

Ely, Nevada.

Written for the MINING AND SCIENTIFIC PRESS
By ARTHUR H. HALLORAN.

Ely, or rather the Robinson mining district, occupies the course of a transverse gash in the Egan range in the east-central part of White Pine county, Nevada. This range is one of a large number of north-south folds rising from the desert floor of this, the Basin Region, the characteristics of which have been so well described in the writings of the earlier members of the Geological Survey. It lies 30 miles west of the Utah-Nevada line and is parallel to it for nearly 150 miles. Ely is 85 miles east of Eureka and 139 miles south of Cobre on the Southern Pacific railroad and it is this comparative inaccessibility that has prevented rapid growth. But now the Nevada Central had laid 50 miles of the standard-gauge track from Cobre (135 miles west of Ogden) and is expected to reach Ely by the end of July. This railroad follows the easy grade of the west ridge of the Steptoe valley, forming an entrance much more convenient than the present tortuous travel over five mountain ranges and across four desert valleys.

Leaving the main line of the Southern Pacific at Palisade in April of this year, I rode 80 miles south to Eureka on the Eureka and Palisade narrow gauge, taking five hours to make the trip. One should buy a ticket from Palisade to Ely for \$15 rather than pay \$8, the railroad fare from Palisade to Eureka, and the \$10 stage-fare from there to Ely. This stage runs six times a week, at this time of the year, usually requiring 24 hours of continuous riding night and day to make the trip. There has been such a congestion of traffic that travelers often have to wait their turn for two or three days at Eureka. This route in its course across the grain of the country, rises to an elevation of nearly 8,000 ft. Ely and Eureka are both at an altitude of 6,350 feet.

The Ely of to-day is yet in the making, the rawest of Nevada mining camps, just awakened to its enormous possibilities after a lethargy of thirty years. Already one thousand men are crowded into its insufficient accommodations and thousands more are but waiting convenient access and more definite data before making a rush. The past winter and spring have been the severest in years, and in consequence the roads have been bad and the hauling of supplies has often been delayed until the town was on the verge of famine. There is now abundant food, such as it is, but very little accommodation. A few fortunate ones have beds in frame houses. Many are glad of the privilege of paying 50 cents per night for a cot in a tent, and often the saloon tables and chairs are utilized as makeshift couches. All timber for building and for mining has to be brought from a distance, as nothing but mountain mahogany, juniper, and scrub-pine grow in even the most favored parts of this desolate region. An unfortunate combination of muddy roads, poor and insufficient horses and great demand caused a mighty gathering of supplies at Eureka that taxed the freighting facilities to their utmost. One team took three weeks to make the round trip. Many men have waited over a month for such baggage as exceeded the limit of 30 pounds.

The object of this 'rush' is the enormous bodies of low-grade copper ore. It is yet too early to predict their extent, but enough work has been done to show that Ely is destined to be the center of a great copper-producing region. Extravagant reports of the immensity of the deposits have been issued, based upon certain unproved assumptions. These reports have often overreached themselves in endeavoring to attract an influx of capital. There is little to suggest that these

low-grade ores can ever seriously threaten Butte's supremacy as a copper district.

While this district has been visited by many of the best known mining engineers, their reports have been made to private companies and but little has been published concerning the orebodies and their occurrence. That of J. Parke Channing, made in August, 1905, was the conservative basis for a development which has since opened up enormous bodies of copper. The ore is found in a porphyry dike, intrusive in limestone and shale. The dike has been tracked for seven miles in an east and west course. As shown by surface croppings, its width will vary from 1,500 to 4,000 ft. with an average of 2,500 ft. On the surface it is weathered brown, with but little trace of copper, but after sinking from 50 to 100 ft., pyrite and chalcocite are found in small seams and disseminated masses throughout the whole rock.

This igneous rock, or porphyry, has been determined as rhyolite, intrusive in Carboniferous limestone. It carries disseminated irregular grains of metallic sulphides, the latter apparently taking the place of the black bi-silicates. The mineralized areas seem more silicious than the unaltered rock. As before stated, a leached cap covers the workable ore. At a depth of from 300 to 400 ft. the ore becomes leaner, until it is too low-grade for profitable working. This suggests that subsequent to the primary mineralization of this dike its upper portions were leached and the copper re-precipitated by reaction with pyrite as first shown by the experiments made by H. V. Winchell on the Butte ore. This theory is borne out by the finding of pyrite coated with chalcocite and covellite.

This limits the depth of the ore to 350 ft. at the most, with an average less than this. It has been stated that ore has been found wherever a shaft was sunk in the porphyry, and on such foundation it has been reasoned that the whole body is mineral-bearing. That such reasoning is fallacious is shown by the occurrence of barren zones of monzonite and by the intersection of unexpected limestone bodies in depth. In a number of places the ore has been opened up for a length of 900 ft. and a width of 500 ft. Exploratory work in the two properties of the Nevada Consolidated Copper Co. is said to disclose 22,000,000 tons of ore. Channing estimated it at 12,000,000 tons, but a great amount of work has been done since then. This great mass of ore averages 2.5% copper, 40 cents in gold and a trace of silver. It is easily broken, as most of it will crumble in the hand, and it can be readily concentrated in the ratio of 9 to 1 by simple crushing, jigs and tables.

The whole lode, together with the limestone on either side, has been staked out by prospectors. Many of these claims have been gathered together to form the large acreage owned by the companies now operating. On this cropping there seems to be no claim which has not been consolidated or is in process of consolidation with others. The accompanying map (Fig. 1) shows the approximate holdings and positions of the various companies together with a rough outline of the surface geology. I could not determine whether the area marked rhyolite and tuff was wholly extrusive.

The western limits of the porphyry are being worked by the Veteran Ely Copper Co., which has opened up a large tonnage by means of a long cross-cut tunnel. George Gunn is manager and D. Shovlin, superintendent. Adjoining on the east, the Giroux Consolidated Copper Co. has done considerable work, particularly on the contact of the limestone and monzonite. Six shafts have been sunk to a depth of from 200 to 800 ft. and good ore opened in both the porphyry and limestone. A site for the concentrator has been graded and a blast-furnace

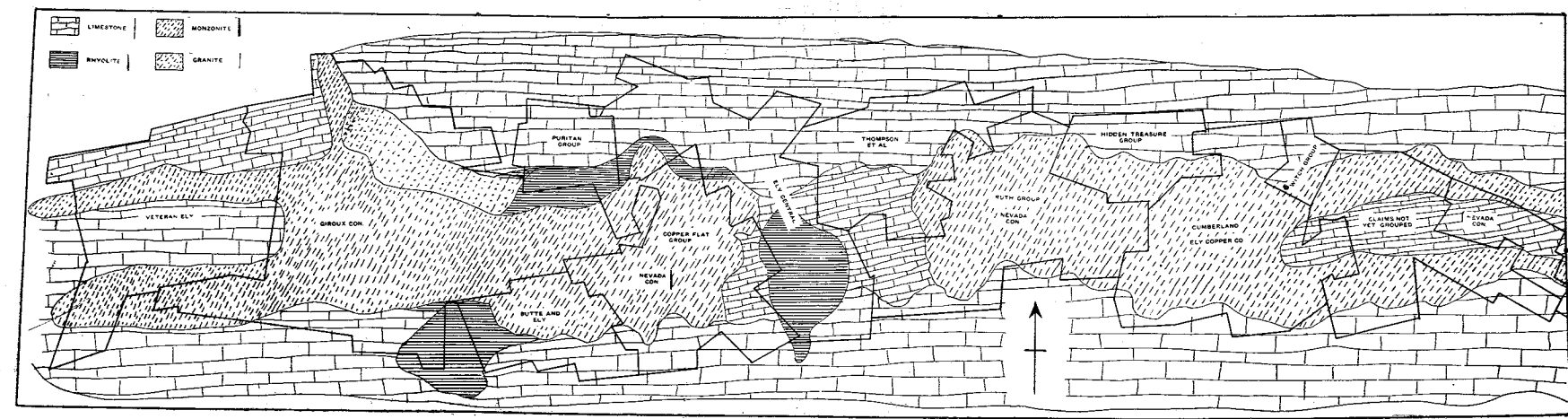


Fig. 1. Geological Map of Ely, Nevada.

