".....Upon emerging from the canyon, we entered a sandy plain, and at once lost all signs of the river bed. After traveling 13 miles across this plain, we were fortunate enough to find a hole containing some water, and here we made our camp late at night. The water was barely sufficient for our nearly exhausted animals.... We afterwards found some uninhabited huts near here, and saw an abundance of old Indian tracks, but no Indians..... We observed today that to the north of our camp was a large lake-bed, and here we inferred the waters of the Mojave were collected. The question now was, whether this lake had an outlet, or whether it was a basin, and the terminus of the Mojave.... To the east of our camp was a high range of barren mountains, its crest fifteen to twenty miles distant. Lieutenant Stoneman and myself ascended to the summit of one of the nearest peaks, from which we had an extended view.... To the eastward were to be seen nothing but mountains; we saw, however, that to the northward of the salt lake, and not far distant from it, were several other lake beds.....

On the morning of November 16, at 5 o'clock, we started by fine moonlight and travelled to the northern extremity of the salt lake, and thence on to the next one. We found the two connected by a ditch, cut by water in the clay soil, and about twenty feet wide, with banks two feet high. The two lakes were from three to four miles apart. The second one was six miles long and three broad. The character of the second lake was entirely different from that of the first. It was dry, hard clay-bed, on which the shoes of the mules scarcely made an impression..... On arriving at the north end of the lake, we found a very low ridge, connecting the hills on either side. We searched for a passage through this ridge, but could find none..... I hence concluded that the true sink of the Mojave river was in the salt lake.... but that in time of very high water in the salt lake, its surplus flowed through the ditch into the second lake."

* Lieutenant R. S. Williamson, Corps of Topographical Engineers, United States Army, on his discovery of the sink of the Mojave River at Soda and Silver Lakes (1856).
ROAD LOG
SODA LAKE TO CIMA DOME

Mileage  Interval
00.0     0.0

The road log begins at the swing gate on Zzyzx road, adjacent to the Bureau of Land Management's Orientation Center.

The man-made structures visible through the Tamarisk trees looking west from Zzyzx Road at the swing gate represents the efforts of the two largest "landlords" of Soda Springs, Curtis Howe Springer and the Federal Government.

It was a follower of "Doc" Springer's who built the brightly colored low rock wall just visible through the trees. The wall marks the boundary of a lot claimed by one of the full-time residents of "Zzyzx Mineral Springs and Health Resort", as it was called during the Springer era, from 1944 - 1974. A series of lots were laid out at one time in this area; the concrete posts in a row along the west side of Zzyzx road mark some of the boundaries. These all date from Doc Springer's "confident" period in the late '50s and '60s, before his legal troubles started. Springer felt he was going to gain title to the land
eventually and by bringing in street people from Los Angeles, he had a ready source of cheap labor to undertake his improvements. The decision did not swing in his favor, however. Doc Springer was evicted from Zzyzx by the Bureau of Land Management (Dept. of the Interior) on April 11, 1974.

To the left are visible the three major rock formations that form the southern end of the Soda Mountains. Behind to the south are Mesozoic age granites which have intruded upon Jurassic and Triassic metamorphosed volcanic and limestone rocks (see Geologic Time Chart, Appendix I). The lighter colored limestone stands in contrast to the darkly varnished metavolcanics; the granites typically form the higher parts of these mountains. Recently, investigations on the alluvial fans descending to the playa (dry lake bed), and their relationship to dated shorelines of ancient Lake Mojave have helped elucidate the role of Quaternary climatic changes in forming fan deposits in the region (see Appendix II).

Ground water which has surfaced to form a seep is visible as we pass over a culvert, and was also abundant at this location in historic times. This spot was dubbed "upper
Badger Holes" by miner Frank Riggs and his wife Sarah when they added it to their claim on the Hetzel Mill site, which included what was known as Soda Station in 1889. The Riggs filed on the water rights to this pool "located one-half mile north of the station" in the year 1898.

00.7 00.1 STOP at north chain gate area to view petroglyphs, marsh plant community and evidence of Pleistocene Lake Mojave.

Zzyzx Road slices a toe of the Soda Mountains at the north chain gate. On the south side of this toe and a very short distance upslope is a flat boulder displaying less than a dozen petroglyphs. At road level farther north on Zzyzx Road (but still south of the chain gate), there is another small scattering of petroglyphs on two boulders. Petroglyphs are images made by prehistoric people by purposefully scratching, pecking or abrading a rock surface, exposing the lighter unpatinated rock beneath. This small panel is noteworthy for having the most distinct images of the few examples of rock art in the vicinity. The exact meaning of the petroglyphs is unknow. As to dating, this rocky point was submerged during the high stands of Lake Mojave, thus these glyphs are more recent than about 8,000 years ago. Looking upslope on the toe you can see undercutting which occured along the old shoreline.

Analysis of sediments taken from cores on Soda and Silver Lakes,
as well as flood evidence from along the Mojave River’s course is helping to understand Late Pleistocene and Holocene paleoclimates, and therefore the conditions under which this current desert formed (see Appendix III).

Around on the north side and uproad from this toe, the debitage from a lithic quarry is eroding down the steep hillside. Large, primary reduction flakes (shed during trimming of a potential stone tool) can be traced up to the top of the toe. Lithic quarry sites, trails and other features in the Soda Mountains were recorded by archaeology students from C. S. U. Fullerton and C. S. U. Long Beach. Several sites have contained a remarkable abundance of flaked material. This suggests a long or intense period of use, perhaps dating as far back as 10,000 years ago (see Appendix IV).

Just as humans were attracted to this site because of water, so are many kinds of wildlife. Just at the base of this toe is a sizable seep, supplying enough water to the surface to produce a small pond on the outer edge. This pond usually dries up in summer months, when evaporation and a dropping water table reduce it to salty mud. However, from mid-fall until then, it is a refuge for ostracods, algae, aquatic beetles (Dytiscidae and Gyrinidae), water striders (Gerridae), Pacific treefrogs (Hyla regilla) and occasional migrating water fowl. Some desert wildlife cannot go long without some water available, particularly birds and larger mammals. Sites like the seeps and

4
springs along the southwestern shore of Soda Lake are excellent places to observe birdlife and mammals like coyote (*Canis latrans*), bobcat (*Felis rufus*), gray fox (*Urocyon cinereoargenteus*), badger (*Taxidea taxus*) and cottontail rabbits (*Sylvilagus audubonii*). Marsh hawks (*Circus cyaneus*), redtailed hawks (*Buteo jamaicensis*) and turkey vultures (*Cathartes aura*) are often seen soaring or perched nearby, while marsh wrens (*Cistothorus palustris*) forage and nest in the stands of cat-tail (*Typha domingensis*), bulrush (*Scirpus olneyi*) and common reed (*Phragmites australis*) which do well in the saturated, alkaline and oxygen poor lake sediments. Other plants adapted to the damp alkaline/saline soils seen here are salt grass (*Distichlis spicata stricta*), which can excrete excess salt from its leaves, Cooper’s rush (*Juncus cooperi*), the large leaved yerba mansa (*Anemopsis californica*) and slim aster (*Aster exilis*).

