KELSO DUNES AND THE PROVIDENCE MOUNTAINS AREA

ROAD LOG AND BACKGROUND INFORMATION

Desert Studies Center
March 2, 3, 4, 1990

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DESERT STUDIES CENTER

FIELD TRIP ROAD LOG

KELSO DUNES AND THE PROVIDENCE MOUNTAINS AREA

Prepared by

Constance Cameron, Director
Anthropology Museum
California State University,
Fullerton

Dr. David Sigurdson
Department of Earth Sciences
California State University,
Dominguez Hills

Dr. Glenn Stewart
Department of Biological Sciences
California State Polytechnic
University, Pomona

March 2, 3, 4, 1990
Many of the most interesting and scenic features of the Providence Mountains lie along its eastern slopes and to travel around the range will require a very full day. For that reason, we should plan on leaving Soda Springs no later than 8:00 am. Some of the roads we will travel are rather rough so our vehicles should be in good condition and have high ground clearance. A van or pick up truck is recommended although four-wheel drive will not be necessary.

miles  total
  0.0  0.0  Depart CSU Desert Studies Center facilities at Soda Springs. The rocks seen at the facility were deposited as limestone in a marine environment about 300 million years ago during Late Paleozoic time. Since that time they have been metamorphosed, perhaps by the younger Mesozoic granitic rocks that outcrop extensively in the Soda Mountains, the large range immediately west of the facility. We are driving north along the western margin of Soda Dry Lake which is the sink of the Mojave River drainage system. Soda Springs with its year-round fresh water was an important milestone on the old Mojave Road for it was here that travelers reached the Mojave River after cutting across from the Colorado. They could then water their stock more frequently at springs and at places where the river surfaces

1
as they moved along the river from Soda Springs to Cajon Pass. The dark rocks on our left consist of metamorphosed volcanic and sedimentary rocks of Early Mesozoic age.

Springs well up at several places along Zzyzx Road. They can be spotted by the rushes which grow around them. There was enough water in the desert for the prehistoric inhabitants but the Europeans also had horses, sheep and cattle. At three places along Zzyzx Road, where there are springs, you can find boulders with petroglyphs. Three boulders near the north gate contain multiple designs. One rock face, half-way to the freeway, also contains historic graffiti dated to 1859.

The two ponds at Zzyzx are artificial. Their configurations have been changed several times, most recently by the Bureau of Land Management. However, the large pond with the water fountain is "Lake Tuendae" of Doc Springer's health resort that existed from the mid 1940's to 1974. The edges of the ponds support a growth of cat-tail *Typha* sp. that provides habitat for marsh wrens *Cistothorus palustris*. American coots *Fulica americana* also are resident on the ponds, and a variety of migratory waterfowl visit them. During evenings in the warm seasons, several species of bats may be seen flying over the water's surface
as they forage for insects. The native Pacific treefrogs *Hyla regilla*, produce an enjoyable serenade on spring and summer evenings. The small to medium-sized fish in Lake Tuendae are Mojave Tui Chub *Cila bicolor mohavensis*. The Mojave Tui Chub is an endangered species of minnow endemic to the Mojave River. Due to habitat changes and the introduction of a closely related chub species from coastal California, populations of this chub have dwindled. The population at Zzyzx is one of only three or four genetically pure populations that remain.

The "streets" of Zzyzx are lined by tamarisk trees *Tamarix aphylla*. These hardy trees, which are native to Eurasia and also known as Athel, frequently are used as windbreaks in desert regions of southwestern United States. Another species of tamarisk, the shrubby saltcedar *T. ramosissima*, is scattered around the ponds at Zzyzx. This introduced east Asian shrub has become widely established at water sources in our deserts where it aggressively competes with native plants. Saltcedar is regarded as a serious pest because a stand of the transpiring shrubs can suck a spring or water course dry and deprive both native plants and wildlife of a water supply. On the grounds of the Center, one may expect to see such common reptile species as the
zebra-tailed lizard *Callisaurus draconoides* and the side-blotched lizard *Uta stansburiana*. Gopher snakes *Pituophis melanoleucus* occasionally may be seen here, though they are more likely to occur on the nearby rocky hillsides. Keep in mind that desert reptiles are most active during the spring months and may be difficult to find at other times of the year. Also, note that most small mammals of the desert, except for the ground squirrels and rabbits, are primarily nocturnal in their activity patterns.

The rocky hillsides of the Soda Mountains west of Soda Lake are sparsely vegetated with a Creosote Bush Scrub plant community. The indicator species for this community, creosote bush *Larrea tridentata* and white bursage *Ambrosia dumosa*, are mixed here with a variety of other shrubs and springtime annuals. Finding a preferred habitat on these rocky hillsides are a number of desert animals, including the desert woodrat *Neotoma lepida*, canyon mouse *Peromyscus crinitus*, rock wren *Salpinctes obsoletus*, desert collared lizard *Crotaphytus insularis*, chuckwalla *Sauromalus obesus*, and speckled rattlesnake *Crotalus mitchellii*. Driving up the sloping alluvial deposit toward I-15, we may see some conspicuous whitish shrubs along the road. These are desert holly *Atriplex hymenelytra*, a species of saltbush with
unusually large leaves shaped like holly leaves. Along the braided washes in this area are a few small smoke trees *Psorothamnus spinosos*, so called because the dense mass of slender branches with their covering of grey pubescence makes the trees look like puffs of smoke from a distance. Smoke trees are restricted to washes because germination of their seeds can occur only after the hard seed coats are broken by pebbles rolling in a flowing wash bed. Mammals commonly seen while driving through this area are the white-tailed antelope ground squirrel *Ammospermophilus leucurus* and black-tailed hare *Lepus californicus*.

