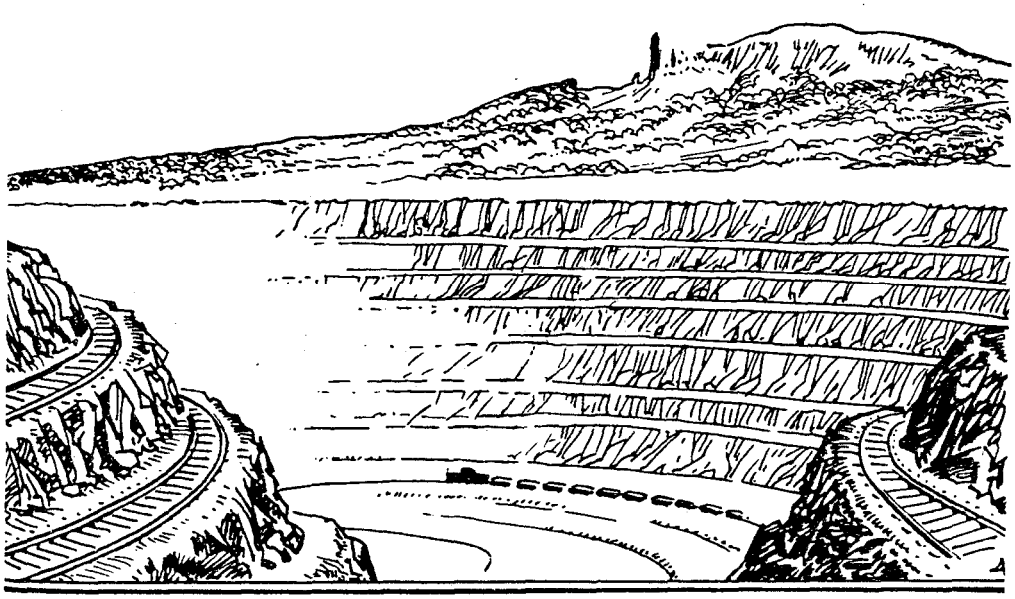
SCENIC TRIPS
to the
GEOLOGIC PAST



SILVER CITY
SANTA RITA
HURLEY

NEW MEXICO

Scenic Trips to the Geologic Past Series:

No. I - Santa Fe, New Mexico

No. 2 - Taos-Red River - Eagle Nest, New Mexico, Circle Drive

No. 3 - Roswell- Capitan - Ruidoso and Bottomless Lakes Park, New Mexico

No. 4 - Southern Zuni Mountains, New Mexico

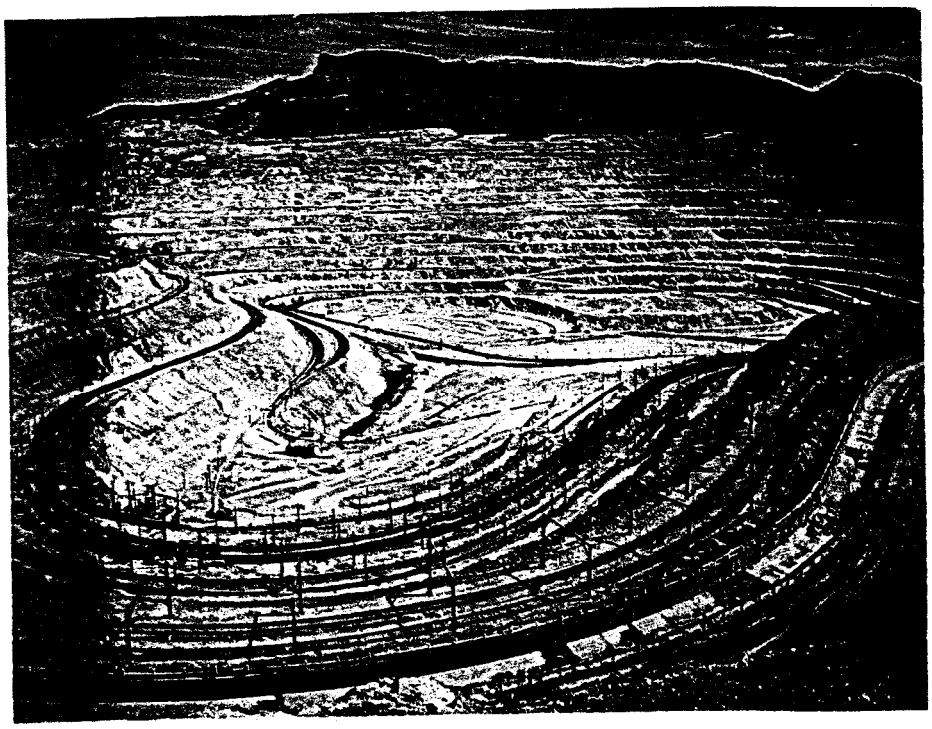
No. 5 - Silver City-Santa Rita-Hurley, New Mexico

Additional copies of these guidebooks are available, for 25 cents, from the New Mexico Bureau of Mines and Mineral Resources, Campus Station, Socorro, New Mexico.

HO: FOR THE GOLD AND SILVER MINES
OF NEW MEXICO

Fortune hunters, capitalists, poor men,
Sickly folks, all whose hearts are bowed down;
And Ye who would live long, be rich, healthy,
and Happy; Come to our sunny clime and see
For Yourselves.

Handbill -- 1883



Kennecott Copper Corporation

Santa Rita Open Pit, 1959.

Scenic Trips to the Geologic Past

No. 5

SILVER CITY - SANTA RITA - HURLEY, NEW MEXICO

by

JOHN H. SCHILLING

1959
STATE BUREAU OF MINES AND MINERAL RESOURCES
a division of
NEW MEXICO INSTITUTE OF MINING AND TECHNOLOGY
Socorro - New Mexico

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PREFACE

Much of the work undertaken at the New Mexico Bureau of Mines and Mineral Resources is done to help the mineral industries -- the prospector, miner, geologist, oil man. This work is published in technical reports -- dry at their best.

There are many who are not interested in these reports but would like to know more about the geology of New Mexico and about its mining, oil, and gas industries. To meet this need, the Bureau publishes a series of popular guidebooks ("Scenic Trips to the Geologic Past") designed to tell the New Mexico resident, and the outof-State visitor, about the numerous scenic and geological attractions found in the State. Earlier booklets in this series covered areas around Santa Fe, Taos and Red River, Roswell and Ruidoso, and Gallup and Grants.

These first four scenic guides emphasize geology -- the geologic history, rock types and structures. In contrast, this booklet will emphasize mining -- how the ore deposits were formed, who found them, how the ore is mined, and how the ore is converted into useful metals.

So many persons have helped to make this booklet possible that there is not space to acknowledge everyone by name. The writer is especially indebted to the staff of the Chino Mines Division, Kennecott Copper Corp. , who helped in so many ways. The New Mexico Magazine and Silver City Chamber of Commerce supplied photos. Bureau and Institute personnel did their part. To each and every one, many thanks.

John H. Schilling

INTRODUCTION

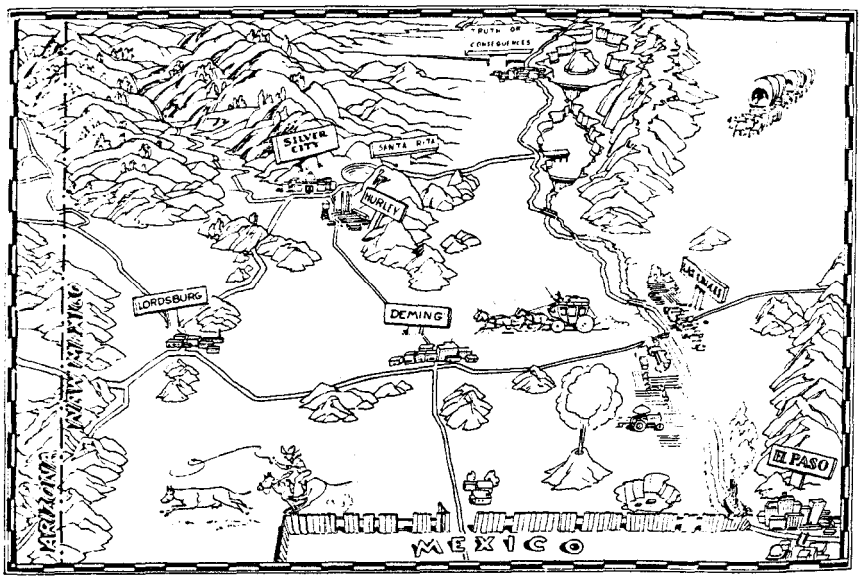
The Silver City area is the most important metal mining district in New Mexico, the total value of its production exceeding that of all the rest of the State combined. The area is one of contrast and variety; of ghost towns and a modern company town; of big mines and little mines; of ore bodies, veins, and placer deposits; of underground mining and open pits; and of copper, zinc, molybdenum, lead, gold, iron, silver, manganese, turquoise, and uranium.

Here the Indians, Spaniards, Mexicans, and Anglo-Americans each took their turn controlling the area and working its mines. Here, too, there were men of vision who turned waste into ore -who saw that the low-grade deposits, rejected by the prospector and early miner, could be mined profitably by using a radically different mining method based on a just as radically different economic concept.

* * * * * * * * *

Let's take a drive around the Silver City area, so that you can see the variety and contrasts mentioned above, and learn more about the men who turned waste into ore.

The tour is arranged as one continuous trip. First we'll visit most of the mining district, then stop at the huge Santa Rita pit, and finally continue on past some of the other mines to Hurley,



where the Kennecott mill and smelter are located. Each main point of interest is described at some length, followed by a section telling how to get to the next point of interest and what can be seen on the way.

Although mining will be emphasized, there are many other interesting things to do and see along the way. I'll tell you about them as we drive along. Don't forget your camera -- there's lots of picture-snapping scenery ahead.

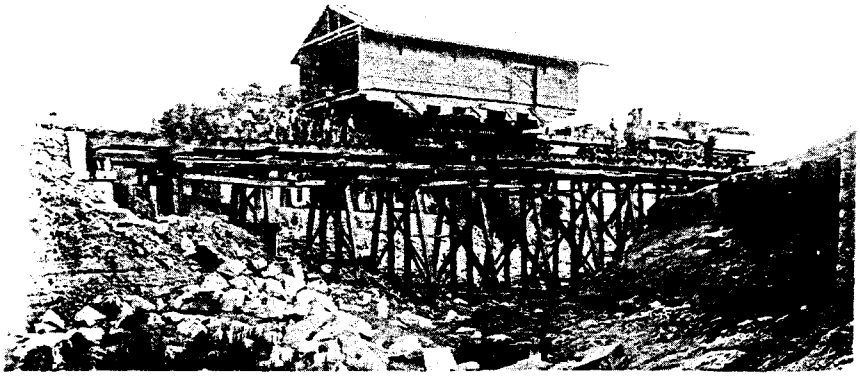
A section on Silver City's colorful history precedes the road log of the tour.

SILVER CITY

It had been an unsuccessful trip; James and John Bullard had not found the lost mine they had been looking for along the Frisco River. Now, in the spring of 1868, they were on their way back. But, like all prospectors, they were keeping their eyes open and examining all the promising outcroppings they pas sed. Persistence paid off; 2 miles west of what is now Silver City they found a rich silver deposit, later known as Chloride Flat.

As mines were opened at Chloride Flat, the town of Silver C ity grew up nearby. By 1870, the mushrooming town had swallowed up an older Spanish village called San Vicente de la Cienega (St. Vincent of the Marsh). This small Spanish settlement had grown up on a campsite used by the Gila and Mimbres Apache Indians, who claimed ownership of this entire region and felt that the United States should have negotiated with them, not Mexico, when acquiring this area in 1848.

Pack trains and freight outfits filled the streets of the booming city until well into the 1890's. Twelve- and fourteen-horse teams hauled ore from the nearby mining camps and Mogollon Mountains to the Silver City smelters. Bricks of silver and gold were stacked on the sidewalks outside the express offices awaiting shipment and were often left there overnight -- robbery had been strongly discouraged by sure, swift, and numerous hangings.



