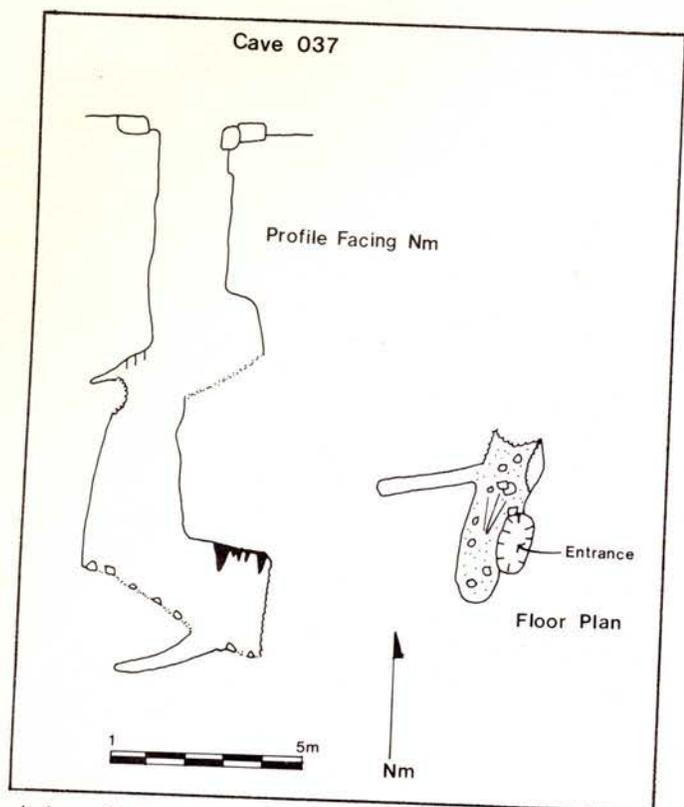
Mitigation: Aside from some taphonomic surface collection, no mitigation of an active nature is recommended. Visitation should not be encouraged.

CAVE 036

Location: Stanislaus River Canyon, Tuolumne County
Elevation: 360 ± 18 m (1180 ± 60 ft)
Height above Base Level: 76 ± 15 m (250 ± 50 ft)
Relation to Pool Level: This cave is located 28 m (92 ft) above gross pool level and 40 m (150 ft) above recreational pool level.
Description: At the top of a talus cone is a horizontal crack 1 m in height extending 3 m into the side of the gulch. A large slab of rock measuring approximately 3 by 3 by 6 m long composes the present floor. Other smaller blocks form an irregular floor on the east side of the shelter. Talus from the edge of the fallen rock obscures observation of what is below the previous ceiling.
Speleogens: The present space was formed by the ceiling collapsing to the floor of the former shelter.
Speleothems: A small amount of cave coral was observed in a few small areas.
Significance: This shelter has potential cultural significance.
National Register Eligibility: Unknown, therefore not determined eligible.
Mitigation: No active mitigation is recommended at this time.

CAVE 037

Location: Skunk Gulch, Calaveras County
Elevation: 512 ± 3 m (1680 ± 10 ft)
Height above Base Level: 245 ± 3 m (805 ± 10 ft)
Relation to Pool Level: 256 ± 3 m (840 ± 10 ft) above gross pool level.
Description: The 1 by 2 m entrance drops vertically for 7 m to a dirt slope of about the same dimensions. The floor slopes to another drop 5 m below. A room at the bottom of the drop is 1-1.5 m in width and 4 m in length with a steeply angled breakdown floor. At the end of the breakdown a small crawl leads to a soil plug.
Speleogens: Joint pockets occur in the cave.
Speleothems: The cave exhibits stalactites, cave coral, draperies and flowstone. A stalagmite occurs that is 5 m in length.
Hazards: The cave has a vertical drop of 7 m.
Sediments and Stratigraphy: The floor of both rooms is a



light reddish-brown soil intermixed with breakdown.

Biological Observations: A bird was found in the cave. Snail shells were also present.

Biological Identifications:

Snails: *Monadenia mormonum mormonum*

Helminthoglypta cypreophila

1 Juvenile Dusky-Footed Packrat: *Neotoma fuscipes*

Mitigation: Due to its hazardous nature, this cave should be gated as specified in the Master Plan. Inexperienced cavers should not be encouraged to visit the site.

CAVE 038

Location: Stanislaus River Canyon, Calaveras County

Elevation: 317 ± 9 m (1040 ± 30 ft)

Height above Base Level: 37 ± 6 m (120 ± 20 ft)

Relation to Pool Level: The cave is located 17 m (48 ft) below gross pool level and 69 m (226 ft) above recreation pool level.

Description: The entrance is located in breakdown at the base of a cliff face. A room 10 m long and 5 m wide extends into the mountainside. At its highest point the ceiling is only 1 m high. The sloping dirt and scree floor leads up to a tight opening too small for human passage beyond which more cave can be seen.

Speleothems: Flowstone, draperies, popcorn, and stalagmites are present.

Sediments and Stratigraphy: Fine brown (organic origin) soil with occasional breakdown blocks covers the floor.

Biological Observations: Dung (possibly procupine) was noted at the base of the room near the far wall.

Mitigation: No further study is recommended for this cave.

CAVE 039

Location: Stanislaus River Canyon, Calaveras County

Elevation: 291 m (955 ft)

Height above Base Level: 1.5 m (5 ft)

Relation to Pool Level: The cave is located 20 m (66 ft) below recreation pool level.

Description: The cave was not visited during this project. It has been described by Squire (1975b) as "a classic cave entrance $1\frac{1}{2}$ by 2 ft leading downward on a slope for about 3 ft to a solution cavity filled with water. A small resurgence (spring), emerging about 4 ft below the opening, is the obvious drainage for the cave."

Mitigation: No further study is recommended at this time.

CAVE 040

Location: Grapevine Gulch, Calaveras County

Elevation: 579 ± 9 m (1910 ± 30 ft)

Height above Base Level: 308 ± 9 m (1010 ± 30 ft)

Relation to Pool Level: The cave is located 251 ± 9 m (822 ± 30 ft) above gross pool level.

Description: The entrance, measuring 2 m in height and 35 cm in width, intersects a vertical fissure 1.5 m in length and 0.5 m in width which drops 3 m to a sloping rubble and earth floor. The floor dips toward the north for 6 m where it intersects a smaller fissure leading upward.

Speleogens: The cave exhibits pendants.

Speleothems: Cave coral was noted.

Sediments and Stratigraphy: Sediments consist of black earth overlying a lighter deposit. An older matrix consists of weathered fragments of limestone (rounded) with finer material covered with cave coral cemented to the walls.

Biological Observations: Neotoma-size dung was noted as well as 3 rat nests. One live snail and a small frog were present.

Paleontological Observations: Gastropods were found cemented to the floor matrix, but may be younger than the overall matrix. A sample of matrix was collected from the ground surface next to the cave entrance.

Significance: the High elevation of this cave and its location near the base of Table Mountain suggest that breccias present at the entrance of the cave may be of considerable antiquity.

Mitigation: No active mitigation is recommended at this time.

CAVE 041

Location: Skunk Gulch, Calaveras County

Elevation: 530 ± 5 m (1740 ± 20 ft)

Height above Base Level: 264 ± 6 m (865 ± 20 ft)

Relation to Pool Level: The entrance to the cave is 199 m (652 ft) above gross pool level.

Description: The cave is a series of vertically oriented fissures. The entrance is located in a 2 by 3 m depression on a hillside. At one end of this depression the small 0.5 by 0.5 m entrance proceeds horizontally for about 1 m before dropping out over the top of the fissure. The main fissure bottoms in a 4 by 1.5 m room about 30 m below the entrance. At 10 m above the floor of this room is a small ledge with another series of vertical fissures proceeding downward. These cracks eventually become too small for further exploration (Squire, personal communication).

Speleothems: Those noted include flowstone, stalactites, stalagmites, columns, soda straws, draperies, and popcorn

—all of limited size and number.

Hazards: Bar air was encountered at the bottom of the room 30 m below the entrance. Vertical drops comprise another hazard of this cave.

Sediments and Stratigraphy: The floor of the room included loose, light brown soil and rocks from fine gravel to 0.5 by 0.2 m in size.

Biological Observations: A few invertebrate forms were present, including a number of harvestmen.

Biological Identifications:

Isopod: *Brackenridgia heroldi*

Spiders: *Aptostichus* sp.

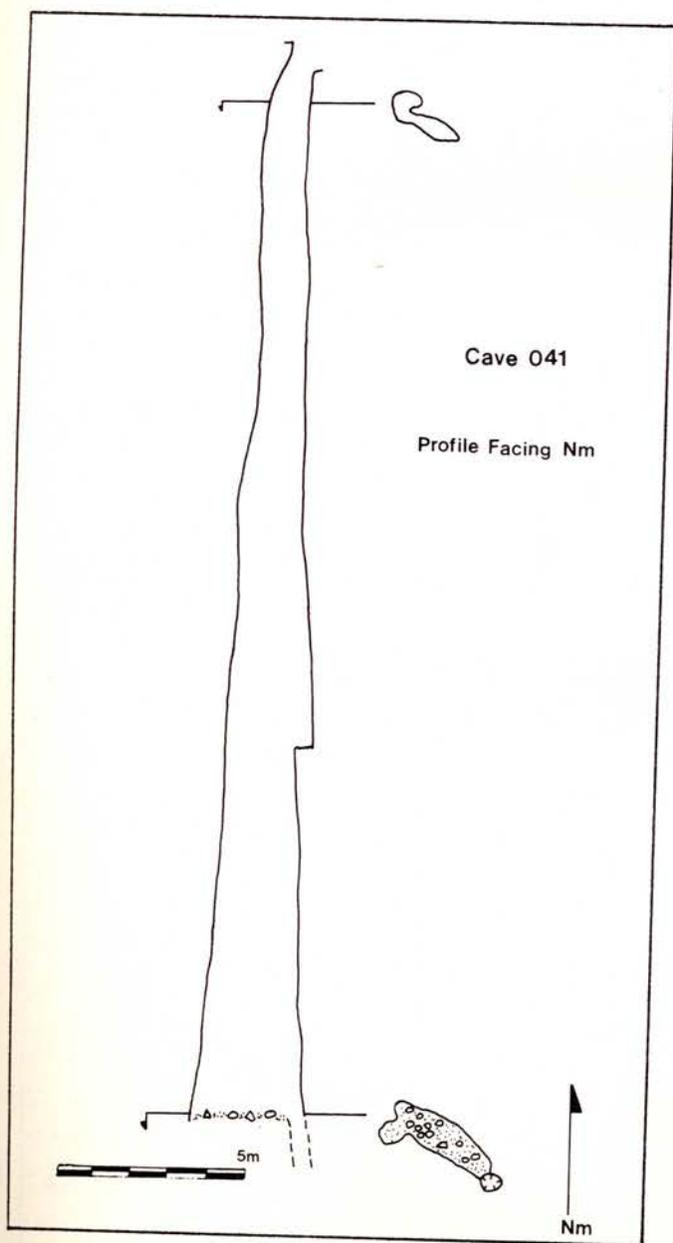
Liocranoides sp.

Harvestmen: *Banksula n. sp.* near *melones*

Beetle: Curculionidae unidentified

Pselaphidae undetermined species #2

Paleontological Observations: In the main room, a snake skeleton of probable recent origin was observed. Also a few small extant mammal bones were noted on the floor.



Significance: A new species of harvestmen of the same genus as the *B. melones* form was collected from the cave. Taphonomic data of some importance is also present.

Mitigation: Due to its hazardous nature, visitation to this cave should be actively discouraged.

CAVE 042

Location: Coyote Creek, Calaveras County

Elevation: 457 m (1500 ft)

Height above Base Level: 137 m (450 ft)

Relation to Pool Level: The cave is located 126 m (412 ft) above gross pool level.

Description: The cave was not visited during the project. However, an unsuccessful attempt was made to locate the cave. It has been described by Squire (1972) as a small cave located in the "rockpile."

Mitigation: See the discussion relating to mitigation of the "rockpile".

CAVE 043

Location: Grapevine Gulch, Calaveras County

Elevation: 585 ± 3 m (1920 ± 10 ft)

Height above Base Level: 310 ± 3 m (1020 ± 10 ft)

Relation to Pool Level: The cave is located 254 ± 3 m (832 ± 10 ft) above gross pool level.

Description: Cave 043 is entered through a collapsed doline composed of large breakdown blocks. This opening leads into a breakdown room with two passages. The passage straight from the entrance is 12 m in length and ends in a series of 3 false floors dividing 3 small rooms. Leading off to the right from the breakdown room is a small upward crawl that leads to a well decorated passage 3 m wide and 5 m long. The passage narrows and then opens into a large room 30 m in length and 20 m in width with a ceiling height of 5 meters. At the back of the large room is a small hole that leads through a crawlway to a room 2 by 2 meters. To the left of the main room is a side passage 11 m in length. This passage has a breccia ceiling.

Speleogens: Joint pockets, pendants, and scallops were noted.

Speleothems: The cave exhibits flowstone, stalactites, stalagmites, columns, soda straws, helectites, serrated draperies, rimstone dams, false floors, and at least one shield. Two large columns are present, measuring 2 m in length and 10 and 30 cm in diameter.

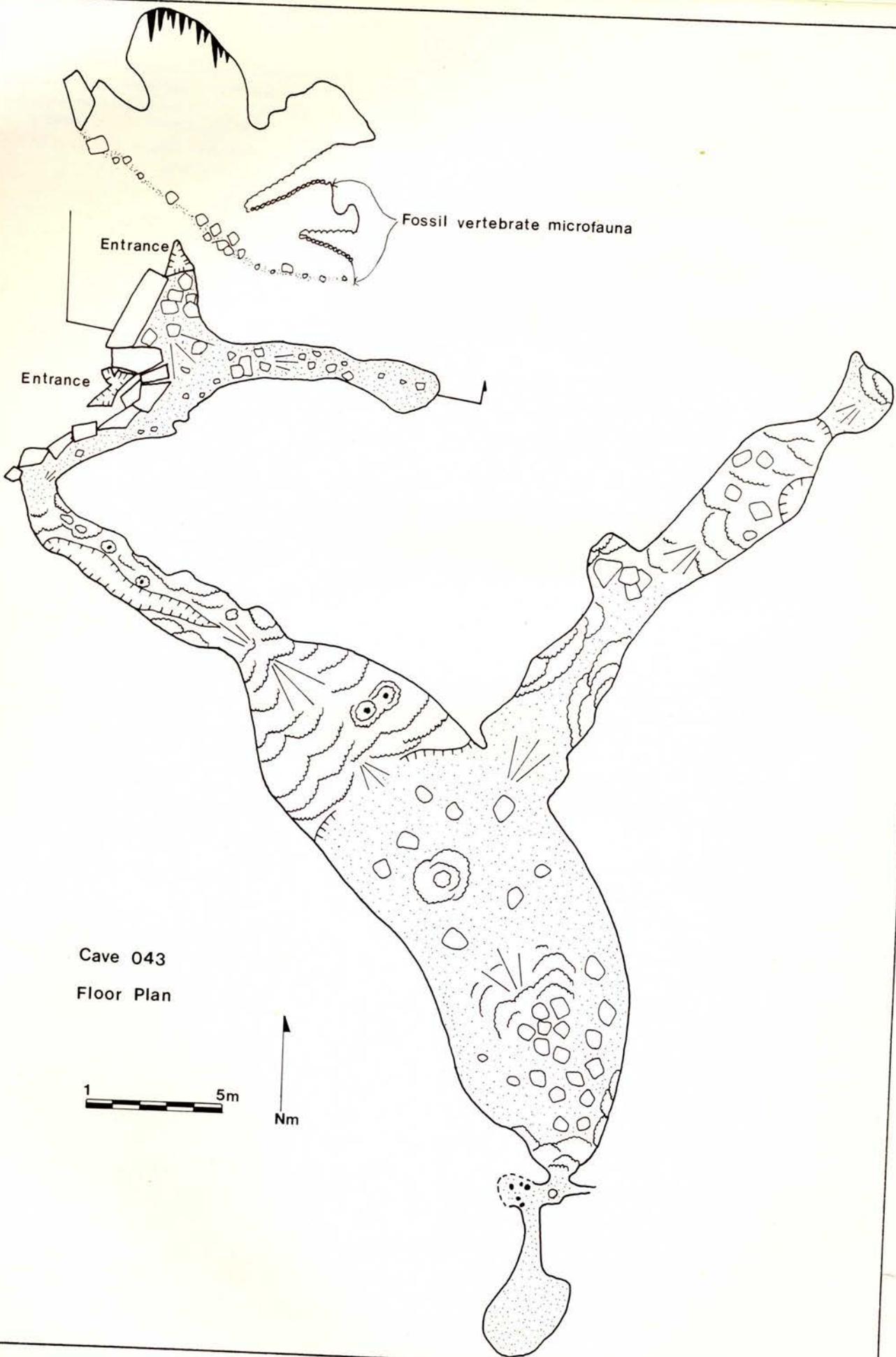
Vandalism: Many formations have been broken including stalactites and columns. Beer bottles and cans occurred throughout the cave which were removed by the survey team.