**miles**

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granitic rocks between fifty and one hundred million years ago. Turquoise Peak forms the highest point to the left of the freeway and is named after the Toltec turquoise mine that occurs on the NW slope. Students still find turquoise chips on the mine dumps.

There was nearly always evidence of prehistoric mining activities at turquoise outcrops in the form of open pits, cuts, and stone tools. One such pit, cleaned up in 1895, was 30 feet long, 12 feet wide and 12 feet deep. From this main pit, numerous short tunnels branched off where veins had been followed. There is very little soil at this site and the entire excavation was into bedrock. In cleaning out these aboriginal pits, many desert tortoise shells were found. They were probably used as scoops to carry out the muck. At least 50 prehistoric workings at the Western Himalaya group, 20 at the Middle group, and 200 at the Toltec have been identified. Stone mauls, picks and axes were found as well as heavy hammers weighing as much as eight pounds. Most of the hammers were full-grooved, a Southwestern tradition. About 25 Puebloan-type pottery sherds were found. No Mohave pot sherds have been found at any of the mines.

Along I-15 here we see a typical example of the Creosote Bush Scrub community that covers vast areas of the
Mojave Desert, especially the valleys, rolling hills and bajadas, to an elevation of at least 3,500 feet. The dark green leaves and scraggly, dark grey branches of the creosote bush make it easy to recognize from a distance. Creosote bush (also known as greasewood) is named for its strong, resinous odor that is suggestive of creosote. Its sweet, resinous scent is particularly noticeable after a rain. Creosote bush is the most widespread and successful shrub in the arid regions of North America, showing a composite of several adaptations that have independently evolved in many desert shrubs and trees. For example, its leaves are small to reduce the surface through which water may be lost to the atmosphere. A waxy leaf surface further reduces evaporation. Two root systems are present - a tap root that may be 40 feet long obtains water from deep in the ground while numerous small surface roots enable the plant to immediately utilize precipitation. Several years ago, it was discovered that some creosote bushes may be more than 10,000 years old and, thus, the oldest living things in the world. This is possible because, as old creosote bushes die, new ones sprout from the radiating surface roots producing a ring of younger bushes. As these die in turn, they give rise to a larger ring of bushes, and the process may continue for many generations. Each bush is connected by its roots to its neighbors in the ring and, of course,
each is a clone of the original parent bush. Creosote bush clone rings are common in some areas and the largest known ring, called "King Clone", is about 60 feet in diameter, and is located in the Mojave Desert.

Although monotonous in appearance, the Creosote Bush Scrub community may produce colorful displays of wildflowers (annuals) in March and April of years that receive adequate amounts of winter precipitation. However, few of the people speeding on their way to Las Vegas realize that the Creosote Bush Scrub community also is home to a great diversity of animals. In addition to the antelope ground squirrel and black-tailed hare or California jackrabbit, mammals one may find here include the deer mouse *Peromyscus maniculatus*, southern grasshopper mouse *Onychomys torridus*, several species of pocket mice *Perognathus* spp. and kangaroo rats *Dipodomys* spp., desert cottontail *Sylvilagus auduboni*, kit fox *Vulpes macrotus*, coyote *Canis latrans*, and bobcat *Felis rufus*. Birds that occur on or near the ground are the greater roadrunner *Geococcyx californianus*, black-throated sparrow *Amphispiza bilineata*, sage sparrow *Amphispiza belli*, and burrowing owl *Athene cunicularia*. Soaring overhead may be the common raven *Corvus corax*, red-tailed hawk *Buteo jamaicensis*, ferruginous hawk *Buteo regalis*, prairie falcon *Falco mexicanus*, and golden eagle *Aquila chrysaetos*. In
addition to the side-blotched and zebra-tailed lizards, and
gopher snakes and common kingsnakes, reptiles occurring here
include the desert iguana *Dipsosaurus dorsalis*, common
leopard lizard *Gambelia wislizeni*, western whiptail
*Cnemidophorus tigris*, glossy snake *Arizona elegans*,
coachwhip *Masticophis flagellum*, Mojave rattlesnake *Crotalus
scutulatus*, and desert tortoise *Xerobates agassizii*. Due to
the cumulative impacts of many factors (e.g. livestock
grazing, off-highway vehicle use, agricultural developments,
mining, road kills, vandalism, raven predation, and
disease), populations of the desert tortoise have declined
substantially and the species recently has been listed as
endangered.

5.5 21.1

Because of high temperatures in summer,
the Halloran grade is often more
formidable than Cajon Pass. To our left
we can see a layer of basalt formed by a
lava flow that spread over the area near
the summit. Toward the top, we can see
what appears to be a volcanic plug or neck
from which the lava issued. These rocks
are part of the Cima volcanic field which
began erupting here about 7.5 million
years ago and has continued almost to the present time. We are at the west end of the field where the earliest eruptions occurred.

