

Old Ores

Mining History in the Eastern Mojave Desert

Robert E. Reynolds, Editor



The Oro Belle claim in Hart. Photograph courtesy Larry Vredenburg.

**Old Ores: mines and mineral marketing
in the east Mojave Desert—a field trip guide**

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Abstracts from the 2005 Desert Symposium

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Old ores: mines and mineral marketing in the east Mojave Desert—a field trip guide

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Summary

On Day 1 we will visit base metal mines: gold, lead, silver, zinc and copper. These metals occur in relatively thin deposits in contrast to the bulk-commodity, open pit mines we will visit on day two. Thin, metal-bearing hydrothermal dikes and secondary enrichment deposits required crushing, concentration and smelting to produce a marketable product. Free-milling gold in quartz simply required crushing followed by water panning to concentrate the heavy metal. Complex processes were developed to extract low-grade ores of mixed metals associated with uneconomical “gangue” minerals of pyrite, calcite, barite and fluorite.

Gold extraction (beyond simple arrastra crushing) required:

- (1) Classification and fine pulverization; density concentration on shaker table.
- (2) Amalgamation. Gold has an affinity for, and sinks in, mercury, which floats other materials. Heating drives off mercury for collection and reuse, leaving gold behind.
- (3) Cyanidation. Gold attaches to cyanide, and can be filtered in charcoal. Roasting the charcoal leaves behind the gold.

Copper extraction is accomplished by leaching.

- (1) Copper ore is pulverized and saturated with sulfuric acid (pyrite helps).
- (2) The copper sulfate solution is mixed with tin (cans), causing precipitation of native copper, then sent to blast furnace for purification.
- (3) Copper ore needs sulfides for roasting (mix of oxides with copper sulfides or pyrite). The blast furnace produces native copper “matte” which can be shipped economically.
- (4) Ultimate refinement involves dissolving copper into a sulfate solution, and using electrolysis to separate pure copper from gold and silver.

Lead and silver extraction involves furnaces.

- (1) Sulfide ores run through a roasting furnace; oxide ores run through a blast furnace.
- (2) Multiple runs through roasting and blast furnaces leave lead bullion, and continue the separation of copper matte and blister copper.
- (3) Lead/silver bullion is put into acid solution that allows lead chloride to be precipitated and roasted into bullion.

On Day 2 we will visit bulk commodity mines whose production was facilitated by the economics of population growth and two World Wars. We will see mines for pure limestone (marble) that have produced raw material for cement since the 1930s. The first Portland cement factory was commissioned in 1900 at Alameda, California by F. M. Smith (Hildebrand, 1982). Iron mines active from the 1930 produced iron as an additive for cement and for the steel industry. Talc was used in cosmetics, ceramics, and manufacturing rubber products. These mines were mainly open pits where precision ore removal was followed by crushing and size classification that allowed shipment of a marketable product.

Historic mining: what to look for

1. Claim Location (location monument, claim notice corner posts, discovery prospect)
2. Ore (vein, lode, or placer; stockpile)
3. Mine workings (adit, shaft, tunnel, stope decline, tunnel, winze, raise, prospect pits, open pits)
4. Equipment (collar, winch, headframe, bin, shoot, hoist, tram chute, hoist, ball mill, Wilfley concentrating table)
5. Milling equipment (arrastra, crusher, grizzly)
6. Smelting equipment (assay shop, ovens, slag)
7. Leaching equipment (reservoirs, ponds, tanks, tin cans, sludge)
8. Ore transport (conveyor, tram, roads, wagon ruts, rail beds)

Introduction

Native Americans in the Mojave Desert used fine-grained volcanic rocks, chalcedony, and chert for cutting, chopping, and piercing tools. They used coarse crystalline rocks and vesicular basalt to abrade and grind vegetable and animal material, clays for pottery, salts for tanning, and metallic oxides for pigment. Turquoise and other stones were used for jewelry and ceremonial objects.

Gold and silver were located in the Mojave Desert in 1849 by immigrants on their way to the gold fields of the Sierra Nevada foothills. We will visit the Amargosa Gold Mine at Salt Springs on the Spanish Trail, and the Mojave Road will take us through the early Rock Springs mining district of the Mid Hills.

Many early strikes were of high-grade (secondary enrichment) concentrate. The low cost of extraction by simple mining tools (pick and shovel) and concentration in arrastras was offset by the expense of transporting ore to mills and smelters as distant as Wales, Utah, or Alameda on the California coast. Advances in milling technology (concentrating jigs, flotation solutions, blast furnaces, cyanidation, and heap leaching) allowed extraction and processing of lower grade ores. We will investigate ore processing techniques at several historic mines as we travel through vast stretches of mineralized mountains that are now withdrawn from mineral location and extraction.

Excellent summaries of mining history in the eastern Mojave Desert are recommended as further reading: Ver

Planck, 1961; Vredenburg and others, 1981; Vredenburg, 1995, 1996a, 1996b, 1996c; Hensher, 1996; Hewett, 1956; Shumway, 1980; Casebier, 1973, 1974. Also see articles by Vredenburg and by Hensher in this volume.

Day 1

Early exploration, transportation, ore deposits, mines, and prospects.

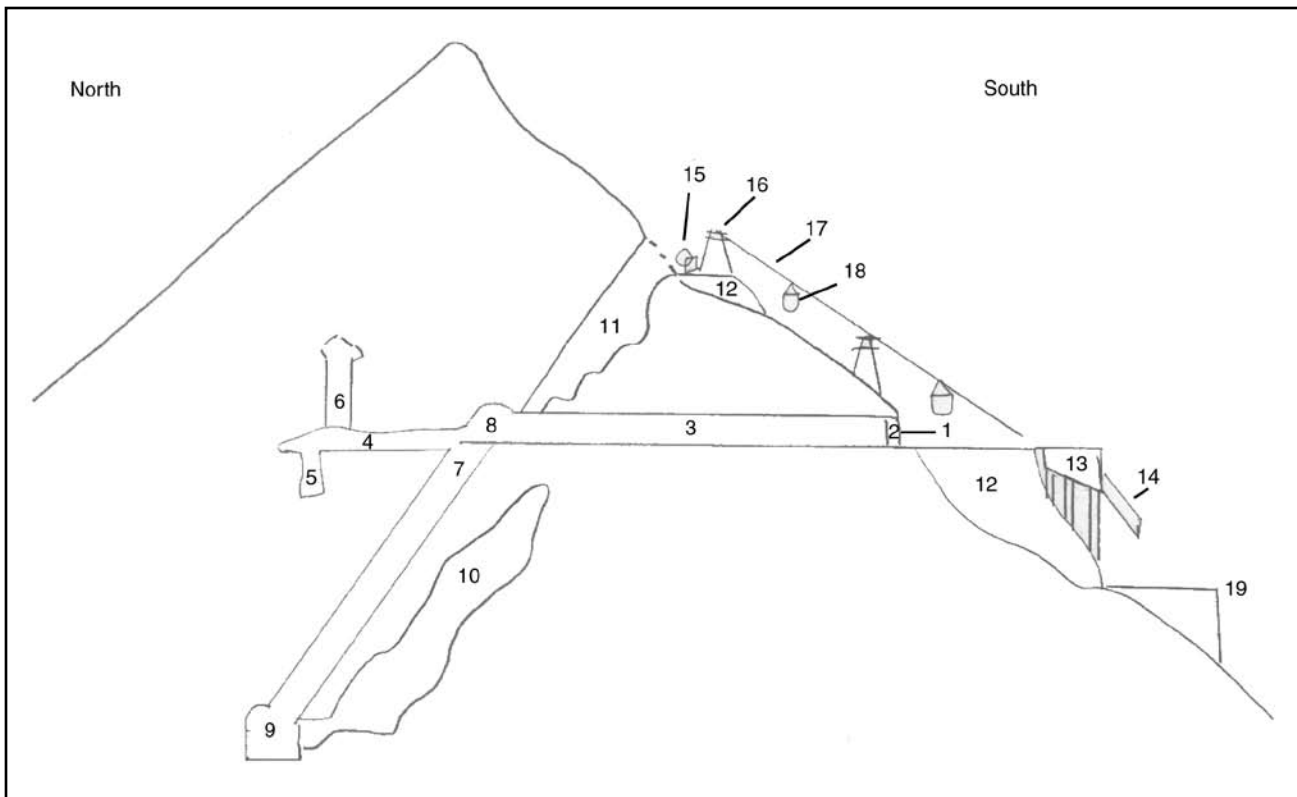
0.0 (0.0) Convene at Zzyzx with a full tank of gas for the 212 mile trip. Wear sturdy shoes and dress for the occasion; bring water, hats and sunscreen.

4.7 (4.7) Enter I-15 eastbound, toward Baker.

11.0 (6.3) Continue past Kelbaker Road and central Baker. Proceed eastbound on I-15.

24.4 (13.4) continue past the Halloran Spring offramp.

30.4 (6.0) Continue past the Halloran Summit exit. An electrical wind generator is shown on 1956 USGS quad maps south of this exit. Ahead, Shadow Valley contains the sites of three mills. The Valley Wells mill and copper smelter were two miles north of Highways 91/466. On the south side of I-15, one mile west of Cima Road, is the site of Windmill Station (Hubert Well), the mill site for the Evening Star Mine. Another mill site (Evening Star Mine



The Mohawk Mine on Mohawk Ridge: simplified cross-section. 1: landing (=dump). 2: adit portal. 3: adit. 4: drift. 5: winze. 6: raise. 7: incline (decline). 8: main landing. 9: lower landing. 10: stope. 11: stope to daylight. 12: dump (waste). 13: ore bin. 14: ore chute. 15: winch/hoist. 16: tram station. 17: tram cable. 18: tram buckets. 19: haul road to mill.

Mill, Evans, 1971) is shown east of the Stuckys complex at Cima Road. Valley Wells Station and an associated cattle ranch were adjacent to the I-15 rest stop.

37.6 (7.2) **Exit** at Cima Road/Excelsior Mine Road.

38.0 (0.4) **Stop** at Cima Road. **Turn left** (north) and proceed north over the freeway.

38.5 (0.5) **Turn right** (east) on old Highway 466 (gas pipeline road) and proceed to the Mohawk Mine.

43.3 (4.8) **Turn left** (north) toward the Mohawk Mine.

44.3 (1.0) **STOP 1-1. Park.** The Clark mining district was formed in July, 1865, and claims such as the Copper World and Mohawk were surveyed in from stone "mineral monuments" such as USMM1, USMM 3, and USMM 35 and from vertical-angle bench marks (VABM 7929 in that district). The Mohawk ore body is high on a ridge, and the ore follows fractures downward into the hill. The miners had to work against gravity to bring ore to the surface, and then use gravity to help bring ore down shoots and cables to loading bins. The mine produced lead, zinc, and copper, along with a small shipment of gold. The Mohawk Mine has produced the most diverse secondary assemblage of arsenates, sulfates, carbonates and silicates in the Mojave Desert (Wise, 1989, 1996).

Although the Copper World Mine, two miles north, was worked in the 1890s (Vredenburg, 1996a and this volume; Hensher, this volume), there are no records of claims or mill site at the Mohawk until 1916. This suggests that ore extraction and shipment was prompted by World War I. In 1916, stopes and the mill on the north side of Mohawk Ridge produced 1.5 tons of lead and silver. A drilling program in 1942 located deposits on the south side of Mohawk Ridge, and by 1952, 16 tons of ore had been produced. It contained lead, silver, and zinc, and 206 ounces of gold (Wise, 1989; Wright and others, 1953). **Retrace** to Cima Road.

50.1 (5.8) **Turn right** (north) on Cima/Excelsior Mine Road.

50.8 (0.7) **Turn right** (northeast) onto the road leading to the Valley Wells copper smelter.

51.7 (0.9) **STOP 1-2. Park** at Valley Wells (Rosalie). The Valley Wells copper smelter milled ore from surrounding mines, and was a shipping point for incoming goods and outgoing products. Ore processed at the smelter came from the Copper World mine as early as 1898, first by 20-mule team and later by tractor and trailer (Vredenburg, 1996a). The two ore bins at the Copper World mine were for different purposes (Labbe, 1960): the larger held copper ore, and the smaller held iron and lime for fluxes at the Valley Wells smelter. Sulfur, to charge the smelter, came from the Francis copper mine in the southern Providence Mountains and from Utah (Vredenburg, 1996a). The assay house and pyrite from the dumps were removed by the EPA in late 1990s because of arsenic (arsenopyrite) with the pyrite. We are looking at the remains

of the 1917 blast furnace foundations, acid tanks, and slag. The slag was poured hot into forms that developed a flat, working floor when it cooled. The iron arsenate scorodite at the Valley Wells smelter suggests that some ore processed here came from the Mohawk Mine.

The copper milling process involves trucking ore to ore bin above the crusher. Upon crushing, it was sent by belt conveyor to a ball mill for fine grinding. Iron pyrite was roasted in the adjacent sulfuric acid plant, and sulfurous gas mixed with the fine ore. The ore was washed and filtered, and the copper sulfate solution ran through tin cans in a series of concrete tanks (launders). The copper-iron mud was taken to the adjacent smelter or shipped as concentrate (Labbe, 1960). The smelter produced copper matte, which was first hauled to Manvel (Barnwell) and later to the new (closer) rail head at Ivanpah. After 1917, the copper matte was hauled to Cima and shipped by rail for further refinement at Garfield, Utah.

The community surrounding the smelter included wooden buildings and cabins excavated under a roof of Pleistocene caliche. Rosalie was the post office (Vredenburg, 1996a), and the Valley Wells Cemetery is located northwest (Reynolds, 1996). Be careful of collapsing structures and of snakes as you explore the mill site and miner-dug cabins. Note that the shelves dug into the cabins' clay walls of are the size of wooden dynamite boxes. **Retrace** to Cima Road.

53.3 (1.6) **Turn left** (south) onto Cima Road.

54.4 (1.1) Cross to the south side of I-15.

55.4 (1.0) **Turn left** (east) and enter east-bound I-15.

64.2 (00) **Exit** at Bailey Road.

64.5 (0.0) **Stop, reconvene** at the overpass, **turn right** (south), and **stop** at Frontage Road.

STOP 1-3. The first mining in the Mountain Pass district to the north was at the Sulfide Queen, for gold, silver, and lead (Wright and others, 1953). The government encouraged prospecting for radioactive minerals after WWII. Prospectors recognized radioactive monazite, and the United States Geological Survey identified lanthanide-series minerals in 1950 (Wright and others, 1953; Ririe and Nason, 1991; Hensher, 1996; Morton and others, 1991).

The Mollusk (Mescal, Cambria) Mine dumps can be seen upslope to the southwest. High-grade gold and silver and associated antimony extracted between 1882 and 1888 were processed through a 10-stamp mill at Mescal Spring (Vredenburg, 1996a; Wright and others, 1953). An exciting story about counterfeit coinage is associated with this mine (Bennett, this volume). Return to vehicles; **proceed east.**

65.1 (0.6) **Turn south.**

65.6 (0.5) **Turn left** at the junction of roads at a corral. Continue to summit.

67.2 (1.6) **Bear right** at the summit.

67.5 (0.3) **Bear right** at the road junction with a sign to Kokoweef Cave.

68.2 (0.7) **Stop** at the intersection with a sign to Kokoweef Cave.

STOP 1-4. Kokoweef Peak is to the southeast. The Carbonate King Mine (southern dumps) produced zinc from the zinc silicate, hemimorphite, and the zinc carbonate, smithsonite, along with lead and silver between 1940 and 1944. Additional ore was shipped as late as 1950 (Evans, 1971; Wright and others, 1953). Dumps to the north are from the adit intersecting Kokoweef Cave, where 75 years of looking for the Lost River of Gold have produced more fossils than base metal (Reynolds and others, 1991). **Proceed southwest.**

68.9 (0.7) **Bear left** (south) where the road forks toward Striped Mountain.

69.2 (0.3) Cross an airstrip.

69.3(0.1) Pass through a reverse junction and continue southwest toward Striped Mountain.

69.7 (0.4) **Turn left** (south) at the three-way junction, toward the saddle on the east side of Striped Mountain.

70.0 (0.3) Continue past a left turn.

70.5 (0.5) Pass through "Y" junction.

71.2 (0.7) Continue past mine workings to the southwest.

71.5 (0.3) Cross over the saddle.

71.8 (0.3) **Turn right** (north) toward the Silverado-Tungstite claims.

72.1 (0.3) **Stop 1-5. The Silverado-Tungstite claims.** Silver was shipped from the Silverado Claim before 1900 (Wright and others, 1953). The Tungstite skarn is along a dolomite/granitic contact containing epidote, garnet and scheelite (calcium tungstate); it was prospected until 1951. The four rock ruins were apparently housing and an assay building. **Retrace** to main road.

72.4 (3) **Turn right** (south).

72.8 (0.4) **Turn left** (southeast) toward the Standard No 1 Mine.

73.0 (0.2) Continue past mine dumps.

73.2 (0.2) **STOP 1-6. Standard No. 1 (Excelsior, Bluegrass, Copper Town) Mine Camp.** The Excelsior was located in 1896 and produced copper with gold and silver between 1902 and 1908 from a skarn that contained magnetite, chalcopryite, and scheelite (Hewett, 1956; Wright and others, 1953; Weasma, 2005). Before 1905, ore from the Standard No.

hailed by wagon to a smelter at Needles. Rail service was established to Cima in 1905, and ore was then hauled by 16-horse-team wagons to rail cars bound for smelters in Salt Lake, Utah. **Retrace** to the west.

73.3 (0.1) **Turn left** (southwest) at the "Y" junction toward the Evening Star Mine.

73.5 (0.2) Pass a reverse "Y" junction.

73.9 (0.4) Continue past the cemetery with headstones that read J. Riley Bembry, Raymond Arthur Walker, and Joseph N. Kelley.

74.3 (0.4) Continue past a left turn and proceed southwest.

74.5 (0.2) Proceed southwest across a road running west to Cima Road.

75.0 (0.5) Three-way junction. Two forks trend southeast; take the **southern fork** toward the Evening Star head-frame.

75.2 (0.2) **STOP 1-7. Evening Star Mine.** The Evening Star Mine was the only producer of tin ore (cassiterite, tin oxide) in the eastern Mojave Desert. The cassiterite was found associated with copper sulfides (chalcopryite, bournite and covellite) and their oxides (malachite, cuprite, tenorite) in a skarn body that contained the gangue minerals pyrite, scheelite, chrysocolla, and wollastonite (Aubury, 1908; Wright et al, 1953; Joseph, 1984.). The mine was in production between 1939 and 1944. The tall head frame was built to hoist ore from underground workings. When the ore reached the top, it was dumped through a series of four-cylinder engine-powered crushers and screens that classified the ore into marketable concentrate could be separated from unwanted gangue minerals. The amount of imported timber and the crushing equipment (now missing) indicate how serious the miners were



1 was The Evening Star Mine. R.E. Reynolds photograph.

in their fight against gravity.

At first ore was hauled by truck to Cima and shipped by rail to Texas City, Texas. After the headframe and crushers were installed, the concentrated/classified ore was hauled by truck to Windmill Station on Hwy 466 (south of Valley Wells) for cleaning and concentration. The Windmill Station mill was constructed by Steel Service and Sales Company (Chicago, Ill.), owners of the Bernice (Evening Star) group. The Windmill Station mill further concentrated the ore, passing it through a rougher and cleaning jig, followed by concentration (enrichment) on a sand and slime (Wilfley shaker) table. A diesel generator provided electricity, and water came from a 100-foot-deep well on site (Page and Weise, 1945). The first milling operation was in 1943, when one ton of concentrate was trucked to the government stockpile at Jean, Nevada. Later (Thompson, 1978), 400 tons of ore were processed at this mill. **Retrace west** to Cima Road.

75.4 (0.2) **Turn right** (northeast) at a complex intersection.

75.7 (0.3) **Turn left** (west) on a graded road toward Cima Road.

78.3 (2.6) Pass a corral and **stop** at paved Cima Road. Watch for cross traffic and **turn left** onto Cima Road; **proceed south**.

81.2 (2.9) Continue past the turn to Valley View Ranch.

82.4 (1.2) **Slow** for dangerous curves.

84.1 (1.7) Continue past Kessler Spring Ranch.

87.3 (3.2) Pass under power lines.

88.4 (1.1) **Slow** for curves.

88.7 (0.3) **Stop** at a complex intersection north of Cima, where the Cima and Morning Star Mine roads meet.

Turn left (north) on Morning Star Road.

88.8 (0.1) **Turn right** (east) across the railroad tracks; proceed to the Death Valley Mine.

89.1 (0.3) Pass a right turn.

91.4 (2.3) Continue to the Death Valley Mine foreman's house, built in 1920s.

91.5 (0.1) **Park** at the gate and **walk** to the Death Valley Mine and associated structures.

STOP 1-8. Death Valley Mine. The Death Val-



The Death Valley Mine. Photographs courtesy Larry Vredenburg.

ley Gold Milling and Mining Company (initially called Dawson Camp) was formed by the Dawson brothers. First opened in 1906, most production was between 1917 and 1921. The quartz veins contained argentite (silver sulfide) and galena (lead sulfide). Typical of ore bodies in arid climates, the silver at the ground surface was dissolved and carried down the dip of the vein and redeposited. The portion of the vein above the water table was "secondarily enriched" with embolite (silver chloride/bromide). The underground workings burned in 1927. The equipment present today is the result of mine reactivation in the 1950s, and includes an unusual steel headframe.

The first ore was hauled to the rail head at Cima, bound for the mill at Needles. By 1907, ore was sent to the American Smelting and mining Company in Salt Lake City. The onsite mill burned in 1927. The 1931 concentration plant consisted of a Blake-type (14 x 21") crusher, and classified ore went to an elevator feeding a marathon rod (roller) mill, then to elevated 10-mesh screens where oversize ore was returned to the crusher. The fines went to a cone classifier that fed the coarse fraction to an Isabell

concentrator, and fines to a double-deck Deister (concentrating) table. The entire plant was driven by an electric motor.

When one author (Bob Reynolds) visited the mine caretakers (Dick and Bea Huff) in the mid-1970s, Dick had just finished clearing debris from the collapsed vertical shaft. He and Bob climbed down to the main crosscut and observed almost a hundred skeletons of birds (scrub jays and flycatchers) and mammals (cottontails and ground squirrels). During hot weather, the animals had worked their way down fissures in the collapsed shaft, following the scent of moisture. Groups of skeletons lay pointed at puddles; they could enter the mine to drink sulfate-rich water, but could not climb out for food.

Return to vehicles at the gate; **retrace** to the paved Morning Star Mine Road.

91.6 (0.1) Pass a left turn on the scenic road south to Cedar Canyon Road.

94.2 (2.6) **Stop** at paved Morning Star Mine Road. Watch for cross traffic and **turn left** (south) toward Cima.

94.3 (0.1) **Stop** at a complex intersection where Cima and Morning Star Mine roads meet. **Turn left** (south) on Cima Road.

94.6 (0.3) Pass the Cima store and Post Office. This was a community center, supply source, and rail head for shipping from 1915 to 1960.

98.8 (4.2) **Turn left** (east) on Cedar Canyon Road. We are traveling on the Mojave Road, first pioneered by Lieutenant Edward Beale in 1856 and well established by 1858 (Casebier, 1974; Vredenburg, 1995). After Mojave Indians forced emigrants to turn back in 1858 and prospector Moses Little was killed in 1866 (Casebier, 1973; Vredenburg, 1995), troops were sent to man outposts at springs that were one day's travel apart; the route then became known as the Government Road (Casebier, 1974). This area along the Mojave Road was originally called the Providence Mountains and was later divided into the New York Mountains (north), Mid Hills (ahead), and Providence Mountains (south).

The Rock Spring mining district (Stop 1-9) is the oldest district in this area (April 1863: Vredenburg and others, 1981; Vredenburg, 1995), established after Beale opened the Mojave Road. The Rock Spring mining district was large, including Macedonia Mountain in the New York Mountains. The eastern New York Mountains (New York, Manvel district, April 1870) contained deposits of copper, lead-silver-zinc, and iron/manganese tungstates along with a system of mule trails to haul lumber and charcoal (Reynolds and Reynolds, 1995). The Columbia (Macedonia) district, organized August, 1865 near Columbia Mountain to our east-southeast, produced lead-silver-zinc and minor gold; scheelite (calcium tungstate) is also recognized in the district.

101.8 (3.0) Continue past a left (north) turn to the Death Valley Mine.

102.4 (0.6) **Slow**; enter Cedar Canyon Wash.

103.7 (1.3). **Slow** for sharp right turn ahead.

104.7 (1.0) Continue past a right (south) turn on Black Canyon Road that leads to the Hole-in-the-Wall and Mid Hills campgrounds.

105.4 (0.7) Pinto Mountain is on the north.

107.6 (2.2) **Slow** for a sharp left turn just beyond the rise.

108.2 (0.6) Continue past a right (south) turn that leads to Government Holes, marked by a corral, water tank, and cottonwood trees. This is the site of a battle between gunmen hired by the 7IL Cattle Company and homesteaders who were trying to claim and farm rangeland in Lanfair Valley (1925, Casebier, 1987; Reynolds and others, 1995, p. 16). After a brief duel at the range cabin, one gunman was killed; the other died later of bullet wounds. Reportedly, bullet holes could still be seen in the cabin in 1950.

109.5 (1.3) **Slow** for a steep downhill stretch.

110.0 (0.5) **Turn right** (south) into the sand wash that leads to Fort Rock Spring.

110.1 (0.1) **Bear right** at the fork.

110.2 (0.1) **STOP 1- 9. Camp Rock Spring.** Indian attacks in 1866 claimed the lives of troops and civilians at Soda Lake, Marl Spring, and Camp Cady. Moses Little, a miner, was killed at Macedonia Mountain in the New York Mountains northeast of Rock Spring on June 12, 1866. In response, government troops built and occupied redouts or small fortified camps at springs one day's travel apart along the Mojave Road. Immigrants and mail stages entered California at Fort Mojave on the Colorado River, continued westward to Fort Piute, Camp Rock Spring, Marl Spring, and passed Seventeen Mile Point to reach Fort Soda (Zzyzx). The Mojave (Government) Road continued up the sandy outwash of the Mojave River, through Afton Canyon, joined a branch of the Old Spanish Trail, and proceeded west to Camp Cady. It continued from Fish Ponds on the Mojave River (between Daggett and Barstow) to the Drum Barracks in Los Angeles.

Mining in the Rock Spring area preceded the military camp. Camp Rock Spring was established on a cold December 30, 1866 (Casebier, 1973) by soldiers that were under-supplied and nervous; petroglyphs around the spring indicated heavy Indian usage. They chose the site for its water and defensible position, and they stored supplies in mine adits dug previously (Casebier, 1973).

Return to vehicles, **retrace** to the Old Government Road.

110.5 (0.3) **Stop**, watch for traffic on the Old Government Road, and **turn right** (east) toward Lanfair. Proceed slowly along the curving road.

111.0 (0.5) The Old Government Road bears right.

- 112.5 (1.5) The Old Government Road bears left.
- 113.0 (0.5) The Old Government Road bears right.
- 114.0 (1.0) The Old Government Road bears left.
- 117.2 (3.2) Pass on the north side of a Paleozoic limestone outcrop.

120.2 (3.0) **STOP 1- 10** at the intersection of Ivanpah and Lanfair roads. The site of the Lanfair school house is to the northeast. Lanfair was a community center in the 1890s–1930s. The Nevada Southern Railroad brought supplies from Needles to mines in the mountains surrounding Lanfair Valley and connected with Manvel (Barnwell) in 1893 (Myrick, 1963). The California Eastern Railroad was continued to Ivanpah in 1902 to receive ore from the Copper World Mine and the Vanderbilt Mine. When the Tonopah & Tidewater Railroad siphoned off trade in 1907, the Santa Fe built the Barnwell & Searchlight Railway to service mines and communities. Labor difficulties and severe washouts halted rail service to Barnwell by 1923 (Myrick, 1963). Homesteaders, often working in the mines and for the railroad, grew dry crops on their 40-acre parcels and sent their children to school at Lanfair. In the hot summer months, railroad workers in Needles sent their families to the cooler reaches of Fourth of July Canyon.

Turn right (south) on Lanfair Road.

- 122.3 (2.1) Continue past a right (west) turn to Fords Dry Lake.
- 124.7 (2.4) **Slow** for sharp turns downhill.
- 125.4 (0.7) Cross Vontrigger Wash.
- 126.2 (0.8) Continue past a turn to Vontrigger Springs (Hensher, this volume). The California Gold and Copper mine lies to the east at 9:00.
- 132.7 (6.5) Pass under a powerline road leading northeast to the Leiser Ray Mine, a vanadium producer.
- 140.5 (7.8) **Stop 1-11. Goffs School House.** Enjoy a tour of local history, discussion of the Government Road, and Mojave-wide mining paraphernalia. We will see steam boilers that powered mining equipment and stamp mills, head frames, ore bins, ore cars, and other equipment used to extract minerals from Mojave Desert mountains. Return to vehicles and **proceed south** to Route 66.
- 140.7 (0.2) **Turn right** (west) on Route 66 and proceed toward Fenner.
- 150.5 (9.8) Continue past Fenner.
- 150.8 (0.3) **Enter** westbound I-40.
- 158.0 (7.2) **Exit** at Essex Road.
- 158.2 (0.2) **Turn right** (north) on paved Essex Road.
- 160.1 (1.9) **Slow** for upcoming left turn.
- 160.6 (0.5). **Turn left** off pavement onto a west-trending dirt road.

161.4 (0.8) **Turn left** (south) at the intersection. Continue past a hill of white Paleozoic limestone overlain by Miocene volcanics.

162.6 (1.2) Pass under I-40.

162.8 (0.2) **STOP 1-12. Gold Hammer Mine. Park and walk** to the Gold Hammer Mine (Wright et al, 1953). **Caution:** Watch for open mine shafts. We have passed through Paleozoic limestone and are now standing on “Archean Gneiss” which contains gold-bearing quartz veins. The Gold Hammer Mine workings consist of an ore loading structure (jaw crusher probably present), an Ellis Ball Mill for pulverizing ore, and a Wilfley shaker table for concentrating the ore before shipment. **Retrace** to Essex Road.

164.1 (1.3) **Turn right** (east).

164.9 (0.8) **Stop** at pavement: **turn left** (north) on Essex Road toward Mitchell Caverns. **If you do not have a high-clearance vehicle, take the alternate route, below:**

Alternate Route (50 miles on pavement)]

164.9 (0.8) **STOP at pavement: Turn right** (south) on Essex Road toward I-40.

(2.3) **TURN RIGHT** (west) onto I-40 toward Kelbaker Road Pass, the Clipper Mountains, and the northern Marble Mountains.



Loading bin at the Gold Hammer Mine. R.E. Reynolds photograph.



Ball mill at the Gold Hammer Mine. R.E. Reynolds photograph.



Shaker table at the Gold Hammer Mine. R.E. Reynolds photograph.

- (21.6) **Exit** I-40 at Kelbaker Road.
- (1.0) **Stop** at Kelbaker Road, **turn right** (north).
- (4.4) Continue across the Granite Mountains pediment, passing a left turn to the Granite Mountain Research Station.
- (3.3) Pass the intersection with Hidden Hills Road.
- (0.5) **Slow** for a 30 mph curve.
- (0.8) Drive over the cattle guard at Granite Pass; a microwave station is to the east. Continue north on Kelbaker Road.
- (4.4) Right at 2:00 is the Vulcan Mine, north of Foshay Pass.
- (1.9) Pass the junction with the powerline/gas line road.
- (0.2) Pass the junction with a road to the Kelso Dunes.
- (2.8) Kelbaker Road bends to the right.
- (0.9) Kelbaker Road bears left. **Prepare to turn right.**
- (0.3) **Slow, turn sharp right** onto Vulcan Mine Road.
- (4.6) Enter the canyon; Paleozoic rocks cap the ridge on left (north). Dikes cut Proterozoic gneiss on the right (south).
- (0.3) Pass a left turn to the mine dumps.
- (0.3) **STOP 1-13. Park** at the Vulcan Mine concrete mill footings.]

164.9 (0.8) **Stop** at pavement: **turn left** (north) on Essex Road toward Mitchell Caverns. The Blind Hills to the east were a site of one of General Patton's camps for desert training late in World War II and in the early 1950s.

The view at 1:00 is of the Colton Hills with Wild Horse Mesa in the distance. Wild Horse Mesa is the largest mesa in the Mojave Desert. The granitic and metamorphic rocks at the base are overlain by fine-grained fluvial and lacustrine sediments, breccias and mud flows (Reynolds, Hunt and Albright, 1995) which are in turn capped by the Peach Spring Tuff (18.5 Ma) and the tuff of Wild Horse Mesa (17.8 Ma, McCurry et al, 1995). Piñon and juniper were cut on the top of the mesa, and hauled by burros down steep trails west to the Columbia Mine and south to the Bonanza King Mine (Reynolds, 1995).

168.6 (3.7) **Stop** at the junction of paved roads. Black Canyon Road to the northeast leads to the Woods Mountains, Wild Horse Canyon, and the Hole-in-the-Wall and Mid Hills campgrounds. The paved road to the northwest leads to Mitchell Caverns. West of Wild Horse Mesa and east of the Providence Mountains is the town site of Providence (Hensher, this volume). The Trojan (Providence/Bonanza King) district was organized in 1880. At this junction, note the powerline that runs west; we will proceed west on this utility road. **High clearance vehicles** are required for this road. Low vehicles, even with four wheel drive, **must take alternate route** (above). **Proceed west** on the powerline road toward Foshay Pass, the low area in the southern Providence Mountains.

169.9 (1.3) Pass to the north of a cattle tank and corral.

171.1 (1.2) Pass a right turn to Foshay Spring. To the northwest, Fountain Peak (6,996') rises above Foshay Spring (4,200').

171.9 (0.8) Foshay Pass, elevation 4,790. Pass gasoline valve. View west of Old Dad Mountain and Tiefert Mountain. **Caution: proceed down the steep grade. An even steeper, rocky grade is over the next saddle. Make sure you turn left at the gully at the bottom of this grade!**

172.0 (0.1) Bottom of hill. **Turn left** and pass over the saddle.

172.1 (0.1) Proceed downhill.

172.2 (0.1) **Bear right** at the fork. View north of recumbent folds in Paleozoic limestone.

172.3 (0.1) Stop, **turn left** (west) toward the Vulcan Mine at a utility road.

172.7 (0.4) Pass a left turn where the utility road goes southwest over the saddle.

173.0 (0.3) Pass a right turn to the east workings of the Vulcan Mine.

173.1 (0.1) **Park** at three concrete diesel tank footings.

STOP 1-13. Walk north to the Vulcan Mine open pit. The mine developed a downward-spiraling haul road to



Bunkhouses and mess hall, looking northwest toward the orebody. Photograph from the Bud Davenport collection, Mojave National Preserve.

take advantage of the magnetite/hematite ore body in limestone on the east side of a contact with quartz monzonite. During World War II (1942–1949), the Kaiser Steel Corporation produced 2.6 million tons of blast furnace-grade ore (Wright et al, 1953).

Ore from the Vulcan Mine open pit was loaded by cable-operated shovels into haul trucks, then taken from the pit up the spiral haul road to an onsite crusher. Crushed concentrate was hauled by truck to Kelso, and ramp-loaded into Union Pacific gondolas bound for the steel smelter in Fontana, California.

Our walk takes us past black magnetite and hematite (the iron ore) oxidizing to red and brown limonite. Associated gangue minerals are green serpentine and white to tan marble altered from the Paleozoic limestone. Proposed post-war uses of the mine include a repository for auto tire carcasses. Bighorn sheep come to the mine for drinking



Vulcan Mine mess hall and foundation excavation for bunkhouses, August 1942. Photograph from the Bud Davenport collection, Mojave National Preserve.



Test drilling on the east orebody at the Vulcan Mine. Photograph from the Bud Davenport collection, Mojave National Preserve.

water. **Return** to vehicles and **proceed** to Kelbaker Road.

173.5 (0.4) Pass the road at the west end of the dumps.

174.9 (1.4) The Kelso Dunes are ahead; Old Dad Mountain rises over Kelso Hills.

177.4 (2.5) **Stop** at pavement; **turn right** (north) on Kelbaker Road.

180.1 (2.7) **Slow** for a curve to the right.

180.6 (0.5) Pass a dirt ramp where Vulcan iron ore was loaded onto rail cars.

180.9 (0.3) Railroad tracks at Kelso Depot. The road forks; **bear left** (northwest) on Kelbaker Road toward Baker.

182.1 (1.2) View northeast of Cima Dome and Teutonia Peak.

186.2 (4.1) The road bears left (northwest).

189.8 (3.6) The road bears left.

190.8 (1.0) Cross under power lines.

191.1 (0.3) View north of Cima volcanic field and a cinder cone notched by mining activities to recover light-weight aggregate and road-base material.

193.7 (2.6) Bend in road.

194.0 (0.3) Pass the left turn to the microwave facility; pass Willow Wash Road on the right. To the north, the Old Government Road from Cedar Canyon meets Willow

Wash, and proceeds west past Seventeen Mile Point and the Old Dad Mountains.

199.3 (5.3) Slow through curves.

199.6 (0.3) Cross Willow Wash.

200.4 (0.8) Pass Seventeen Mile point on the left (west). Seventeen Mile point is about halfway between Marl Spring to the east and Fort Soda (Zzyzx), the next stop on the Old Government Road where protection and fresh water were available.

201.7 (1.3) **Slow through curve.** The road bends sharply left (west) toward Baker. View west past Seventeen Mile Point toward Fort Soda, Cave Mountain, and Afton Canyon along the Mojave River.

212.1 (10.4) **Cross I-15 into Baker.** Be sure to fill gas tank and pick up drinks, snacks, and sunscreen for tomorrow.

End of Day 1

Day 2

Introduction

Along the way as we visit bulk-commodity mines, we will stop at the West Camp/Apache Canyon turquoise mines that have been prospected for over a thousand years (Reynolds, this volume). Who knows, maybe you will find a blue nugget overlooked by prehistoric miners!

0.0 (0.0) **Convene at Zzyzx** with a full tank of gas for the 150 mile trip. Prepare for a walking trip to local salt mining operations before the full day vehicular trip. Wear sturdy shoes and dress for the occasion; bring hats and sunscreen.

Fort Soda Tour: Historic Mines, Railroads, and



Silver Lake, filled with water. R.E. Reynolds photograph, February 2005.

Mining Scams

A. Soda Lake Salt Works. Walk east to the salt flats of Soda Lake (see Fulton, this volume for details). Excavated into the lake surface are ponds that were filled with brine from wells on the lake. Ample solar heating was available to evaporate water and leave a salt (sodium chloride) crust. The crust was to be collected, shipped, and concentrated in Los Angeles. Despite promotional advertisement, excavation of ponds, and railroad availability, no product was ever shipped.

B. Tonopah & Tidewater Railroad (Chappell, this volume; Myrick, 1963; Mulqueen, 2002). Borax Smith, competing with Senator Clark of Nevada for borax and base metals in Death Valley, started building the Tonopah & Tidewater Railroad (T & T) north from Ludlow in November, 1905. Rails reached Soda Lake and the active community and shipping center (Rose, Heath, Fisk Co.) of Silver Lake in March, 1906. The T & T roadbed can be seen just west of the main pond at the CSUF Desert Studies Center as it runs north across Soda Lake toward the site of Silver Lake (below). Building the T & T through the Amargosa River gorge was extremely difficult, but Beatty, Nevada was reached in October, 1907. Further difficulties arose when the Mojave River flooded Silver Lake in 1908 and again, more severely, in 1916. This prompted the move of the T & T roadbed and the town to higher elevation on the east side of the lake. The line was abandoned in 1939. Winter/spring rains in 2005 again flooded Silver Lake, submerging the original roadbed

C. Lost Gold Never Found! During the 1970-1980s, “mining” companies promoted the recovery of gold from sands and silts located in valley centers (Shadow Valley, Soda Lake, and Silver Lake). The ore was a kind of water-soluble gold (great clue!), and was leached from surrounding mountains and washed centrally to dry lakes. Here’s the pitch: you could buy stock, buy “ore” and process it yourself, or buy “ore” and pay the company to process it! The operation on Silver Lake had samples assayed, and the values increased to the west—that is, toward the T & T roadbed, which was built with gold-bearing andesite from the Bagdad-Chase Mine at Ludlow. However, the roadbed couldn’t be touched because it was an historic site! **Return** to vehicles, assemble at main gate.

1.1 (1.1) Pass the main gate.

4.6 (3.5) Enter I-15 eastbound.

10.4 (5.8) Baker Hill (Bishop, this volume) is north of the west Baker offramp.

10.9 (0.5) **Exit** at Kelbaker Road, central Baker.

11.3 (0.4) **Stop, turn left** (north), and proceed north over the freeway.

11.7 (0.4) **Stop** at Main Street in Baker. **Proceed north** on Highway 127.

12.2 (0.5) The Aga Mine (Housley, this volume) is located in the hill to the west, at the south end of Silver Lake.

13.4 (1.2) The Soda Mountains are on the left (Gourley and Brady, 2000).

18.9 (5.5) Pass the second townsite of Silver Lake, rebuilt at elevation 960' along the relocated grade of the Tonopah and Tidewater (T&T) railroad. Adobe ruins on the right mark the terminus of a stage line where O.J. and Della Fisk operated a mercantile store. Oliver James (Jim) Fisk was born in Iowa on August 10, 1873.

At age 14, Fisk headed for California, crossing the southern Nevada Mud Hills (Muddy Creek Formation at Moapa) on foot. He was 20 when he worked as a hoist man on the Gold Bronze Mine in Vanderbilt, California. In 1901 he built an ice place in Manvel (Barnwell; Hensher, this volume) that supplied ice to boom camps: Searchlight, Crescent, and Sandy, Nevada; and Hart, California. He then went into partnership with the Rose & Palmer transportation firm which hauled freight from the desert railhead at Ivanpah Dry Lake across Stateline Pass north into Pahrump Valley to Sandy Valley, Pahrump, Beatty, Bullfrog, and Rhyolite, Nevada.