Moving the Santa Fe station to its present location,
Silver City, 1898.

It was a wide-open, ripsnorting town, with the hell-raising ways of the mining camp and cowtown. Gamblers, miners, merchants, soldiers from Fort Bayard, cowboys, teamsters, and the gals from Shady Lane crowded the pretentious bars -- the Blue Goose, Red Onion, and others -- keeping three shifts of bartenders jumping in the never ending job of quenching their thirsts. Fights and shootings were commonplace.

Billy the Kid lived in Silver City. It was here according to legend that he killed his first man. Henry McCarty (also known as Henry Antrim, later as Billy Antrim and Kid Antrim, then as William H. Bonney, the Kid, or Billy Kid, and finally as Billy the Kid:) moved to Silver City in 1873 with his mother, stepfather, and older brother. Soon his mother developed "quick consumption." In the Silver City cemetery is a plot marked off by rocks, and in the center a simple headstone with this inscription:

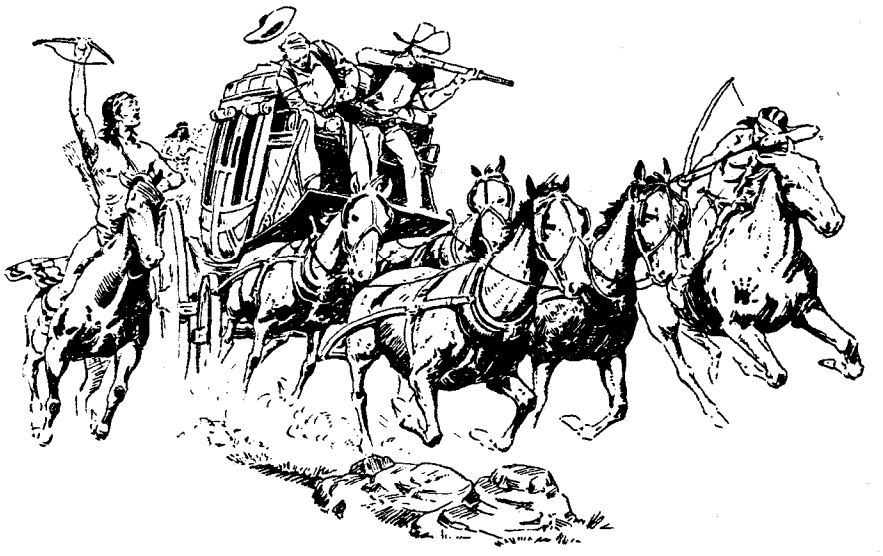
In memory of Mrs . Katherine Antrim
1829-1874
Mother of "Billy the Kid"

After his mother's death, friendly neighbors offered the youth a home. Slightly more than a year later, however, before he was 16, he was involved in a robbery -stealing clothes from a Chinaman. While in jail awaiting grand jury action, he escaped and began his life of wandering.

It is doubtful that Billy committed his first murder in Silver C ity - - in defense of his mother's "honor ," as the legend says- - and that the murder was the reason for his fleeing Silver City. He did kill E. P. Cahill, a blacksmith, near Fort Grant, Arizona, 2 years after leaving Silver City; this apparently was his first killing.

The Apaches were a constant menace well into the 1880's, driving off and killing cattle, attacking the stagecoaches, and in general keeping things in anuproar . The soldiers from the Army post at Fort Bayard, near Silver City, were frequently called out to guard travelers, offer protection during raids, or avenge some act of violence.

On July 11, 1871, after a raid on Silver City, John Bullard (mentioned earlier as codiscoverer of the silver deposit which led to Silver City's founding) got together a company of men who chased and defeated the Apache war party. But while Bullard was bending over a supposedly dead Apache, the Indian grabbed his



gun and shot him through the heart. This happened on the peak which now bears his name. One of Silver City's main streets also was named after him.

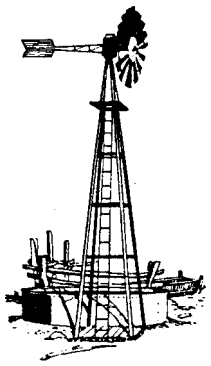
In 1883, the Apache chief Geronimo invited the Apaches on the San Carlos Reservation in Arizona to join him in Sonora, Mexico. Splitting into three bands, they headed for Mexico, killing any whites unfortunate enough to be in their path. Among others, they attacked Judge McComas, who was driving through the Burro Mountains toward Lordsburg with his wife and 6-year old son Charlie. They killed the Judge and his wife, and carried off the boy. What happened to the boy? Was he killed? Rumors persisted for a long time that he had been seen south of the border. In 1938, an archaeological expedition in Mexico found a tribe of Indians, apparently Apaches who escaped at the time of Geronimo's capture in 1885. Their chief had blue eyes and red hair -- some thought he was Charlie McComas.

But even after the Apaches were subdued, Silver City's troubles were not over. When the town was first laid out, someone suggested that it should be located away from the valley bottom for protection from the dangers of flash floods. Floods in this dry country. Don't be silly. So the town grew up in the bottom even though flood debris could be seen in trees along San Vicente Creek, 20 feet above the ground.

By 1895, Main Street was flanked by solid rows of 1- and 2-story buildings. On July 21, a big flash flood raced through town. About midnight, a second wave, over 12feet high, hit the tottering buildings, sweeping everything before it. Still nothing was done. In 1903, after another flood, a piano from a second-story room was found 7 miles downstream. Main Street had become a 25foot-deep gulch. In 1935, CCC workers lined the gulch with masonry walls and built thousands of tiny dams in the surrounding hills to check too rapid runoff.

The Big Ditch, as the gulch is called, is worth seeing. It is one block east of and parallel to North Bullard Street, which became the "main street" after old Main Street was destroyed. Many buildings facing on Bullard Street still have fronts on old Main Street, now the Big Ditch. An interesting old building, the Hotel Southern, can be seen at the corner of Broadway and Hudson Street.

* * * * * * * *

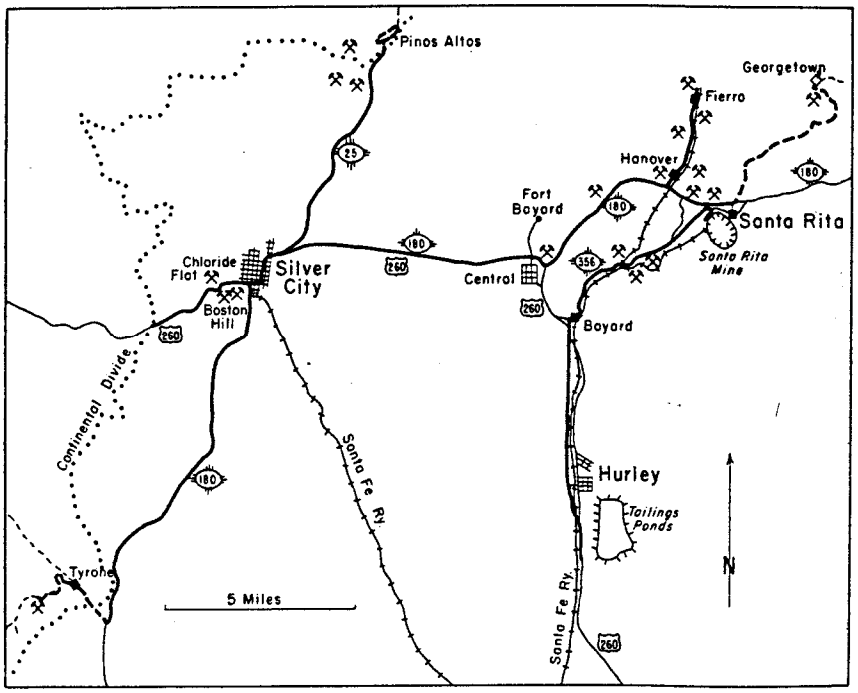


Today Silver City continues to flourish, a modern, thriving city. At 5,900 feet, it occupies a beautiful setting in the foothills of the Pinos Altos Range, a prong extending southeastward from the Mogollon Mountains. It has become a business and shipping center for the surrounding mines and ranches, and for the irrigated farms of the Mimbres and Gila River valleys. It is the seat of Grant County and the home of New Mexico Western College, and the center for trips into the many hunting , fishing

camping, and scenic areas in the surrounding mountains.

THE TOUR

The trip is 98 miles long and will take 5 to 6 hours to cover completely. Mileages are given at each point of interest, and also at "check points," such as road junctions (mileages given may vary slightly from those registered by your car; check points will help you compensate for any such differences). Distances between

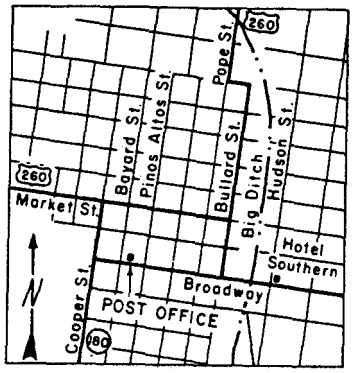


points of interest are also given, to help you find such points more easily.

It will take a little while to "get the hang" of using a road log. A passenger, not the driver, should keep track of the mileage -better still, he can read the booklet out loud. It is better to stop or slow down rather than pass a point of interest while still reading about the last point'. If you stray off the "trail," refer to the map above.

The trip starts at the Silver City post office.

Mileage



0.0 Go west 1 1/2 blocks from the post office. Then turn left onto State Highway 180 (Cooper St.). We'll be on Highway 180 for the next 10.5 miles.

0.7

0.7 On right, mine dump, first glimpse of the Boston Hill mining district.

0.2

0.9 Silver City cemetery.

.6

1.5 On right, at some distance from the road, dumps of the Boston Hill mine. This area first attracted attention in the 1870's because of its similar appearance to nearby silver deposits. Since 1916, the mine has produced manganese-rich iron ore for the steel industry. Total production has been over 1,400,000 tons.

6.4

The ore occurs in irregularly shaped ORE BODIES (masses of ore). Hematite (deep-red iron oxide) and pyrolusite (sooty-black manganese oxide) are the main minerals in the ore.

The deposit has been mined by OPEN PITS (surface workings, like quarries) and a few under ground workings.

7.9 Road is climbing up the northeast slope of the Little Burro Mountains.

1.4

9.3 Crest of Little Burro Mountains. The roadcuts for the next mile expose highly ALTERED (changed by heat, pressure, or chemical action) and BRECCIATED (badly cracked) IGNEOUS rock (rock formed by the cooling and solidification of molten rock.)

1.3

10.6 Junction; turn right across cattle guard onto dirt road to Tyrone.

Highway 180 continues straight ahead to Lordsburg. Along the highway is the White Signal mining district, where one of the first uranium deposits was found in *New* Mexico. The uranium minerals were first noted in 1920. The deposit was mined in a small way, and the product used in making radioactive water for "medicinal" purposes:

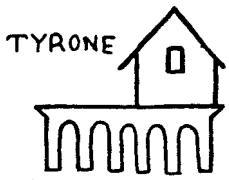
0.5

11.1 Continental Divide. To the left of the road is a cut on the railroad line,
0.9 now abandoned, to Tyrone.

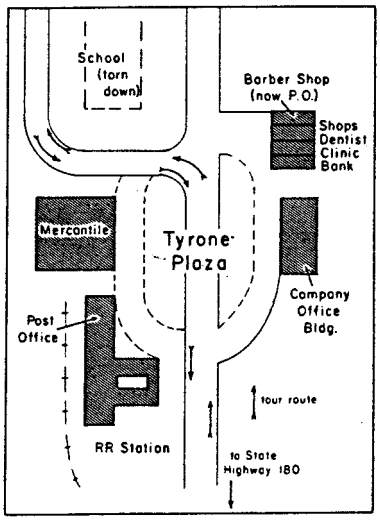
12.0 Entering Tyrone.

.1

12. 1 STOP A. TYRONE'S PLAZA. The road cuts across what was once the plaza.