At this point we see a transition from the Creosote Bush Scrub community to a Joshua Tree Woodland community. After we exit on Cima Road at 35.0 miles, we will be in the largest and densest Joshua Tree Woodland to be found anywhere. The Joshua tree *Yucca brevifolia* may be considered an indicator species for the Mojave Desert, though it does not occur throughout this desert and is not entirely restricted to it. The species also occurs in parts of the Sonoran Desert of west-central Arizona. This plant is found on well-drained soils of the Mojave’s periphery and interior at elevations of 2,000 to 6,000 feet. It generally does best at elevations of 3,000 to 4,500 feet where the woodland community may develop. In the Eastern Mojave Desert, where we are, we see the variety *Yucca brevifolia jaegeriana*, named in honor of the famous desert naturalist, Dr. Edmund C. Jaeger. This variety of Joshua tree is characterized by relatively short leaves, dense branching, and small size compared to Joshua trees of the Central and Western Mojave.
miles total

1.0 28.7 Halloran Summit elevation 4125 ft. As we begin the descent into Shadow Valley, we can see Clark Mountain at 11:00 o’clock and the freeway crossing Mountain Pass on its way to Nevada. At 9:00 o’clock we can see the Kingston Range, known for its iron deposits. Japanese steel companies operated the Blackwater Mine here until about 12 years ago. Cima road was paved for transport of ore to the railroad at Cima and thence to Japan. Cheaper sources in Australia forced closure of the mine. At 10:00, if the air is clear, you can see the huge Spring Mountains which lie west of Las Vegas. At 1:00, east of the freeway, is the mineral-rich Mescal Range and at 2:00 the Ivanpah Mountains where we are bound. At 3:00, we can make out the gentle curve of Cima Dome. For many years, geomorphologists regarded Cima Dome as a classic example of a range nearly completely planed off by the retreating slopes of a pediment. Only a small remnant remains as the jagged Teutonia Peak. More recent studies have maintained that the area was eroded to a flat peneplain and later bowed up into a dome by tectonic forces.

6.3 35.0 Exit I-15 at Cima Road.

2.5 37.5 At 1:00 observe Teutonia Peak with its jagged outcrops of a granitoid called
Teutonia Quartz Monzonite, a type of granite intruded here 50-100 mya during the Laramide episode of mountain building. The prominent mountain straight ahead is Kessler Peak, elevation 6152.

6.8 44.3
Turn left off Cima Road at the tank at an angle of 45 degrees so that you are heading due east on a dirt road. You are passing through an impressive Joshua Tree Woodland.

1.5 45.8
On the left, you can see Striped Mountain which is composed of Paleozoic marine sedimentary rocks and is sheared by the Mesquite and Mescal thrust faults.

1.1 46.9
Turn right on dirt road intersection

0.5 47.4
The headframe of the Evening Star Tin Mine is visible on your left.

STOP #1
Deposits of tin oxide, cassiterite, were discovered here in the Ivanpah Mountains in 1940 (Hewett, 1956). With the outbreak of war, sources of the strategic metal in Malaya were cut. The U.S. has no tin mines and few prospects so this site was extensively explored during the early 40’s. Two shafts were sunk and a mill was built near our turnoff from I-15. At least 25 tons of 6.4% ore were mined in 1942, but the deposit has never been a significant
source of tin. The deposit occurs in the Bird Spring Formation, a dolomite rock deposited during the Late Paleozoic (Pennsylvanian) in a marine environment. Intrusion of the Teutonia Quartz Monzonite from below at the end of the Mesozoic (Late Cretaceous or Early Tertiary) Era introduced ore-bearing fluids. These fluids were generated and circulated as the magma crystallized. Ore minerals were deposited in a tubular body that dips steeply south and trends E-W. In addition to cassiterite the ore zone contains serpentine, epidote, magnetite, calcite, tremolite and forsterite. Copper minerals derived from minor chalcopyrite include azurite, malachite and tenorite. The tenorite resembles cassiterite but is softer and has a reddish streak. If time permits, we will also explore an adit about 200 meters south of the headframe. Here we may observe underground workings and evidence of the kinds of animals that inhabit abandoned mines.

From this vantage point we can get an idea of the extent of the Joshua Tree Woodland that covers much of the Cima Dome area. In addition to the Joshua tree, we may find two other species of yucca here - Spanish Bayonet Yucca baccata and Mojave yucca Yucca schidigera. Spanish bayonet is a rather low-growing yucca with long bluish leaves while Mojave yucca usually has trunks up to several feet tall with
occasional branches and yellowish-green leaves. Mixed in with the yuccas are a number of other desert perennials commonly found at moderately high elevations. These include Great Basin sagebrush *Artemisia tridentata*, antelope bush *Purshia glandulosa*, pygmy cedar *Peucephyllum schottii*, bladder sage or paper-bag bush *Salazaria mexicana*, and Mormon tea *Ephedra* sp., a shrubby, leafless conifer. It is the yuccas, however, that give character to the community and provide for the needs of a number of desert animals. Except for certain reptiles (the desert iguana, zebra-tailed lizard, leopard lizard, and desert tortoise), which probably find this area a bit too high, most of the vertebrates occurring in the Creosote Bush Scrub community also may be expected to occur here. In addition there are others that specifically utilize the yuccas in some way. For example, the desert night lizard *Xantusia vigilis* generally requires the fallen leaves and trunks of yuccas for shelter. The desert spiny lizard *Sceloporus magister* commonly climbs on the yuccas, foraging for insects and finding lookout points from which to survey its territory. The desert woodrat (also known as the packrat for its habit of carrying objects to decorate its nest) often builds its nest of sticks and cactus joints among the trunks and lower leaves of yuccas, and it uses the leaves as sources of food and water. Scott’s oriole *Icterus parisorum* uses long fibers peeled
from yucca leaf margins to weave an intricate, pendulant nest among the yucca leaves. The ladder-backed woodpecker Picoides scalaris carves out a hole in the trunk of a dead yucca for its nest, and vacated woodpecker holes may be taken over by the ash-throated flycatcher Myiarchus cinerascens. The yuccas also have a close symbiotic relationship with yucca moths Tegitigula spp. Each species of yucca is pollinated by a particular species of Tegitigula. In return, the seed pods of the yuccas provide a home and food for the developing moth larvae, which eventually fall to the ground, pupate and wait for the following spring when they will emerge as adult moths to complete the cycle.

