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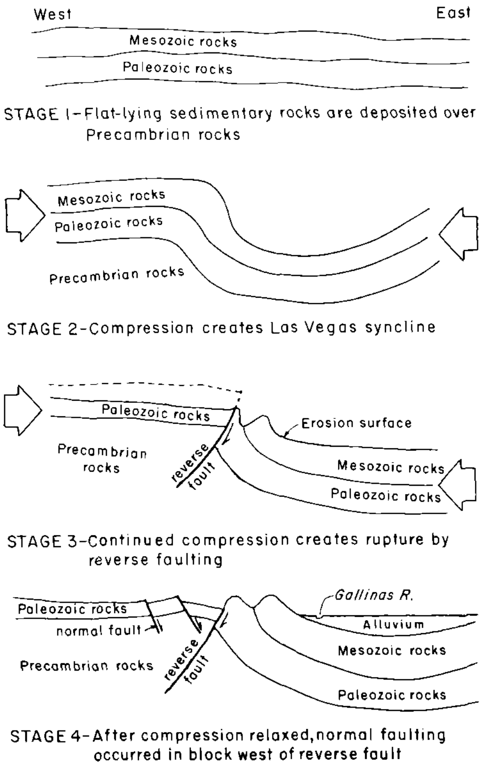

FIGURE 4—GENERALIZED SECTION TAKEN DUE EAST FROM POINT A OF CROSS-SECTION LINE.

vicinity. The most commercially feasible, simple enterprise would be a series of greenhouses located below the hot springs and heated year round for growing vegetables and flowers.

A more complicated, industrial generation of electricity on a small scale might be accomplished through the use of heat engines. Apparently the temperature differential between the hot spring waters and the cold water of the Gallinas River is great enough to make heat engines economically feasible, although a substantial capital investment would be necessary for their installation.

References cited

Baltz, E. H., 1972, Geologic map and cross sections of the Gallinas Creek area, Sangre de Cristo Mountains, San Miguel County, New Mexico: U.S. Geol. Survey Misc. Geol. Inv. Map 1-673 (sheet 1 of 2)

Bejnar, C. R., 1967, Temperature gradients of thermal springs at Montezuma, New Mexico, unpublished paper

Las Vegas (NM) Daily Optic, 20 April, 1885

Lessard, R. H., and Bejnar, W., 1976, Geology of the Las Vegas area: New Mexico Geological Society Guidebook, 27th Field Conf., p. 103-108

Reinerts, T. H., 1966, A history of the Montezuma Hot Springs, hotels, and bathhouses, 1849-1937: M.S. thesis, New Mexico Highlands Univ., 97 p.

Summers, W. K., 1965, Chemical characteristics of New Mexico's thermal waters: New Mexico Bureau of Mines and Mineral Resources Circ. 83, 27 p.

———, 1968, Geothermics—New Mexico's untapped resource: New Mexico Business, v. 21, no. 8

———, 1976, Catalog of thermal waters in New Mexico: New Mexico Bureau of Mines and Mineral Resources Hydrologic Report 4, p. 69-72 □

Mining, milling, and smelting operations in southwest New Mexico

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The ultimate goal of mining and mineral-processing operations in southwest New Mexico is the production of a relatively pure metal or nonmetallic mineral. Most metals occur in chemical combination with other elements to form minerals. These minerals are dispersed throughout generally valueless rock-forming minerals (gangue) to form ore — rock masses of sufficient size and value to be processed economically. These ore bodies occur in the surrounding rock or waste and vary in size from very high-grade ore deposits a few inches thick in some precious-metal mines to low-grade ore deposits hundreds of feet thick in porphyry copper mines. The mining process removes the ore from the surrounding waste rock; milling separates the valuable minerals from the gangue; and smelting breaks down the minerals to yield the pure metal. Various company operations use different equipment and procedures to accomplish these steps.