Around 1894 O.M. Fisk and Della May White were married in Redlands, California. Della, born in Sommerville, Oregon in 1875, was the daughter of Harsha and Maude Yount White. Della's father managed the Manse Ranch in the Pahrump, developed by Joseph Yount, Della's grandfather. Mr. Yount was a cattleman, and on the ranch he raised and sold hay and managed a vineyard and winery. He later owned a sawmill and valuable timber options in the Charleston Mountains. Eventually Jim Fisk, a mining engineer credited with building and operating some of the largest and most successful ore recovery mills in the gold boom, became involved in the mercantile and lumbering business. He and Della made their home in Greenwater, a copper camp near Death Valley. While Jim was mining, Della ran a general merchandise store.

During the mining boom in Goodsprings, Nevada (Kepper, 2000; Hensher, 2000), Harsha White and Joseph Yount located the Boss Mine (Housley, this volume) and, two years later, the Columbia Mine. Jim went to Goodsprings in 1892 to take over Harsha White's interest in the mines and, with S. E. (Sam) Yount, formed the Boss Gold Mining Company. In 1898 Jim built one of the mills in the mining camp Johnnie, Nevada. He returned 10 years later as a master mechanic in the operation.

Jim Fisk built a 30-mile road from Silver Lake to Crackerjack, a mining camp to the west on the south side of the Avawatz Mountains, over which the Rose, Palmer & Fisk stage line made tri-weekly trips carrying people and mail

(Vredenburgh, 1994). For weeks the stages were crowded with outbound, not inbound, miners. Because of the panic of 1907, Crackerjack (only 90 days old) slumped, as did other camps. About 1910, O.J. and Della Fisk moved to San Bernardino where they became active civic leaders.

20.2 (1.3) Pass under the LADWP powerline. We will return to this intersection after Stop 2-1, the Amargosa Mine at Salt Springs.

20.4 (0.2) Pass over the saddle. Highway 127 leaves the Silver Lake basin and descends into Silurian Valley, marking the present divide between the Mojave River and Salt Creek drainages. Salt Creek flows northward through Silurian Valley and joins with the Amargosa River just north of the Dumont Basin.

22.1 (1.7) The Avawatz Mountains and Mormon Spring are to the northwest.

26.9 (4.8) Continue past a turn to Riggs and the Silurian Hills (Duffield-Stoll, 1996).

31.7 (4.8) The site of Renoville is on the left. Continue past a right turn to Valjean Valley.

37.3 (5.6) Continue past Lake Dumont (Anderson and Wells, 1997).

38.8 (1.5) **Turn right** into the Salt Spring BLM information center (and rest rooms) at the southern Salt Spring Hills.

STOP 2-1. Amargosa (Salt Spring) Gold Mine. Salt Spring was a stop on the Old Spanish Trail, opened by Armijo in 1830 and traveled by Frémont in 1844. Argonauts discovered gold here in 1849 (Lingenfelter, 1986; Harder, 1997, 2000; Vredenburgh, 1994, 1995). The current mine owner, Emmet Harder, offers the following excerpts regarding this discovery:

Amargosa Gold Mine (from Vredenburgh and others, 1981, p. 60)

The earliest recorded gold discovery in San Bernardino County occurred at Salt Springs, at a point on the Santa Fe-Salt Lake Trail. Persistent rumors have it that gold was panned... here by the Mexicans ...trading between Santa Fe, New Mexico and Los Angeles from 1826



The Amargosa River. R.E. Reynolds photograph.

until 1848. In December, 1849, a Mr. Rowan and other members of a party of Mormons led by Jefferson Hunt discovered a quartz vein in a small canyon near the spring, in which they found nuggets, the largest about the size of a pea. In 1850, Frank Soule, later a state senator, relocated the gold deposit and took some samples back to San Francisco. A Mormon party headed to San Bernardino in December, 1850 met William T. B. Stanford ... near Daggett, ... hauling a mill to Salt Springs. Ben Sublette, a "noted mountaineer" worked the mines from 1850 to 1852 with great success. However, after several men were killed by Indians, he abandoned the enterprise.

In September, 1860, a Los Angeles company employed 30 men and had 3 arrastras running. Also in 1860, placer ground was discovered about 2 miles away and the gravel was hauled in wagons to the springs, indeed an expensive way to placer.

In 1863 the Amargosa Gold and Silver Mining Company of San Francisco acquired the mines at Salt Spring and in the fall of 1863, they installed a new mill that "met with good success." On October 29, 1864, news broke in Los Angeles concerning the death of three... caretakers at the property. One of the men had been killed by Indians, and the mill had been burned. The other two men were found 20 miles away, having committed suicide by putting bullets through their skulls.

In the middle of the 1860s, a new company took over the mine and operated it successfully for a couple of months. Yet, even though they later were reported to have grossed \$11,000 from one blast of two tons of ore, and during a period of one month, the five-stamp mill produced \$58,000 in gold. By 1870 the property was idle.

In 1902, J. B. Osborne worked the mine. In a week's run of his five-stamp mill, \$60,000 of gold was produced. Mendenhall (1909) described the site: "At the old mine there is a little canyon that descends sharply to the north, in which are the ruins of a twenty-stamp mill. Near the mill are two wells, protected by curbing and covered..."

Journals of Forty-Niners—Addison Pratt's Diary (Hafen and Hafen, p. 94-107)

Stayed here (Archalette) ...a great abundance of grass here. A year or two since [1844] some Spaniards were camped on this

spot with a drove of horses and were attacked by a band of Indians, nearly all massacred. Bro. Rich and his company of packers left us here and went ahead...

Nov. 30th Traveled 7 miles and come to Salaratus Creek or Vegas, covered with grass and a part of it was white as snow with Salaratus ... We traveled down the stream... [Amargosa River] ...about knee deep and strongly impregnated with alkali that it is said to kill cattle when they drink it, in many places grass is plenty and good, the banks or walls on each side appear to be composition of clay lime and salaratus

Dec. 1st Left the Vegas after following it 6 miles [where] the high banks run out and we passed over a sandy desert to Salt Springs. As we drew near the spring we left the wagon track and followed Capt. Hunt up a narrow canon, when I espied some [granite]; ...and observed that if we could find quartz among it we might perhaps find gold, as I was the only one among us that had been in the gold mines, was why I took more notice of it at first than the rest, we then all four of us commenced looking, ... we had not gone far before Mr. Rowan says "Here is gold," on looking I saw that he had found some in a stratum of quartz about four inches wide running through a ledge of granite. It was a collection of small particles the largest about the size of a pea. We found other specimens but the spring was so salt that we could not drink it and we had to go ahead to the camping place to get water which we found standing in holes, left by the last rains.

Walk northeast over the saddle on a BLM hiking trail to the Amargosa Gold Mine. **Caution:** stay away from vertical shafts that have collars subject to collapse. Do not enter mine tunnels, adits or stopes, since they are homes for rattlesnakes and bats. Return to vehicles, **retrace** toward Baker.

38.9 (0.1) **Stop** at Hwy 247. Watch for cross traffic; **proceed south.**

46.1 (7.2) Pass a turn to Valjean and Kingston Wash.

50.9 (4.8) Pass a turn to Riggs and the Silurian Hills.

58.2 (6.8) The road crosses a saddle ahead. Prepare to turn right at the LADWP Powerline Road.

58.7 (0.5) **Turn right** (west) on LADWP Powerline Road and proceed through hills of Riggs Carbonate (white) and black diabase (Gross, 1959).

59.0 (0.3) **STOP 2-2. The Silver Lake Outflow** drains to the north through a saddle at elevation 945' before entering the Salt Creek Drainage flowing from Red

Pass north into the Amargosa basin. The T & T Railroad was completed across Silver Lake in 1906. When the Mojave River flooded the Silver Lake in 1908 and 1916, the railroad attempted to drain the lake by excavating a channel through this pass. The attempts failed, and the railroad, along with the town of Silver Lake, were relocated at the higher elevation (960') that we passed earlier in the day. Look south at the first T & T road bed that was built across the flat lake surface. Today, the road bed and first townsite are submerged under lake waters that rise to approximately 940 feet.



The T&T roadbed across Silver Lake. R.E. Reynolds photograph.

Continue west on the LADWP power line road.

60.4 (1.4) Crest of ridge. Drop into the swale containing Silver Lake Climbing Dune (Reynolds, 2004)

61.2 (0.8) **Turn right** past an electrical shed at the road junction.

61.8 (0.6) Crest of saddle.

62.1 (0.3) Base of hill.

62.9 (0.6) Cross the wash.

63.3 (0.4) Pass a right turn to the southern Avawatz Mountains (Spencer, 1990).

67.6 (4.3) Mesozoic volcanics on road side are a gravity slide block over Miocene silts.

67.8 (0.2) **Turn left** to the Iron King Mine.

67.9 (0.1) **Stop #2-3. Iron King Mine** (Wright and others, 1953). Walk a few hundred feet around the southeast end of the hill to the open pit Iron King Mine, excavated in megabreccia. The hill exposes megabreccia of a large-runout landslide in the Miocene Avawatz basin. The iron ore body consists of magnetite and hematite replacing minerals at the contact of Paleozoic carbonate and Jurassic volcanic rocks (Wright and others, 1953; Bishop 2003).

Retrace to the left turn to Silver Lake.

68.3 (0.3) Right bend in the road; proceed east.

73.4 (5.1) Pass a road leading to the southern Avawatz Mountains.

74.7 (1.3) Saddle.

75.2 (0.5) **Turn left** at the junction with the powerline, near the utility shed.

76.0 (0.8) Crest of ridge.

77.8 (1.8) **Stop** at the pavement of Highway 127. Cross the highway and **proceed east** on the LADWP Powerline Road.

78.4 (0.6) Pass a LADWP construction camp built be-

fore 1950 (Myers, 1983). **Watch out for a dip ahead.**

80.3 (1.9) Drop into wash.

80.7 (0.4) Pass the left turn for the old road to the Silver Lake Talc Mine.

81.1 (0.4) **Caution:** bend and washout in road.

83.9 (2.8) **Beware of dip.**

85.1 (1.2) **Turn left** (north) toward the Kern River Pipeline valve station and toward the talc mine.

85.2 (0.1) Pass valve station #617.

85.8 (0.6) **Turn right** on the talc mine road.

86.0 (0.2) **Turn left** toward the talc mine.

86.4 (0.4) Continue past a right turn.

87.0 (0.6) **Turn right** (east) to the Silver Lake Talc Mine.

87.2 (0.2) The talc loading chute at 12:00 is at Addenda Extension Shaft; the road bends east.

87.5 (0.3) **Stop 2-4. Silver Lake Talc Mine** (Wright, this volume; Wright, 1954). **Park** at Sierra Camp, with concrete building foundations and ore bin. The Gould Shaft is to the east, and the Addenda Workings are to the north. Claimed in 1911 by the Western White Talc Company, the group was reorganized in 1918 as the Pacific Coast Talc Company. Production began in 1915 and continued through 1952; the commodity was used in cosmetics, ceramics and robber goods. **Retrace** to the LADWP Powerline Road.

87.9 (0.4) **Turn left** (south).

88.5 (0.6) Continue past a left turn.

88.9 (0.4) **Turn right** (west) at the junction.



Sierra Camp at the Silver Lake talc mine. R.E. Reynolds photograph.

89.1 (0.2) **Turn left** (south) at the junction toward the powerline.

89.7 (0.6) Pass valve station #617.

89.8 (0.1) **Stop** at the LADWP Powerline Road, look for traffic, and **turn left** (east), preparing for an immediate right turn (south). Make a **quick turn left and then right** (southeast) and drive along the sand wash.

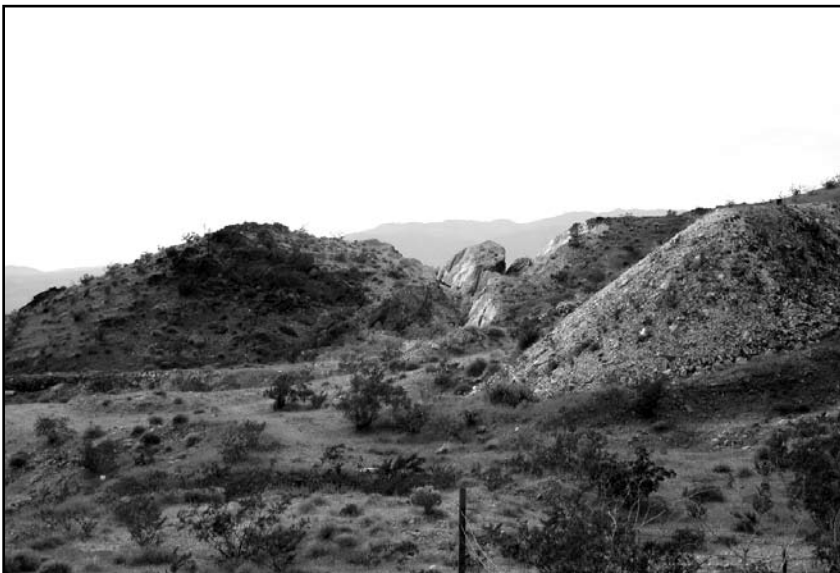
90.1 (0.3) Slow for a dip.

91.0 (0.9) **Turn left** (east) up the terrace.

92.3 (1.3) **Turn left** at a complex intersection.

92.5 (0.2) The road drops into the wash.

93.1 (0.6) **STOP 2-5. Halloran Turquoise** (Reynolds, this volume; Sperisen, 1897, 1983). Park at the



The Gould shaft at the Silver Lake talc mine. R.E. Reynolds photograph.

clearing before the road begins a steep four-wheel-drive ascent. The canyon to the north with a car body was flowing 12" wide in March 2005. The road northeast continues to the Himalaya (Tiffany Turquoise) Mine (West Camp). The Apache Canyon Turquoise diggings are to the north-northwest. Both are accessible by hiking or by high-clearance 4WD vehicles with low range gears. Mr. Ed Nazelrod continues to work the local mines and prospects. Return to vehicles, **retrace** to the complex intersection.

93.9 (0.8) **Stop** at a complex intersection and **turn left** (east).

94.2 (0.3) The road drops into the wash. **Turn right** (south).

94.4 (0.2) Roads join at a complex intersection. Stay to the right (south).

94.5 (0.1) **Bear right** (south) at the fork, past the mine shafts. (The left fork runs east past the microwave station and the site of the historic air beacon.). Our route is over Teutonia quartz monzonite (Beckerman,1982).

94.7 (0.2) **Bear right** (south) at the junction.

95.6 (0.9) **Turn left** (east) at the junction.

95.7 (0.1) Continue past the **Wander Mine** (Wanderer Mine and Mill), one of the earliest gold mines (1902) in the Halloran Spring mining district (Vredenburg, 1996c; Tucker, 1931 p. 320). The district was active in 1900 and again in the 1930s. Today the Telegraph Mine, east of Halloran Spring, is sporadically active, depending on the price of gold.

97.2 (1.5) Continue past a turn to the left (NN 577).

97.3 (0.1) Continue past a turn to the left (NN 572).

97.9 (0.6) Continue past a turn to the left (NN 569).

98.5 (0.6) Continue past a deposit of pyroxene andesite to the left.

98.7 (0.2) Continue past a turn to the south (NN 567) at Mesquite Wash.

99.2 (0.5) Bull Spring Wash Road (with patchy pavement). **Turn left** (north) and **immediately right** (east).

99.6 (0.4) Continue past a black pyroxene andesite outcrop and a mine cabin on the right (south).

100.0 (0.4) **Stop** at the paved Halloran Springs/Microwave Road. Look for traffic; **turn right** (east) and



West Camp diggings. R.E. Reynolds photograph.

make an immediate left turn onto BLM road NN 484.

100.2 (0.2) **Turn right** (northeast) onto BLM road NN 486.

100.8 (0.6) **Turn right** (southeast) onto BLM road NN 488.

101.0 (0.2) **STOP # 2-6. Arrastras.** Hike 1/3 mile south through the saddle in the ridge line for an overview of arrastras and a stone cabin (built much later). The Halloran Spring mining district contained quartz veins with free-milling gold (Tucker, 1931). The ore required pulverizing before the final concentration by panning in water. Arrastras have been used in the west since Spanish/Mexican time, and its use during the depression of the 1930s is often misinterpreted as being from an earlier period. An arrastra consists of a stone base, stone walls (race), and a central, vertical pivot-shaft. A beam was suspended from the pivot, and drag stones were suspended from that beam. Animals (burros or oxen) were driven in a circular path outside the race, causing the drag stones to crush the quartz ore. The pivot in this arrastra may be the front axle from an early twentieth century wagon (Rory Goodwin, p. c. to Reynolds, March 2005). **Hike back** to vehicles and **retrace** to paved Halloran Springs/Microwave Road.

102.0 (1.0) **Stop** at paved Halloran Springs Road, look for cross traffic, and **turn left** (southeast).

102.3 (0.3) Pass Halloran Spring.

102.5 (0.2) Cross Halloran Wash.

103.0 (0.5) **Enter** I-15 westbound, toward Baker.

115.3 (12.3) Exit at central Baker.

115.7 (0.4) **Stop; turn right.**

115.9 (0.2) **Stop** at Main Street in Baker. Check your gas gauge; then enter I-15 westbound toward Barstow.

122.0 (6.1) Continue past Zzyzx Road.

127.8 (5.8) Pass Razor Road.

131.2 (3.4) Exit the freeway at Basin Road.

131.5 (0.3) **Stop, turn left** (south) over freeway.

132.5 (1.0) Pass a BLM kiosk.

133.6 (1.1) Take the right fork in the road.

140.8 (1.0) Cross a branch of the Mojave River.

141.2 (0.4) **Turn left** at a sharp reverse turn.

141.3 (0.1) **STOP 2-7 Cave Canyon (Basin/Baxter) Iron Mine.** Park at the cut to examine black magnetite and hematite in white marble (Brown and Monroe,



Arrastras in the Halloran Spring mining district. R.E. Reynolds photographs.

2000; Wright and others, 1953). This mine was opened in 1930 and the iron was used in the manufacture of cement. **Retrace** to Basin Road.

141.7 (0.4) **Turn sharp right** at Basin Road. Ahead lie the Cave Canyon (Baxter) limestone mines, and the World War II Afton Canyon (Cliffside) magnesite mine (Wright and others, 1953). Roads from the south brought Afton fluorite to Baxter Siding for shipment (Wright and others, 1953) .

143.2 (1.5) Approach the Mojave River channel.

CANCELLED DUE TO FLOODING !!!!! (see Presch, this volume).

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Cancelled due to flooding

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Southern California experienced heavy rains during October, November, and December of 2004 and January and February, 2005. Lake Arrowhead received rainfall amounts of 19.23, 3.71, 8.85, 36.46, and 12.43 inches during that time period. The surrounding watershed provided sufficient water to fill Lake Arrowhead, a rise of about 25 feet, and filled Silverwood Reservoir. To prevent an overflow of the reservoir and to provide room for snow melt, the Mojave Dam flood gates were opened on January 11, 2005, releasing an estimated 10,000 to 12,000 cubic feet of water per second into the Mojave River.

Flow in the Mojave River resulted in the appearance of the river above ground through Victorville, Barstow, into and out of Afton Canyon, and into Soda Dry Lake. Water flow continued under Interstate 15 and the Baker Road bridge into Silver Lake. Silver Lake currently remains flooded to a depth of about 3 feet in the deeper areas.

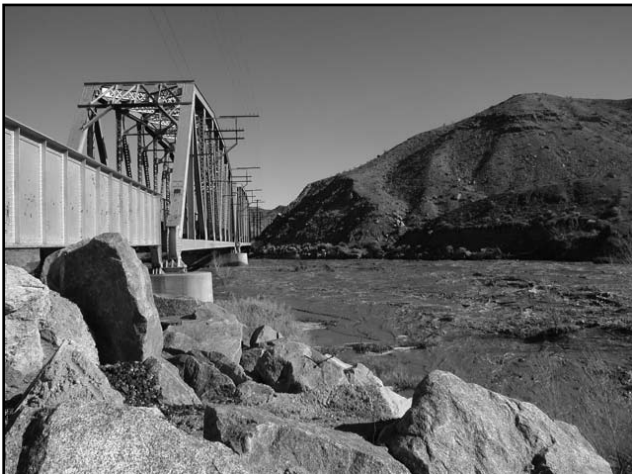
A second release of water occurred during the second week of February, 2005. Water is still being released from Silverwood Reservoir but at a lower rate. The Mojave River remains above ground at Barstow, but at a greatly reduced volume.



Mojave River from the Afton Canyon group camp.



Afton Canyon; west crossing



West Afton trestle.



East Afton trestle.



Basin/Baxter crossing on the Mojave River.



Mojave River, south of Razor Road.



West Baker Boulevard.



I-15 at Baker



Sandy Fulton kayaking on Silver Lake; view south toward Baker. R. Fulton photo.



Fresh water at Badwater, Death Valley.

An overview of mining in the California Desert

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Placer gold, eroded from its host rock and deposited as nuggets or flakes in stream-bed gravel, provided the first non-native American mineral production in California. Shortly after the establishment of a Spanish community at the present site of Yuma, Arizona, placer gold was discovered about ten miles to the northeast on the California side of the Colorado River at the Potholes. The deposit was worked from 1779 to 1781. (The Yuma Indians wiped out the Spanish community on July 17, 1781.) About this same time placer gold was discovered and worked briefly in the nearby Cargo Muchacho Mountains. The Potholes again began to yield gold following Mexican independence in 1823.

On the western-most fringe of the Mojave Desert, Francisco Lopez, Domingo Bermudez, and Manuel Cota discovered gold on March 9, 1842 just some 30 miles from downtown Los Angeles and 50 miles from Palmdale in Placerita Canyon. Gold was mined here actively until 1845.

However, these early gold discoveries are simply historical footnotes in comparison to John Marshall's find on January 24, 1848 on the South Fork of the American River. Marshall made his discovery nine days before the signing of the Treaty of Guadalupe Hildalgo. This treaty called for Mexico to cede 55% of its territory, present-day Arizona, California, New Mexico, Texas, and parts of Colorado, Nevada and Utah, in exchange for fifteen million dollars in compensation for war-related damage to Mexican property. In May 1848, Kit Carson, acting as official courier for the U.S. Government, left Los Angeles, carrying a dispatch to Washington D.C. announcing the discovery of gold in California. On the trip east, following the Old Spanish Trail, he would have naturally have stopped at Salt Springs at the south end of Death Valley. The reports of astoundingly rich placer gold finds caught the imagination of the entire civilized world. Soon it seemed that everyone was on his way to California to strike it rich.

In October 1849, some 500 gold seekers in 110 wagons, who had arrived too late in the season to safely cross the Sierras, chose to head south guided by Jefferson Hunt – at \$10 per wagon. The route from Salt Lake City approached the gold fields via snow-free southern California. On November 1, near the Utah-Nevada boundary, a group 100 immigrants decided to follow a doubtful map to cut hundreds of miles off the route. Those that left soon disintegrated into a number of smaller groups that found themselves lost in the Death Valley country. Somewhere

in the Panamint Range, Jim Martin picked up a rock which was nearly pure silver. Later, when he had arrived in Mariposa, he had the specimen made into a gun sight. This discovery has been known as the “Lost Gunsight Mine” ever since.

Shortly after the scattered survivors of the “short cut” arrived in the gold country, a man named Turner returned with a party to search for the source of the gun sight's silver. Turner headed south from Mariposa and set out for Death Valley from the ranch of Dr. E. Darwin French near Fort Tejon, now in Kern County. This expedition returned empty-handed. In September 1850, Turner mounted another expedition. This time Dr. French accompanied the group. This second group also returned without finding the lost silver ledge.

Meanwhile, Jefferson Hunt led the rest of the party south, eventually joining the Old Spanish Trail. Near the south end of Death Valley they came to the resting point, Salt Spring—the same spring Kit Carson would have stopped at a year earlier. Here two men who had been in the California gold fields the previous year discovered placer gold. The gold flakes were traced up a small ravine that drained nearby hills. The source of the gold, a quartz vein that contained pea-sized nuggets, was easily found. Within months a company was organized to mine gold at Salt Springs.

Following John Marshall's discovery, prospectors quickly fanned out to test nearly every river and ravine in the Sierra Nevada. The last of the Sierra Nevada placer gold discoveries occurred on the lower Kern River in May 1854. By January 1855 exaggerated reports of riches at the “southern mines” began to fill newspapers from San Francisco to Los Angeles. By this time all of the easily recovered placer gold had been mined out further north, and men looking for another chance at easy riches immediately poured into the area. The reports of easy riches soon proved highly exaggerated, and by April the rush was over. However, after most of the adventurers had gone home, a string of gold discoveries was made in the adjacent mountains. In 1855 and 1856, lode gold was discovered in the Greenhorn Mountains, at Keyesville, and in Erskine Creek Canyon, and placer gold immediately south of Tehachapi. The small community of Keyesville was soon established just up from the Kern River, near the lode gold mines. A few miles north of Keyesville, the rich Big Blue Mine was discovered in 1861. That same year placer and lode gold was found about 15 miles to the southeast, high in the Piute Mountains, giving birth to

the community of Claraville. Ten miles to the northeast of Claraville, also in 1861, lode gold discoveries resulted in the formation of Sageland. In 1864, located little more than 6 miles south of Keyesville, gold was discovered on Clear Creek. The adjoining lode discoveries resulted in the establishment of the town of Havilah which, in 1867, became the first county seat of Kern County. Many of the men who were actively involved with mining in the Southern Sierra between 1855 and the mid-1860s would turn up in mining camps though the Mojave Desert and Great Basin.

Far to the north of the Kern River, about 20 miles east of the northern shore of Lake Tahoe and just north of the Carson River, prospectors began recovering placer gold as early as 1852. This small-scale mining continued until spring 1859 when Peter O'Riley and Patrick McLaughlin discovered the top of the Ophir bonanza. Within days they were extracting as much as \$1,000 a day in placer gold. In July a local rancher had ore assayed in Grass Valley from O'Riley and McLaughlin's discovery that was found to contain \$3,000 per ton silver and \$876 per ton in gold. The "blasted blue stuff" which had fouled gold rockers since 1852 was found to be high-grade silver ore. With this assay, the Comstock Lode had its beginning. California's gold towns were emptied as thousands poured into the "Washoe" region. A new rush for riches had begun. The late-comers, finding the surrounding ground completely staked, immediately fanned out into Great Basin and eastern California looking for a second Comstock.

Fueled by the Lost Gunsight Mine story, prospectors began to scour the Death Valley region. Dr. Darwin French decided to give the search another try. In 1860, following the Comstock discovery, he led a group of about a dozen prospectors from Oroville and Sacramento in a search for the lost ledge of silver. While the expedition failed to find the source of the gun sight silver, they did find rich silver ore in the Coso Range. One member of the French party was Dennis Searles. He returned with his brother John not long later. Together the brothers found gold and silver mineralization in the Slate Range. By the fall of 1860 there were hundreds of prospectors in the area. By early 1861 the Telescope Mining District had been established in the Panamint Mountains, and the Washington District in the Amargosa Range on the east side of Death Valley. In the early 1860s mineral discoveries in the desert of southeastern California came in quick succession. At the base of the mountains at the eastern edge of the Owens Valley several gold discoveries were made in the 1860s. From south to north these were Bend City (1863), San Carlos (1862), and Owensville. In 1863 the Kersarge Mine was discovered high on the crest of the Sierra Nevada west of Independence. To the south, gold and silver was also found in the El Paso Mountains.

In the East Mojave silver ore was found in 1863 essentially right beside the route of the Government Road in Macedonia Canyon in the northern Providence Mountains. Located just 15 miles inside Nevada, the Potosi

lead-silver mines in 1861 were attracting considerable attention. At the same time the gold placers of El Dorado Canyon (east of present-day Searchlight, Nevada) and La Paz, Arizona (seven miles north of Ehrenberg) were also active. These discoveries drew men either overland from the coastal regions of California or up the Colorado River.

During the Civil War the relatively easy transportation along Colorado River, rich copper deposits adjacent to the river, and growing demand and the high price of copper combined to yield small tonnages of high-grade ore. During this time copper was mined in the Dead Mountains, Whipple Mountains, Turtle Mountains, and in Riverside County in the Ironwood Mining District. What little ore that was mined was shipped around the globe to Swansea, Wales for smelting.

In the late 1850s, just prior to the outbreak of "Washoe fever," miners were successfully recovering placer gold north of Mono Lake at the camps of Dogtown and Monoville. Then, in July 1859, Waterman "Bill" Body found placer gold some 20 miles east of Dogtown at the location that bears the name Bodie. A year later gold was discovered some 16 miles farther to the east, just inside Nevada, at Aurora. In 1861, lode gold was discovered at Bodie and shared the limelight with nearby Aurora. Aurora grew rapidly into a town. Many of the houses and stores were built of fine brick. Samuel Clemens worked here briefly in 1862. It was even the seat of Mono County for a short time until a boundary survey proved it to be in Nevada. It boasted two newspapers and a population of several thousand. But more importantly, the inflated value of the mining stock, extreme speculation in mining property, and costly mills that largely stood idle led to a collapse in the price of mining stock. It began in January 1864 with Aurora's Wide West Mine, but soon spread to all the mining stock associated with Aurora and ultimately the Comstock mines as well. At the time the mines of the Comstock were themselves struggling, and would until the discovery of bonanza ore in 1871.

As mining capital dried up in the mid-1860s, most of the mines within the California desert region were deserted. An outbreak of Indian hostilities at this time also contributed. One bright spot in the region during this time occurred in 1865 high in the Inyo Mountains with the discovery of the Cerro Gordo Mine. The first wagon of silver bullion from this mine arrived in Los Angeles in June 1868 for shipment to Selby Smelter in San Francisco (which had been erected in 1867). Regular shipments began arriving in Los Angeles in December 1868 and continued until the summer 1872. At that time the bullion was hauled over Tehachapi Pass to the Southern Pacific railhead near Visalia. However, this arrangement proved a disaster, and again in June 1873, Los Angeles became the recipient of Cerro Gordo's output. The flow of silver-lead bullion continued through Los Angeles until April 1875 when the bullion route was again shifted over Tehachapi pass to the railhead of the Southern Pacific Railroad at Caliente, located at the base of the pass. In late July 1875

rails finally reached Mojave. The teams of bullion from Cerro Gordo soon were connected here. But by December 1876 the mine's output had essentially come to an end.

The discovery of Cerro Gordo in 1865 and the 1871 discovery of bonanza ore at the Comstock proved a stimulus through out the desert. As a result of the immense quantities of silver extracted from the Comstock between 1871 and 1878 several men became fabulously wealthy, and in general the investment climate greatly improved.

In the East Mojave the Ivanpah silver mines were actively mined beginning mid-1870 with ore shipped to the Selby smelter in San Francisco. A mill was erected at the New York Mine, located in the New York Mountains, in December 1873, though it ran only briefly. The McFarlane brothers later moved it to Ivanpah. By the mid-1870s two mills located near the town of Ivanpah were processing ore. About 10 miles south of Ivanpah, the Bullion and Cambria silver mines were productive in the early 1880s, and the Bonanza King Mine was found in the spring of 1880 when two prospectors from Ivanpah discovered silver ore in the Providence Mountains.

In Inyo County silver ore was discovered at Panamint in January 1873, at Darwin in October 1874, at Lookout in January 1875, and near Resting Springs in August 1875.

Silver and gold were discovered in the hills above Oro Grande in the summer of 1879, and a substantial water-powered mill was erected along the Mojave River by April 1881. Silver was also discovered in 1879 at the Waterman Mine located just north of the Mojave River at what is now Barstow. A mill to work this ore was constructed in November 1881. At nearby Calico, silver ore was discovered in April 1881. Initially ore was hauled from the Silver King Mine at Calico to the Oro Grande mill. But within a couple of years there were a number of mills located in the vicinity of Calico.

The significant output of silver during this time was influenced by events that were transpiring far away in Washington D.C. Silver was a relatively scarce commodity prior to the discovery of bonanza ore in the Comstock mines in the early 1870s. On the open market, it was worth \$1.02 an ounce. However, prior to passage of the Coinage Act in 1873, the U.S. Mint would only pay one dollar to purchase an ounce of silver. With the passage of this Act, the United States demonetized silver, and silver dollars were no longer were produced (although the half dollar, quarter and dime continued to be minted). In addition, U.S. bonds had to be redeemed only in gold as silver was no longer a monetary metal. During the mid-1870s the market became flooded with newly mined western silver. Also, France and Germany had adopted the gold standard, dumping millions dollars worth of silver on the market. As a result, its price had dropped to ninety cents an ounce by 1878. Mining interests clamored for repeal of the Coinage Act that they labeled as the "crime of 1873."

In 1878 the Bland-Allison Act, passed to reverse the effect of the Coinage Act of 1873, mandated purchase of



The Bidwell mill at Ivanpah.

between \$2 million and \$4 million worth of silver each month from the western mines. The Bland-Allison Act of 1878 was repealed by the passage of the Sherman Silver Purchase Act of 1890. The 1890 act required the U.S. government to purchase nearly twice as much silver as before, and pay for it with legal tender, treasury notes redeemable in gold. The silver was to be purchased at market rates. After the financial panic of 1893, President Cleveland called a special session of Congress and secured, in 1893, the repeal of the act.

The Bland-Allison Act and the Sherman Silver Purchase Act provided stable silver prices at a time when market forces would have otherwise depressed silver prices due to over-supply. As a result silver was king in the California desert from 1878 until 1893. The repeal of the Sherman Act in 1893 sounded the death knell to silver mining. One victim was the New York Mine, also known as the Sagamore, located in the East Mojave. Issac Blake, the mine's principal promoter, had invested much time, energy and money in the construction of the Nevada Southern Railroad to primarily serve this mine. The railroad, constructed north from Goffs, reached Manvel by July 1893. However his entire empire collapsed at nearly the same time.

Bodie, one of the premier gold mines in the region, was an exception to predominance of silver mining during

the 1870s and 1880s. Rich gold was discovered in the underground workings in 1872, reviving the mine. By 1888 more than \$18 million was produced. The gold mines of the Cargo Muchacho Mountains and at Picacho in Imperial County were also exceptions. In 1877, with the arrival of the Southern Pacific Railroad in the area, the mines here began to be worked.

Gold reigned as king with the loss of silver price supports in 1893. As if on cue, several important gold deposits were discovered. These included Vanderbilt (1893), Red Rock Canyon (1894), the Summit Diggings (1894), the Yellow Aster Mine (1895), the Mojave Mining District (1894), the Ratcliffe Mine in the Panamint Range (1897) and the Bagdad-Chase Mine (1901). Mining revived at Picacho, in the Cargo Muchacho Mountains, and many other older districts.

In June 1903 a standard gauge railroad, the Ludlow and Southern, was completed from Ludlow to the Bagdad-Chase Mine. Ore was shipped to the Randsburg-Santa Fe Reduction Company's 50-stamp mill at Barstow for processing. This mine was to become one of the premier producers in the entire desert. The Yellow Aster Mine at Randsburg was another major producer. In November 1897 the 28 mile long Randsburg Railroad was constructed north from Kramer on the Santa Fe to Johannesburg near the mines.

In addition to economic considerations that favored gold, there were several technical innovations. Foremost was the introduction of cyanide to recover gold. In 1890 John MacArthur and Robert and William Forrest of Glasgow, Scotland introduced the cyanide process to the Witwatersrand gold mines in South Africa. The process was found to extract 96 percent of gold from the ore. This enabled recovery rates unimagined with mercury amalgamation alone. The use of cyanide breathed new life into many older gold districts. Bodie, whose production by then had slumped, became one of the first mines in the United States to utilize cyanide. Soon its use became the industry standard. Also, men with portable cyanide plants reworked old mill tailings.

After the Southern Pacific Railroad reached Mojave in 1875, the line was pushed into Los Angeles, then south through the Coachella Valley. In May 1877, the line crossed the Colorado River at Yuma. The railroad had an immediate impact on the mining industry. Silver-lead ore was hauled from Darwin, Lookout, and Panamint City to the new railhead at Mojave. Borax ore, which had been shipped from Searles Lake to San Pedro since 1873, was now only hauled 80 miles. Beginning in the winter of 1882, and continuing for the next six years, William Coleman hauled borax from the Harmony Borax Works in Death Valley to Mojave in the world-famous "twenty-mule teams." The Bonanza King Mine located far out in the east Mojave Desert had its mill delivered in July 1882 from Mojave.

The Southern Pacific began construction at Mojave in February 1882 of a new line to Needles, on the Colorado

River. The destination was reached April 19, 1883. At the same time the Atlantic and Pacific Railroad had been building westward from New Mexico. It reached the Arizona bank of the river a month after the Southern Pacific. On August 8 the A&P completed a bridge across the river. The Southern Pacific built its line to halt the A&P's advance into SP's lucrative California markets. However, A&P stood ready to make good on its threat to build a parallel line into California. This would have rendered the newly built Southern Pacific line redundant and of no economic value, and as a result the Southern Pacific agreed to sell the new line. On October 1, 1884 the A&P paid about \$7 million for the rail line to Mojave. In alliance with the Atlantic and Pacific, the California Southern Railroad was built from San Bernardino over Cajon Pass to Barstow where it connected to the A&P in November 1885. (After 1893, the Atlantic and Pacific was known as the Santa Fe.) The mines at Oro Grande, especially the limestone quarries for cement, immediately benefited from the improved transportation.

Daggett was by far the most important source of revenue along the new line between Mojave and Needles. The mining activity at Calico was in full swing. In addition, Daggett became an important receiving point from desert mines. Between 1882 and 1883 borax ore was hauled from the Eagle Borax Works in Death Valley to Daggett. Borax was also hauled from William Coleman's Amargosa Borax Works located at Shoshone. In 1890 the borax deposit at Borate, located just east of the silver camp of Calico, was developed. In 1898 an eleven-mile railroad was built from the deposit to Daggett.

With depletion of the borax deposit at Borate and the discovery of borax southeast of Furnace Creek Ranch in Death Valley, Francis Marion "Borax" Smith was looking for a transportation solution that didn't involve mules. In his first attempt, a road was graded from the California Eastern Railroad terminus at Ivanpah to the Lila C. Mine. In the April 1904 inaugural run, a steam powered tractor pulled a "train" of open ore cars 14 miles, then quit operating. Smith concluded constructing a railroad was the only alternative. On July 19, 1904 the Tonopah and Tidewater Railroad was incorporated. The first rails were laid in November 1905 from Ludlow on the Santa Fe; by June 1907 the rails had finally reached Zabriski, north of the Amargosa River gorge, near Shoshone. Briefly ore was teamed from the Lila C. Mine to the railhead. The line reached the mine on August 16, 1907, and was completed on October 30, 1907 to Gold Center, just south of Beatty, Nevada. When the Lila C. Mine became exhausted, operations were moved twelve-miles to the northwest to the Biddy McCarty Mine. The Death Valley narrow gauge railroad was constructed to connect the mines with the Tonopah and Tidewater. This line was completed on December 1, 1914.

Just a year earlier, in 1913, John Suckow, drilling for water on his homestead claim, at a depth of 40 feet discovered the largest borax deposit in the world, scarcely three

miles north of the Santa Fe Railroad, about 10 miles northwest of Kramer. Immediately Smith's Pacific Coast Borax Company bought up the property. In 1927 the Death Valley operations were moved to the Baker Mine near Boron.

Just as the discovery of the Comstock Lode rocked southeastern California, the discovery of silver at Tonopah on May 19, 1900 and the subsequent discovery in 1902 of gold at Goldfield scarcely 25 miles away, sent prospectors scampering through out the region looking for gold.

Gold discoveries in the immediate aftermath of Goldfield include Skidoo (1906), Harrisburg (1905), Hart (1907), and Crackerjack (1906).

In 1905 the Los Angeles and Salt Lake Railroad (later the Union Pacific) was constructed south through Las Vegas, connecting with the Santa Fe at Daggett. The close proximity of this new line to mines located south of Mountain Pass proved to be a stimulus to that district.

A rail line was built in 1907 from Barnwell (Manvel) to the booming gold camp of Searchlight. The line skirted the north edge of the newly established town of Hart.

At this time the use of the automobile was becoming widespread, and soon became as essential to the desert prospector as the burro had been. Also, gasoline motors were beginning to be used in mills, replacing steam powered equipment. By the mid 1910s trucks began to be utilized to haul ore. Electric power was furnished by lines from the newly constructed Los Angeles aqueduct or, as was in the case of Bodie and Calico, generated locally.

Another stimulus to mining in the late in the 1800s and in the early years of the 1900s was the relatively high price of copper. The Copper World Mine, discovered in 1869, was systematically mined beginning in 1898. Ore was smelted west of the mine at Valley Wells. After reduction at the smelter, the nearly pure copper was teamed to the California Eastern Railroad at Manvel, 30 miles southeast. Supplies and coal from New Mexico were hauled in on the return trip. Three or four times a month a 20-ton carload of copper matte was shipped to New York for final smelting. Each rail car of matte was worth \$7,000. By late 1899 the Copper World was said to be one of the four largest copper mines in the United States. Even though the California Eastern Railroad was extended 13 miles closer to the property in 1902, the mine sputtered and closed. The costs were simply too high. Between 1906 and 1908 the mine was again active. During this time ore was shipped to the Needles Smelter.



An Excited Crowd Examining Gold Float Found on Main Street, Hart, Cal., Feb. 7, 1908

Hart gold discoveries, from a souvenir booklet about the town.

At about the same time, the widespread copper-stained volcanic rocks of the Greenwater Range, east of Death Valley, convinced many that a literal mountain of copper ore lay at depth. (Not a far-fetched idea, considering that in 1906, Kennecott began open-pit mining the Bingham Canyon Mine.) The town of Greenwater sprang up, fueled by frenzied stock speculation and encouraged by investment by some of the biggest names of the day in mining. By 1907 over 1,000 called Greenwater and its satellite communities home. The fact that the promised ore never materialized, coupled with the financial panic of 1907, caused the demise of Greenwater. Speculation in the railroad and banking industries led to a short but painful depression in 1907-1908. Many mines had to suspend operations; banks from Goldfield to Los Angeles failed.

In a discovery that is reminiscent of Comstock, Randsburg prospectors recovering gold using dry placer methods had been bedeviled by "heavy spar" from the beginning. In 1904 the confounded heavy white mineral was found to be the tungsten ore, scheelite. Mining began in 1906 and continued through World War I. Production soared during the war years, as did the number of employees.