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<th>miles</th>
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<tbody>
<tr>
<td>Drive south along the dirt road toward Teutonia Peak.</td>
<td></td>
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<tr>
<td>4.0</td>
<td>51.4</td>
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<tr>
<td>Intersection with paved Cima Road. Turn left toward Cima.</td>
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<tr>
<td>3.0</td>
<td>54.4</td>
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<tr>
<td>New York Mountains on the left. Mid Hills straight ahead and Providence Mountains at 2:00.</td>
<td></td>
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<tr>
<td>2.8</td>
<td>57.2</td>
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<tr>
<td>Cima Store. Turn right (south).</td>
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<tr>
<td>2.5</td>
<td>59.7</td>
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<tr>
<td>View of Kelso Dunes.</td>
<td></td>
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<tr>
<td>1.9</td>
<td>64.1</td>
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<tr>
<td>Historical marker describing old Mojave Road. Turn left toward Cedar Canyon.</td>
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</table>
4.7 68.8 View of colorful Pinto Mountain elevation 6144.

1.0 69.8 Turn right (south) through the Mid Hills on Black Canyon Road.

2.0 71.8 View of round Valley on our left, Table Mountain straight ahead.

0.8 72.6 Turn right (west) toward Mid Hills Campground.

2.0 74.6 Turn right into Mid Hills Campground where we will have lunch. This uncrowded campground is set in a beautiful juniper-pinyon pine woodland.

STOP #2

In the Mojave Desert, Pinyon-Juniper Woodland communities generally occur at elevations of 4,500 to 7,000 feet. The species of pine involved usually is the one-leaf pinyon pine Pinus monophylla, but two species of juniper commonly are co-dominants with the pinyon. Which juniper species is present depends on the location. Around the western margins of the Mojave, it is the California juniper Juniperus californica. The Pinyon-Juniper Woodland community in the Mid Hills is dominated by one-leaf pinyon and Utah juniper Juniperus osteosperma, and here the trees of both species are of unusually large size and full form.
As understory plants, we find the Great Basin sagebrush and some other shrubs characteristic of even cooler, moister habitats. Because they occur at moderately high elevations and generally receive 15-20 inches of rainfall annually, Pinyon-Juniper Woodlands are not true desert communities. Rather, they are essentially montane islands of a more mesic biota surrounded by desert. They probably represent relicts of the mixed woodlands and grasslands that covered much of what is now desert during the Pleistocene Epoch that ended about 10,000 years ago. Few, if any, strictly desert species of vertebrates will be found here. Most of the reptiles, mammals and birds are the wide-ranging species that occur also in coastal and/or desert habitats, e.g. side-blotched lizard, western fence lizard *Sceloporus occidentalis*, western whiptail, gopher snake, common kingsnake *Lampropeltus getulias*, deer mouse, Great Basin pocket mouse *Perognathus parvus*, Panamint kangaroo rat *Dipodomys panamintinus*, desert cottontail, coyote, bobcat, mule deer *Odocoileus hemionus*, roadrunner, raven, red-tailed hawk, prairie falcon, and golden eagle. However, there are some species that are closely associated with the Pinyon-Juniper Woodland, eg. the pinyon mouse *Peromyscus truei* which frequently eats juniper berries and the pinyon jay *Gymnorhinus cyanocephalus* which commonly eats pinyon nuts.
miles  total
0.3  74.9

Leave the campground and turn right to continue on Wildhorse Canyon Road. This section, according to Rae, 1989, was declared the nation’s first "Back Country Byway". It winds through junipers to sagebrush and cholla. We may be a bit early in the season to enjoy the abundant wildflowers that color these hills, but other scenic values compensate for the detour.

STOP #3
We will stop along Wildhorse Canyon to take photos and examine some of the plants.

Somewhere below the Pinyon-Juniper Woodland we should find a high desert plant community characterized by a variety of shrubs, cacti, and yuccas. This plant association sometimes is called a "devil’s garden". A similar plant association, perhaps with even a richer mixture of species, may be found at Mitchell’s Caverns. However, we will not be stopping there. Among the cacti we may see are buckhorn cholla *Opuntia acanthocarpa*, silver cholla *Opuntia echinocarpa*, pencil cholla *Opuntia ramosissima*, beavertail cactus *Opuntia basilaris*, old man
cactus *Opuntia erinacea*, prickly pear cactus *Opuntia* sp., barrel cactus *Ferocactus acanthodes*, hedgehog cactus *Echinocereus engelmannii*, and nipple cactus *Mammillaria tetrancistra*. The vertebrate fauna here is essentially the same as in the Joshua Tree Woodland, but we are more likely to find the cactus wren *Campylorhynchus brunneicapillus* which prefers the protection of chollas for its nests.

miles  total
  10.4  85.3  Turn left on poorly marked dirt road leading to cliffs at Hole-in-the-wall.
  0.3  85.6  Park below cliffs.