Copper was discovered in the Burro Mountains in 1871. Severa periods of boom and bust followec until, in 1912, the Phelps Dodge Corp. acquired most of the property in the district.

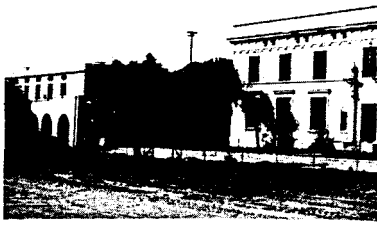


The company decided ("encouraged" by the wives of two important company officials, so the story goes) to build a model mining camp. Goodhue, architect for the San Diego Exposition, designed the buildings (of Spanish Colonial style), the principal business buildings alone costing over $1,000,000. The railroad station, patterned after San Diego's beautiful station, has a marble drinking fountain, tile floors, an elaborate chandelier, and hand- tooled ceiling beams. The other buildings are just as elaborate. No expense was spared. By 1915, Tyrone was a thriving town of over 5,000 people.

In 1921, however, the rich copper ore "played out," and the mine
0.4 was closed. Tyrone became a ghost town. The railroad tracks are gone, and the school was torn down. Rock throwers made short work of the many windows; otherwise the picturesque buildings still stand in all their splendor. Today, many of the houses are rented, but Tyrone still is only a shadow of its former self.

Tyrone today.

Mercantile with railroad station in background.



Company office building with bank in background.

Maybe someday Tyrone will boom again, and trains will again visit the station.

Let's continue on. Turn left uphill on the steep, winding road (just past the plaza) leading to the houses and mine.

12.5
0.6 Sharp turn to the left past company houses. Continue on the most traveled road.

13.1 STOP B. Just before making sharp left turn.

0.5 Straight ahead (to the north) is the company hospital. Beyond the hospital is the Mangas Valley, with the Mogollon Mountains in the distance; the Little Burro Mountains , which we crossed earlier, are to the right (to the east) across the valley. We are in the Big Burro Mountains.

13.6
0.2 Ahead, to the right, pits on hills ide (across gulch) worked by the Indians in prehistoric times for turquoise. Turquoise (a blue to blue-green, hard copper mineral) is the favorite gem stone of the Indians of the Southwest. Thousands of turquoise beads and other ornaments have been found in Indian ruins.

TURN AROUND. Ahead, beyond fence, is the Phelps Dodge Corp.'s main plant site, the headframe of the No. 2 shaft,
13.8 and the portal of the Niagara tunnel. This is the mine that supported Tyrone. The road continues around to the right, to
3.1 Leopold (1 mile).
Return to Silver City over the same route.

A WORD OF CAUTION: NEVER ENTER OLD MINE WORKINGS. TO DO SO IS EXTREMELY DANGEROUS BECAUSE OF BAD AIR, ROCK FALLS, ETC.

16.9 Stop sign; turn left back onto State Highway 180
2.0 (blacktop).

18.9 Emory (black) oak trees and staghorn (cane) cholla
5.8 cacti are abundant for the next 3 miles.

24.7 Yucca plants (the State flower of *New* Mexico) are
1.0 scattered over the hills .

25.7 At left, again we see the chocolate-brown dumps
1.5 and open pits of the Boston Hill district.

Entering Silver City. Continue straight into town
27.2 on Cooper Street.
0.4


Yucca

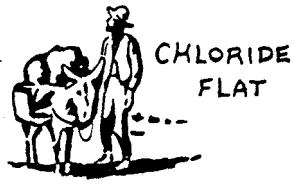
27.6 Stop sign; turn left onto U. S. Highway 260 (Market
0.9 St.). We'll be on Highway 260 for the next 3 miles.

28.5 To left, more chocolate-brown dumps and open pits of the
0.3 Boston Hill mining district.

28.8 Crest of hill.
.4

29.2 STOP C. CHLORIDE FLAT. Pull off on right side of highway at bottom of hill just before highway crosses arroyo.

The flat-bottomed valley to the right rear is the site of the Chloride Flat mining district. Here was located the silver deposit, found by John Bullard in the spring of 1870, which led to Silver City's founding and early growth.



The silver ore was found just below the surface -- a "grass roots" deposit -- in irregular masses and VEINS (sheets of minerals along cracks cutting through the rock). The chief mineral was cerargyrite (soft, waxlike silver chloride, commonly called "horn silver"). Chloride Flat takes it name from this chloride mineral.

1.7

Most of the rich ore was mined in the first few years, although some mining continued until the 1930's. Over $3,300,000 worth of silver was produced. Much of the ore was smelted locally in crude adobe furnaces.

Today, only a few, small dumps remain.

Continue on Highway 260.

30.9 Continental Divide (6, 230 ft). TURN AROUND and return to Silver City.

After turning around, the Boston Hill dumps and open pits are seen ahead. Farther ahead, to the right, is the smokestack of the Hurley smelter. The high peak behind and just to the right of the stack is Cooks Peak (altitude 8,400 ft), in the Cooks Range.

U. S. Highway 260 continues northwest around the Mogollon Mountains. Mogollon, an old gold mining camp in a deep, narrow canyon in the rugged Mogollon Mountains, is well worth visiting. (Continue on Highway 260 to just north of Alma; turn right on State Highway 78,a good dirt road, which goes through Mogollon, 80 miles from Silver City.) On the way to Mogollon, an interesting side trip can be made to the "Catwalk," a very narrow, spectacular, slotlike canyon through which a walkway has been built, suspended over the creek. (At Glenwood, turn right on dirt road at the State Historical Marker describing the Catwalk. Drive 5 miles; at end of road, follow trail through turnstile one-eighth mile to Catwalk.

2.6

33.5 Silver City limits. Continue through town by following U.. S. Highway 260 signs.

2.3

35.8 Junction with State Highway 25. Turn left on Highway 25, to Pinos Altos.

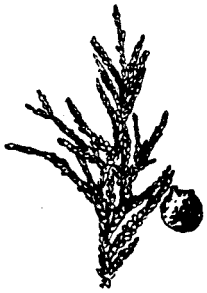
0.6

36.4 Curve to left; continue on Highway 25.

5.0

The little trees along the highway for the next 6miles are juniper (scalelike "leaves" and blue berries; commonly called cedar) and pinon pine (the State tree of New Mexico).

Pinon pine



Juniper

Ahead and to the left are yellow-brown and gray dumps of the mines of the Pinos Altos district.

41.4

0.3

41.7

Notice the round boulders on both sides of the road. The same rock, granodiorite (an igneous rock much like granite), of which the boulders are made, is exposed in the roadcuts. The rounded boulders were formed by weathering of the bedrock.

0.5

Continental Divide (7,007ft). On the right is an old mine dump overgrown with trees. There are many peach and

42.2

apple orchards in this area, a beautiful sight in the spring.

0.3

Enter Pinos Altos . Blacktop ends; take left fork and follow the loop tour of town as shown on map.

42.5

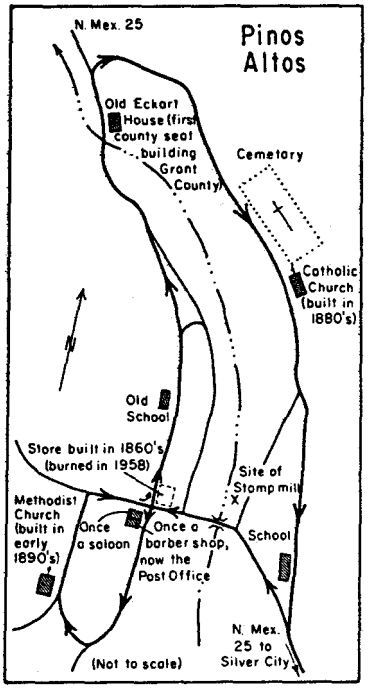
Pinos Altos (Spanish: tall pines) is named from abundant Ponderosa pines -- tall, straight trunks with yellow-brown or black bark.

The town sprang up in 1860, when placer gold was found in the surrounding gulches.

1.3

Ponderosa pine

PLACER gold deposits are formed when gold veins are eroded and the gold is carried away by a stream and then concentrated in a stream bed at the first spot where the stream no longer is moving swiftly enough to carry the heavy gold farther.



Prospectors soon found the "MOTHER LODE" (the veins from which the gold was eroded). Numerous mines were developed; among the more important were the Wild Bull, Pacific, Mountain Key, Deep-Down-Atlantic , Fortune, Kept Women, Ohio, Long, Mogul, Monmouth, Silver Cell, and Aztec. The gold occurred as native gold in quartz; silver also was found in the veins. Later, zinc-lead deposits were found on the other side of the mountain.

Many different methods were used to recover the placer gold. A common method was to wash the gold-bearing stream gravel through a SLUICE BOX (wooden trough with cleats fastened across the bottom at intervals). The heavy gold settled to the bottom and was caught by the cleats (RIFFLES). To prevent the loss of the finer gold flakes, mercury was placed in the riffles; the gold and mercury combined to form AMALGAM, which was easy to recover. DREDGES ("boats" using dragline shovels or endless chains of buckets to scoop the gold-bearing gravel out of the bank of the pool in which they float) were also used.

Over $8,000,000 worth of gold, silver, zinc, lead, and copper has been produced in the Pinos Altos mining district.

The Apaches frequently raided the town. On September 27, 1861, some 500 Apaches, led by Cochise and Mangas Coloradas, attacked the town; the miners fought back, killing over a dozen Indians. But the raids continued, and during Indian scares the town often was almost deserted. The story is told that the miners finally entered into a pact with the Apaches. A large cross was erected on a prominent hill; there would be no killings as long as the cross remained.

Neat houses with flower-filled yards show that many people still live in Pinos Altos. The mines are closed--only the tree-covered dumps and crumbling mine shafts hint of the boom days -- but people still "pan" for gold along the gulches and still find thumb-size nuggets.

43.8 Make sharp right turn up hill.

Highway 25 continues ahead through the beautiful Gila National Forest. A scenic loop drive, known as the Inner Loop, can be made by following Highway 25, then continuing southeast on Highway 61, and finally turning west on Highway 180 to Silver City (a 70-mile, 3- to 4-hour drive). A short distance beyond Pinos Altos, the piles of gravel along the gulch are the remains of gold placer mining. There are campgrounds and picnic areas along the road, and lots of good hunting and fishing country.

1.0

Seventeen miles beyond Pinos Altos, the Copperas Canyon Truck Trail (for jeeps or high-centered pickups and carryalls with compound low gear) turns north into the Gila Wilderness Area and the Gila Cliff Dwellings National Monument. (For pack trips or other information about this area, write the Silver City Chamber of Commerce.)

44.8 Blacktop begins. Return on Highway 25 toward Silver City.

6.7

51.5

1.0 Stop sign; turn left onto 4-lane, divided U. S. Highway 260.

52.5 Roadcuts for the next 3 1/2 miles expose SANDSTONE (rock made of sand-size grains) and SHALE (rock made of fine clay-size particles that breaks into paper-thin layers).

4.9

The beds are hard to see because the rocks have been badly FRACTURED (cracked) and FAULTED (offset along cracks).

57.4
0.9

At right, roadcut exposes white TUFF (small pieces of ash blown out of a volcano whichhave settled to the ground and formed a thick layer; often blown into "drifts" by the wind or washed away and redeposited by streams).

58.3
0.4

Crossroad; continue straight ahead.. Town of Central to right; to left, Fort Bayard, built in 1 8 6 7 to control the Apaches, now a veteran's hospital.

58.7
.2

Turn left onState Highway 180 to Hanover and Santa Rita.

58.9
2.2

At left, Peerless mine (inactive), most westerly mine of the Central mining district. Gold and some lead and zinc occur in narrow, nearly vertical veins.

61.1
0.2

Historic marker: " Kneeling Nun."

On the skyline, 3 miles to the south, is the Kneeling Nun, named for its resemblance to a nun kneeling before a giant altar. Numerous legends have grown up around this famous landmark.