01.4  0.7  To the east across the playa between 1:00 and 3:00 on the horizon is a view of plioene age basalt flows. Note the abandoned grade of the Tonopah and Tidewater (T & T) Railroad on the floor of the playa in the foreground. The realization of F. M. ‘Borax’ Smith’s dream to develop his borate properties in Death Valley, the T & T (locally known then as the "tired and tardy") was completed in 1907. The T & T
operated between Ludlow, California and Gold Center, Nevada (near modern day Beatty) with varying frequency for 32 years, during which the Soda Lake section of the line saw flooding several times by 'mega-floods' from the Mojave River.

The rocky slopes and canyons of the Soda Mountains give rise to relatively small but well developed alluvial fans, as eroded material is transported down slope by water. Where these fans merge, a "bajada" (spanish for "slope") forms, which gradually levels out onto the playa surface. As material is washed down a fan, larger boulders and rocks settle out, and finer material is transposed down the fan and onto the bajadas. Thus soil conditions such as drainage, aeration and salinity change as one moves up slope, and can be indicated by the changes in flora and associated fauna. The dominant plant community on the flanks of these mountains is Creosote Bush Scrub. Here perennial shrubs such as creosote bush (Larrea tridentata), white bursage (Ambrosia dumosa) and brittlebush (Encelia farinosa) find preferred habitat along with a host of other shrubs and annual wildflower species. Near the bottom of the bajadas, where mountain runoff and drying lakes have combined to increase soil salinity/alkalinity, desert holly (Artiplex hymenelytra) and hoary saltbush (Artiplex canescens canescens) find their preferred conditions. Desert holly, with its whitish herbage and holly-like leaves, is an indicator of calcareous soil.
conditions, and can come to dominate areas with carbonante rocks such as the locally exposed limestones. Some of the fauna associated with rocky slopes and canyons here would include ringtail (*Bassariscus astutus*), desert woodrat (*Neotoma lepida*), canyon mouse (*Peromyscus crinitus*), rock wrens (*Salpinctes obsoletus*), chuckwalla lizards (*Sauromalus obesus*) and the speckled rattlesnake (*Crotalus mitchelli*).

02.0 0.6 On a vertical face of rock upslope to the left (where Lake Mojave cut a short cliff), and scattered in the area below on several boulders are examples of "historic graffiti".

Until March, 1776, no white man had ever crossed this part of California or stopped at Soda Springs to drink as the Chemehuevi and Mohave Indians did. In that year, Padre Francisco Garces was led across the desert by Mohaves on a trail between the Colorado and Mojave Rivers. This opened the way for caravans to travel into Southern California along what became known as the Mojave Road.

This historic graffiti, such as "GH 1859", mark a wagon freighter’s rest stop, and were probably done with axel grease or "wagon tar". The first written application of the name "Soda Springs" to this area occured this same year, in a military report on local conditions made by Lt. Col. William Hoffman.
Wagon traffic began in earnest through the area in the 1860s (see Appendix V).

As the Soda Mountains drop away from the road, a thicket of honey mesquite (*Prosopis glandulosa torreyana*) is visible on the left. "Mesquite camp" as it is now known, is an archeological site recorded by archaeological students from C. S. U. Fullerton in 1979-80. Evidence of food storage and processing (grinding stones) were found. Mesquite camp appears to have been used by prehistoric people of the relatively recent past, perhaps within the last 2,000 years. This area was part of Chemehuevi territory then, though visited by the Mohaves as well. Mesquite growth is an indicator of relatively shallow ground water.

Zzyzx Road climbs onto a large Holocene alluvial fan. Here along the roadside and in the braided washes cutting the fan, two other common perennial shrubs are found, cheese-bush (*Hymenoclea salsola*), and sweetbush (*Rebbia juncea*). Aromatic cheese-bush is bright green during new spring growth; the long linear leaves
contrasting with the straw color of old
growth. The flowers are unisexual, with the
male flowers showing silvery involucres
which gives the plant a distinctive
appearance during spring. Sweetbush forms a
medium to large hemispherical shrub with old
and new flower heads radiating from the
surface.

In this more open Creosote Bush Scrub we may see two of the few
day active mammals in the Mojave, the antelope ground squirrel
(Ammospermophilus lecurus) and the black tailed jackrabbit
(Lepus californicus). Both have physiologies adapted for water
conservation, but they must maximize water intake through their
food choices. Both species seek out the moister plant tissues
available during spring growth, particularly annual species, and
the ground squirrel also preys heavily on the moist bodies of
insects. Both will retreat into shade or burrows during the
extreme heat of summer days.

03.7  1.1  As we near the end of Zzyzx Road, large
washes or "arroyos" cross it's path.

These larger arroyos support stands of smoke tree (Psorothamnus
spinosa), named for its dense growth of slender grey pubescent
branches, which from a distance can look like smoke rising out
of the wash. Smoke tree is common below 500 meters (1500 feet),
and like several other trees of the pea family, it has become a
desert wash specialist whose seed germination and establishment
is closely tied to wash conditions. Such species may require
abrasion of the seed coat (scarification) during flash flooding,
in order to begin oxygen and water uptake. Young trees must
establish a strong and deep root system to anchor it against
flash floods and to take advantage of percolating flood waters.

04.8       1.1       Turn right (northbound) on I-15.
05.0       0.2       Exposures of ancient alluvial fan deposits
called Tertiary fanglomerates are revealed
in the road cuts and form the north-south
trending linear ridges. These fanglomerates
are composed of rocks which were not derived
locally from the Soda Mountains.
Large-scale deformation during the Tertiary
removed these ancient fans from their source
area and incorporated them into younger,
uplifted mountains, such as the Soda
Mountains.

05.7       0.7       Panorama of Pliocene (6-3 million year old)
basalt flows on the horizon between 12:00
and 3:00; in the distance, Old Dad Mountain
and the Devils Playground can be seen at
3:00 to 6:00 with Soda Lake playa in the
foreground. Watch along the road the next
few miles for another specialized wash tree
in the pea family (Fabaceae), palo verde (Spanish = Green sticks: *Cercidium floridum*), which has about the same elevational range as smoke tree, and is more common to the Sonoran desert. This species is drought deciduous, bearing leaves only when adequate water is available to the tree. However, like smoke tree, the majority of its photosynthesis occurs from chlorophyllous tissues in the stems and younger branches. In flower the outer branches are a showy display of bright yellow corollas.

10.3 4.6 Exit I-15 at Hwy 127/Kelbaker Road junction.

10.7 0.4 Stop and turn right onto Kelbaker Road.