STOP #4  Follow the trail toward the cliffs for 300 meters. The rocks here are composed of volcanic ash and tephra and make up a pyroclastic rock called tuff. They were formed by volcanic eruptions that occurred during Tertiary time about fifteen million years ago. Deposition occurred along the eastern side of the Providence Mountains which existed as an impressive range at the time (Hazzard, 1954). The pyroclastic tuffs range in color from grey to pink to white. Some of the massive types appear to be mudflows but others show bedding indicative of surges of hot volcanic ash clouds. The tuffs are soft and easily eroded and develop a cavernous appearance due to seeping groundwater. We will proceed up the narrow canyon where,
with the help of the rings, we can climb up to the campground. It is thought that water was impounded east of these cliffs and overflowing, cut the narrow gorge called Hole-in-the-Wall. This is not the same Hole-in-the-Wall associated with Butch Cassidy.

The eroded cliffs at Hole-in-the-Wall provide perching and/or nesting sites for a number of the larger bird species, including the raven, red-tailed hawk, prairie falcon, and the great horned owl Bubo virginianus. Evidence of bird utilization may be seen as white deposits of uric acid staining the rocks. Also, we may hear the beautiful song of the canyon wren Catharus mexicanus, though the bird itself tends to be inconspicuous.

There are two areas of petroglyphs at Hole-in-the-Wall. Most of them are curvilinear in style and one area has a "great tangle of circles, ovals, wavy lines, grids, and meanders". One figure representing an atlatl and another with two anthropomorphs have been noted. There may be some artifacts in this area. Archaeological artifacts should never be removed from a site. This completely obliterates the prehistoric record. Likewise, rock art should never be traced over with chalk or altered in any way. Archaeological remains are fragile, non-renewable resources which contain knowledge invaluable to all people, but they must be analyzed in a methodical manner.
niles total Climb back down the canyon and return to the vehicles. Drive out to the Wildhorse Canyon road and turn left for a half mile of travel.

0.8 86.4 Turn right (south) on Black Canyon Road toward Essex. We are traveling down a gigantic apron of gravel called an alluvial fan that extends 30 miles from the Woods Mountains to Essex. On our right lie the Providence Mountains. The sharp reddish peaks are composed of an intrusive volcanic rock called the Fountain Peak rhyolite and is regarded by Hazzard, 1954, as being the same age as the pyroclastics of Hole-in-the-Wall. Just below the rhyolite we can see the grey, Bird Spring limestone and dolomite such as we saw in the Ivanpah Mountains. Lower down on the slopes, and separated by a fault from the limestone, outcrops a Precambrian complex of igneous and metamorphic rocks.

8.6 95.0 At this point we will continue past the Mitchell Caverns turnoff but at some future time you may wish to show your students this worthwhile site. The caverns were formed by circulation of groundwater through Bird Spring limestone. The slightly acid groundwater was able to form the caves by dissolving the limestone. It is difficult to explain how the water table could have been above the present 4400-foot elevation.
of the caves, especially since the Providence Mountains were uplifted prior to cave formation. According to Emory and Easton, 1951, Clipper Valley was filled to the level of the top of Wildhorse Mesa. If this surface is extended across the valley it intersects the Providence Mountains above the level of Mitchell Caverns and could have been the reservoir for the groundwater. There are two caverns and the south cave, Tecopa, was the site of an Indian burial. The north cave, El Pakiva, contained a drawing and numerous baskets, torches and mats. These were artifacts of a Shoshonean group called Chemehuevi. The Caverns consist of several hundred feet of underground passages and include many examples of dripstone including stalactites, stalagmites, columns and curtains. The caverns were operated commercially for many years by Mr. and Mrs. J. E. Mitchell but are now part of the State Park system. Guided tours are conducted by California State Park personnel at specified times. The most convenient time for a group based at Soda Springs would be the 1:30 tour but you should check with State Parks & Recreation to verify times. There is a nature trail and picnic tables at the large parking area.

0.2 95.2 Turn right (west) and follow powerline road up through Foshay Pass. It's a rough, rocky road, so take it easy.

6.0 101.2 Top of Foshay Pass elevation 4350 ft. From here we descend two steep hills.
These require 4-wheel drive on eastbound vehicles but should not bother us since we are going downhill.

1.2 102.4 Striking folds in Bird Spring Limestone on the right.

0.3 102.7 Turn right. Road forks - stay right.

0.6 103.3 Vulcan Mine - Turn right into parking area and walk down to the large open pit.

STOP #5 The Vulcan Mine, owned by Kaiser Steel Company, began operations on December 1, 1941 and produced 2,500 tons of ore daily during its years of operation. Grade was about 50%. About 5.7 million long tons of ore were present when production began but probably less than 40% of this was actually mined. The ore was trucked to Kelso and transferred by rail to the Kaiser mill in Fontana. The deposit has been described by Lamay, 1945, and is regarded as a contact metasomatic deposit with a similar origin to that of the Evening Star Tin Mine. A body of Late Mesozoic monzonite (a granitoid), intruded Paleozoic limestone. As the molten magma cooled and crystallized, hot corrosive fluid circulated at the contact, locally replacing the limestone with magnetite and hematite ore. Other minerals we will find here include serpentine, limonite, epidote, pyrite and calcite. Subordinate amounts of gypsum and copper minerals are sometimes found. Notice the
outcrops of Fountain Peak rhyolite on the skyline above the open pit.

The habitat in the immediate vicinity of the Vulcan Mine was severely disturbed by the previous mining activity. Visitors’ vehicles and a concentration of domestic cattle around the water seeps maintain the disturbance today. However, some native wildlife, including Bighorn sheep *Ovis canadensis*, may utilize the water when people and cattle are not in the vicinity.