Showing Boundaries of Mining Properties.

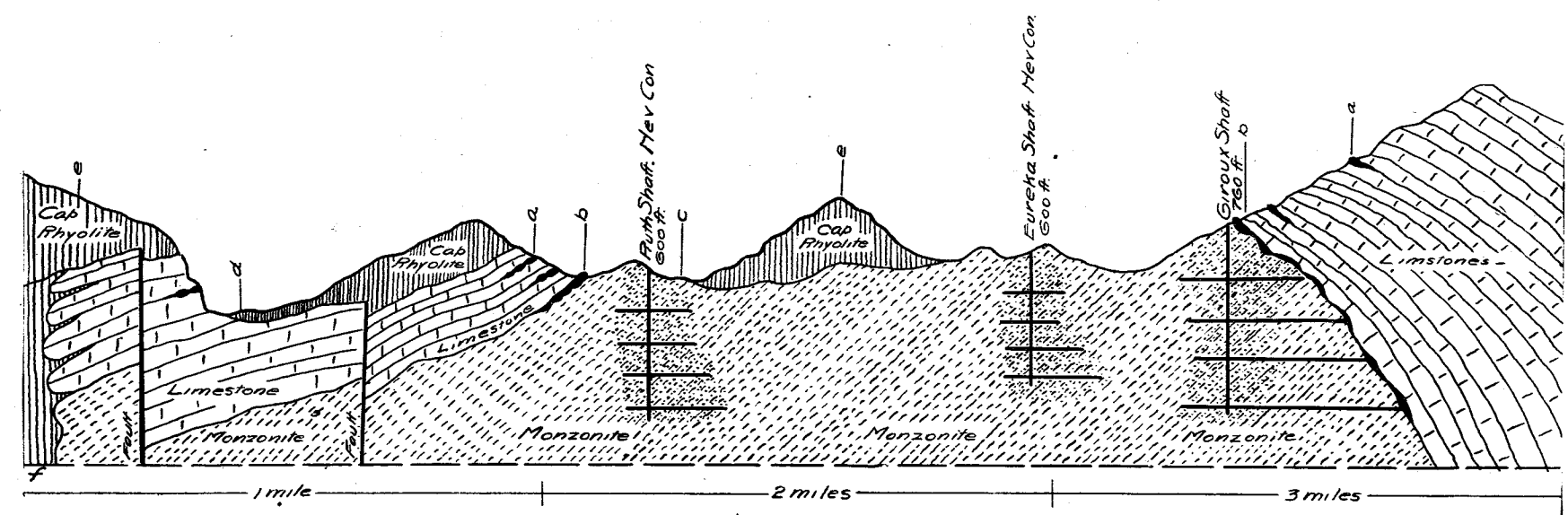


Fig. 2. Longitudinal Section of the Ely District.

Showing Principal Shafts.

installed. The property was first worked to develop the high-grade contact deposits, but it promises also to produce large quantities of low-grade ore. The mine workings are centered around Kimberley, eight miles west of Ely.

The next holdings to the east are those of the Nevada Consolidated Copper Co., at present the best developed property in the district. It includes the combined claims of the old New York and Nevada Copper Co. and of the White Pine Copper Co. The Chainman mill-site near Ely has also been absorbed. At Copper Flat this company has two shafts, the Eureka No. 1 and Eureka No. 2, each down over 400 ft. From these, drifts and cross-cuts have opened up large bodies of low-grade copper ore which are to be stripped and extracted with steam-shovels. The ore is friable and readily handled by this method. A mile and a half to the east, the Ruth shaft has been sunk to a depth of 650 ft. on an incline of 41%. Drifts have been run at the 200, 300 and 500-ft. levels, showing an orebody 900 ft. long and 300 ft. wide with three faces still in ore. Cross-cuts driven every 200 ft. prove the continuity. This immense body of ore is to be worked by the caving system through a new four-compartment vertical shaft now being sunk at the Star Pointer. A 60-ft. steel head-frame and an electric hoist will replace the present equipment.

An experimental mill on the Ruth indicated that a saving of 78% could be made in a water concentration of this ore. Ground is now being broken for a 1,000-ton concentrator two miles below Ely to treat the combined output of these two mines. Plans have been made for a 2,500-ton copper smelter below the concentrator and an initial unit of three 85-ft. reverberatory furnaces, with the necessary converters, are to be put in at once. An abundant water-supply has been provided.

To the south of the Nevada Consolidated and Giroux, the Butte & Ely Copper Co. has sunk a shaft 100 ft. through the leached cap into the sulphide zone. Fine specimens of chalcocite and covellite, precipitated on pyrite, are found in this mine. H. S. Wales is superintendent. Between the Copper Flat and Ruth holdings of the Nevada Consolidated, the Ely Central Copper Co. have ground that is to be tested with drills. The porphyry here is covered with what is apparently a rhyolite capping, the thickness of which must be ascertained before much development work can be done. On the east the Ruth group is bordered by the Cumberland-Ely and by the Witch group. The former is being opened up by shaft and tunnel, and the latter by a tunnel. A number of ungrouped claims to the east are soon to be united into a company.

At the present incomplete stage of development work it is impossible to more than outline the holdings and indicate the possibilities. Undoubtedly a large number of 'wild cats' will be organized to work copper near Ely, but there is every reason to believe that the companies mentioned mean business. It is possible, but not probable, that the whole of the great dike is mineralized; an assumption that it is all metalliferous has formed the ground-plan upon which has been erected an alluring superstructure promising to tower far above the substantial edifice of assured production. The real object of this has been to boom lots in the town-site of Ely. Its success is shown by the fact that a corner 49 by 100 ft. was recently sold for \$15,000. Real-estate speculators are naturally anxious that people should crowd into the district. Conservatively, it is estimated that by the end of this year 3,000 people can be profitably employed in the mines, smelters and dependent industries. But a low-grade camp is no place for a poor man. Abundant capital is necessary to open up and equip the mines. Wage-earners, except those employed in smelter construction, should

not go there until after the railroad is completed. It remains to add that 'porphyry copper' is not the only asset of this recently forgotten district. Rich lead, silver, and occasional gold veins are found throughout the tributary country. Cheap transport will solve the problem of their treatment, and it is to their development that the late-comer is now turning his attention. Companies will also be formed to prospect for contact copper deposits and possible lenses in the adjacent limestone.

PRODUCTION OF RARE EARTHS.—A number of minerals that were formerly supposed to be of extremely rare occurrence have lately been found in quantity. The discovery of these deposits is an example of the truth that the supply responds to the demand. It is the advance made during the last five years in the manufacture of various forms of apparatus for lighting purposes that has developed a use for metals and metallic oxides such as tantalum, cadmium, zirconia, thoria, yttria, and cerium, lanthanum, and didymium oxides. With the exception of cadmium, all these materials are now used commercially in the manufacture of different lamps, and are obtained from the following minerals: Monazite, zircon, gadolinite, columbite and tantalite. Monazite is the mineral which contains the oxides used in the manufacture of mantles for the Welsbach and other incandescent gaslights. Although monazite has been found sparingly at many localities throughout the United States, the Carolinas are still the only States that are producing this mineral commercially. An interesting mineral, thorinite, was discovered early in 1905 near Balangoda, Ceylon, associated with corundum, zircon, tin, topaz, spinel, etc. According to the reports on this mineral, it is one that could be more easily utilized as a source of thoria than monazite, and as it has a much higher percentage of this compound, it would be much more valuable. It is not improbable that this new mineral may be found in certain localities of the United States where tin, topaz, zircon and monazite are found. The tantalum minerals are in demand because they contain the metal tantalum. This is employed at the present time in the manufacture of very fine wire for use in the construction of a special lamp. An interesting occurrence of a tantalum mineral has recently been discovered in a feldspar quarry at Henrytown, in Maryland. Near Glastonbury, Connecticut, an old feldspar quarry is being investigated as to the quantity of columbite or other tantalum mineral that may be found in this feldspar. A mineral from Tinton, South Dakota, gives on analysis 44% of tantalic oxide and 30.5% niobic oxide. The production of monazite, zircon and columbite during 1905 amounted to 1,352,418 lb., valued at \$163,908, as compared with 745,999 lb., valued at \$85,038 in 1904, an increase of 606,419 lb. in quantity and of \$78,870 in value. From one-sixth to one-fourth of the monazite mined in 1905 was exported to Germany.—*U. S. Geological Survey.*

CONCERNING the relative efficiency of the better-class station-pumps underground we have the following data: To raise 500 gal. against a head of 3,000 ft. a compound-condensing pump will consume 1,370 lb. per hour, a triple-expansion condensing pump 1,060 lb. per hour, while a high duty Worthington pump will consume 840 lb. per hour. Compared with the first-named pump, therefore, the triple-expansion pump makes a saving of 22.63% and the Worthington high-duty pump a saving of 38.68%. Taking these various points into consideration the engineer will arrive at the conclusion that for the majority of Western mines the compound-condensing pump is all that is required, while, for shaft-sinking and general prospecting, the ordinary high-pressure pump is the most advantageous.