The town of Baker, behind us, was born a railroad town; one of the routine stops of the old T & T. Silver Lake, just to the north, was the main stop, but a section house for the road gang was constructed at Baker and the train did stop there three times a week in the early days. Originally known as "Berry", the town was renamed for Lord Richard C. Baker, an important backer and partner in Borax Consolidation, Limited, owner of the railroad (Hildebrand 1982).
The Arrowhead Highway, Hwy 91, (later to become I-15) was only a dirt track through the Soda Mountains when Enos B. Failing bought the northeast corner of Baker in 1927. When R. J. "Dad" Fairbanks moved his operations to Baker a few years later, there were approximately one dozen permanent residents in town. By 1933, Baker had a post office and in 1941, its first school (O'Conley 1969).

12.7 2.0 On the right skyline, Old Dad Mountain at 1:30 and the Cowhole Mountains at 2:30 flank the northern edge of the Devils Playground. Climbing dunes bury the north flank of the Little Cowhole Mountains at 3:00.

For the next several miles the Kelbaker Road crosses modern and Holocene distal fan deposits from drainages in the Cima volcanic field approximately 15 miles to the east (ahead). Note varnished cobbles and boulders of basalt scattered across grus (decomposed granite) sediments. These clasts have been transported 6 miles across slopes of 1 to 2 degrees and at least another 6 miles across slopes of 2 to 4 degrees.

To the north, at 9:00, are the Silurian Hills, and at about 10:00 is Turquoise Mountain with a microwave relay station on top (4500 feet). On the north west slopes of Turquoise Mountain is the Toltec turquoise mine which gives the moutain its name. Evidence of prehistoric mining of the desirable material was
found in the area 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 branch off where veins had been followed. In cleaning out these aboriginal pits, many tortoise shells were discovered; they were probably used to "muck out" or remove unwanted material chipped from the face. Stone mauls, picks and axes were found, as well as heavy hammers.

The Creosote Bush Scrub on these gentler slopes is dominated by the common assemblage of creosote bush and white bursage, with occasional cheesebush and saltbush along drainage courses. In years of adequate winter precipitation, the perennials would be joined by many species of annuals in March and April. As you can see, this was not one of those years. This open, flat brushland is good habitat for the desert iguana (Dipsosaurus dorsalis), a pale grayish lizard with some darker blotches and/or banding (see the D. S. C. logo). These iguanas are omnivorous, taking insects or young plant tissues and flowers, or carrion when found. They are also tolerant of extreme temperatures, and can be seen abroad when other lizards find it too hot to be on the surface. When ground temperatures soar, it is common to see desert iguanas in the branches of shrubs, avoiding contact with the ground. Other lizards common to Creosote Bush Scrub of this type are the predacious leopard lizard (Gambelia wislizenii) which hunts other lizards and insects such as grasshoppers, and zebra-tailed lizard
(Callisaurus draconoides), which has the same tastes as leopard lizards, but take smaller prey, as they are about half the size of the former. All three of these lizards are extremely fast runners, getting up on their hind legs and running bipedly for maximum speed; thus they are rarely found where vegetation is so dense as to impede running. Other reptiles to be seen here are the red coachwhip snake (Masticophis flagellum), western whiptail lizard (Cnemidophorus tigris), and Mojave green rattlesnake (Crotalus scutulatus scutulatus). The latter is of some concern as it tends to be an aggressive species which will advance or hold its ground when disturbed, and whose venom is the most dangerous of North American rattlesnakes (possessing both a strong hemotoxin and neurotoxin which effect blood and nerves, making medical treatment difficult).

Another reptile of particular note is the desert tortoise (Xerobates agassizii) which has recently been listed as an endangered species by the federal government. The accumulative effects of desert development, road kills, burrow vandalism, raven predation, cattle grazing, off-road vehicle use and a respiratory disease possibly spread by released ex-captives has placed increasing pressure on some populations. Tortoise activity is usually associated with spring annual growth and flowering periods, which provides their primary food source; during much of the year they will remain dormant in their burrows.
For the next several miles this route presents impressive views of pediment domes that form a prominent landscape in this part of the Mojave Desert (Fig. 1). Pediment domes are large erosional surfaces cut across bedrock and tertiary fanglomerates in broad conical shape. The origin of such features is controversial. Note the robust creosote bushes along the road side as compared with the general aspect presented away from the road. This is a result of increased water availability from road run-off, taken to full advantage by the plant's dual root system of shallow finer roots to catch water near the surface, and deep tap roots to access ground water layers. We also begin to see cacti such as silver cholla (*Opuntia echinocarpa*) and pencil or diamond cholla (*O. ramosissima*) on these better drained soils higher upslope. Slow down for an abrupt turn to the right (south). As seen in the hills adjacent to the road, inselbergs of granitic gneiss result as less resistant granite is eroded away, leaving behind more resistant metamorphic rocks. Desert bighorn sheep (*Ovis canadensis nelsoni*) have been seen
Figure 1: Halloran Hills (north) to Cima volcanic field (east) to Old Dad Mountain (south). Letters at the south end of the Cima volcanic field designate several of the more prominent volcanic cones in that part of the field. Panoramic view east from along the Kel-Baker Road.
here, and in the nearby Old Dad Mountains. Several herds exist in other mountain ranges in the Mojave, but all are constricted by habitat encroachment and competition for food and watering sites from other animals, especially feral burros (*Equus asinus*), which number in the thousands in the north and east Mojave.

Road passes by remnants of middle pleistocene alluvial fans on the left. The fan surface here is heavily armoured with large boulders of basalt. The fan was deposited between 0.3 and 0.2 million years ago.

SLOW to view old basalt flows. The road crosses over a 0.17 million year old flow (at road level) and skirts the western end of three flows the are 0.58, 0.3, and 0.17 million years old. The oldest flow, which flowed down an ancient channel, now stands the highest topographically, representing "inversion of topography." These flows temporarily dammed the ancestral Willow Wash. The road passes through a small notch cut across the distal end of these flows where they impinged upon the flank of the Old Dad Mountain.
24.4  0.4  Turn right into wash and immediately angle up wash towards the far cut bank (do not go up road visible along poles).

24.5  0.1  Take the track to the right out of the wash.

25.0  0.5  Crest pass. There is a 20 foot deep shaft on the left, and mining camp debris about.

As we descend the steep grade ahead, you can see several species of cacti on the rocky slopes above, including beavertail (Opuntia basilaris), hedgehog cactus (Echinocereus engelmannii), barrel cactus (Ferocactus acanthodes), cottontops (Echinocactus polycephalus) as well as silver and diamond chollas seen earlier along Kelbaker Road. This succulent component of the Creosote Bush Scrub seen here is probably a result of well drained soils and relatively stable slopes. Halfway down this grade on the left is an easily seen burro trail, and the amount of burro droppings usually found here indicate that this pass is a frequently traveled route.

25.2  0.2  Stop at the bottom of the grade to view an abandoned mining camp of the early 1900s.

Around 1900 there was a flurry of interest in mining in the Halloran Springs - Old Dad Mountain area, fueled by a gold stike near what is known as Seventeen Mile Point. This toe of land at the northernmost tip of Old Dad Mountain marked a half-way point on the Mojave Road between Soda Springs and Marl Springs, a
distance of 34 miles. Seventeen Mile Point was a dry camp for
the freight wagons and later the name of the mining camp set up
there between 1900 and 1914.