61.3
2.2

At left, dumps and old headframe of the Copper Flat mines. Some copper, lead, and zinc was mined here.

63.5
0.4

Turn left, just before Highway 180 crosses railroad track, onto blacktop road to Hanover and Fierro.

63.9
1.0

Bear to right past Hanover zinc mine headframe and surface plant (Empire Zinc Division of the New Jersey Zinc Co.). Road continues north along Hanover Wash and the Santa Fe Railway branch line, and pass es through the town of Hanover. Old adits , dumps , trestles , ore bins , abandoned mills, and headframes cover the hills.

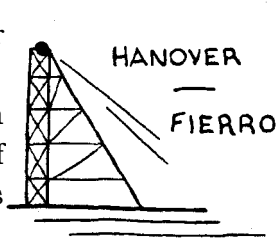
64.9
1.3

The many open pits in the hills ahead to the right were mined for iron ore.

66.2
0.3

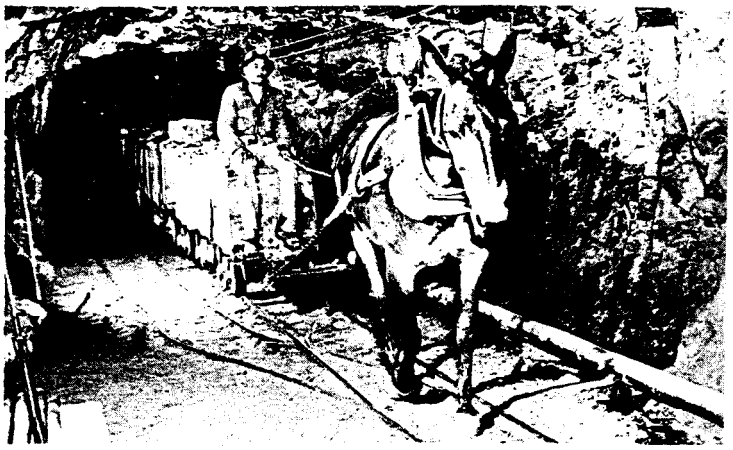
Town of Fierro (Spanish: iron).

66.5 End of blacktop. TURN AROUND and return over same route to Highway 180.



The Hanover-Fierro mining district through which we have been driving includes two different groups of mines: iron mines around Fierro, and zinc mines around Hanover.

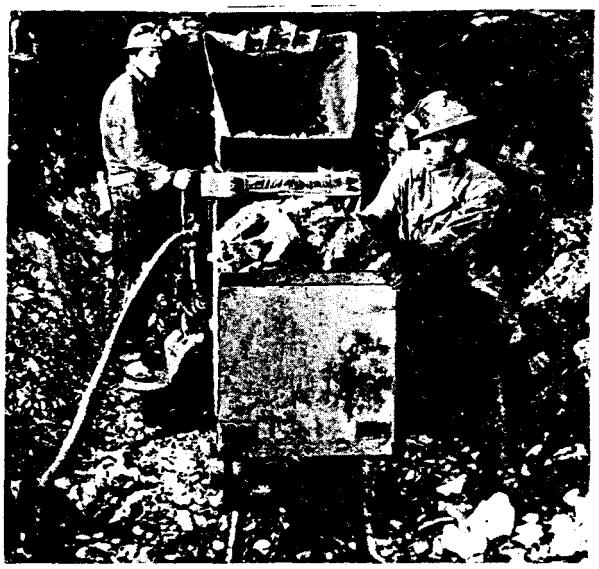
After the Santa Fe Railway reached Hanover in 1891, both the iron and zinc ores could be mined profitably. Early mining was by open pits; later more deeply buried ore bodies were mined by underground methods. Over 4,000,000 tons of iron ore has been produced, much of it



Mule haulage, Hanover.

being shipped to the Colorado Fuel and Iron Co. , at Pueblo, Colorado. Nearly all the iron mines have been closed since 1932. Large-scale underground zinc mining started in 1910 and has continued intermittently since then.

Hanover Wash cuts through the center of a large body of quartz monzonite (an igneous rock much like granite). This rock pushed up into LIMESTONE (rock formed on an ocean or lake bottom when lime, calcium carbonate, crystallized out of the water and settled to the bottom) and other rocks as a molten mass, then cooled and solidified.



Loading "muck,"

Hanover.

As the quartz monzonite cooled, it gave off water containing dis solved minerals; the water penetrated and dissolved away part of the limestone and deposited the iron and zinc ores in its place. The main mineral in the iron ore is magnetite (black, heavy iron oxide; will attract a magnet); the main zinc-ore mineral is sphalerite (black, zinc sulfide, a combination of zinc and sulfur). The iron ore bodies occur around the north end of the quartz monzonite mass; the zinc ore bodies occur around the south end.

2.9

69.4

0.1

Stop sign; turn left onto Highway 180.

69.5

0.2

To the right, on hill, the headframe ofthe Princess shaft (zinc and lead mine of the U. S. Smelting Refining & Mining Co.).

69.7

0.1

To the left, Oswaldo No. 1 headframe and shaft of Kennecott Copper Corp. zinc mine.

69.8

0.3

Continue straight ahead; blacktop road turns off to right.

70.1

0.3

To the left, dumps and headframe of the Kearney mine (Peru Mining Co. zinc mine). In the distance, about 1 mile to the north, are the headframe and buildings of the
Pewabic zinc mine.

70.4 (0.1) Continue ahead and slightly to the left on Highway 180.

70.5 (0.2) To the right, the Santa Rita shopping center and huge Santa Rita mine .

70.7 (0.7) To the right, headframe of the Oswaldo No. 2 shaft of the Kennecott Copper Corp. zinc mine. This shaft is connected to the Oswaldo No. 1 shaft, seen earlier, by a tunnel three-fourths of a mile long.

71.4 (1.1) Turn left off Highway 180; continue straight ahead through settlement.

Highway 180 continues straight ahead, crossing the Black Range and then passing through the old mining camps of Kingston and Hillsboro. It connects with U. S. Highway 85 in the Rio Grande Valley (60 miles).

72.5 (0.6) Bear right on most traveled road. Less well traveled road continues straight ahead; a second road turns off to left. Stay on most traveled road all the way to Georgetown.

Gray limestone is exposed along the road for the next 3 miles.

73.1 (2.0) Gila National Forest boundary.

75.1 (0.5) Ahead, view of Mimbres Valley and Black Range beyond.

75.6 (0.3) On left, old Georgetown graveyard.

75.9 (1.0) Starting down hill, we begin to see the old dumps of the Georgetown mines . From bottom of hill, roadcuts expose black, platy shale for next 0.5 mile. Notice that the dumps are not made of shale; the workings extend through the shale into lighter colored igneous rocks.

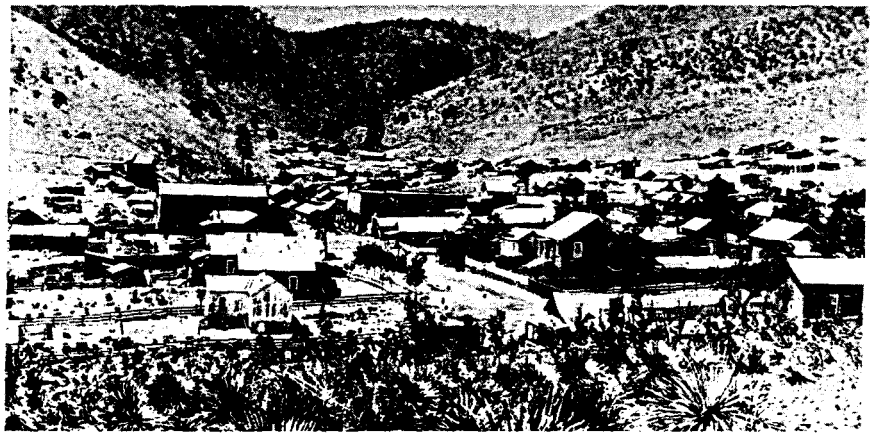
76.9 (0.1) Entering Georgetown. Buildings were torn down during World War II when building materials were scarce.

77.0 (0.2) Continue straight ahead. Road (poor) to right continues on to Mimbres Valley.

77.2 (5.8) Crest of hill. TURN AROUND and retrace route to State Highway 180.

Silver was discovered here in 1866. The camp boomed until the

early 1890's, when the falling price of silver forced the mines -- the Naiad Queen, Commercial, and MacGregor -to shut down. Almost overnight Georgetown became a ghost town. Over $3,500,000 worth of silver was produced.



New Mexico Magazine

Georgetown during its boom.

83.0 Stop sign; turn right onto Highway 180.

0.7

83.7 Again, on left, Oswaldo No. 2 shaft.

1.3

84.0 Turn left onto blacktop road just past gas station. Follow the signs and arrows to Visitors Lookout.

1.1

85.1 STOP D. VISITORS LOOKOUT -- SANTA RITA MINE.
Park your car and walk to the white lookout platform.

* * * * *

We are standing at the edge of one of the largest mines in the world, the Santa Rita open-pit copper mine. At first glance, it looks as if the mine were shut down even when operating full blast. But after looking for a while you will see all sorts of activity -- electric shovels filling railroad cars and trucks, trains coming and going, drills cutting holes, and here and there men working.

Santa Rita is not only one of the biggest but also one of the oldest copper mines in the United States. But, first, before relating Santa Rita's colorful history, let me describe what we can see from here. (Mining progresses so fast that by the time you visit Santa Rita, the description may be inaccurate. But figures, even though outdated, will help give you an idea of its huge size.)

It is difficult to realize the tremendous size of the pit and the mining equipment. From the point where we are standing, the pit is slightly over a mile across, and the bottom is 700 feet below us. The pit is 980 feet deep from its highest to lowest point (in 1959). Each BENCH ("step") is 50 feet high.

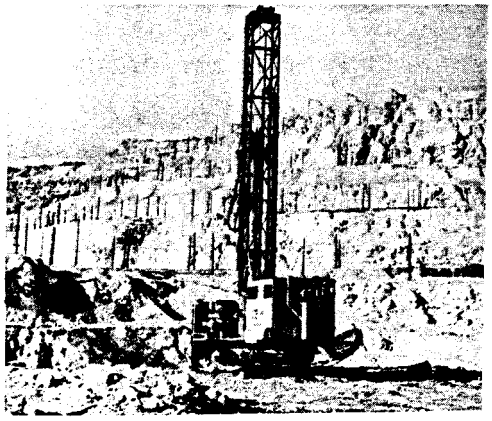
THE MINE'S JOB IS TO GET THE ORE OUT OF THE GROUND. The mining methods used at Santa Rita are different from those used in the other mining districts you have just visited. Here, MASS MINING (both the ore and waste are dug out of the ground and carried away) is used; in contrast, the other mines do SELECTIVE MINING (the ore bodies or veins are removed, but the barren rock is left in place). Santa Rita also is an OPEN PIT; most of the other mines are UNDERGROUND mines. Mass, open-pit mining with big, modern machines is, in a way, much cheaper than selective, underground mining with small machines and more hand labor. Although the initial investment is great, more tons of ore can be mined for the same cost, offsetting the lower value of each ton of the lower grade ore. This does not automatically me an higher profits per ton of ore, but it has a much more important result more ore can be mined. Waste has literally been changed into ore; jobs and copper have been "created."

Operating normally on a 7- day-week, around-the-clock schedules, 67,500 tons of rock are mined every day. Only 22,500 tons of this is ore which is sent to the mill; 45,000 tons of rock is hauled to the "waste" dumps. (As you will see later, copper is removed even from this "waste.") The ore averages less than 1 percent copper. On the average, only 15 pounds of copper are recovered per ton (2, 000 pounds) of ore:

Before any mining is done, a series of holes are drilled. From the rock "cuttings" removed from the drill holes, the grade, size, and shape of the ore body can be determined. This information is used to plan future mining for years ahead.

The benches ("steps") provide flat places on which the drills, shovels, trains, and trucks can operate.