Sediments and Stratigraphy: The cave sediments are generally a fine, black soil filtering into the cave from above. Roots are present, having entered through cracks in the ceiling of the big room. Cemented breccia occurs in a side passage off the big room, and is composed of red sediments and small, subangular limestone. Three layers of false floors are present in the passage off the entrance room.

Biological Observations: Fauna existing in the cave includes invertebrates, California newts, and arboreal salamanders.

Biological Identifications:

Isopod: *Brackenridgia heroldi*



Millipede: *Paeromopus* sp.
 Xystodesmidae
 Trichopolydesmidae sp. #2
 Centipede: *Taiyuna* sp.
 Pseudoscorpion: *Neochthonius troglodytes*
 Microcreagris grahami
 Mite: Unidentified
 Spiders: *Liocranoides* sp.
 Psilochorus, n. sp.
 Archoleptoneta schusteri
 Blabomma sp.
 Harvestmen: Variety of *Banksula grahami*
 Collembola: *Sinella* n. sp.
 Tomocerus celsus
 Beetle: *Ptomaphagus californicus*
 Leiodidae
 Catopinae
 Pselaphidae sp. #1
 Snails: *Monadenia mormonum mormonum*
 Helminthoglypta crpreophila

Paleontological Observations: Cave 043 is already being heavily visited, and this recreational use will probably increase. Most unconsolidated surface fills in the cave already are considerably disturbed. The fills containing vertebrate bone are mostly quite small, 1-3 square meters in extent, and bone is not particularly abundant in any of these pockets.

Flowstones form the surface in many parts of the cave and these presumably cover clastic fills of completely unknown extent. In the few places examined where the flowstones have been breached to reveal underlying clastic fills, no fossils were observed.

In one large room near the entrance, a thick section of fossiliferous breccia is exposed along the lower wall. There is evidence that this area of the cave functions as a sump during times of high water. Numerous cycles of erosion and redeposition (of both secondary calcite and clastic fills) are reflected in the unusually complex stratigraphy exposed in the lower wall of this room. At least two breccia deposits of different ages and the debris deposits forming the present floor contain vertebrate fossils.

Fossiliferous breccias occur in at least two other parts of the cave: in an extensive (approximately 10 sq m) exposure with low to moderate bone concentration at the lower end of a cul-de-sac to the left of the entrance room, and a more limited exposure (approximately 3 sq m) below a ledge in the lower part of the large main room. The age relationships between these deposits and the others mentioned above is not immediately apparent.

Significance: This cave is one of the most frequently visited caves in the area, due to its large size and abundant formations. Several unique and unusual invertebrates may be restricted to the immediate area; at least one new species was found in the cave during the present study. The numerous false floors and breccias, some which include vertebrate fossils in stratigraphic context, make this cave one of the most important geological and paleontological records existing in the area.

Mitigation: Due to its esthetic, geological, paleontological, taphonomic, and biological value, this cave should be gated as per the Master Plan suggestion. Controlled access should be allowed, however, as the cave is of considerable recreational value to conscientious cavers.

CAVE 044

Location: Stanislaus River Canyon, Calaveras County

Elevation: 277 ± 2 m (910 ± 6 ft)

Height above Base Level: 8 ± 2 m (25 ± 6 ft)

Relation to Pool Level: The cave is located 34 ± 2 m (111 ± 6 ft) below recreation pool level.

Description: The cave is a low "L" shaped crawlway with two entrances near the waters edge. One entrance formed along a crack is 3 by 1 meters. The low crawlway leads to a tight squeeze and then more low crawlway which leads to a breakdown entrance. The total passage length is about 4.5 meters.

Speleothems: Cave coral occurs on some of the breakdown.

Sediments and Stratigraphy: The floor is covered with breakdown blocks, and sand and gravel from the river.

Mitigation: No further study is recommended for this cave at this time.

CAVE 045

Location: Skunk Gulch, Calaveras County

Elevation: 517 ± 8 m (1700 ± 25 ft)

Relation to Pool Level: The cave is located 186 ± 8 m (612 ± 25 ft) above gross pool level.

Description: From the 1.5 by 0.5 m vertical entrance a sloping passage 1.5 by 1 m leads downward 10 m to a narrow crack which was jammed by rubble. Rocks thrown into the crack indicated that a substantial drop was located below. About 2 cu m of loose rubble were subsequently removed to gain access to the drop. This passage, a 1.5 m and 3 m long enlarged fissure, drops 35 m vertically to a narrow 1 meter wide floor perched on an island of bedrock. The floor is littered with animal bone. On one side of the floor the fissure continues downward for an additional 20 m although it narrows to 0.5 m in width and 2.5 m in length. At the bottom of the drop the floor, composed of angular pieces of limestone, fine sediment and much fossil bone, slopes steeply downward. The fissure was explored for an additional 10 m vertically and continues beyond that point.

Speleogens: Pendants are present.

Speleothems: Cave coral, flowstone, stalactites, and stalagmites occur in the cave.

Sediments and Stratigraphy: The sediments include rubble mixed with fine sediments and contemporary and fossil bone. In an exposed section stratigraphic layers were noted in the bone deposit.

Biological Observations: Several invertebrates, including an epigeal pseudoscorpion (Fig. 14) similar to a cave-adapted form, were recorded.

Biological Identifications:

Collembola: *Tomocerus celsus*

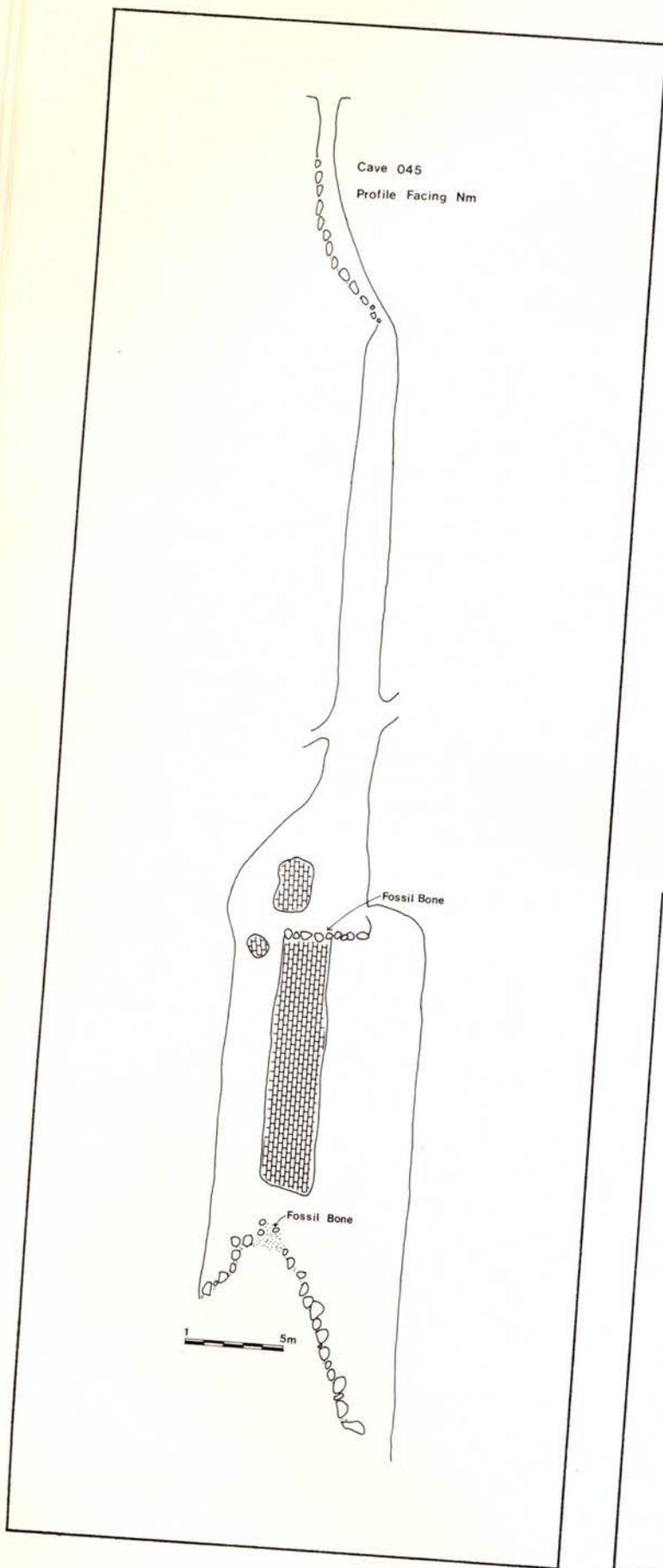
Millipede: *Paeromopus* sp.

Pseudoscorpion: *Microcreagris* sp. (epigeal)

Spider: *Cicurina* sp.

1 Deer: *Odocoileus* sp.

Paleontological Observations: Two separate bone deposits were observed in the cave. The upper deposit, located on the first floor, is about 1 m wide and 3 m long and is estimated to be over a meter (possibly several meters) in depth. The lower deposit, located on the second floor, is considerably larger in extent—approximately 1 m wide and 5 m long. A section of the deposit exposed by slumping revealed that stratigraphy is present in the deposit and teeth from two species of extinct megafauna were recorded



and collected from the section. The deposit is estimated to be at least 3 m in depth and may be considerably deeper. In their present state the deposits are extremely fragile and it is impossible to traverse the cave without stepping on them.

Paleontological Identifications:

1 Pleistocene Horse: *Equus sp.*

1 Extinct Shrub Ox: *Euceratherium sp.*

Significance: This cave has the best preserved paleontological deposit known in the area, including caves outside of the project boundaries. The apparent stratigraphy of the deposit indicates that it may be possible to identify faunal shifts within the region through time.

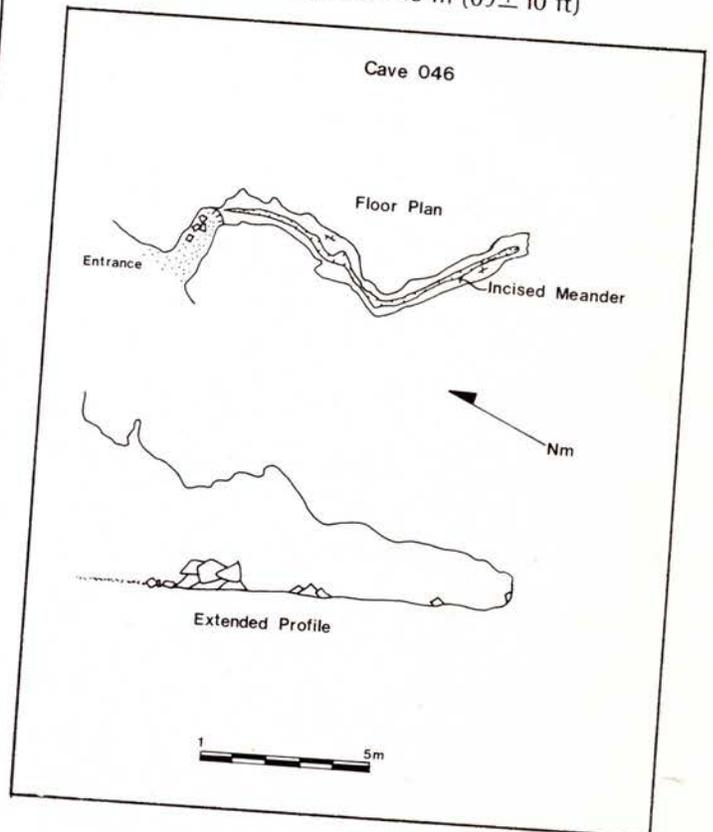
Mitigation: Preservation and limited stabilization are recommended. The cave is the deepest one known in the project area and has one of the longest known drops of any of the wild caves in the region. However, vertical recreational caving would have a severely detrimental affect on the paleontological and taphonomic resources. Therefore, it is recommended that the upper bone deposits be preserved by minimal surface collection and by covering the deposit with a sterile matrix to protect the bone from being crushed. In the lower bone deposit a very fragile exposed section composed of about 2 to 5 cu m of deposit should be removed for data study as there seems to be no other practical way to stabilize this portion of the deposit. The remainder of the deposit should be covered by clean fill to prevent it from being trampled. Finally, access to the cave should be controlled by gating and visitation vigorously discouraged.

CAVE 046 (Ca-Tuo-771)

Location: Stanislaus River Canyon, Tuolumne County

Elevation: 295 ± 3 m (968 ± 10 ft)

Height above Base Level: 21 ± 3 m (69 ± 10 ft)



Relation to Pool Level: The cave is 37 m (120 ft) below gross pool and 17 m (53 ft) below recreational pool level.

Description: The entrance to this phreatic passage is 3 m high and 1 m wide. The passage varies from 1 m to 1/2 m wide and 1 to 3 m high. It ends in a flowstone plug.

Speleogens: The ceiling contains joint pockets and the floor is inscribed with an incised stream meander.

Speleothems: Flowstone, a small canopy, and cave coral are present.

Vandalism: There was no prominent vandalism evident.

Sediments and Stratigraphy: Gravels and sediments are found cemented to the walls. At the end of the cave cemented material, including some fine sediments are covered by flowstone.

Biological Observations: The cave has been used as a small animal den.

Biological Identifications:

1 Juvenile Raccoon: *Procyon lotor*

1 Adult Pocket Gopher: *Thomomys sp.*

Paleontological Observations: A mandible was found embedded in flowstone.

Archaeological Observations: Charred wood and a possible smoke-blackened ceiling were noted. A river cobble hammerstone was also found near the dripline. An area of the floor had been cleared of loose rocks, which seem to have been discarded into a nearby crack, and much of the floor was covered with a thick layer of leaves. Of historic significance is a jar (screw) lid and metal can 2.8 cm tall. An historic trail paralleling the river is also directed past the entrance to this cave.

Significance: The bone deposits in the cave can be identified, and possibly dated both by radiocarbon analysis of the bone itself and by uranium-thorium dating of the flowstone. The presence of the hammerstone suggests that calcite quarrying took place during the prehistoric period. The cave may also have been briefly inhabited during the historic period.

National Register Eligibility: Yes

Mitigation: Excavation would allow sufficient material to be collected to indicate the total context within which this cave was used prehistorically and historically. Taphonomic and geological mitigation are also recommended.