Methods of Mining at Ely, Nevada.

Written for the MINING AND SCIENTIFIC PRESS
By C. EVERARD ARNOLD.

On account of the low content of the ore in the Nevada Consolidated Copper Co.'s property, it is imperative that the ore shall be mined and treated in large quantities and at the lowest possible cost, in order to ensure profitable working.

The white porphyritic rock which carries the copper is fortunately very much decomposed, soft, and easily mined, and in accordance with the opinion of J. Parke Channing (who reported on the company's holdings) that the methods of mining employed in working the wide hematite deposits of the Mesabi Range could not be successfully applied here, the company has decided to follow the scheme used by the Oliver Iron Mining Co. in their Pioneer mine at Ely, Minnesota. This scheme, of which a description is given later on, is being carried out under the supervision of Capt. Richard Toms, who, for many years, was mine captain at the Chandler and Pioneer properties.

As regards the present state of mine development, all operations have ceased at the Eureka property (which

by 6 ft.; this will enable the loaded timber-truck to be run onto the cage, lowered, and run right into the workings, thus avoiding the troubles incidental to lowering heavy timbers when they have to be loaded on the cage at the surface and transferred at the station to the truck.

After connecting the two shafts, a large ore-pocket will be built off the Star-Pointer shaft, under the 500-ft. level, and the level continued on the west side of the shaft far enough for the accommodation of a train of cars. Fig. 2 shows a plan of portion of the proposed workings on the 500-ft. or main level, illustrating the manner in which the orebody is to be divided up into a number of pillars, approximately 50 by 70 ft. each, by the intersections of the drifts and cross-cuts that comprise part of the main level. This level is being cut large enough to allow 8 ft. clear between cap and sill, 6 ft. 2 in. between tops, and 8 ft. between bottoms of posts.

Electric traction is to be used underground and the reason for the number of turns in the drifts and cross-cuts is that the tracks will contain as many stationary switches as possible, and with this arrangement the process of running the ore out to the station will be as follows: Suppose, for example, that there are ore-chutes at *A* and *B*, in front of which is a train of loaded cars;

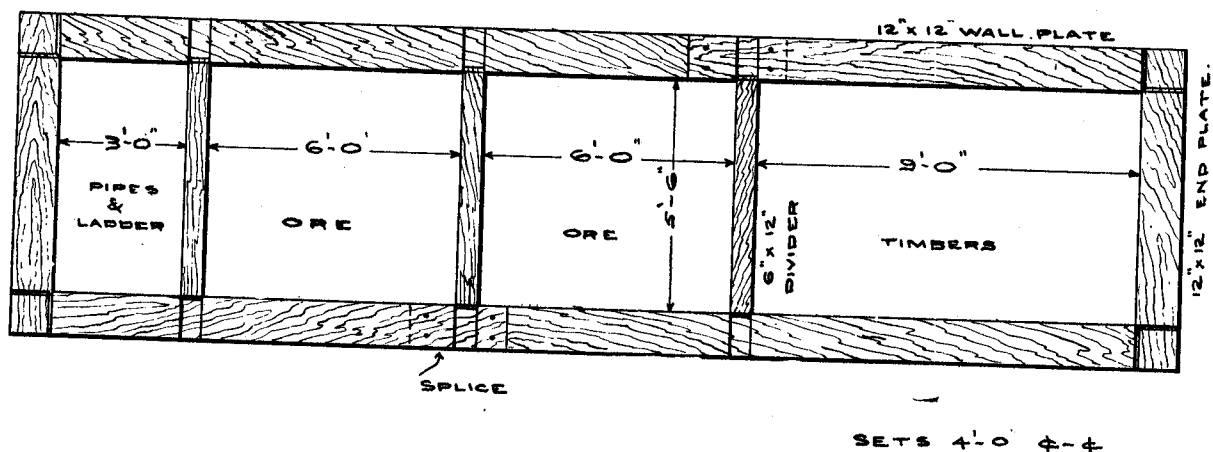


Fig. 1. Plan of Timber-set for Star-Pointer Shaft.

lies six miles west of Ely), and on account of the soft nature, width, and proximity to the surface of the orebody, it is extremely probable that steam-shovels will be employed in mining it. At the Ruth mine (which is $1\frac{1}{4}$ miles east of the Eureka mine) all energies are being put forward to connect the Ruth shaft with the new Star-Pointer shaft. The Ruth shaft pitches north at an angle of 42° , and the connection is being made by means of a level running west, started at a depth of 500 ft. on the incline. This level has been driven through 950 ft., and after having gone 2,300 ft. it is expected to tap the Star-Pointer shaft, which is vertical, at a depth of 342 ft. A plan of a timber set for this shaft is shown in Fig. 1; the shaft has been sunk 230 ft., striking the orebody at a depth of 150 ft. All drilling is done by hand, and working three eight-hour shifts with five men per shift, the shaft was sunk and timbered 72 ft. during the month of September, all broken rock being hoisted after every round before drilling was re-commenced. No water has been encountered as yet either in this shaft or in the 500-ft. level of the Ruth.

All the hoisting of ore is to be done through this shaft, which will be equipped with a steel head-frame and sub-structure, the railroad from the concentrator coming right up to the storage bins which are now in course of erection, their capacity for the present to be 3,742 tons. On a platform above these bins will be erected two No. 7 $\frac{1}{2}$ Gates gyratory crushers, a 30-in. belt-conveyor distributing the crushed rock into the bins. It will be noticed in Fig. 1 that the shaft has one very large compartment, 5 ft. 6 in.

and that a train of empty cars is wanted at chutes *C* and *D*. The locomotive leaves the station with a train of empty cars behind it; running along in the direction indicated by the arrows, it couples onto the train of full cars at chutes *A* and *B*, and still pulling the empty train it pushes the full train ahead along the course shown past chutes *C* and *D*, where the chute-tender uncouples the empty cars from the locomotive. The journey is then continued, the full cars being pushed along and emptied into the pocket at the station. The locomotive next reverses and pulls the now empty cars behind it, being then ready to perform a similar cycle of operations. Thus the empty cars can be run into, and the full cars run out of, the workings without the inconvenience and loss of time which accompany such switching.

After completion of a series of pillars on the main level, vertical raises will be put up in the pillars at intervals of 25 or 30 ft., and after rising 30 ft. a sub-level will be run directly over the course of the main level below. This system of raises and sub-levels will be continued up to the next main level, thus dividing the ground between the two main levels into a system of pillars that are ready to be caved, the raises having been cribbed up and used as chutes. The caving is to be performed by carrying inclined raises, tributary to the vertical raises, from the four sides and into the centre of the pillar, thus rendering possible the caving of a pillar directly above it, the rock being blasted and caved down into the raises, where it will run straight to the chute-gates on the main level.

It will necessarily be some time before this scheme can

be put into running order, but it will doubtless be completed in time to enable the mine to keep the concentrating and smelting plant supplied, which it is estimated will be in operation by May, 1908, its initial capacity to be 5,000 tons daily, with an approximate ultimate capacity of 15,000 tons.