Primarily built to service construction of the Los Angeles aqueduct, the Southern Pacific completed a branch line from Mojave north to the southern Owens Valley in 1910. However, one of the largest mineral deposits in the United States was to benefit significantly from the new line. Borax recovery from Searles Lake had ceased in 1895, but in 1905 potash was identified in the lake brines. In 1913 the American Trona Corporation was incorporated to extract potash, soda ash, sodium sulfate, salt, and borax from the brines. A standard gauge railroad was completed to Searles Lake September 1, 1914, and at the same time a plant was constructed at Trona. A German

embargo of potash fertilizer during World War I sharply raised potash prices, creating a rush of activity at Searles Lake—the only American source of potash at the time. With the decline of prices at the end of the war, potash was no longer economically recoverable. However the deposit continues to produce a host of products from the lake brine.

Between 1905 and 1910 the Santa Fe constructed a line from Phoenix, Arizona, crossed the Colorado River at Parker, and then continued north to the main line at Cadiz. On August 9, 1916 a branch line was completed to Blythe. In 1925 limestone mining began at Chubbuck midway between Cadiz and Rice. A short narrow gauge railroad was constructed from the mines to the kiln located along the railroad. Also in 1925, mining operations began at the large gypsum deposit at Midland, situated north of Blythe two miles west of the railroad.

In 1910 a nine-mile long rail line was constructed from Tecopa, on the Tonopah and Tidewater Railroad, to the Noonday and Gunsite lead-silver mines. The mines operated until 1918. Many other mines were able to operate economically along the T&T's route as well, due to the cheap transportation it afforded.

In April, 1918 Congress passed the Pittman Silver Act. Under provisions of this law the United States purchased about \$260 million dollars worth of silver at \$1.00 an ounce. This silver was used to coin silver dollars. As a result there was renewed mining at Calico, but most importantly, the well timed discovery of the Kelley-Rand silver mine in 1919 soon became the largest silver producer in the state. This deposit was discovered right beside the road that is now U.S. Highway 395 in an area that had been intensely prospected since 1895.

By the end of World War I the frontier was gone. Accurate maps had existed for decades. Roads and railroads crisscrossed the desert. The Automobile Club of Southern California placed road signs through out the desert. Soon dirt roads would be replaced by pavement. Truck transportation would replace rail for many operations. Electrical lines already served the largest operations. High-volume low-grade operations were replacing the high-grade deposits that led to the discoveries in the first place. During the 1920s, inflation and the fixed price of gold put a damper on mining. Increasingly industrial minerals would play a more important role in the mining mix. During the 1930s the price of copper bottomed out, however the increase of the fixed price of gold in 1933 stimulated gold mining for a while. But by government order gold mining was shut down during World War II in order to concentrate on the mining of strategic minerals such as iron, tungsten, copper, and lead. After the war, gold mining did not recover. Again, inflation and fixed gold prices were the primary reason. In 1968 the price of gold was no longer fixed. The high price of gold coupled with new innovations in the fields of exploration, mining, and recovery led to a new gold rush through the western United States. During the last few decades, large low-grade gold

deposits have been mined in California. But it is the huge deposits of salines, borax, gypsum, and limestone that will continue to be mined for many dozens of decades yet in the future, providing the nation and the world some of the basics of every-day life.

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The historical mining towns of the eastern Mojave Desert

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Abstract

In 1869, a prospecting expedition discovered copper and silver veins in the Clark Mountains. A supply center named Ivanpah arose at Ivanpah Spring, several miles from the silver deposits; the two main properties became the Beatrice and Lizzie Bullock. Mills were built at Ivanpah in the mid-1870s. The district reached its peak about 1879 and then declined rapidly during the early 1880s.

The Copper World, the other major strike, was developed in 1898, when a smelter was built at nearby Rosalie Wells. Although the production was large at times, the operations were erratic, and the Copper World shut down about World War I.

In 1879, gold and silver were found near Mountain Pass. This became the Mescal Mine. The property was developed in 1882 and remained active at least into 1887. The Mescal produced an estimated \$250,000 in bullion.

Silver ore was discovered in the Providence Mountains in 1880. The main property was the Bonanza King Mine. Two speculators in Colorado, Wilson Waddingham and Thomas Ewing, bought the property several years later. They built a mill at a nearby spring and sank a deep shaft. After producing \$1,500,000 in bullion, the mill burned in 1885; as the price of silver declined, mining became erratic, and work in the district ended during the early 1890s. The Bonanza King was revived in 1906-1907 and 1915-1920.

Bob Black, an Indian, struck gold ore near Vanderbilt Spring, in the New York Mountains in 1891 and a tent camp was founded. In late 1892, major development began. The main mines were the Gold Bronze and the Boomerang. Meanwhile, the Nevada Southern Railway was built into the area, and a railhead was established at Manvel. The veins were small, and the district's two mills were inefficient. The district began to decline in 1894, though some mining continued through the late 1890s.

Several prospectors from Goldfield, Nevada, found gold in the Castle Mountains in late 1907. A town named Hart was founded in early 1908, and a mill was built. The leading properties were the Oro Belle, Big Chief, and Hart Consolidated, but the veins were small and broken, and the district began to decline in 1909. Occasional mining continued until about 1915.

Mining began in the Vontrigger district during the 1890s, but the mines were small. After 1904, Albert H. Cram, a promoter, developed a copper deposit known as the California Mine north of Goffs. He built a large camp

and installed a leaching operation, which produced some copper. The nearest shipping point was Vontrigger on the California Eastern Railway, two miles away. Cram discontinued work about 1911. Several miles to the west in the Hackberry Mountains, the Getchell Mine was developed in 1925 and a large camp, also named Vontrigger, was built there, but the work soon stopped.

Ivanpah

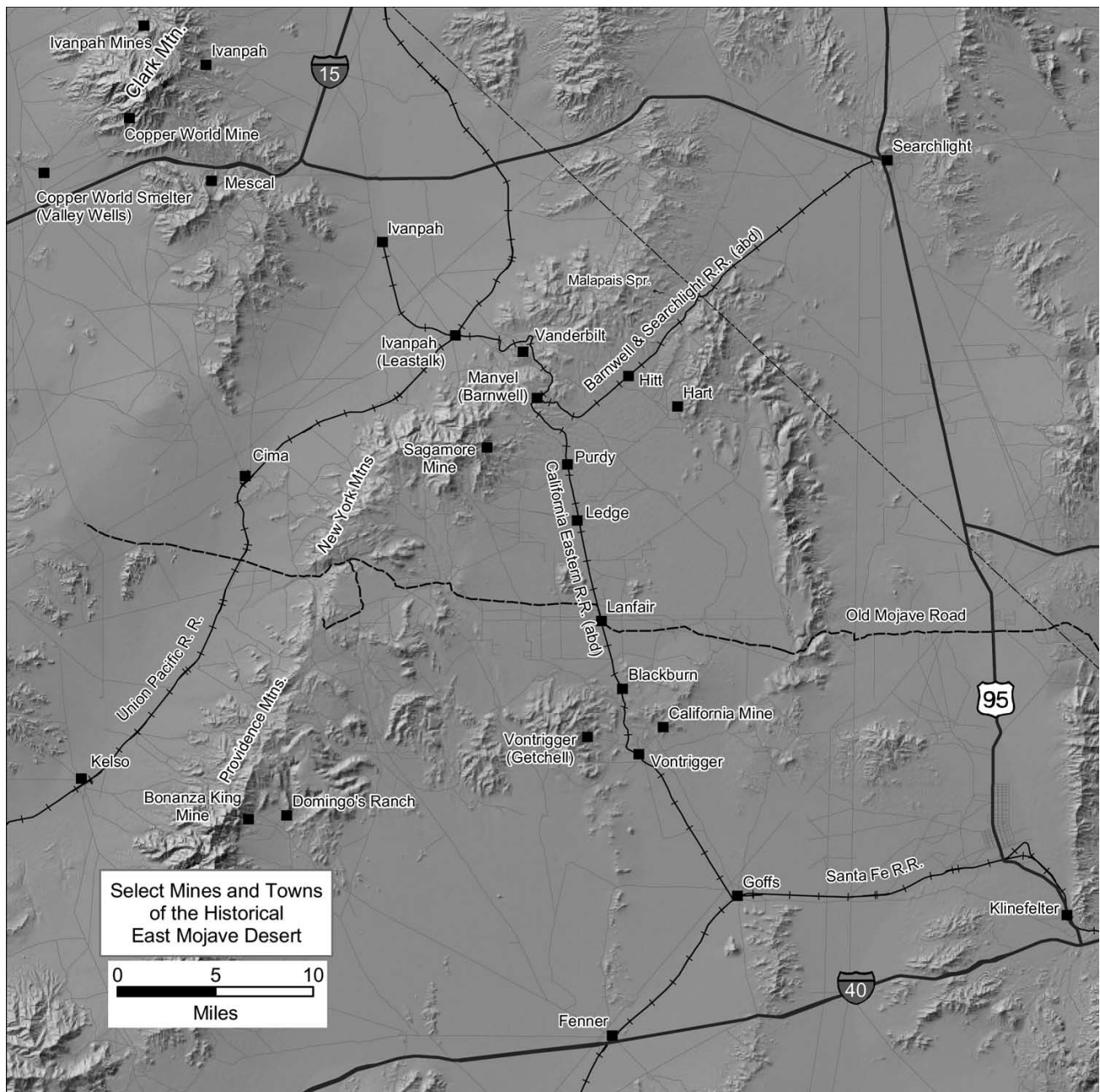
What a disappointment. A newspaper publisher in San Bernardino had just received the annual report of the United States Mint, yet it was full of errors and incomplete. Not a word had been written about "our most productive mines," near Ivanpah.

Lured by the rush to the White Pine Mining District in northeastern Nevada, a prospecting expedition found promising copper and silver veins in the Clark Mountains, in the eastern Mojave Desert in early 1869. This was about 200 miles from San Bernardino. The party named the district after Albert H. Clark, a businessman in Visalia who was one of the supporters of the expedition. The group also organized the Yellow Pine Mining District, adjacent to the Clark district, in Nevada. The Piute Company of California and Nevada was organized in June of 1870 to develop the veins.

The company had an impressive pedigree. One of the trustees was John Moss, the leader of the expedition; a noted mountain man, he maintained friendly relations with Indians along the Colorado River. The secretary was Titus F. Cronise, who had recently written an encyclopedia on the state's resources. The superintendent was J. W. Crossman, who was becoming an important writer on mining.

The Piute Company planned four towns. Two of them, Cave City and Pachocha (variously spelled), were never built. The third site was Good Spring, in the Yellow Pine district. Ivanpah, a 160-acre townsite, was laid out at a spring on the southeast slope of Clark Mountain, eight or nine miles southeast of the mines.

Despite the isolation and heat, 300 men were in the district by the summer of 1870. The first ore was shipped out in September, to San Francisco. Freight cost about \$70 a ton, but the ore was yielding as much as \$2,000 a ton, mainly in silver. By August of 1871, Ivanpah contained 15 buildings, including a hotel, two stores, the office and headquarters of the Piute Company, and small houses, all of them built of adobe and covered with good shake roofs. Three of the buildings measured 40x60 feet, includ-



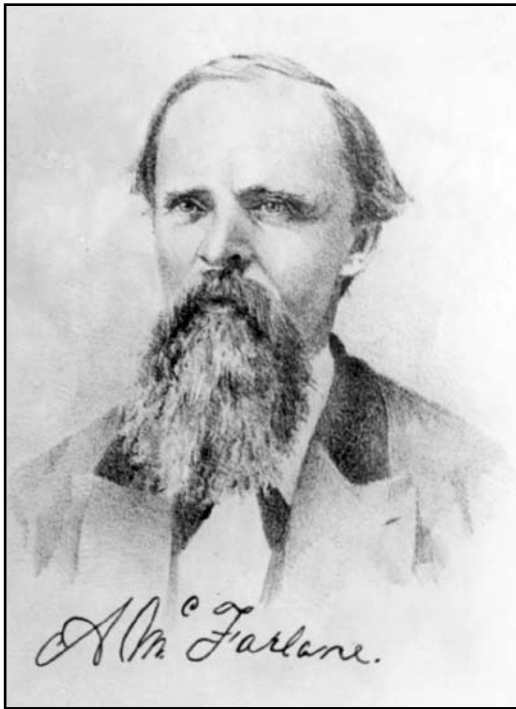
ing the hotel, the largest structure in town. (These might have been tents.)

The mines were on Mineral Hill (also called Alaska Hill), eight or nine miles northwest of the town. The most promising properties were the Hite & Chatfield claim (later renamed the Lizzie Bullock) and the Monitor and Beatrice, owned by the McFarlane brothers—Tom, Andrew, John, and William. The work force included Indians, Mexicans, and Anglos; among them were several pioneers of the Kern River mines: Dennis Searles, William A. Marsh, and the McFarlane brothers. (Six miles southwest of Ivanpah was the Copper World claim, which would remain unworked for three decades.)

The original operations were primitive. The Beatrice Mine No. 2, owned by the McFarlanes, was equipped with

only a hand windlass in 1871. John McFarlane's house, office, and sleeping quarters, which contained several berths, consisted of a very large tent where he had several mineral cabinets that held more than 200 specimens. Since the mines were dry, Indians were employed to haul water by pack train from Ivanpah Spring. Mexicans were employed to work the ore in arrastres, or circular stone mills. They received \$125 a ton, which meant that lower grades of ore, worth at least \$150 a ton, had to be left on the dump. Even so, the firm of Hite & Chatfield earned a \$20,000 profit in 1872. Teamsters arrived from San Bernardino with supplies and returned with heavy loads of ore. During six months in 1873, the mercantile firm of Brunn & Roe forwarded \$57,000 worth of ore to San Francisco.

With returns like those, the mine owners could af-



Andrew McFarlane.

ford to develop their properties. In November 1873 the McFarlane brothers put up a small smelting furnace and a comfortable house. About early 1875, they moved a five-stamp mill from the New York Mountains to a hill above Ivanpah, where water was available. By then, their main mine, the Beatrice, was nearly 300 feet deep. The brothers also incorporated the Ivanpah Consolidated Mill and Mining Company, which was often called the "Ivanpah Con." By mid-1875, the district had produced \$300,000. J. A. Bidwell and a partner, who had bought the Lizzie Bullock Mine, built a 10-stamp mill near the Ivanpah Consolidated in 1876. It started up in June.

Regional and national depressions, which had begun in 1875, finally affected the Clark district in 1876. Both the Bidwell and Ivanpah Consolidated mills had difficulty getting enough ore to run full time. About \$40,000 in attachments were filed against the Ivanpah Consolidated. Apparently, the property was sold and operated only intermittently through 1877, although the McFarlanes were kept on as managers. One writer charged that the mines never had been properly developed, having been "gouged too much by incompetent miners."

It's likely that Bidwell's operation became the main producer then. In late 1877, he overhauled his mill and increased his force at the Lizzie Bullock Mine, to 20 in August 1878. Both mills ran steadily, but well into 1879 Bidwell continued to send out heavy loads of bullion, including one shipment worth \$8,000.

The camp reached its peak about then. A post office was established in June of 1878. By April of 1879, when more than 100 hands were working on Alaska Hill, the business district comprised two saloons, stores, blacksmith shops, shoemakers' shops, hotels, and hay yards, besides one butcher shop and "neat and comfortable" houses. By early 1880, about 65 people were living in town and about the same number at the mines. In May two printers, James B. Cook and Wilmonte (Will) Frazee, started a weekly newspaper, the Green-Eyed Monster, but they had to suspend it after a few issues.

Though the Ivanpah Consolidated had produced a reported \$500,000 in bullion by the end of 1879, it continued to sink into debt. The owners, a San Francisco company, resorted to issuing scrip, for which it neglected to pay a 10% tax to the federal government. After failing to pay its employees for several months, the company suspended work. The



The Ivanpah mill.



The Bidwell mill.

government won a judgment for \$1,480 and sent out E. F. Bean, a deputy collector for the Bureau of Internal Revenue, to attach the property. Upon his arrival, in mid-May of 1881, a dispute arose; two days later, John McFarlane tried to shoot Bean, who managed to get off a shot first. McFarlane died instantly. A judge in San Bernardino ruled that the killing was “a clear case of justifiable homicide.”

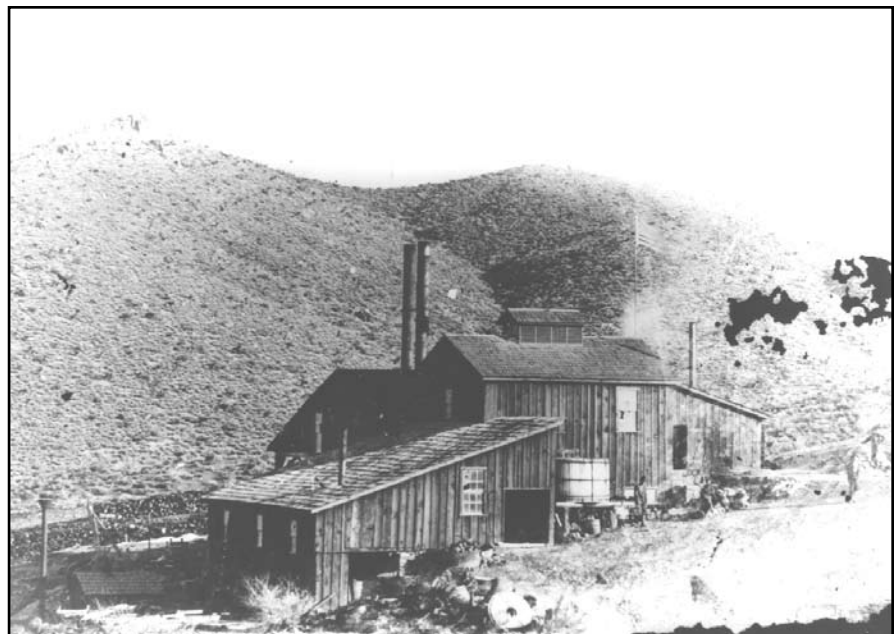
The district shipped out at least \$162,000 in treasure in 1881, but a decline soon followed. Most of the population departed during the early 1880s. Only 11 residents remained in early 1890. About the only businesses left in December of 1892 were a store and boardinghouse and the post office, which Bidwell and his wife ran. Soon after collecting mineral specimens for San Bernardino County’s exhibit at the World Columbian Exposition, in Chicago, Bidwell died. His widow received \$75 from the county. A depression followed in June of 1893, and the price of silver fell to 58¢ an ounce, its lowest level, in 1898. The store closed about then. The post office was moved in April of 1899.

For nearly three decades, the Copper World discovery remained neglected. In August of 1878, James Boyd, who owned the property, built an experimental smelting furnace in San Bernardino, but nothing materialized.

But that changed in 1898, when new owners began developing the property; it would become the largest copper producer in Southern California. A large smelter was built in early 1899 at Valley Wells (also called Rosalie Wells), several miles below the mine; the Ivanpah post office was moved to Valley Wells in April and its name was changed to Rosalie. Eighty-five men worked at the mine and smelter. Every four days, long mule teams would haul 20 tons of copper concentrate, or matte, to Manvel, 30 miles away, and would return with coal and supplies. The operation

produced 11,000 tons of matte until litigation forced the mine, smelter, and post office to close in July, 1900, but the Copper World was soon revived.

This time, the California Eastern Railway built a 16-mile extension from Manvel into the Ivanpah Valley in early 1902 and established a shipping point. Known as Ivanpah, the station contained an agency and telegraph office (housed in a box car), several stores, and other buildings. From 25 to 30 persons lived there. A post office, also called Ivanpah, was established there in August, 1903. But costly, wasteful operations forced the Copper World to shut down after a year or two. When the San Pedro, Los Angeles, and Salt Lake Railroad was com-



The Bidwell mill.



The Copper World smelter at Rosalie (Valley Wells).

pleted in early 1905, the line passed within a few miles of Ivanpah station. The post office was moved to nearby Leastalk, a station at the junction of the Salt Lake line and California Eastern. The Copper World reopened in 1906; it produced 487,000 pounds of matte in 1907 alone. But the matte was shipped through Cima, another station on the Salt Lake line. The operation was large enough to warrant the formation of a local of the Western Federation of Miners. When the Copper World shut down again, the California Eastern abandoned its station at Ivanpah. Four or five buildings, all of them vacant, were burned in April, 1908, supposedly by tramps—the usual suspects.

World War I drove up the price of copper (and other metals). The Copper World was reopened in 1916, a large blast furnace was later built, and the work force rose from six to 60. A tractor hauled the matte to Cima. But when the war ended in November 1918, metal prices declined, and the Copper World was shut down for the last time. The California Eastern tore up its tracks in 1921. Several years later, Leastalk was renamed South Ivanpah, which was soon shortened to Ivanpah. The post office remained open until 1966.

Mescal

Six miles south of Ivanpah, near Mountain Pass, was the Mescal Mine (also known as the Cambria or Mollusk), which was discovered about 1879. William A. McFarlane, one of the pioneers of Ivanpah, bought the property several years later and began developing it. By early 1885, he

and a partner, Simon A. Barrett, had extracted a large lot of ore worth \$100 a ton in silver and gold. They shipped their ore by pack train to Ivanpah, where the Ivanpah Consolidated mill processed it in June of 1885. A few weeks later, Wells, Fargo & Company carried away the first bullion: two bars worth more than \$2,000.

Mescal entered its most productive period after McFarlane and Barrett leased out, and then sold, the Cambria to a company of businessmen in Los Angeles in January, 1886. A 10-man crew drove a second tunnel and laid a 350-yard ore-car track. (Eventually, two 300-foot tunnels were driven.) By late 1886, the camp contained an assay office, comfortable offices, a boardinghouse, a lodging house, adobe houses for men with families, and other buildings. The company also built a five-stamp mill near Mescal Springs. The machinery started up in early December. In January of 1887, the mill produced 15,000 ounces of bullion; the company soon added five stamps. A post office named Nantan was established in March. By then, the camp had a store.

That was Mescal's heyday. The price of silver gradually slipped; the value of the ore fell to only \$20 a ton. Only 12 people remained in 1890; in December, the post office closed. The mine had produced an estimated \$250,000 in gold and silver.

Providence

Along the steep slopes of the Providence Mountains, south of the Clark Mining District, parties of prospec-

tors from Ivanpah found extremely rich silver ore during the spring of 1880. Some of the rock assayed as much as \$5,000 a ton. The richest claim turned out to be the Bonanza King, which was sold to Jonas B. Osborne, H. L. Drew, J. D. Boyer, and Charley Hassen, all of whom had some knowledge of mining.

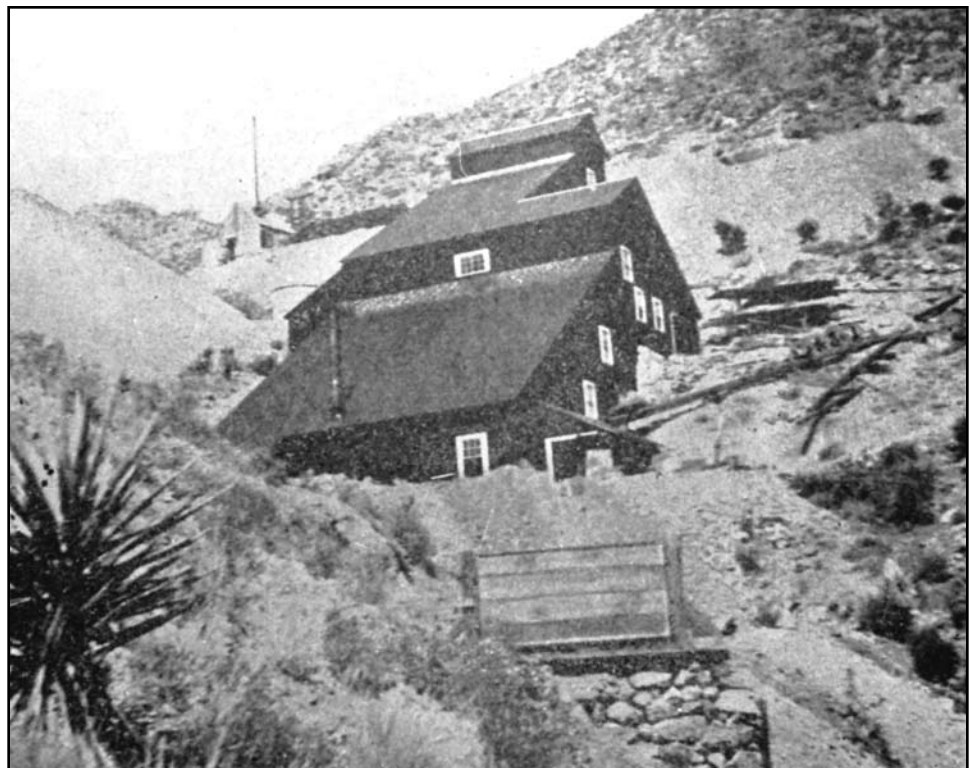
Though a rich vein was found in early 1882, the owners of the Bonanza King sold their interests to the Bonanza King Consolidated Mining & Milling Company of New York. The owners were Wilson Waddingham and Thomas Ewing, who had recently swindled investors in a mine in Colorado. They put at least 100 men to work round the clock developing the mine. The company erected a 10-stamp mill at a spring on Juan Domingo's ranch, a mile and a half from Providence. (The milling camp was known as Crow Town.) The mill started up on January 1, 1883. During its first six months, the mill produced \$573,376 in bullion, according to mint reports. The company then put its stock on the New York mining exchange and began paying regular dividends. By early 1885, the main shaft of the Bonanza King reached 800 feet; the ore was worth as much as \$100/ton in gold and silver. About 100 men worked at the mine and mill then. The company spent \$20,000 on wages and supplies each month, whereas the operation was producing at least \$35,000 a month. By then, the mill had produced \$1,500,000 in bullion.

Meanwhile, Providence thrived. A post office was established in June of 1882, and in October the county supervisors created an election precinct. By early 1883 the camp had 300 residents. The business district contained the post office, several mining-company offices, two general stores, two hotels (with livery stables), a saloon, a contractor, a blacksmith and wagon maker, a deputy sheriff, and a United States mineral surveyor. Many of the buildings were made of a distinctive, locally quarried volcanic ash called tuff. The business district soon shrank, though: by early 1885, the only lodging available was a mattress on a store counter.

Waddingham and Ewing paid their men promptly, but they weren't especially generous. The miners received \$3.50 a day; board cost \$8 a week. The company would fire any man found drunk. A foreman and a shift boss were accused of working the men more "than their health and strength will permit."

Meanwhile, the price of silver continued to slip. After paying dividends through early 1885, the Bonanza King suspended work in March. When the company reopened the mine a week later, it hired 15 men—at \$3 a day—and hired others as fast as they could apply: 40 men in the mine and 35 in the mill when it started up several months later. The shipments of bullion averaged \$60,000 a month. But in late July, the mill burned. The company discharged most of its workers. Although it cleared away the debris, the Bonanza King never rebuilt its mill. Finally, assured that the coinage of silver would continue, the company reopened the mine in early 1886. Rich assays encouraged Waddingham and Ewing to keep at least 20 men at work, but it seems that they shut the operation down about then. At the nearby Kerr and Patton property, however, Godfrey Bahten, a widely traveled mining man, built a five-stamp mill that started up in January of 1887. The Kerr and Patton claim was worked until at least 1890; it reportedly paid good dividends. As a sop to mine owners and impoverished farmers, Congress passed the Sherman Silver-Purchase Act. The measure pushed up the price of silver to \$1.05 an ounce. But it was only a token measure, and the price dropped to its earlier level. The post office was discontinued in May of 1892, although a store or saloon remained in business at least into 1893.

Providence experienced several revivals. The Trojan Mining Company built a gasoline-powered, 10-stamp mill and worked the Bonanza King Mine from 1906 through September of 1907, but the stock market crashed a few weeks later. Meanwhile, Thomas Ewing had returned



The Bonanza King mill in 1905.

from Arizona and set up a small camp, where a short-lived voting precinct was established in May of 1908. In 1915, the Hall-Rawister & Company of Massachusetts rebuilt the mill, reopened the mine, and hired 30 men; work went on round the clock. The presence of five families gave the place “a more charming appearance.” The company installed an electric-light plant, a water line, gasoline engines, and the most modern hoisting and milling equipment. Two trucks made daily trips to Fenner. During the next few years, the company reopened several shafts, as far as 800 feet, and was taking out very rich ore. But when World War I ended, the price of silver again declined, to \$1.01. The company suspended work in July of 1920.

Manvel

By the late 1880s, discoveries were being made throughout the eastern Mojave Desert. Among the most promising places were the Montgomery and Yellow Pine districts. In the Yellow Pine district, about 40 miles north of the New York Mountains, Samuel S. Godbe was opening up a silver-lead deposit.

Isaac G. Blake, a mining magnate in Denver, was especially interested in the Sagamore Mine, a deposit of lead, silver, copper, and zinc in the New York Mountains, just inside California. He also liked the potential of the Yellow Pine Mining District, which contained veins of silver, lead, and gold. In December of 1892, Blake began work on a branch line from Goffs: the Nevada Southern Railway. (Goffs would be renamed Blake in 1894.) Most of the route passed over a gently sloping plain. In late February 1893, the grade reached the foot of the New York Mountains 25 miles north of Goffs.

A construction camp named Purdy, after Warren G. Purdy, one of Blake’s partners, was built there. A post

office opened in late April 1893. It was named after Allen Manvel, the late president of the Santa Fé Railway. Several businesses (probably housed in tents) opened about May. In early September, C. K. Dixon received a license to operate a saloon there.

A camp also arose at the Sagamore, where 80 men worked in early 1893. E. H. Leibey kept a grocery store there. H. Ramsey moved his business from Providence to the Sagamore where, in early September, he received a liquor license, probably for a store. Leibey soon moved.

The onset of a long depression forced the Nevada Southern to halt most work in June of 1893, but the construction of a grade over the New York Mountains continued. About five miles beyond Purdy, the railroad founded another camp. It was named Summit and stood on a juniper-covered mesa at 4,800 feet. In early June, the county supervisors granted licenses for two saloons; Virgil W. Earp owned one of them. Scheduled trains began running there about August, when the businesses of Purdy were moved to Summit. The camp supported one store, owned by R. J. Halsey. In early October the Manvel post office, which had been suspended for two weeks, was re-established at Summit; the postmaster was E. H. Leibey, who had moved his business from the Sagamore.

Manvel served as the nearest railhead for several widely scattered mining camps, including Vanderbilt, Goodsprings, Crescent, and Montgomery. A shipment to the Montgomery mines, 125 miles northwest, for example, totaled 25 tons. The trade increased in the late 1890s, when the Copper World Mine was opened up and gold was discovered 20 miles to the east at what became Searchlight, Nevada. By early 1898, Manvel supported a flour, grain, and lumber dealer, a general store, a hotel, a blacksmith, the post office, and a stage line running to Montgomery. A school district was organized in January 1900. In early 1902, the Nevada Southern completed a 15-mile extension into the Ivanpah Valley, to serve as the shipping point for the Copper World Mine. The railhead was named Ivanpah. (Several months later, the Santa Fé Railway bought the Nevada Southern and renamed it the California Eastern Railway.) At Searchlight, meanwhile, the production steadily increased.

As the main shipping point for Searchlight, Manvel was busy. The town contained a depot and telegraph office, a freight-forwarding house, and



Providence in 1984. Larry Vredenburg photograph.

an agency of Wells, Fargo & Company. The increased business at the post office made it eligible to sell money orders. The Brown-Gosney Company's store transacted several thousand dollars worth of business a day. T. A. Brown, the co-founder of the store, organized a telephone system, started several freight lines and a stage line, and opened branches in several nearby camps and towns. (To prevent confusion with a town in Texas, Manvel was renamed Barnwell in early 1907.)

As long as Manvel remained the only railhead in that region, its importance remained secure. But in early 1902, the railroad extended its line into the Ivanpah Valley, where it established a shipping point for the Copper World Mine. Then, in early 1905, the San Pedro, Los Angeles & Salt Lake Railroad was completed. The line passed only 20 miles from Searchlight and 15 miles from the Copper World Mine. The management of the Santa Fé opposed building lines into mining districts. But in early 1907, the company finally completed a 23-mile extension to Searchlight, the Barnwell & Searchlight Railway—just as Searchlight's production plunged. A depression followed in October. In Manvel, blue pieces of scrip were introduced as money; families began to drift away. Several miles away, in the Castle Mountains, Hart boomed in early 1908, but the shipping point was established at Hitt, a siding and freight house on the Barnwell & Searchlight. That September, a fire destroyed most of Barnwell's business district, including the depot and the Brown-Gosney Company's store. The company, which had moved its headquarters to Searchlight, closed its store in Barnwell in February, 1910. Another fire followed in May. The production at Searchlight fell to \$23,000 in 1911. T. A. Brown moved his family away in 1912. The railroad closed its agency in 1914; the post office was discontinued in April, 1915; and the school district was abolished about 1918. All train service was discontinued in late 1923, and the rails were torn up.

Vanderbilt

During the 1890s, as the price of silver was allowed to decline, gold became the preferred metal. In January, 1891, an Indian named Robert Black struck gold ore in the New York Mountains, about 40 miles north of Goffs on the Santa Fé Railway. An assay made at Providence yielded considerable gold. To protect his interests, Black brought in a trusted rancher, M. M. Beatty, the namesake of the town near Death Valley, to file a claim. Two mining men from Providence, Richard C. Hall and Samuel King, then hurried in and located several veins, which became the Gold Bronze Mine. Two other miners from Providence, Joseph P. Taggart and James H. Patton, joined Hall and King in June of 1891. The four men sank several shafts and took out a few tons of rich gold and silver ore. A camp soon arose at Vanderbilt Spring in a cove-like gully in the side of a hill. Within a short walk were copious springs and abundant piñons, which made excellent fuel.

A strike made by Taggart in the fall of 1892 finally set off a rush. Allan G. Campbell, a Salt Lake City investor, joined Beatty in developing the Boomerang property; they even sank a 100-foot shaft. Two former lords of the Comstock lode, John L. Mackay and J. L. Flood, studied other nearby properties. By January of 1893, 150 people were living at Vanderbilt camp, which contained 50 tents, two stores, one saloon (unlicensed), three restaurants, a lodging house, a blacksmith shop, and a stable. A stage arrived three times a week from Goffs. A post office was established in February 1893, although at first all the businesses except one were housed in tents. In May, the county supervisors appointed W. A. Nash justice of the peace, which also made him a deputy coroner, and granted four liquor licenses. When rail service to Manvel began about August, a stage brought passengers the remaining five miles to Vanderbilt. Meanwhile, Nash established a weekly newspaper, the *Nugget*, although it lasted only two or three issues. Then, in early December, Ben C. Jordan, a young correspondent for the *Los Angeles Evening Express*, began issuing a weekly newspaper, the *Shaft*. The county supervisors established a voting precinct in January of 1894 and belatedly organized a school district in April.

With an estimated population of 400, Vanderbilt probably reached its peak in 1894. The business district contained three saloons (including one owned by Virgil Earp), two barbers, a Chinese restaurant and two other eating houses, two meat markets, a stationery and fruit store, one lodging house, two blacksmiths, and three well-stocked general stores. William McFarlane, one of the pioneers of Ivanpah, owned an interest in one of them, in which he ran the post office, and owned a drugstore, which Dr. E. A. Tuttle managed.

Ten-stamp mills started up at the Gold Bronze and Boomerang mines in March of 1894. The mills used a design from Gilpin County, Colorado, where 1,850-pound stamps would laboriously drop from 25 to 30 times a minute to crush the typically undecomposed granite of the Rocky Mountains. The owners, after all, owned properties in Colorado and Utah. The typical mills in California, however, were designed to crush decomposed rock, using 850-pound stamps, which rose and fell 60 times a minute. (At Ixex Tank, 20 miles west of Needles, a well was sunk and a 10-stamp mill started up in May, 1894. It had a short-lived post office, named Klinefelter.)

As the mines were pushed deeper, accidents became a problem. The first death occurred when a young miner was blown up by a powder explosion in the Boomerang, in May 1894. He was buried that afternoon. The next month, a miner fell down a shaft in the Gold Bronze after his candle was blown out. All of the mines and businesses closed during the afternoon of the funeral.

The end of 1894, when about 100 men were working at the mines, marked the end of the boom. The Gold Bronze produced \$47,000 during its first two years. Its shaft eventually reached 260 feet. The shaft of the Boomerang, which reached nearly 500 feet, once employed 50 men.



James Hart

The Original Discoverers of Hart, Cal.
Clark Hitt

Bert Hitt

The St. George group employed only 14 hands.

Even then, shortages of water, parts, or ore forced the mills to shut down often. Finally, in May, 1895, one mill was converted to the California-style batteries. Even so, the Gold Bronze company was placed in receivership in June. Allen Campbell still employed a force at the St. George group of mines, from which he laid a pipeline to the Boomerang's mill. But the line failed to provide enough water.

All of the mining companies except the Boomerang began to lease their properties to small, independent miners, such as Frank Williams, a young man from Kansas. The mill of the Gold Bronze lost so much gold—perhaps as much as 20%—that Williams and other small-time miners considered suing. Williams considered the operators of the Klinefelter Mill “mere robbers,” who paid him just enough to cover the costs of milling and freighting. When Williams sent a load of ore to the Boomerang mill, it lost at least \$9 a ton in gold. Even after Allen Campbell managed to obtain enough water to mill custom ore, his plant remained in such poor condition that Williams barely made a profit. Finally, in the summer of 1895, a milling there brought Williams and his brother \$600, enough to pay off all his debts and enable him to visit his parents.

Signs of decline in the town had appeared early. One merchant closed his store in July of 1894 and moved his stock to Needles. Jordan suspended the Shaft a month later. Several months later, another store closed, and Virgil Earp sold out. The Nevada Southern, which had been placed in receivership, stopped work on its grade to Vanderbilt in 1895. Businesses continued to close throughout the year. The school lost most of its students in 1898 and the district was abolished. The post office was discontinued in March, 1900.

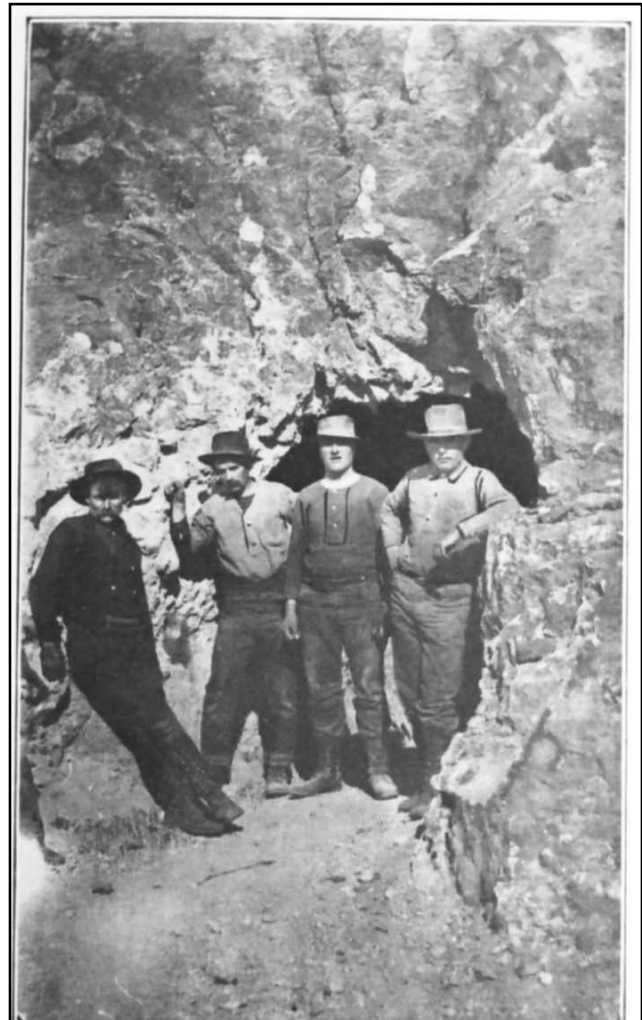
Hart

The fall of 1907 was a poor time for mining. A short but severe depression began in October. Banks and min-

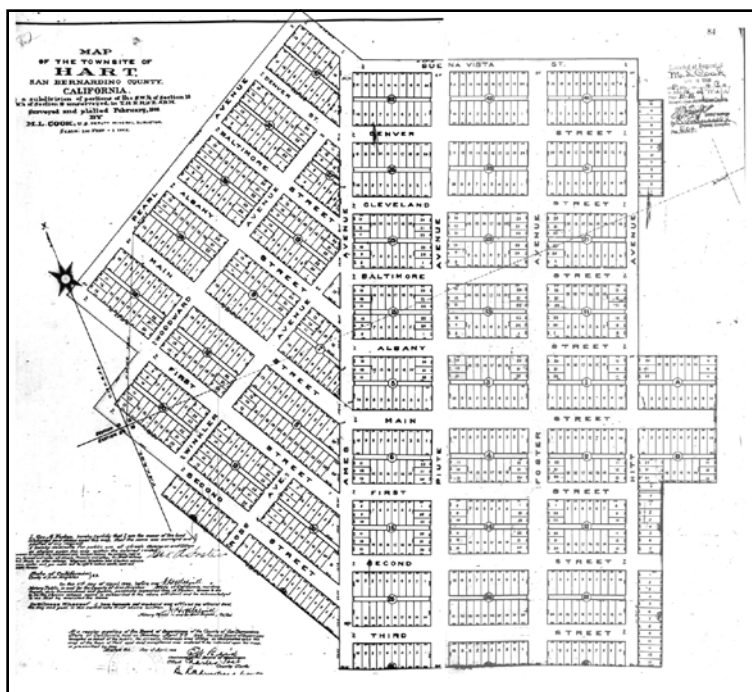
ing company were especially hard hit.

It remained for three prospectors from Goldfield—James Hart and the brothers Bert and Clark Hitt—to recognize the possibilities of a rhyolite formation that resembled the gold-bearing outcrops of western Nevada. In the Castle Mountains, the trio found pockets of rich ore and located several abandoned claims in late December of 1907. Their claims became the Oro Belle and Big Chief mines. Tipped off by the discoverers, George A. Foster, a young broker in Goldfield, snapped up a group of claims and laid out a townsite in a basin below the properties. He named the site Hart. (A siding and freight house on the Barnwell & Searchlight Railroad, about four miles north, would soon be named Hitt.)

In early January of 1908, the district began to boom. Two stores in nearby Searchlight opened branches in Hart; telephone lines were strung to Barnwell; J. B. Flanagan, the publisher of the Searchlight News, began issuing



The Oro Belle No. 1 in Hart.



a small, four-page weekly, the Hart Enterprise (although he waited several months before moving the plant); a townsite was surveyed; and a four-mile pipeline from Malapais Springs was completed. A post office opened in late April. By July, Hart had an estimated population of 400. The business district embraced two hotels (both of them two stories), a rooming house, two general stores, one bookstore, a real-estate office, a candy store, two lumberyards, a combination bakery and restaurant, and eight saloons. Among the utilities were the water line, the post office, telephone and telegraph service, and stage and auto lines to Searchlight and Hitt.