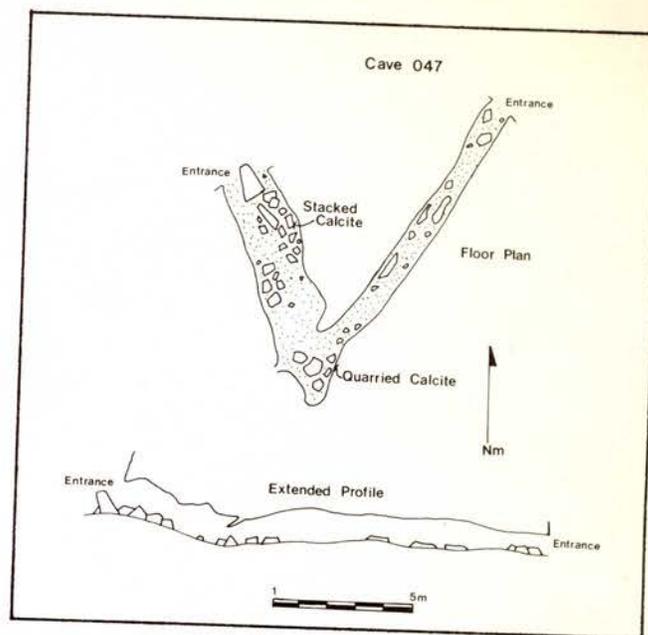
CAVE 047 (Ca-Tuo-772)

Location: Stanislaus River Canyon, Tuolumne County

Elevation: 305 ± 3 m (1000 ± 10 ft)

Relation to Pool Level: The cave is located 27 m (88 ft) below gross pool level and 5 m (21 ft) below recreational pool level.

Description: The cave, reached by a well-developed trail, exhibits a classic horizontal solution passage with flat ceiling and rounded sides. The 1 m tall and 1.5 m wide upstream entrance was exposed to the surface as the cliff wall collapsed, opening the 12 m long passage. This passage intersects an adjoining corridor at approximately a 60° angle. The later passage—7 m long—exits at the downstream entrance, which is 4 m in height and 2 m in width. A complex maze of small passageways off of the main passage were not mapped. At the passage intersection a false floor 1 m above the passage floor is laminated with 3 layers of sediments and flowstone. Calcite has been broken off the false floor. Calcite blocks are stacked near the downstream entrance.



Speleogens: The cave exhibits joint pockets and pendants.

Speleothems: Blue and pink cave coral occurs on the walls and ceilings throughout the cave.

Sediments and Stratigraphy: The floor of the two passages is composed of breakdown blocks ranging in size from 1 m in length, width, and height to breakdown and calcite rubble. Light brown sandy soil occurs below the loose rock. The false floor consists of three layers of flowstone separated by 10 cm of sediments.

Biological Observations: Current habitation by rodents and carnivores is evidenced by recent scat. One big-eared bat was seen.

Archaeological Observations: The cave appears to have been a prehistoric calcite quarry. No hammerstones are present on the surface, but calcite is broken from walls and removed from upper layers of the false floor. Calcite blocks are stacked against the wall near the downstream entrance. A water-worn and possibly utilized redwood bark wand was located in the entrance of the cave. Some historic use is suggested by the trail leading to the cave.

National Register Eligibility: Yes

Significance: The site has abundant evidence of prehistoric mining for calcite and some suggestion of historic occupation. Extensive evidence of current use by medium-sized vertebrates is present in undisturbed condition, making the cave ideal for taphonomic studies.

Mitigation: Selected excavation of this cave should be implemented to assess and explain the range of aboriginal and historic uses to which it was put. Taphonomic collections should also be made. Geological study is recommended as well as the cave will be inundated.

CAVE 048 (Ca-Tuo-773)

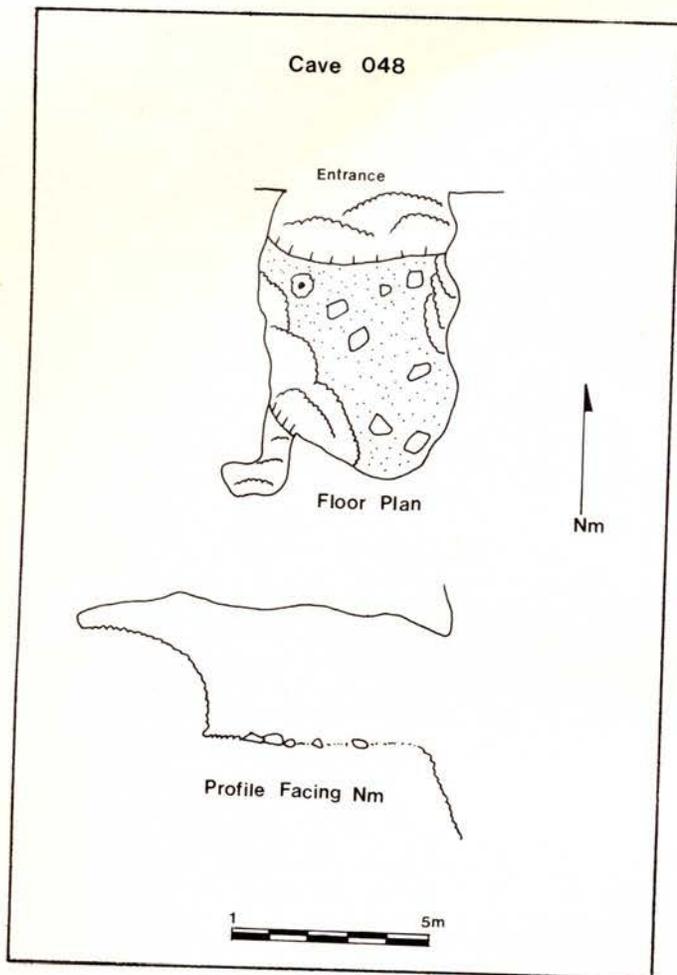
Location: Stanislaus River Canyon, Tuolumne County

Elevation: 319 m (1049 ft)

Height above Base Level: 45 m (149 ft)

Relation to Pool Level: The cave is located 13 m (39 ft) below gross pool level and 8 m (28 ft) above recreation pool level.

Description: The cave is small, being a single room with a



large entrance measuring 4 by 4 meters. The ceiling and floor are flat while the walls are slightly curved. A small passage 2 m in length exhibits flowstone that has covered much of the floor of the cave.

Speleogens: The cave has joint pockets and pendants.

Speleothems: Within the cave are stalactites, flowstone, cave coral, and a stalagmite 1 m in height.

Vandalism: Innumerable names have been inscribed on the cave walls, with the earliest dating to 1912. Considerable "vandalism" is evident in the battered nature of the speleothems.

Sediments and Stratigraphy: Most of the floor of the cave is covered with a layer of flowstone, but 4 sq m are composed of fine, dry, light red, sandy soil of unknown depth. The sediment is concentrated in a possible rimstone dam that is now eroding away.

Biological Observations: Small carnivore scats were noted.

Paleontological Observations: Recent micro-vertebrate remains were observed on the surface of the deposit.

Archaeological Observations: Possible soot was present on the ceiling of the cave.

National Register Eligibility: Yes

Significance: The cave may well be an aboriginal calcite quarry.

Mitigation: The roof blackening substance should be chemically tested and the quarry hypothesis evaluated through limited excavation of the deposit. Taphonomic

collections should also be made. Some geological study is recommended as well—especially as it relates to the archaeology of the cave.

CAVE 049

Location: Coyote Creek, Calaveras County

Elevation: 457 m (1500 ft)

Height above Base Level: 137 m (450 ft)

Relation to Pool Level: The cave is located 126 m (412 ft) above gross pool level.

Description: The cave was not visited during the project. Several attempts were made to locate the cave by persons who had previously visited the cave, but none were successful. The cave has been described by Squire (1972) as a small cave within the "rockpile."

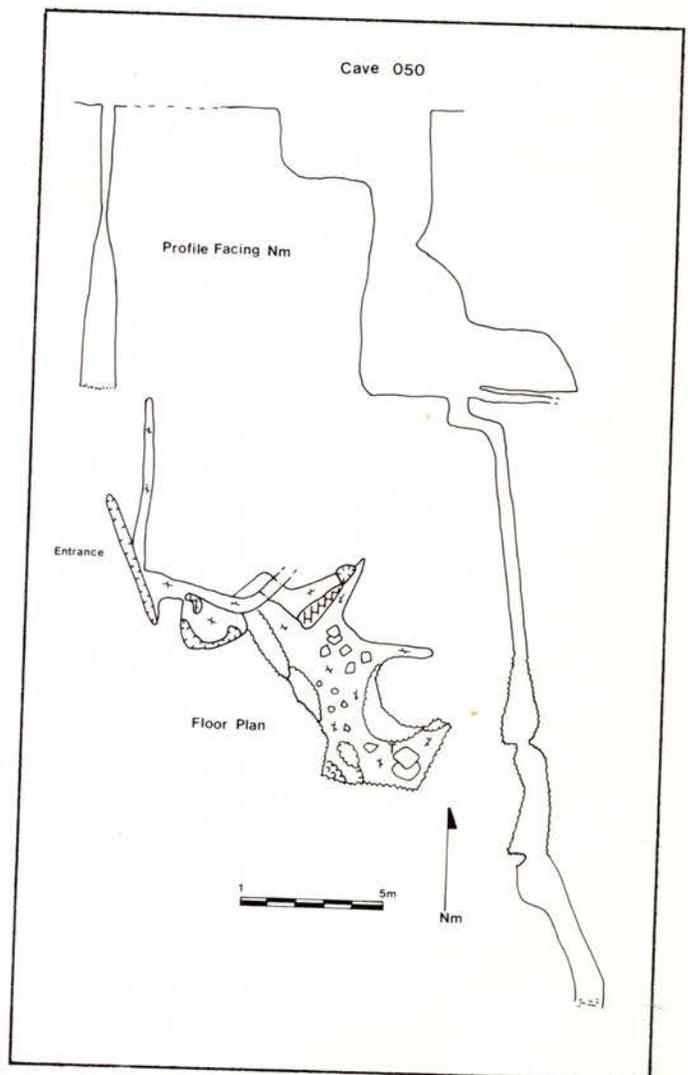
Mitigation: See the discussion of "rockpile" mitigation. Care should be taken in investigating this cave as it is known to contain bad air.

CAVE 050

Location: Coyote Creek, Calaveras County

Elevation: 475 ± 6 m (1560 ± 20 ft)

Height above Base Level: 155 ± 6 m (510 ± 20 ft)



Relation to Pool Level: The cave is located 143 ± 6 m (472 ± 20 ft) above gross pool level.

Description: Situated on the top of a karst outcrop, the long, narrow fissure entrance measures 7 m in length and 0.25 m in width. The entrance drops about 7 m into a fissure passage that leads into a 1.50 m high crawl. The crawl in turn leads to a vertical squeezeway which drops 12 m into a small, well decorated room about 3 m in width and 7 m in length. A constricted opening in the floor leads down another 7 m through a passage 1.50 m in width to a dead end.

Speleogens: Pockets and pendants were noted.

Speleothems: Flowstone, stalactites, stalagmites, draperies, cave coral, and false floors are present. Cave pearls are found in the small lower room and on a ledge 4 m above the bottom of the cave.

Hazards: The narrow vertical fissure entrance located on the top of a karst outcrop is not easily seen; however, it is very tight and a person could get lodged in the entrance.

Sediments and Stratigraphy: The sediments in the fissure passage below the entrance are light tan colored, fine-grained and intercalated with small (1 cm or less) globular pieces of rubble. In the lower room the sediments are wet, brown, and fine grained. A false floor in the lower room is older than the sediments.

Biological Observations: Epigeal salamanders were observed.

Biological Identifications:

Pseudoscorpion: *Apochthonius n. sp.*

Centipede: *Nadabius sp.*

Collembola: *Tomocerus celsus*

Spider: *Aptostichus sp.*

Liocranoides sp.

Telema gracilis

Harvestmen: *Banksula grahami*

Beetle: Pselaphidae undetermined species #1

Snails: *Monadenia mormonum mormonum*

Unidentified Fish

Unidentified Salamander—at least 3 different species represented

Unidentified Frog

Unidentified Lizard

Unidentified Snake—at least 5 different species represented

Unidentified Bird—at least 5 different species represented

Adult Western Pipistrelle Bat: *Pipistrellus hesperus*

Juvenile Ringtail: *Bassariscus astutus*

Unidentified Rodent

California Ground Squirrel: *Citellus beecheyi* (3)

Pocket Gopher: *Thomomys sp.* (6)

California Pocket Mouse: *Perognathus cf. californicus*

White-Footed Mice: *Peromyscus sp.*

Packrat: *Neotoma sp.*

Vole: *Microtus sp.*

Paleontological Observations: The fissure passage below the entrance passage is rich in small, recent vertebrate bones and snails.

Significance: This vertical cave has a well decorated and unvandalized room at the bottom. A false floor and associated sediment are an important segment of the local geological record and some undisturbed recent microfauna deposits are of value for taphonomy. A few species of pseudoscorpion were found in the cave during the present study.

Mitigation: Taphonomic collection will be required in areas of predicted caver impact, however no other active mitigation is recommended. Visitation should not be encouraged.

CAVE 051

Location: Coyote Creek, Calaveras County

Elevation: 424 ± 6 m (1390 ± 20 ft)

Height above Base Level: 70 m (230 ft)

Relation to Pool Level: The cave is located 92 m (302 ft) above gross pool level.

Description: A horizontal entrance (0.7 by 1.3 m) in a limestone outcrop slopes down 8 m to a 9 m drop through a fissure. A few meters along the fissure it drops another 4 m to the lowest level of the cave. The fissure opens into a 4 m by 8 m chamber with two low adjoining grottos.

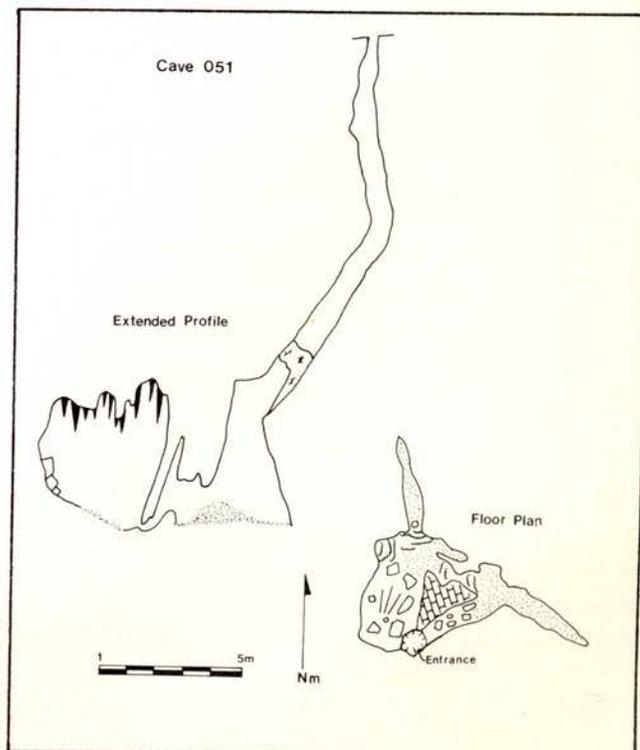
Speleogens: Vadose solution in a chalky limestone formed this cavity.

Speleothems: Draperies are the predominant feature in the lower levels while cave coral, stalactites, soda straws, and flowstones also occur.

Hazards: The vertical fissure which comprises most of the cave presents a definite climbing danger. The cave should not be entered by individuals not familiar with or not equipped to deal with vertical caving procedures.

Vandalism: Even though the entrance is not obvious in the karst hillside, the cave is heavily visited, and many formations have been chipped away to allow explorers to move more easily through the cave passages.

Sediments and Stratigraphy: Red clay forms the floor where flowstone is absent. Varying thicknesses of flowstone, 0.1 to 2 cm thick, cover red clay sediments in the lowest level. Several false floors are visible where the clay has eroded away. A snail shell 15 cm above the floor is partially embedded in a flowstone wall.



Biological Observations: Small semicolorless scorpions are reported to occur (Winterath 1970:11). Salamanders and recent rodent bones are also found in this cave. Dung occurs in many areas of the entrance passage.