The first step in mining is to drill 12-inch holes 60 feet deep into the 50-foot benches. Electric-powered ROTARY DRILLS (the tall tower like affairs seen here and there in the pit) do this work. The actual drilling is done by a bit on the end of a long rod. The rod and bit rotate, and push and cut their way down through the

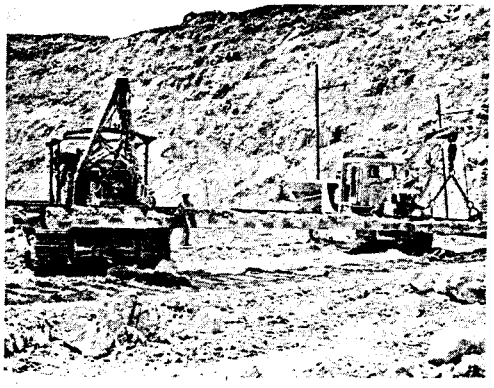


Kennecott Copper Corporation

A rotary drill, Santa Rita mine.

solid rock, much like a power drill. High-pressure air is forced down the center of the rod and blows the "cuttings" out of the hole, at the same time cooling the bit. One of these drills can "make" 200 to 400 feet of hole in an 8-hour shift. The rock is so hard that the drill bits wear out after 3 or 4 days.

Detonating fuse, with an electric blasting cap on the end, is used to connect the holes to be blasted. Powder (ammonium nitrate; also used as fertilizer) is poured into the holes (on the average 650 pounds per hole, the amount depending on the type of rock and how badly it is cracked). Then the holes are filled with STEMMING (in this case, screened dirt or cuttings from the hole) in order that the main force of the explosion maybe directed sideways into the rock rather than be dissipated by blowing upward through the drillhole.



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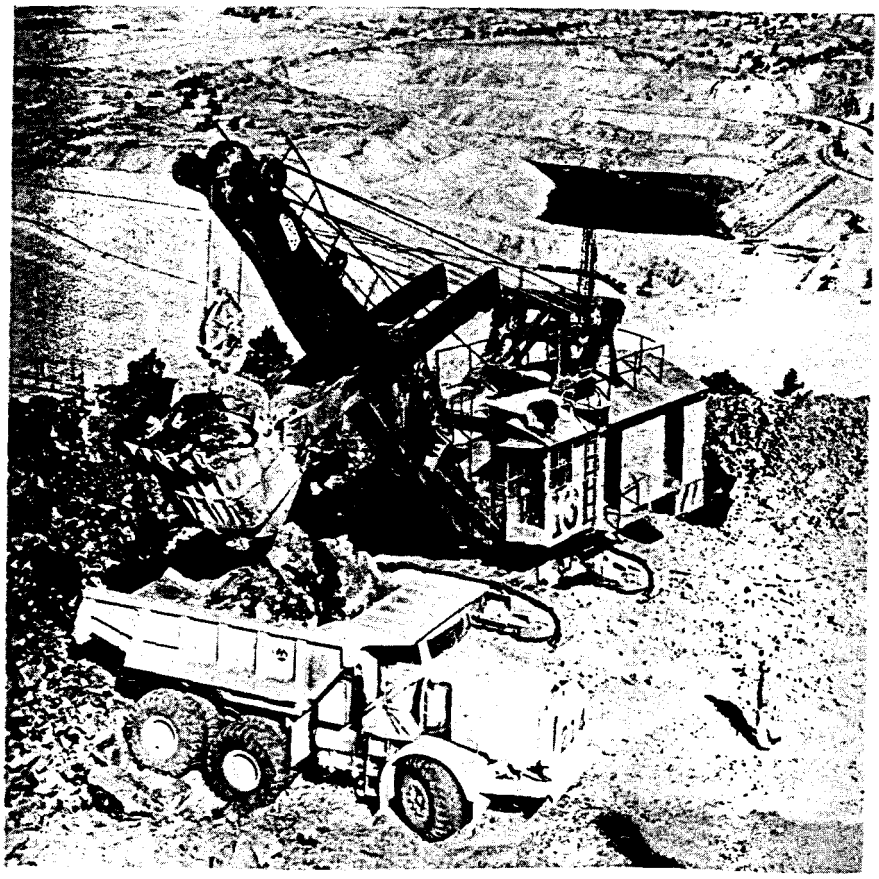
Bulldozersmoving track, Santa Rita mine .

Blasting is done at all times of the day. Before each blast, a warning signal is sounded (10 short toots followed by another signal indicating the location of the blast within the pit). Boom,

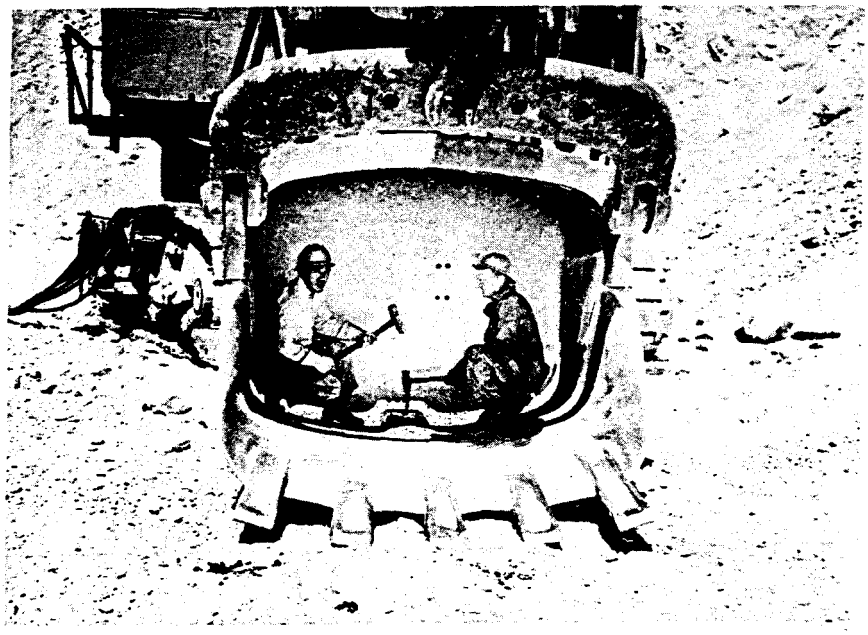


Kennecott Copper Corporation

Shovel loading truck, Santa Rita.

the blast goes off: Puffs of dust shoot from the holes, the rock rises slightly and settles back in a heap. It is not very spectacular. As many as 60 holes are shot at a time, using up to 50,000 pounds of powder and breaking as much as 250,000 tons of rock. The broken rock is scooped up by giant, self-propelled, electric SHOVELS and loaded into either waste or ore cars depending on how much copper is in the rock. There are 10 of these big

fellows scattered on the benches. All but one can scoop up 5 or 6 cubic yards (10-13 tons) at a time and load up to 4,500 tons per 8-hour shift; one supergiant can handle 8 yards (17 tons). When



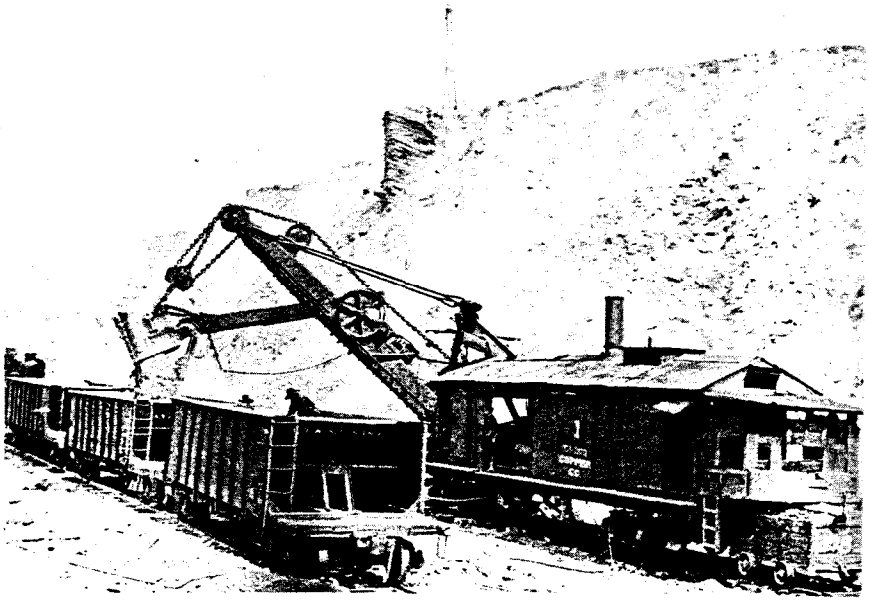
Kennecott Copper Corporation

Workers in shovel bucket.

the pit was first started, smoke-belching 31-yard (7-ton) steam shovels mounted on rails were used.

Eighteen electric LOCOMOTIVES, each weighing 85 or 125 tons, haul 7- to 10-car trains of ORE CARS (solid bottoms with high sides, holding 80-90 tons) or WASTE CARS (side-dump with low sides, holding 60-80 tons) out of the pit, zigzagging back and forth, with the locomotive first pushing, then pulling. The waste cars go to the dumps (to the extreme right of the Lookout); the ore cars go to the gathering yard and are made up into longer trains of 50 cars for the haul to the mill. Steam locomotives were used prior to the introduction of the more efficient electric equipment.

Train movements are directed by radio phone from a control tower. Lights on a control board show the location of each train. Most of the main switches are controlled electrically from the tower.



Shovel No. 1 below old Spanish shaft in 1915.

Over 40 miles of track circles the pit. Because it must be moved frequently, the track has been assembled in prefabricated sections, much like track for toy trains. Working in pairs, bull-dozers with special booms move the sections of track to the new location, where they are rebolted together.

TRUCKS are used to haul the rock from the hard-to-reach spots where the trains can't go. The "small" trucks carry 25 tons; the "big" trucks haul 40 tons. Yellow "school" buses convey the men to and from work.

A new system, SKIP HOISTING, is planned to simplify the long haul out of the pit. Cables will pull loaded "cars" straight up the side of the pit on steeply inclined tracks. (Possibly this system will be in operation -- to the right of the Lookout -- by the time of your visit.)

Water is both a problem and a resource. To prevent the pit from becoming a lake, water is collected in a pond at the bottom of the bigger South Pit, then pumped up to a storage pond in the North Pit (to the left). This water, which contains dissolved copper, is used in leaching operations (more about this later). Santa Rita Creek ran across what is now the middle of the pit. To prevent a cloudburst from suddenly filling the pit bottom, a concrete-lined

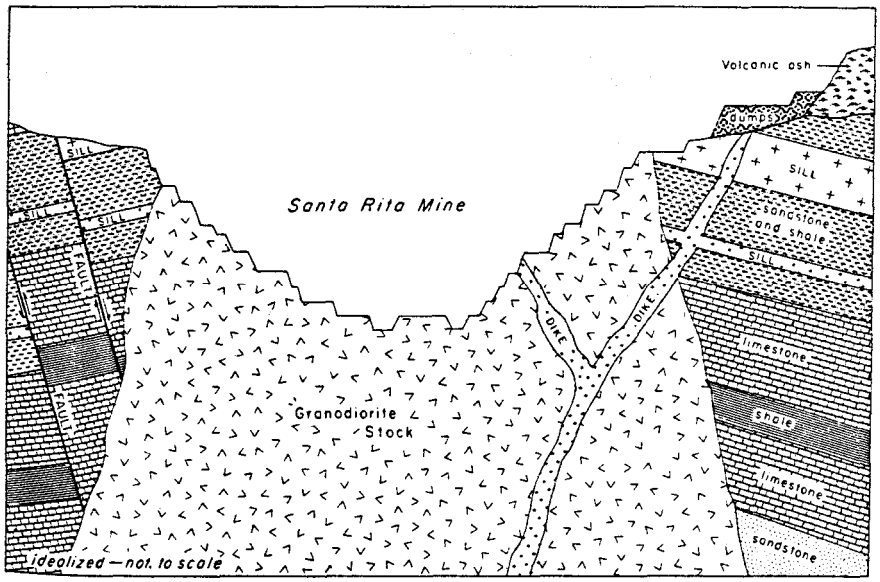
flume (passing directly below the Lookout) was built to divert any such flash flood around the pit edge.