But Hart boomed too fast. Claim-jumping and swindling had become common as early as January. In February, three men from Searchlight sued the Foster brothers

over the validity of their claims. In response, some of the leading citizens organized a Business Men's League, which limited the sale of liquor and enforced police and fire regulations. The league's law-and-order committee discouraged gamblers, toughs, and wildcat promoters from moving into the camp. Finally, the San Bernardino County Board of Supervisors organized a judicial district in early March and appointed a justice of the peace and a constable. The supervisors then granted nine liquor licenses, created a voting precinct, and, in early April, approved an official townsite.

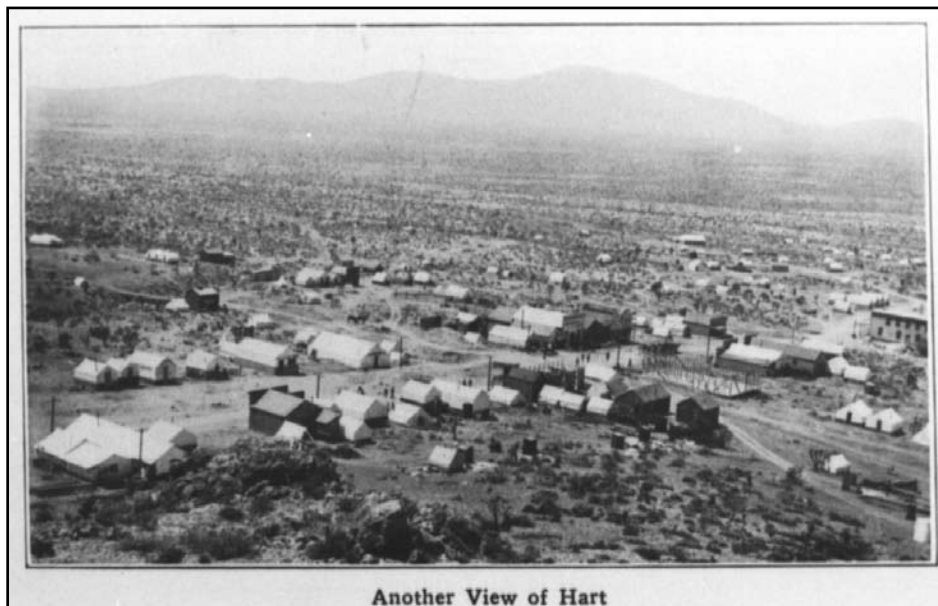
Milling, however, became a problem. In May 1908, Hart, the Hitt brother, and Foster shipped in a 10-stamp mill from Goldfield and erected it near the Big Chief Mine. But the heavy machinery shook apart the foundation, which had been poorly laid. The mill had to be modified and didn't start up again until November. A Searchlight mill ended up processing most of Hart's best ore.

The leading mines, however, were better developed. The Oro Belle, owned by James Foster and the Hitt brothers, had a 1,000-foot tunnel and a 200-foot shaft. The shaft at the Big Chief, owned by George Foster, extended several hundred feet. Several others, including Harry S. McCallum, who headed the Business Men's League, owned the Hart Consolidated. The mine owners, however, granted many leases that accounted for much of the production.

A local of the Western Federation of Miners was organized in early 1908; by July, it numbered 44 members. During the most productive years, laborers and surface workers received \$4 a day, underground workers \$4.50, and carpenters \$6—comfortable wages for the time.

The district began to decline in 1909; the veins at the Big Chief and Oro Belle

remained narrow and broken. In November, 1909, Flanagan suspended the Enterprise. Only 40 people remained by early 1910. In January of 1911, a fire destroyed half of the town—mostly vacant buildings. A month after the fire, one merchant restocked and moved his store into a vacant building. Later that year, W. B. Andrews, the manager of the Oro Belle, tried to drill a well, lay a water line, and build a tube mill, which was designed to recover 96% of the gold and silver in the ore. Andrews completed the pipeline, but nothing else materi-



alized. After intermittent production, both the Oro Belle and Big Chief shut down in 1913, and the union local was disbanded. A company in Tonopah, Nevada, worked the Oro Belle for a while, but that was the last hurrah. The post office closed in December of 1915. Up to early 1919, the mill, three furnished saloons, hotels, restaurants, laundry, the office of the Enterprise, and many houses still stood.

Vontrigger

Small-scale mining began in the Vontrigger Hills during the 1890s, but larger operations appeared after 1904. One operator, the Pentagon Mining Company, founded a camp about six miles north of Blake (Goffs); it comprised an assay office, bunkhouse, and shafthouse. Nine miles north of Blake was the California Mine. Its owner was Albert H. Cram, a prominent mining-stock promoter in Riverside.

Cram's promotional activities were somewhat dubious, but he carried out a great deal of development. Organizing the California Gold & Copper Company, Cram sank three deep shafts and installed modern equipment. By the summer of 1906, Cram had 25 men at work. In 1907, he built a large camp, which contained a barn, a well-stocked store, and a reservoir, and laid a nine-mile pipeline to Hackberry Springs. By then, about 40 men were employed. In October, Cram began work on a leaching plant

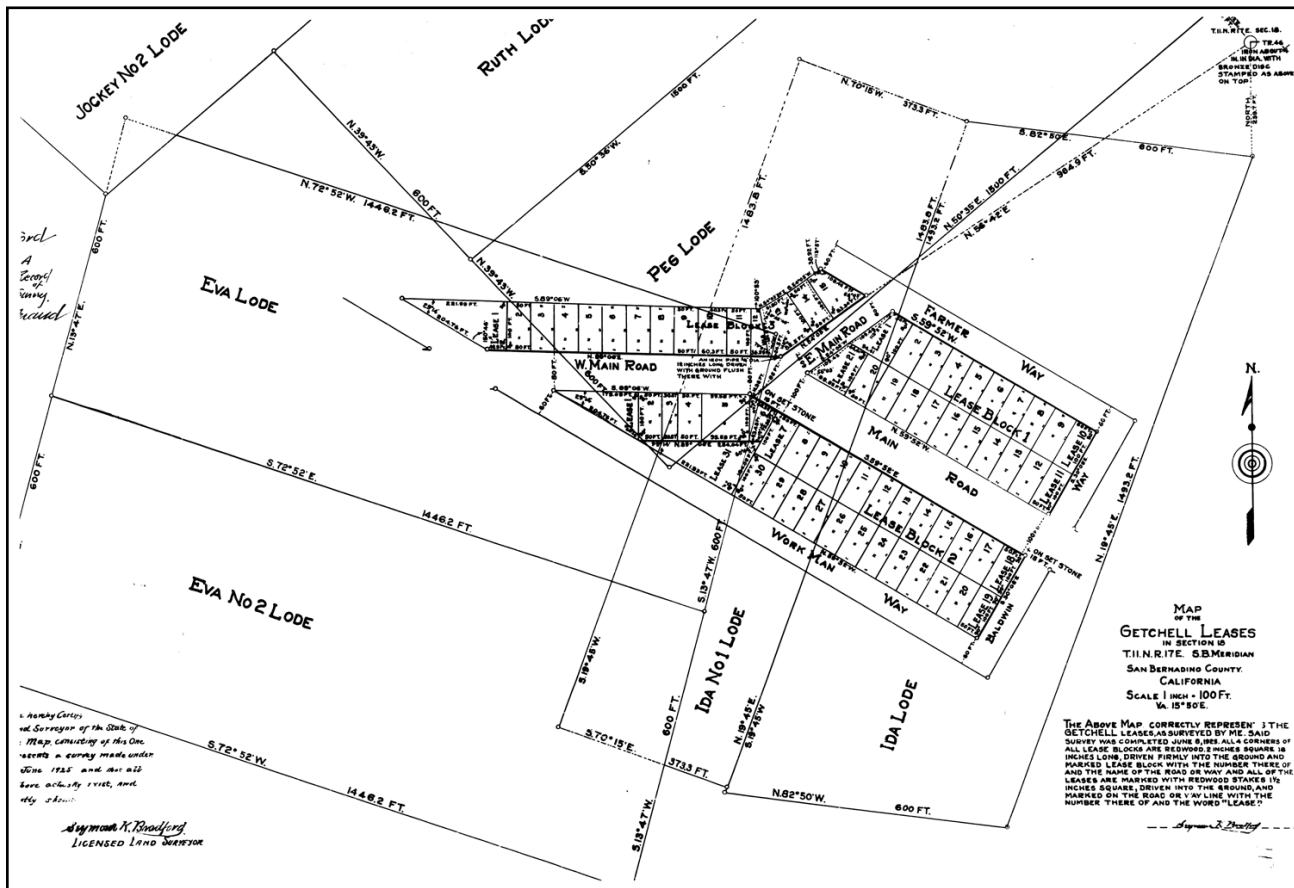
that turned out 5,400 pounds of copper in 1907.

By June 1909, the camp had grown to 20 buildings, including the store, a boardinghouse, a rooming house, and cabins. The main shaft had reached 317 feet and 17,000 gallons of water a day were flowing through the pipeline. Cram also developed an "electro-chemical" system that, he said, could extract gold and copper from the ore. The equipment was housed in a 96x100-foot building.

In 1911, Cram kicked off his final promotional campaign. The electrochemical plant, he claimed, was leaching out copper ore "on a commercial scale." A fully equipped roller mill with cyanide tanks started up about June. Cram visited Goldfield, Nevada several times to buy additional equipment. In fact, he produced 4,000 pounds of copper that year. The operation probably shut down after 1911.

Meanwhile, a settlement arose two miles away at Vontrigger, a siding on the California Easter Railway. A post office was established there in May 1907. In late 1908, Vontrigger consisted of a water tank, a loading platform, and a combination store, post office, and restaurant. A monument made of copper ore greeted travelers. The post office closed in October, 1913. All that remained in 1917 was the side track.

Another camp, also called Vontrigger, grew up at the Getchell Mine, several miles to the west in the Hackberry Mountains. By May 1925, the camp contained a store,



Plat of Getchell in the Hackberry Mountains.

restaurant, cold-drink resort, and 30 tents, and others were rising "every other day." A 30-room hotel was reportedly under construction. The work probably was suspended about then.

Bibliographical Essay

Introduction

Larry Vredenburg, Alan Patera, and Phil Serpico have provided important information.

Two books offer the most extensive coverage of mining in the Mojave Desert: Larry Vredenburg, Gary Shumway, and Russell Hartill, *Desert Fever: An Overview of Mining in the California Desert* (Canoga Park, 1981), and volume 2 of David Myrick's *Railroads of Nevada and Eastern California* (Berkeley: Howell-North Books, 1963).

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The San Bernardino County of Supervisors created and abolished voting precincts, court districts, and road districts; granted liquor licenses; approved townsites; appointed justices of the peace and constables; and held elections and certified the results. Their actions appear in their minutes (also called records), which are available in the county archives.

The statistics on the school districts appear in the annual reports of the county superintendent of schools. Few counties kept them. I used the official copies in the California State Archives in Sacramento.

The most important periodicals were the *Mining & Scientific Press*, published in San Francisco from 1860 to 1922, and the *Los Angeles Mining Review*, of which broken files exist from 1901 to 1913.

Ivanpah

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Providence

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Railroads around Mojave National Preserve

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No one knows when civilization began, but sometime around fifteen or twenty or thirty thousand years ago mankind first discovered he didn't have to live in caves, but could build his own at whatever site he preferred using rocks and mud and logs and twigs and other building material, the beginning of architecture. At some time chasing wild cattle for food he found he could drive them into a box canyon and keep them there, handy to be slaughtered as needed, without running around hunting for them in the wild, the beginning of ranching or animal husbandry. After hunting wild edible vegetables and fruits, he found that tossing their remains on a trash heap led to germination of seeds close at hand, and he learned he could grow what he wanted close to where he lived instead of having to hunt wild plants in the wild - the beginning of agriculture. At some point he discovered he could ride a wild horse instead of just killing it for food, and you had the beginning of horse-borne transportation.

From that point fifteen or twenty or thirty thousand years ago until less than two hundred years ago, the fastest a man could move on land was as fast as a horse he was riding could run. And then, with the beginning of the industrial revolution, and the invention of the steam engine, and the application of that engine to a locomotive that rode on wheels that ran on metal rails, you had the invention of the railroad in the 1820s and within eight decades, by the end of the 19th Century, man's speed on land increased from the speed of a running horse to the speed of a railroad locomotive moving at about a hundred miles and hour.

The invention of the railroad represented a revolution in transportation unlike any that had occurred in all human history since the harnessing of the horse to carry man and pull his wagons. Furthermore, the railroad is the most efficient system for moving passengers and freight over land that has been invented to this day in terms of energy expended. The amount of a steel wheel that encounters a steel rail on a railroad car is about the size of a dime, and the amount of resistance of steel on steel as compared with the much larger interface of rubber tires on dirt or asphalt or concrete roads is infinitesimally smaller. That is why the railroad network in the United States remains a key foundation block of the nation's infrastructure. Imagine if you will, all of the freight and passengers carried on trains (with passengers, especially commuter trains in urban settings) being all transferred to trucks, buses and automobiles, and the congestion unto gridlock that would

follow. The railroad is still with us today and construction by the Union Pacific of a second main train across Mojave National Preserve is a measure of just how much it is still with us today.

On May 10, 1869 at Promontory Summit (or Promontory Station) Utah, two railroads met to complete the first transcontinental railroad. Beginning at Omaha, Nebraska, where it connected with river borne transportation which via the Missouri and Mississippi Rivers connected with oceanic transportation through the Gulf of Mexico and across the Atlantic Ocean, the Union Pacific had built westward, and beginning at Sacramento, California, where it connected with river borne transportation on the Sacramento River which connected in San Francisco Bay with oceanic transportation across the Pacific Ocean, the Central Pacific Railroad built eastward, and when their locomotives touched, pilot to pilot, on May 10, 1869, above golden and silver spikes which secured the last rails, the first transcontinental railroad in North America was in business.

The Southern Pacific and later Santa Fe transcontinental route

It is a common urge when business entrepreneurs make a pile of money off of some investment that want to replicate that feat by doing the same thing or a similar thing again, and so the builders of the first transcontinental railroad immediately upon its completion began looking for places they could make another pile of money by building a railroad. Relevant here, the "Big Four" of California capitalism who had built the Central Pacific, Collis P. Huntington, Mark Hopkins, Governor Leland Stanford, and Charles Crocker began looking north and south for arenas in which they could replicate their success with the Central Pacific, and almost immediately they incorporated new companies and undertook construction both north and south of Sacramento. To the south, they extended rails first to San Francisco Bay, and then incorporated the Southern Pacific Railroad to try to replicate their Central Pacific success by building a southern transcontinental railroad. From San Francisco Bay their construction headed southward on two lines, one down the east shore of the San Francisco Peninsula and then southward generally paralleling the coast to Santa Barbara and Los Angeles, and a second line down the central valley and over difficult Tehachapi Pass to Mohave, which their construction crews reached in 1878. From there they resumed con-

Figure 1. San Pedro, Los Angeles & Salt Lake Railroad 4-6-2 Locomotive No. 3414 with a Vanderbilt tender pulls out with a passenger train which will cross the lands now in Mojave National Preserve, early in the history of the railroad. The train may be the crack "Los Angeles Limited."



struction southeastward via Waterman (later renamed Barstow) and Daggett to the Colorado River at Needles in 1882, and in so doing they built the railroad line which today flanks the southern boundary of Mojave National Preserve between Fenner and a point about 4.5 miles east of Goffs.

But in transcontinental railroad strategy, while the Southern Pacific's principal effort towards building a southern transcontinental railroad through Texas and Louisiana to the Mississippi and the Gulf followed a different route eastward from Los Angeles to Yuma, this Southern Pacific line from Mojave to Needles was built at least in part as an attempt to block a competitor, the Atlantic & Pacific Railroad, Western Division, a part of the Santa Fe System, which was even then building westward from near Albuquerque, New Mexico Territory, across northern Arizona Territory, establishing towns such as Winslow, Flagstaff and Williams en route, toward the Needles from the east. When the A. & P. in fact reached Needles in 1883 and bridged the Colorado in 1884, it faced a competitor already there—the Big Four's Southern Pacific. However, the Santa Fe crowd was not without its own leverage, and threatening to parallel the Southern Pacific all the way to San Francisco and by other means heading for Cajon Pass and Los Angeles, the Santa Fe forced the Southern Pacific to work out an agreement acceptable to both parties which among other things involved selling the Needles-Mojave line to the Santa Fe System, specifically to the Atlantic & Pacific Railroad, Western Division, and acquiring trackage rights over the Southern Pacific over Tehachapi Pass all the way to San Francisco so that the Santa Fe System would be able to offer through passenger traffic on that route, although in time the Santa Fe built and acquired its own line up through the Central Valley and around via Martinez to Richmond and Oakland on San Francisco Bay, with ferryboats across the Bay into San Francisco itself. In taking over this Southern Pacific

line, especially the part between Needles and Barstow, the Santa Fe System achieved ownership of a transcontinental railroad from Chicago to the Pacific Coast eventually at Los Angeles and through trackage rights at San Francisco.

Thus the trackage which runs between Barstow and Needles south of Mojave National Preserve and, whose right-of-way from Fenner to a point east of Goffs actually forms the southern boundary of Mojave National Preserve, started out as a part of the Southern Pacific Railroad, but soon became trackage of the Atlantic & Pacific Railroad, Western Division, a part of the system owned by the Atchison, Topeka & Santa Fe Railroad. It was operated initially with the typical 4-4-0 American Standard, 2-6-0 Mogul and 2-8-0 Consolidation-type locomotives which most American railroads used in the 1880s, but in the search for new motive power, larger and ever large locomotives would be added. Among the first were a number of 4-8-0 types, not a common wheel arrangement, but when first put in service they had so many more wheels than their predecessors that A. & P. railroad men in the desert between Needles and Barstow and Cajon and Tehachapi Passes nicknamed them "tarantulas" after the many-legged spider seen often in those regions.

In the decade which encompassed the Silver Crash of 1893, the Atchison, Topeka & Santa Fe Railroad went into bankruptcy and when reorganized was renamed the Atchison, Topeka & Santa Fe Railway, and its subsidiary Atlantic & Pacific Railroad, Western Division, followed it into bankruptcy, was reorganized, and emerged renamed Santa Fe Pacific Railroad, which operated from the late 1890s until 1902, at which time it was absorbed into the Atchison, Topeka & Santa Fe Railway as a part of the "Coast Lines" of that company, headquartered in Los Angeles. The railroad continued under that name until 1996

when through a merger with the Burlington Northern (itself a merger of the Chicago, Burlington & Quincy, Great Northern, and Northern Pacific railroads), it became the Burlington Northern & Santa Fe Railway, a name changed further early in 2005 when the company dropped the name in favor of being known officially just by the initials, BN&SF Railway. Thus the trackage between Fenner and a point east of Goffs, which also runs along parallel to the southern boundary of Mojave National Preserve although some distance to the south of it west of Fenner, has been known by six different names under six different companies: Southern Pacific; Atlantic & Pacific, Western Division; Santa Fe Pacific Railroad; Atchison, Topeka & Santa Fe Railway; Burlington Northern & Santa Fe Railway; and finally, BN&SF Railway.

During its long history this line carried not only an impressive amount of transcontinental freight traffic, but operated a long list of famous passenger trains, starting with the **California Limited** and the **Santa Fe De Luxe** and in later years adding **The Grand Canyon Limited**, **El Capitan**, **The Chief**, and **The Super Chief** which, under Amtrak's operation of passenger trains since 1971, continues today as an Amtrak train known as **The Southwest Limited**.

Three Santa Fe subsidiaries

What began as one morphed into three railways north from Goffs which all became wholly-owned subsidiaries of the Santa Fe System. The first of these was the Nevada Southern Railway, the grade of whose abandoned track north of the Santa Fe is intact and evident today, and a historic earthwork structure, running north through the Lanfair Valley, first on the west side of the dirt road, later crossing over to the east side, up to a station called Manvel where the Rock Springs Land and Cattle Company had established its home ranch headquarters. Begun in January 1893 by a group headed by Isaac C. Blake of the Needles Reduction Company, it was intended to reach mines in the New York Mountains and beyond. This railroad was completed to Manvel in July 1893, and stalled there. There were grandiose plans to extend it all the way to Pioche, but the mines were declining and the railroad went into bankruptcy in 1894, the year after it had been built.

Others then refinanced and reorganized the railroad in 1895 and renamed it the California Eastern Railway. As the 19th Century came to an end, the Copper World Mine of the Ivanpah Copper Company began producing, and this plus a new smelter in Needles rejuvenated the railroad, the Atchison, Topeka & Santa Fe Railway loaned it money, and in April 1901, the California Eastern resumed construction over the New York Mountains from Manvel, renamed Barnwell, through Vanderbilt and out into the Ivanpah Valley and north to a terminus more or less in the middle of that valley which became the second location named Ivanpah, 15 miles south of the original Ivanpah on Clark Mountain. Again there were grandiose

plans of extension, and even a survey to Goodsprings, but nothing came of it. The Atchison, Topeka & Santa Fe purchased the remaining 51 per cent of stock in the California Eastern and took it over effective July 1, 1902, making it, in effect, a Santa Fe branch line. Today, portions of the grade across the New York Mountains are used by the unpaved road, while the two legs of the wye north of Barnwell and the section of grade approaching and passing through Vanderbilt is more-or-less preserved. In 1905, Senator Clark's San Pedro, Los Angeles & Salt Lake Railroad crossed the California Eastern north of Vanderbilt at a place initially named Leastalk, which eventually became the third location called Ivanpah, and sucked much traffic away from the California Eastern, while subsequent construction of two north-south railroads, the Las Vegas & Tonopah reaching north from Las Vegas and the Tonopah & Tidewater reaching north from Ludlow more-or-less killed the California Eastern's hopes of ever expanding northward to additional mining districts. The California Eastern continued to provide weekly train service across the New York Mountains between Goffs and the second Ivanpah until 1913, after which the track north of Leastalk ceased to be used. Train service continued from Goffs to Leastalk, or South Ivanpah as it now was called, until 1918, and then for three years was available not on schedule but only when traffic was offered, and effective March 10, 1921, the entire line north of Barnwell was abandoned and subsequently dismantled.

The southern portion of the line between Goffs and Barnwell had won a reprieve, however, for in 1906 and 1907 the Santa Fe built a subsidiary 23.22-mile Barnwell and Searchlight Railway, separately incorporated, spurred by efforts of promoters in the mining camp of Searchlight to build their own railway connection to the Salt Lake Route at Nipton. The Santa Fe was determined to nip that scheme in the bud. The railway was completed March 31, 1907 and went into operation on April 1, no fooling! Initially the railway provided daily except Sunday service, and it took 2 1/2 hours to travel from Goffs to Searchlight by rail. Unfortunately the years in which the railway was built were the years in which Searchlight boomed as a mining camp, after which it declined, no doubt helped by a sharp little recession in the fall in 1907 from which many mining enterprises in the American West failed to recover. By 1919, trains ran to Searchlight only on Mondays and Fridays. Cloudbursts washed out the line in numerous places on September 23, 1923, halting all traffic, the Santa Fe looked at the balance sheet, and applied to the Interstate Commerce Commission for permission to abandon the line. The I.C.C. granted approval on February 18, 1924, and the history of the three little lines north of Goffs, the Nevada Southern, California Eastern, and Barnwell & Searchlight Railways, all eventually branches of the Atchison, Topeka & Santa Fe Railway, came to an end. These three railroads had operated right through the heart of Mojave National Preserve.

The Salt Lake Route

Another railroad destined to operate through the heart of what now is Mojave National Preserve, from northeast to southwest, would operate under three different names: San Pedro, Los Angeles & Salt Lake Railroad from its completion in 1905 until 1916; Los Angeles & Salt Lake Railroad from 1916 to 1988; and overlapping with that second name, Union Pacific Railroad from the 1920s to the present. The idea of a railroad connecting Salt Lake City with southern California probably went back practically to completion of the first transcontinental railroad at Promontory Station in May 1869, which was followed by construction of the Utah Central from Ogden on the Union Pacific to Salt Lake City, making the capitol of Utah Territory a railroad town, and the Union Pacific would soon take over the Mormon-built Utah Central. The first concrete evidence of Union Pacific intentions consisted of the Union Pacific interests pushing construction of a subsidiary Utah Southern southwest from Salt Lake City to Milford, Utah. Union Pacific interests then played with the idea of an extension southwestward across Utah and Nevada to a connection with the Southern Pacific at Mohave, but the Union Pacific entered an era of financial difficulty and reorganization in the 1880s and 1890s, though during 1888 Union Pacific surveyors worked on a line from Milford to Barstow with the intention of reaching Los Angeles. In 1890 the Union Pacific actually built about 145 miles of grade from Milford to Pioche, but after laying a mere eight miles of track on it, construction stalled. Then the faltering Union Pacific went into bankruptcy in the silver crash of 1893 and was not reorganized and rejuvenated under the direction of Edward Henry Harriman until 1898. Meanwhile the railroad picture became greatly complicated, more a part of Utah's history than that of Mojave National Preserve, and while the Union Pacific was stalled, in 1900 a copper magnate from Butte, Montana, named William Andrews Clark, who was also a United States Senator, entered the competition initiating a two year contest between Clark and Harriman. In a brilliant move, Clark bought the Los Angeles Terminal Railway, which gave him a railroad route through and base in Los Angeles, and initiated surveys for a railroad to Salt Lake. Covertly he had also bought the assets of a corporation that had never built any railroad, the Utah and California Railroad, which however had rights to a surveyed route from Salt Lake City across Utah to the Nevada state border. In one brief coup, Clark had the two ends of his Salt Lake to Los Angeles Railroad; now he had to acquire rights across Nevada and the rest of California, and build a railroad between Salt Lake City and Los Angeles using those rights. What followed was an incredibly complex contest between Clark and Harriman involving lawyers, courts, legislatures, newspapers, competing grading crews, and every weapon either magnate could bring to bear, the result of which was a secret compromise on July 9, 1902, in which Harriman agreed to sell portions of Union Pacific-owned (technically Oregon Short

Line Railroad) grade and track to Clark in exchange for 50 per cent of the stock in Clark's San Pedro, Los Angeles & Salt Lake Railroad. Thereafter, construction continued eastward from Los Angeles and westward from Utah, to a joining of the rails at an empty piece of Nevada desert roughly 27 miles west of Las Vegas on the afternoon of January 30, 1905.

As was typical of railroads at the beginning of the 20th Century, the San Pedro, Los Angeles & Salt Lake Railroad established side tracks or passing tracks often accompanied by a section house and bunk house for the maintenance crews known as section gangs about every ten or fifteen miles along the railroad, some of these with water tanks to provide locomotives with boiler water, occasionally a wye track, and so forth. The railroad established a number of these across what now is Mojave National Preserve, the most important being a "helper station" at a place called Kelso, which would be a base for "helper" locomotives which would be coupled on the front of eastbound trains to "help" them climb the grade to the summit at Cima, after which the helper locomotives would be uncoupled, turned on the wye track at Cima, and run back "light" or without train to Kelso to await their next helper assignment. As a helper station, Kelso required an engine house and eventually its replacement with a larger roundhouse, and crews of mechanics and others to help keeping the railroad running, as well as a restaurant or eating house and some accommodations for train crews staying overnight between runs. Thus Kelso, in the middle of the Mojave Desert at a location where the railroad had acquired springs and wells to serve as reliable sources for boiler water for locomotives, became a railroad company town, with company housing and other such facilities.

The first through passenger train on the new railroad started out from Salt Lake City for Los Angeles on February 9, 1905, carrying, among others, Senator Clark. The Salt Lake Route was equipped with a stable of modern standard gauge steam locomotives, most equipped with partly cylindrical Vanderbilt tenders, and the latest of passenger cars. It soon had a premiere train, **The Los Angeles Limited**, which would remain the most prestigious, Pullman-sleeping-car-equipped train on the railroad. Whereas most of the line's passenger trains stopped for the passengers to have meals at stations such as Kelso, Las Vegas, Caliente, and Milford, **The Los Angeles Limited** had its own dining car and did not need to make meal stops. It was not until the mid-1930s brought new technology of locomotives powered by Winton and later diesel-electric engines pulling new "lightweight" streamlined passenger cars that a still newer train, the Armour yellow **City of Los Angeles** eclipsed the **Limited** as the principal train on the line.

The railroad remained the San Pedro, Los Angeles & Salt Lake Railroad until 1916 when management of the line decided to shorten the name, dropping the words "San Pedro" to make it simply the "Los Angeles & Salt Lake Railroad." Five years later, in 1921, the company

persuaded Senator Clark to sell his 50 per cent interest in the line, and the Los Angeles & Salt Lake Railroad became a wholly-owned subsidiary of the Union Pacific Railroad. Unlike most such instances, when the Union Pacific dissolved and absorbed the property of a subsidiary into its own corporate structure, in the case of the Los Angeles & Salt Lake Railroad, the Union Pacific retained it as a separate company until 1988, when it was finally dissolved and absorbed into the Union Pacific Railroad. Until that time it was common for locomotives owned by the L.A.& S.L. to carry the name "UNION PACIFIC" in large letters but to have elsewhere on cabs or tenders or both of steam locomotives the initials "L.A.& S.L."

Commonly called the Salt Lake Route, the line featured a number of fairly ordinary depots and eating houses, many of them wood frame, until the early 1920s when Union Pacific management caught a contagious disease that might be termed either "Santa Fe Envy" or "Fred Harvey Envy." The Atchison, Topeka & Santa Fe System had worked out with an entrepreneur named Fred Harvey in the 1870s an agreement under which Harvey took over and managed railroad depot eating houses and depot hotels. Harvey had very definite ideas about how such establishments should be operated, hired first rate chefs, obtained the highest quality of fresh meat, poultry and produce, installed the finest of linen and china, and employed energetic young women uniformed in black dresses with white aprons as waitresses, this in an era where railroad eating houses were notorious for their awful coffee, their stale sandwiches with desiccated bread, rancid meat, and rubberized cheese, greasy China and implements, and dirty employees. After the Santa Fe bankruptcy in the 1890s and its reorganization, under a new president named Edward Payson Ripley the company began hiring first rate architects to build attractive permanent depot hotels, depots and eating houses in Spanish mission revival, English Tudor half-timbered, Moorish and neo-classical Palladian designs. This was the competition the Union Pacific faced after the end of World War I, and west of Mojave National Preserve at Barstow the Santa Fe and Fred Harvey had their Moorish-style depot hotel and restaurant known as Casa de Desierto, or "house of the desert," and east of Mojave National Preserve at Needles the railway had its neo-classical, Palladian Harvey House and restaurant known as "El Garces" after a Spanish padre of that name, both impressive pieces of architecture. Worse, west of Daggett through Barstow and over Cajon Pass to San Bernardino, the Union Pacific shared joint trackage with the Atchison, Topeka & Santa Fe, so that westbound travelers on Union Pacific trains who had been fed at little board and batten eating houses across Utah, Nevada and at Kelso, now passed by the elegant depot restaurants and hotels the Santa Fe had to offer its passengers. Eastbound, after passing such structures, they were then faced with the Salt Lake Route's rough facilities from Daggett to Salt Lake City. So it should not be surprising that by the early 1920s the Union Pacific, infected

with Fred Harvey envy, should decide to build at Milford, Utah, Caliente and Las Vegas, Nevada, and Kelso and Daggett, California, attractive new depot-eating-house-hotel combinations all in the California mission revival style, emulating the style of some of the Harvey Houses such as the Alvarado in Albuquerque. And thus it was in 1923 and 1924 that Kelso, California acquired a spiffy new depot, eating house and hostelry which the National Park Service now owns and has just finished restoring as a visitor center for Mojave National Preserve.

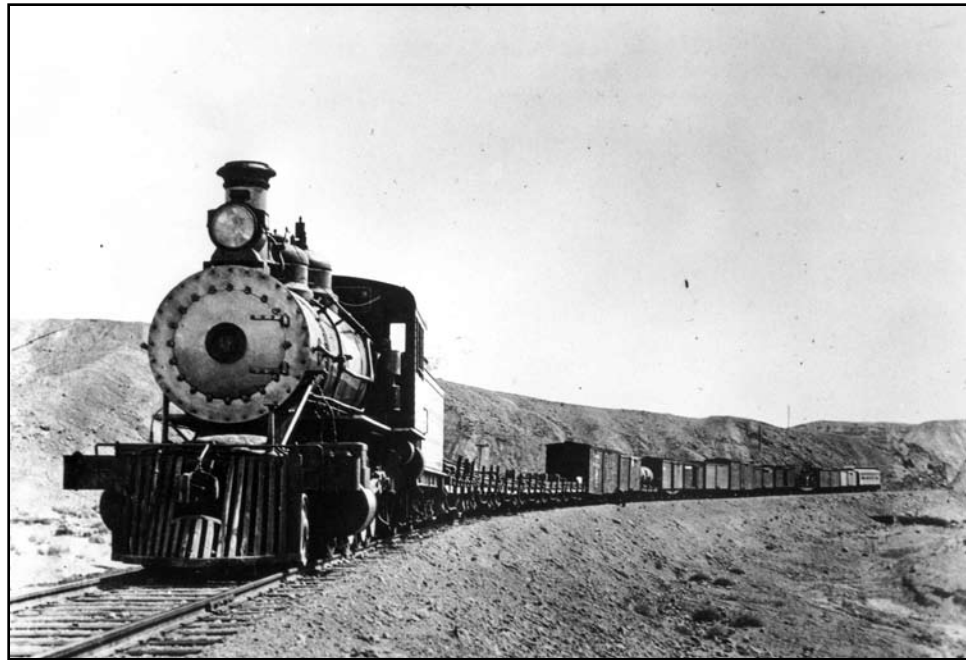
The Union Pacific continued operating passenger trains through Kelso until 1971, when the Federally chartered National Railroad Passenger Corporation, better known as Amtrak, took over most of the national's passenger trains. On the Salt Lake Route, Amtrak operated a through streamlined passenger train known as the **Desert Wind** between Salt Lake City and Los Angeles until May 10, 1997, when it was discontinued, and earlier operated a "Las Vegas Fun Train" between Los Angeles and Las Vegas, Nevada. Since the discontinuance of the **Desert Wind**, the Salt Lake Route has experienced no passenger traffic across its line. Only freight trans now pass across Mojave National Preserve, but freight traffic has grown to such proportions that the Union Pacific is preparing to convert the main line across Mojave from single track to double track. Meanwhile, the Salt Lake Route from its completion in 1905 to the present, connecting with the Union Pacific at Salt Lake City and Ogden, has offered that company another transcontinental railroad connection as well as access to the markets of southern California, so with its operation Mojave National Preserve had not only one transcontinental railroad along part of its southern boundary, but another right across its heart!

The Tonopah & Tidewater Railroad

Another desert railroad flanked the western boundary of Mojave National Preserve and cut across a part of its northwest corner. That was the Tonopah & Tidewater Railroad, a wholly-owned subsidiary of the Pacific Coast Borax Company, which from 1905 to 1907 built a standard gauge railroad between Ludlow on the Santa Fe main line to Death Valley Junction and Beatty, where it connected with the Bullfrog-Goldfield Railroad which in turn connected with the Tonopah & Goldfield Railroad and provided a through railroad link which via the Southern Pacific ran all the way up into western Nevada east of Reno, not that through traffic ever characterized that line because of its fractured ownership.

The Tonopah & Tidewater grew out of an instance in which Senator W.A. Clark misled and then double-crossed Francis Marion Smith of the Pacific Coast Borax Company and the international conglomerate known as Borax Consolidated headquartered in London. By 1905, Smith and Pacific Coast Borax were running out of borate ore which they were mining about eleven miles north of Daggett on the Atchison, Topeka & Santa Fe, to which they had built a narrow gauge ore railroad known as the

Figure 2. Tonopah & Tidewater Railroad 2-8-0 Locomotive No. 6 takes a construction train up to the end of track in 1906 or 1907, having north of Soda Springs crossed the northwest corner of lands now in Mojave National Preserve. Note the carloads of rail. Probably a Frank Green photo [he was a fireman on the railroad], collection of Mallory Hope Ferrell.



Borate & Daggett. Smith's next closest holdings were borate mines on the west side of the Amargosa Valley in the Greenwater Mountains east of Death Valley at the Lila C. Mine he had bought from William Tell Coleman in 1890. Smith needed a railroad to haul that ore, but the management of Borax Consolidated did not want to build one. As a substitute, Smith proposed building a wagon road from the upper end of the California Eastern at the second Ivanpah reaching all the way north over State Line Pass to the Lila C. Mine, and he proceeded to build just such a road. He proposed to use on it an experimental form of electric drive traction wagons powered by diesel motors, but after he built his road, the electric drive tractors never got off the drawing board, and when he converted the steam tractor he had used north of Daggett before building the Borate & Daggett Railroad from coal to oil fuel, on its first trip north from Ivanpah II it blew a flue on State Line Pass and had to be towed by mules back to the railhead.

Next, Smith proposed building a railroad north from Senator Clark's then-under-construction Salt Lake Route at Las Vegas to the Lila C. Mine, and Clark encouraged him, but after Smith had built a number of miles of standard gauge railroad grade north out of Las Vegas, and was ready to build track, when he sought a switch and track connection with the Salt Lake Route at Las Vegas, Clark double-crossed him and refused to let him make the connection, because Clark had decided to build his OWN railroad north from Las Vegas to the Lila C. Mine, to Beatty, to Rhyolite, and a connection with the railroads at Tonopah and Goldfield. In a rage beyond the powers of written description, Smith vowed never to give Clark's Las Vegas and Tonopah Railroad a car load of ore, backtracked to Ludlow on the Santa Fe, and began construction of his own Tonopah & Tidewater Railroad all the way north from Ludlow, crossing the Salt Lake Route at a point called Crucero, then passing across a portion of Soda Dry Lake, through Baker, across Silver Dry Lake, up

through the Amargosa Canyon, to Death Valley Junction, with a branch from there down to the Lila C. Mine, and on from Death Valley Junction through Rhyolite up to Beatty, where it connected with the Bullfrog-Goldfield Railroad to Goldfield and the Tonopah & Goldfield to Tonopah. True to his word, he gave the Las Vegas & Tonopah no traffic at all, and when the U.S. Railroad Administration took over the nation's railroads during World War I, it decided the traffic-poor Las Vegas & Tonopah was superfluous and dismantled it, leaving the Tonopah & Tidewater to carry the borate ores from the Lila C. Mine and after 1914 from the Played Out, the Upper Biddy McCarty, the Lower Biddy McCarty, and Grandview, the Lizzie V. Oakley, and the Widow Mines. The Tonopah & Tidewater continued to prosper carrying borate ores for the Pacific Coast Borax Company until 1927, at which time that company opened the richest of all California borate mines a stone's throw from the Santa Fe main line east of Kramer near a station called Boron. Borate mining moved there in 1927, where it continues to this day, leaving the Tonopah & Tidewater without a meaningful quantity of freight traffic. Pacific Coast Borax then developed a tourist business in Death Valley to give the T. & T. passenger and some freight traffic, converting its offices at Death Valley Junction into the Amargosa Hotel, its dormitories at the mining camp of Ryan into the Death Valley View Hotel, building a new Furnace Creek Inn in Death Valley, and converting Greenland Ranch which had supplied alfalfa to the mule teams into Furnace Creek Ranch with a golf course for tourists. That might have saved the Tonopah & Tidewater had not the Great Depression begun in the fall of 1929. The Tonopah & Tidewater suffered a slow death throughout the 1930s, and was finally dismantled for scrap for the war effort in 1942 after the beginning of World War II.



Figure 3. Burlington Northern & Santa Fe Railway Locomotive No. 718, still carrying the red, yellow and silver color scheme of the former Atchison, Topeka & Santa Fe Railway, heads a westbound freight between Goffs and Fenner, California, along the southern border of Mojave National Preserve on February 17, 2000. Photo by Gordon Chappell

The smallest railways

Completion of the Tonopah & Tidewater in 1907 led to construction of two tiny little railways connected with its line. These were both at Soda Station, which is to say Soda Springs, on the west shore of Soda Lake south of Baker, California. The Tonopah & Tidewater skirted the eastern shore of Soda Lake from the south, and just north of Soda Springs, cut across a portion of the normally dry, white lakebed to Baker Station. Soda Lake, of course, was a dry lake topped with white chemical salts, and with railroad transportation at hand, two groups of entrepreneurs decided to try to make a business of trying to harvest, purify and sell those chemical salts from the vicinity of Soda Springs. Thus it came to pass that by May 1907 the Pacific Coast Soda Company was building sheds and other structures at the south end of Soda Lake, and in October 1907 Russ Avery sold his 22 soda claims southeast of Soda Springs to the company. The **Los Angeles Mining Review** of August 8, 1908, carried an article describing the plant the company had built just south of Soda Springs and was in the process of enlarging, and the “narrow gauge track

a mile and a half long” which it said extended out onto the lakebed. What sort of motive power this little railroad used is unknown, although it seems likely to have been a four-wheeled

gasoline locomotive. The article in the mining journal is not the only evidence of the little railroad, for a mile and a half long grade, much of it still carrying little wooden ties, still lies on the lake today, and measuring the holes for spikes in the ties suggests that it had a gauge of 30

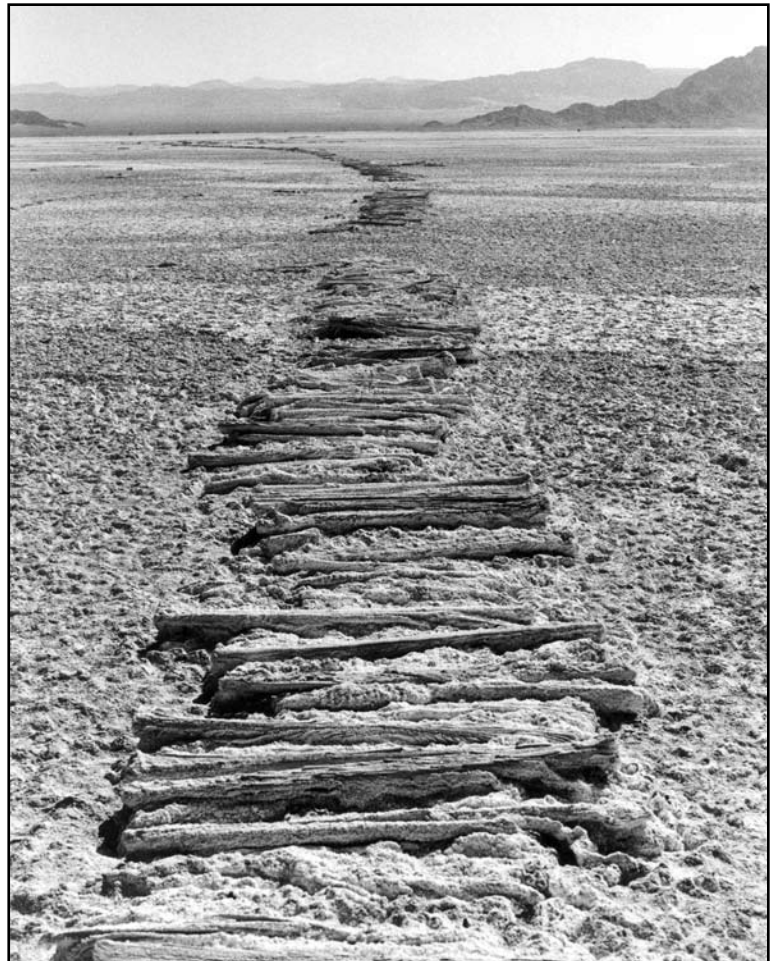


Figure 4. Southeast of Zyzzx out on the salt pan of Soda Lake, abandoned ties and grade mark the route of the 30 inch narrow gauge railway which extended a mile and a half out onto the lakebed and brought chemical salts to the refining plant of the Pacific Coast Soda Company at the south end of Soda Springs about 1907. Photo by Gordon Chappell

inches between the rails.