At present, some of the major mines, mills, and smelters in southwestern New Mexico are shut down as a result of depressed copper and zinc prices. Although significant quantities of nonmetallic minerals such as fluorspar were produced in the past, present production is limited, except for the Mathis lime plant midway between Hanover and Central.

Most of the major operators provide for some form of public access. During the summer Kennecott Copper Corporation normally conducts tours of its operations at Hurley for the general public. As a rule, given advance notice, both Kennecott and Phelps Dodge Corporation at Tyrone are able to arrange special group tours. Other operators vary in their policies regarding public tours. In addition, Phelps Dodge, Chino, and Tyrone have readily accessable public lookouts at the pits.

The potential hazards of abandoned mines are significant and many. ***Do not enter abandoned mines, pits, or workings.*** Children in all mining areas should be under careful supervision at all times.

Mining

In general, mining operations can be divided into two categories: underground and open-pit. Open-pit mining is the method of choice in areas where ore deposits occur at or near the surface. Deposits of this type occur at Santa Rita and Tyrone as large, low grade ore bodies. Underground mining methods are used to recover ore in narrow, nearly vertical veins and chutes (in the case of the Groundhog mine at Vanadium); or when the ore body is covered by too much overburden to remove economically (in the case of UV Industries). Both conditions are present in the area.

There are three major open-pit mines in the district. UV Industries at Fierro, Kennecott Copper Corporation at Santa Rita, and Phelps Dodge at Tyrone. In the pits, ore and waste are first broken by drilling holes up to 14 inches in diameter and 60 ft deep at a predetermined distance back from the edge of the bench. The holes are loaded with explosive, then blasted. The broken rock is loaded into trucks by electric shovels—some of which can move up to 25 tons at a time (fig. 1). Such shovels, at present, cost in excess of a million dollars. Trucks used in the pits have capacities from 40 to 150 tons each, and there is a trend towards even larger trucks.

With the present ore grade at Chino and Tyrone, about 3 tons of waste must be moved for each ton of ore mined. Allowing for milling and smelting losses, this means about 700 lbs of rock must be blasted, loaded, and hauled for each pound of copper produced. The Chino mine produces about 23,000 tons of ore per day, Tyrone about 46,000 tons.

Because most of the underground mines in the district have been closed down due to depressed metal prices, UV's Continental Mine at Fierro is currently the only one of its kind in operation. ASARCO's (American Smelting and Refining Company) Groundhog unit at Vanadium and Federal Resources Corporation's Bonney Mine at Lordsburg can be expected to open if lead, zinc, and copper prices rise. Several small underground mines ship limited amounts of precious-metal bearing fluxing ore to the ASARCO smelter at El Paso, and a few other mines produce fluorspar on an intermittent basis.

Milling

The ores produced are treated locally by various concentrators and smelters. Little direct-shipping (high-grade) ore is produced, therefore the ores are processed in concentrators to separate the metal-bearing minerals from the barren rock, or gangue. The high-grade product, or concentrate, is shipped to a smelter where concentrates are melted with fluxes to remove further impurities, and finally to remove the sulfur by oxidation, leaving approximately 99 percent pure metallic copper.

Since the bulk of the area's production is copper, the production of metallic copper from ore will be described first; lead-zinc treatment will be noted later. Basically, the process involves three steps: breaking the copper minerals and gangue apart, separating the copper minerals from the gangue, and recovering the copper from the minerals. Because of differences in concentrator design and ore composition, the three major operators, Chino Mines Division of Kennecott Copper Corporation, UV Industries, and Phelps Dodge use somewhat different equipment to accomplish these steps.