* * * * * * *

The geology at the Santa Rita mine is rather complicated. The rocks have been broken and moved around into a jumbled-up mess, and are so badly altered that it is difficult to tell what they once looked like. But by careful study, the geologist, using clues like a detective, can piece together the story of how the copper got where it is, even though much of the evidence has been destroyed. So much of the evidence has been destroyed that some details of the geologic history are not known with any certainty. Many geologists will not agree with all the details as they are described below.

Millions of years ago, oceans covered this area. SEDIMENTARY rocks (limestones, shales, and sandstones) formed on the ocean floor and along the shore, and slowly piled up into a thick layer. Later, forces within the earth folded and cracked these rocks.

Some 70 million years ago, great masses of hot, pasty IGNEOUS rock (rock formed by the cooling and hardening of molten "rock") began to force their way upward from deep within the earth,



Cross-section through the Santa Rita mine.

forming DIKES (sheets of once-molten rock which filled cracks cutting other rocks), SILLS (sheets of once-molten rock between layers of sedimentary rock), and STOCKS (dome-shaped masses of once-molten rock cutting other rocks).

The Santa Rita open pit is in one of these STOCKS. As the hot, pasty rock forced its way upward, it cracked the surrounding rocks and the top of the stock, which had already cooled enough to be somewhat solid. Hot water, containing dissolved minerals, was driven off as the rock cooled. The water found its way into every tiny crack in the badly cracked rocks and deposited the dissolved minerals as pyrite (combination of iron and sulfur), chalcopyrite (combination of iron, copper, and sulfur), and other minerals. But less than 2 pounds of copper was deposited in each ton of rock, too little to be mined profitably.

Later, the overlying rocks and the top of the stock were eroded away. Rainwater and air trickled down along the many cracks, causing the pyrite to decompose and form sulfuric acid and iron sulfate. The acid, in turn, dissolved the copper-bearing chalcopyrite. The copper-carrying water continued to move downward along the cracks till the water table was reached; here the copper reacted with the pyrite and deposited CHALCOCITE (a soft, black mineral made up of copper and sulfur).

The zone from which the pyrite and copper have been removed is called the LEACHED ZONE (the areas stained reddish-brown on the upper pit walls). The zone in which the chalcocite was deposited is called the ENRICHED ZONE (the green-stained areas on the lower pit walls); here the rock has been "enriched" till, in many places, it contains over 12 pounds of copper in each ton, enough to be mined profitably. The copper-bearing chalcocite is DISSEMINATED (scattered) through the rock as tiny specks and films along cracks. A very small amount of MOLYBDENITE (a greasy, black mineral composed of molybdenum and sulfur) also is disseminated through the rock.

Finally, volcanoes spewed out LAVAS (once-molten rock which flowed out over the land surface) and ash (which formed TUFF beds; the cliffs behind the pit are this type of rock), burying the copper deposit. Luckily, erosion later uncovered the deposit. Probably there are other similar deposits hidden by the blanket of volcanic rocks, a real challenge for the geologist.

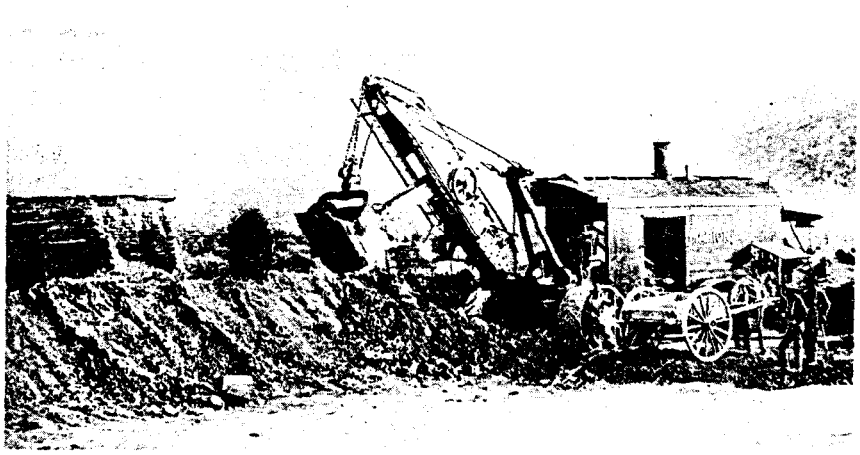
* * * * * * *

Santa Rita has a fascinating history as one of the oldest mines in the United States. Long before the coming of the white man, the Indians were using native copper. Copper bells and other ornaments and implements have been found in many ruins of the

Southwest. The Indians probably "mined" native copper from the abundant outcroppings at Santa Rita.

In return for a favor, an Indian told Lt. Col. Jose Manuel Carrasco, the Spanish commandant in charge of military posts in an area to the south, about the copper deposits and showed him a copper sample. He visited the deposit, likedwhat he saw, quit his job, and set out to make his fortune.

Around 1800, Carrasco began mining the native copper, but like many another mine owner, he did not have enough money to exploit his mine. In 1804, he sold his interest in Santa Rita to Don Francisco Manuel Elguea, a rich Chihuahua banker , who began major mining operations. Elguea obtained a crown grant, the Santa Rita del Cobre (Spanish: Saint Rita of the Copper) grant,



Kennecott Copper Corporation

Adobe tower of old Spanish fort-prison (at left) and early shovel.

from the Spanish Government and built the town of Santa Rita. He also built a combination fort-prison, a triangular structure with thick, round adobe towers guarding each corner, joined by strong adobe walls, to keep out the raiding Apaches and confine the Indian slave labor and convicts borrowed from the Spanish Government in Mexico to work the mine.

Mining methods were primitive. Vertical shafts were sunk, and from them horizontal passageways were driven along fracture s until a rich pond of native copper was encountered. The miners working on their hands and knees in the tiny pitch-dark holes, Picked the rocks to pieces and put them into rawhide bags. Then,

carrying the bags on their backs, they climbed out of the shafts on nearly vertical "chicken ladders" (poles in which notches had been cut for foot holds; the miners hung on by hugging the pole). On the surface, the ore was carefully sorted to remove any barren rock.

It was not the easiest or safest work in the world. Cave-ins were frequent, and many miners lost their lives. Legend has it that 50 miners were killed by one cave-in. Rawhide bags, chicken ladders, skeletons of miners killed by cave-ins, and other relics of these times have since been uncovered by open-pit mining.

At first, only native copper, needing no smelting, was mined. Later, rough smelting works were built, and the copper was extracted in a crude way from the other copper minerals.

The copper was shipped to Chihuahua and Mexico City by mule trains with military escorts, each mule carrying 300 pounds. In 1807, Zebulon Pike, the American explorer, stated that the mine produced 20,000 muleloads of copper a year. The entire production was used by the Royal Spanish Mint to make copper coins.

As if the hard and dangerous working conditions were not enough, the Apaches were a constant menace for many years, and the mines were closed down as often as they were worked. It took determined men to get any mining done.

After Elguea's death in 1809, the mine was worked until 1822 under various leases negotiated by his widow. After 1822, there were frequent changes in ownership and numerous lessees.

Sylvester Pattie was the first American to operate the mine. In 1812, he and a party of trappers (16 men, all that were left of a party of 116 after numerous attacks by the Apaches) were stranded at Santa Rita when the Indians ran off their horses and stole their furs and supplies. Seeing a chance to recoup his losses, Pattie arranged a lease for 5 years at $1,000 per year. He managed to keep the Indians in check and was doing well until, in 1827, he sent a clerk to Santa Fe with $30,000 in gold to buy supplies. So large a sum was too big a temptation for the clerk; Pattie never saw the money or the clerk again. He was ruined and had to give up the mine. A year later he died in a California prison while being held as a spy.

Robert McKnight was another of the bold, determined men who tried to operate the mine. In 1812, he was one of a group who

loaded a caravan with trade goods and headed for Santa Fe , only to be arrested there as a spy and imprisoned in Durango, Mexico, for 9 long years. While in jail, he heard of the fabulous Santa Rita copper mine and, when finally released, headed there and took a lease. But the Apaches caused so much trouble that he was forced to abandon the mine. For a short time, Kit Carson worked for McKnight as a teamster.

In 1837, before McKnight arrived on the scene, a group of trappers had invited the Apaches to a party near Santa Rita. Suddenly, a hidden cannon, with one blast, killed most of the Indians. The chief of the Mimbres Apaches was killed. His successor, Mangas Coloradas (Bloody Sleeves), lived to make the white man rue the day of the massacre.

During the Civil War, the Confederate Army occupied Santa Rita and used the old adobe fort as an outpost.

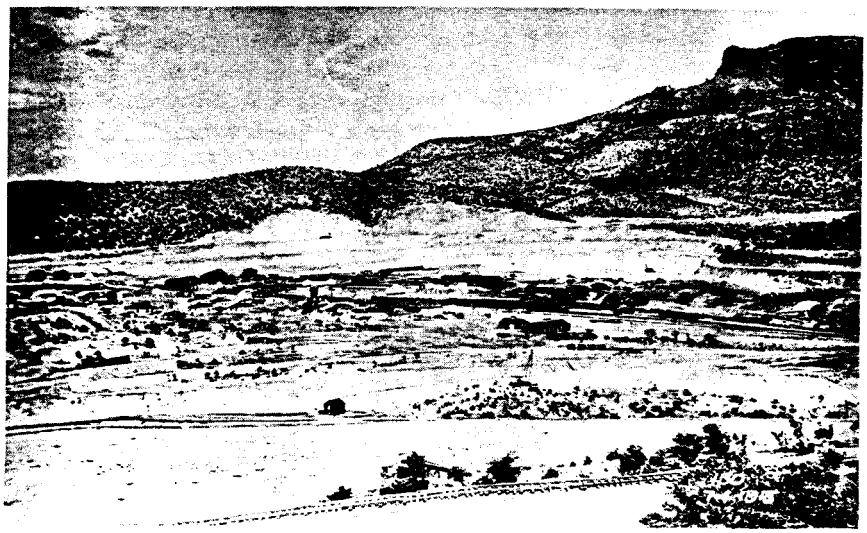
In 1873, Martin B. Hayes appeared on the scene. He is remembered chiefly as the man who cleared the title to the mine. Elguea's heirs still owned the property, and Hayes had to track down and settle with each and every one of them, scattered all over Mexico and Spain. Taking no chances, he further strengthened his title by laying out 45 mining claims'.

After a series of leases, options, sales, and mergers, the property is now the open-pit mine of the Chino Mines Division, Kennecott Copper Corp. , which also operates a mill and smelter at Hurley.

After the Apaches were finally subdued in the 1880's, a completely new problem had to be faced. Eighty years of underground mining had removed most of the high-grade ore (ore with more than 10 percent copper), and the lower grade material couldn't be mined profitably. Santa Rita was about played out and, unless something changed, soon would become just another ghost town.

In 1905, John M. Sully, a young mining engineer fresh out of MIT, was given the task of determining Santa Rita's future possibilities. After collecting and assaying over 4,300 samples, he found that there was a tremendous amount of copper ore left, but that it contained less than 2 percent copper. Impressed by the huge size of the ore reserves, he suggested in his report that steam shovels should be used to open-pit everything, both veins and low-grade deposits -- the lower mining cost would offset the lower value per ton. Sully's boss rejected the idea but allowed Sully to find other backers. In 1910, open-pit operations were started. Waste had been turned into ore.

The NORTH PIT (to the left of the Lookout) was the first area to be open-pitted. The old underground workings were in this same area. Until a few years ago, part of the town of Santa Rita, as



Kennecott Copper Corporation

Santa Rita in 1915 -- as it would have looked from the Visitors Lookout. Buildings at left are in area of what is now the "island"; much of the remaining area is now in the pit.

well as the company offices and shops , were located on the "island" in the center of the pits. Everything has now been removed to get at the ore below.