THE HAILE MINE in South Carolina has been worked more or less continuously since about 1830 and during all that time has been one of the most important mines of the region. In early days leases were given on sections 50 ft. square, and open-cuts were made on these claims by slave labor. This was of course disastrous to systematic, economic mining. The upper, oxidized portions of the orebodies were rich and some of them yielded lumps of gold worth from \$300 to \$500. Except during war time, open cutting was carried on until about 1880, when

Korean Mining Laws.

Among the new regulations recently promulgated are the following:

ARTICLE 4. The boundaries of mining claims shall be limited by straight surface lines extending vertically downward. Their area in the case of coal shall not be less than fifty thousand tsubo, and in the case of other minerals not less than five thousand tsubo; and in neither case shall it exceed a million tsubo. The latter limit may, however, be exceeded in case it is absolutely necessary for the protection of public mining interests or for the amalgamation or division of mining claims.

ARTICLE 7. The Minister of Agriculture, Commerce, and Industry shall have the power to refuse permission for mining, in case he considers such a step to be necessary in the public interest or for any other reason.

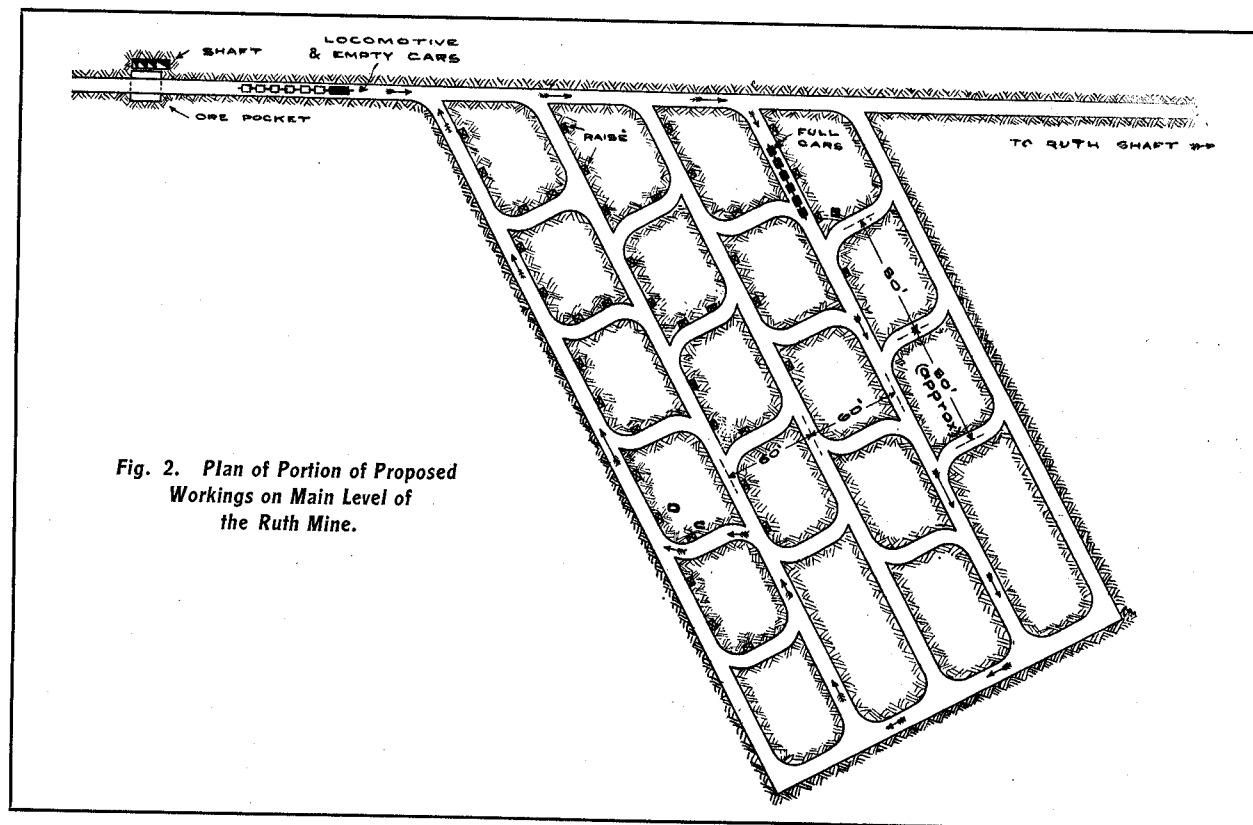


Fig. 2. Plan of Portion of Proposed Workings on Main Level of the Ruth Mine.

actual underground mining was begun and continued up to about four years ago. A return to the open-cut system has been made on a much larger scale than formerly. This mine, said to be the only steady dividend-paying gold mine in the Southern Appalachians, owes its success in recent years very largely to the intelligence and persistent efforts of Capt. Adolph Thies, who for nearly 20 years was its manager. Mr. E. A. Thies, his son and the present manager, is following the same policy.—L. C. Graton, U. S. Geological Survey.

THE London Stock Exchange does not, like the New York Exchange, require daily payment for, and delivery of, the stocks bought or sold upon its floor. Such accounts are settled once a fortnight; their settlement occupies three days, respectively known as 'ticket day,' when the names of buyers and sellers are given up, 'account day' or 'contango day,' when provision is made, if desired, to carry a speculative operation over another fortnight, and 'pay day' or 'settlement day,' when accounts are finally adjusted. What London calls the 'carry-over' is effected by payments of a 'contango' or continuation rate, which varies according to the outside discount market, and the account to be carried over.

ARTICLE 10. No mining right may be sold, assigned, or mortgaged without permission of the Minister of Agriculture, Commerce, and Industry. A mining right may be acquired by inheritance.

ARTICLE 21. The Government shall not be responsible for any damage that may be caused by any measure taken by the Minister of Agriculture, Commerce, and Industry by virtue of the present Law or of the Detailed Regulations for carrying it out.

ARTICLE 27. Inasmuch as the measures to be taken under the present Law and the Detailed Regulations for carrying out the same will in many cases concern foreigners, no such measure shall be decided upon or executed without the previous consent of the Residency General. This stipulation shall also apply with regard to the mines belonging to the Imperial Household Department.

ARTICLE 30. Foreigners who have been granted mining rights and have begun operations in connection therewith before the promulgation of the present Law and are still carrying on such operations, shall observe the provisions hereof in so far as they do not conflict with the terms of the grants made to them.

A Visit to Ely, Nevada.

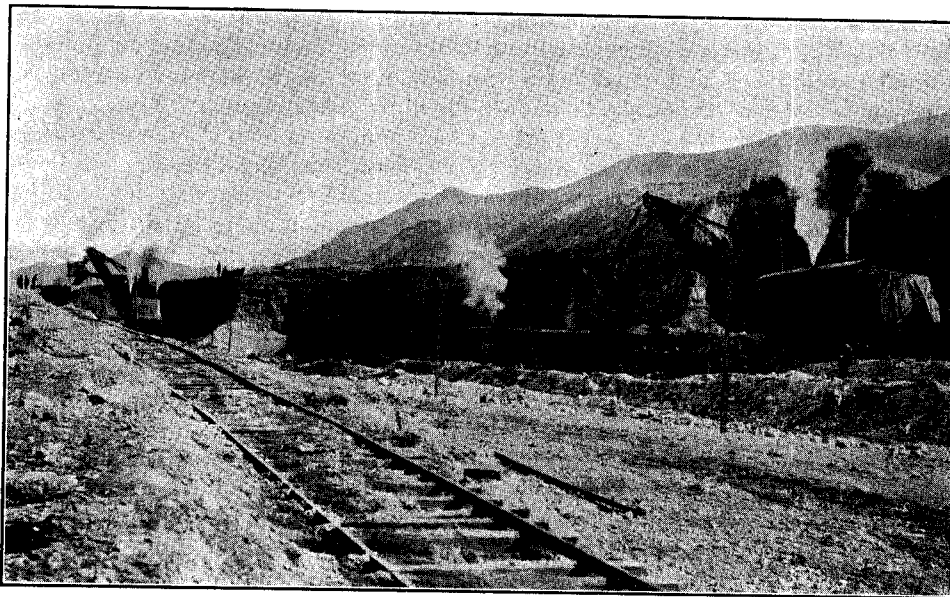
Written for the MINING AND SCIENTIFIC PRESS
By JAMES W. ABBOTT.