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<th>miles</th>
<th>total</th>
<th>Return to our vehicles and continue northwest.</th>
</tr>
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<tbody>
<tr>
<td>0.5</td>
<td>103.8</td>
<td>Distant view of the Kelso Dunes.</td>
</tr>
<tr>
<td>4.6</td>
<td>108.4</td>
<td>Turn left on Kelso-Amboy road (south).</td>
</tr>
<tr>
<td>4.3</td>
<td>112.7</td>
<td>Turn right on graded dirt road toward dunes.</td>
</tr>
<tr>
<td>3.5</td>
<td>116.2</td>
<td>Enter second parking lot and walk 300 meters out into the Kelso Dunes.</td>
</tr>
</tbody>
</table>

Robert P. Sharp of Caltech has studied the dunes and reports that they originated as windblown stream sediments derived from 30 km west of the present dunefield in the Mojave River wash. The sands were blown eastward and may have been accumulating for 10-20 thousand years. Once in their
present basin they have been swept back and forth by shifting winds but measurements show that though dune movement is very active, the field itself is not going anywhere. The size of the grains is typical of aeolian sand (90% is 0.25-0.5mm) but the mineralogy is complex. In addition to quartz and feldspars there are hornblende, pyroxene, sphene, tremolite, biotite, apatite, zircon, ilmenite, and enough magnetite to justify experimental placer mining operations. The dunes cover 115 km² and approach 215m in thickness. The largest dunes have radial ridges produced by variable wind directions and are called star dunes. Much of the dunefield is made of transverse dunes, crossing from different directions, which show a grid pattern when viewed from the air. Sand avalanches may occur (with a little encouragement) on the steep faces of large dunes and these can produce a low-pitched vibrating sound that has given rise to the legend of the singing sands.

Water often is preserved in the sand, at depths of a few inches to a few feet, for long periods. Due in part to this supply of water, more than 100 different species of plants live on or near the dunes. Common perennials include creosote bush, salt bush *Atriplex* sp., plicate coldenia *Coldenia plicata*, and galleta grass *Hilaria rigida*. A much greater variety of annuals may appear in the spring, but the
species represented and their abundance in a given year will depend on the amount and timing of the preceding winter's rains. Following a good winter, annual flowers may cloak the dunes in late March and April with a spectacular display of color. Especially common species may include desert primrose *Oenothera deltoides*, sand verbena *Abronia villosa*, and desert lilly *Hesperocallis undulata*. Although rather inhospitable to vertebrate animals, at their fringes the dunes provide habitat for several species of reptiles and mammals. These include the Mojave fringe-toed lizard *Uma scoparia*, zebra-tailed lizard, western whiptail, desert iguana, desert horned lizard *Phrynosoma platyrhinos*, sidewinder *Crotalus cerastes*, shovel-nosed snake *Chionactis occipitalis*, glossy snake, desert kangaroo rat *Dipodomys deserti*, antelope ground squirrel, black-tailed hare, kit fox, and coyote. The Mojave fringe-toed lizard and sidewinder are sand-dwelling specialists and may be found even in the more central parts of the dune field. The desert kangaroo rat occurs only in areas of soft sand, but it is further restricted to sites where there are some perennial plants to provide food and shelter. We will see its conspicuous burrows here. A number of beetles and other insects also occur on the dunes and serve as a source of food for the lizards. If the day is not windy, tracks of many of the dune animals may be seen clearly on the surface.
of the sand. Early morning is a particularly good time to look for tracks, and sometimes one can interpret the story of the previous night’s happenings (eg. a kit fox stalks and captures a kangaroo rat, or a sidewinder searches for a place to partially bury itself and wait for passing prey).

Mankind is also fond of the dunes as evidenced by the numerous Indian campfire rings that dot the southern edge of the field.

<table>
<thead>
<tr>
<th>miles</th>
<th>total</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>3.5</td>
<td>119.7</td>
<td>Backtrack to the Kelso-Amboy Road.</td>
</tr>
<tr>
<td>7.2</td>
<td>126.9</td>
<td>Turn left toward Kelso.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Kelso - continue straight ahead toward Baker.</td>
</tr>
<tr>
<td>21.5</td>
<td>148.4</td>
<td>Lava flow from Cima volcanic field.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Alkaline-olivine basalt provides a fine example of a young lava flow at this point. Indian petroglyphs have been chipped into the desert varnish.</td>
</tr>
</tbody>
</table>
Here in the Creosote Bush Scrub community we can see how it is developed on the margins of the lava flow. The species of vertebrate animals expected at this site are the same as those on the rocky hillsides near Zzyzx.

<table>
<thead>
<tr>
<th>miles</th>
<th>total</th>
<th>Continue NW on the Kelbaker Road.</th>
</tr>
</thead>
<tbody>
<tr>
<td>6.0</td>
<td>167.4</td>
<td>Zzyzx offramp. Exit freeway here. Turn south.</td>
</tr>
<tr>
<td>4.6</td>
<td>172.0</td>
<td>CSU Desert Studies Center Soda Springs.</td>
</tr>
</tbody>
</table>
HISTORIC HIGHPOINTS OF THE MOJAVE DESERT

The Mojave Desert abounds with fading roads, old mines, crumbling buildings, empty railroad berms, broken fences, and vanished dreams. Because of the desert environment, many historic activities overlie prehistoric sites in order to take advantage of the infrequent watering places.

The ancient Mojave Trail, running from the Colorado River to the Pacific Ocean (through Mid Hills and Soda Springs), was also utilized in historic times. In 1776, Father Francisco Garces was the first European to travel this road when he crossed the Mojave Desert to break a trail from Arizona to the Mission San Gabriel. He was followed in later years by Mountain Man Jedediah Smith (the first American to travel overland to California), Kit Carson, and Lt. John C. Fremont, among others.