Biological Identifications:

Millipede: Trichopolydesmidae unidentified species #2 (perhaps *Bidentogon* sp.)

Pseudoscorpion: *Aphrastochthonius* n. sp.
Hesperochnes mimulus
Microcreagris grahami

Spiders: *Liocranoides* sp.
Achaearanea fresno
Aptostichus sp.

Harvestmen: *Banksula* n. sp. near *melones* unidentified species #1

Collembola: *Sinella* n. sp.
Tomocerus wilkey

Diplura: Unidentified

Beetle: *Ptomaphagus nevadicus*
Leiodidae, unidentified species

Snails: *Monadenia mormonum mormonum*

Unidentified Salamander

1 Rattlesnake: *Crotalus* sp.

Weasel Family: Mustelidae sp.

Unidentified Squirrel

Unidentified Rodent (5)

1 Adult California Pocket Mouse: *Perognathus californicus*

1 Adult Dusky-Footed Packrat: *Neotoma fuscipes*

1 Bush Rabbit: *Sylvilagus* cf. *bachmani*

Paleontological Observations: Cave 051 is a vertical cave with clastic fill exposed only at the bottom. The recent surface fills are of limited extent and, although they contain relatively abundant vertebrate bone, they are unlikely to produce a very diverse fauna.

A small passage trending east off the north end of the lower level, approximately two by three meters in cross-sectional area, contains remnants of a fossiliferous breccia along its walls and ceiling. This deposit has one of the highest concentrations of fossil material encountered in the project area. It is capped above by a thin flowstone veneer. Both this flowstone and the breccia have been eroded and only a few cubic meters of breccia remain in place. Even this limited amount of matrix could produce a significant Pleistocene fauna.

Significance: Besides recreational and scenic value this vertical cave contains one of the most important vertebrate fossil localities identified in this study. Significant biota are also present in the cave and three new species of invertebrates were found.

Mitigation: Since the cave is technically several meters beyond the boundary of the recreational area, it should first be acquired for management by the BLM. A gate should be constructed at the top of the 9 m drop and traffic should be severely restricted.

CAVE 052

Location: Coyote Creek, Calaveras County

Elevation: 366 ± 3 m (1100 ± 10 ft)

Height above Base Level: 0.0 m (0.0 ft)

Relation to Pool Level: The cave is located $4+ \text{---} 3$ m (12 ± 10 ft) above gross pool level.

Description: A 60 m stream passage carried Coyote Creek in the upstream entrance and out the lower end. The underground passage averages 10 m wide and 3 m in

height. Ledges on either side can be traversed or the cave can be waded most of its length, as the water averages less than a meter deep. No parts of the cave are in total darkness. Cave 052 does not evidence indications of marble solutioning but seems to have been formed by successive build-up and undercutting of travertine.

Speleogens: Scallops are found on the walls of this cave. Pendants hang from the ceiling and joint pockets protrude up into the ceiling.

Speleothems: Flowing water has restricted some types of formation growth, but flowstone, draperies, rimstone dams and ledges, and cave coral are found in the passage.

Vandalism: Initials have been painted and inscribed on several formations and walls. Most of the delicate formations have been broken.

Sediments and Stratigraphy: Flowing water prevents fine grained sediments from being deposited. Sand is present in pockets and among cobbles on the floor.

Biological Observations: A large colony of transitory bats temporarily occupy the cave.

Significance: The cave has considerable historical significance, having been visited by Americans since before the gold rush period. The presence of mortar holes in the immediate vicinity suggests that it might have been of some value to aboriginal peoples, although this could not be substantiated. A chamber in the roof of the caves is used by a colony of transitory bats. Some taphonomic material was observed in relatively inaccessible localities in the cave. Its main significance, however, is in its recreational potential.

Mitigation: This site should be developed as a recreational location, with appropriate educational displays and similar such information apprising the public of the fragile nature of this cave as well as caves in general. This will require collection of the taphonomic material, as well as biological mitigation.

CAVE 053

Location: Coyote Creek, Calaveras County

Elevation: 366 ± 6 m (1200 ± 20 ft)

Height above Base Level: 28 ± 6 m (90 ± 20 ft)

Relation to Pool Level: This cave is located 35 ± 6 m (115 ± 10 ft) above gross pool level.

Description: Cave 053 is a sloping fissure 10 m long, 8 m tall and averaging one meter wide except for a short stretch which is only 0.4 m wide. The entrance is 0.4 m wide and 1 m tall.

Speleogens: This cave was formed by solution enlargement of a sloping bedding plane.

Speleothems: There are no formations present.

Sediments and Stratigraphy: The floor is primarily recent material from the entrance although there is some cemented fill.

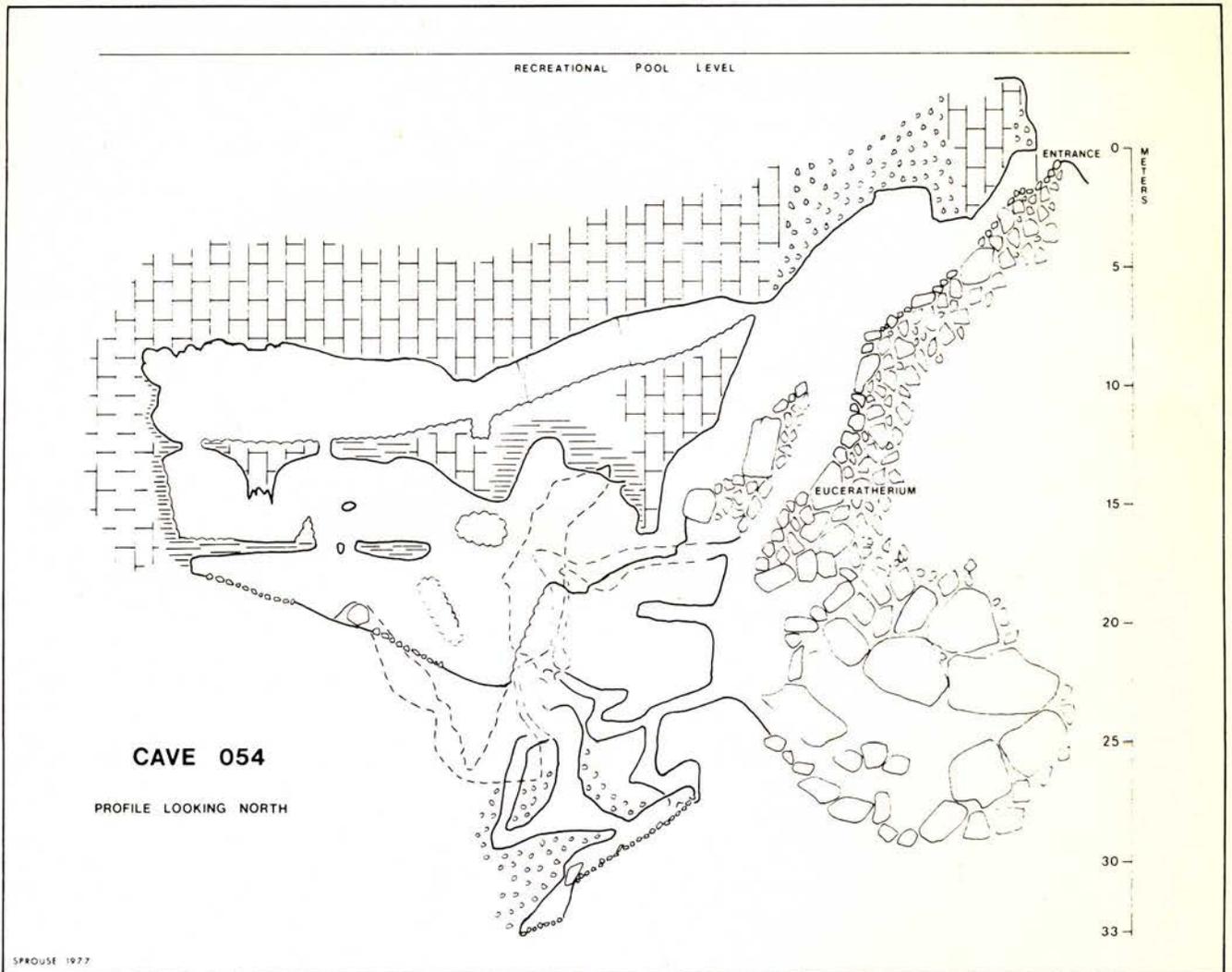
Biological Observations: The left mandible of a recent *Peromyscus* was found. Polished rock and compacted sediments from animal visitation were noted.

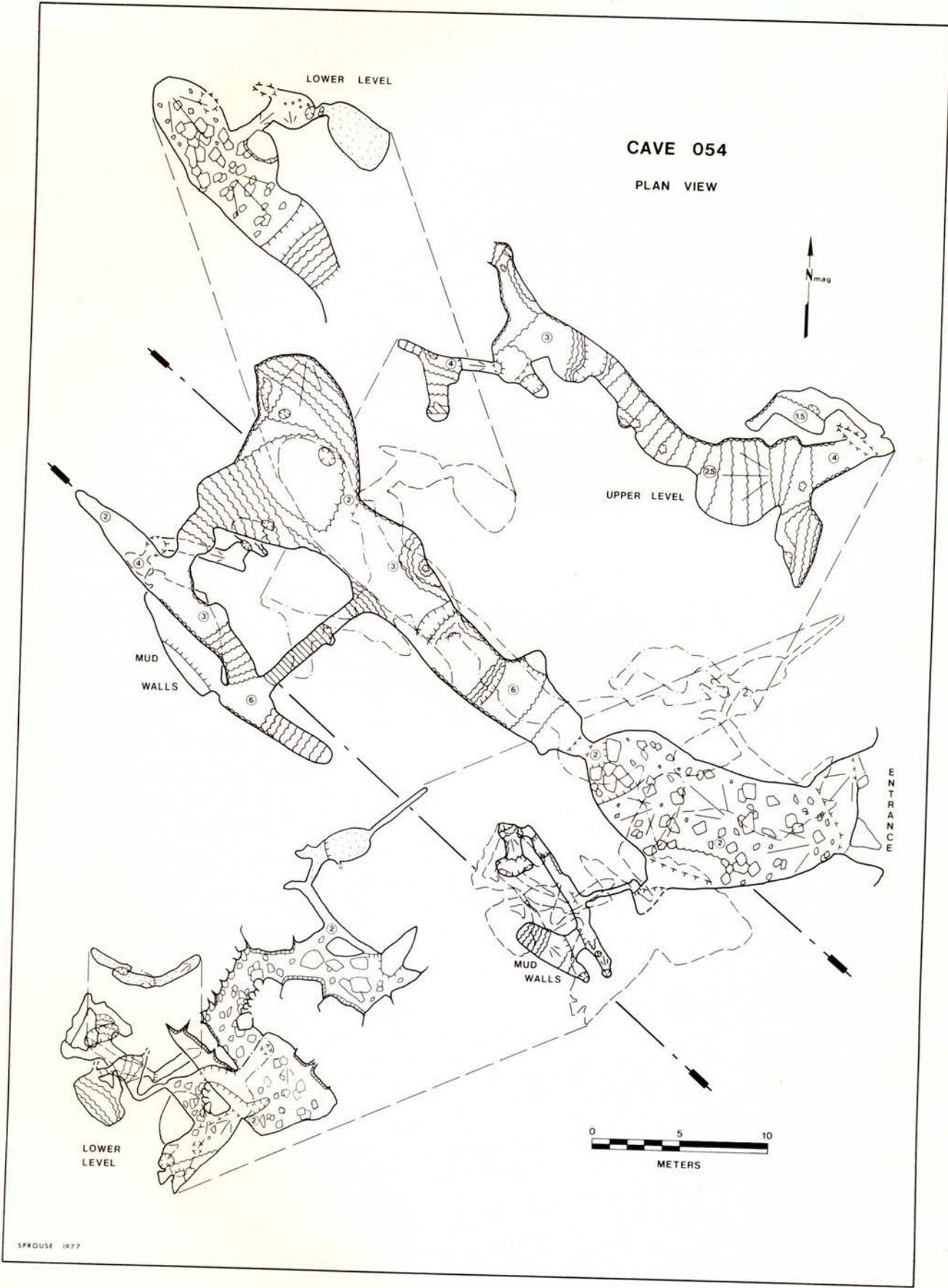
Mitigation: No active mitigation is recommended at this point.

CAVE 054

Location: Stanislaus River Canyon, Calaveras County

Elevation: 307 ± 2 m (1008 ± 5 ft)





CAVE 054
PLAN VIEW

SPROUSE 1977

Height above Base Level: 30 ± 3 m (98 ± 1 ft)

Relation to Pool Level: The cave is located 25 m below gross pool level and 4 m below recreation pool level.

Description: Two small entrances, both gated, lead to the first large chamber, 15 m long and 6 m wide. A small, short passage in the end of the first chamber intersects with a second chamber which is 25 m long and an average of 4 m wide. Each of the two primary chambers has side passages leading to smaller rooms on either side. The first chamber is divided by flowstone into rooms and levels which are interconnected where the flowstone has eroded away. Older cave sediments have been covered with flowstone in the second chamber and subsequent erosion has left large flowstone layers (false floors) suspended across the chamber.

Speleogens: Cave development is illustrated by such examples as joint pockets in the ceiling, pendants, scallops, and stream meanders.

Speleothems: This cave exhibits a broad range of calcite formations including draperies, bacon rind, travertine dams, helectites, cave coral and popcorn, stalactites and stalagmites, soda straws, dogtooth spar, gours, false floors, columns, and a wide variety of flowstone.

Hazards: Moving from one level of this cave to the next often involves climbing over dangerously exposed routes. Large, loose rocks also pose a threat to the unwary visitor in the breakdown sections of this cave. Becoming lost in the maze of passages below the first chamber is an additional potential hazard.

Vandalism: Throughout the cave broken formations were noted and paths, reflected as compacted areas of the cave, were observed. Litter, muddy handprints, and names written or incised in the formations occur in numerous areas in the cave.

Sediments and Stratigraphy: Laminated sediments of clays and sand are found at many locations in the cave. The ceiling and walls in the entrance chamber are largely breccia rather than bedrock. The false floors once covered massive amounts of intrusive deposit which has since been flushed out. Varve-like sediments occur in at least two rooms where fine clays seem to have been periodically deposited.

Biological Observations: The cave is richer in invertebrate faunal material than any other known cave within the project area. Several pseudoscorpions, a blind beetle, a likely undescribed form of centipede, a unique form of planthopper and several springtails were observed in addition to the well-known harvestman. Most of the fauna were discovered in the entrance room, where high levels of food input are combined with stable, moist environmental conditions.

Biological Identifications:

Centipede: *Arenophilus* sp.

Pseudoscorpion: *Neochthonius troglodytes*
Microcreagris grahami

Harvestmen: *Banksula grahami*
Banksula melones nes

Homopteran: Unidentified

Collembola: *Oncopodura* n. sp.
Entomobryoides sp.

Beetles: *Ptomaphagus nevadicus*
Tenebrionidae species #2

Spiders: *Telema* n. sp.
Liocranoides sp.

Snails: *Monadenia mormonum mormonum*

Unidentified Fish

Unidentified Salamander (4)

Unidentified Frog

Unidentified Snake (5)

Unidentified Bird (3)

Unidentified Bat

Unidentified Rodent

Adult Big-Eared Bat: *Myotis* sp.

Adult Big Brown Bat: *Eptesicus fuscus*

Pocket Gopher: *Thomomys* sp.

Adult Pocket Mouse: *Perognathus* sp.

California Pocket Mouse (2): *Perognathus californicus*

Western Harvest Mouse: *Reithrodontomys megalotis*

White-Footed Mouse: *Peromyscus* sp.

Packrat: *Neotoma* sp.

Dusky-Footed Packrat: *Neotoma fuscipes*

Vole: *Microtus* sp.