Anyone approaching Ely from the west leaves the Southern Pacific train at Cobre, 405 miles east of Reno and 137 miles west of Ogden. Just two miles west of Cobre the train passes a siding where today not even a freight is scheduled to stop. About this siding, if one looks closely, may be seen some ruins of the old town of Toano, famous in the days of Nevada's primary period of production. Then the Central Pacific was the only railroad to the Coast and Toano served as the shipping point for the rich camps in White Pine and Lincoln counties. The regular rate for freighting supplies to Pioche, 250 miles to the south, was six cents per pound, and in similar proportion to other camps according to distance, while by Pritchard's 'fast freight' the rates were much higher. This express service had regular stations, where the mules were changed, so that the wheels were kept rolling day and night.

Until recently the belated traveler, compelled by mis-

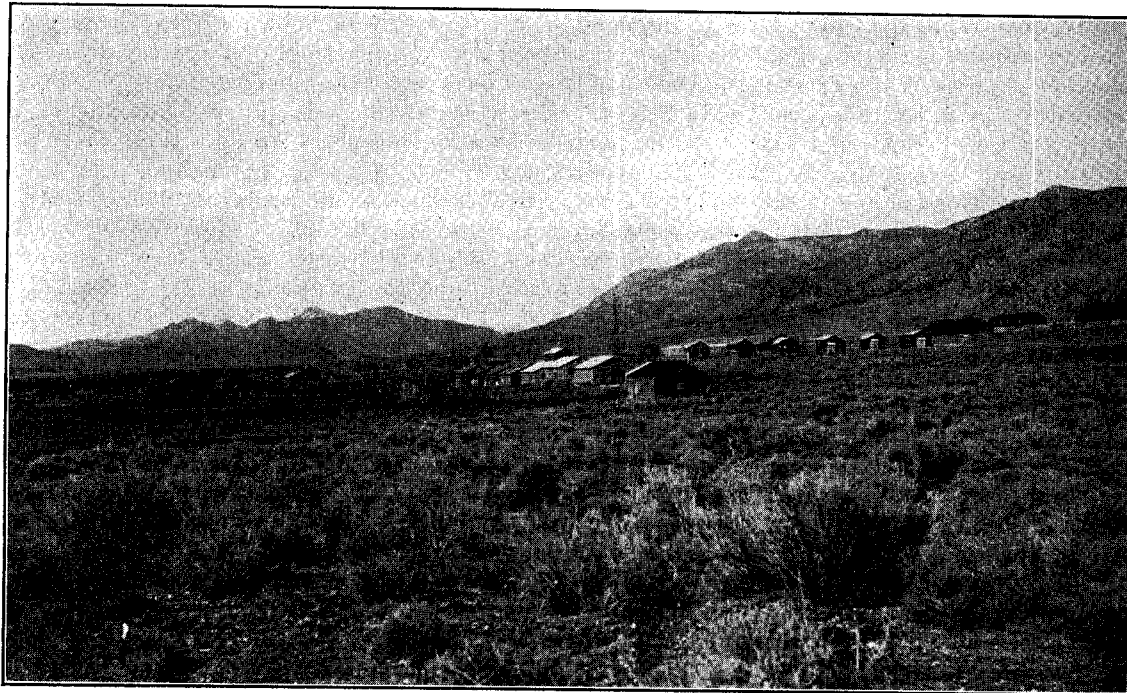
run through each way between Ely and Salt Lake City, and new equipment to be immediately installed on the Northern will further ameliorate travel to the Nevada mines.

This railroad from Cobre to Ely (141 miles) runs through the Steptoe valley, an old lake-bed, level as a floor and nowhere less than five miles wide. Through-



Excavating for Foundations of Concentrator.

out this entire distance the rise in elevation, approximately uniform, averages less than three feet to the mile, and there is neither cut nor fill, culvert nor bridge, more pretentious than one finds on the ordinary country highway. When the roadbed becomes thoroughly settled



The Site of the Big Smelter at McGills, April 1, 1907.

chance to spend the night at Cobre, obtained atrocious meals, a cot in a tent corral, and no adequate protection against a climate often bitterly cold. The rapid march of progress throughout this entire region has already bettered conditions in many ways. Now even the limited trains actually stop at Cobre, where a comfortable hotel, managed by refined people, furnishes wholesome food and suitable beds. Daily standard pullman cars

and is properly ballasted, the railroad conditions will resemble those in the Mohawk valley on the New York Central.

The first station on the road to Ely, 20 miles from Cobre, is Bews, the place where Gould's Western Pacific line to the Coast will cross the Nevada Northern. From Bews to Salt Lake by the Western Pacific is about 160 miles, practically 35 miles less than it is by the Southern

Pacific. Bews, yet a tent city, is today the centre of great activity. The Western Pacific, already operating its construction trains 85 miles out from Salt Lake, hopes to reach Bews about next Fourth of July, when daily Pullman service to Ely will be established by that line also. Three different routes for a branch road to Ely have been surveyed, and as soon as one of these has been selected, grading is to begin. The Clark road (San Pedro, Los Angeles & Salt Lake) will without doubt extend its Pioche branch (now under construction from Caliente) to Ely, while two lines are already projected west from Ely to Tonopah, one of which is sure to be built in the immediate future. Ely then, with its own Pullman service to San Francisco, Los Angeles, and Salt Lake by the Santa Fe, Southern Pacific, Western Pacific, and Clark systems, may be expected to confidently challenge any other mining camp on earth (not in Nevada) to rival her facilities for transportation.

When the Nevada Northern was first built, inflated by the opportunity presented to make money, the railroad company began to levy toll in a fashion that Ely much despised. The old Southern Pacific theory, so vividly remembered in California, of levying "all the traffic would bear," was here exemplified in 10 cents per mile for passenger fares and the former wagon-rates for freight. But a new management, with clearer perspective (perhaps influenced by the Nevada State Railroad Commission), has seen a great light, and definite promise of immediate relief to come has made the heart of Ely very glad. Present rates on brick and cement from Salt Lake to Ely are, respectively, \$12.80 and \$9.60 per ton. On April 17 the rate on brick dropped to \$3 per ton, and on May 13 cement went to \$5.60. The lumber rate today is nearly \$20 per thousand feet, but it is confidently expected that this will be decreased at least one-third, while even a four-cent passenger rate is expected by the optimists.

Eighty miles from Cobre the railroad passes through Cherry Creek, a high-grade silver camp, where they are now reviving memories of White Pine days. One hundred and twenty-eight miles from Cobre, with Ely yet 13 miles away, the train stops at a water-tank, just on the border of a region where history is being made rapidly. On the gentle slope of the foothill three miles to the east, is arising what is to be one of the world's notable industrial cities. It is known as McGill's, named after old Billy McGill, who located a ranch here early in Nevada's primary period and for 35 years raised potatoes, hay, and a family. Billy McGill believed in the country and he kept gathering unto his ranch contiguous acres until his faith reached fruition a year or so ago when he sold his holdings to the Steptoe Valley Mining & Smelting Co. for \$90,000.

The interests at the head of the American Smelting & Refining Co. entered the Ely district about two years ago and secured the properties now grouped into two corporate managements, known as the Nevada Consolidated and Cumberland-Ely companies. They built and own the Nevada Northern railroad, and control the company that is erecting the vast reduction plant at McGill's to treat their own product, present and prospective, as well as custom ore. The Nevada Northern is planning to drop a network over the hills behind Ely. Over these will come the cars laden with ore. When this ore drops into the bins it will probably contain an average of less than 2½% copper. It will leave McGill's ready for the refinery.

The plant of the Steptoe Valley Mining & Smelting Co. is to be 6,000 ft. long and will have separate concentrating, leaching, and smelting departments. The concentrating department is planned to have 10 sections, each

with a capacity of 1,300 tons daily of crude ore, to be concentrated in the ratio of seven into one. Three of these sections, or units, are to be completed immediately and installed with the least possible delay. Two 3-yard bucket Bucyrus steam-shovels are now at work day and night excavating for the foundations, and their labor is being supplemented by six 4-horse scrapers, two 2-horse ditto, a 6-horse plow, and a 2-horse stone-boat, all delivering dirt on top of the bank above the shovels.