Gold was discovered south of Seventeen Mile Point at the Oro
Fino Mine in the 1890s and at what became known as the Brannigan
Mine in 1905. By 1909, another group of claims nearby was being
worked by the Precious Metals Development Company of Los
Angeles. These claims later came to be known collectively as
the Whitney Mine. A mill to refine the ore was set up and
running at the camp at Seventeen Mile Point by February, 1911.
Water for the mill was reportedly piped in from Indian Springs
some 4 miles away.

After a shut-down in the 1920s, activity at the Brannigan Mine
resumed in March, 1930. That year M. A. Sisley and John Herrod
relocated the claims and worked them until 1935. The Oro Fino
Mine was also reactivated, and from 1930 to 1943 produced about
$50,000 in Gold (Vredenburgh, Shumway and Hartill 1981).

The foundations and artifacts we see here today are the remains
of a mining camp. Although it may have begun during the earlier
period of activity in the area, the artifacts visible at this
camp are associated with the later phase of mining activity in
the area undertaken in the 1930s. The well-preserved dug-out is
a typical structural form for an historic desert dwelling in an
area where there is a severe shortage of construction materials.

Although it has not generally been a good year for annual plant growth, careful observation will reveal several species in flower here now, including desert poppy (*Eschscholzia minutiflora*), pincushion flower (*Chaenactis* sp.), woolly plaintain (*Plantago insularis*) and forget-me-nots (*Cryptantha* sp.). While you are scanning the ground for the minute individuals typically produced in a dry year like this, notice the delicate dark crust which covers the soil in places. This is a form of lichen (symbiotic association between algae and fungi), which is very important in soil development and moisture retention. These lichens send down dense growths of microscopic fungal filaments (hyphae) into the upper 2-3 centimeters of soil, helping to anchor the soil from wind erosion, and forming a moisture barrier which minimizes evaporation from the soil. These lichens are probably also important in nutrient cycling in the soil.

25.4 0.2 Go straight up slope. Notice the growth of straw colored galleta grass (*Hilaria rigida*) which is common in sandy areas. Much of it here has been grazed, probably by feral burros

25.7 0.3 The sand dunes at 9:00 represent the eastward most extension of the massive eolian (wind blown) sand deposits which
cover the Devils Playground and climb onto the western flank of Old Dad Mountain. Eolian landforms are more prominent and spectacular within a 50-km radius of Soda and Silver Lakes than they are in most other parts of the California desert. Various eolian formations, from active dunes to stabilized sand sheets, occur immediately west of this site and provide an excellent field setting for eolian geomorphology and plant/animal ecology related to sandy soils.

Mormon tea (Ephedra sp.) becomes a codominant shrub in this area. It appears as a leafless shrub of mostly erect green branches. Male and female plants are separate and look alike, unless the males are at pollen release, in which case the tiny pinecone-like srobili (they have no flowers) burst out with bright yellow pollen sacs.

25.9 0.2 Stay left and descend the wash.
26.6 0.7 Continue down wash, passing three poles on your right. The dominant shrub occurring in this part of the wash is groundsel (Senecio douglasii).
26.9 0.3 Make a tight right turn just before another group of three poles; gain a good road headed east.
27.8 0.9 STOP at Kelbaker Road and turn right.

33.3 5.5 Turn left onto road which heads towards a three humped cinder cone group.

33.7 0.4 Cross deeply cut Willow Wash (caution: do not stop in wash with two wheel drive vehicles, but keep momentum up inorder to ascend far bank). The trees in Willow Wash are desert willow (*Chilopsis linearis*), which are not true willows, but do give the wash its name. Desert willow is common to washes below 1650 meters (5000 feet).

As we ascend a flow of middle Pleistocene basalt, Mojave yucca (*Yucca schidigera*) can be seen in flower and fruit. This is the first of three yucca species we will see and is the most widespread in the Mojave Desert. As we traverse the stone pavement on top of the basalt flow, note the interlocking nature of "varnished" basalt clasts on the surface. These clasts rest upon a 0.5 to 3 meter thick layer of eolian silt! We will discuss these relations later on the trip.

34.2 0.5 Continue straight as you cross the boundary between the basalt flow and Holocene (?) age tephra (volcanic cinder) blown out of the Black Tank cone immediately ahead. Few plants have been able to establish themselves on the young and calcareous soils
of these youngest cones. Shadscale (Atriplex confertifolia), the grey-green shrubs near the base of the cone, and skeleton weed (Eriogonum deflexum), on the slopes above the shadscale, are apparently two early colonizers. Shadscale is a significant indicator of rocky, well drained and calcareous soils, and in some places becomes the dominant shrub of an assemblage known as Shadscale Scrub.

34.7 0.5 STOP near the T-shaped trench cut into the fresh cinder left of the road. We will discuss the geology of the Cima volcanic field, the history of the youngest eruption in the field, and the ecology of the different ages of volcanic landscapes.

34.7 0.0 Turn around and retrace the route to Kelbaker Road.

36.2 1.5 STOP at Kelbaker Road and turn left.

39.7 2.5 As the road starts curving left, look for a graded dirt road to the right and turn on to it.

39.7 1.0 As you move slowly upslope in this creosote bush/bur sage community, plants which show an affinity for loamy soils and higher elevations begin contributing to the plant community, such as blackbrush (Coleogyne
ramoisissima), boxthorn (Lycium cooperi), hopsage (Gravia spinosa) and white ratany (Krameria grayi), the latter of which is a root parasite on some of its woody perennial neighbors. These shrubs, particularly boxthorn and hopsage, have stiff and spiny branches which probably discourages browsing on their fleshy leaves.

The road ascends Rocky Ridge, which is composed of eastward tilted Tertiary fanglomerates characterized by car-sized boulders of granite and metamorphic rocks derived from the Cima Dome area. We have now entered the lower reaches of another yucca species which is often synonymous with the Mojave Desert, the Joshua Tree (Yucca brevifolia jeageriana). This subspecies, named for famed desert naturalist Edmund C. Jaeger, is more densely branched and has shorter leaves than the type species found in the western Mojave. We will later travel through the most extensive stand of Joshua Trees anywhere, which is comprized of this subspecies.

STOP at the top of Rocky Ridge adjacent to the microwave towers. Walk a few hundred yards to the south and west for an overview
and discussion. A 360 degree panorama of the Cima Dome, Cima volcanic field, Old Dad Mountains, Devils Playground, Kelso Dunes and the Granite Mountains, among others, is available here. **BREAK FOR LUNCH.**

Rocky Ridge is composed of ancient alluvial fan deposits which were deposited in a subsiding basin between 19 and 11 million years ago. After 11 million years ago this region experienced a change in the tectonic setting and the ancient alluvial fans were uplifted along faults to produce Rocky Ridge. This region also represents a transition from the pedimented terrain eastward and towards Cima Dome, to the fault-bounded mountains and deep alluvial basins towards the Devils Playground. The Old Dad Mountains form a major structural boundary between the tectonically active Soda Lake basin and the relatively tectonically inactive Cima Dome area. The mountains to the west of this point are bounded by northwest trending strike-slip faults which offset Quaternary age alluvial fans in the area of the Old Dad Mountains (Fig. 2).