Paleontological Observations: Different paleontologic data were obtained in three distinctly different areas of Cave 054. The portion of the cave farthest from the entrance on the upper level is most impacted by visitors, but it possesses little if any paleontological potential. Surfaces in this part of the cave consist of limestone and marble bedrock and thick layers of flowstone. No bone at all was observed in this part of the cave.

The lower levels of the cave, entered via a chimney along the west wall of the entrance room, are formed mostly of large breakdown blocks and are generally floored by unconsolidated silt-to-cobble-sized material which has fallen from above. These fills are partially disturbed due to modern human activity. They contain little bone, and no good evidence for *in situ* deposits. The entrance room, several rooms directly off the entrance room, the area around the cave entrance itself, and several areas along the trail leading to the entrance contain a variably cemented cave-fill breccia. One tooth from a *Euceratherium*—the extinct Pleistocene shrub ox originally described from Samwel Cave in Shasta County—was identified in the unconsolidated fill of the entrance room. This tooth and other fossil remains have evidently weathered out of the breccia walls and mixed with the sediments and Holocene faunal remains on the floor. The breccias both inside and outside the cave thus contain many vertebrate fossils and represent a significant source of Pleistocene material.

Rich taphonomic assemblages at several locations in the cave will also provide important clues to the modes of accumulation of contemporary faunal remains, thus aiding in the paleoecological interpretation of the older faunas. Some of these concentrations contain a considerable range of identifiable vertebrate taxa.

Paleontological Identifications:

1 Extinct Shrub Ox: *Euceratherium*

Significance: This cave is the largest and most complex known within the project boundaries, and is also one of the most popular recreational caves in the region. Although the cave has suffered considerably from accelerated vandalism in the last few years, many areas still exist that are esthetically significant, and a wide variety of speleothems and other cave formations are still extant. A number of invertebrate taxa are known for the cave, and are believed to compose an important, complex, and unique ecosystem. Paleontological and taphonomic materials of considerable importance are known in the cave, and the geological history manifested by the sedimentary record is of great significance.

Mitigation: Since at times the cave will be completely inundated, mitigation studies must take into account the

total data base identifiable as being significant. Mitigative research must be done for the cave biota, the paleontological and taphonomic materials, and the geology. Further discussion of this issue appears in the mitigation and scheduling sections of the report.

CAVE 055

Location: Stanislaus River Canyon, Calaveras County

Elevation: 330 ± 10 m (1085 ± 40 ft)

Height above Base Level: 42 m (138 ft)

Relation to Pool Level: The cave is located 1 m (3 ft) below gross pool level.

Description: A 1 m high and 30 cm wide entrance leads to a small room 1 m wide and 2 m long. Two narrow horizontal extensions lead from this room for about 1 m each. The cave is developed in a fissure that extends upward for about 10 m where it is plugged by flowstone and earth.

Speleogens: Boxwork is present.

Speleothems: Flowstone, stalactites, draperies and popcorn decorate the cave.

Sediments and Stratigraphy: The flowstone is covered with small mammal dung, a few rocks and fine sediments. Older breccia is found in the fissure.

Biological Observations: The cave is floored with animal dung. Snails are common and vertebrate remains (including snake) are present.

Biological Identifications:

1 Western Rattlesnake: *Crotalus cf. viridis*

Snails: *Monadenia mormonum mormonum*

Paleontological Observations: A small amount of bone was present in the breccia.

Mitigation: Geological and taphonomic mitigation are recommended as this cave will be inundated.

CAVE 056 (Ca-Tuo-774)

Location: Stanislaus River Canyon, Tuolumne County

Elevation 287 ± 3 m (943 ± 10 ft)

Height above Base Level: 4 m (13 ft)

Relation to Pool Level: The cave is 45 m (156 ft) below gross pool level.

Description: An entrance with a low ceiling in the side of the cliff leads to 8 m of passage which terminates at the back of the cave. At no point is the ceiling more than 1 m in height. One meter inside the cave the passage turns downstream for 4 m and then continues for 4 m perpendicular to the river.

Speleogens: A ceiling joint is present which runs parallel to the entrance 0.75 m inside the cave.

Speleothems: A small amount of cave coral was noted.

Sediments and Stratigraphy: Sand and river-derived cobbles are present on the lowest levels of the floor of the entrance room.

Archaeological Observations: One bedrock mortarhole is located inside of the entrance at the upstream (north) end. Two pestle-hammerstones were noted in close proximity to the mortarhole. Two low dry-laid rock walls are also in the entrance room. Although the walls probably date to the historic period, the mortarhole attests to the fact that the shelter was used aboriginally.

National Register Eligibility: Yes

Significance: The cave shows signs of aboriginal occupa-

tion as well as Euro-American use. Differential use patterns should be examined.

Mitigation: A sample of the deposit should be excavated and the features mapped. Archaeological, historical, and geological study is therefore suggested.

CAVE 057

Location: Coyote Creek, Calaveras County

Elevation: 457 m (1500 ft)

Height above Base Level: The cave is located 126 m (412 ft) above gross pool level.

Description: The cave was not visited during the project. However, several attempts were made to determine its location. It has been described by Squire (1972) as a small cave located in the "rockpile".

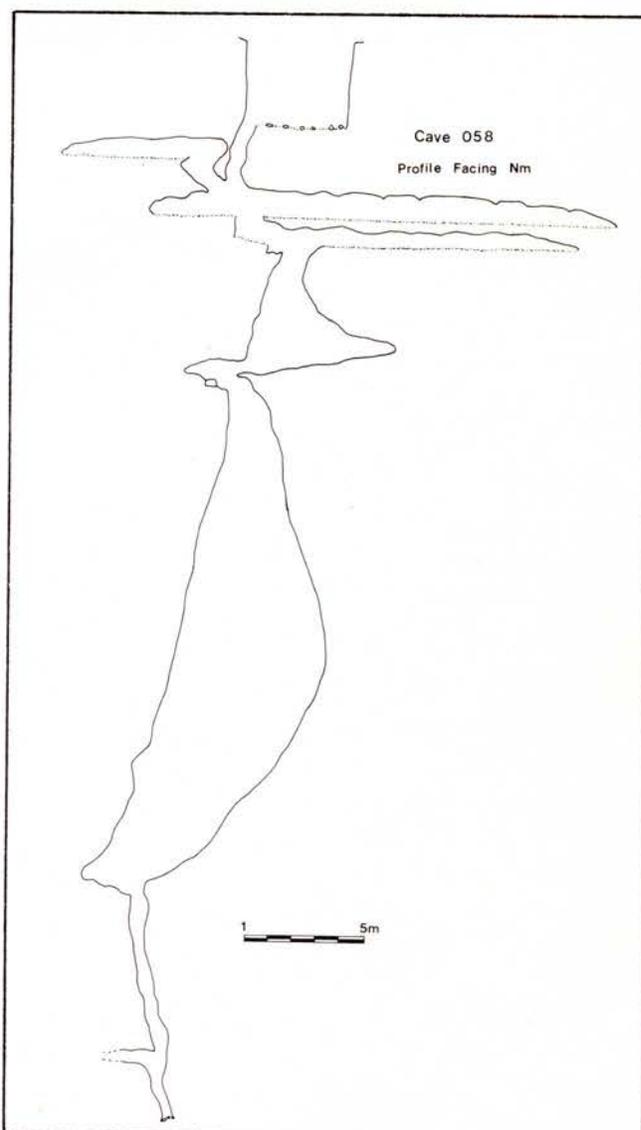
Mitigation: No active mitigation is recommended at this time.

CAVE 058

Location: Coyote Creek, Calaveras County

Elevation: 475 ± 6 m (1560 ± 20 ft)

Height above Base Level: 155 ± 6 m (510 ± 20 ft)



Relation to Pool Level: The cave is located 143 ± 6 m (472 ± 20 ft) above gross pool level.

Description: The horizontal fissure entrance, measuring 1 m in width and 4 m in length, is located along the top of a karst outcrop. A climb down of about 15 m leads to a room 5 m in length and 3 m in width with two long, phreatic, elliptical passages extending from the room for 22 and 12 m. A short crawlway connects another small room 3 m in length and 3 m in width with a long "L" shaped side passage 19 m in length. An angled opening leads to a sloping fissure passage 7 m in width but only 0.40 to 0.70 m in height. At the bottom of this passage is a hole, excavated through fine sediments and gravel, that leads down a tight fissure passage for another 7.50 meters.

Speleogens: The cave exhibits elliptical tubes and pendants. Several passages contain huge bedrock pendants, a good example of phreatic cave formation.

Speleothems: Flowstone, stalactites, and cave coral are present.

Vandalism: Recent names and dates have been written on the cave wall over historic signatures dating to 1851.

Hazards: The cave has a vertical fissure entrance.

Sediments and Stratigraphy: The floors of the upper level rooms consist of fine, dry, reddish-brown sediments. False floors also occur. The lower tight fissure passages contain gravel and fine sediments.

Biological Observations: One big-eared bat was seen in a side passage.

Biological Identifications:

Isopod: *Brackenridgia heroldi*

Centipede: *Taiyuna* sp.

Pseudoscorpion: *Apochthonius* n. sp.
Aptostichus sp.

Spiders: *Telema gracilis*

Aptostichus sp.

Harvestmen: *Sitalcina sierra sierra* (epigeal)

Collembola: *Tomocerus celsus*

Beetle: *Anillus* (9)

Pselaphidae sp. #1 (11)

Snails: *Pristiloma subrupicola spelaeum*

Paleontological Observations: Occasional bones and bone fragments of recent vertebrate fauna were noted.

Significance: The sediments in the cave, which include false floors, are important geological records of the Quaternary period of the area. The cave contains an unusual biota which includes four different species of pseudoscorpions, one of which is a new species. Historic signatures in the cave date from the Gold Rush.

Mitigation: No mitigative measures are recommended at this time.

CAVE 059 (Ca-Tuo-775)

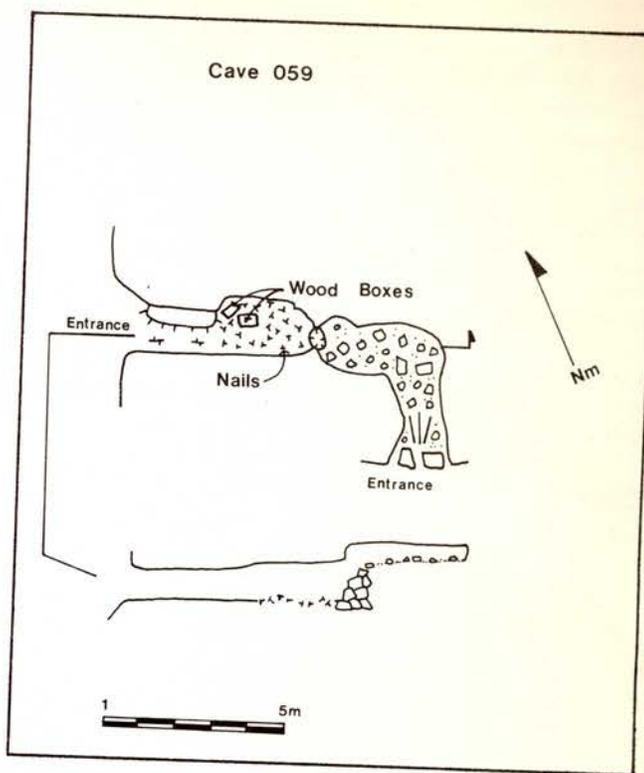
Location: Stanislaus River Canyon, Tuolumne County

Elevation: 283 ± 1 m (930 ± 3 ft)

Height above Base Level: The cave is located 28 m (93 ft) below recreation pool level.

Description: The 1 m high by 2 m wide entrance is in the side of a small cliff face. The entrance passage extends 6 m to a hole in the ceiling where the passage continues 4 m further. It is characterized by a 0.4 m high ceiling over a floor of breakdown. A gentle upward slope in the back leads 4 m to a second small entrance.

Speleogens: The passage is developed along structural



planes dipping to the north. Veins of a mineral (possibly calcite) protrude the ceiling. Scallops in the walls ranging from 5 to 50 cm across indicate fast moving water was important in the development of the cave.

Vandalism: All calcite extrusions protruding from the ceiling have been broken off.

Sediments and Stratigraphy: River-derived sand and small gravels cover the floor.

Archaeological Observations: Several thousand square nails ranging from 8 to 16 cm long were scattered over the floor in the last 3 m of the entrance passage (Fig. 18). Several bolts approximately 30 cm long with square heads and nuts are interspersed throughout the square nails. Wire nails are also present. Two wooden boxes are lying on top of the nail scatter.

Significance: Miners apparently used this cave for storage (Moratto 1976:174; Squire, n.d.). Collection of the artifacts could verify this fact as well as securely date the depositional events.

National Register Eligibility: Yes

Mitigation: The square nails cover an area of 4 sq m to a depth of 0.2 m in the back of the entrance passage. Removal of all the nails may expose any other material cached in the cave. Limited excavation of the deposit below the nails will indicate the extent of previously unrecognized use of the cave.

CAVE 060

Location: Grapevine Gulch, Calaveras County

Elevation: 366 ± 2 n (1200 ± 6 ft)

Height above Base Level: 91 ± 2 m (300 ± 6 ft)

Relation to Pool Level: The cave is located 34 ± 2 m (112 ± 6 ft) above gross pool level.

Description: The 3 by 1 m high entrance leads to a single passage 4 m long. The passage is divided horizontally by a

13 by 0.1 m thick false floor extending about 2 m into the cave from the entrance.

Speleothems: Cave coral and flowstone are present.

Sediments and Stratigraphy: The floor is a loose, light brown soil. Some breakdown also occurs on the floor.

Biological Observations: Snail shells occur on the brown soil floor.

Significance: The cave is currently in use as an animal den and would provide information useful for taphonomy. The sediments and false floor in the cave are important remnants of the Quaternary geological record.

Mitigation: Some limited surface collections of taphonomic materials might be necessary; otherwise no active mitigation measures are recommended.

CAVE 061

Location: Stanislaus River Canyon, Calaveras County

Elevation: 286 m (940 ft)

Height above Base Level: 20 m (65 ft)

Relation to Pool Level: The cave is located 25 m (81 ft) below recreation pool level.

Description: A small entrance, 1 by 0.5 m, in the base of a cliff opens into a 4 m long passage 1 m wide. The back of the passage widens to 2 m and it is possible for 1 person to sit up in the small room.

Speleothems: Cave coral is present.

Sediments and Stratigraphy: The floor consists of a firmly packed red clay.

Biological Observations: Small mammal dung and snail shells were present.

Mitigation: No further study is recommended for this cave.

CAVE 062

Location: Coyote Creek, Calaveras County

Elevation: 476 ± 12 m (1560 ± 40 ft)

Height above Base Level: 155 ± 12 m (510 ± 40 ft)

Relation to Pool Level: The cave is located 144 ± 12 (472 ± 40 ft) above gross pool level.

Description: The 0.3 by 1 m entrance leads into a fissure filled with soil and breakdown.

Speleothems: Cave coral was noted.

Sediments and stratigraphy: Recent brown organic soil is present.

Paleontological Observations: Snail shells occur in the cave.

Mitigation: No further study is recommended at this site.

CAVE 063

Location: Stanislaus River Canyon, Calaveras County

Elevation: 365 ± 24 m ($1200^+ - 80$ ft)

Height above Base Level: 97 m (320 ft)

Relation to Pool Level: The cave is located 34 m (112 ft) above gross pool level.

Description: The cave is a horizontal fissure which has been plugged with breakdown along the top. The entrance is on a steeply sloping hillside overlooking the river. Moss and poison oak cover the area just outside the entrance.

The entrance is 1.5 m wide and 3 m high with a floor composed of large breakdown blocks which proceeds for about 4 m to a room which also has a breakdown floor. The room is about 4 m high, 4 m long, and 4 m wide. At one edge of this room a small passage drops down about 2.5 m through the breakdown to a passage 1 to 2 m wide, 3 m high and 11 m long. At the end of this passage a tight squeeze leads to the final chamber, a small room 4 m long, 2 m wide and 1 m high.