The first step, breaking the minerals and gangue apart, involves crushing and grinding (comminution). The ore, which comes from the mine as rocks up to 6 ft in diameter, is dumped into a primary crusher that reduces the rock to 8- to 12-inch pieces. Both UV and Chino use jaw crushers for this step, while Phelps Dodge uses a large gyratory crusher. From the primary crusher, the ore goes to secondary and tertiary crushers at Chino and Phelps Dodge. Both use gyratory (cone) crushers for the secondaries that reduce the ore to approximately 2 inches. Phelps Dodge then uses shorthead cone crushers, and Chino, roll crushers, to reduce the ore to 3/8-inch pieces. Typically, motors of about 500-hp are used on these crushers. At UV, the ore goes from the primary crushers to a semi-autogenous mill, a large diameter (30-ft) rotating drum in which the physical action of the ore itself tumbling with large steel balls combines to reduce the ore. At UV's No. 2 concentrator, a 5000-hp motor drives the mill. Finally, Phelps Dodge and Chino use ball mills — large, drum-shaped rotating mills filled with steel balls — to grind the ore to the required final size (fig. 2). At Phelps Dodge, there are 20 of these 1250-hp primary ball mills, each 12 ft in diameter × 12 ft long, holding 80 tons of steel balls. The discharge from these mills is classified (sized) by cyclones at Phelps Dodge and rake classifiers at Chino; the larger particles are sent back to the ball mill for further grinding, smaller material goes to flotation. (At Phelps Dodge, about 95 percent of the discharge will pass a 65-mesh screen.) UV uses pebble mills for fine grinding. Here the final grind is achieved using lumps of ore about 2- to 3-inches in diameter rather than steel balls. After the first (rougher) flotation, Phelps Dodge regrinds the rougher concentrate to separate the pyrite (iron sulfide) and chalcocite (copper sulfide). This two-step approach is far more economical than grinding all the ore to the size required for the final concentrate.

The second step, separating the valuable minerals from the waste, is done by

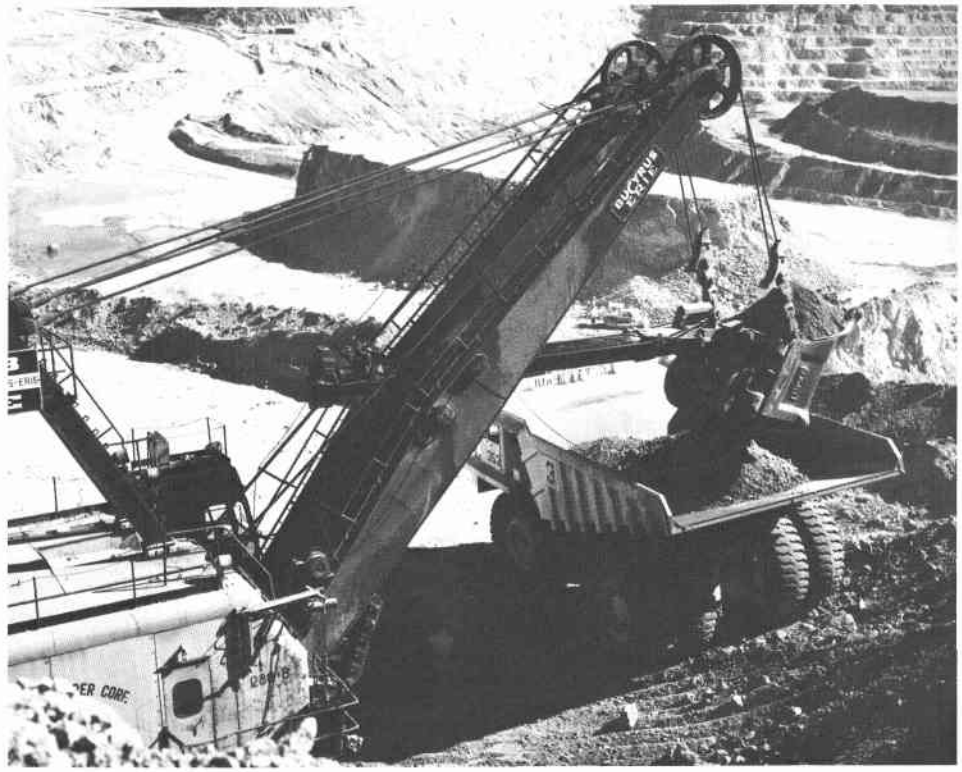

FIGURE 1—ELECTRIC SHOVEL LOADING 150-TON TRUCK. Courtesy Chino Mines Division, Kennecott Copper Corporation.