* * * * * * *

0.8 Let's continue on our drive. TURN AROUND and follow the road on which we came.

85.9 After climbing up steep hill to stop sign, turn left on blacktop road.

0.4

86.3 Ahead, the huge waste dumps of the open pit.

0.5

86.8 To the left, shops of the Santa Rita mine.

0.4

87.2 Road junction; continue straight ahead.

0.5

87.7 On left, next to road; old Ivanhoe shaft and headframe.

0.2

87.9 STOP E. Pull off on left side of blacktop at entrance to Ground Hog mine. CAUTION -- BLIND CURVE AHEAD.

Below is the Star shaft of the Ground Hog mine (American

Star shaft of the Ground Hog mine and (at left) the Kennecott leaching plant.

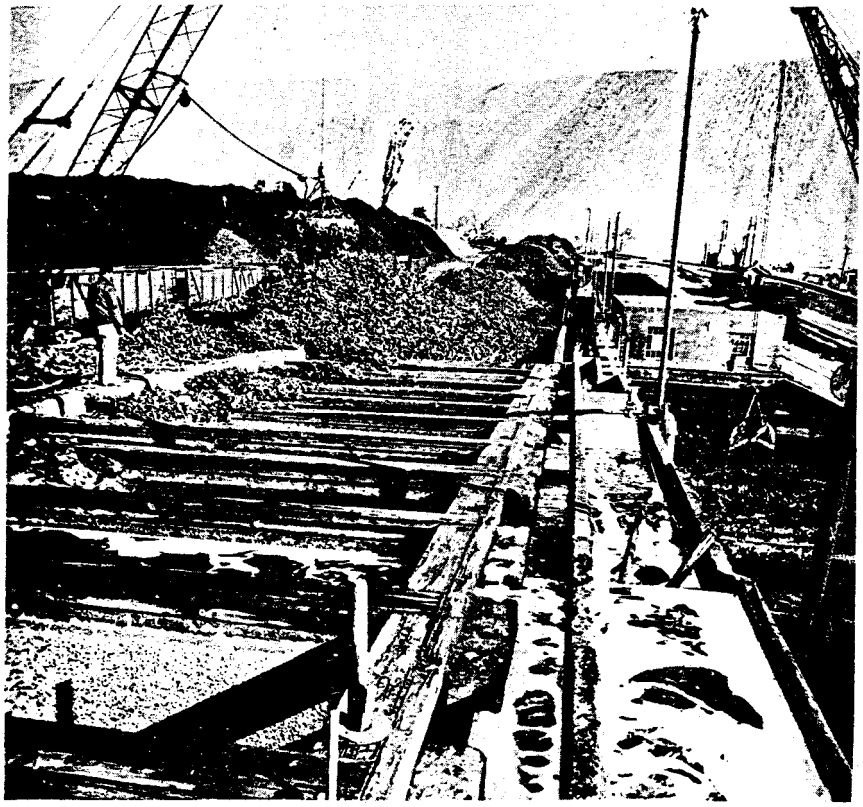
Smelting & Refining Co. lead-zinc mine). To the left of the shaft is the Kennecott leaching plant.

* * * * * * *

Even the small amount of copper in the waste dumps is being recovered by the LEACHING PLANT. Water containing acid is pumped into ponds on the dumps, trickles down through the loose rock, dissolving the copper minerals, and then seeps out at the bottom of the dump. The water, now bright green with dissolved copper, is collected and run through vats filled with "tin" cans. The copper water reacts with the iron cans and deposits powdery bits of copper metal on the cans. As more and more copper metal forms, the cans are completely eaten away, and more cans must be added (piles of cans can be seen). The water, now clear, colorless, and copper-free, is pumped back up onto the dumps (notice the pumphouse and pipes going up the hill) and recirculated. The red copper precipitate is shipped to the Hurley smelter. About one-fourth of the total copper produced from the Santa Rita mine comes from the "waste" dumps.

* * * * * * *

There are many zinc and lead mines in the area to the northwest and west of Santa Rita. The ore occurs both in VEINS (sheets of minerals along cracks) and ORE BODIES (masses of ore). Galena (silvery cubes; combination of lead and sulfur) and sphalerite (shiny-black; combination of zinc and sulfur) are the minerals



Kennecott Copper Corporation

The leaching plant vats being filled with cans by a magnet-equipped crane. "Clam shell" at right is loading the copper precipitate into railroad cars . Santa R ita's waste dumps loom up in the background.

mined. Some mines have only zinc, others have lead and zinc mixed together.

The mining methods used in these underground mines vary greatly. Holes are drilled in the ore body or vein with jackhammerlike drills powered by compressed air. Dynamite is placed in the holes and the ore blasted down. Often the rock is solid enough so that no timber is needed in the STOPES ("rooms" from which the ore is mined). If there is danger of caving, wooden timbers are used to hold up the BACK ("ceiling").

As ore is blasted out of the "ceiling" of the stope, waste rock is placed on the floor to make a "platform" on which the miners can

stand while drilling, the stope moving slowly upward as mining continues. This method is called OVERHAND (upward) CUTAND-FILL mining. Where no timbers are needed, the ore commonly is blasted from the stope floor, making a higher and higher "room." This method is called UNDERHAND (downward) OPEN mining. Many other methods are also used.

The broken ore is loaded into cars on narrow-gage track and hauled out through DRIFTS (horizontal "tunncls" following or paralleling the ore) and CROSSCUTS (horizontal "tunnels" that do not follow or parallel the ore), then hoisted up SHAFTS (vertical or inclined "tunnels" extending to the surface) in SKIPS ("buckets"), and dumped into an ore bin before being taken to the mill.

* * * * * * *

Turn back onto highway and continue ahead.

0.7 Cross bridge over Hanover Wash. To left is another shaft of the Ground Hog mine.

88.6
0.2 Ahead, headframe and surface plant of the Bullfrog mine (U. S. Smelting Refining & Mining Co. lead-zinc mine).

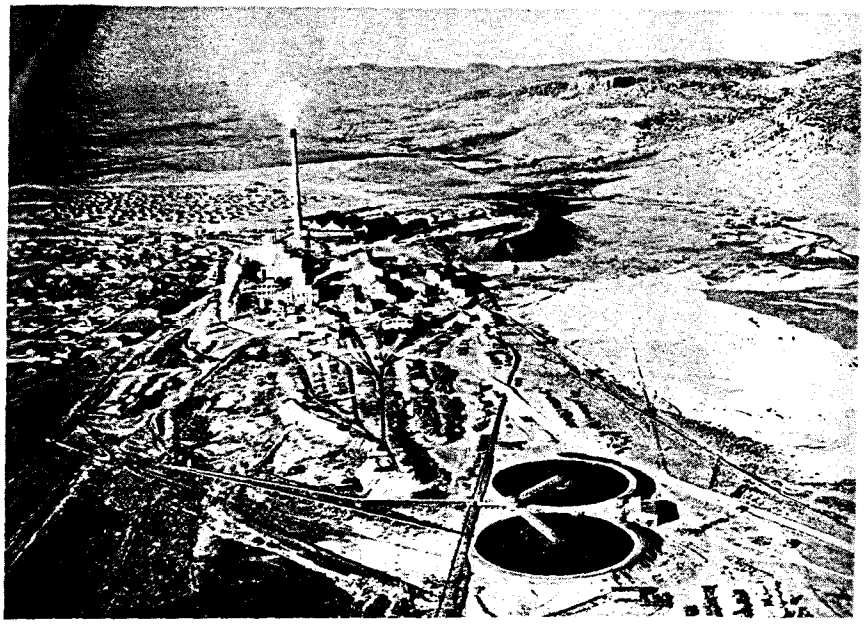
88.8
0.2 Crossing Fierro branch of the Atchison, Topeka & Santa Fe Railway. We have been following Santa Rita Creek and the Santa Rita branch
89.0 of the Santa Fe Railway.

1.8 The Santa Fe Railway is the connecting link between the Santa Rita mine and the Hurley mill. The ore cars

Kennecott Copper Corporation

Santa Fe ore train on way to Hurley.

(owned by Santa Fe) are made up into 50-car trains at



Kennecott Copper Corporation

Hurley -- town, mill, and smelter.

the mine and then hauled over the 10 miles of track to Hurley -- 7 or 8 trains every 24 hours.

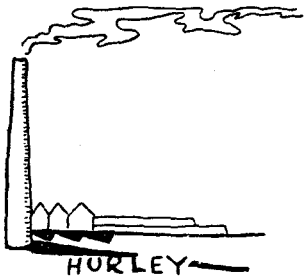
Diesels pull the trains once handled by steam engines. Although this is one of the busiest stretches of the Santa Fe Railway system, there are no passenger trains. Its main traffic is the copper ore, but it also hauls equipment and supplies and transports the refined copper to Kennecott's customers.

The Santa Fe is a vital part of New Mexico's mining industry, the hauler of "pay dirt, " supplies, and metal.

90.8 Bayard.

91.4 (0.6) Turn left onto blacktop road marked to U. S. Highway 260 and Deming.

91.6 (0.2) Stop sign; continue straight ahead on U. S. 260.



92.3 Ahead, to the left, 500-foot stack of the Hurley smelter.

3.5

95.8 Continue straight ahead; blacktop road to left to Hurley.

Hurley (population 2, 500) is a company town owned by the Kennecott Copper Corp. The mill, smelter, and refinery whichprocess the ore from the Santa Rita mine are here, as well as the general offices of the Chino Mines Division.

2.0

97.8 To the left, TAILINGS PONDS (the waste separated from the copper minerals in the mill).

END OF TRIP. We hope you have enjoyed the tour.

Highway 260 continues on to Deming, crossing the famous Butterfield Trail on the way (a State Historic Marker gives its history). The City of Rocks State Park -- weird rock formations -- is an interesting side trip (turn left off highway at sign 12 miles from end of trip; 5 miles on dirt road).

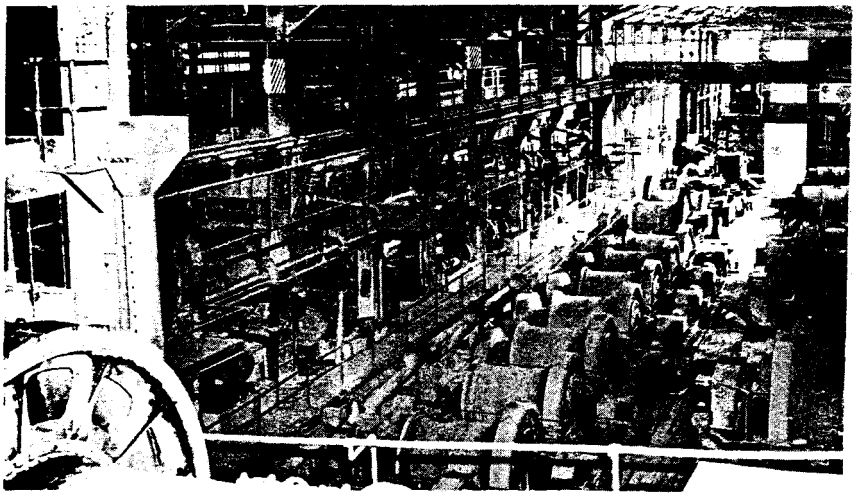
MILLING AND SMELTING

After the ore has been mined, it is still quite a job to turn the ore into metal. Kennecott's Hurley mill and smelter are good examples of how this is done.

* * * * * * *

THE MILL'S JOB IS TO SEPARATE THE VALUABLE MINERALS FROM THE ROCK. The railroad cars full of ore are dumped into the Hurley mill by a ROTARY DUMPER (a big cylinder into which a car is pushed and held tight; then the cylinder rotates, turning the car upside down and spilling out the ore -- taking less than 3 minutes per car). The ore then passes through a series of CRUSHERS which break the chunks into smaller and smaller pieces. A GRIZZLY (a heavy-duty "screen" made up of parallel bars) and VIBRATING SCREENS allow small pieces to bypass certain stages of crushing; a series of CONVEYOR BELTS carry the ore from one crusher to another.