Should the concentrator get into service ahead of the smelter, its product will be shipped temporarily to Garfield, near Salt Lake City.

It is the purpose to start the smelter plant with 16 McDougal roasters, each with a daily capacity of 40 to 50 tons of concentrate; three 111 by 19-ft. reverberatories, each with a daily capacity of 250-300 tons; a blast-furnace for smelter-slugs and odds and ends; and three 15-ton converters. The stack, to be the largest ever constructed, will be 550 ft. high, with an inside diameter of 23 ft. at the top. The main flue leading to it will be 1,400 ft. long, with branches from the roasters and reverberatories. A power-house, 320 by 135 ft., to generate at first 8,000 h.p., is to be built at once. The grading for roasters, reverberatories, and power-house is already practically done. The hillside has a slope of about 10%, thus lending itself readily to the plans for automatic handling of products in the successive processes of treatment. The company has purchased the right to the water of Duck creek, on the eastern slope of the hill. The plan will probably be to bring this water through the hill in a 2,600-ft. tunnel and with it to generate 10,000 h.p. Springs on the old ranch also furnish the water now being utilized for immediate needs.

Ely, like Gaul, was once divided into three parts. Ely proper was the old Robinson camp, in the days when the Eberhardt mine at Hamilton, 50 miles west, was turning the heads of millions of people and making the name of White Pine as well known throughout the world as Pioche and Virginia City. At the zenith of its frenzy the three camps of Hamilton, Shermanville, and Treasure Hill, which together constituted White Pine, had a population of 30,000 and the streets at times were filled with a dense mass of humanity, making traffic well-nigh impossible. As in all mining excitements, the restless tides ebbed and flowed. Distance lends enchantment. The search for the Golden Fleece lures men from camp to camp, and the prospector is the typical Wandering Jew. Pioche was ever a magnet, drawing recruits from White Pine, and the gold of Robinson Camp furnished diversion by the way. So the stream from White Pine to Pioche helped to swell the camp at Robinson, and many tarried there to prospect.

It was the lure of gold that brought the pioneers to these camps of the West, now famous for copper, and in this respect Robinson had a history akin to that of Butte, Iron Mountain, and Bingham. Here also the gold played out and the detested copper came in and for years gloom and despondency attended the transformation.

Some time before the new day had dawned for the old camp its name had been changed to Ely. Then came the real estate boom. Bordering Ely to the north, Steptoe valley widens out into a regular flat with alluring opportunities for corner lots, the play of fancy and the temptation to glowing rhetoric and other things. They call it Ely City. Up the cañon of Robinson creek, two miles nearer to the mines, the gulch widens to a flat with a good many acres suitable for building. The real estate man has attached to this evidence of God's bounty the name Lane City, and a goodly hoard of dollars has been gathered from lots here sold at city prices. So the three parts into which Ely is divided really form one commun-

ity which, to the world outside, means just Ely. Lane City will always be in demand for miners' homes, because nearer to their daily work. Whether the commercial supremacy will remain with the old town or be shifted to its rival will depend upon conditions yet to develop.

What the future of mining in that belt shall be must depend also upon conditions not yet clear. Enough is already known to suggest the splendid future of Ely. Two properties of the Nevada Consolidated, the Copper Flat and the Ruth, have been examined separately by three different mining engineers, of high repute and wide experience. One of these reported 16,000,000 tons of commercial ore in the Copper Flat and 6,000,000 in the Ruth, averaging about 2.3% and which should yield a profit with 10c. copper. Another reported 12,000,000 and 10,000,000, respectively. The exact figures of the third report have not been given out, but it is known that he confessed to finding over 20,000,000 tons in the two properties.

No one believes for a minute that either of them reported all he saw. For seven miles in length and in places over a mile in width, copper ore has been found along the belt. Besides the Copper Flat and the Ruth, the Cumberland-Ely, Chainman Group, Giroux Consolidated, Turner-Ely, Ely Central, Ely-Witch, Ely Mines Co., Boston-Ely, Ely Consolidated Copper, Federal-Ely, McDonald-Ely, and the Ely-Revenue are all known to be in ore, but how much they have is not known. The Giroux Consolidated has recently been examined by engineers representing those in control of the Nevada Consolidated and the Cumberland-Ely properties. The report has not been made public, but the salient facts are that in the Alpha shaft, at 1,000 ft., there have been found bodies of ore 50 ft. wide that assay 20% copper, still oxidized, so that there is probability of finding even large masses of concentrating ore below the zone of oxidation.

When nature starts in to mineralize a whole body of porphyry and make ore out of it, there is a good deal doing and it is not easy to draw the line.

GOLD MOVEMENTS into the United States in the fiscal year which ends with this month will exceed those of any earlier year, and the excess of imports over exports of this metal will also probably be greater than in any earlier fiscal or calendar year. The 10 months' figures of the Bureau of Statistics of the Department of Commerce and Labor now available show gold importations amounting to \$109,616,707 and gold exportations of but \$23,003,407, making the excess of imports over exports in the 10 months \$86,613,300; while for the 12 months ending with April the imports of gold are \$146,896,815, and the exports are \$31,981,947, making the excess of imports over exports for that period \$114,914,868. The largest importations of gold ever occurring in any fiscal year were \$120,391,674 in 1898 and \$100,031,259 in 1881, while in no other fiscal year has the total of gold imports ever crossed the 100-million-dollar line. A comparison of these figures of excess of imports over exports with those of previous years indicates that unless a marked change shall occur during the next two months in the general movements of gold into and out of the United States, the net imports for the full fiscal year about to end will be larger than ever before. The only fiscal year in which the net imports of gold, or excess of imports over exports, exceeded 100 millions was 1898, when the figure of net imports was \$104,985,283. The nearest approach to the 100-million-dollar line on any other occasion was in 1881, when the net importation of gold was \$97,466,127.

The Prospector.

Enquiries sent to this department are answered free of charge, if submitted by subscribers who are not in arrears. The full name and post-office address of the sender must be given, otherwise no answer will be made. Those who are not subscribers must accompany their questions with a fee of \$3 for each question. No assays are made.

Two specimens of Andesite were sent by T. P. B., of Alamos, Mexico.

G. H. H. sends a specimen of Kaolinite from Sulphur Springs, Colorado.

A specimen of black Quartzite was sent by P. G. from Naranjera, Mexico.

The brown mineral sent by J. W. O., of Piute, Cal., is an Andradite Garnet.

Specimens sent from Mill Valley, Cal., by W. B. H., have not been received.

A specimen of the arsenic ore, Realgar, was sent by D. F. O., from Manhattan, Nevada.

The two specimens which were sent from Denver by S. W. and which were supposed to contain Tungsten are Magnetite in a Pegmatite Granite.

The Kaolinite from Yerington, Nev., sent by C. B. C., appears to be of good quality. Some Western firms using clay are: Corona Press Brick & Terra Cotta Co., Corona, Cal.; Douglas Clay Product Co., Los Angeles, Cal.; St. Louis Fire Brick & Clay Co., Los Angeles, California.

The rocks sent from Nogales, Ariz., by E. E. N., are: No. 1, Quartzite; No. 2, Quartz; No. 3, Andesite; No. 4, altered Andesite; No. 5, Dacite; No. 6, Rhyolite Tuff; No. 7, Rhyolite Porphyry; No. 8, Andesite; No. 9, Dacite; No. 10, Dacite; No. 11, Andesite; No. 12, Andesite; No. 13, impure Limestone; No. 14, Rhyolite; No. 15, Rhyolite.