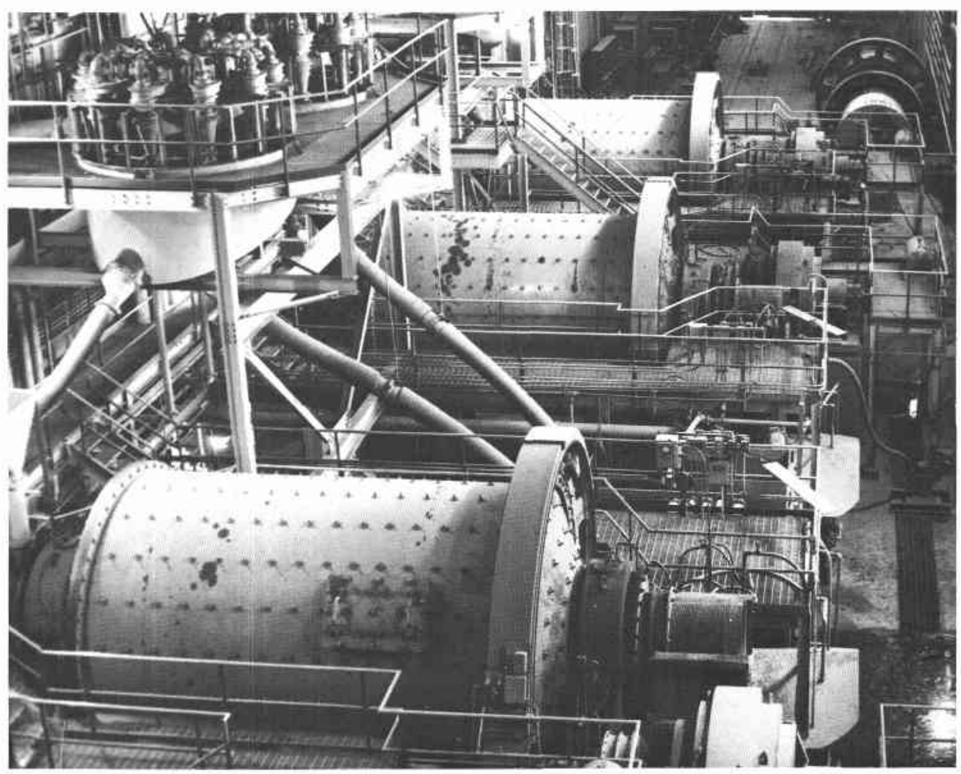

FIGURE 2—GRINDING SECTION AT CHINO; ball mills in foreground, cyclone classifiers at upper left. Courtesy Chino Mines Division, Kennecott Copper Corporation.

froth flotation. Here the water-ore mixture (pulp) coming from the grinding section is agitated in a series of flotation cells that also introduce small air bubbles. Chemicals called collectors are added to the pulp to coat the small mineral particles. Other chemicals called frothers are added to make a stable froth that rises to the top of the pulp. The coated mineral particle attaches itself to the foam rising to the top where it is skimmed off. The concentrate from these first cells is refloated to produce the final concentrate. Material which did not float in the first cells (tailings) is sent to thickeners where most of the water is recovered, and then on to tailings dams. The concentrates are thickened, filtered, and dried before shipping to the smelter. The ASARCO mill at Deming differed from the others in that two concentrates were produced. A lead concentrate was first floated from the pulp using chemicals that will not float zinc minerals, then an activator (copper sulfate) was added and another series of cells produced a zinc concentrate.

In addition to the flotation plants, both Chino and Tyrone have leach plants which also recover copper. A solution containing sulfuric acid is spread on the leach dumps: some of the copper is dissolved as the solution drains through the dumps into holding ponds, from which it is pumped to the precipitation plants. The copper-bearing leach solution is passed over scrap iron in launders at Phelps Dodge and cone precipitators at Chino. The copper in solution replaces the metallic iron in the scrap, producing a fine copper powder (precipitate or cement copper). After drying, the cement copper is sent to the smelter.