Speleothems: Cave coral is present.

Sediments and Stratigraphy: The entrance area of the cave is covered with large breakdown blocks. The floor in the back portion has light brown soil intercalated with small angular rocks and an occasional larger piece of breakdown.

Biological Observations: The last room contained small

Biological Observations: In the passage leading to the back of the cave a single bat was noted on the wall. Several millipedes were also in the passage. Mammal dung was noted in the last room in the cave as well.

Paleontological Observations: The last room contained small bones and snail shells mixed with the floor deposit.

Mitigation: Some taphonomic surface collections may be required. Otherwise, no active mitigation measures are recommended at this time.

CAVE 064

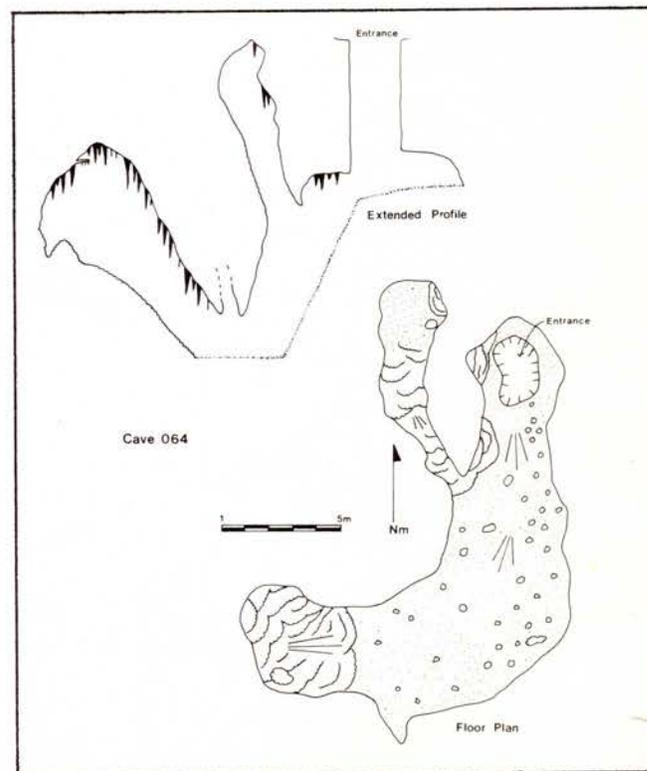
Location: Skunk Gulch, Calaveras County

Elevation: 536 ± 3 m (1760 ± 10 ft)

Height above Base Level: 280 ± 3 m (920 ± 10 ft)

Relation to Pool Level: The cave is located 205 ± 3 m (672 ± 10 ft) above gross pool level.

Description: Cave 064 has a large entrance pit measuring 3 m in length, 2 m in width and 7.5 m in depth. A large



room extends from the pit entrance, the former of which measures 9 m in height and 6 m in width at the widest point. The large room is heavily decorated with formations and has two unexplored ceiling passages. A small upward sloping passage extends 15 m from the large room and is about 2 m wide. This latter passage is also well decorated.

Speleogens: Pendants are present.

Speleothems: The large room is well decorated with stalactites, stalagmites, draperies, cave coral, soda straws, helectites, one canopy, and flowstone. A large stalagmite is present measuring 2.5 m in height and 1.5 m in diameter.

Vandalism: Approximately 35% of the stalactites are broken. Mud has been tracked onto flowstone slopes.

Hazards: The cave has a large pit entrance 7.5 m deep.

Sediments and Stratigraphy: A deep deposit of reddish-brown soil and some breakdown blocks cover the floor of the entrance and large room. The deposit is noted to be eroding out from under flowstone in one area. The sloping passage is also mantled by a reddish soil which appears to be coming in from above. There are also many roots in the ceiling of this passage.

Paleontological Observations: Bones of recent mammals occur in the deposit. No other bone was noted, but buried deposits are possible as the matrix appears to be deep.

Significance: The cave contains many beautiful formations and is esthetically significant. The deep sediments present in the cave are also a significant part of the geological record, and may contain important faunal resources.

Mitigation: Since entry requires knowledge of rope climbing techniques and many fragile formations are present, both irresponsible and inexperienced visitation should be actively discouraged.

CAVE 065

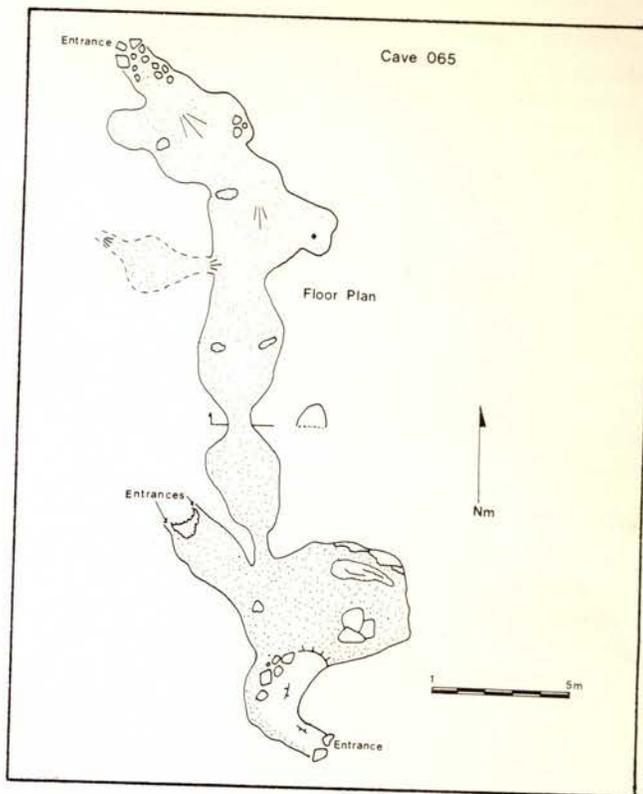
Location: Grapevine Gulch, Calaveras County

Elevation: 551 ± 12 m (1790 ± 40 ft)

Height above Base Level: 271 m (890 ft)

Relation to Pool Level: The cave is located 214 m (702 ft) above gross pool level.

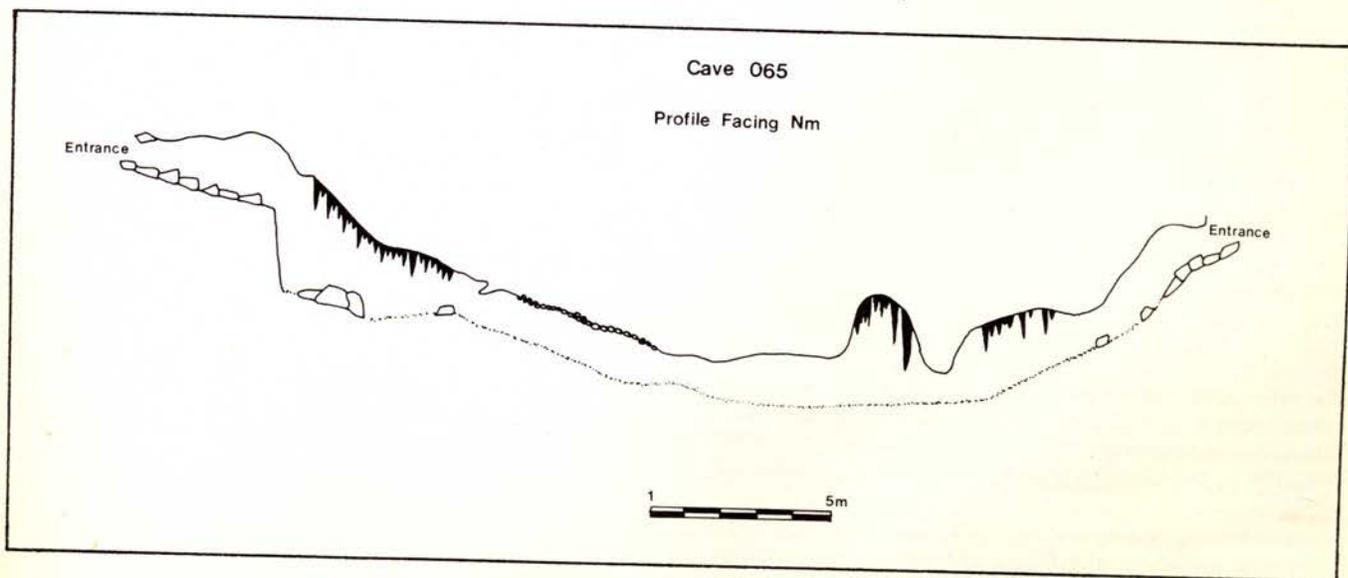
Description: The cave has an entrance at either end. From the north entrance a breakdown slope leads into a 4 m wide by 1.5 m high room with a sloping dirt floor. This



connects with another room 3 m wide which has a small entrance. The room continues for about 7 m, then narrows. A small crawl leads into another room which connects with another crawlway to the southern entrance room. This latter chamber is 7 m wide, 4 m long, and 3 m high. A flowstone and dirt slope leads up to the northern entrance and a breakdown and dirt slope leads to the south entrance.

Speleothems: The cave contains flowstone, draperies, stalactites, stalagmites, columns, cave coral, and false floors.

Sediments and Stratigraphy: The floor is covered with brown soil which in some places buries the ends of stalagmites and draperies. Breccia occurs on the ceiling in the middle crawlway.



Vandalism: Some of the speleothems have been broken.

Biological Observations: Vertebrates observed included California newts and Myotis bats. Porcupine dung and quills were also noted.

Biological Identifications:

Spiders: *Chasmocephalon shantzi*

Collembola: *Dicyrtoma marmorata*

Pterostichus cf. vicinus

Carabidae unidentified species

Paleontological Observations: Small mammal bones were noted scattered on the dirt floor.

Significance: False floors, breccia, and deep sediments found in the cave are an important part of the geological record. Some taphonomic value exists as well.

Mitigation: Within the indirect impact area, this cave will require limited taphonomic mitigation.

CAVE 066

Location: Grapevine Gulch, Calaveras County

Elevation: 588 ± 5 m (1930 ± 15 ft)

Height above Base Level: 314 ± 5 m (1030 ± 15 ft)

Relation to Pool Level: The cave is located 257 ± 5 m (842 ± 15 ft) above gross pool level.

Description: This cave has a small entrance 1 m wide and 50 cm in height. The entrance widens into a vertical drop 8 m in depth. The drop leads to a chamber 7 m in width and 5 m in length. A small passage slopes downward 4 m to a dry sump.

Speleogens: The cave exhibits pendants and joint pockets.

Speleothems: The cave is well decorated with flowstone, stalactites, stalagmites, serrated draperies, helictites, and rimstone dams. One column measures 2 m in height.

Hazards: The small unobtrusive entrance could be a potential danger as it opens immediately into a 8 m deep drop that cannot be climbed without technical assistance.

Vandalism: The vandalism includes some broken stalactites and graffiti on cave walls.

Sediments and Stratigraphy: Cave sediments consist of fine, black soils. Tree roots are growing through joints in the ceiling. A false floor is present, underlain by a breccia with calcite matrix.

Paleontological Observations: This cave would appear to be a natural trap, but due to its small entrance and the presence of several fissures at the bottom allowing small animals to escape from the interior, it is not currently functioning in that capacity. The debris cone below the entrance does contain moderately abundant small vertebrate remains, but most are completely disarticulated and appear to have been washed into the cave via the several narrow soil-clogged fissures which clearly conduct water into the cave during storms. The debris cone may be several meters in depth and could contain significant fossil deposits near the bottom, but this possibility could not be evaluated without extensive testing. The young flowstone cascade which mantles the clastic fills on the south side of the main room presumably covers a debris cone which could contain older deposits than the one currently developing, but again, excavation would be necessary to determine the paleontological potential of this part of the cave as well.

Significance: This small but well decorated cave has deep sediments including false floors, breccias, and vertebrate

remains, all of which form an important part of the geological and taphonomic record.

Mitigation: Due to the hazardous entrance drop the cave should be gated. Visitation should not be encouraged.

CAVE 067

Location: Stanislaus River Canyon, Tuolumne County

Elevation: 298 ± 5 m (978 ± 15 ft)

Height above Base Level: 18 ± 3 m (59 ± 10 ft)

Relation to Pool Level: The cave is located 13 m (43 ft) below recreation pool level.

Description: The entrance to this cave is 1.5 by 2 m wide and is located above a talus slope on a sheer cliff face. A narrow calcite band 2 cm wide protrudes 15 cm from the center of the ceiling for 7 m - the length of the cave - leaving a meter wide passage on either side. Stalactites formed along the vertical joint containing the calcite band as well as other areas.

Speleogens: This is a joint-controlled phreatic solution tube exposed by the downcutting of the Stanislaus River.

Speleothems: Two dry rimstone dams contain cave pearls. Stalactites hang from the calcite vein and from other areas of the ceiling.

Sediments and Stratigraphy: The floor is composed of a fine white calcite sand cementing together small fragments of breakdown. Three levels of calcite shelves protruding from the walls indicate past water levels.

Biological Observations: Piles of recent bat guano indicate that this cave is a migratory roosting location. Scattered feathers near the entrance indicate that other avifauna also use the cave.

Paleontological Observations: A badly fractured snail shell is cemented into the wall 0.3 m above the floor.

Mitigation: In the direct impact zone, this cave should be subjected to minimal taphonomic, geological and paleontological mitigation.

CAVE 068

Location: Stanislaus River Canyon, Tuolumne County

Elevation: 298 ± 3 m (980 ± 10 ft)

Height above Base Level: 279 m (915 ft)

Relation to Pool Level: The cave is located 12 ± 3 m (41 ± 10 ft) below recreation pool level.

Description: A 0.3 by 1 m entrance fissure at the base of a cliff opens into a small room 5 by 6 meters. A very tight squeeze at the top of the room leads into a larger terminal room 8 by 12 meters. The entrance side of the room is massive flowstone-covered breakdown. The ceiling slants down and the lower half of the room is a low crawl. This room ends with a dirt slope emerging from a small speleothem-barred passage.

Speleogens: There are many ceiling pendants of chert in the terminal room. The sloping ceiling is structure-controlled.

Speleothems: There are many speleothems, most of which are pure white calcite. Some exhibit faceting. Types include flowstone, rimstone dams, draperies, stalactites, columns, soda straws, and cave coral.

Sediments and Stratigraphy: Most of the floor is flowstone-covered; river sand is present in the terminal room at the base of the breakdown. Soil is apparent in a small lead in

the back of the terminal room.

Biological Observations: Small deposits of scat are located at various spots in the terminal room.

Paleontological Observations: Small bones and bone fragments are scattered about the terminal room in local concentrations.

Mitigation: Photographic recording and geological and taphonomic collecting are recommended for this cave.

CAVE 069 (Ca-Tuo-776)

Location: Stanislaus River Canyon, Calaveras County

Elevation: 291±3 m (955±10 ft)

Height above Base Level: 10 m (33 ft)

Relation to Pool Level: The cave is 20±3 m (66±10 ft) below recreation pool level.

Description: A 1.5 by 0.5 m entrance 2 m from the base of the cliff leads to a small 0.5 to 0.5 m passage which angles up for 11 m and ends.

Speleogens: Ceiling pendants were noted.

Speleothems: Flowstone, false floors, and popcorn were noted.

Vandalism: A 1946 signature is written on the wall.

Sediments and Stratigraphy: The floor is covered with fine gray sediments. Near the entrance a false floor was noted.

Biological Observations: The cave was inhabited by a vulture when visited by the survey.

Paleontological Observations: Small vertebrate bones and snail shells were noted near the entrance.

Archaeological Observations: The cave could have been a calcite quarry site as flowstone has been broken from a false floor. The ceiling has a black stain that could be soot.

Significance: The cave has a blackened ceiling and a false floor which appears to have been broken as the result of quarrying in prehistoric times.