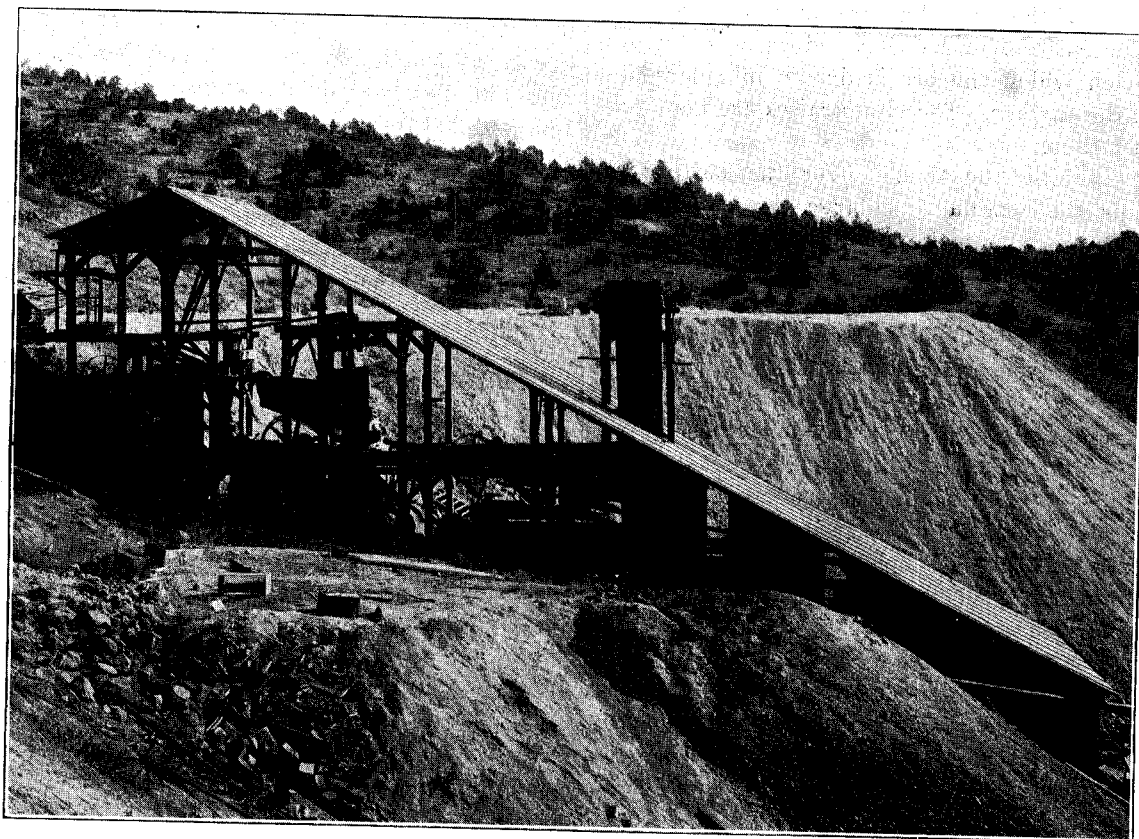
SILVER MOVEMENTS into and out of the country seem likely to show a smaller excess of exports over imports in the fiscal year about to end than on any occasion during the past decade. Movements of silver into and out of the United States are in each case large, the inflow coming chiefly from Mexico. This large movement of silver into the United States, already a great silver-producing country, is due largely to the fact that her facilities for smelting and refining are more satisfactory than those of her silver-producing neighbor, Mexico, and that Mexican silver moves to the smelting and refining establishments of the United States, a part of it coming in lead ore and a part of it in the form of base bullion. The largest imports of silver in any full fiscal year were those of 1906—\$41,442,540—and those of the present fiscal year seem likely to be about the same. The largest exports of silver in any fiscal year occurred also in 1906—\$65,869,063—while the total for the present fiscal year seems likely to fall considerably below that of last year. The excess of exports of silver over imports of that metal amounted in 1906 to \$21,426,523, and has been continuously above the 20-million-dollar line (and in some cases above 30 millions) since 1893, but the present indications are that the excess of exports over imports will, in 1907, be far below that of any other year in the period just named. For the 10 months ending with April, 1907, the excess of exports of silver over imports of that metal was \$11,194,235, and for the 12 months ending with April, \$13,086,196, against \$21,426,523 in the fiscal year 1906.

EXPERIMENTAL MILL OF THE NEVADA CONSOLIDATED COPPER COMPANY.

Written for the MINING AND SCIENTIFIC PRESS
By M. L. REQUA.

The two problems that were necessary of solution before the future of the Ely district could be assured were, first, tonnage, and secondly, the concentrating value of the ore. The district was remote from railroad transportation. Eureka, then the nearest railway station, is 85 miles to the west, but railway construction from that point was never seriously considered, because of the much more favorable though longer route from Cobre, on the Southern Pacific, 140 miles north of Ely. This road follows the Steptoe valley, has a maximum grade of 0.7%,

that a small experimental concentrating mill be erected and actual tests made. The ores of the Ely district, as is now well known, are almost entirely concentrating. The amount of direct-smelting ore developed is comparatively small and insignificant. The future of the camp is dependent entirely upon success in concentrating its ores to a satisfactory saving. A small experimental mill was erected at the collar of the Ruth shaft. This mill consisted of a grizzly, on which the mine-car was dumped and the larger lumps of ore broken by hand. From the ore-bin the ore was fed by a plunger feeder into a trommel. For the purpose of experimenting, screens of various sizes were used, and it is probable that some of these experiments were not wisely made, and this is one of the reasons for believing that in a large mill, prop-

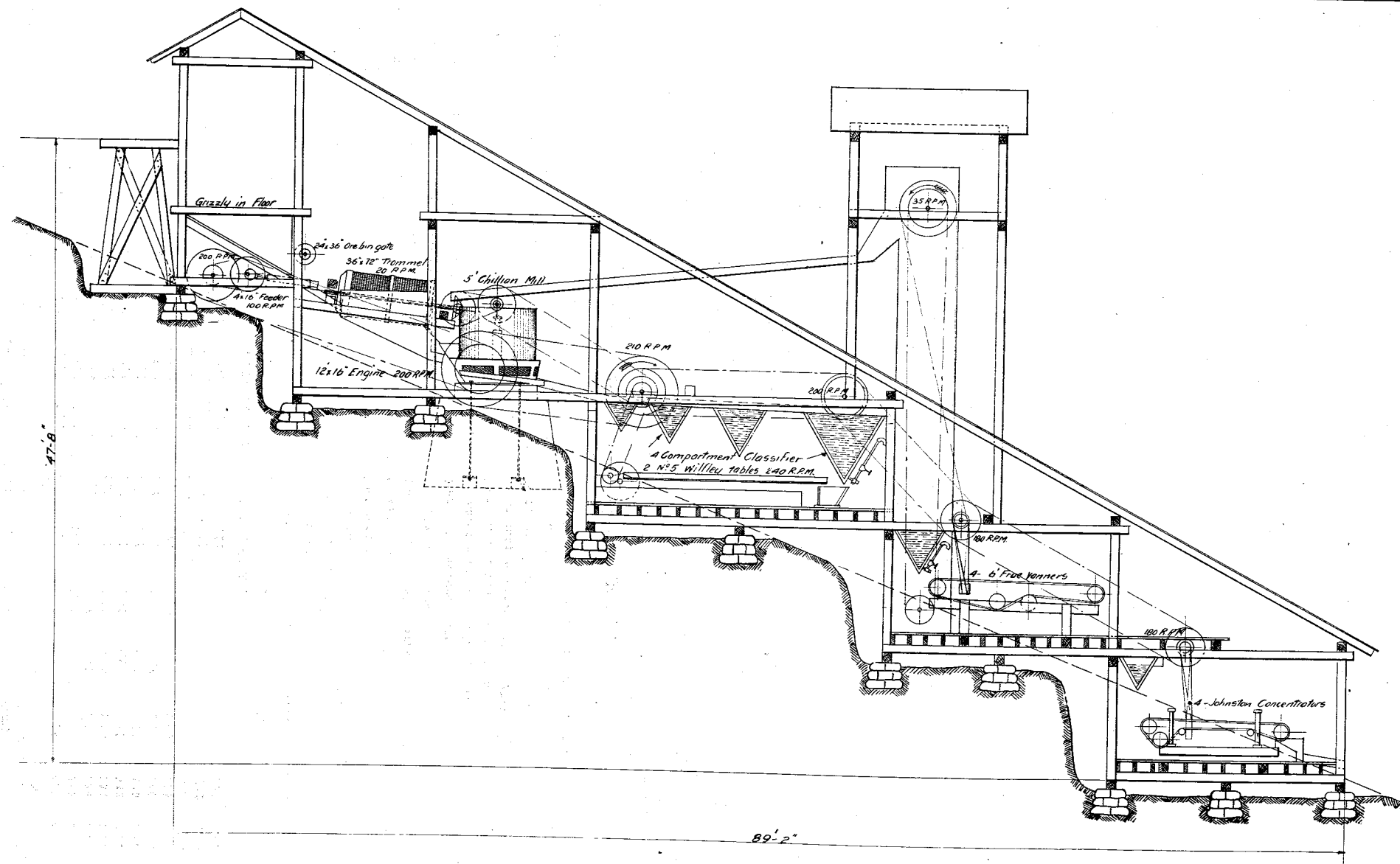


Experimental Mill, Nevada Consolidated Copper Company.

maximum curves of 6°, and practically neither cuts nor fills. Against this the Eureka route would have had four summits to cross, with a maximum grade of 4%. The investment was of necessity large in order to put the property on a producing basis, and it was not conservatism to leave anything to chance. It meant at least \$2,000,000 in the railway, \$2,500,000 in plant, and \$500,000 for mine equipment, or a total of \$5,000,000.