The view from here includes a glimpse of the historic Mojave Road route below, swinging east around Old Dad Mountain. As desert conditions do tend to preserve the trace of vehicular passage over the landscape, for better or for worse, the track up Rocky Ridge is still visible. From the lower ridgeline, the old road comes up the slope at about an 80 degree angle to the
GENERALIZED GEOLOGIC MAP – ODM/CVF STUDY AREA

Qpl  Plays
Qfu  Mid – late Pleistocene alluvial fans
Qfp  Pediment + alluvial fans
Qe2  Eolian sand dunes and sand sheets
Qb3  Late Pleistocene basaltic flows and cinder cones*
Qf2  Early–mid Pleistocene basaltic flows and cinder cones*
Nbg  Neogene basaltic flows and cinder cones*
Nfg  Neogene conglomerates and volcanic rocks
Kgr  Late Cretaceous granitic rocks
Dkg  pre-Cretaceous metamorphic and sedimentary rocks

0 5 km

PROSPECT WASH SHEAR ZONE

OLD DAD MTN.

Volcanic Field

*(FROM TURRIN ET AL., 1985)

Figure 2
Edison powerline, which runs through Jackass Canyon (see Casebier 1983 and 1988). From the works of Dennis Casebier and the Friends of the Mojave Road, we learn that the distance between Marl Springs and Soda Springs is about 35 miles, the longest stretch between water holes on the Mojave wagon road. In an effort to cut the march as much as possible, one early version of this route went up and over Rocky Ridge. The journal entries suggest that taking the route downhill presented no special problems and shaved several miles. Headed east from Soda to Marl Springs, however, the ascent was nearly impossible for freight-wagons, and the longer, sandy track through Jackass Canyon had to be used.

By 1859, the Mojave Road had been opened by way of Seventeen Mile Point and the climb up the hill was abandoned. An early description states that "the last twenty-five yards, at the top, the rise is so steep, that our wagon, in addition to its eight mules, had to be assisted up by thirty men, and I doubt if any number of mules could take up a loaded wagon" (Hoffman in Casebier 1983).

<table>
<thead>
<tr>
<th>Mileage</th>
<th>Distance</th>
<th>Instruction</th>
</tr>
</thead>
<tbody>
<tr>
<td>42.3</td>
<td>0.0</td>
<td>Turn around and retrace route to Kelbaker Road.</td>
</tr>
<tr>
<td>46.0</td>
<td>3.7</td>
<td>STOP at Kelbaker Road and turn left.</td>
</tr>
<tr>
<td>46.4</td>
<td>0.4</td>
<td>Turn right onto Aikens Cinder Mine Road.</td>
</tr>
<tr>
<td>48.0</td>
<td>1.6</td>
<td>The corral on the left is part of local cattle ranching operations using grazing</td>
</tr>
</tbody>
</table>
leases on public land.

Cattle and other livestock were probably first brought into the East Mojave as small herds accompanying the military in the 1860s. Commercial cattle-ranching is believed to have entered the East Mojave in the 1880s. The largest operation, the Rock Springs Land and Cattle Company, traced its beginnings to the year 1888 and used the "88" brand on its cattle. The Rock Springs outfit ran cattle for 40 years across a huge range which extended into Nevada. They built many of the water improvements visible in the East Mojave today, such as cattle tank at Government Holes, near Rock Springs on the Mojave Road. Today, much of the original ranch is still supporting cattle, but under new operations like the OX Cattle Company, Resting Springs Ranch and the YKL Ranch into Nevada.

The flora in this area varies with edaphic conditions and aspect, but is generally represented by creosote bush, Joshua tree up on the basalt flows and slopes of older cones and mixed with mojave yucca, bur sare, hopsage, boxthorn, desert senna (Cassia armata) and Mormon tea. This mixture of perennial species may give way to patchy areas dominated by one or two species only, as we will see approaching the next mileage mark. Where washes adjoin or cross the road, and along the road cuts, species like woolly brickellia (Brickellia incana), and cheesebush are seen.
SLOW to observe dense stand of desert senna on the right, just before the road starts to curve right. Take the narrow road to the left as the road begins to curve.

Pass a second corral on the left; turn left at the end of the corral fence.

STOP to view lava tube, and observe volcanic landforms and discuss their change through time (see Appendix VI).

As we continue to cross this flow we are in a transitional plant community form Creosote Bush Scrub to Joshua Tree Woodland; important components of both communities are present. Note the return of cactus species including barrel, cottontop and hedgehog cactus, and diamond and silver chollas. Watch for movement on the ground and we may see some of the lizards that inhabit the lava flows, such as the abundant side-blotched lizard (*Uta stansburiana*), desert spiny lizard (*Sceloporus magister*), or the large predaceous collared lizard (*Crotaphytus collaris*). The lizard populations on these flows exhibit darker coloration than their neighbors on other substrates, and are harder to spot unless they move.

Make a sharp "U" turn to the right to gain a newly graded road.

Turn left on Aikens Cinder Mine Road.
SLOW as we drive through the sorted piles of cinders being removed from the cone to the right.

The Aikens Cinder Mine has operated for over 40 years, producing up to 50,000 tons of cinders per year. About 70% of the cinder block structures on the Las Vegas Strip had their origin at this cone. Cinders are used because they provide a strong, low-cost, light weight aggregate. Cinders are also used for landscaping, road chip-seal, soil conditioners, and are presently being considered for rocket launch pad coverings. Many rare-earth minerals are found in the cinders, but no economical extraction methods currently exist. Presently claimed cinder cones are capable of providing needs for 600 years at the current rates of extraction (Ely in Casebier 1988).

The deeply eroded R vent (0.85 million years old) lies straight ahead.

Turn left under phone line to continue on Aikens Cinder Mine Road.

To the left on the slope above, you can see the statified layers resulting from "base surge" (see Appendix IV).

SLOW and look for a left turn just as the road starts to curve right; take the left turn.
56.1  0.7 Make a quick jog to the right before ascending the flow ahead, and then left and right in quick succession to weave your way onto a track heading towards Aikens Wash ahead.

56.5  0.4 Enter Aikens Wash; cross it towards the basalt flow visible on the far side of the wash.

56.55 0.05 Turn left down wash following tracks.

56.65 0.1 STOP at the "lava bubble" cultural site.

The "Aikens Lava Bubble" is part of a small lava tube within a middle Pleistocene (probably 0.33 million year old) flow. This site is distinctive among Mojave Desert cultural sites in that their are both petroglyphs and pictographs. This site is also noteworthy for the large concentration of the scratched and abraded images (petroglyphs) located on the outside of the bubble on the south face of the lava flow. The "glyphs" continue in scattered locations both up and down the wash from the bubble. Pictographs, the red painted markings on the inside of the arch, are restricted to the rock faces in this one area alone. The red pigment is probably hematite mixed with a natural binder such as yucca juice, egg white and/or blood.