A few years later, around 1911, the Pacific Salt and Soda Company built a plant north of Soda Springs, to process the chemical salts, and it reportedly had a little railroad which, although it did not extend out onto the lake surface, did serve the plant itself. Measuring again spike holes in a surviving tie, this plant apparently had a railroad or tramway with a track gauge of 36 inches.

There is little information regarding either of these companies with respect to how long they survived or whether they made any money from their salt-processing plants, but from the remains today, both seem to have invested a fair amount of money in building such plants.

Rails around Mojave National Preserve

Thus historically Mojave National Preserve had railroads along its southern and western edges and penetrating its very heart. Two of them were components of transcontinental railroad systems, one operating under six different names in its history, the other under three, and both of those continue to operate today. Three were essentially branch lines of one of the transcontinental systems, although the first two of those had began as separately inspired short lines. Another was a short line railroad wholly owned by a mining company that lasted for a quarter of a century. And two were little tiny industrial railways, easily overlooked in the shadow of greater enterprises. Altogether, the lands now within Mojave National Preserve played a role in the history of more railroads than those of any other unit of the National Park System, and with a double-tracked main line across the center of the Preserve and a former railroad depot, eating house and employees' hotel as its principal visitor center, Mojave National Preserve and the history of American railroading are inextricably linked together.

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Archives and Library of the Mojave Desert Heritage and Cultural Association, Goffs, California, courtesy Dennis Casebier
Archives and Library of the Mojave River Valley Museum, Barstow, California

The Mint at the Mescal Mine

An article in the Los Angeles Sunday Times, December 8, 1895,

by John E. Bennett, U.S. Secret Service Bureau

The Mescal mine lay on the east slope of one of the largest mountains in the Mescal range...A tunnel opened in the side of the mountain about half way between its base and summit, ran in three hundred feet and crosscut an almost perpendicular vein of silver ore of about eight feet in thickness. The ore had been stoped down from the top for some distance and a wide chamber had thus been made about the interior locality of the "pay."

This was the condition in which the mine was left in 1889 when the price of silver dropped from 95 to 65 cents an ounce, and Bill Williams, the owner, shut down the property with a suddenness which fell like a heavy blow upon every human heart in camp.

At this time there were about sixty people there whose livings depended on the product of this mine. The houses were well built, of adobe brick with good shingle roofs, and this notwithstanding that all lumber had to be hauled fifty miles from the railroad over a dry desert trail. There was a store there and a postoffice. The small smelter employed about ten hands, and the balance found work in or about the mine; a number of men lived with their families there, wages were good, work steady and everybody was happy; but through politics, or finance, or commerce, or whatever else, the price of silver tumbled, and a forty-ounce silver ore mine situated as was this could no longer be mined at a profit; so that with this decline in the market value of the commodity, operations at the Mescal ceased.

Activities there remained suspended until the early part of 1892, when, silver lying at the bottom notch on the market, the inhabitants of one or two little copper camps near by and the agent and a few others at the railroad station, forty miles distant, who comprised all the population for

fifty miles around were astonished one day to learn that the Mescal was going to start up again.

"What was the reason?" this was the inquiry on every one's lips. The mine, it was rumored, had been sold, bought by a man named Davis, of Denver. He had examined the property carefully and had a great confidence in it; believed the grade of ore would run higher as it got deeper, and he was going to sink on the vein at the end of the tunnel.

Strangely enough, rumor proved true. Williams, who had long realized he had an elephant on his hands, sold, almost for a song, a property which had cost him \$30,000, on which he had spent \$20,000, and from which he had only received about \$10,000 in return. The mine had never been patented, and after it had been shut down, Williams, who was a wealthy man, never troubled himself about doing the annual representation work upon it as required by the statute, and the property had been jumped by two men who had thereby a more or less valid claim to it. The relocations were made, however, as a sort of "hold up" scheme on Williams, so that if he should ever want to start up the mine again, he would have to either compromise with these or have a lawsuit before he could peaceably resume.

This man Davis had, however, taken advantage of both horns of the dilemma. He had been able to buy out Williams for a trifling sum, partly because of the relocation by Brooks and Boswell, and he was able to buy out the latter two for another trifle because they held only a cloud upon the title to the property, which property was really in Williams.

Having completed his purchase, Mr. Davis proceeded at once to revive the camp. His first move was to bring in a lot of new, and a part of it, singular machinery, which had been made at

a foundry and machine shop which he conducted in Denver. There was a small refining plant added to the smelter, and a considerable portion of the machinery was, oddly enough, taken into the tunnel; after the shaft had been sunk some distance, it was put down the shaft.

While this latter machinery was being put in, several miners applied at the mine for work; they were told that no one was needed, that the price of silver was so low that it was necessary for the mine to employ just as few men as it was barely possible to operate with, and those who were then employed had been brought from Colorado from one of Mr. Davis's mines there, and were tested men. The applicants were advised to acquaint any miners who wanted work not to come to the camp as they would certainly be refused employment, and as the distance from the railroad or adjacent camps was great, they would have a long and fatiguing journey for nothing.

The miners asked concerning the machinery, which was, in its carefully boxed condition, then being put into the tunnel. Mr. Spencer, the superintendent, replied that it was hoisting machinery; that it was to be set up at the end of the tunnel, and above the shaft. When asked if this was not a rather unusual way in which to work a mine, Mr. Davis replied that it might be but, that the necessity for keeping down expenses compelled them to operate in the most economical manner possible.

All of the above facts I learned from my guide and driver of the team which conveyed me to this camp early in July, 1893.

About a year after this mine recommenced operations, the Treasury Department at Washington became aware that a new and wholly unprecedented counterfeit one dollar silver

coin was in large circulation, apparently all over the United States. It was not made of spurious metal, to the contrary, it was of pure silver, containing only the proportions of alloy used in like coins turned out by the mints. The coins were not molded, as all the counterfeit coins I have ever known have been made, but it was punched, pressed and milled, in other words, it was minted just as are the pieces coined at the mints.

The fact that this new counterfeit was silver, that it had, consequently, the proper weight and the proper "ring," made it an imitation exceedingly difficult to detect; only by the closest inspection, and the most accurate analysis and comparisons were the experts of the Treasury Department finally able, positively, to declare that these pieces had not been made at any of the government mints, and were therefore, illegal and counterfeit.

The points of difference between the genuine and the imitation coins having been once noted, it was possible to detect all of these fraudulent issues, since they were all lacking in the same particulars. These particulars consisted of certain shades of inferiority in the execution of the whole of the obverse and of the eagle of the reverse; a difference which, however, was not apparent upon casual observation, and could only be originally perceived by the aid of lenses in a studied comparison between the genuine and the counterfeit.

It was clear, therefore, to the Secret Service Bureau of the government that all of these illegal coins were made with the same die. Where that die was located and at work, whether within the United States or without, and who was operating it, these were the great questions which concerned, not along the Treasury Department, but the entire administration, and was committed to the Secret Service Bureau for its best work.

It was clear to us that the manufacturers of this coin had been incited to their enterprise by the wide margin that then existed between the commodity price of the silver contained in the coined dollar and the value of

that dollar as legal tender. This margin was something over 40 cents, and if any large number of coins were being turned out daily those engaged in the unlawful enterprise were doubtless accumulating immense fortunes.

It was a hard case to handle. Not alone was it difficult by reason of the fact that the operators were evidently men of means and of intelligence far above that of persons who usually engage in debasing the currency, but also from the fact that certain existing popular and political conditions seemed likely to hedge about the culprits a kind of indefinite sympathy and support... Thousands of persons wanted free coinage of silver. They earnestly believed there was not enough money of all kinds in circulation, and whoever these illegal coin manufacturers were, the money they were making was being turned directly into circulation, while unfortunately much of the coinage of the government never left the mints where it was made... All of the numerous circulars distributed broadcast by the department, offering enormous rewards for the apprehension of the makers of this coin, were without avail...

After scouring the country for months for a clue, we stumbled upon one by accident. The Treasury Department was at that time, under the Sherman law, purchasing about 4,400,000 ounces of silver monthly, and this was delivered at the mints in the usual form of bars. In a consignment which reached the mint at Philadelphia there was a bar which, when subjected to the ordinary probing which is undertaken in ascertain that the government purchases of "gold bricks," appeared so singularly cast that the director ordered one end of it sawed off. Imagine the surprise of every one present when it was seen that the exterior of the bar was really a heavy box or shell, and that within there was a large number of these spurious silver collars. They were packed in rows so closely as to make the entire practically a solid mass. There were one thousand of these dollars and it became clear that it was in this manner that the counterfeit coin which had been flooding the

country for months, was transported from its place of manufacture to co-conspirators, doubtless in the centers of trade, by whom it was distributed.

The task then was to trace down from whence this particular bar had come. In order to do this we had to "run down" each of the bars received in that consignment. This was quite difficult, but after two weeks of labor we succeeded in tracing it to Kansas City, where we learned it had come from a pawnshop, a sort of "fence," the keeper of which had bought it from a thief.

Operating through the local authorities, the [person] who kept this place was arrested and thrown into jail upon a charge of receiving stolen goods; we told him if he would divulge from whom he had receive it we would let him go free. He very gladly did so, and this brought us in contact with the thief. Employing the same tactics with him we learned that he had stolen the bar from the room of a lodger in a lodging-house where he was employed; that the fellow had, one night while drunk, employed him to escort him to his lodgings; he did so, and while the man was in a sodden sleep he ransacked the room and everything in it, and he had found this silver bar at the bottom of a big trunk which he had broken into.

We secured a good description of this bacchanalian silver owner, and I started in search of him. I soon found he was no longer in the city and as it was more important to continue to trace down where the bar came from than to pursue this criminal, I turned this part of the investigation over to the bureau and myself continued on the main case.

To find out through what channel that bar had gotten into town was the important thing. It was most likely that it had come under some sort of a cover—enclosed in something intended to disarm suspicion of the fact that bar silver was being transported. It was almost a matter of course that I should first call at the various railroad offices to inquire if any person answering the description of the drunken lodger had at any time received any freight which

might allow of the hypothesis of its being bullion. Imagine my surprise and delight when the division superintendent of the first road I called upon, the Santa Fe Railroad, told me that large quantities of bar silver had been shipped over the line, billed to a man I described, who went by the name of Reynolds. He told me there was no secret about these shipments; that the bars were refined silver and that they came from the Mescal mine in California. The Santa Fe hauled all the silver from this mine and most of it was taken to Kansas City and delivered to Reynolds, who from there reshipped it to various points throughout the United States.

Possessed of this information, and feeling myself on a hot trail, I communicated at once with the bureau at Washington, advising them of my intention of going to California, taking charge of the Mescal mine, and arresting every person having any relation to it. I advised the chief that in order to successfully carry out this programme it might be necessary to make a show of force, and I wanted a detail of some sort to be placed under my command. Accordingly I received instructions through the War Department to call on Gen. McCook of the Department of Arizona to place at my disposal whatever force I should feel myself in need of.

This being arranged, I started for California. Arriving at the station of Bitter Creek, which was the point nearest the Mescal mine, I sought out a teamster known as Dolph Kevane, who had been an old prospector, who was well acquainted with the country, and especially with the locality of the Mescal mine.

At that time Liuet. [sic] Ferguson, with a detachment of twenty men of the cavalry, had arrived from Fort Wingate and were camped at Burton's Bridge across Dry River. The lieutenant reported to me and I ordered him to proceed with his troop to the Mescal mine, and to arrive there under the cover of the night, at daybreak on the morning of the 5th of August.

Kevane and myself, equipped with a sparse camping outfit, and driving a

good team of mules in a light covered wagon, started for the mine on the 1st day of August. It was a long and weary drive, across a broad desert into a country of rugged and bare mountains, the most desolate region the mind can imagine. We traversed the dry bed of an ancient lake where the ground was blistering hot and our animals nearly strangled to death with the dust of alkali. Far down the valley hovered a water-like mirage, as though in mockery of a cooling sea. The ground was partially covered with a stubby sage brush which made travel difficult, and occasionally we were forced to cross a deep dry rut which had been plowed in the surface by the running waters of a winter's cloudburst.

Ultimately we entered the mouth of a wide pass which Kevane said was five miles from the mine. The great mountains on either hand were bare in their dry desolation. Only little dots of color here and there against the bare reddish earth told that some famished shrub continued to cling to a weak existence in desperate defiance of the furious sun. Occasionally in small gulches, or depressions, orchards of yucca grew like stunted trees, the little tufts of green palm-like leaves sticking from their tops, while often almost all the balance of the plant was dead and rotted. Across the valley stood Park's Mountain, bold, gigantic, grand! A great dark mass, dark, for it is limestone, while all the rest are granite.

We turned around a small cone-like hill, and there before us, close upon us, was the Mescal camp. It lay on a ridge which made out from the mountain into the valley. A scramble down a steep hillside brings you to a little stream trickling away from a pool of the most delicious water, fed from a pipe communication with a wet shaft in the mine. Above on the bald side of the high roaring mountain is the mine, its grey dump marking with a light splotch the dark slope. There is a bucket cable railway leading down over trestles from the mouth of the tunnel to the smelter several hundred yards below, to which place the ore is carried for treatment.

In my long experience as a detec-

tive I have found that the best way to work up cases is to conceal your identity while you can and never reveal your true case. Invent a set of circumstances to employ for the time, which will prompt the one upon whom you are operating to do your will; the need of this will be but transitory and employed to overcome a present obstacle or carry a point at hand, when you have done this and your true character has been discovered, the man whom you have thus deceived will think nothing of it so long as he himself is not injured, and this it should not be your purpose to do, except he be the party against whom you are operating. Indeed, it seems to me that the ability of a detective is measured by the readiness with which he invents these circumstantial subterfuges and the depth and strength of them.

If I had told Kevane that I was a government detective, that I knew the operators of the Mescal mine were a lot of counterfeiters and that I had come there to arrest them, his tongue would have burned at the roots, and he could never have cooled it until he had told the men at the camp all I had told him. I did not commit this error, besides, had I done so, he would have realized that the camp was about to be broken up, and as it was a source of great revenue to him, and of nearly all the prosperity of the little town about the station, where the spurious dollars circulated like air, he would naturally have sided with the camp against me. I therefore told him I was an agent of Williams; that Williams had sold the mine upon the condition that if the ore developed over forty ounces he was to get a certain royalty on the difference, that we had reliable information that the ore was averaging seventy ounces, and yet Davis had never told us anything about this increased yield. The purpose of my visit to the mine was to secretly ascertain how the ore was running.

Knowing it was the strict rule of the operators to allow no stranger in the camp or on any of the claims, and wishing to remain here as long as possible, I went disguised as a laborer seeking employment. I arranged with

Kevane to have a mock quarrel with me after our arrival, the upshot of which would be that he would refuse to take me away on the team. Having no food nor water, I would then be an object of pity and sympathy to those at the mine, and being very harmless and inconsequential in appearance, I relied on my chances of being tolerated in camp, and given a little food, while, without making any inquiries, I would keep my eyes open to all that went on about me.

This programme came to be carried out exactly as it was laid down. The quarrel with Kevane passed off successfully, and I was left alone. I was ordered out of camp by Superintendent Spencer, but I told him I would not go, that I had neither food nor water, and that I could not walk over the desert, as my feet were sore. I told him that the only thing I could do was to remain at the camp until a team went down to the station and go on that. My excuse did not please Mr. Spencer, but he did not drive me off.

So far as the mining of the ore and the smelting and refining was concerned, I observed nothing unusual nor extraordinary, except that they should have a refinery in connection with their plant, then they could have shipped the bullion and have had it refined much cheaper in the East, and this is the usual method pursued at all mines where any smelting is done, but I asked no questions. I observed, also, that after the silver was cast into bars it was taken up into the mine, and subsequently the bars were brought back to the refinery again, and piled up there in an iron vault.

After witnessing this I felt sure that coining was going on in the mine, doubtless in the bottom of one of the shafts, and that the coins were packed in these silver boxes which were then sealed up and made to look like solid bars. I felt sure that the eight bars of silver which I saw stack up in the refinery were so many boxes of counterfeit silver dollars, and this theory was confirmed by the story that Kevane had told me about the machinery which went into the mine, and by the fact of their keeping such a close guard over

the mouth of the tunnel.

Mr. Davis, the proprietor, worked in the mine, and, to my idea, he operated the minting and rolling machine. Mr. Spencer appeared to keep a general lookout on the surface, a part of his practice being to carry a pair of glasses in a case hung about him, and with these to occasionally sweep the valley.

From what I saw of the operation of the mine, they must have been taking out about twenty tons of ore daily; this reduced and refined, would have yielded an average of eight hundred ounces of silver, this quantity of metal coined into silver dollars would produce about one thousand coins, so that it might be said that the gross output of this enterprise in false money was \$1000 per day.

With silver at 63 cents per ounce, which was then the ruling market price, the silver contained in each coin was worth, as I have said, about 40 cents; this left a profit of about 60 cents on each coined dollar, or \$600 on the \$1000 as profits obtained over and above their profits upon the production of the silver.

I managed to ascertain that no shipment of bars would be made for two weeks, and, as there were quite a pile of them in the refinery, chuckled over the thought that I should capture all of these silver bars or boxes, each one of which contained a thousand of their silver dollars. It was the 4th of August. On the following morning Lieut. Fitzgerald and his troop would be on the ground. I knew the direction they would come so that night I stole away from camp and went to meet them.

The troop was within four miles of the camp at 3 o'clock in the morning, and, acting upon my suggestion, they dismounted, left their horses with a guard and traveled the balance of the way on foot. I went ahead and returned to the camp alone, directing that they should advance as closely as possible without exposing themselves, and to remain concealed until I should give them a signal to appear.

The morning shift was just about to go into the mine when I approached Mr. Spencer, a low-browed, moon-

faced man, with taffy-colored hair, who, seeing me, said:

"The team will be here this morning, and I want you to go in on it; and if you ever come here again I shall send you to San Bernardino to jail."

"Is that so?" I replied: "then I will have you to know that you yourself, sir, are under arrest. I am an officer of the United States and I arrest you."

I threw back my coat and displayed my star, which I had lately pinned on my vest. The man looked upon it almost paralyzed with astonishment.

"On what charge do you pretend to arrest me?" he said, without questioning my authority.

"Upon a charge of counterfeiting the coin of the United States," I replied.

"Pooh," he said, affecting a coolness he did not feel. "You talk like a fool" He pulled a cord which rang a bell in the mine, giving the signal for the men below to appear on top. "I'll have you to know, sir," he said, "that it will take a better man than you to arrest a whole camp and shut down a mine on such a fool charge as that: how d'ye suppose you're goin' to take us in the railroad? D'ye think we will furnish our own transportation and haul you besides? Ha, Ha!"

At this juncture the men who were working below began to come out of the tunnel, and Spencer started to explain to them that they had been spied upon by a detective who wanted to arrest all hands upon the nonsensical charge of counterfeiting. A short, thick-set man with black hair, a black moustache, and light eyes whom I supposed was Davis, wanted to argue with me what an absurd thing it was to talk about any counterfeiting going on at that place.

I was not disposed, however, to play on words.

"I command you to call every man here," said I: "they must deliver to me whatever arms they have, and prepare themselves to go to the railroad with me."

They laughed. "I will see," said I. I blew a shrill blast on my whistle and instantly there tumbled over the top of the mountain the blue forms of twenty

soldiers, their legs in brown leggings, and their rifles in their hands. They scrambled rapidly down toward us, while Davis and Spencer turned white and looked appalled. Instantly Spencer blew a large whistle with a peculiar sound, and then I heard a great commotion in the refinery below us; they he beckoned to his men, and they ran as rapidly as possible together down the side.

Almost immediately after this, and while the soldiers were still about half way between the summit and the tunnel, there came at first a dull roar, accompanied by a slight shock, apparently from the center of the mountain, then in an instant followed an enormous and most terrific explosion, an explosion of volcanic violence which seemed to [come] from below us and through the tunnel and to convulse the entire mountain. The earth on which I stood heaved and threw me from it. I was hurled forward, forcibly striking the ground head first, and rolled down the slope. I looked above me; the concussion had loosened a quantity of overhanging rock, and an avalanche of debris was sliding down among the panic-stricken soldiers. A great rock bounded past me and shocked me with its wind as it went tumbling on in the gulch below. Men came sprawling headlong down, dome rolled down, while others remained lying flat on the side of the mountain.

When the effects of the explosion had passed I found, happily enough, that I was uninjured and that Lieut. Fitzgerald had also the good fortune to escape. He joined me and we began to get together the members of the troop. We found that one man had been so crushed between rocks that he was in a dying condition, another had a leg broken and another had sprained an ankle.

Such was the list of our killed and wounded. We turned to look for those whom we had come to arrest, and we were in no pleasant frame of mind to undertake the business. They were all huddled together, about twenty of them, in a sheltered ravine. We charged upon them. They did not repent. Davis told us there had been

a blast in the mine. "A shot," he said, "had been set and the fuse lighted; we had come out of the mine to allow it to take effect without hurting anyone."

"Are all your shots like that?" I asked.

He replied that that seemed to be a unusually heavy one, and it was. There must have been a ton of giant powder burnt in that explosion. The tunnel had caved in, and the debris from above on the mountain had covered the place many feet in depth. It was perfectly apparent that both shafts within must have been torn to pieces and the whole mine was a wreck. Thousands of tons of much doubtless filled the holes, and to have reached the bottom of the shafts would have required as great an expenditure as the total amount that had been used in developing the mine.

It was clear to all of us that the explosion had been effected on purpose. These counterfeiters had taken into account the chances of the mine being some day raided by the officials who would trace to that place the counterfeit silver dollars. They had stored hundreds of pounds of dynamite where the concussion of its ignition would produce the severest of effects, and they had connected it with an electric wire leading to the refinery. Spencer had given the signal to discharge the blast, and the battery was turned on; the result was that minting machine, dies, rollers and whatever else of evidence as in the crime of counterfeiting had instantly become buried beneath thousands of tons of debris.

We then proceeded to the refinery, intending to seize the silver bars which I had seen so numerous piled therein, but lo! every one had vanished. I asked where they were, but received no reply: to direct questions put to the foreman of the refinery I received the reply that he did not know. I looked into the melting kettle; it was full of silver metal. The box bars with their silver dollars had been thrown into the kettle, and had melted into bullion; but no trace of the form of a box or the shape of a dollar could be discerned in the molten mass of bright

metal.

I chafed under the realization that withal I was to leave the mine without a particle of legal evidence that any counterfeiting had been in progress there, but such was the fact: I had no such evidence. We took with us all the men employed at the place, together with Davis and Spencer, but the most of them ... knew nothing beyond their immediate duties at the mines, and from these I learned nothing.

Davis, Spencer and Coughman, the smelter foreman, were put on trial, charged with counterfeiting, but not a word of damaging testimony could be elicited against them. The metal I took from the refining pot was assayed and found to contain just the proportion of pure silver and the identical kind of alloy contained in the silver dollar; but they produced in court samples of the ore of the mine which was shown to contain the same minerals, to wit: Silver and copper. A quantity of the spurious silver coins were found on their persons and we put our experts on the stand, who examined the coin and pronounced it counterfeit: but they produced a greater number of experts who declared it to be genuine. But what discomfited us most in the trial of the case was their tendering one of our experts on the stand a coin and asking him whether it was genuine or spurious. He examined it with great care and pronounced it to be the latter. They then put a number of witnesses on the stand, each of whom testified that they had together on that very morning procured that identical coin from a government mint, where it had been issued to them as genuine.

We found it impossible to trace to this mine, with the certainty of legal evidence, the bar containing the silver dollars which we had cut open at the mint. There was no doubt that the only way we could get evidence against the accused, proving that they had been engaged in the manufacture of counterfeit coin, was by penetrating those innumerable tons of rock in that mountain, and bringing to light that machinery which lay buried hundreds of feet below. There were no available funds to meet this expense, and,

though Congress was called upon to make an appropriation to this end, yet the bill therefor, like many other good measures, died in committee and never reached passage.

The accused were acquitted and they went their way. That way, however, was not back to the Mescal mine; that enterprise abides silenced, and the silver dollar counterfeits have about disappeared from circulation. I did not succeed in convicting the culprits, but I did succeed in squelching the industry. I afterward learned that Davis and Spencer were partners, and while they have been conducting several important enterprises, yet they had been pressed close to the wall of bankruptcy; unable otherwise to raise much-needed money, they took this means of veritably raising it out of the earth in defiance of United States laws. Whether they accumulated sufficient profits from their lawless venture to recoupe their fortunes or not I have never learned; but certainly, so far as I have ever heard, their careers as counterfeiters closed with that terrible explosion at the Mescal mine.

JOHN E. BENNETT.

Evaporative salt production on Soda Dry Lake

Rob Fulton, Desert Studies Consortium, Zzyzx, California.

The Mojave River is the southernmost major river drainage in the Great Basin of North America. The River headwaters in the northwestern San Bernardino Mountains, and travels ~200 km to its terminal basins at Silver and Soda Lake playas (figure 1). This large (~9500 km²) drainage produced prolonged high lake stands in the late Pleistocene/early Holocene that covered both playas (pluvial Lakes Mojave I and II) and occasionally breached a sill at the north end of Silver Lake, allowing flow northward towards the Amargosa River and Lake Manley in Death Valley. As the Holocene has progressed, several intermittent shallow lakes have flooded these playas during intense wet winter events, largely flowing from the mountainous headwaters, which accounts for about 90% of the precipitation in the Mojave River drainage (see Wells, et al, 2003 for a review).

Soda Lake is the first of these two playas to receive surface or subterranean flow from the Mojave River. In addition, Soda Lake receives water from the significant portion of the drainage to the south and east of the playa, including the Cima Volcanic Field, and the arc of mountainous terrain (the Mid-Hills, and Providence, Granite and Bristol Mountains) that feed Kelso wash and others. As a result, much of its sediments are perennially saturated, resulting in a type of playa sometimes referred to as a "salina". The millennia of mineral salts deposited here form concentrated brine, and evaporation from the surface often forms a distinctive white efflorescence of salts on its surface.

The American trapper and trader Jedediah Strong Smith provided the first recorded description of Soda Lake during his crossing of the Mojave Desert in 1826. While being guided by traders of the Mohave tribe from the Colorado River to Mission San Gabriel, he writes:

I crossed a Salt plain about 20 miles long and 8 wide; on the surface was a crust of beautiful white salt, quite thin . . . (Smith, 1827).

American military surveyors in 1853-54, first described the basin as the terminus of the Mojave River. The Prussian born artist and documentarian H. B. Mollhausen, attached to the expedition of 1854 lead by Lt. A. W. Whipple, was the first to record the name "Soda Lake".

From this point we had a view over the second half of the sandy valley, and it looked like a field of snowthrough this white plain,

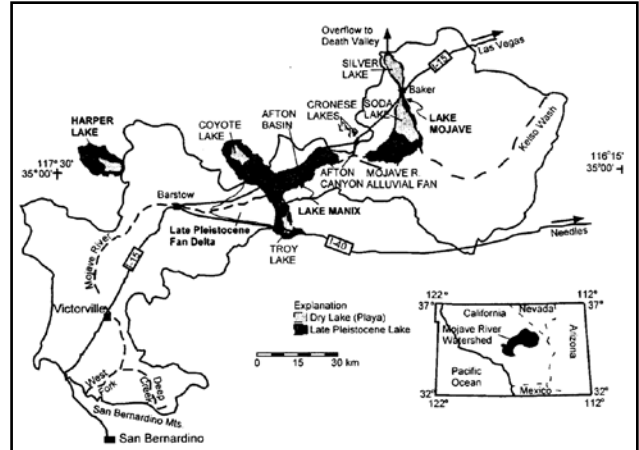


Figure 1. The Mojave River drainage basin showing maximum extent of latest Quaternary Lake Mojave. (Wells, et al, 2003).

which we named Soda Lake [emphasis added] we proceeded in a southwesterly direction (Mollhausen, 1969 translation).

The salts of Soda Lake received little attention until the construction of the Tonopah & Tidewater Railroad (T&T) in 1906-07. About 33 miles north of its junction with the Santa Fe Railroad, the T&T started to cross the playa of Soda Lake, on its way farther north to Death Valley and Goldfield, Nevada. Those interested in commercial exploitation of the salts of Soda Lake now had a convenient method to get product to market from the desert interior. Thus, in May of 1907, the Pacific Coast and Soda Company began construction of a solar evaporation plant designed to concentrate and process the salts of Soda Lake. A description of this operation was published in the American Mining Review of Los Angeles on August 8, 1908:

The Pacific Coast Soda Company has nearly completed the enlargement of its plant at Soda Lake Station, on the Tonopah and Tidewater Railroad, 33 miles north of Ludlow, in the San Bernardino county, California. This plant is only for separation and purification of the saline crusts that cover the sink of the Mohave River. This sink is one of the "dry lakes" of the desert, from two to five miles wide and 18 miles long. Much of its surface is covered with crusts of saline matter that look like snow to the traveler. The top crust is white and is



Figure 2. Remnants of evaporation ponds of the Pacific Coast Soda Co. Photo taken looking SE from the adjoining limestone ridge. R. Fulton, photo.

largely salt (sodium chloride) below which is a gray deposit that is salt and sodium sulphate mixed, and below is a damp silt-like material that is mainly sulphate of soda. A narrow-gauge track a mile and a half long extends out on the lake, and a small train is used to carry the crusts to the works, where they enter a revolving tube mill and are rapidly crushed in water kept at a temperature of about 100 degrees Fahr., until saturated brine is formed. Centrifugal pumps lift this brine to v-shaped wooden vats, or spitkatzen, where the sand is removed by settling, the brine overflowing through a series of vats until free from sediment. It is pumped from the last settling tank into huge rectangular tanks with sloping bottoms and moveable covers. These are the chilling tanks, and are fitted with brine pipes connecting with an am-

monia ice machine. The cold brine from the ice plant circulating through these pipes soon chills the brine in the tank down to nearly the freezing point, when the sulphate of soda is no longer held in solution, but settles on the bottom of the tank like so much snow.

When nearly all the sulphate has been precipitated, the liquor is drawn off and the sulphate is allowed to drain for some time in the cold tank. When well drained, the crystals are raked out onto a conveyor belt that carries them to the dryer. This is a revolving tube, over 40 feet long, where the crystals are dried by a blast of heated air until the water of crystallization is removed and the sulphate is dry as flour.



Figure 3. Concrete equipment foundations (?) of the Pacific Coast Soda Co. at the south end of the limestone ridge, just west of ponds seen in figure 2. R. Fulton, photo.



Figure 4. Dry-laid retaining walls forming building pads (?) near the foundations in figure 3. R. Fulton, photo.

carbonate, bicarbonate and caustic soda.

Both plants are the result of the work of Prof. G. E. Bailey, the chemist of the company, who has devoted several years to a study of the saline deposits of the state and their utilization and who now sees his ideas carried

The liquor from the chilling tanks is run into large soar vats or "salt floors" where the salt (chloride of sodium), crystallizes out in a few days. When the salt crop is complete, the mother liquor is drawn from the salt floors into another series of solar vats where it is allowed to evaporate to dryness under the desert sun. This gives three products for the plant - - sulphate of soda from the chilling tanks, salt from the salt floors, and impure sodium carbonate carrying some sulphate, and some salt, from the last solar vats.

The works were started up the last of May and proved so successful that the plant was at once ordered enlarged to a daily capacity of 25 tons of sulphate. The plant is equipped with the narrow-gauge road mentioned: a 60-horsepower and 25-horsepower engine; a 40 ton ammonia ice-plant, and several acres of vats and floors. The sulphate of soda and the salt produced are both practically chemically pure, analyzing over 99 per cent pure. The sulphate is produced at once and the salt is gathered in a few days, instead of months as by the ordinary process. Some of the sulphate is sold for glass making and other purposes, but the main use of the plant is to furnish sulphate for the large plant building at Santa Ana, California, where the sulphate will be converted into

into practical operation.

The plant at Soda Lake cost over \$25,000, and the plant at Santa Ana will cost about \$75,000 when completed this fall."

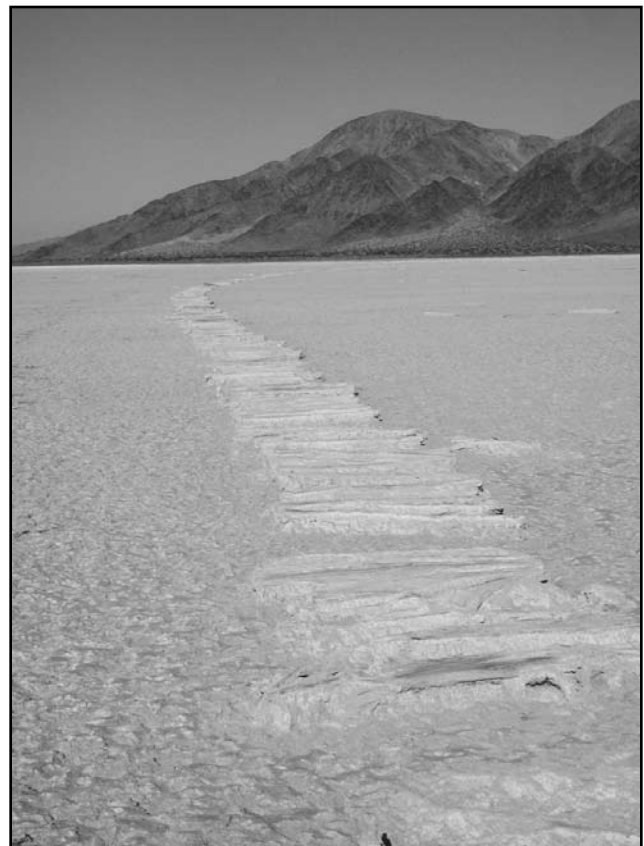
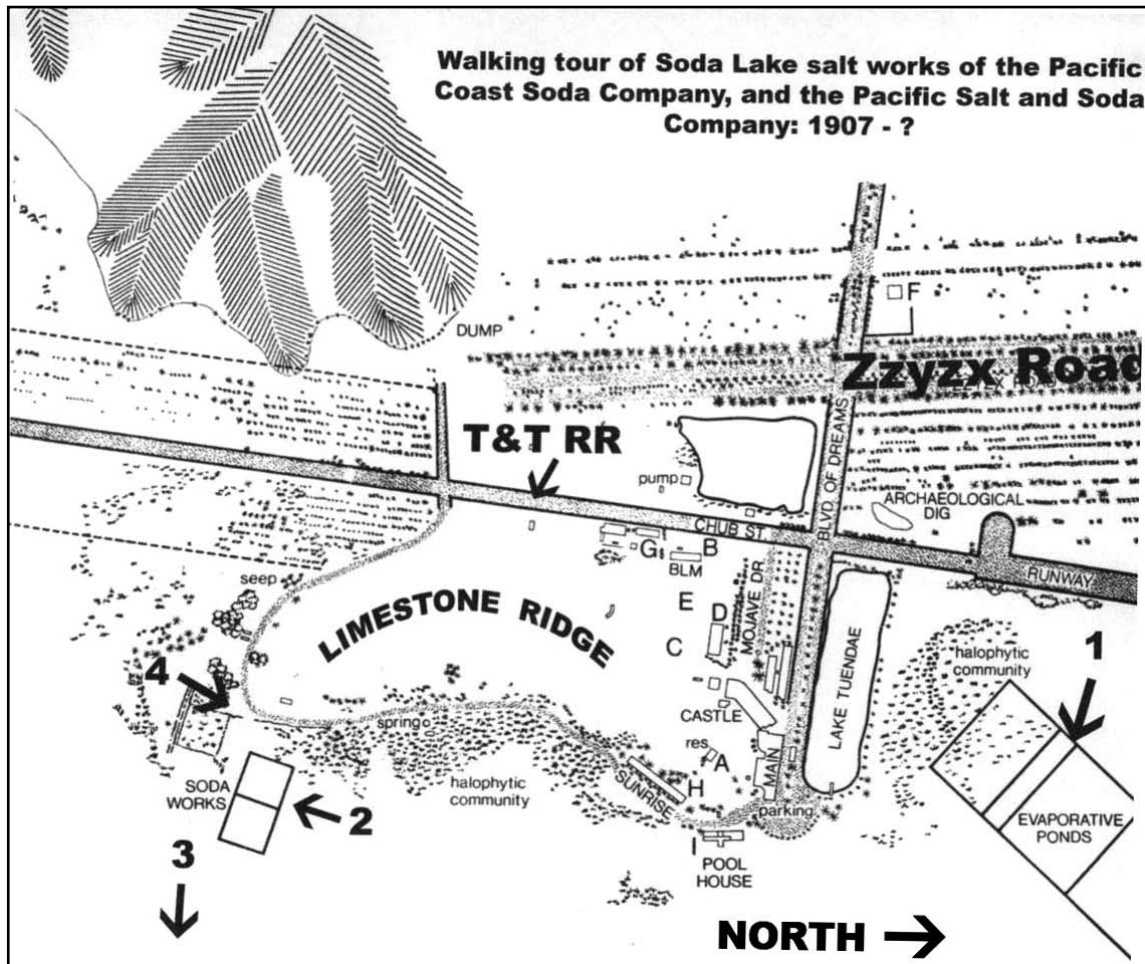


Figure 5. Wooden cross-ties of narrow gauge rail system on Soda Lake, curving westward towards the salt works of the Pacific Coast Soda Co. R. Fulton, photo.



Walking tour of Soda Lake salt works

Step 1: Remnants of the Pacific Salt and Soda Company operation are north of the Desert Studies Center and east of the Tonapah and Tidewater Railroad grade. Evaporative ponds, remains of sluice gates, railroad ties, and foundations for machinery and buildings can be found in this area.

Step 2: Walk south past the abandoned Pool House along the east side of the limestone ridge (there is a path). You will pass Mojave Chub Spring (a small artesian pool with the endangered Mojave Tui Chub fish survives), and arrive at the southeast corner of the ridge. Evaporative pond structures of the Pacific Coast Soda Company are visible on the playa adjacent to the shoreline.

Step 3: Walk to the east onto the playa from the evaporative ponds for about 15 minutes to the remains of the narrow gauge (30 inch) railroad cross-ties that were installed by the Pacific Coast Soda Company in 1907.

Step 4: Just south of stop 2 you will encounter the remains of several concrete foundations and a few retaining walls constructed of limestone rock that form construction pads (buildings or machinery?). Continue westward to the T&T railroad grade (now a dirt road), which you can follow northward to return to the Desert Studies Center.



Figure 6. Aerial photo looking south, showing the evaporation ponds of the Pacific Salt and Soda Co. The smaller remains of the Pacific Coast Soda Co. ponds are visible at the top of the image just left of center. Desert Studies Collection.

The description of this operation fits with remnants of evaporation ponds or “salt floors”, concrete foundations with protruding anchor bolts, and constructed building pads with limestone block retaining walls found at the south end of a limestone ridge along the western shore of Soda Lake just east of the T&T railroad grade (figures 2 – 4). An abandoned narrow gauge grade extends eastward from this site, and if followed for about a third of a mile,

the wooden cross ties (and at least one short section of rail) are still in place (figure 5). One tie with spikes at both ends indicates a railroad gauge of 30 inches.

A second salt recovery concern operated at the north end of the aforementioned limestone ridge, and north of the CSU Desert Studies Center at Zzyzx (figure 6). This operation is thought to be that of the Pacific Salt and Soda Company. This company also developed evaporative ponds in 1907, and a narrow gauge rail system of about 36 inches (National Park Service, 2002). An article in the San Bernardino Sun on August 11, 1907 titled “A Trip Over the Tonopah and Tidewater” states:

The next development is that being made by the Pacific Salt and Soda Co. at Soda Lake. The railroad passes through this wonderful deposit of almost pure soda for a distance of nearly 12 miles, and the road bed is made of this great component of the American biscuit. The company is building large evaporating beds into which the waters of the lake will be pumped and then allowed to evaporate under the influence of the solar rays. Large furnaces are being constructed in which the deposit will be refined for table use.



Figure 7. View looking NE over salt works of the Pacific Salt and Soda Co. circa 1908. Frank Green, photo: Hugh Tolford Collection.



Figure 8. Scene in figure 7 as it appears today. Note tamarisk tree at approximate location of wooden shed, and the berm angling up and left from that location. An approximately 4" diameter pipe visible in the 1908 image (just right of an upright tank), is also visible in this modern image. R. Fulton, photo.

The company doing this work must not be confounded with the Pacific Coast Soda Co. (emphasis added). The Pacific Salt and Soda Co. has no stock for sale. It is a closed corporation that is working the deposit (Haenszel Collection referenced in Duffield-Stoll, 1994).

A photographer, Frank Green, took a photograph of these workings about 1908 (figure 7), which the author attempted to reproduce in 2000 (figure 8).