Beginning in 1853, army engineers surveyed the eastern Mojave Desert because many people were interested in the best route for a railroad. Lt. A. W. Whipple was instrumental in completing this work. An unusual sidelight during the late 1850's was Edward Beale's use of a camel train while he was working to improve the Mojave Trail into a wagon road.

By 1859, pack trains traveled from Los Angeles to Fort Mojave on the Colorado River by using the Mojave Road. They were joined one year later by the mail riders. A string of army forts and redoubts were built to protect travelers from an occasional Indian ambush along the road. One of these redoubts was built at Soda Springs. Pictographs near a spring along the Zzyzx Road commemorate this time. Messages such as "1859 G. R.", "Wagon Boss", and "Letty" can be seen. Historian Dennis Casebier discovered that George Hanson was a teamster on the old Mojave Trail and the wife of one of the officers at the redoubt was named Leticia. Camp Rock Springs, east of the Mid Hills Campground, is another U.S. Army outpost. Built in 1866, it was also part of the mail route. Because it is a source of water, the history and prehistory of this site also spans centuries.

Mining for turquoise, silver, salt, soda, quicksilver, and then gold began during the 1860s by the Americans, although Indians from the Southwest mined turquoise in the Mojave Desert hundreds of years earlier. Very rich silver mines were found in the New York, Clark, and Providence Mountains. The "boom" time for mining in this area was from 1900-1919 when copper, lead, and zinc were also in demand. In recent decades, the most important elements to mine have been talc, clay, and cinders as well as a revival in gold mining.

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The Union Pacific railroad tracks were laid east/west in the early 1880s but it was not until after the turn of the century that the north/south area was serviced by the Tonapah and Tidewater Railroad. The latter ran from Ludlow, California to Gold Center, Nevada (on Soda Lake and into Death Valley), but fell into disuse as mining activities declined. The rails were finally donated to the war effort in 1943 and the cross-ties were used in constructing many buildings, ramps, and fences in the area. The historic Kelso Train Depot, built in 1924 when Kelso was a stop for steam-powered locomotives, has been saved from destruction. It is a large two-story, Spanish-style building.

The Mojave Desert has also been used as grazing land for vast herds of cattle and sheep. The remains of buildings used by ranchhands, farmers, and homesteaders were much more abundant in past decades. Vandalism takes as large a toll of historic as of prehistoric remains.

The most visible change around Soda Springs occurred when Curtis Howe Springer utilized the area as part of his health resort and spa facility between 1944 and 1974. Most of the buildings, pools, and plants date to this period.

Springer brought out derelicts from Skid Row in Los Angeles, both to rehabilitate them and to build his resort. The BLM took over Springer's facility in 1974 and a Consortium, composed of seven Southern California State Universities began a program of upgrading the buildings in 1977.
PREHISTORY OF THE MOJAVE DESERT AREA

Archaeological sites spanning at least 12,000 years have been found around Pleistocene lake beds. Terraces around the former lakes contain the large, crude tools used by big game hunters 12,000 years ago. Mojave and Pinto points, scrapers, grinding stones, split twig figures, pottery, and small triangular projectile points span the last 10,000 years.

The Mojave Trail, running from the Colorado River to the Pacific Ocean, was in use since ancient times. Obsidian and sea shells were two major trading items and Pacific Ocean shells have been found in sites in Arizona and New Mexico. A few pieces of Southwestern pottery have likewise been found in California.

Prior to European contact, it is not certain which people lived here. Tribal boundaries of desert peoples are indistinct at best. Both the Chemehuevi and the Vanyume have been mentioned in the area since contact times.

Linguistic research suggests that the Chemehuevi were fairly recent inhabitants of the Great Basin, and the only local tribe to migrate into California during historic times. They migrated because of Yuman warfare along the Colorado River (in 1867, war began between the Chemehuevi and Mojave because of the Mormons, who wanted Mojave women for wives). The Chemehuevi eventually moved as far south as Twenty-nine Palms, which had been Serrano territory. The Serrano moved because of a smallpox epidemic in 1830.

The Chemehuevi tribal area was one of the largest in California. It occupied the territory west of the Colorado River from the Kingston Range south of Death Valley, through the Providence Mountains to about the boundaries of Riverside and Imperial Counties. It is believed, however, that the population was very small, not exceeding 800.