Here is another reason the petroglyphs in Aikens Wash are important; several panels upstream from the bubble have been tested using cation ratio dating, a controversial technique
which was experimented with in the area by Ron Dorn and David Whitley. Cation-ratio dating is based on the differences in the rates at which certain elements are preferentially leached from the rock varnish on the basalt surfaces. A ratio of titanium to potassium and calcium is compared as a leaching curve to the radiocarbon age of the high shoreline of pluvial Lake Mojave and to accelerated radiocarbon ages of rock varnishes in the Mojave River basin. The results were suprising: several petroglyphs in Aikens Wash were over 10,000 years old, and some were as young as 200 years old.

The thickets of low trees in front off the bubble are desert willow, as first seen in Willow Wash earlier in the trip. The wash is also well endowed with cheesebush, desert senna, and desert almond (Prunus fasciculata). This last species is a common host to "tent caterpillars", which are gregariously nesting larvae of Lappet moths in the family Lasiocampidae, and are common in many habitats. The larvae hatching from an egg cluster will join forces in constructing their silky shelter, where they all retreat at night and in cold weather.

Also in this wash are boxthorn (one is in bloom under the bubble’s arch), woolly brickellia, and a few struggling annuals such as golden yarrow (Eriophyllum sp.) with their small yellow sunflowers dotting the grus (decomposed granite), and blazing star (Mentzelia sp.), a few of which should still be flowering. Up on the Rocky face of the basalt flow, we should see
California brickellia (*Brickellia californica*), jimson weed (*Datura meteloides*), desert tobacco (*Nicotiana* sp.) and ground cherry (*Physalis* sp.); the latter three sharing the same family as cultivated tobacco, potatoes and tomatoes (*Solanaceae*), and sharing a common trait of the family, that of being poisonous or in the case of jimson weed, also narcotic. Another species found nearby on the top of this flow or where the cliff has crumbled has affinities to a commonly cultivated family; turpentine broom (*Thamnosma montana*) is in the Rutaceae, which also includes citrus fruits such as orange and lemon. Examination of the fruits will reveal oily glands in the skin, and squeezing them releases a strong aromatic scent.

This basalt cliff is also home for the large herbivorous chuckwalla lizard, dozens of woodrats (whose nests dot recesses in the wall), and at least one active feral honeybee hive (*Apis mellifera*) located upwash from the bubble a short distance (watch for bee activity outside the hive).

56.65  0.0  Turn around and retrace route back to Aikens Cinder Mine Road.

57.9   1.25  Turn left on Aikens Cinder Mine Road.

59.1   1.2  Three lava flows lie at three different levels on the left at 9:00. The lowest flow topographically is the Z1 flow (0.27 million years old) which rests upon a pediment surface 5 meters above the modern channel.
and cut into Cretaceous-age granitic rocks. The next higher flow, the Z2, is 0.67 million years old and buries a pediment which lies 12 meters above the modern channel. The highest flow, BB, is 0.33 million year old and buries the Z2 flow. These relationships suggest that the pediment surfaces have been downwasting near the tops of the domes at rates faster than the distal reaches (see Fig. 3).

Corral and water tanks to right. For the next several miles the road traverses pediment surfaces cut across the Cretaceous plutonic rocks. Vents DD and EE lie on the northern skyline at 10:00 and Cima Dome forms the skyline ahead on the right.

The Joshua Tree Woodland here is quite well developed, and briefly forms an assemblage with the third yucca of our trip, banana yucca (Yucca baccata), which is acaulescent (without stems) and does not rise on a growing trunk, but rather stays low to the ground spreading vegetatively. Its leaves appear similar to mojave yucca, but are longer, narrower and often have a bluish color. Diamond cholla and buckhorn cholla (Opuntia acanthocarpa) join in here is well
Figure 3
to produce a rather dense 'understory' for the Joshua trees.

Cattle guard and telephone booth. The road turns left 90 degrees and for the next several miles follows the telephone line across a low pediment dome. From this point pediment surfaces extend from horizon to horizon. Compare this view with the landscapes observed west of Rocky Ridge; we have now passed into a terrain dominated by long-term erosion and relatively little tectonic activity for the past several million years!

Note the exposures of granite rocks along the road and adjacent to the road from this point to the crest of the small pediment dome. Geophysical studies indicate that this granite is weathered to depths in excess of 40 meters below the surface. Deep weathering may have occurred under moister climatic regimes during the Tertiary and early Quaternary.

As we move through the Joshua Tree Woodland of the Cima Dome population (the largest continuous stand of the species), you can watch the codominant shrubs drop out to a point where seemingly the only species besides Joshua tree is bur sage
(Ambrosia dumosa). After we pass the last corral and turn to the northeast, we will begin to descend into Shadow Valley. Eventually you will begin to see creosote bush again as we enter the transition back to Creosote Bush Scrub; however this valley is shallow and high enough to support Joshua trees almost to its bottom.

72.8 10.4 Turn left onto Cima Road (paved)
73.2 0.4 Turn left onto I-15. Return to the Desert Studies Center via I-15 to Zzyzx Road, and then south 4.8 miles.

END OF ROAD LOG
BIBLIOGRAPHY


BIBLIOGRAPHY


## APPENDIX I

### GEOLOGICAL TIME SCALE

<table>
<thead>
<tr>
<th>Era</th>
<th>Period</th>
<th>Epoch</th>
<th>Tentative Absolute Age</th>
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<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td><strong>11,000 yrs.</strong></td>
</tr>
<tr>
<td>Quaternary</td>
<td>Holocene</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td><strong>2 million yrs.</strong></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Pliocene</td>
<td><strong>8</strong></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Miocene</td>
<td><strong>26</strong></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Oligocene</td>
<td><strong>37</strong></td>
</tr>
<tr>
<td>Cenozoic</td>
<td>Tertiary</td>
<td></td>
<td><strong>53</strong></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Paleocene</td>
<td><strong>70 m.yrs.</strong></td>
</tr>
<tr>
<td></td>
<td>Cretaceous</td>
<td></td>
<td><strong>135</strong></td>
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<tr>
<td>Mesozoic</td>
<td>Jurassic</td>
<td></td>
<td><strong>190</strong></td>
</tr>
<tr>
<td></td>
<td>Triassic</td>
<td></td>
<td><strong>230 m.yrs.</strong></td>
</tr>
<tr>
<td></td>
<td>Permián</td>
<td></td>
<td><strong>280</strong></td>
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<tr>
<td></td>
<td>Pennsylvaniano</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Mississippiano</td>
<td></td>
<td><strong>350</strong></td>
</tr>
<tr>
<td></td>
<td>Devoniano</td>
<td></td>
<td><strong>400</strong></td>
</tr>
<tr>
<td>Paleozoic</td>
<td>Silurian</td>
<td></td>
<td><strong>430</strong></td>
</tr>
<tr>
<td></td>
<td>Ordovician</td>
<td></td>
<td><strong>500</strong></td>
</tr>
<tr>
<td></td>
<td>Cambriano</td>
<td></td>
<td><strong>600 m. yrs.</strong></td>
</tr>
<tr>
<td>Precambriano</td>
<td></td>
<td></td>
<td><strong>600-3600 m.yrs.</strong></td>
</tr>
<tr>
<td></td>
<td>Lost Interval</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Origin of Earth</td>
<td></td>
<td></td>
<td><strong>4600 m.yrs.</strong></td>
</tr>
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</table>
APPENDIX II