Smelting

The concentrates from the mills are mixed with silica and limestone fluxes and melted to produce a molten bath containing an upper waste layer (slag) floating on a lower copper-iron sulfide layer (matte). Chino mines at Hurley uses a reverberatory furnace for this step; Phelps Dodge at Playas, a flash furnace. The molten slag is hauled to waste dumps directly from the reverberatory at Chino. After cleaning in an electric furnace at Phelps Dodge, the molten matte, containing about 40 percent copper, is transferred to converters in large ladles. Here, air is blown through the molten matte, oxidizing the sulfur to sulfur dioxide and producing metallic copper. The sulfur dioxide in the exhaust gas is converted to sulfuric acid which is shipped to various markets. Blister copper from the converters ($\sim$ 99 percent Cu) is treated in reducing (anode) furnaces to remove most of the remaining impurities (mostly oxygen). The copper is cast in molds and either sold directly for brass manufacture or sent to an electrolytic refinery for further processing. Lead and zinc concentrates are treated out-of-state by significantly different methods to produce metallic lead and zinc.

Summary

The major improvements in mining and mineral processing equipment have allowed mining of much lower grade ore, therefore extending the life of many mines in the district. The underground mines, for example, and the first Phelps Dodge concentrator at Tyrone discontinued operations in the early twenties and did not reopen until mining was reintroduced in 1969 (as evidenced by the recent closure of ASARCO's Deming Concentrator). Mining is still very cyclical, however, with the profitability of the operation dependent on fluctuating metal prices.

Future projections for most metal prices, as well as recent exploration activity, indicate that the district has considerable future potential. □

New books

Carlsbad, Caves, and a Camera, by Robert Nymyer, published by Zephyrus Press, Inc., Teaneck, NJ, first printing 1978, 318 p., 185 illustrations, hardcover, $14.95, softcover, $8.95.

Carlsbad, Caves, and a Camera is a deeply felt tribute to a way of life and a part of nature that have almost disappeared in this day and age. In 1927 Aaron Nymyer began working for Ray V. Davis, pioneer photographer of Carlsbad Caverns, and has been active in cave photography and exploration ever since.

The adventure, fascination, and beauty of this publication will appeal to geologists and non-geologists alike. The author recalls his cave exploration as a young man in the 1930's—in those days, despite an abundance of outstanding caves to be discovered and explored in the Carlsbad region, caving lacked its present-day sophistication.

This is the story of young amateurs who ventured underground—inexperienced, unadvised, and unguided—into an unknown world. They faced their problems as they arose, and eventually acquired a high degree of technical competence in caving. The book captures the thrill of exploring the unknown, accompanied by the ever-present threat of danger in the darkness beyond; and the incomprehensible beauty wrought over the eons and lost to the world until an explorer's lamp discovered its breathtaking splendor. It conveys the surge of pride in knowing that no human footstep has disturbed the silence of centuries.

The author has kept a concise visual and written record of his explorations, intimately reflecting what these young men saw, said, and felt during their adventures. An outstanding photographic essay section reveals the awesome beauty of the caverns. The photographs, dating from the late 1880's through the 1940's, represent a cross-section of the author's work, together with a few contributions (now in Nymyer's collection) by other photographers.

The clarity, quality, and originality of this publication are outstanding. Following the caption of each photo is the page number where the narrative appears, explaining the site and purpose of the picture. The photo numbers appear in the margin near the appropriate passages in the text (a particularly helpful feature).

Acknowledgment—We appreciate Robert Nymyer's kindness for the opportunity to review this valuable contribution to New Mexico's history and geology.—*Neila Pearson* □

The Clansman in New Cave, with the author crouching in front. This is one of the more awesome sights in the cave (photo taken September 24, 1938).