Any production records for these two operations are unknown to this author, but production is thought to have been market driven in part, and probably seasonal, as temperatures on Soda Lake can soar up to 120° F in summer. Combined with single digit relative humidity and, at times, strong hot winds throughout the night, conditions for evaporation may have been optimal, but difficult for a workforce to endure. The Pacific Salt and Soda Company's elaborate plant may have initially operated for less than two years, with a resurgence of activity in 1912, when "new blood" reportedly had joined the company. There may have been activity as late as the end of World War I (NPS, 2002). Records of operational duration for the Pacific Coast Soda Company have yet to be discovered.

The area of Soda Springs (Zzyzx), including the rem-

nants of these two operations, have been nominated for the federal Registry of Historical Places by the National Park Service.

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The Silver Lake talc deposits, San Bernardino County, California

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Deposits of commercial talc in the vicinity of Silver Lake, San Bernardino County, California were almost continuously mined from 1915 to the mid-1970s. They yielded an estimated 300,000 tons of metamorphosed sedimentary rocks. These deposits consist of mixtures of magnesian silicate minerals – mostly tremolite but also various proportions of talc, chlorite(?), serpentine, and forsterite. The products sold as commercial talc were used as a ceramic raw material and a paint ingredient. The talc-rich rock was also marketed as a lubricant in the manufacture of rubber goods.

In mapping and describing these deposits for the California Division of Mines more than 50 years ago (Wright, L.A. 1954), I found that they were part of a strongly metamorphosed succession of sedimentary rocks and associated igneous rocks engulfed in a granitic batholith.

The invading granite is now known to be Late Cretaceous in age (DeWitt, and others, 1984). The relative ages of the metamorphic rocks and the various igneous rocks that intrude them can be reasonably well established but their absolute ages remain in question.

As shown in Figure 1, the typical body of commercial talc is stratiform and generally 10 to 15 feet thick. It was once a sedimentary carbonate rock and was later altered to assemblages of calcium-magnesium silicate minerals. Most of the talc-rich rock occurs in tabular bodies along the walls of the deposit, permitting it to be mined selectively. The tremolitic part of a typical deposit commonly encloses masses of an earlier, higher temperature assemblage composed mostly of forsterite and tremolite. These composite bodies of commercially mined rock have been invaded by bodies of granitic rock, both fine-grained

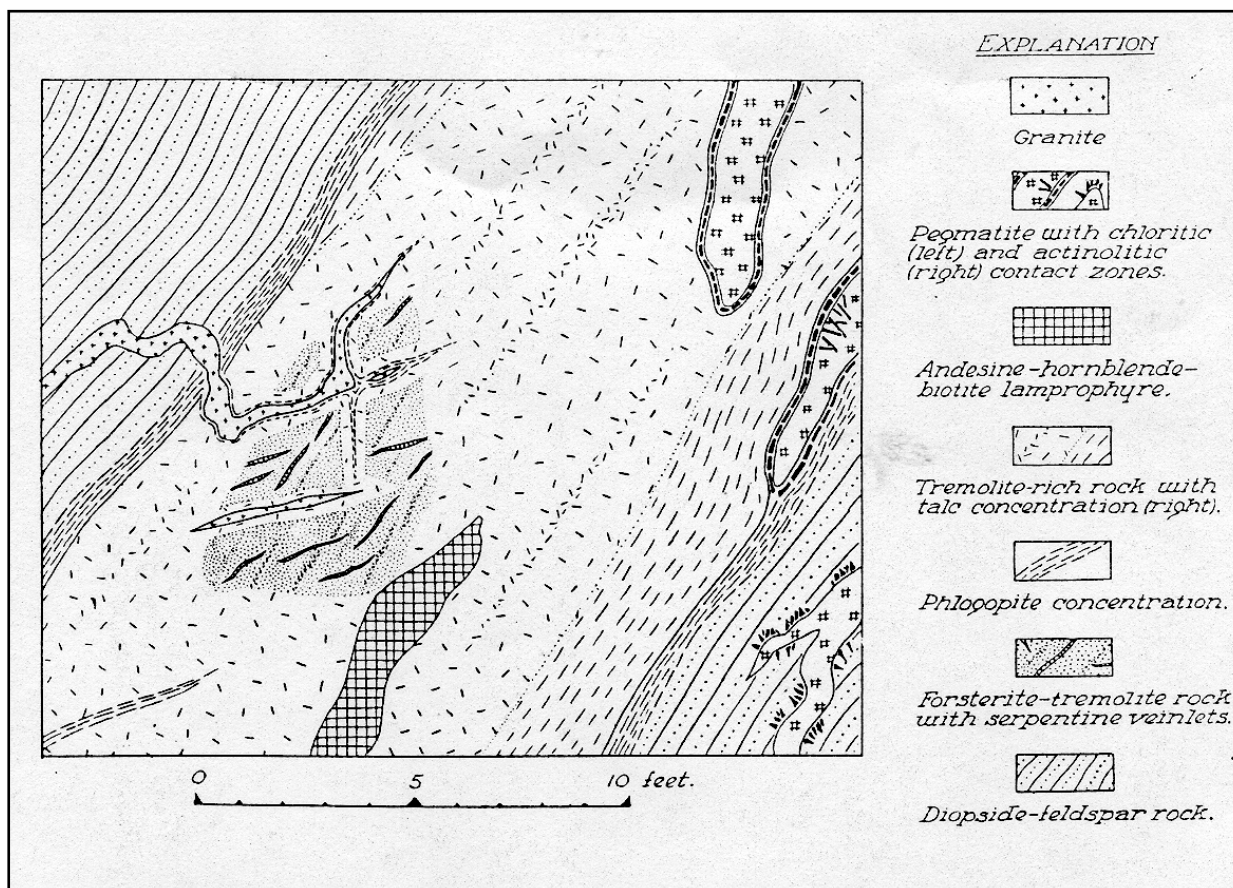


Figure 1. Idealized cross section through a typical body of commercial talc showing bodies of various igneous rocks that intrude the body (Wright, L. A., 1954)

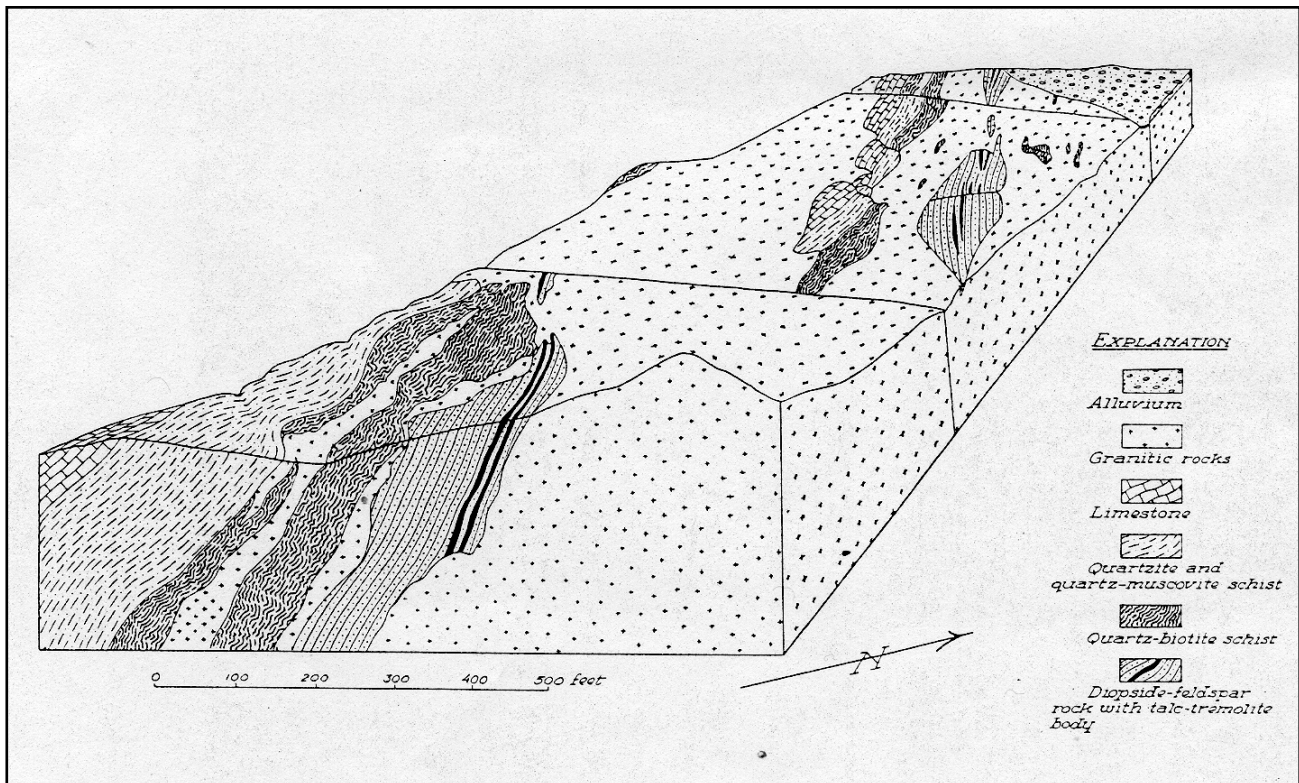


Figure 2. Block diagram showing the geologic setting of the Silver Lake talc deposits (Wright, L. A. 1954)

and coarse-grained, and other bodies composed of mafic minerals.

The geologic setting and the major rock units of the Silver Lake talc deposits are shown in Figure 2. Note that the bodies of commercial talc have formed in a well-defined, layered part of a succession of metamorphosed sedimentary rocks. This succession, in turn, has been engulfed and separated into isolated islands in a sea composed of the much younger batholith.

It is tempting to correlate the sedimentary rocks and the associated talc deposits at the Silver Lake mine with the talc deposits of the Proterozoic Crystal Spring Formation which is extensively exposed in the bordering region athwart southern Death Valley (Wright, 1968). The talc deposits of the Crystal Spring Formation, however, are very different from those at Silver Lake in that they have formed along the contact between a region-wide diabase sill and the lowest carbonate strata in the Crystal Spring. This setting is clearly unlike that of the Silver Lake talc deposits - the diabase sill is missing and the metamorphosed sedimentary succession that contains the deposits remains uncorrelated with any part of the Pahrump Group.

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Halloran turquoise: a thousand years of mining history

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Abstract

The Halloran Hills in the eastern Mojave Desert contain alunitized Mesozoic quartz monzonite, cupriferous Miocene gravels, and phosphate-rich Pliocene basalts, a combination that has allowed ground water to precipitate turquoise—copper aluminum phosphate. Although generally botryoidal, turquoise also fills voids and replaces original minerals in miarolitic cavities in the Teutonia quartz monzonite pluton. Turquoise mining in the Halloran Hills has continued from 500 A. D. to the present: over one thousand years of mining.

Mojave Desert Turquoise

Turquoise localities are distributed across the Mojave Desert from the Iron Mountains (west of Barstow), north to the Lava Mountains (east of Randsburg), north of Barstow at Lane Mountain, and southwest of Needles in the Sacra-

mento Mountains (Murdoch and Webb, 1966; Pemberton, 1983). Turquoise is reported from the Crescent District of the eastern Mojave Desert in Clark County, Nevada (Castor and Ferdock, 2004; Morrissey, 1968). In the Mid Hills area of the eastern Mojave Desert in California, turquoise is reported from Signal Hill, Wild Horse Mesa, Barnwell (Kunz, 1905; Murdoch and Webb, 1966; Pemberton, 1983), and farther north in the Mescal Range. The Halloran District and the Crescent District to the east contain aboriginal stone hammers suggesting a history of mining that spans more than 1,000 years (Kunz, 1905; Morrissey, 1968; Leonard and Drover, 1980).

Geology and Depositional Environment

The geology and tectonic history of the Halloran Hills, northeast of Baker (Fig. 1), presented in separate focused studies (Bishop, 1994; DeWitt, 1980; Dohrenwend and

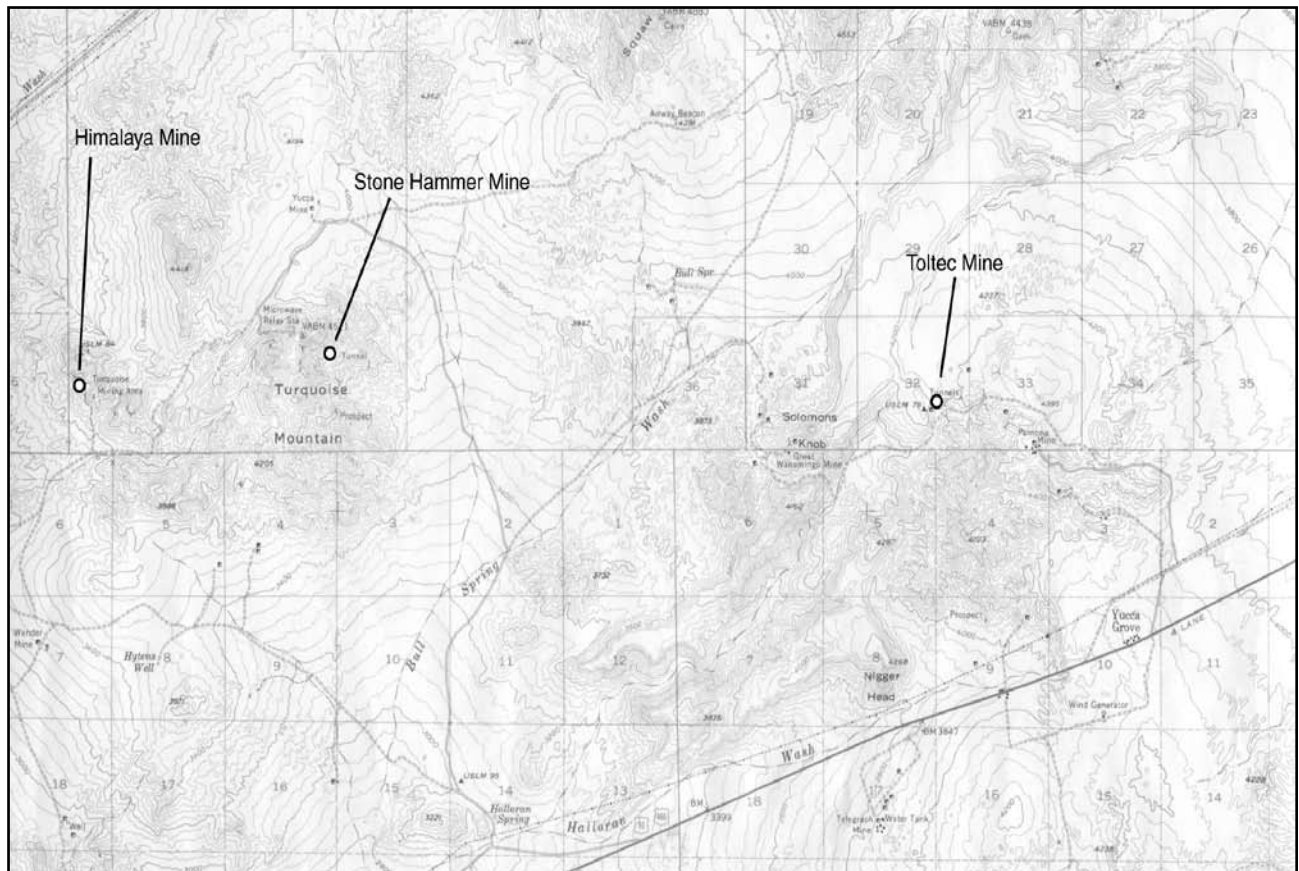


Figure 1. The Halloran turquoise districts: West, Middle, and East camps (after Pemberton in Murdoch and Webb, 1966). U.S. Geological Survey Halloran 15' quadrangle, 1956.

others, 1984; Friedman, 1996; Reynolds, 1988, 1990, 1993; Reynolds and Calzia, 1996; Reynolds and others, 1996), is summarized below.

Cretaceous (100 Ma) granitic plutons intruded older rocks, leaving gneissic roof-pendants surrounded by Teutonia quartz monzonite (Beckerman, 1982). Little remains to record early Tertiary intrusion or deposition in the Mojave Desert interior, but there is evidence of extensive erosion and deep weathering. All rock deposits overlying the Teutonia quartz monzonite have been removed by erosion. Iron oxides have stained this granitic rock red, and the interior of joint-bounded granitic blocks show leisingang weathering rings that indicate deep weathering. Decomposed granite has eroded away, leaving spheroidal boulder piles in place. Proterozoic quartzite lag-gravels remain in paleotopographic swales.

The early Miocene Peach Spring tuff (PST, 18.5 Ma.) is the oldest dated rock retained on the pre-Miocene erosional surface. Associated with fine-grained lacustrine and fluvial sediments, this volcanoclastic sequence heralds the formation of the Halloran Hills–Shadow Valley basin. This west-vergent detachment basin was actively extending westward between 13 and 10 Ma. The extension-related listric-normal faulting left a geologic signature or pattern repeated in fault blocks from west to east. The pattern is quartz monzonite, volcanic rocks (PST or pyroxene andesite) and fine grained sediments, then coarse, basin-filling deposits of conglomerate and of avalanche and gravity slide debris from eastern, copper-rich sources. Degraded fault scarps and the pre-Miocene surface are recognized on the west and east sides of each granitic block.

After 10 Ma, erosion smoothed the surface of the east-tilted fault blocks. Interaction between the left-lateral Garlock fault zone and the right-lateral Soda-Avawatz fault zone thrust plates of Proterozoic Riggs Carbonate east over the Halloran Hills. Beginning about 5 Ma, Pliocene basalts flowed west and east over Halloran structures and topography.

Turquoise Deposition

Turquoise is a copper aluminum phosphate $[\text{CuAl}_6(\text{PO}_4)_4(\text{OH})_8 \cdot 4\text{H}_2\text{O}]$; because there are six aluminum atoms for each copper atom, a source for aluminum is important for the formation of turquoise. The Halloran Hills contain four important components for the deposition and formation of turquoise:

- (1) A porous host rock
- (2) A source of aluminum. Certain areas of quartz monzonite in the Halloran Hills were alunitized, probably at the time of listric-normal faulting (13 - 10 Ma). "Alunition" is hydrothermal alteration of feldspathic igneous rocks producing alunite-rich rocks.
- (3) A source of copper. Copper minerals in gravel from the Mescal and Clark ranges to the east filled the Halloran Hills–Shadow Valley basin after 12 Ma.

- (4) A source of phosphate. Phosphate is more abundant in basalt (0.5+%, Turner and Verhoogen, 1960) than in other volcanic rocks. Basalts flowed over the Halloran Hills after 5 Ma years.

Turquoise was probably deposited in the Halloran Hills after 5 Ma. Ground water leached phosphate from basalt, picked up copper sulfate solutions from the gravels, and traveled laterally through the porous, weathered quartz monzonite until it reached alunitized quartz monzonite. The mineral alunite $(\text{K}_2\text{Al}_6(\text{SO}_4)_4(\text{OH})_{12})$ is a high aluminum sulfate produced by sulfate-rich water alteration of feldspar $(\text{KAlSi}_3\text{O}_8)$. Therefore, the altered quartz monzonite is a porous, high aluminum sulfate/silicate host rock. When it receives copper phosphate/sulfate solutions, the copper aluminum phosphate turquoise is precipitated. All the turquoise deposits in the Mojave Desert (above, Murdoch and Webb, 1966; Pemberton, 1983) are associated with Jurassic or late Tertiary volcanic rocks which may provide the phosphate sources.

The host rock for turquoise in the Halloran Hills is Teutonia quartz monzonite (Beckerman, 1982). Unaltered minerals and turquoise pseudomorphs give an picture of the original fabric of the Teutonia quartz monzonite. Most Halloran turquoise (Plate 1-1) is found in fractures between blocks of quartz monzonite. In certain areas, turquoise is associated with quartz and beryl, suggesting deposition in miarolitic cavities. These cavities were formed near the end of emplacement of the granitic Teutonia quartz monzonite pluton, and have the composition of small pegmatite dikes, containing microcline feldspar, quartz, beryl, and occasional apatite and (hematite-replaced) pyrite crystals. The cavities now contain turquoise pseudomorphs of what appears to represent the following mineral assemblage:

Quartz	Unaltered hexagonal crystals
Muscovite	Unaltered monoclinic crystals
Beryl, var. aquamarine	Unaltered hexagonal crystals
Microcline feldspar	Triclinic turquoise pseudomorphs
Pyrite, p. a. hematite	Cubic turquoise pseudomorphs
"Barite?"	Orthorhombic turquoise pseudomorphs
Apatite	Hexagonal turquoise pseudomorphs

The triclinic turquoise pseudomorphs have the morphology of triclinic microcline feldspar; the process of replacement would be more straightforward if the feldspar had already altered to alunite. Cubic pyrite crystals altered to goethite (limonite) are common in pegmatites and miarolitic cavities. The dissolved, empty cubic hollows can be filled by turquoise.

The hexagonal turquoise pseudomorphs in the Halloran Hills (Plate 1-2) have a different morphology than the associated beryl (Plate 1-3). The hexagonal pseudomorphs were originally described as being a beryl replacement, since unaltered beryl was found in association. However, the beryl has a relatively long "C" axis, prominent prism faces and no pyramid faces. All the hexagonal pseudomorphs have a short "C" axis, and many show

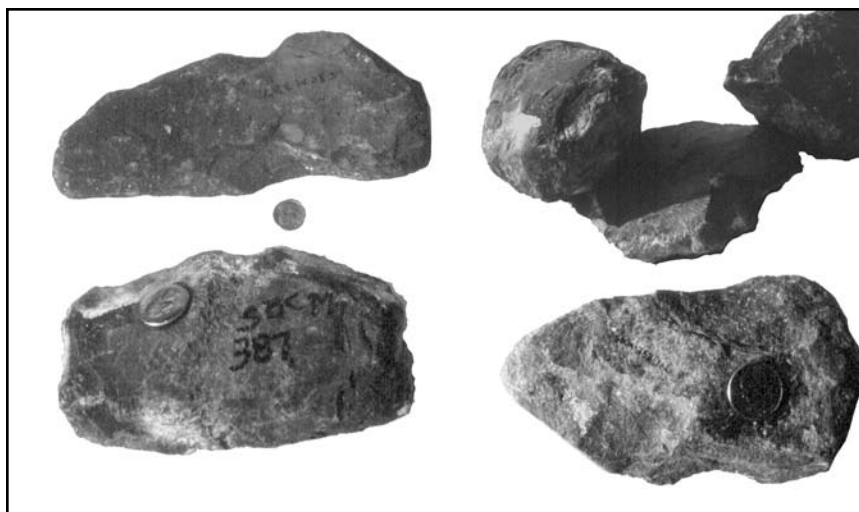


Figure 2. Stone hammers from the Halloran turquoise mines.

pyramid faces. Alteration of a beryllium silicate to an aluminum phosphate is not as chemically easy as altering a calcium phosphate (apatite) to an aluminum phosphate (turquoise). Additionally, SEM work by R.M. Housley has identified crystals of xenotime and monazite (yttrium phosphate and lanthanide phosphate) embedded in the hexagonal turquoise pseudomorphs. These two phosphates require high temperatures (hydrothermal/pegmatite temperatures) to crystallize, and are commonly found embedded in apatite.

Tabular, orthorhombic turquoise pseudomorphs (Plate 1-4) have been called replacements after barite crystals. The occurrence of barite ($BaSO_4$) is unusual in miarolitic cavities. These pseudomorphs need more study since other minerals known from pegmatites (e. g. columbite/tantallite) are also orthorhombic.

Prehistoric Mining

Stone hammers from prehistoric turquoise mining have been recorded from the Halloran Hills (Eisen, 1898; Sperisen, 1897, 1938; Leonard and Drover, 1980). Many hammers were pecked to develop grooves around their median and show impact abrasions on both ends (Fig. 2). Hammers were made from, in order of abundance, basalt, quartz, quartz breccia, meta-quartzite, and quartzite, with minor use of gneiss and chalcedony breccia (Leonard and Drover, 1980). All these lithologies occur locally (Leonard and Drover, 1980; Reynolds, 1988, 1990); quartzite cobbles are also abundant along Colorado River terraces 60 miles to the east. The reconstruction of aboriginal mining and mucking to recover turquoise and remove waste rock has been described (Rogers, 1929; Leonard and Drover, 1980). Descriptions of dead-falls and booby-traps left by ancient miners to guard their excavations have been reported by recent miners (Ed Nazelrod, p. c., 1975). Petroglyphs described in early reports from the Halloran Hills (Fig 3; Eisen, 1898; Kunz, 1904) are not directly associated with aboriginal turquoise pits, but instead have

been identified on basalt flows at Halloran Spring and to the east at Cow Cove (W. G. Turner, p. c., 1975).

Dates of prehistoric mining in the Halloran Hills has been determined by three different methods (Leonard and Drover, 1980):

A. Radiocarbon dates from bone and wood found in the turquoise mining pits (500 and 1070 A. D. respectively)

B. Pottery that is present in the vicinity of the Halloran Hills turquoise mines dates between 750–1000 A. D.

C. Half-Moon Cave, four miles south of the turquoise deposits,

contains strata with turquoise and pottery that date between 700–1050 A. D.

Distribution of the Halloran turquoise throughout the southwest has been documented (Sigleo, 1970, 1975) as far east as Snaketown, south of Phoenix, Arizona. Halloran turquoise appeared along the Virgin River (Moapa-Overton, NV) as well as in central Arizona by 400–750

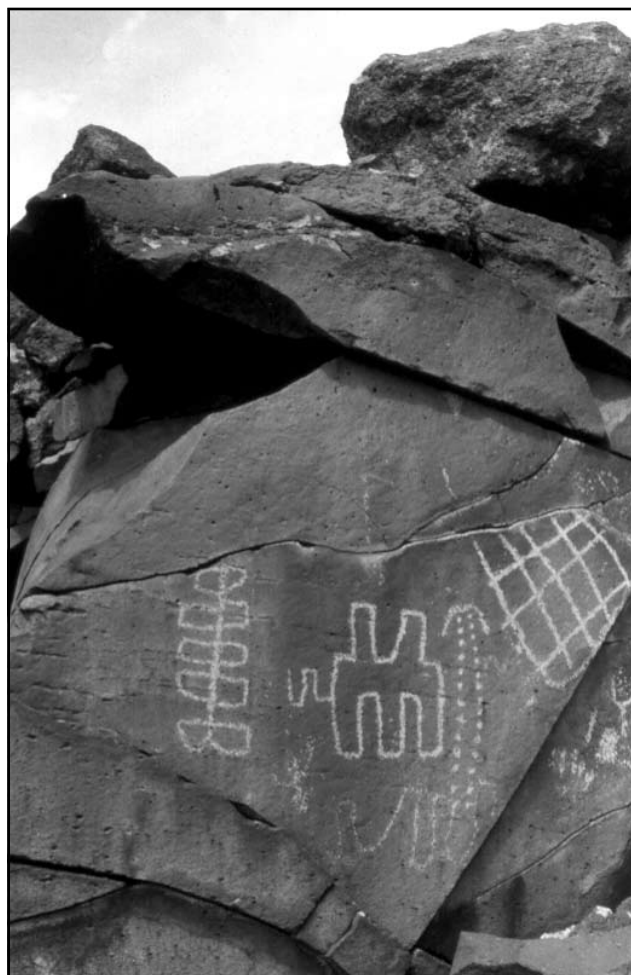


Figure 3. Petroglyphs in the Halloran Spring district.

A. D. (Leonard and Drover, 1980). A second period of mining by Patayan cultural branches (Yuman and Prescott branches) took place from 750–1200 A. D. A late period of mining by Panamint Shoshone and Chemehuevi occurred from 1200–1900 A. D. (Leonard and Drover, 1980).

Rediscovery and Commercial Mining

Sperisen (1938) published a portion of gemologist George F. Kunz's (1905) summary of the "re-discovery" of Halloran turquoise deposits:

In the extreme northeastern part of this county there have been discovered old and abandoned mines of turquoise covering an area of many square miles. Associated with these mines were found the relicts of an early race; and it is supposed that this is the original source of much of the turquoise found in the hands of the Indians of the southwestern United States and Mexico. The turquoise occurs in small veins and also in kidney-shaped masses about the size of a bean. ...

The first published announcement of the turquoise discoveries in this region was made in 1897, (Sperisen, 1897). The locality was given as near Manvel [Barnwell] ... Mr. T. C. Bassett observed ... a vein of turquoise... and aboriginal stone hammers... as usual at all turquoise localities in the southwest... the location was named the Stone Hammer mine.

On the reports of prospectors reaching San Francisco ... an exploring party was organized by the San Francisco "Call," and Mr. Gustav Eisen, of the California Academy of Sciences, became attached to it as archaeological expert. The party set out in March, 1898, going first to Blake Station [Goffs] on the Santa Fe Railroad, thence north to Manvel [Barnwell], and onward some sixty miles, across the Ivanpah Sink, and up into the mountains ... The region is conspicuously volcanic in aspect, being largely covered with outflows of trap or basaltic rock reaching outward from a group of extinct craters.... In canyons and on sides of hills are the old turquoise mines, appearing as saucer-like pits, ... around them the ground consists of disintegrated quartz rock, like sand and gravel, full of fragments and little nodules of turquoise. ... Stone tools are abundant in the old workings, and the indications are plain that this locality had been exploited on a great scale and probably for a long period, and must have been an important source of the turquoise used among ancient Mexicans. ... The canyon walls are full of caverns, now

filled ... with wind-blown sands and dust, but whose blackened roofs and rudely sculptured walls indicate that they were occupied for a long time by people who worked the mines. In the blown sand were found stone implements and pottery fragments of rude type, incised but not painted. The openings to these caves are partly closed by roughly built walls of trap blocks piled upon one another with no attempt at fitting and no cement, but evidently made as rude protection against weather and wild beasts. The tools, found partly in the caves and largely in the mine pits, are carefully wrought and polished from hard basalt or trap, chiefly hammers and adzes or axes, generally grooved for a handle and often of large size. Some are beautifully perfect, others are much worn and battered by use.

The most impressive feature, however, is the abundance of rock carvings in the whole region. These are very varied, conspicuous, and peculiar ... Some are recognizable as 'Aztec water signs,' pointing the way to springs ... They are numbered by many thousands ... Some are combinations of lines, dots, and curves....; others represent animals and men; a third... is that of the 'shield figures'...

One curious legend still exists among the neighboring Indians that is in no way improbable or inconsistent with the facts. The story was told Mr. Eisen by 'Indian Johnny', son of the Piute chief, Tecopah, who died recently at a great age, and who, in turn had received it from his father. Thousands of years ago, says the tale, this region was the home of the Desert Mojaves. Among them suddenly appeared, from the west and south, a strange tribe searching for precious stones among the rocks, who made friends with the Mojaves, learned about these mines, worked with them and got great quantities of these stones. These people were unlike any other Indians, with lighter complexions and hair, very peaceable and industrious, and possessed of many curious arts. They made these rock carvings and taught the Mojaves the same things. This alarmed and excited the Piutes, who distrusted such strange novelties, and thought them some form of insanity or 'bad medicine', and resolved on a war of extermination. After a long and desperate conflict, most of the strangers and Mojaves were slain, since which time, perhaps a thousand years ago, the mines have been abandoned. Mr. Eisen connects this account with the existence of a fair and reddish-haired tribe, the Mayos (not Mayas),

in parts of Sinaloa and Sonora, some of whom may have reached these mines and carried on a turquoise trade with Mexico.

This region has since [1898–1905] been opened at several points, and at least a dozen mines are now being worked by various parties, mostly with eastern capital. The principal work is being done by the Himalaya and Toltec mining companies. The turquoise obtained, when pure and of good color, is cut into fine gems;...ornamental stone....and beads. Most of the material produced is sent to New York. The yield in 1900 was estimated at a value of \$20,000.

Acknowledgments

The author thanks Mr. Ed Nazelrod, Apache Canyon Mining Company, whose interest in prehistoric mining led him to save examples of the mine pits, hammers, bone and charcoal, and to provide samples of turquoise for study. The late Wilson Turner was instrumental in locating petroglyphs figured in 1898 reports. N. Nelson Leonard provided discussions of the dates of cultural material associated with the ancient mines. Robert M. Housley provided SEM analysis and thoughtful discussion and review.

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Recent rare mineral finds at the Noonday and War Eagle mines, Tecopa Pass, Inyo Co. CA

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Introduction

In conjunction with a loose collaboration with the Shoshone Museum, a few members of the Southern California Friends of Mineralogy and friends including myself, Garth Bricker, Bob Reynolds, Dick Thomssen, and Joe Marty have begun a systematic study of the mineralogy of the abandoned lead/zinc/silver mines in the Tecopa Pass area of the Resting Springs mining district. We are using scanning electron microscopy with energy dispersive x-ray analysis to identify previously unrecognized minerals. Most of our efforts so far have been focused on the Noonday and War Eagle mines where our combined collections provide a good selection of samples (Plate 2). Such mines offer an unparalleled scientific opportunity to find and study rare minerals that only form in unusual chemical/geologic environments and which are insufficiently stable under surface conditions to ever be found in natural outcrops. Indeed we have already found some rare minerals as well as fine specimens of some more common ones. These will be described in the main body of this report after brief discussions of the history of mining in the area and of the geological setting of the mines.

The main mines of the area are now mapped on the USGS 7.5" Tecopa Pass quadrangle as the Gunsight, the Noonday, the Columbia no. 2, and the War Eagle. The Gunsight also often appears in the literature as the Gunsite. What was once known as the Grant Mine is now considered to be part of the Noonday since their underground workings interconnect. It appears that the Columbia no. 2 was once known as the Noonday no. 2. There seems to be little documentation of prior studies of the mineralogy of these mines. The mining literature indicates that the ore minerals were galena and cerussite at the Gunsight (Hamilton, 1921), galena, cerussite, and smithsonite at the Noonday (Waring and Huguenin, 1919), and galena, anglesite, and cerus-

site at the War Eagle (Newman and Stewart, 1951). Woodhouse in personal communications recorded in CDMG Bulletin 189 mentioned scorodite from the Noonday in 1945 and aurichalcite from the War Eagle in 1954.

The Caltech mineral collection has specimens of cerussite from the Columbia no. 2 Mine and galena, anglesite, cerussite, aurichalcite, brochantite, and linarite from Shoshone Mines, a grouping that included all the above mines, but primarily worked the Columbia no. 2 and the War Eagle. These were mostly donated by Thomas Coons in 1954. The Los Angeles County Natural History



Figure 1. Topographic map of study region. Flags show the locations of the main mines in the region as given in the MAS/MILS database as well as the lower dump of the Noonday where we saw good jarosite and the S. E. entrance of the War Eagle.

Museum also has linarite from the War Eagle.

Figure 1 reproduces the portion of the latest USGS topographic map showing the region we studying. The most recently used south access adit to the War Eagle is labeled "W. E. entrance."

History

The Balance, the first mine in what came to be known as the Resting Springs mining district, was located by the Brown brothers in the spring of 1875. The early history of the district up through the turn of the century is well summarized by Hensher and Vredenburg (1997). Another account of the history for roughly the same period with pictures is given at http://www.ttr.org/tt_tocs.html (McCulloch, 2004). From this table of contents page one needs to go to Tecopa Railroad/Revisiting the Tecopa Railroad/History. In a nutshell the Balance and other nearby mines including the Noonday were soon purchased by Jonas Osborne who formed the Los Angeles Mining Company in May of 1877 to develop and operate them. This company then also bought the Gunsight whose discovery site and subsequent developments are photographically documented at the above website at Tecopa Railroad/A look at the Gunsight Mine. Largely because of the remoteness of the location and difficulties in processing the ores, the Los Angeles Mining Company was never a financial success. Osborne sold his stock in early 1880. The company ceased operations in July of 1881 after drilling more than 1000 feet of adit to intersect the Gunsight vein at depth. Osborne then bought all the property back in 1883 with backing from a San Bernardino banker. He kept the mines and mill in operating condition waiting for the time when transportation or processing would be cheaper. At one point Osborne even built a large steam tractor and used it to haul a couple of loads of ore to distant railroad terminals, but this still did not prove profitable.

Things changed in 1906 when the Tonopah and Tidewater railroad was laid out to pass within a few miles of Resting Springs. In that same year Osborne and the heirs of the banker sold their Tecopa holding for \$350,000, apparently to the Tecopa Consolidated Mining Company or to investors that soon formed such a company under the laws of South Dakota. When the T. and T. was completed to Tecopa Station in February of 1907, Tecopa Consolidated already had 800 sacks of ore ready for shipment. The ore was transported the 10 miles or so from the mines to the station in horse-drawn wagons. By December 1907 Tecopa Consolidated reportedly had 100 men working and were shipping 100 tons of ore a day from the Noonday while they also had reserves in the Gunsight.

By July of 1908 Tecopa Consolidated had started work on a work on a railroad spur to the Gunsight and Noonday Mines. When the company was sold to Philadelphia investors in November of 1908 it reportedly had reserves with a net value of \$1,650,000 in sight. At some time before 1919 the company also built a 100 ton concentrating

mill at Tecopa. By the time Tecopa Consolidated ceased operation in 1928 it is estimated that they had produced about \$4,000,000 worth of ore.

The most recent history of the mines (Newman and Stewart, 1951) began after 1938 when they were purchased by Shoshone Mines Incorporated. They were then sold to the Finley Company and in June 1947 to Anaconda Copper Mining Company, which operated them as Shoshone Mines. Anaconda built a concentrating mill at Noonday City, and focused their operations in the Columbia no. 2 and War Eagle Mines. It is estimated that by the time they ceased ore production in 1957 that they had produced an additional \$4,000,000 worth of ore (Baltzer, 2004, cited below).

Geology

The lead/silver mines in the Tecopa Pass area generally occur as replacements and vein fillings in roughly north/south trending fissure veins in the Proterozoic age Noon-

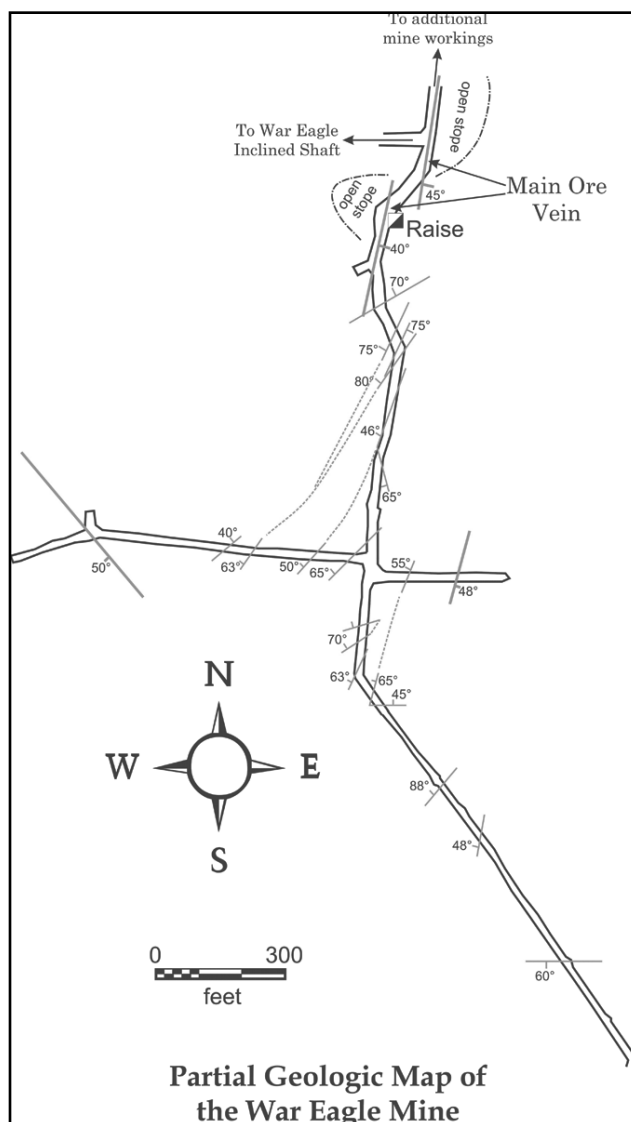


Figure 2. Map begins at southeast entrance of the mine, which is labeled W. E. entrance in Figure 1.

day Dolomite (Newman and Stewart, 1951). A geologic map of the larger Tecopa region and discussion of the rock units is provided by Mason (1948). Some additional discussion compiled by David Jessey and students, particularly S. Baltzer, as background for a Death Valley field trip can be found at <http://geology.csupomona.edu/docs/DVT2004.pdf>. This website includes a partial map of the 250 foot south entrance level of the War Eagle Mine, which is reproduced with permission as Figure 2. It appears that the primary ore in the region was for the most part argentiferous galena, which in many parts of the mines was largely oxidized to earthy anglesite and cerussite.

War Eagle Minerals

The later underground workings of the War Eagle which were accessed from the southeastern Anaconda entrance are extensive and we have a number of samples from them. We have not been able to locate any samples from the older workings. From the entrance, or 250 foot level (Newman and Stewart, 1951) we have some nice rosasite with calcite and also galena and bindheimite.

From the 350 foot level we have very nice aurichalcite in the altered dolomite. An example is shown in Figure 3. From cavities in gossan from this level we also have very nice fraipontite associated with aurichalcite, zincian malachite, and hemimorphite. To the best of our knowledge this is the second reported occurrence of fraipontite in California and ranks in quality with the best that has been found anywhere. Figure 4 is an SEM image of one of the fraipontite clusters. Several other minerals also were found in this vicinity and are listed in Table 1. Of particular interest is the indium hydroxide mineral dzhalindite which we recently found during an SEM study of material from



Figure 3. Blocky hemimorphite on aurichalcite blades.

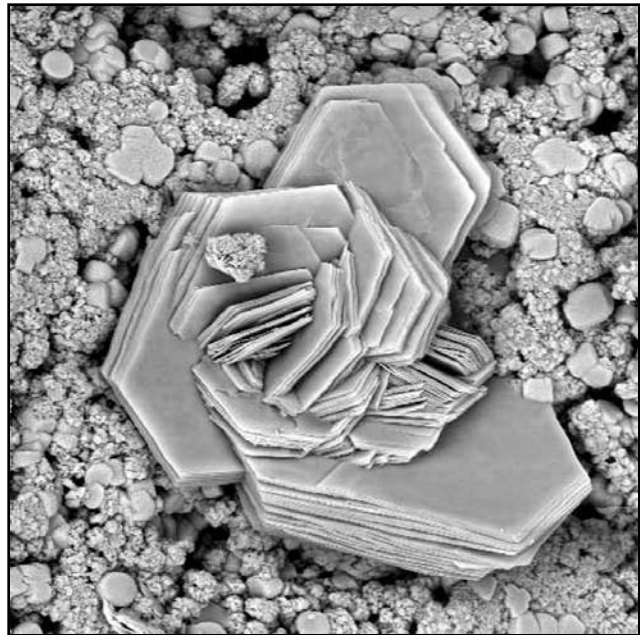


Figure 4. SEM image of fraipontite cluster. Field of view 70 micrometers.