ALLUVIAL FANS ALONG THE FLANK OF THE SODA MOUNTAINS

Radiocarbon dated shorelines of Lake Mojave help to provide age constraints for alluvial fan deposits flanking Soda and Silver Lake playas. The alluvial fans in this part of the eastern Mojave Desert apparently were deposited in response to climatic changes beginning during the Holocene (see Appendix I), approximately 11,000 years ago. In 1986, Jean-Luc Miossec initiated a M.S. thesis project aimed at examining the sedimentological differences between Pleistocene and Holocene alluvial fan sequences along the southern Soda Mountains and near the Desert Studies Center. The primary goal of Miossec's thesis was to compare the sedimentary facies of alluvial fans deposited during the Holocene and Pleistocene in order to establish the relative role of Quaternary climatic change on alluvial fan depositional processes. In 1988 and 1989, Steve Wells, Les McFadden and several graduate students from the University of New Mexico combined efforts with Adrian Harvey from the University of Liverpool in England to carry on with the work initiated by Miossec, who was killed in an automobile accident in 1987 while leaving his study area.

This region (Figs. 1 and 2) provides an excellent setting for studying alluvial fans because:

(1) the fans are small and their boundaries can be easily traced;

(2) several fans of different ages occur along the Zzyzx Road and can be easily seen with their differences in the degree of desert pavement formation, of rock varnish coatings, and of soil development;

(3) latest Pleistocene Lake Mojave shore features (dated at approximately 18,000 and 11,000 years ago) provide an excellent time line across the landscape and can be used to distinguish Pleistocene and Holocene fans; and

(4) the alluvial fans along this section of the Soda Mountains piedmont can be physically traced to their bedrock source areas, showing the exact locations of the fan sediment.
APPENDIX III

AN OVERVIEW OF FLOODS AND LAKES WITHIN THE MOJAVE RIVER DRAINAGE BASIN: IMPLICATIONS FOR LATEST QUATERNARY PALEOENVIRONMENTS IN SOUTHERN CALIFORNIA.

The Mojave River flows eastward over 200 km from the Transverse Range across a large arid drainage basin in southern California (approximately 9500 km²) and terminates at the playas of Soda Lake and Silver Lake (Fig. 1). The terminal area of the Mojave River contains numerous indicators of past climatic and geomorphic conditions which record variations in the hydrologic cycle during the past 22,000 years, including (1) radiocarbon-dated shore features from late Pleistocene and Holocene lakes, (2) thick lacustrine sediments of pluvial Lake Mojave which record individual large-volume flood events, and (3) paleo-sheetflow deposits on adjacent alluvial fan surfaces. In addition, the watershed has well-documented, historical hydrologic and climate data on flood events at the river’s terminus. The combination of latest Quaternary geologic record and historical hydrologic/climatic record provides an unique physical setting for determining how large arid drainage basin responded to climatic changes during the latest Quaternary.

During the 20th century, several short-term lakes formed in the playas at the terminus of the Mojave River in response to prolonged precipitation events in the Transverse Ranges. Results from analyzing 13 cores of pluvial Lake Mojave sediments reveal that prolonged late Quaternary lake events also occurred in response to increased frequency of large-volume flood events which were associated with climatic changes in the Transverse Ranges. Paleo-hydrologic features preserved at Lake Mojave were directly impacted by precipitation variations in a very small portion of the Transverse Ranges. Only a small part of the Transverse Ranges was glaciated during this time; thus glacial meltwaters provided only a small fraction, if any, of the discharge into pluvial Lake Mojave relative to rain and snow. Between 22,000 and 8,000 years ago, pluvial Lake Mojave was sensitive to variations in precipitation and runoff from a mountainous area which represents only five percent of the total drainage basin area.

Documented lake-forming events occurred in 1903, 1910, 1916, 1921-22, 1938, 1969, 1978, 1980 and 1983 at the terminus of the Mojave River (Fig. 2). Lake stands approximately 3.1, 6.7, and 1.8 m deep occurred during the best documented and largest lake events in 1916, 1938 and 1969. The maximum discharges in the headwaters of the Mojave River and along its course at Victorville and Barstow during the 1938 flood were 2000 and 1821 m³/sec, respectively. Flood stages exceeded 6.3 m during the 1938 event. In 1969, discharge exceeded 500 m³/sec at Afton Canyon gaging station with a stage exceeding 3 m. These discharge events produced ephemeral desert lakes 200 km away...
Appendix III

from the runoff-generating mountainous uplands and typically occurred during the winter from December through early March which is the primary precipitation maximum in southern California.

The Mojave River floods recorded at The Forks, Afton, and the playas demonstrate that the majority of large floods have originating in the headwaters were able to produce lakes at the terminus of the river. Few floods reached Afton with insignificant water volume and did not produce a lake in the terminal basins. Thresholds related to precipitation and to groundwater storage apparently must be exceeded before flood volumes sufficient to support a lake can reach the terminal playas. Under present conditions, flooding occurs only when a single high-magnitude flood (e.g., 1938) or few, closely spaced lower-magnitude floods (e.g., 1978) occur during the winter months (Fig. 2). These floodwaters drain into Cronese Lakes and the distal areas of Silver Lake playa (Fig. 1). Annual precipitation exceeds a range between 1.5 to 1.75 m in the high elevations of the headwater area dueing the documented flood/lake event years. The majority of this precipitation occurs in less than a month. Climatic data from the Transverse Ranges suggest that a threshold range related to precipitation from a single and clusters of winter storms affect the volume of runoff and episodes of lake-building (Fig. 2).