The ore, now all less than quarter-inch size, is fed into BALL MILLS (large cylinders, lying on their side, containing iron balls).

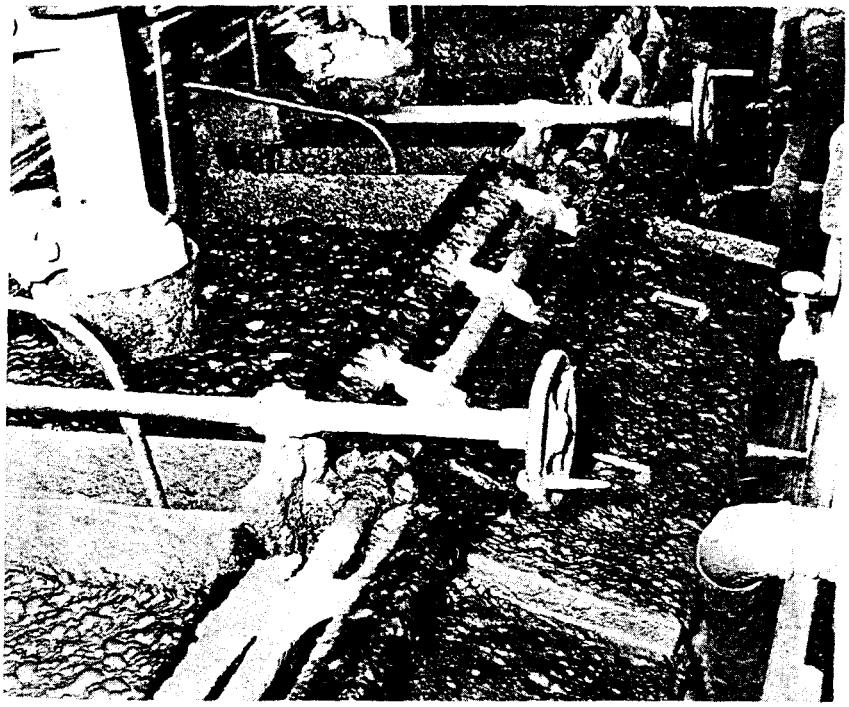


Ball mills, Hurley mill.

As the ball mills rotate, the 2- and 3-inch balls tumble around, smashing and grinding the ore. Water and ore are fed continuously into one end, and powdered ore pours out the other end into a tank. Any oversize particles settle to the bottom of the tank and are raked back into the ball mill by CLASSIFIERS, and reground. The grinding is done in 2 stages -- a total of 33 ball mills are used. Over 27,000 pounds of iron balls must be added every day. Not only do the balls grind the ore, but the ore grinds the balls until they are completely worn away:

The "muddy" water from the ball mills passes through THICKENERS which remove some of the water. It takes a lot of water (over 10,000 gallons per minute) to run the mill. Water is scarce in the dry Hurley area (the company wells produce only 4,000 gallons per minute); so as much of the water as possible must be saved and reused.

The water and fine particles of ore are mixed with various REAGENTS (chemicals and oils) and fed into FLOTATION



Flotation machines. Bubbles are coated with black molybdenite.

MACHINES (tanks filled with the mixture of ore, water, and reagents, through which air is forced, churning the mixture into a froth of oily bubbles). The tiny particles of the copper and molybdenum minerals stick to the oily bubbles and are skimmed, off the top of the tank; particles of the other minerals in the ore do not adhere to the bubbles and sink to the bottom. The various REAGENTS have different jobs: milk of lime is used to reduce the acidity of the mixture; pine oil makes the oily bubbles; xanthate coats the particles of copper minerals, helping them to stick to the bubbles. To separate out other minerals, different combinations of reagents would be used.

The TAILINGS (waste material) are carried in water out to the TAILINGS PONDS (which you have seen), where the particles settle out of the water and slowly build up a pile of waste. The water is recovered and reused.

The copper and molybdenum minerals sticking to the oily bubbles which were removed from the top of the flotation machines are steam-treated to destroy all the reagents, and cooled. Then another combination of reagents is added, and the mixture is run through more flotation machines , which separate the molybdenum from the copper.

The copper CONCENTRATES (the copper mineral chalcocite, with most of the waste' removed) are dewatered by a series of THICKENERS and FILTERS, then shipped to the smelter for further processing. The DRUM FILTERS are interesting devices; cylindrical frames lying on their sides and covered with cloth, they rotate, dipping into the "muddy" mixture. A vacuum inside the cylinder sucks the particles of concentrate, suspended in the water, onto the cloth. The vacuum is released, and the concentrate is blown and scraped off the drum. The water is saved and reused.

The molybdenum CONCENTRATES are also dried, packed in barrels, and shipped to the East for further processing. Molybdenum compounds are used to harden steel, for lubrication, in fertilizers, etc. As a metal, it can withstand extremely high temperatures -- an essential space-age metal.

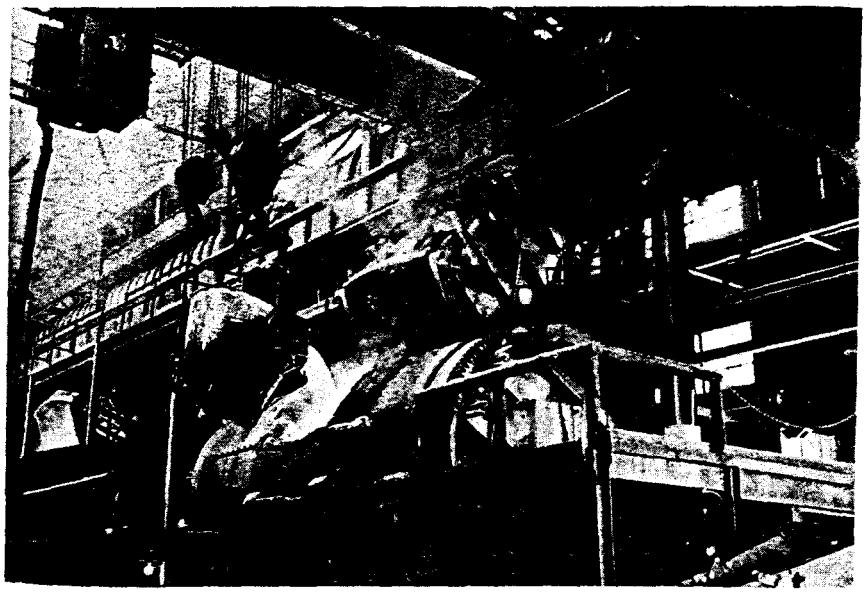
* * * * * *

THE SMELTER'S JOB IS TO CONVERT THE COPPER CONCENTRATES INTO COPPER METAL. The copper concentrates and copper precipitate from the leaching plant are mixed with crushed limestone, then fed into a REVERBERATORY FURNACE (a 120-foot hallwaylike affair made of fire brick to withstand the high temperatures). There are two furnaces, one being used while the other is being rebuilt or is waiting as a standby. The high

temperatures slowly melt away the bricks. The "reverb" is fired with natural gas supplied by the El Paso Natural Gas Co. The furnace uses 4,000,000 cubic feet per day (in contrast, Silver City uses 340,000 cubic feet per day). The burning gas heats the "reverb" to over 2,800°F. The concentrates and copper precipitate melt and separate into three substances: SLAG (molten waste), MATTE (molten copper with some iron and sulfur), and SULFUR DIOXIDE (gas).

The slag is light and floats on the surface of the molten "lake" in the "reverb." It is drawn off through holes in the furnace side, then hauled in SLAG POTS to the dump, where the still-molten slag is emptied from the "pots ," forming miniature "lava flows."

The sulfur dioxide gas passes out through the tall smelter stack, as do dust and gases from other smelter operations. The COTTRELL PLANT (produces static electricity through which the dusty gas is passed) removes 90 percent of the dust, 4 tons per day. The rest of the gas and dust escape through the 500-foot stack. Its great height allows the gas to mix thoroughly with the air, preventing damage to plants and animals. Heat is recovered from the gas and used to help run the power plant, one-third of the electricity used by the Santa Rita mine and the Hurley mill and smelter.



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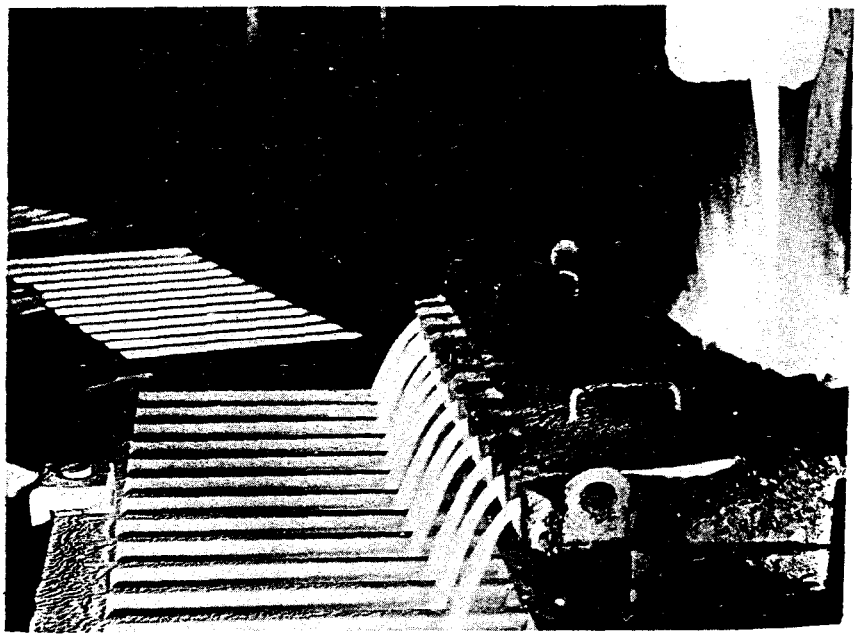
Ladle pouring into converter, Hurley smelter.

The heavy matte (copper, and iron sulfides)sinks to the bottom of the "reverb," is drawn off into a ladle, and then poured into the copper converters. In the CONVERTERS (cylindrical furnaces lying on their sides, each holding 65 tons of molten copper), silica FLUX is added, and air is forced through the molten "bath"; the iron is oxidized and combines with the silica to form slag. To remove the slag, the converter is tilted, and the slag poured out from the hole in its side. The air blowing through the molten mass also oxidizes the sulfur, forming gas which is carried off up the smokestack. No heat is added to keep the material molten. The oxidization process caused by the air blast creates heat; in fact, it is a problem to keep the converters from getting too hot'.

Now that the iron and sulfur have been removed, only BLISTER COPPER (99.4 percent pure, but still too impure for most uses) is left. The "blister" is transferred to the FIRE REFINERY FURNACE, where air again is blown through the molten copper, oxidizing the impurities, which float to the surface and are skimmed off. But now the copper contains too much oxygen. This is removed by "POLING" (sticking green pine logs into the



Pouring copper ingots, Hurley smelter.

molten copper; the logs burn and use up the oxygen). Finally, soda ash and charcoal are added to remove selenium, which is skimmed off as slag. The fire-refined copper is about 99.9 percent pure.

Most copper is electrolytically refined, making it possible to recover the small amount of gold and silver mixed with it. Ore from the Santa Rita mine contains so little gold and silver that its recovery would not pay for the extra expense of electrolytic refining.

The refined copper is poured into molds which move around on a CASTING WHEEL. On their way around, the molds are first sprayed with bone ash (to prevent sticking, much like a housewife greasing her breadpans) and then filled with copper. The copper partially cools as the molds continue on around the wheel, the ingots being dumped into water for final cooling.

Copper has many uses. Because it conducts electricity especially well, copper is widely used as wire, the biggest market for copper. It also is a good conductor of heat, being used in car radiators and cooking utensils. Other valuable properties are its excellent corrosion resistance (copper tubing, etc.) and ductility (ease of being drawn into wire). Brass is a mixture of copper and zinc; bronze is a mixture of copper and tin.