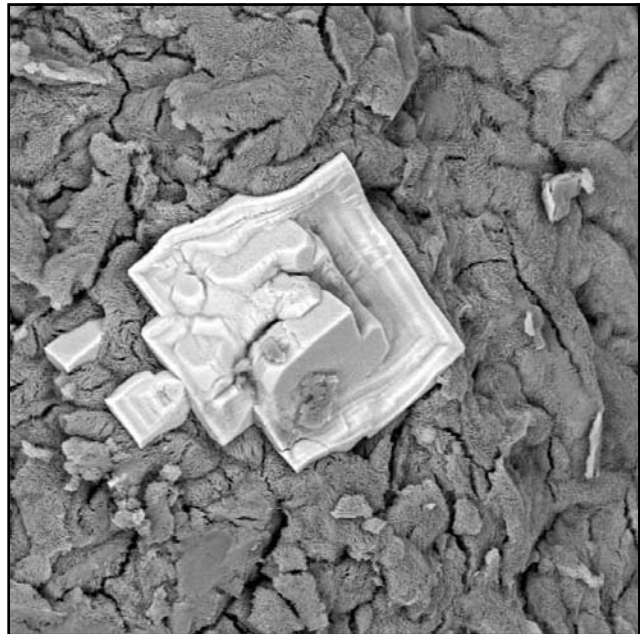


Figure 5. SEM image of dzhalindite on fraipontite. Field of view 70 micrometers.

this level. This appears to be the second reported United States occurrence of this mineral. Figure 5 shows an SEM image of the dzhalindite.

Some nice brochantite associated with linarite and aurichalcite came from the 500 foot level. Also a little bit of plattnerite on white calcite occurred there.

From the 600 foot level, in addition to more aurichalcite, are several sulfates including serpierite, schulenberg-

Table 1. Minerals of the War Eagle Mine

250 foot level	350 foot level	500 foot level	600 foot level
Bindheimite	Aurichalcite	Aurichalcite	Aurichalcite
Calcite	Calcite	Brochantite	Gypsum
Galena	Cerussite	Linarite	Serpierite
Hemimorphite	Dzhalindite	Plattnerite	Schulenbergite
Rosasite	Fraipontite		unknown Cu/Zn/S
	Hemimorphite		Zincian malachite
	Hydrozincite		
	Mimetite		
	Smithsonite		
	Zincian malachite		

ite, and unidentified Cu/Zn sulfate needles, all associated with gypsum

Stan Bogosian tells me that he found nice aurichalcite with cerussite twins on the upper War Eagle dumps as recently as the Spring of 2002.

More complete descriptions of the individual minerals I have seen from the War Eagle follow.

Aurichalcite. Sharp, clear, well terminated crystals to about 3 mm in sprays, which can coat surfaces, forming nice cabinet specimens as well as micros. Commonly associated minerals are calcite and hemimorphite. Other associates include hydrozincite, fraipontite, smithsonite, cerussite, brochantite, mimetite, and dzhalindite.

Bindheimite. Typical yellow earthy or powdery material.

Brochantite. Sharp green crystals to about 2 mm which can form nice cabinet specimens as well as micros.

Calcite. Small clear crystals, sometimes enclosing rosasite on 250 foot level, and white blades to about one cm on the 350 foot level.

Cerussite. White flat lying plates to several mm on green botryoidal fraipontite.

Dzhalindite. Tiny square plates associated with tiny complex mimetites and conforming to the surfaces of green botryoidal fraipontite. First report for California and second for U. S.

Galena. Polycrystalline masses in dolomite.

Gypsum. Small flat-lying crystals associated with other sulfates on the 600 foot level.

Fraipontite. In cavities in the gossan, fraipontite forms white balls to about 0.2 mm and small clusters of individual crystals. On the dolomite it sometimes forms pale green botryoidal coatings somewhat resembling malachite or chrysocolla. Second California occurrence. Good crystals for species.

Hemimorphite. Frequently in typical striated blades to a few mm lying on surfaces or intergrown with

aurichalcite. Also sometimes as sharp, clear, unstriated, equant crystals, which could easily be mistaken, for example, for barite.

Hydrozincite. Tiny white crystals associated with and sometimes growing on aurichalcite. It can be easily recognized by its fluorescence.

Linarite. Tiny crystals associated with brochantite on the 500 foot level. Nice crystals from unknown level in Caltech and Los Angeles Museum of Natural History collections.

Mimetite. Tiny but well formed and sometimes complex crystals, recognized as pale yellow regions associated with cerussite.

Plattnerite. Black needles on white calcite.

Rosasite. Deep green balls associated with and sometimes imbedded in clear calcite on 250 foot level.

Schulenbergite. Blue hexagonal appearing platy to blocky crystals associated with gypsum, serpierite, and unidentified Cu/Zn sulfate needles on 600 foot level. Identified by EDX composition and appearance. First California and second U. S. occurrence.

Serpierite. Sharp, clean, deep blue crystals associated with gypsum, schulenbergite, and unidentified Cu/Zn sulfate needles on 600 foot level. Identified by EDX composition, crystal shape, and appearance. Very nice crystals for the species. Second California occurrence.

Smithsonite. Occurs as clear complex crystals associated with aurichalcite and as druzey coatings on the 350 foot level.

Unidentified Cu/Zn sulfate. Occurs as long thin needles of constant cross section either singly or in clusters; parts or cleaves easily along needle axis. Needle shape is indistinct possibly due to twinning.

Zincian malachite. Occurs as complex needles to 4 mm associated with fraipontite in the gossan on the 350 foot level and associated with aurichalcite on the 600 foot level. Although not recognized as a species, zincian malachite has been previously reported.

Noonday Mine Minerals

Garth Bricker and I spent a few hours at the Noonday in early summer of 2000 and after picking up some nice jarosite on the lower dump we followed a series of shallow surface workings that had accessed the top portions of the vein along the hill south and up from the entrance. About half way up the series we spotted a couple of blue/green areas along the walls where the vein had been removed. These contained micros of blue and green minerals, mostly in gypsum, and we took a number of samples home for further study. One of the green minerals proved

to be the rare paratacamite. On a trip in 2004 in the same general area, Joe Marty found plattnerite.

Bob Reynolds has also found hydrozincite veins with hemimorphite in rocks on the dump. In an old ore pile along the road he found galena with cavities containing anglesite, caledonite, malachite, and cerussite.

More detailed descriptions of the Noonday Mine minerals I have seen follow.

Anglesite. Small clear crystals in cavities in galena from the ore pile.

Bindheimite. Typical yellow powder in cavities in galena of the ore pile and in altered dolomite of surface workings

Caledonite. Small but sharp blue green crystals in cavities in galena from the ore pile.

Cerussite. Druzy yellowish coatings in galena, frequently associated with caledonite.

Galena. Small chunks of weathered porous crystal aggregates with small crystal-lined cavities in the ore pile.

Gypsum. Crystals to several mm associated with other mineralization in the surface workings.

Hemimorphite. Small clear striated crystals associated with hydrozincite from the dump and gypsum and other minerals in the surface workings.

Hydrozincite. As about 3 mm veins in altered dolomite from the dump and as small white balls on gypsum in the surface workings.

Jarosite. Attractive specimens of sparkly reddish brown crystals coating surfaces of altered dolomite on dump.

Linarite. Tiny individual blue crystals on gypsum from surface workings.

Malachite. Tiny sprays of crystals in cavities in galena from the ore pile.

Paratacamite. Equant deep green crystals to about 0.2 mm on gypsum, and associated with linarite, hemimorphite, and an unidentified Cu/Zn sulfate similar to the one found at the War Eagle Mine. Identified from EDX composition and appearance. First reported occurrence in California.

Plattnerite. Tetragonal black needles to about 0.1

mm on Pb bearing secondary dolomite and associated with other Pb minerals altered to black Pb oxide.

Unidentified Cu/Zn sulfate. Similar to material describe under War Eagle Mine.

Concluding thoughts

I think it is important to emphasize that as long as they remain open these mines continue to be a treasure trove of interesting minerals waiting to be discovered and studied. Even though we report three firsts and two seconds for California as well as a couple of very-good-for-species, we have examined a relatively small collection of samples from these mines. It is very likely that if we obtain access to more samples we will have to extensively modify the tables and mineral lists above. Nonetheless it seems worthwhile to document what we know now. I will be interested in hearing from other people with samples from the area and will try to keep the combined information up to date.

Disclaimer. This report is intended only to provide historical and scientific information. It is not to be construed as granting permission to enter or study these mines, many of which are private property.

Acknowledgements. First of all I want to thank Garth Bricker whose cheerful and enthusiastic companionship helped make this work a pleasure. I want to thank Bob Reynolds who first suggested we look at the mineralogy of these mines and who provided samples from his collection. I greatly appreciate the help of Dick Thomssen and Joe Marty who also selected and sent me interesting samples to study. Joe provided all the serpierite, schulenbergite bearing material from the 600 foot level. I want to thank David Jessey for providing information on the recent history of the War Eagle and for allowing me to use his mine map. I also appreciate information provided by Stan Bogosian, Carl Moran, and John Samuals.

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Table 2. Minerals of the Noonday Mine

Ore Pile	Dump	Surface workings
Anglesite	Hemimorphite	Bindheimite
Bindheimite	Hydrozincite	Gypsum
Caledonite	Jarosite	Hemimorphite
Cerussite		Hydrozincite
Galena		Linarite
Malachite		Paratacamite
		Plattnerite
		Unknown Cu/Zn sulfate

Recent rare mineral finds in southern California and Nevada desert mines

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During the last few years a number of rare mineral finds have been made at Southern California and Nevada desert mines. Each undoubtedly deserves a detailed write-up. Such a write-up is provided for the War Eagle and Noonday Mines in the volume. For the other mines, it seems worthwhile to at least mention the occurrences.

California Mines

Aga Mine, Baker, San Bernardino County (Plate 3)

In January of 2004 the rare Cu/Pb tellurate parakhinite was discovered associated with anglesite, pyromorphite, and gold at this mine. Subsequently, besides vanadinite, mottramite, and cerussite, the additional tellurium minerals plumbotellurite, fairbankite, khinite, burckhardtite, and moctezumite have been found, although the later two can only be recognized in the SEM.

Bagdad-Chase Mine, Ludlow, San Bernardino County (Plate 3)

In January of 2003 exceptionally fine crystals of the Bi/Pb oxychloride perite were found associated with colorless mimetite and wulfenite at this mine. Other minerals occurring here include duftite, hedyphane, malachite, goethite, hematite, and cerussite.

Nevada Mines

Boss Mine, Goodsprings (Yellow Pine) District, Clark County (Plate 4)

Nissonite from the Boss Mine is listed in "Minerals of Nevada", (Castor and Ferdock, 2004). In February of 2004 two more good quality samples of this Mg/Cu phosphate were found on the 200-foot level dump of the mine. This brings to four the total number of pieces of nissonite that have been found there during the last 10 years. This latest nissonite is on gossan and is associated with dendritic malachite pseudomorphs, probably after cuprite.

Quo Vadis Mine, Alunite District, Clark County (Plate 4)

Abundant mimetite, willemite, and fornacite were noticed at the Quo Vadis Mine in November of 2003. In February of 2004 very nice murdochite crystals associated with mimetite and fornacite were found. Also found were

a couple of light yellowish green sprays of the Pb silicate creaseyite. Later, conichalcite was also found.

Winter Prospect, El Dorado District, Clark County (Plate 4)

This location is listed as being nine miles northwest of Nelson in "Minerals of Nevada," and several minerals are listed as being found there including the rare chromates hemihedrite and iranite. Even though this area is small and difficult to access, during February 2004 additional samples of hemihedrite and iranite along with mimetite, willemite, and wulfenite were obtained.

Acknowledgements

These finds were a joint result of the combined efforts of Tish Hunter, Walter Margerum, Dick Thomsson, Joe Marty, Jim Soboleski and myself. The fact that I have written this listing should not imply that my role was greater than any of the others.

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Rich Hill, Arizona: a modern gold rush to a historic gold district

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Rich Hill, also known as Weaver District No. 2, is among the most productive placer gold localities in Arizona. Located near Congress, Arizona, this district hosted major placer rushes in the 1860s and 1930s, followed by an electronic metal-detecting rush that started in the 1980s and continues to this day. Thousands of ounces of gold have been produced by these modern amateur and professional metal detectorists, many of whom see more gold in an

afternoon than Nevada mine workers will ever see outside of the mill.

Inspired northeastward by Spanish legends, a party of ten men left Yuma, Arizona on April 1, 1863, including Pauline Weaver, Henry Wickenburg, and Abraham Peeples. Wickenburg left the group near the Hassayampa River and discovered the Vulture Deposit. The rest of the group arrived at the base of Rich Hill in late May.

While drying antelope meat on the first day, a few of the men prospected a nearby creek bed and immediately found gold. In a couple of hours they picked up over 90 ounces of gold. The next day, four members of the party went searching for their horses, and returned with news that a nearby hilltop was literally graveled with nuggets. The next morning the party went to the top of the "Rich Hill" and found chunks of native gold as big as potatoes littering the ground of a gently sloping basin, hence the depression's nickname "Potato Patch." During the height of the following rush, Weaver was bringing in twenty-five pounds of gold each week, and placer miners averaged sixty-five dollars each day. Over 25,000 ounces of gold were found around Rich Hill in the first five years.

After several years the easy placer gold was mined out. The area started to attract men like Charles Stanton who were

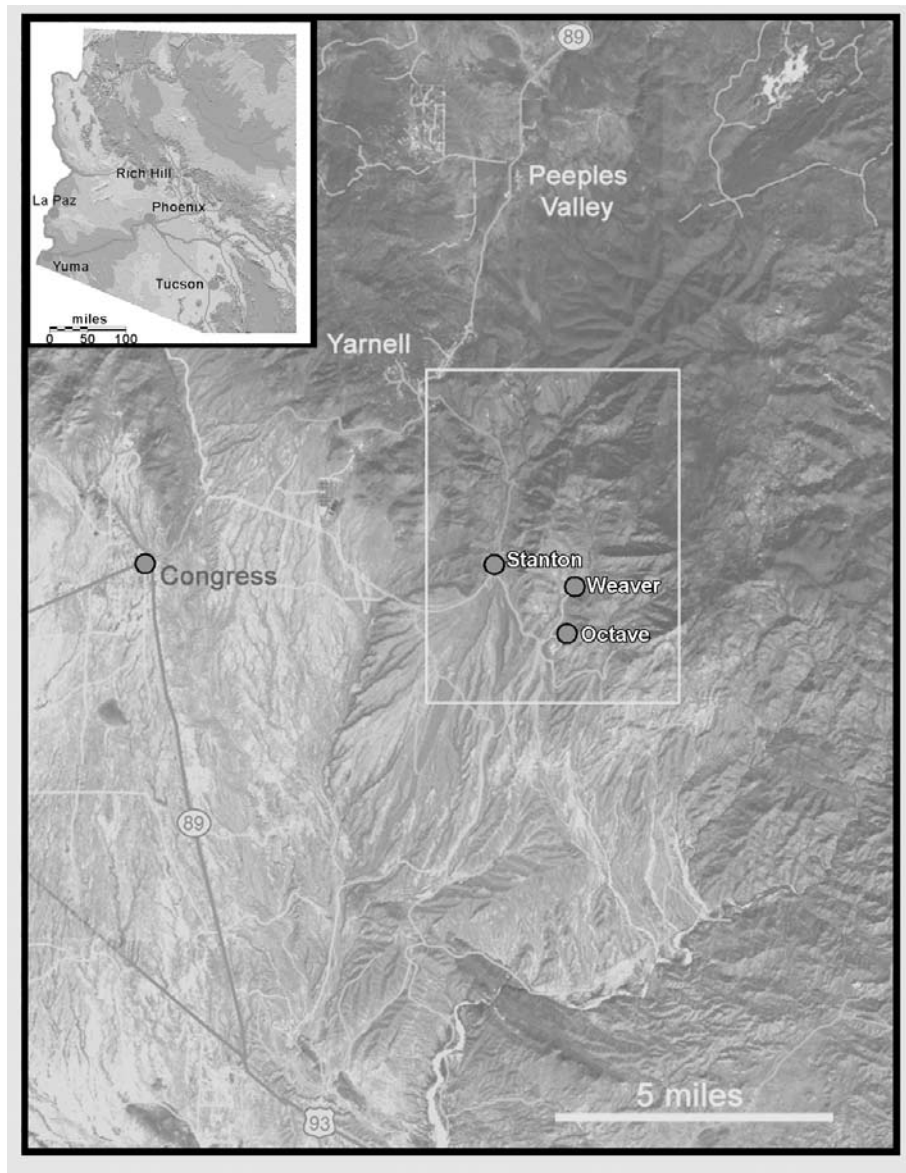


Figure 1. Index map of Arizona, showing the location of Rich Hill, and a detailed satellite image of the greater Rich Hill District. Note the visible mine tailings (white) below Octave, and the large alluvial fan (reddish) below Stanton. The white box is the approximate outline of the Rich Hill Mining District.

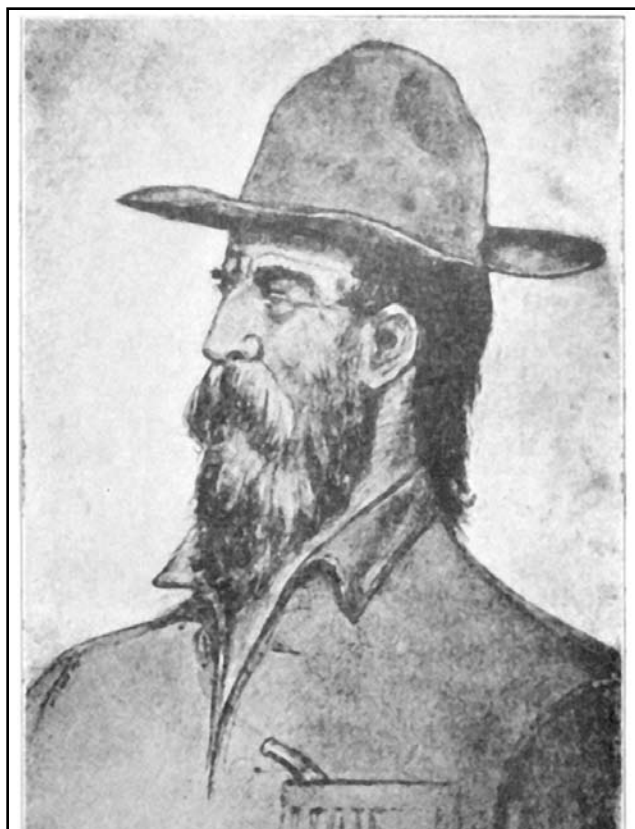


Figure 2. The only known image of Pauline Weaver. Weaver was an explorer, rancher, trapper, prospector, and entrepreneur, and was involved in the discovery of two of Arizona's richest gold strikes, including Rich Hill. *Courtesy of Sharlot Hall Museum.*

more interested in stealing gold than mining it. In March 1875 a post office was established at Antelope Station and Charles Stanton was appointed postmaster. His first act was to rename the town "Stanton." Stanton was later elected deputy and justice of the peace, though behind the scenes he was the mastermind of the Vega gang. There were several murders and Stanton, acting as justice of the peace, named himself as sole beneficiary. Charles Stanton was gunned down by unknown attackers.

Placer gold production was at least 50,000 ounces by 1883. By 1899 only twenty men were working the placer fields fulltime, each producing about 100 ounces of gold

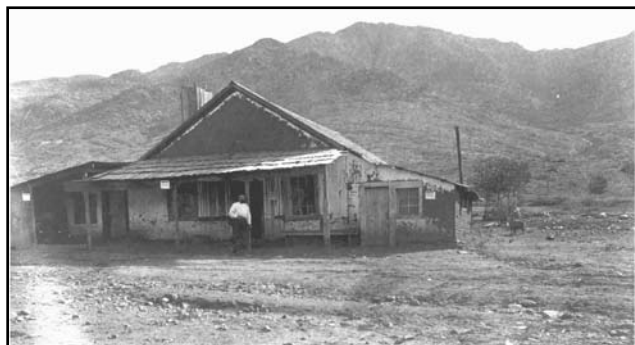


Figure 3. Charles P. Stanton in front of "his" store. *Courtesy of Sharlot Hall Museum.*



Figure 4. Certificate of stock in the Mountainside Gold Company. *Courtesy of Fred Holabird Americana, <http://www.holabird.org>*

per month. Despite the decline, the Octave Mine manager noted that after a good rain most of the shift workers would skip work to hunt for nuggets. By 1907, only 400 ounces of placer gold were produced. Placer mining remained in a slump until the Great Depression, which spurred a short revival of placer gold mining at Rich Hill.

In 1975, the Rhenium Corporation floated a scheme to reprocess the Octave mine tailings, claiming a grade of 1 opt palladium, ½ opt platinum, and 1 opt rhenium. The unsuspecting Reverend Jack Oliphant, the executive director of the Ranch Challenge Hallelujah People, purchased \$100,000 of this stock. In the winter of 1976 Reverend Oliphant and about fifty of his followers, known as the "Hallelujah Boys," took up residence in some of the abandoned buildings at Octave, believing their stock in the defunct Rhenium Corporation gave them ownership of the mine. This didn't sit well with Carl Carlson, another man who claimed ownership of the mine, and his trio of armed guards who lived directly across the road from

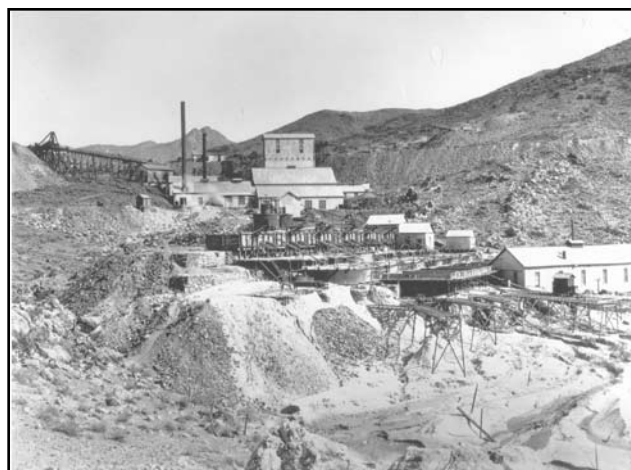


Figure 5. The Octave Mine in the late 1890's. In the upper left corner is the #2 shaft and headframe. The mill, to the center-right, was connected to the shaft by an elevated wooden tramway. *Courtesy of Sharlot Hall Museum.*

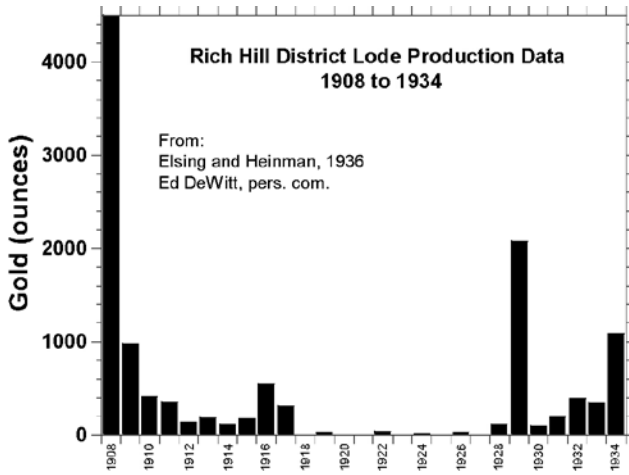


Figure 6. Lode gold production from the Rich Hill area, 1908 to 1934. Over 100,000 ounces of gold has been produced historically from the hard-rock mines of the district.

the Hallelujah Boys camp. Tensions quickly began to run high between the two heavily armed camps. On March 20, 1978, Reverend Oliphant lost most of his right arm when he pulled a 16-gauge shotgun barrel first from his car to confront Carlson's guards. This feud wasn't the only incident at Rich Hill, and when gold hit \$800 an ounce, things got so crazy that the police and propane refueling trucks refused to come out to Octave.

During the late 1970s, members of the Lost Dutchman's Mining Association (LDMA) began to routinely visit the area and pan for gold along Antelope Creek. They also would camp among the historical ruins of the town of Stanton. The members of the LDMA were not looking to get rich and considered themselves recreational prospectors. They were drawn to Stanton as much for the beauty and solitude of the area as for the rich gold deposits. The group purchased the town and mineral rights to some of the surrounding areas in 1978. Seventy R.V. hook ups and dry camping for 125 people were constructed, and the original buildings were restored. Without the LDMA's efforts to preserve this historic town from vandalism, it is likely that nothing would remain today. Probably the most



Figure 7. The old church at Octave, which was temporarily occupied in the 1970's by the "Hallelujah Boys."



Figure 8. The original Butterfield Stage Stop, where Charles Stanton was gunned down, now serves as the Lost Dutchman's Mining Association main office in Stanton, AZ.

famous recent find is the two-pound "Tongue Nugget." With thousands of metal detector and drywasher hobbyists annually producing many hundreds of ounces of gold in the Rich Hill area, this revitalized district is a dramatic example of a modern gold rush.



Figure 9. Fifteen gold nuggets totaling over 1-½ ounces, found with metal detectors in the Devil's Nest area at Rich Hill. From left to right: an "L" shaped nugget of ½ ounce, 10 smaller nuggets totaling a little over ½ ounce, and 4 nuggets totaling a little over ½ ounce with the largest weighing 0.3 ounces. *Courtesy Arizona Outback, <http://www.arizonaoutback.com>*



Figure 10. A 4-½ ounce nugget found at Rich Hill at a depth of 1-½ feet with a Minelab SD 2100 metal detector. *Courtesy Arizona Outback, <http://www.arizonaoutback.com>*

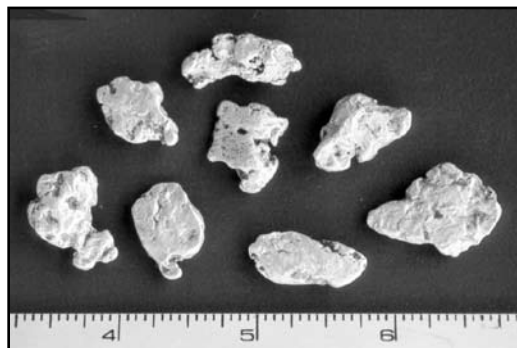


Figure 11. Eight large nuggets between ¼ and ½ ounce found in the Rich Hill area, including (from top, clockwise) Weaver Creek, Johnson Mine area, two from Potato Patch, three from Devils Nest, and the center one from south of the Octave Mine. *Courtesy Arizona Outback, <http://www.arizonaoutback.com>*

The 100% true story of Hubert Tecumseh Miller (except for the made-up bits)

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To study history you either go to some books and other documents or you go talk to the people that lived it. The sad truth is that you miss some of these people. One person I have discovered in my history searches that I wish I could have met is Hubert Tecumseh Miller.

Miller was born in St. Joseph, Missouri on December 4, 1858. His father served under General William Tecumseh Sherman in the Civil War. After Missouri, the family moved west in a Conestoga wagon. Miller remembered his father telling him of the move, "When I was five months old he put me in an ox cart and we headed west." They first settled in Yuma, Arizona.

As a young man Miller became a prospector. He spent the next seventy years looking for gold. In 1880-82 he worked at Calico. The places that Miller claimed to have explored stretched from Central America to Alaska. About his mining success he was quoted as saying, "Although I have found some rich pockets I never made a fortune. I was never smart enough for that." He worked mines until 1953 when he was temporarily blinded by dynamite dust.

He married in 1882, his wife dying 11 years later in Alaska giving birth to their fifth child. Miller outlived all of his children. In 1941, he left Alaska and moved back to our desert area, still looking for a gold strike. At one time or another he claimed Lone Pine, Bishop, Palmdale, and Lancaster as home. Once he quit prospecting and worked as a dealer in Reno, Nevada.

On Sunday December 5, 1958 his friends, Mr. and Mrs. Eisenhower (the paper did not give their first names and they seemed to be no relation to President Eisenhower) threw him a 100th birthday party. Mrs. Eisenhower first met Miller in Daggett when she contacted him while working for the Emergency Welfare Relief of Barstow. The party was held at Will's Café that was located out of town on the old road to Needles and Las Vegas, Highway 91. Mayor George Oakes started the celebration by reading a birthday greeting from President Eisenhower. The next speaker was Leonard Nunally, a representative from the National Distillery Company of Beverly Hills, who presented Miller with a bottle of Old Crow whiskey, a fitting gift because when Miller was asked about his secret to long life, he said, "I have been trying to find that out myself. I guess have drunk just the right amount of whiskey to preserve me." There were no other gifts at the

party. The forty guests were instead asked to contribute to a money tree. After the fried chicken dinner and the required singing of Happy Birthday, a birthday cake was presented which had one big candle.

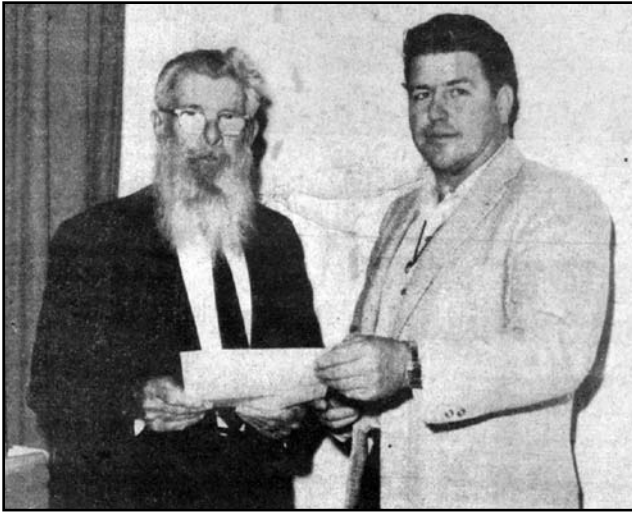
Miller's celebration did not end at the party. On December 30 Art Linkletter invited him to his television show. After they talked Linkletter presented Miller with a gift. He had a number of showgirls escort Miller on an overnight trip to Las Vegas. "I loved every minute of it." Miller was quoted as saying about the trip. Miller must have been a good guest because Linkletter invited him back again January 19, 1960.

Also in 1960 Miller made it into the record books. He signed on as worker for the 1960 census. At 101 years old he was the oldest census taker for that census and may have been the oldest in history. The Desert Dispatch ran a picture of Miller, in his best suit looking like the typical grizzled prospector with a beard down to his chest, getting his instructions from R.J. Steck the Director of the Barstow Census. The picture was picked up by the news service UPI and was run by several papers nationwide. His work on the census also got him a mention in the Ripley's Believe it or Not comic strip.

After his work on the census I had a hard time finding



Miller on the way to the Art Linkletter show in 1960.



Miller receiving instruction from his census supervisor, R.J. Streck. Photo taken by Bob Striegel of the *Desert Dispatch* went out over the wire and was reprinted nationwide. Also basis of Ripley's Believe it or Not comic strip.

money and had to find lodging at a different home, this time in Victorville. He lived there a few months and was planning to work the 1970 census if "he felt spry enough."

Miller lived in the home for only a few months. He died May 5, 1970. According to reports he was still full of life up until he passed in his sleep. He was cremated and interred at Victor Valley Memorial Park in Victorville.

I am still looking for facts and stories about Hubert Miller. If anyone has information about Miller please contact me at the Mojave River Valley Museum at (760) 256-5452 or e-mail me at barstow@verizon.net.

any more information on Miller so I checked with all the local cemeteries to see if I could find the date of his death with no luck. So I went looking through the newspaper files to find his obituary thinking "He turned 100 in 1958— how much longer could he have been around?" I went through the papers in order from 1960 on. A tedious task but I was determined. In the January 5, 1963 edition, I found, not his obituary, but his wedding announcement. The 104-year-old Miller married 58-year-old Edna M. Mills from Victorville. They were married by Justice of the Peace Myron E. Leavitt. Leavitt commented about the groom "(Miller) had no trouble repeating the vows, he was hale and hearty." The newlyweds went on a honeymoon to Las Vegas but it was cut short because Miller had to get back to work. I don't know what he was doing at the time and I have yet to find out what happened to Edna Miller.

The wedding announcement gave me a few clues about his obituary. I had mistakenly thought he died in the early 60s when in reality I was looking in the wrong decade!

December of 1969, shortly after his 111th birthday and after losing his sight again, Miller found himself in another adventure. He was living at an old folks home in Pomona at the time and he thought the people that worked at the home were stealing his money, so he escaped the home and hopped a bus back to Barstow. He got a room in the El Rancho Hotel and, as he thought, he settled down to die. Somewhere along the way I think he ran out of



Miller front and center and the Charlie Anthony family around 1964. Miller was 106 at the time but lied about his age and claimed to be 120.

Age constraints of the Copper Canyon Formation, Death Valley National Park, California

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Extremely well preserved ichnofossils including tracks and trackways of mammals and birds occur abundantly throughout the fluviolacustrine deposits of the Copper Canyon Unit. The Copper Canyon Unit was deposited in an ancient lake that attracted an abundant and diverse fauna to its muddy shores, leaving their tracks as evidence of their activities. To date, thirty-six ichnospecies of cat, camel, horse, mastodon, and bird tracks have been identified from the fluviolacustrine sediments (Nyborg, 1998; Nyborg and Santucci, 2000).

Two conflicting dates were previously reported for the Copper Canyon Unit (Scrivner, 1986; Holm et al., 1994). New age constraints confirm that the Copper Canyon Unit was deposited approximately between 6 to 3 Ma. More importantly, new age data place further time constraints on the vertebrate tracks (Figure 1).

The Copper Canyon Unit consists of carbonates, evaporates, shales, claystones, siltstones, sandstones, conglomerates, and basalt flows exposed within Copper and Coffin Canyons, Black Mountains, Death Valley National Park (Figure 1). The sequence includes over 3000 meters of basin sediments deposited in a tectonic setting involving large magnitude extension, normal faulting, basin formation, deposition, and subsequent uplift (Drewes, 1963; Otton, 1977; Holm, 1992; Holm et al., 1994; Wright et al., 1999; Miller and Prave, 2002) (Figure 1). Since the initiation of extensional faulting, which began about 14Ma, low angle normal faults, called detachments, have uplifted the Black Mountains and formed associated basins (Wright et al., 1999). Within these basins a succession of middle Miocene through Pliocene fluvial, lacustrine, and alluvial sediments and volcanic flows that define the Furnace Creek Basin and the northern portion of Death Valley Basin accumulated (Wright et al., 1991, 1999). Four deposits, the Artist Drive (14-6 Ma), Furnace Creek (6-5 Ma), and Funeral formations (5-3 Ma), and the Copper Canyon (6-3Ma) Unit, form the Cenozoic basin sediment deposits associated with the uplifting of the Black Mountains and formation of the Furnace Creek and Death Valley basins (McAllister, 1970; Fleck, 1970; Cemen and Wright, 1988; Wright et al., 1991; Wright et al., 1999; Miller and Prave, 2002).

Approximately seventy percent of the Copper Canyon Unit consists of fanglomerates that underlie and interfinger with fluviolacustrine deposits (Drewes, 1963). The fanglomerates represent alluvium deposits that accumulated before and during the fluviolacustrine sequence.

The fluviolacustrine deposits consist of lower, middle and upper sub-units (Figure 1). The lower sub-unit deposits are dominated by claystones, siltstones and debris flows reflecting an initial unit of fluviolacustrine deposits. Up section within the lower middle sub-unit, the claystones are replaced by the evaporite gypsum, which reflects hypersaline standing water conditions and evaporation. Further up section within the middle sub-unit the gypsum layers become rare and lacustrine shoreline facies are prominent, preserving lingoid ripples, raindrops, mud-cracks, and mammal and bird tracks in abundance. At the upper sub-unit limestone beds are prominent. Within these limestone beds ostracodes and gastropods are common and shoreline features are absent. The transition from middle to upper sub-units probably reflects a transition from shoreline to freshwater conditions. At the top of the upper sub-unit the Copper Canyon Unit is eroded and unconformably overlain by younger conglomerates of the Funeral Formation (Drewes, 1963).

The Copper Canyon Unit is contained and well exposed within a five square mile rectangular fault bounded basin (Figure 1). Structurally the Copper Canyon Unit has been synclinally folded and tilted to the southeast (Drewes, 1963). There are quite a few small northwest-trending normal faults within the lower section, but displacement is minimal.

The Copper Canyon Unit is sandwiched between the Badwater Turtleback to the north and the Copper Canyon Turtleback to the south (Figure 1). Turtlebacks represent low angle thrust faults that occurred during the extension and subsequent uplift of the Black Mountains (Curry, 1938, 1954; Holm et al., 1994; Miller and Prave, 2002).

On the east, rocks of the Copper Canyon Unit are unconformably in fault contact with conglomerates of the Funeral Formation (Drewes, 1963) (Figure 1). On the south, rocks of the Copper Canyon Unit are in fault contact with Precambrian metasedimentary rocks of the

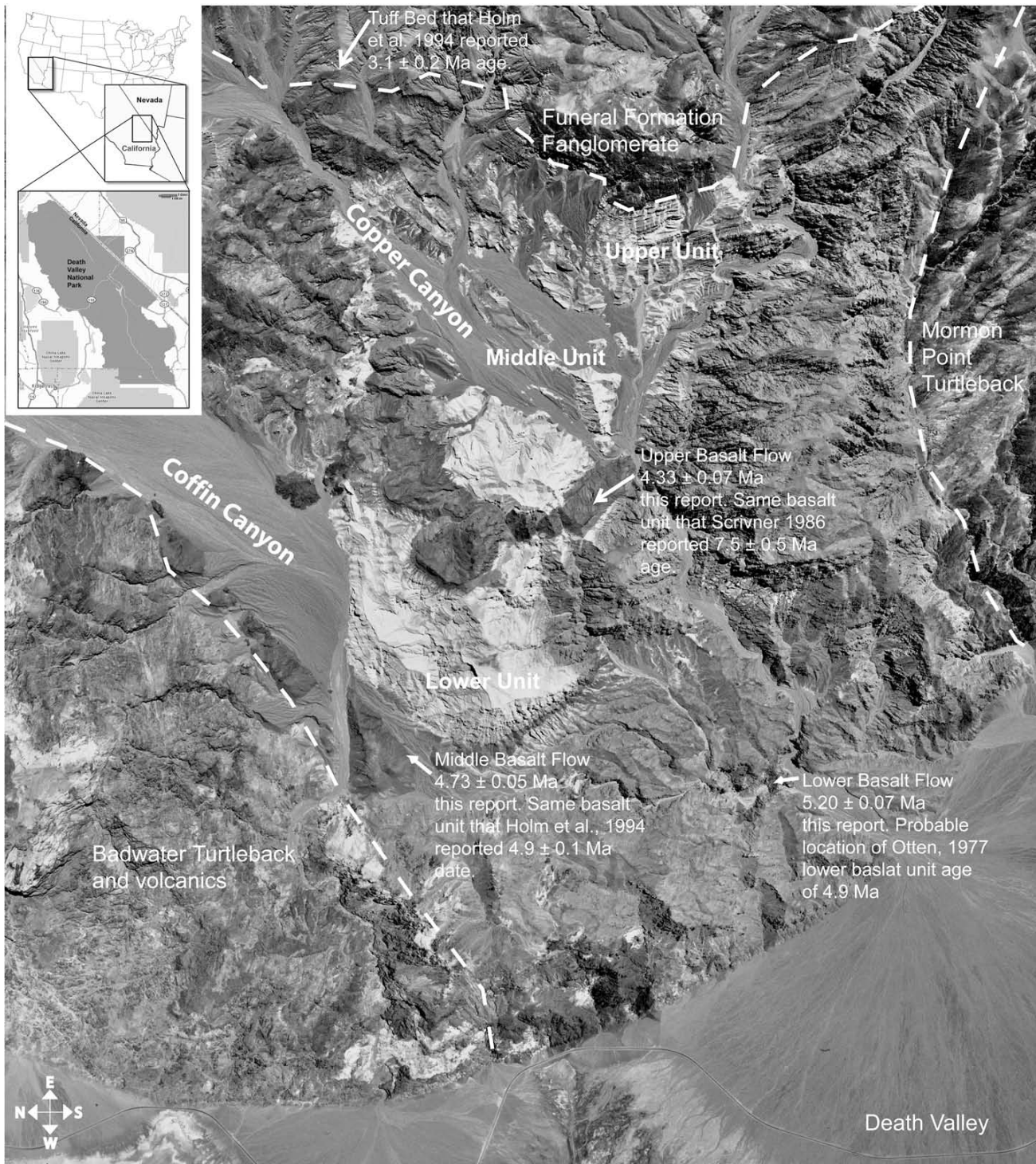


Figure 1. Aerial photograph of Copper and Coffin Canyons with age determinations reported herein. Aerial photo from USGS. The fluviolacustrine deposits have been divided into lower, middle, and upper units.

Copper Canyon turtleback (Drewes, 1963) (Figure 1). On the north, rocks of the Copper Canyon Unit are in fault contact with and partially overlie the Badwater Turtleback (Drewes, 1963) (Figure 1). In addition, the Copper Canyon Unit unconformably overlies volcanic units (Drewes, 1964; Holm et al., 1994).

Age Constraints

The Copper Canyon Unit was first assigned a middle Pliocene age based upon horse track morphology (Curry, 1941). The middle Pliocene age determination was probably based on knowledge of Hemphillian equid skeletal hoof structures at the time Curry published his abstract.

The first radiometric age obtained for the Copper Canyon Unit was a K-Ar whole rock age of 4.9 Ma from a basalt flow "low in the formation," reported by Otten (1977) as a personal communication from Hildreth in 1976. The exact location of the basalt flow, reported by Otten (1977), is unknown but fits into the dates reported by Holm et al. (1994) and the dates reported herein.