Several core and borehole data are used to reconstruct the configuration of the depositional basins of Lake Mojave. Lake Mojave was composed of two depositional basins centered over Silver Lake and Soda Lake playas where lacustrine sedimentation was greatest, and apparently a more complete record of sedimentation occurs in Soda Lake basin (Fig. 3). Pluvial Lake Mojave existed from approximately 22,000 to 8,700 years ago based upon radiocarbon dating of shell material, tufa and organic matter from Silver Lake cores and shore features. Some of these types of dateable deposits and materials can be seen in the Baker dump quarry across the road from this site (Fig. 4). Two radiocarbon dates from the SIL-I core at depths of 9 and 16 m are 14,660+/- yrs BP (Beta-21800) and 20,320+/-740 (Beta-21801), respectively (Fig. 3,5). Pluvial Lake Mojave sediments in Silver Lake basin can be divided into six phases from oldest to youngest: (1) Incipient Lake, (2) Intermittent Lake I, (3) Lake Mojave I, (4) Intermittent Lake II, (5) Lake Mojave II, and (6) Intermittent Lake III (Fig. 5). The latest Pleistocene sedimentation rate in the Silver Lake basin was approximately 8700 years ago, and playa sediments with interspersed thin lacustrine deposits dominate the remainder of the sequence.
Appendix III: Figure 5

CORE SIL-I   CORE SIL-H
LACUSTRINE/PLAYA PHASES

DEPTH
METERS  FEET
0 —
2 — 10
4 —
6 — 20
8 —
10 —
12 — 40
14 —
16 —
18 —
20 —
22 —

PLAYA

INTERMITTENT LAKE III

LAKE MOJAVE II

INTERMITTENT LAKE II

LAKE MOJAVE I

INTERMITTENT LAKE I

INCIPIENT LAKE

TRANSgressive BEACH/PLAYA

T.D.—20.8 meters

T.D.—23.8 meters

EXPLANATION

☐ CLAYS
☐ SILTS
☐ SILT & SAND
☐ SAND
☐ COBBLES & PEBBLES
☐ MUDCRACKS
☐ OSTRACODS

CORE SIL-I   CORE SIL-H

FEET    METERS
— 15
50
— 15.5
51
— 16

CORRELATION OF DEPOSITIONAL UNITS

Simplified core descriptions of drill holes Sil-I and Sil-H, northern Silver Lake playa. Major lake phases are shown based on lacustrine conditions represented by sediment in cores. An expanded view of the zone between 14 and 16 m. depth is shown to emphasize the detailed nature of event correlations between the two core locations. The location of AMS radiocarbon dates are also shown.
APPENDIX IV

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.
Appendix IV:

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.
### Appendix IV:

**CULTURE CHRONOLOGY FOR THE AMARGOSA-MOJAVE BASIN**

<table>
<thead>
<tr>
<th>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 Diequito I period, associated with cleared circles and intaglios.)</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>
</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>
</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>
</tr>
<tr>
<td>Saratoga Springs Period</td>
<td>AD 500 to AD 1200. Rose Springs and Eastgate points, Gray Ware Pottery.</td>
</tr>
</tbody>
</table>
Appendix IV:

Shoshonean Period

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.)
APPENDIX V

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. H.", "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.
Appendix V:

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.
APPENDIX VI

VOLCANIC LANDFORMS IN THE CIMA AREA

The Cima volcanic field lies immediately east of this transition zone in an area that has not experienced the faulting and uplift of the Old Dad area (see Fig. 2, page 25). The field is situated on the crest and west flank of a large and actively downwasting pediment area cut across Cretaceous granitic rocks (the Teutonia Quartz Monzonite) and gently deformed Tertiary fanglomerates. The Cima field is composed of approximately 40 vents and more than 60 associated lava flows of basaltic composition (Fig. 1). The cones and associated flows are assigned letters for reference, e.g. the E cone; please use the map in Figure 1 to locate these volcanic features. The cones range in height up to 170 meters and approximately 900 meters in diameter. The flows range from 100 to 1700 meters wide and over 9 kilometers long. The flows range in age from approximately 7.6 to 0.02 million years old, with a period between 5.1 and 3.3 million years ago being the most voluminous eruptions (Fig. 1). A major period of eruptions occurred during the past 1.0 million years which produced the spectacular cones and fresh-looking flows of the field.

The majority of eruptions in the Cima volcanic field are relatively nonviolent and are classified as Strombolian or Hawaiian types. These types consist of mild lava effusions with cinder cone buildint phases. The I vent, however, had a slightly different eruption style! When viewed from the air, one can see that vent I is a classic "tephra cone" which forms during phreatomagmatic eruptions. That is, eruptions in which the ascending magma body encounters groundwater, causing a violent eruption. A common feature of violent eruptions are base surge deposits which form as debris-laden eruption clouds move out radially from the vent. Such clouds carry blocks, lapilli, and ash suspended in water vapor and gases and move outward with tremendous velocities. Base surge deposits associated with the eruption of the I cone can be traced around this area as far as the Aiken cinder quarry, 2 to 3 kilometers away. Late stage cinder cones formed within the center of the I cone after the violent eruption.

The flow from vent I is one of the youngest date flows in the Cima volcanic field. This flow has been dated by K-Ar methods at approximately 0.13 million years. Recent studies suggest, however, that the flow may be 0.06 million years.

The flow from vent I exhibits numerous well preserved basaltic flow features. A lava tube approximately 95 m long, 5 m high and as much as 6.5 m wide marks the proximal end of the flow near the vent. This tube quickly gives way to an open channel, 3 to 5 m deep and up to 20 m wide, floored with pahoehoe.
Appendix VI: Figure 1

Generalized map of the Cima volcanic field showing the distribution of the various ages of lava flows, cone designations, K-Ar sample locations.
Within a few hundred meters the pahoehoe texture makes an abrupt transition to aa which forms a channelized series of low pressure ridges, continuing some distance down the flow.

Although the flow is several tens of thousands of years old, the surface of the flow is relatively fresh and contains several original construction features! Flows, however, that are older than 0.2 million years are extremely modified. Geologic studies show that over time eolian silts blown from the Devils Playground and the nearby playas accumulate on the flow surfaces. Over time and as the flows are buried by silt, soils form in the silts. Fe-rich clays and calcium carbonate accumulate in the soil eventually reduce the infiltration of water on the flow surfaces and enhance runoff. Over time this runoff erodes the flow surface and begins to remove the accretionary mantle. A simple model of how the flow surfaces change with time is given in Figure 2. These types of changes on the flow surface over time can be used to help map and approximate the age of the lava flows!
CROSS SECTION OF FLOW SURFACES AND ACCRETIONARY MANTLES
FOR DIFFERENT AGES OF VOLCANIC FLOWS

STAGE A
HOLOCENE-LATEST PLEISTOCENE (<20,000 yrs)

STAGE B
MIDDLE PLEISTOCENE (0.20-0.70 m.y.)

STABILITY OF STONE PAVEMENTS AND PEDOGENESIS,
RUBBLING CONTINUES ON TOPOGRAPHIC HIGHS, REDUCED
EOILIAN INPUT

RENEWED EOILIAN DEPOSITION, POST DEPOSITIONAL STABILITY,
AND PEDOGENESIS

LATE PLEISTOCENE (0.05-0.14 m.y.)

STAGES C AND D
EARLY PLEISTOCENE AND PLIOCENE

ACCUMULATION OF EOILIAN FINES IN TOPOGRAPHIC LOWS,
AND DEVELOPMENT OF STONE PAVEMENTS AND STAGE 1 SOILS

PLUGGING OF SOIL WITH CARBONATE AND CLAY, INCREASED
RUNOFF, STRIPPING OF PAVEMENT AND MANTLE

Schematic topographic and stratigraphic sections of late Cenozoic basaltic
lava flows illustrating stages of flow surface modification.