National Register Eligibility: Yes

Mitigation: The blackened material on the cave ceiling should be examined for chemical constituents, and samples of the quarry remains collected for analysis. Both archaeological and geological data study will be required.

CAVE 070

Location: Stanislaus River Canyon, Calaveras County

Elevation: 299 m (980 ft)

Height above Base Level: 32 m (105 ft)

Relation to Pool Level: The cave is located 12 m (41 ft) below the recreational pool level.

Description: This cave has 3 small entrances in the base of a cliff. The lower entrance is 1.6 by 0.7 m and opens into a sloping passage 4 m long and 1 m high. This short passage ends at a tight hole that leads into a small room which can also be seen through the middle entrance (which is too small to enter). The tightest entrance is a round hole 0.8 m in diameter that drops 4 m into a fissure with a dirt floor. A very small passage slants down and connects with the middle room.

Speleogens: The cave is developed along fissures and bedding planes.

Speleothems: Cave coral was noted.

Sediments and Stratigraphy: Brown earth-fill composed the

floor of the cave.

Biological Observations: Snail shells were present.

Mitigation: No further study is recommended for this cave.

CAVE 071

Location: Stanislaus River Canyon, Calaveras County

Elevation: 309±3 m (1015±10 ft)

Height above Base Level: 20±3 m (65±10 ft)

Relation to Pool Level: The cave is located 2±3 m (6±10 ft) below recreational pool level.

Description: The 1 m wide and 3 m high entrance is located on a fissure with a 15° dip. A crawlway about 1 m in diameter slopes slightly upward for about 8 m before turning sharply upward into a series of chimneys and ledges.

Speleothems: The cave exhibits cave coral, stalactites, soda straws, one small column and flowstone.

Biological Observations: There is evidence of habitation of the cave by a medium-sized mammal.

Significance: The cave is presently being used as a carnivore den and could be important in the study of taphonomy.

CAVE 072

Location: Coyote Creek, Calaveras County

Elevation: 433±6 m (1420±20 ft)

Height above Base Level: 79 m (260 ft)

Relation to Pool Level: This cave is located 101 m (332 ft) above gross pool level.

Description: The small breakdown entrance measuring 60 cm in length and 50 cm in width leads down a sloping passage 7 m in length to a small room with a ceiling height of 5 meters. A tight crawlway leads to another room 2 m in width and 2.5 m in height.

Speleogens: The cave exhibits joint pockets and domes.

Speleothems: The cave is heavily decorated with stalagmites, stalactites, cave coral, draperies, soda straws and flowstone. One stalagmite measures 1 m in height.

Vandalism: A few broken formations were noted in the sloping entrance passage and the lower room.

Sediments and Stratigraphy: From the upper sloping passage to the lowest room, all the floors are dark reddish-brown soil of unknown depth. Roots were also present in the cave.

Biological Observations: A dead white-footed mouse was found on the floor at the bottom of the sloping entrance passage. Dung of approximately 2 cm in length and 0.05 cm in width was found and is likely to be procupine. Quills were also present in the cave.

Biological Identifications:

Pseudoscorpion: *Hesperochnes mimulus*

Spiders: *Physocylus californicus*

Psilochorus sp.

Achaearanea fresco

Beetle: *Nicrophorus nigrita*

Pselaphidae (1) unidentified

Tenebrionidae unidentified

Eleodes undetermined species #1

Paleontological Observations: Recent microfaunal remains were in the soil. Two innominate of approximately 4 cm in length were found at the bottom of the sloping entrance passage.

Speleogens: Pendants and elliptical passages are present.
Speleothems: Stalactites, stalagmites, cave pearls, cave coral, draperies, and flowstone were noted.

Vandalism: Initials are inscribed near the cave entrance. Plugs blocking passages have been excavated.

Hazards: The cave is essentially vertical and is quite deep.

Sediments and Stratigraphy: The sediments include reddish soil with some intermixed gravel.

Biological Observations: Invertebrate fauna were concentrated in the entrance area.

Biological Identifications:

Isopod: *Brackenridgia heroldi*

Millipede: Systodesmidae undetermined species

Collembola: *Sinella n. sp.*

Tomocerus wilkey

Pseudoscorpion: *Neochthonius troglodytes*

Neochthonius sp.

Microcreagris grahami

Spiders: *Liocranoides sp.*

Dipluran: Unidentified

Beetle: Pselaphidae sp. #1

Centipede: *Oabius sp. cf. patonius*

Snail: *Monadenia mormonum mormonum*

Paleontological Observations: Microfauna in the process of becoming cemented in flowstone can be seen in the cave.

Significance: This cave is one of the deepest caves in the project area and has some recreational potential. Some spectacular speleothems are present and the cave supports a rich biota including a new species of collembola.

Mitigation: Irresponsible visitation should not be encouraged due to the hazardous vertical nature of the cave. No mitigative measures are recommended at this time.

CAVE 074

Location: Stanislaus River Canyon, Calaveras County

Elevation: 280±3 m (920±10 ft)

Height above Base Level: 14±3 m (45±10 ft)

Relation to Pool Level: The cave is located 31±3 m (101±10 ft) below recreational pool level.

Description: Cave 074 is located on a sheer cliff overlooking the Stanislaus River. The entrance measures 1.5 m in height and 4 m in width. The cave is a solution pocket with a flat floor and flowstone covered ceiling which meets the floor 1.5 m from the entrance.

Speleothems: The cave exhibits stalactites, stalagmites, a rimstone dam, and 7 layers of false floors.

Sediments and Stratigraphy: The false floors are laminated with sediments 2 to 10 cm thick. On top of the false floor is a layer of loose gravel.

Biological Observations: Mammal dung occurs in the cave. Recent microfauna bones are present on the gravel floor.

Significance: Seven layers of false floors separated by layers of sediments are a unique part of the local geological record. Taphonomic significance is also exhibited.

Mitigation: A sample from each of the false floors should be recovered and dated. Taphonomic collection is required as well, since this cave will be inundated.

CAVE 075

Location: Stanislaus River Canyon, Tuolumne County

Elevation: 351±12 m (1150±40 ft)

Height above Base Level: 23 m (75 ft)

Relation to Pool Level: The cave is located 10 m (62 ft) above gross pool level.

Description: The 1 m high 1 m wide entrance leads to a well-decorated crawlway extending 10 m into the hillside.

Speleothems: The cave exhibits flowstone, stalactites, stalagmites, draperies, columns, and cave coral.

Sediments and Stratigraphy: Fine sediments present on the surface are younger than the flowstone.

Biological Observations: Vertebrate microfauna, small dung, and snail shells were noted on the floor of the deposit.

Mitigation: No active study is recommended for this cave at this time.

CAVE 076

Location: Stanislaus River Canyon, Calaveras County

Elevation: 338±6 m (1110±20 ft)

Height above Base Level: 60±6 m (200±20 ft)

Relation to Pool Level: The cave is located 6±60 m (20±20 ft) above gross pool level and 27±6 m (89±20 ft) above recreational pool level.

Description: A huge slab of limestone slid down and away from the remaining bedrock forming a cavity which was enlarged by solution. The cave itself is manifested as a 2 m high by 0.5 m wide crack at the base of a steep cliff, which allows access to a flat floored chamber 2 by 3 m long. This chamber is one meter in height.

Speleothems: Cave coral is present.

Biological Observations: Porcupine dung litters the floor.

Significance: This small cave is presently being used as a porcupine den and would be important for taphonomic studies.

Mitigation: Aside from the implementing of surface taphonomic collections, the cave is not recommended for further mitigation at this point.

CAVE 077 (Tuol-S-18)

Location: Stanislaus River Canyon, Tuolumne County

Elevation: 351±12 m (1150±40 ft)

Height above Base Level: 23 m (75 ft)

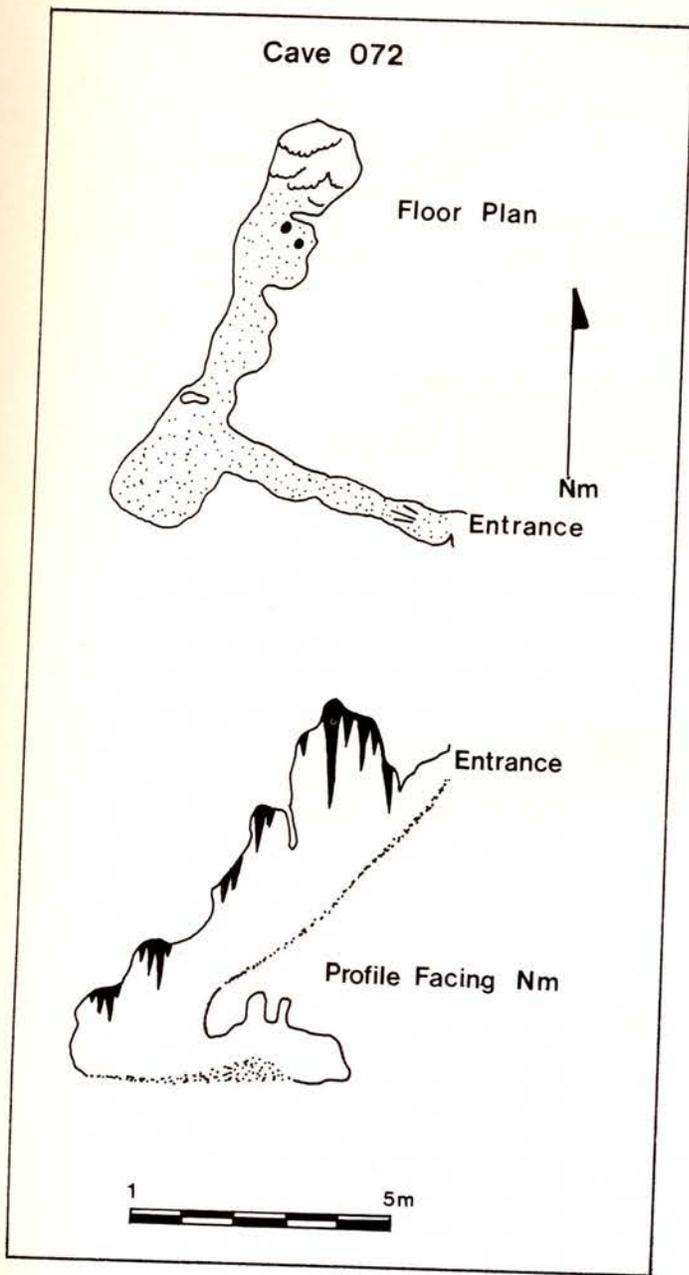
Relation to Pool Level: The cave is 40 m (130 ft) above recreation pool level and 19 m (62 ft) above gross pool level.

Description: A small 0.5 m entrance leads to a small room 1.5 by 1.5 m which joins a sloping passage dropping into a 5 m pit. At the bottom is a well-decorated 5 by 5 m room containing a pool of water. A small passage from here connects with another small room.

Speleogens: Joint pockets in the ceiling indicate some phreatic development.

Speleothems: The largest room is profusely decorated with such formations as helectites, stalactites, stalagmites, rimstone dams, serrated draperies, soda straws, and columns.

Hazards: Since this cave will be very evident in its setting above the recreation pool level, the 5 m pit past the entrance room presents an attractive hazard to most visitors. A path already leads to the entrance.



Significance: The cave has considerable esthetic value. The vertebrate remains in the cave suggest that some taphonomic value also exists.

Mitigation: Uncontrolled visitation should not be allowed.

CAVE 073

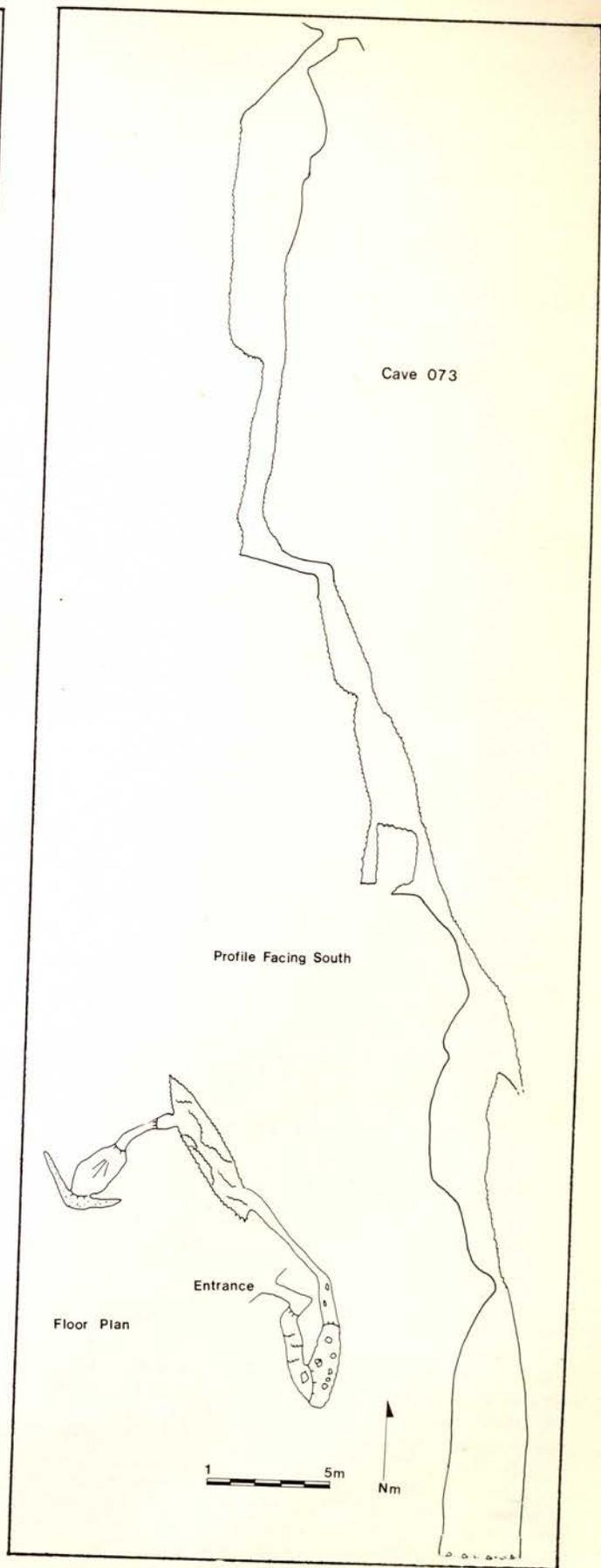
Location: Coyote Creek, Calaveras County

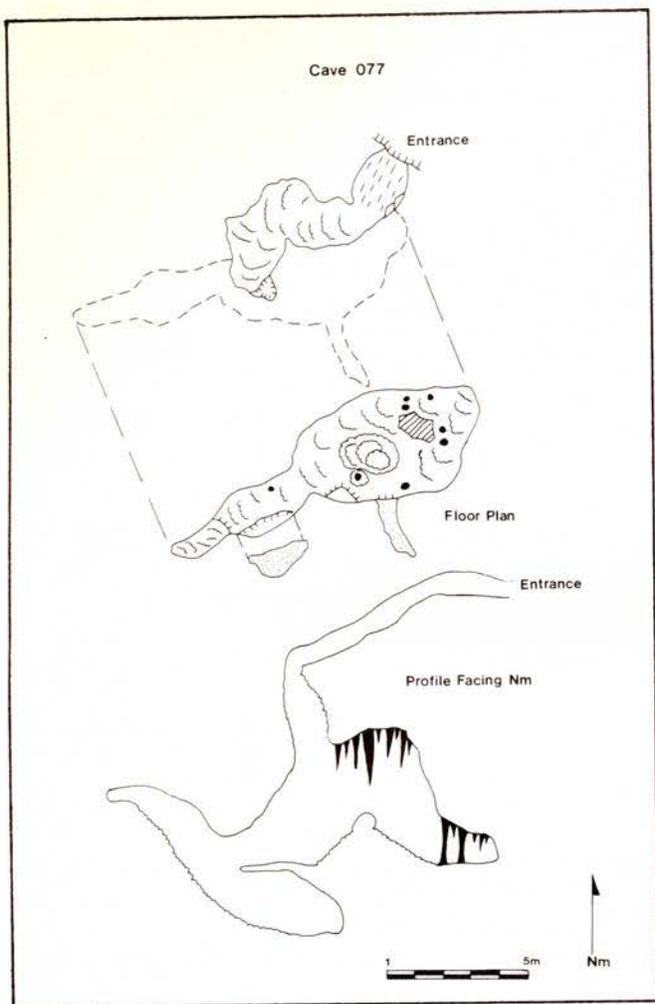
Elevation: 475 ± 3 m (1560 ± 10 ft)

Height above Base Level: 155 ± 3 m (510 ± 10 ft)

Relation to Pool Level: The cave is 144 ± 3 m (472 ± 10 ft) above gross pool level.