Scrivner (1986) reported two radiometric dates from the Copper Canyon Unit: a 7.5 ± 0.5 Ma from a basalt flow in the lower lacustrine deposits; and a 9.4 ± 0.7 Ma from zircons derived from a vitric tuff within the upper lacustrine deposits (Figure 1). The Copper Canyon Unit was deposited within a basin and subsequently uplifted and folded into a SE-plunging syncline. There are a few, small normal faults; however, the deposits would be considered within the boundaries of the Law of Superposition. Scrivner's (1986) ages, without evidence of an overthrust or inversion for the Copper Canyon Unit deposits, must be questioned because the upper fluviolacustrine 9.4 ± 0.7 Ma tuff bed age should be younger than the lower fluviolacustrine 7.5 ± 0.5 Ma basalt age (Figure 1).

Holm et al. (1994) reported a 7.5 ± 0.1 Ma age from a biotite-rich tuff bed just below the unconformity at the base of the Copper Canyon Unit. A similar felsic tuff within the same unit as the biotite-rich tuff bed, about 3 kilometers north, gave a laser-fusion age of 6.1 ± 0.1 Ma (Holm et al., 1994). Although an unconformity separates the underlying volcanics from the Copper Canyon Unit, Holm's et al. (1994) ages do establish a lower age to the deposition of the Copper Canyon Unit. Holm et al. (1994) also reported an $\text{Ar}^{40}/\text{Ar}^{39}$ age date of 4.9 ± 0.1 Ma from the basalt flow just below the lower unit of the fluviolacustrine deposits of the Copper Canyon Unit (Figure 1). In addition Holm et al. (1994) reported a $\text{Ar}^{40}/\text{Ar}^{39}$ age date of 3.1 ± 0.2 Ma from the unconformably overlying Funeral Formation conglomerates (Figure 1).

To confirm Holm's et al. (1994) age dates or that of Scrivner's (1986) and to better constrain the fluviolacustrine deposits of the Copper Canyon Unit, three $\text{Ar}^{40}/\text{Ar}^{39}$ radiometric age determinations were obtained from three volcanic rock flows (Figure 1). Total fusion weighted plateau ages of 5.20 ± 0.07 Ma from a basalt flow low in the Copper Canyon Unit deposits; 4.73 ± 0.05 Ma from the basalt flow just below the lower unit of the fluviolacustrine deposits, slightly younger than the 4.9 ± 0.1 Ma age obtained for the same basalt flow by Holm et al. (1994); and a 4.33 ± 0.07 Ma age from the large basalt flow within the middle unit of the fluviolacustrine deposits were obtained (Figure 1).

The three new age dates confirm Holm's et al. (1994) age dates for the deposition of the Copper Canyon Unit occurring between 6-3 Ma. Scrivner's (1986) age dates are quite different from Holm's et al. (1994) and the new age dates reported herein; therefore Scrivner's (1986) age dates are most likely not valid. Additional age determinations from tuff beds within the upper unit would further age-constrain the Copper Canyon Unit deposits.

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Landslide damage within Big Santa Anita Canyon, Los Angeles County, California

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Introduction

Big Santa Anita Canyon is located north of the city of Arcadia in Los Angeles County, California. The canyon lies within the San Gabriel Mountains and is one of many V-shaped canyons cutting the mountain front. Because the general topography is steep and narrow the canyon is prone to rapid water run off, slope wash and landslides during periods of heavy rainfall. The rainfall event of the past six months (2004-2005) has significantly impacted the canyon and local residents. This paper discusses factors contributing to the performance of the canyon during storm events, human impacts and future mitigation. This is a firsthand account by the author who currently resides in the canyon.

Climate

Big Santa Anita Canyon has a semi-arid to sub humid climate. Typically, spring and summer is dry and warm. There is often early morning fog and commonly the cloud layer can be found below the elevation of the canyon. The winters tend to be mild with the occasional storms. Average annual precipitation is about 26 inches per year with the highest rainfall typically occurring between the months of January through March. The highest rainfall in a 24 hour period was recorded at Hoegees camp in January of 1943 when 26.12 inches fell. Snowfall is highly unusual in the canyon but there are rare occasions when it does take place. During the winter of 1939 and 1949 the canyon experienced snowfall. This past storm season (November 21st, 2004) Sturtevant camp received a light dusting of snow that was gone by the next day.

Geology

The bedrock in the canyon consists of both pre-Tertiary plutonic and metamorphic rocks. Tertiary sedimentary rocks lie in fault contact with the older rocks at the south end of the canyon in the City of Arcadia's Wilderness Park site. The plutonic rocks are the Wilson Diorite (so named by Miller in 1934-CDMG SR105). This rock is a quartz diorite that grades into a granodiorite. The metamorphic rocks are typically gneissic. They are usually hornblende or biotite-hornblende gneiss. Most of the gneiss is a fine to medium grained dark grey to black

rock. The gneiss tends to weather in such a way that it forms well-rounded dark colored slopes. Slope failures typically occur along foliation planes of the gneiss in the steep canyon walls. Failures also occur frequently in the diorite due to its highly fractured nature and presence of joints within the rock. Basaltic and granitic dikes cut across the faces of the intensely fractured bedrock further contributing to slope failure.

Tertiary sedimentary rocks exposed at the mouth of the canyon are a yellow to yellowish brown unconsolidated to moderately consolidated coarse-grained sand. This unit contains large boulders up to 2-3 meters in size. Locally these sedimentary rocks have been crushed and sheared due to movement along the Sierra Madre Fault System, the main thrust fault system found along the mountain front.

Storm History

The rainfall season for Los Angeles County begins on October 1st and ends on September 30th of the following year. According to Los Angeles County Flood Control rainfall records Santa Anita Canyon has an average rainfall of 26.60 inches. The highest recorded rainfall was during the 1968-1969 storm season with a recorded rainfall total of 62.15 inches. Two major flood events have taken place in the canyon. These occurred during the 1937-1938 and 1968-1969 storm seasons.

Beginning in October 2004, through the month of March, a total of 61.14 inches of rain has fallen at Santa Anita Dam (Figure 1). The heaviest rains fell during the months of January and February. Prior to January, the canyon had already received a total of 22.19 inches of rain. Then from January 7th to January 11th 2005 another 18.57 inches of rain fell. Later during February 18th -23rd 2005, another 12.65 inches of rain fell. The intensity and duration of the January and February rainfall events lead to the landslides and destruction in Santa Anita Canyon.

Storm flows into Santa Anita Canyon caused the water to crest the Santa Anita Dam spillway twice this storm season. Peak flows in January had close to 1,700 cubic feet per second (cfs) of water coming into the reservoir. The water went over the spillway at 10:25 p.m. on Saturday January 8th. The rainfall intensity at times exceeded two

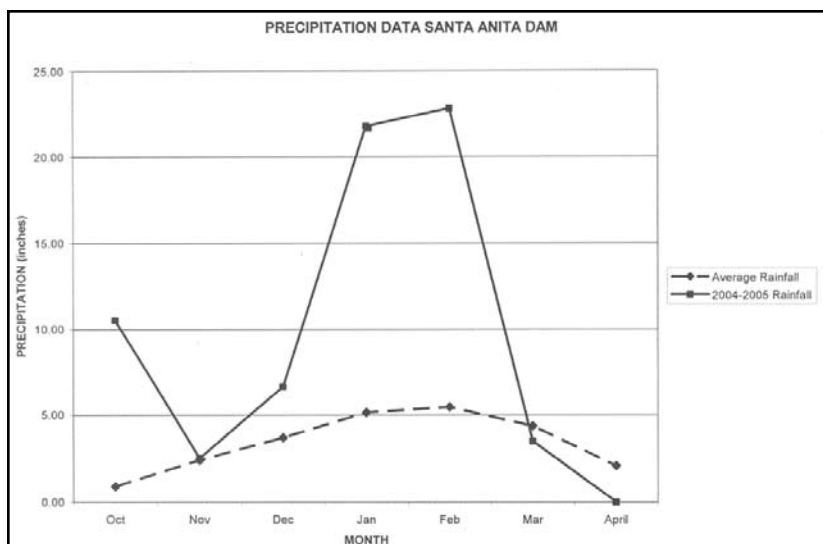


Figure 1. Rainfall for October-April 2005.

The Arcadia Slide

This slide began failing on Jan 8th, 2005 and started as a small debris flow (Figure 3).

Later during the night on January 10th the uphill portion of the slope catastrophically failed taking part of the road with it and leaving the guard rails hanging in space. In February additional large rainfall amounts caused a larger portion of the roadbed to collapse leaving behind a gaping chasm approximately 80 feet deep, 60 feet long and 20 feet wide. This collapsed area has continued to slowly erode as there is still water draining from under the slide debris. This drainage has caused the material under the roadbed to continuously slough thereby further undermining the

road. With the massive weight sitting above the remaining roadbed the asphalt eventually gives way increasing the width of the original failure. Total slide mass is estimated at 7500 cubic yards.

The Arcadia slide is a debris flow consisting of allu-

inches per hour. During the February event the peak flows approached 600 cubic feet per second (cfs) and the water crested the spillway around 4 p.m. on February 20th.

A total of 34 slides (Figure 2) occurred along the main canyon access road and a total of six along the dam access road. Two large slides occurred on the main access road and one large slide occurred on the dam access road. The canyon has several agencies responsible for maintaining the access road, which makes repairing the damaged road difficult. The cities of Sierra Madre, Arcadia, and Monrovia, the County of Los Angeles and the United States Forest Service all lay claim to certain portions of the road. The lowermost large slide (the Arcadia slide) occurred within the City of Arcadia's jurisdiction and has caused the delay of repairs along the higher sections of road. The largest slide occurred adjacent to the Chantry Flat parking lot (Pine slide - U.S. Forest Service) and the third largest on the dam access road (Dam Access slide - L.A. County).

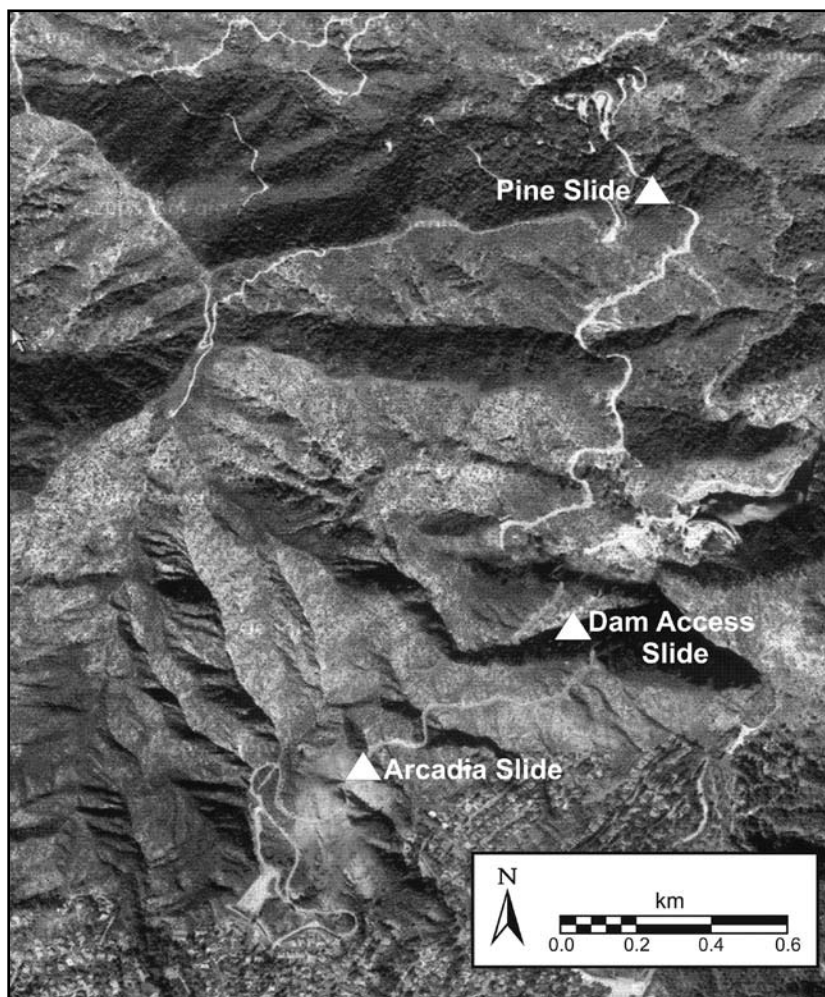


Figure 2. Index photograph showing the location of major landslides in Santa Anita Canyon.



Figure 3. The Arcadia Slide looking west.

vium and poorly consolidated weathered granitic bedrock. The slide debris consists of coarse grained, orange brown silty sands that flow during periods of rainfall. At the slide scarp there is a thin clay layer, which was most likely the slip surface over which the failure occurred. Other factors contributing to the failure were the existence of a one-meter-high graded pad for the former Gray's Inn (removed in the 1930's) above the slide area and the two fires that took place in 1999 and 2002. The fires burned off the existing vegetation that would have aided in minimizing any surface erosion and stabilizing the slope. The canyons steep topography and heavy rainfall were other factors that contributed to the massive slope failure.

Current repair/mitigation costs are estimated to be in the neighborhood of \$500,000. Several mitigation measures have been proposed. One idea is to place a bridge across the chasm where the road has failed. However topography and nature of the underlying bedrock as well as the prohibitive cost do not support this solution. A second proposal calls for realignment of the existing road. This would involve cutting back the hillside to a calculated angle so that slope failure is minimized. This proposal is complicated by private land issues. The feasibility of using soldier piles and tie back anchors to secure and reinforce the slope has also been discussed. With this method, however, there may be associated stability issues. The depth to competent bedrock is not known until a geotechnical investigation takes place. Lastly, reinforcing the soil under the existing roadbed with the combined use of soil nails, Geogrid and gabions has been proposed. The City of Arcadia will need to address several factors such as cost, existing drainage and topography, depth to competent

bedrock, feasibility of repair method and resolution of the private land issues associated with the road right of way and damaged slope areas prior to making the decision of which mitigation measure to use. It is not known at the time of this writing which design scheme the City of Arcadia will decide to adopt.

The Pine Slide

The largest slide on the main canyon road occurred adjacent to the Chantry Flat parking lot (Figure 4). This is termed the Pine Slide due to several pine trees that are trapped in the slide debris. This particular slide failed along joints in the granodiorite and can be classified as a rock/debris slide. The slide debris consists of medium grey coarse-grained sands with abundant rock and boulders present. Some of the larger rocks exceed three feet in diameter. This slide damaged only a small portion of the canyon road but it did destroy the existing retaining wall adjacent to the roadbed. The repairs for this section of road will be mitigated by the U. S. Forest Service. The removal of this slide will be difficult due to its size and the height of the slide scarp. The upper portion of this slide lies approximately 100 to 120 feet above the existing roadbed and another 100 or more feet lies below the road. Total volume of this slide is approximately 15,000 to 20,000 cubic yards. Although mitigation measures for this particular area are not known at this time the damaged section of road will need to be repaired and the retaining wall rebuilt. A wooden wall south of the existing failure, built to prevent debris from covering the road, may need to be extended northward.

The Dam Access Slide

The third largest slide occurred along the access road leading to Santa Anita Dam. This particular slide took place Monday, January 10th around 11 pm. This slide was actually a rock/debris fall with failure about 90 to 100 feet above the dam access road. The rock fall completely covered the roadbed and continued into the bottom of the



Figure 4. The Pine Slide looking northwest.

canyon another 100 feet below. The material was similar in composition to that of the Pine Slide and was made up of medium grey coarse-grained sands with abundant rock and boulders. It also contained a significant amount of plant debris and gunite pieces that had previously covered the slope. The volume of this slide was between 1500 to 2000 cubic yards.

Over the course of the next several weeks the local residents worked on removing the slide debris. Much of the initial work was done using hand tools and wheelbarrows. In seven weeks almost one third of the debris was cleared by hand. During the eighth week a 918 front-end loader was utilized to complete removal of the slide. The most difficult parts of the slide debris to remove were the pieces of gunite and vegetation within the slide mass. The slide materials were stockpiled for removal from the canyon once the Arcadia section of road was cleared.

Removal of this slide was essential to allow transportation of materials between the Arcadia slide and the dam. Transport includes people and supplies such as food, (both human and animal), fuel for use at the dam, and any other items required for normal dam operation. One lane of the Santa Anita Canyon road was subsequently cleared both below and above the dam to allow supplies to be transported between the lower and upper Santa Anita Canyon road slides for those individuals living at Chantry Flat, the Pack Station animals and canyon cabin owners. Previously, all supplies had to be carried in and out with the use of backpacks, wheelbarrows, and the occasional use of donkeys from the local Pack Station.

Several areas of the Dam Access Road have been compromised by slope creep during the heavy rains. Visqueen weighted with sandbags was placed over the slope during

the storms to minimize further erosion. Mitigation for this road involves stabilizing the roadbed by constructing retaining walls from the dam road access gate to just beyond the slide area. Fortunately, the roadbed was not heavily damaged; only one of the crib structures directly beneath it suffered minimal damage.

Additional landslides

The remaining landslides are variable in nature and range from slope wash to small debris flows to rock falls and slides. Many of these only cover the downhill lane of the canyon road. There is a section of road within the City of Monrovia's jurisdiction that has collapsed. This stretch of road is about 200 feet long and the retaining wall and road support has fallen away along the uphill lane. The materials within these additional slides vary in composition from poorly consolidated materials similar to those of the Arcadia slide to sands mixed with rocks and boulders similar to the Pine and Dam Access slides. Much of the cleanup for these slides falls within the jurisdiction of LA County Public Works Road Department.

Human Impacts

There are three permanent residents, 81 recreational cabins and a U.S. Forest Service Fire station within the canyon. All of these have been severely impacted by the road closure due to the slides. The fire personnel have been relocated but the equipment is still trapped. A private contractor for the U.S. Forest Service also has had his equipment trapped. His cost to air lift the equipment out is a prohibitive \$90,000 (that does not include his 29,000 pound dump truck). There are a total of 12 vehicles trapped behind the slide areas, five of which are at the dam. As mentioned before, supplies have to be carried in and out by hand. From the Arcadia slide to Chantry it is a 2.5 mile hike. From the Arcadia slide to Santa Anita Dam it is ¾ mile. There is no trash pick up and forestry personnel have difficulty getting to their work stations. Many of the canyons hiking trails have suffered significant damage and will need to be rebuilt. Several cabin owners are

using small motor scooters to gain access to Chantry Flat. From there it is another hike in to their cabin. Pack animals have been allowed to graze as there is no means of getting food in to them. Although the road is closed, there are approximately 600 visitors to the canyon on any given weekend. When the road was open the Chantry Flat area received almost one million visitors a year. Once repairs begin on the Santa Anita Canyon road there will only be limited foot access. To facilitate foot traffic a "new" trail is currently being constructed, however, canyon access will be severely restricted during road repair.

This year's rains have promoted plant growth and brought abundant water to the canyons' intermittent stream. The heavy flows in January and February washed most of the dead litter in the canyon into the dam reservoir. This has decreased the amount of dead fuel in the canyon thereby temporarily reducing the fire danger. Cabin owners are hiking in to do their required brush clearance and the pack animals are helping out by doing their own version of brush clearance. Fire danger is always a concern in any canyon. With the road gone, the U.S. Forest Service and L.A. County Public Works have discussed getting an alternate route in. Utilities such as Verizon and Edison have also been severely impacted by the road damage. There are several microwave towers that require routine servicing as well as power poles and meters that must be examined and read. In addition, the United States Geological Survey maintains strain meters and slope meters at Chantry that occasionally need monitoring. Currently, the only access for these agencies is by foot or by air.

Conclusions

The storm season of 2005 has brought significant changes to Big Santa Anita Canyon. Record rainfall amounts caused extensive road damage. This in turn has made it difficult for the residents, federal and county personnel, cabin owners and the Pack Station. Numerous landslides of varying nature and size have either covered or destroyed the access roads lying within different city, county and federal jurisdictions. Unfortunately for the City of Arcadia the damage is quite significant and costly. Several mitigation schemes have been proposed for this slide but a decision has yet to be made. Since Arcadia has jurisdiction over the lower most damaged area, the other involved agencies must wait to begin repairs until the City of Arcadia completes theirs. It is difficult to tell when the road will completely reopen. It is hoped that some type of emergency access will be available by early fall. It could be two to three years before complete reopening of the canyon to the public. In the meantime, the hikers and bikers will enjoy the canyon trails and the residents and cabin owners will pretend they are once again living in the 1930's as they continue to hike their supplies in and out while living in their corner of the wilderness.

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Abstracts of Proceedings

2005 Desert Symposium

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Dense-boned late Miocene and Pliocene fossil walrus of the Imperial Desert and Baja California: possible buoyancy-control mechanisms for feeding on benthic marine invertebrates in the Proto-Gulf of California

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Strange walrus-like fossil pinnipeds have been found in marine deposits of Late Miocene and Pliocene age in the Imperial Desert of California and in Baja California, Mexico. The first such discovery was latest Miocene *Valenictus imperialensis* Mitchell, 1961, found in the Imperial Group near Ocotillo Well, Imperial County, California. It differs from other pinnipeds by having a humerus that is very large in mass (pachyostotic) and very dense (osteosclerotic), the latter resulting from greatly reduced marrow cavity. In exposures of the Pliocene marine Salada Formation near Santa Rita, Baja California Sur, México, isolated bones have been discovered that represent at least four species of fossil pinnipeds, all apparently new species. This southerly assemblage of pinnipeds is the most diverse of its age to be documented in Baja California Sur, and it is unusual by being dominated, both taxonomically and numerically, by walrus and walrus-like pinnipeds. One of these is a large typical sea lion of the subfamily Otariinae, and may have resembled the living Steller's sea lion. The three other species, however, are all various kinds of walrus. One is a typical walrus of the subfamily Odobeninae, and resembles the living Arctic walrus. A second species is a new species of *Valenictus*. The third species is a very strange walrus that is even more highly evolved than *Valenictus*, and it is a new genus and new species. The latter two species, like *Valenictus imperialensis*, both exhibit pachyostosis and osteosclerosis. These phenomena seem to characterize highly derived extinct walrus-like pinnipeds of Late Miocene and Pliocene age that lived in the region of Baja California and the Proto-Gulf of California, and might have been buoyancy control specializations that facilitated bottom-feeding on invertebrates. The presence of these strange, specialized walrus-like animals in the Proto-Gulf of California also raises the possibility that their adaptations might have also helped them overcome

the added buoyancy that they might have encountered in more saline inland waters that were affected by evaporation.

Baker Hill: A landslide landform with a possible Miocene analog exposed at Old Dad Mountain, Eastern Mojave Desert, California

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Baker Hill, 0.5 km west of Baker, California forms an outcrop of Pennsylvanian Bird Spring Formation 1.2 km long by 0.4 km wide. The hill rises 80 m above the alluvial fan materials that surround it. Localized brecciation and an out-of-place setting relative to nearby bedrock outcrops indicates that the hill represents a landslide mass. Given the present geomorphology, a possible interpretation is that Baker Hill is a block glide that detached from its source area and moved across the low gradient surface it rests upon. If so, then the mechanics of movement are difficult to explain because friction should be too great to allow sliding.

A possible analog for the Baker Hill landslide is exposed on the east side of Old Dad Mountain. Here, a rock avalanche intercalated within an erosionally dissected Miocene fanglomerate sequence is exposed in cross-section. Across most of its 4 km width, the rock avalanche is a relatively thin sheet-like deposit with an average thickness of 15 m. However, in the central part, the deposit contains a hummock about 1 km wide and 200 m thick. Conceptualizing the evolution of the rock avalanche's exposure after it was buried, it is logical that after a period of time following emplacement, the sheet-like portion of the deposit was buried and the hummock stood as an isolated hill surrounded by an alluvial plain.

Based on the Old Dad Mountain rock avalanche, an alternative interpretation to the block glide model for Baker Hill is that the hill is part of a rock avalanche that is now mostly buried. In this model, the hill represents a hummock embedded in a much more extensive sheet-like deposit. A rock avalanche interpretation presents a viable explanation for the movement of the landslide mass across a low gradient because rock avalanches are known for moving with very low apparent friction.

Goldminer in a fluffy hat: Dr Rose Burcham (1857-1944), Randsburg's "New Woman"

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In 1894 Hutchinson & Company of London, England published a new novel about the budding phenomena of traditional-role defying "new women" titled *A Yellow Aster*. Several years later the name of a new gold mine in California's Mojave Desert was changed from the Rand Mine to *The Yellow Aster*. Coincidence? I suggest not. Particularly when one of the major players beginning that very successful mining operation was Dr Rose Victoria La-Monte Burcham, a brilliant and tough-minded gold miner who performed most of her duties wearing, seemingly as a crown of status achievement, one of her stylish, veiling-and-feather-encrusted fluffy hats. Over the Randsburg desk of this corseted figure passed, for her scrutiny, every piece of the gold mine's legal paperwork.

In the late nineteenth century some in the Anglo-American world were beginning to question the marginalization of women in society. Dr Rose's career and personal life story provide a new perspective on women's place in late nineteenth century mining towns. Rose became very well known for her unique career coupled with her self-described "imperative mode." In addition to numerous mentions in local and Los Angeles newspapers, she was featured in early twentieth century periodicals including *Sunset Magazine* and *London's Wide World Magazine*. Dr Rose was even named one of the "Men of Achievement" in a book published by the *Los Angeles Times* in 1904.

The history of the American West suffers greatly from the mythology created and perpetrated by radio, television, and the movies. In-depth research is necessary to separate western myth from western reality—a reality that even includes an exceedingly successful gold miner whose workday attire often included a fluffy hat.

Investigation of terminal Pleistocene shorelines at Searles Lake, Kern County, Luz Ramirez de Bryson, Post Archaeologist, National Training Center, Fort Irwin, CA 92310.

During the late Quaternary, Searles Lake was part of a complex network of lakes and rivers beginning in the Mono Basin to the northwest and ending 350 miles downstream in Death Valley. Fluvial sediment generated by alpine glaciers in the Sierra Nevada was transported down the Owens River to the Owens Basin, and then carried southward to Little Lake and on to China Lake. Much of this sediment load was finally deposited in Searles Lake.

The Searles Basin went through a rather complex series of fills and desiccations over the past 35,000 years driven by an array of environmental factors affecting the entire Owens pluvial lake system. Attempting to unravel this sequence has proven to be a daunting task. This situation

is due to both the complexities of the natural system and to the fact that the focus of many previous analyses was on mineral exploitation rather than paleoenvironmental studies. Consequently, lake level chronology is known largely from Smith's geochemical analyses of cores taken in the lakebed itself without any comprehensive studies of extant shorelines within the overall Searles basin.

In the present research, 22 new radiocarbon determinations derived from tufa recovered in backhoe trenches, archaeological test units, and drainage exposures located within the Searles basin were supplemented by sediment analyses, obsidian hydration measurements, and pollen analysis. Combined with dates found in the literature, these new data provide considerably more temporal control over actual lake stands than was previously available.

Refinement of these data allowed the identification of 10 phases that alternate between wet and dry periods for the last 30,000 yr B.P. and point to the likely occurrence of a major fluvial event dating to around 18,800 B.P. Contrary to previous interpretations suggesting near complete desiccation during the Holocene, it also appears that regional precipitation increased around 6600 ¹⁴C yr B.P. resulting in a final lake high stand.

Calico Site choppers and chopping tools: morphological and use-wear patterns

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In the Old World, unifacially-flaked choppers and bifacially worked chopping tools were amongst the earliest stone tools invented by early man. Such forms are also found in early New World tool kits such as that recovered at the Calico Site near Yermo, California (see photos of representative specimens at www.calicodig.com). The Calico Site is the oldest stone tool workshop and quarry site yet discovered in the United States. Its major sub-surface component is currently dated between 100ka and 200ka.

This presentation briefly reviews the morphological and use-wear patterns of 20 selected choppers and chopping tools recovered at the Calico Site. Diagnostic use-wear is evinced by very small step-flakes on striking edges. The Calico Site is still regarded as problematic among many American archaeologists. Use-wear patterns offer yet another line of evidence that Calico is a bona fide site.

Surprise Canyon EIS

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The Bureau of Land Management (BLM) and Death Valley National Park (DVNP) are jointly preparing an Environmental Impact Statement (EIS) for Surprise Canyon (Canyon) to amend their respective land use plans on two points: designations for Surprise Canyon Road (Road

for casual use vehicle access and suitability of the canyon stream as a Wild and Scenic River (WSR). The issues have high public sensitivity and reflect a shift in public attitudes over recent years.

The Canyon lies on the west side of the Panamint Mountains, south of Telescope Peak. Its two unique features are the historic mining town, Panamint City, and a perennial stream with waterfalls and riparian habitats and species. Threading through the Canyon is the historic Road, which has provided access—first wagons, then motorized vehicles and hiking—to Panamint City since 1874. For decades after mining faded the Road was a favored recreation touring attraction, especially for visitors to Death Valley National Monument. In 1984 a key portion of the Road washed out, and with it the remainder of any mining and road maintenance interest. General public vehicle access was rendered impossible due to the exposure of several waterfalls in a stretch of Canyon 1000 feet long that had been covered with road base for 110 years. Following the flood the extreme difficulty of the Canyon and Road was discovered by 4-wheel drive enthusiasts for its rock-crawling sport value. At the same time, with greatly reduced vehicle access and the process of natural reclamation, they were also discovered by hikers. Today, the Canyon's natural, cultural, scenic, and recreation values are outstanding in their own right, unique in the aggregate, and regionally superlative for both hiking and rock crawling.

For more than 100 years the road and vehicle use were almost considered a "given," a tradition of mineral access and recreation touring. BLM management, extending the entire length of the Canyon at that time, and including the designation of the road as "Open", was defined in the early 1980s in compliance with Federal Land Policy and Management Act (FLPMA), in consideration of the Endangered Species and Clean Water acts. Little public concern for the environmental effects of vehicle use was expressed. Since 1984, however, several events occurred to change the status quo, some setting the stage for and culminating in the action of this EIS: the end of mining and road maintenance, increasing polarization over vehicle access, increased environmental awareness and non-vehicle recreation, and the 1994 California Desert Protection Act (creating the Surprise Wilderness Area and placing the upper half of the Canyon into DVNP). In 2001 BLM closed vehicle access in the lower canyon due to a lawsuit filed by several environmental entities. DVNP closed its portion shortly after. The temporary nature of both closures will end with an EIS decision. BLM's 2002 Northern & Eastern Mojave (NEMO) Plan included an eligible finding for the lower portion of the Canyon for designation under the WSR Act. Both agencies are required by policy to address WSR values in land use plans. Out of concern for these initiatives two sets of 4x4 vehicle groups recently purchased two parcels of private land at Panamint City area to establish what they hope will be a right of vehicle access through the non-wilderness "cherry

stem" to Panamint City.

The nature of vehicle access since 1984, given the absence of road maintenance and greatly reduced numbers of vehicles, on the canyon's physical and biological values is probably less impacting than before 1984, however the issues involved are much greater and complex today. That the two halves of the canyon are managed by BLM and DVNP suggests that the two agencies should coordinate their management, but the difference in management mandates for the agencies adds yet further complication for analysis and decision. Given the intensity and complexity of the issues, regardless of the EIS decision, yet another lawsuit is sure to follow.

Drought and population decline in a Mojave Desert plant parasite at the Granite Mountains, CA.

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Asphondylia auripila is a tiny gall-forming fly that produces a large, filamentous gall on the stems of creosote bush (*Larrea tridentata*). During my six-year study of *A. auripila* galls at the Granite Mountains, California, gall numbers have precipitously declined. In 1999, some shrubs had heavier gall-loads than one would expect at random (i.e. galls were clumped on certain creosote bushes), and these patterns in gall-loads between shrubs appear to persist through time. Some differences in gall-load between shrubs can be explained by shrub size. The recent *A. auripila* gall population contraction is likely the result of recent drought conditions at the Granite Mountains. *Asphondylia auripila* may be particularly vulnerable to drought because of its high transpirational surface-area. If *A. auripila* is sensitive to water stress, differences in creosote bush water status may explain the original clumped distribution observed in the 1999 gall population.

Protohistoric diseases in southern California: a view from the Portola Expedition

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In the past decade, various scholars have begun to explore the evidence for the protohistoric impact of Old World epidemic diseases on indigenous California populations, prior to the arrival of the first overland expeditions. While they have summarized data for southern California, most of the detailed emphasis has been on the Chumash, for whom the previous research and data-base are the strongest. These studies have also noted the difficulty of evaluating the data for a protohistoric population disaster on the basis of archaeological investigations.

Renewed archaeological research at the Tomato Springs site (ORA-244) in 2003 and 2004 refocused attention on the Gaspar de Portola expedition in 1769. More than 200 years after the first opportunities had occurred for the introduction of European diseases to southern California, Portola and his party passed through Tomato Springs and points farther north leading to the Monterey Peninsula, leaving their eye witness accounts.

Brown (2001) made a major contribution to the study of the Portola expeditions by carefully re-examining the various versions of the Crespi diaries and of others who accompanied Portola on his explorations. His recent work is the most complete and reliable and, for the first time, allows us to fully view the indigenous population as it was along the route, not once, but three times.

This paper recounts the actual sightings of persons and villages as well artifacts which indicate contact with external peoples and therefore potentially, and probably, their diseases.

Finally, following the same precautions as those expressed for the Chumash research, the paper closes by assessing the potential for archaeological research to contribute to protohistoric population research. We also briefly examine whether the independent nature of disease vectors supersedes the need for precise archaeological data.

The Search for Mining Districts

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When I began my study of mining, I was told that there had only been 20 to 25 mining districts in San Bernardino County in its 150 years of history. Sources included Division of Mines publications, Journal of Geology, books on mines, and state and federal geologists who, one would think, would have a good handle on this subject. I also talked to county personnel and found that this county didn't have a list of mines in the county, much less mining districts. Several different agencies had a few pieces of information, but only the County Archives, the BLM and National Archives had any data older than 1995. To add to the confusion, the county became smaller in acreage in 1893 when Inyo and Riverside Counties were formed and land formerly in San Bernardino County now was in others. Add to that the fact that the California-Nevada state line was also found to be in error and that played havoc with property ownership. In the two years or so that I have been studying this, I have come up with 111 mining districts! A couple are questionable, but most are cited in reputable publications, location papers at the County Archives, or on maps of the county. Some have been spelled several ways, but are easy to recognize.

As far as I can determine, the first mine to be located and recorded within the county boundaries was at Salt

Springs along the Mormon Trail in 1849 by members of the Mormon wagon train making its way to Rancho Chino. It was recorded in Los Angeles County since San Bernardino County didn't exist until 1853. Earlier immigrants and travelers undoubtedly looked for minerals, but didn't legally record their findings. The recording at Salt Springs brought a flurry of mining activity to San Bernardino County, and particularly to the Mojave Desert, which continues to this very day.

This is not a search for "lost mines" or "rivers of gold", but for lost and forgotten data that has been deposited in various repositories and odd places that needs to be gathered together and put in one place where anyone who needs to do research can find it, complete with references. At the beginning of my quest, I was looking for the names and locations of mines as well as district data and the people involved in the mines, but it quickly became apparent that there were mountains of data, so I separated my research into categories and decided that finding the districts was the basic building block for further research. I got data and encouragement from Ted Weasma and Larry Vredenburg., which has been incorporated into my database. I want to thank them both.

Creating a mining district is much like creating a corporation. You need to designate a hierarchy, delineate your boundaries, and have a product. All this needs to be recorded with the county in which you are located and with the proper state & federal agencies as necessary. You need to keep accurate records and provide help and other services to your members or mine owners. A mining district has members with a product that needs to be refined and shipped to market. They need a mill, living spaces, roads, transportation, and someone to sell the product to the end user. This is a simple model, but you get the idea. This mining district may decide to sell out to a new "owner" and that requires a new name, a new corporate structure, and lots of paperwork just to keep the mines operating without skipping a heartbeat.

Sourcing the green pigment from Newberry Cave

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Approximately 3500 years ago, Native Americans visited a cave in the Newberry Mountains. These natives, most likely men, painted the wall faces in green (approximately 68%), with some white and red. At the present time, Newberry Cave is the only place in the Mojave Desert known to have green pigment in its rock art. It is also the only archaic site in the Mojave with prehistoric pictographs of animals, as well as the only site known with split twig figurines and rock art, making it a truly unique place.

What process did these Native Americans employ to make those green paintings? First, gathering the green

mineral was important. Several chunks were left behind in the cave, collected thousands of years later and studied. Examination under a scanning electron microscope (SEM) determined the green pigment is composed of celadonite, found fairly commonly in volcanic rocks. It gives the greenish color to some volcanic ash layers and frequently occurs in pure form in vesicles in basalts. Celadonite is generally formed by hot water alteration of volcanic rocks so it is not uniformly distributed in a volcanic unit. It is localized to areas where the rock interacted with water for a substantial period of time while it was still hot. There are outcrops containing celadonite in the Newberry Mountains within easy walking distance of the cave.

The celadonite from Newberry Cave was generally very fine grained and homogeneous, suggesting it was ground down, perhaps mixed with water and reformed into chunks or balls. The SEM examination found no evidence of a binder. One ball had a hole drilled through the center, so it could be carried on a string. Another had a small twig embedded. These portable paint balls were then ground down again to a paint-like consistency. It was then applied to the cave walls, atlatl shafts, and other objects, most likely with ceremony, in enduring designs still visible today.

Lost lakes of the east Mojave Desert: rediscovery and recreation potential.

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The recent rains in southern California resulted in the filling of the water supply reservoirs for most of San Diego, Orange, Riverside and San Bernardino counties. Additional rains have forced the water agencies to release water from the reservoirs to make room for snow melt and any additional rains that may occur in the next month. The effects of released water from the Silverwood reservoir and the flow of water down the Mojave River resulted in a large volume of water flowing through dry river basins, causing damage to county and private infrastructure and filling some of the lost dry lakes of the east Mojave Desert. Rainfall data at selected sites at the source of the river and along the Mojave River and photographs of the resultant down stream flow will be presented. Recreational opportunities, unseen for 50 years, have resulted in an increase in the number of users and a "flood" of people to view the wildflower bloom.

Halloran turquoise: a thousand years of mining history

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The Halloran Hills in the eastern Mojave Desert con-

tain alunized Mesozoic quartz monzonite, cupriferous Miocene gravels, and phosphate-rich Pliocene basalts, a combination that has allowed ground water to precipitate turquoise—copper aluminum phosphate. Although generally botryoidal, turquoise also fills voids and replaces original minerals in miarolitic cavities in the Teutonia quartz monzonite pluton. Turquoise mining in the Halloran Hills has continued from 500 A. D. to the present: over one thousand years of mining.

Paleoenvironmental and geochemical analysis of arthropod-bearing lacustrine deposits, Black Canyon, Barstow Formation, southern California

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A new arthropod-bearing concretion locality, consisting of three distinct horizons, has recently been reported in the Black Canyon area, approximately 30 km west of the Barstow Formation type section in the Mud Hills. Previous studies have focused on the systematic paleontology of the arthropod fauna from the Calico Mountains and correlation of the microfossil horizons between Black Canyon, the Mud Hills, and the Calico Mountains. However, little research has been conducted on the sedimentology and mineralogy associated with the concretions and no previous research has been conducted on the sediments associated with the Black Canyon concretions.

The objectives of this study are to: 1) describe the paleoenvironment and geochemical conditions under which the arthropod-bearing concretions formed within Black Canyon; 2) determine if cycles of events occurred within the concretion-bearing section and within each of the three distinct, concretion-bearing horizons; 3) describe the lacustrine sediments associated with the concretions and; 4) compare the sedimentology and mineralogy associated with the concretions from Black Canyon with those reported from the Calico Mountains.

The preliminary results of this study suggest: 1) cyclic events were responsible for the three microfossil horizons, possibly the result of lake transgressions and regressions; 2) cyclic patterns within each individual fossil horizon in the Black Canyon consist of alternating carbonate and mudstone beds with intermittent gypsum beds.

Deformation on the Manix fault east of Manix wash

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The Manix Basin in the central Mojave contains a nearly

complete, approximately two million year old stratigraphic record of predominantly playa and lacustrine deposition. The transition from a closed-basin playa to the through-flowing ancestral Mojave River and ancient Lake Manix is recorded by these Plio-Pleistocene strata. Sediments within the basin are exposed along the Mojave River and are particularly well exposed near Manix wash. The east-west trending, left-lateral Manix fault cuts the Plio-Pleistocene sediments in the same vicinity; the area was, in fact, the location of a $M_L=6.2$ earthquake in 1947, the largest recorded earthquake in the Mojave prior to the 1992 Landers earthquake. Aftershocks following the Manix earthquake suggest that it occurred at the intersection of the Manix and Pisgah faults. Aftershocks from the Landers earthquake and the 1999 Hector Mine earthquake attenuate along the Manix fault. The area is thus particularly well-suited for unraveling both the short-term and long-term history of the Manix fault, as well as being a regionally important location in the context of Mojave tectonics.

A strain gauge was installed across the Manix fault in 1970 approximately five kilometers east of the Mojave River/Manix wash intersection. The strain gauge requires manual data recording; in the subsequent 35 years, 21 measurements have been recorded. These measurements are remarkably consistent, and, assuming pure strike-slip motion, they indicate that this strand of the fault is creeping left-laterally at a rate of approximately 0.1 mm/year. Our detailed mapping of the area indicates that the fault consists of at least three significant strands in this area, with the strain gauge spanning just one of the strands. Therefore it is quite possible that the total slip rate on the fault is greater than the 0.1 mm/year indicated by the strain gauge. Additional mapping of Plio-Pleistocene sediments should reveal offsets across the fault that place constraints on the earlier history of the fault.

clays for pottery, sand for pottery temper, and pigments for various uses.

Prehistoric Mining in the Mojave Desert

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One ancient turquoise pit in the Halloran Mountains is 30 feet long, 12 feet wide and 12 deep. Even tunnels had been started, and tools of hammerstones and picks were left, as was some black and white pottery. Some 50 Pueblo sites have been reported north and east of the Mojave River, and Anasazi "Gray Ware" pottery shards littered East Cronise Lake, Crucero, Halloran Springs and east into Nevada. These are some of the extant evidence of prehistoric mining (1,150–1,450 B.P.) in the eastern Mojave Desert.

But there was much more mining, i.e., obtaining and utilizing minerals, in the desert. Elephant Mountain, at Daggett, shows evidence of not only a metate quarry site, but debris sites left from shaping and lessening weight to make portable metates. Besides all the quarry sites for making rock tools and points, Native Americans obtained