Their main subsistence was small game, rabbits, rats, lizards, seeds, and other readily available foods. They were primarily basket makers with only an occasional piece of pottery. Their dwellings were little more than shelters against the sun and wind. Temporary shelters were domed-shaped structures made of sticks covered with brush. Some groups built semi-subterranean (one foot below ground level) shelters covered with an overlay of brush and grass and covered with earth.
The Vanyume disappeared so soon after contact so that very little is known about them. Their subsistence pattern would be nearly identical to the Chemehuevi because of the limited resources available in the area. Overall the Mojave Desert was sparsely inhabited, with small family groups moving in a round of hunting and gathering. Post-contact warfare between desert tribes has been noted but the pre-historic associations remain unknown.
<table>
<thead>
<tr>
<th>Period</th>
<th>Time Period</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pleistocene Period</td>
<td>Earlier than 10,000 BC to 8,000 BC. Large bifaces, cores, flakes, scrapers no projectile points. (Rogers' &quot;Malpais&quot; or San Dieguito I period, associated with cleared circles and intaglios.)</td>
<td></td>
</tr>
<tr>
<td>Lake Mojave Period</td>
<td>8,000 BC to 5,000 BC. (Warren and Crabtree, 1986) and 6,000 to 4,000 BC (Bettinger and Taylor, 1974). Sites associated with Pleistocene lake shores. Fluted points similar to Clovis and Folsom, leaf shaped points and knives, crescents, Lake Mojave points, concave scrapers.</td>
<td></td>
</tr>
<tr>
<td>Pinto Period</td>
<td>5,000 BC to 2,000 BC. Contains Pinto Points, but both the points and the period are poorly defined.</td>
<td></td>
</tr>
<tr>
<td>Gypsum Period</td>
<td>2,000 BC to AD 500. Humbolt, Elko, and Gypsum Cave points, grinding stones (manos and metates) become prevalent and continue through later periods. Split twig figures, pit houses and Basketmaker III pottery appear in the east. Turquoise mining occurs.</td>
<td></td>
</tr>
<tr>
<td>Saratoga Springs Period</td>
<td>AD 500 to AD 1200. Rose Springs and Eastgate points, Gray Ware Pottery.</td>
<td></td>
</tr>
</tbody>
</table>
AD 1200 to historic time. Small, triangular arrow points replace the larger, stemmed points - Desert Side-notched and Cottonwood triangular points.

Local brown ware pottery ("Paiute brown ware") is introduced. Use of mortar/pestle, increase of bone and shell tools and ornaments, use of roasting pits

Mortuary customs shift from inhumation to cremation. Linguistics poorly understood (Numic speakers spread from Death Valley, however informants spoke Takic.)
ROCK ART

Pictographs (painted) and petroglyphs (pecked or abraded) are two forms of rock art found in the Mojave Desert. Desert varnish (chemical weathering phenomena which deposits a layer of brown patina on the surface of stone), made large rock surfaces an attractive medium for the creation of petroglyphs.

Petroglyphs in the Great Basin are divided into representational and abstract elements. The abstract category is further broken down into curvilinear and rectilinear. The following categories are found in the east Mojave Desert region.

**Anthropomorphs** - elements having a human-like form, often stick figures.

**Zoomorphs** - elements having an animal-like form i.e. deer, lizards, mountain sheep, scorpions.

**Curvilinear** - rounded figures such as circles, wavy lines, suns, bar-bells.

**Rectilinear** - straight lines or lines joined at angles such as squares, "E" or rake shapes, zig-zag lines.

There are also combinations of these elements such as a possible insect design which combines squares and wavy-lines in its make-up or meandering lines which change from zig-zag to wavy.

The pictographs found in this area are often associated with petroglyphs. They are usually curvilinear and rectilinear designs in red, white, black, or green colors.

Some rock art sites are associated with other archaeological remains such as tools or pottery, but not always. All of the rock art in this area of the Mojave Desert, however, is located near water sources (i.e. near springs, seasonal streams, washes) and trails. Petroglyphs seem to occur along the Mojave Trail wherever there is water.

Attempts to date rock art have met with limited success. It has been suggested that the styles change through time. The curvilinear style may be the earliest, followed by rectilinear.
Although these pictures have been studied for years, there are exceptions to most of the interpretations. Those along trails may be linked with big game hunting in some areas but not in the eastern Mojave Desert. Mountain sheep were the only large game in the area but they did not occur where many of the petroglyphs sites are which depict them. Some researchers believe glyphs in this area simply mark travel routes or indicate ownership of various resources.
SOME PLANTS USED BY DESERT INDIANS

Agave - "cabbages" and stalks roasted and eaten, blossoms boiled and dried. Fibers from leaves used for clothing, sandals, etc.

Brittle Bush - dry seeds gathered from July to August. Often parched with hot coals and ground into meal on metates.

California fan palm - dates were gathered from late June to early November. Eaten fresh or sun-dried and stored. Could be ground into meal.

California juniper - edible berries gathered in large quantities between June and August. Eaten fresh or dried in sun; ground into meal and made into mush or formed into cakes and stored.

Chia - seeds harvested from June until September. Hull ed by rolling on a metate and applying pressure with a mano. Then dry seeds were winnowed in a flat basket. Seeds were parched in baskets with hot coals, then ground into meal.

Creosote Bush - edible flower buds harvested between May and June.

Desert Ironwood - seed pods collected from May to June. Roasted in an open fire and pounded into meal, formed into small cakes.

Jojoba - fruit gathered between May and July. The oily seeds were eaten fresh or ground into meal.

Mesquite - can be eaten as is, tree-dried, or made into a beverage or mush. June through August. Both pods and beans eaten.

Mormon Tea - hard, black seed collected in early summer and ground into meal and eaten as a mush.

Ocotillo - edible blossoms collected from March until mid-summer. Eaten fresh or soaked in water for a drink. Seed pods also collected and eaten.

Opuntia - Beavertail cactus - young fruit and buds collected between March and June. Ripe fruit eaten fresh and tender buds cooked or steamed with hot stones in a roasting pit.
Opuntia - Pencil cactus - fruit gathered between April and May. Eaten fresh or sun-dried and stored.

Saltbush - seeds harvested from June until September. Ground into flour and eaten as mush.

Screwbean - like Mesquite but pod is coiled rather than straight. Ripens several weeks earlier than Mesquite and are sweeter.

Yucca - green seed pods and edible flowers collected in early April and May. Seed pods were roasted in pit with hot coals.
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San Diego, CA

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- *The Broken Stones*
- *Anza Conquers the Desert*

*(Books may be obtained from the publishers, museum gift shops, or Coyote Press, P.O. Box 3377, Salinas, CA 93912.)*
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