Description: The 1 m wide 0.5 m high entrance slopes downward for 4 meters. A 30 cm wide and 1 m high window into another pit provides access to a 12 m drop and a tight squeeze at the bottom leads to another 12 m drop. A tight vertical climb leads to a third 12 m drop with a final squeeze leading to a final drop of 13 meters.





Sediments and Stratigraphy: A clay floor in the first room indicates that it may be present in other rooms which are covered by flowstone. A third room contains a false floor indicating that sediment had already been eroded out from under that surface.

Biological Observations: Spiders, millipedes, and centipedes were noted. Also newts, frogs, and one big-eared bat were seen, but no live collections were made.

Biological Identifications:

- Unidentified bird—coracid hawk size
- Unidentified rodent
- 1 Mole: *Scapanus cf. townsendii*
- 1 Packrat: *Neotoma sp.*
- 1 Dusky-Footed Packrat: *Neotoma fuscipes*
- 1 Cottontail Rabbit: *Sylvilagus bachmani*
- 1 Juvenile Deer: *Odocoileus sp.*

Paleontological Observations: No bone was collected in the main chamber of the cave. In the upper NW chamber, however, there is a small bone-bearing deposit. A false-floor ledge about 3 m sq within this chamber consists of several inches of consolidated breccia capped by a flowstone layer about 2 cm thick. Bones of rodent, insectivores, and one cervid were collected from the flowstone and the breccia immediately beneath it.

There is currently no direct outside opening to this chamber. Thus it either represents a chamber with a previous opening or the bones were brought into the chamber by a small carnivore or scavenger.

Archaeological Observations: Two hammerstones were found in the entrance room (Payne, Scott, and McEachern, 1969:12). "A small section of flowstone near the entrance shows signs of quarrying" (McEachern, n.d.). Fragmented flowstone can still be seen in the entrance chamber. The cave was excavated prior to this study (McEachern, n.d.).

Significance: This profusely decorated little cave has a prehistoric calcite quarry near the entrance. Paleontological material was recovered from the top of a flowstone layer covering older sediments.

National Register Eligibility: Yes

Mitigation: The cave should be gated due to the hazardous nature of the entrance drop, the pristine nature of the formations, and the significance of the paleontological, taphonomic, and biological remains. Efforts should also be made to promote vegetation growth at the entrance and discourage visitation, since the cave will be plainly visible from the water when the reservoir is filled.

CAVE 078

Location: Stanislaus River Canyon, Calaveras County

Elevation: 451 m (1480 ft)

Height above Base Level: 178 m (585 ft)

Relation to Pool Level: The cave is located 119 m (392 ft) above gross pool level.

Description: The cave was not visited by this project although an unsuccessful attempt was made to locate it. Squire (1972) has described the cave as "an opening leading into a room about 20 by 20 ft having a passage leading to a solution tube dropping into an unexplored area."

Mitigation: Additional efforts should be made to locate the cave and recommend responsible management actions.

CAVE 079

Location: Coyote Creek, Calaveras County

Elevation: 476 ± 12 m (1560 ± 40 ft)

Height above Base Level: 155 ± 12 m (510 ± 40 ft)

Relation to Pool Level: The cave is located 144 ± 12 m (472 ± 40 ft) above gross pool level.

Description: The 1.3 by 0.7 m entrance leads down a small solution tube 2 m to the floor of a dirt-filled fissure 6 m in length, 7 m in width, and 2 m in height. Many small side passages off the main fissure lead to small, impassable entrances.

Speleogens: The cave has developed along a joint.

Speleothems: Cave coral and striped mineral stains occur in the cave.

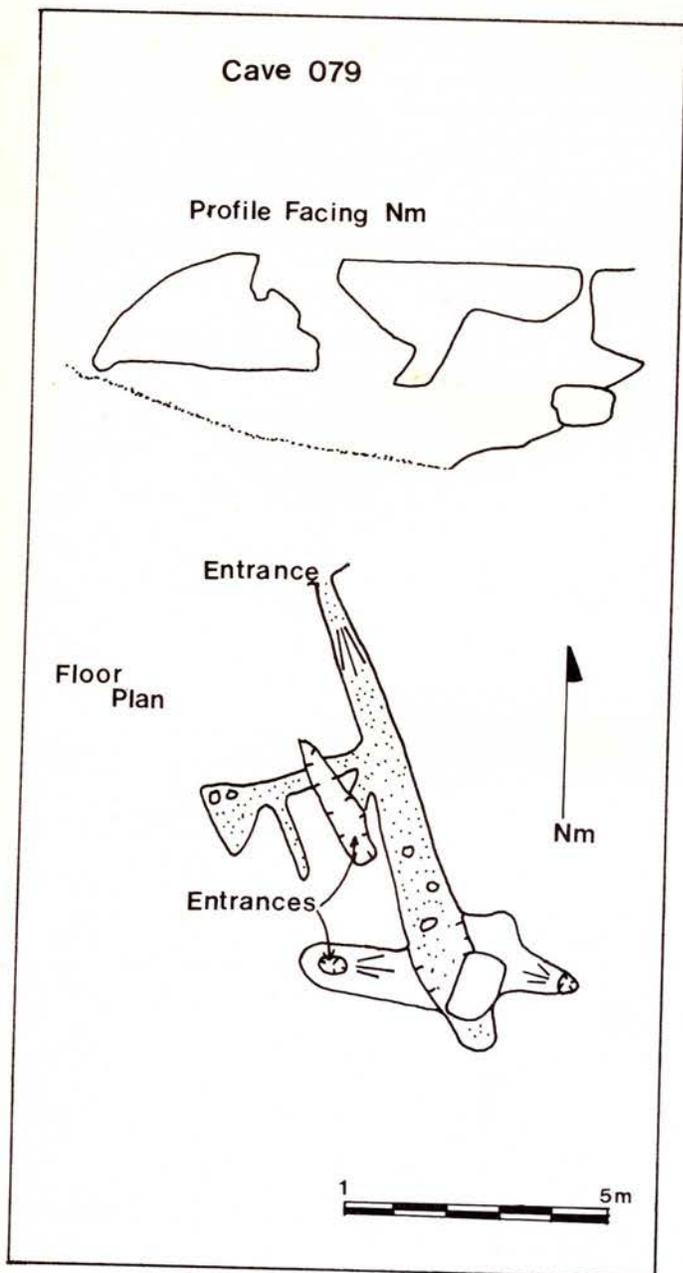
Sediments and Stratigraphy: The cave has a reddish-brown soil floor.

Biological Observations: One bat was seen in the cave. Invertebrate fauna were also noted in small quantities.

Biological Identifications:

- Centipede: *Nadabius sp.*
- Pseudoscorpion: *Apochthonius sp.*
- Spiders: *Telema gracilis*
Chasmocephalon shantzi
Archoleptoneta schusteri
Achaearanea fresno
- Mite: Unidentified

Paleontological Observations: Small, recent, vertebrate microfauna are present in the reddish-brown soil.



Significance: The cave contains important biological, taphonomic, and geological deposits.

Mitigation: Minimal taphonomic mitigation is recommended as the cave is likely to receive considerable recreational use.

CAVE 080

Location: Stanislaus River Canyon, Calaveras County

Elevation: 472 ± 1 m (1550 ± 3 ft)

Height above Base Level: 184 ± 1 m (605 ± 3 ft)

Relation to Pool Level: The cave is located 141 ± 1 m (462 ± 3 ft) above gross pool level.

Description: The entrance measuring 2 m in width and 2 m in height leads to a downward sloping crawlway 2 m in length. The crawlway leads to a small room that is 1.5 m in

width and height. A tight crack leads upward for 2 meters.
Mitigation: No further study is recommended for this cave.

CAVE 081

Location: Skunk Gulch, Calaveras County

Elevation: 465 ± 1 m (1525 ± 3 ft)

Height above Base Level: 198 ± 3 m (650 ± 3 ft)

Relation to Pool Level: The cave is located 133 ± 1 m (437 ± 3 ft) above gross pool level.

Description: The cave has an entrance 2 m in width and 0.5 m in height. The entrance leads to a small, horizontal crack 0.2 m wide and 1.5 m in length. This slot extends farther but is too tight for human passage.

Speleothems: Cave coral covers the walls of this cave.

Mitigation: No further study is recommended.

CAVE 082

Location: Stanislaus River Canyon, Calaveras County

Elevation: 311 ± 7 m (1020 ± 20 ft)

Height above Base Level: 30 ± 7 m (100 ± 20 ft)

Relation to Pool Level: This cave is located 20 m (65 ft) below gross pool level and is at the level of the recreation pool.

Description: This cave and the other nearby shelters are above a steeply sloping bedding plane and below 3 m of alluvial breccia and large boulders. The entrance is 1.5 by 1.5 m and slopes steeply up to the end, 2 m beyond the entrance. Breakdown forms the back wall.

Speleogens: A breccia zone has eroded away, leaving this shelter-like cave.

Speleothems: Only popcorn was noted.

Sediments and Stratigraphy: Sand and small breakdown form the floor.

Biological Observations: Small mammal-sized dung was observed on the floor.

Significance: This cave is easily seen from the river and may be of some boater recreational value.

Mitigation: No active mitigation is recommended at this point.

CAVE 083

Location: Stanislaus River Canyon, Tuolumne County

Elevation: 276 m (906 ft)

Height above Base Level: 20 m (66 ft)

Relation to Pool Level: The cave is located 55 m (182 ft) below recreational pool level.

Description: The entrance measures 3 m in height and 1.5 m in width and leads to a triangular-shaped passage 5.5 m in length. A side passage measures 4.5 m in length. Another side passage at the end of the main passage is blocked by formations.

Speleothems: Flowstone, stalactites, draperies, cave coral, and soda straws 2 cm in length were observed. The cave walls are pink in color.

Sediments and Stratigraphy: Brown soil covered with moss and some calcite were noted.

Biological Observations: A very small amount of recent animal dung was found.

Mitigation: No active mitigation is currently recommended.

CAVE 084

Location: Stanislaus River Canyon, Calaveras County

Elevation: 305 m (1,000 ft)

Height above Base Level: 17 m (55 ft)

Relation to Pool Level: Cave 084 is located 6 m (21 ft) below recreation pool level.

Description: The cave was not visited by this project. It has been described by Squire (1975b) as "a small drainage cavity about 10 ft in length with a 1 by 2 ft entrance."

Mitigation: Efforts should be made to relocate and evaluate the cave and propose responsible mitigative actions.

CAVE 085

Location: Coyote Creek, Calaveras County

Elevation: 354 ± 3 m (1060 ± 10 ft)

Height above Base Level: 0.0 m (0.0 ft)

Relation to Pool Level: The cave is located 22 ± 3 m (72 ± 10 ft) above gross pool level and 42 ± 3 m (139 ± 10 ft) above recreation pool level.

Description: Coyote Creek flows through a travertine bridge with flowstone ceilings and walls. The entrances measure 8 by 7 m and 8 by 3 meters. The passage is on the average 4 m in width and is 70 m in length. Natural springs are present inside the cave, and the water is cold. Sections of the creek in the cave are deep and can be traversed only by swimming.

Speleogens: Joint pockets and scallops were noted on the ceiling and walls.

Hazards: Coyote Creek is deep and it is necessary to swim through parts of the cave.

Vandalism: The surrounding area is marred by the effects of visitation. Beaten paths lead down to the cave. Litter and garbage are abundant in the area. Inside the cave most of the formations are broken and names have been painted and inscribed on the walls.

Significance: The cave is recreationally significant, given its remaining natural beauty. The bridge is visited by hundreds of people annually despite its obscure unpublicized location on private property. It is also of considerable historical significance, having been a natural curiosity since the 1850s.

Mitigation: As per the Master Plan, this site should be developed as a recreation area. Such an action would lead to better protection of the cave and would provide an opportunity for the BLM to educate the public concerning the value of caves and the need to conserve such resources (see description of Cave 052).

CAVE 086

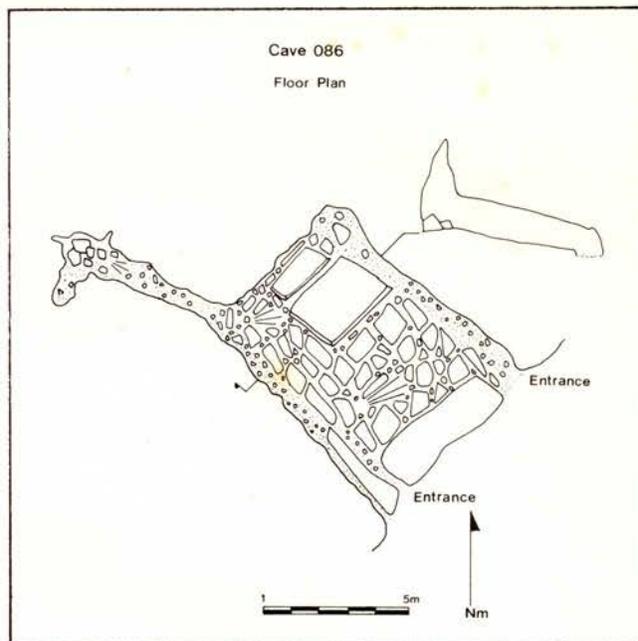
Location: Stanislaus River Canyon, Calaveras County

Elevation: 305 ± 1 m (1000 ± 3 ft)

Height above Base Level: 17 m (55 ft)

Relation to Pool Level: The cave is located 6 ± 1 m (21 ± 3 ft) below recreation pool level.

Description: The cave is formed of large breakdown blocks in the bed of an intermittent stream. There are two en-



trances. The upstream entrance is a vertical crack 4 m in height and 1.5 m in width. The downstream entrance is 3 m in height and 4 m in width. The cave is filled with huge breakdown blocks ranging in size from 3 by 3 m to 0.5 by 5 meters. A crawlway through these blocks has been formed. One axial passage is present, which extends 3 m to a breakdown plug.

Speleothems: Cave coral is the only decoration.

Sediment and Stratigraphy: Small pockets of brown clay occur between the breakdown and along entrances. Some stream pebbles and small angular pieces of breakdown occur.

Biological Observations: Ringtail cat dung was noted at the entrance.

Biological Identifications:

Spiders: *Linyphantes* sp.

Centipede: *Nadabius* sp. (1)

1 Adult California Ground Squirrel: *Citellus beecheyi*

Mitigation: Minimal taphonomic mitigation is required as this cave will be inundated.

CAVE 087

Location: Stanislaus River Canyon, Calaveras County

Elevation: 332 ± 5 m (1090 ± 20 ft)

Height above Base Level: The cave is located 0.6 ± 6 m (2 ± 20 ft) above gross pool level.

Description: A large 3 by 3 m entrance leads to a small fissure 1 m in width, 1.5 m in height and 3 m in length.

Speleogens: Joint pockets and enlarged joints are present.

Speleothems: Cave coral was noted.

Sediments and Stratigraphy: The floor of the cave is covered with breakdown ranging from 10 to 20 cm in size.

Mitigation: No further study is recommended for this cave.