To justify this investment for a deposit of low copper content, demanded millions of tons of developed ore, and absolute knowledge as to its concentrating value. The question of smelting was not one that needed actual demonstration, as it was well known what could be done with such concentrate, but while similar ore was being concentrated in other places and the results known, it was deemed necessary, in order to make possible the financing,

erly tuned up, the saving will be in excess of that secured in this small plant. The oversize from the trommel went into a three-foot Huntington mill; the undersize was carried around the mill and joined the mill-discharge just before entering the first compartment of the classifier. The first-compartment product of the classifier was fed to a Wilfley table, the tailing from which was elevated and returned into the Huntington and re-ground. The second-compartment product of the classifier was fed to a corrugated-belt Frue vanner, the tailing from which was re-treated on a smooth-belt machine. The third and fourth-compartment products of the classifier went directly to either a smooth-belt Frue or a Risdon-Johnston vanner. Round-tank slime was re-treated upon a Risdon-Johnston or a Frue. This gave practically a double treatment throughout the plant, and while not constructed with any idea of economy or



Section Through Experimental Mill, Nevada Consolidated Copper Company.

DETAILS OF TESTS ON 200-FT. LEVEL.

Date, 1904.	Lot, No.	Dry Crude Ore, Lb.	Crude Copper, %	Copper Tailing, %	Approximate Extract, %	Dry Concentrate, Lb.	Copper Concentrate, %	Copper Concentrate, Lb.	Copper Concentrate, %	Actual Extract, %	Ratio.	Shovel-Sample Copper, %	Shovel-Sample Copper, Lb.	Map-Average Copper, age.	Map-Average Copper, Lb.
Nov. 9...	36	12,600	3.29	1.10	66.60	2,031	14.28	414	290	70.05	6.21:1	3.59	452	4.45	560
" 10...	37	12,950	2.37	0.45	81.01	1,857	13.39	307	249	81.11	7.00:1	2.85	369	2.93	379
" 11...	38	13,937	2.52	0.62	75.40	2,159	12.10	351	261	74.36	6.45:1	2.77	384	2.50	348
" 12...	39	10,290	2.16	0.54	75.00	1,525	11.65	221	177	79.73	6.75:1	2.25	231	2.55	262
" 24...	50	11,936	2.48	0.78	68.55	1,725	10.60	296	183	61.82	6.91:1	2.62	312	2.32	276
" 25...	51	12,700	3.29	1.01	68.30	1,935	14.27	418	276	66.03	6.51:1	3.27	415	3.85	478
" 26...	52	10,949	2.19	0.56	74.43	1,507	11.60	240	175	73.00	7.26:1	2.20	240	1.91	237
" 27...	53	11,472	1.84	0.32	82.60	1,373	12.15	211	169	80.00	8.35:1	2.09	239	2.17	248
Total		96,834	20.14	5.38	591.89	14,112	100.04	2,458	1,780	586.10	55.43	21.64	2,642	22.68	2,788
Averages ..		12,104	2.52	0.67	73.98	1,764	12.50	307	222	73.26	6.93:1	2.70	330	2.83	348

RECAPITULATION: 200-FT. LEVEL.

Per cent copper in crude ore as per above average map-average	2.83	Lb. copper concentrate as per above statement	1,780.00
Per cent copper in crude ore as per above average shovel-sample	2.70	Lb. copper lost in tailing (2458—1780).....	678.00
Per cent of copper in crude ore as per above average mill-head	5.25	Per cent apparent extraction as per above average	73.98
Per cent copper in crude ore as per lb. copper in crude ore (2458×100÷96,834).....	2.54	Per cent actual extraction as per above average	73.26
Per cent copper in tailing as per above average	0.67	Per cent actual extraction as per lb. copper (1780×100÷2458)	72.40
Per cent copper in tailing as per lb. copper lost (2458—1780)×100÷96,834	0.69	Per cent actual extraction as per lb. copper sample-shovel (1780÷2642)	67.38
Dry lb. concentrate produced as per above statement	14,112.00	Per cent actual extraction as per lb. copper in map-average (1780÷2788)	63.48
Lb. copper in crude ore as per above statement	2,458.00	Number of lineal feet of cross-cuts and drifts mill-tested	520.00
		Pounds of crude ore milled per lineal foot.....	186.00

DETAILS OF TEST ON 300-FT. LEVEL.

Date, 1904.	Lot, No.	Dry Crude Ore, Lb.	Crude Copper, %	Copper Tailing, %	Approximate Extract, %	Dry Concentrate, Lb.	Copper Concentrate, %	Copper Concentrate, Lb.	Copper Concentrate, %	Copper Concentrate, Lb.	Actual Extract, %	Ratio.	Shovel-Sample Copper, %	Shovel-Sample Copper, Lb.	Map-Average Copper, age.	Map-Average Copper, Lb.
Oct. 23...	19	11,373	1.79	0.26	85.47	1,250	12.90	203	161	79.63	9.10:1	1.93	219	2.95	335	
" 24...	20	10,220	1.57	0.32	80.20	1,025	13.39	160	137	85.62	10.00:1	1.99	203	2.20	225	
" 25...	21	11,771	2.10	0.44	80.00	1,523	15.81	247	240	97.16	7.72:1	2.59	304	2.64	310	
" 26...	22	11,411	2.47	0.38	84.61	1,382	17.00	281	235	83.33	8.26:1	2.75	314	3.27	373	
" 27...	23	11,574	2.21	0.68	69.23	1,402	13.65	256	191	74.64	8.26:1	2.21	256	3.46	400	
" 28...	24	12,574	2.37	0.67	71.73	1,864	13.64	298	254	85.90	6.74:1	3.02	380	2.46	309	
" 29...	25	11,023	1.49	0.51	65.77	1,718	8.90	164	152	92.67	6.41:1	2.03	224	2.24	247	
" 30...	26	11,653	2.48	0.62	75.00	1,658	12.98	289	215	74.40	7.03:1	2.98	347	2.92	340	
" 31...	27	11,900	1.90	0.47	75.26	1,504	11.93	226	179	79.20	7.98:1	2.02	240	2.09	249	
Nov. 1...	28	10,127	2.18	0.75	61.57	1,731	8.46	220	146	66.36	5.90:1	2.45	248	2.87	291	
" 2...	29	10,645	4.50	0.79	82.44	2,510	15.37	479	386	80.58	4.24:1	4.67	497	3.56	379	
" 3...	30	9,795	2.02	0.37	81.68	1,765	10.04	197	171	89.84	5.51:1	2.19	214	2.42	237	
" 4...	31	9,690	2.12	0.36	87.73	1,618	10.00	205	162	79.02	5.99:1	2.34	226	2.56	248	
" 5...	32	11,228	1.80	0.37	79.50	1,752	9.30	202	163	80.60	6.53:1	2.04	229	2.02	226	
" 6...	33	9,254	2.25	0.58	74.27	1,475	10.97	208	162	77.88	6.29:1	2.21	204	2.03	187	
" 7...	34	13,580	4.15	1.67	59.76	2,707	10.22	563	330	58.61	5.02:1	4.15	563	3.33	452	
" 8...	35	11,358	1.85	0.35	75.68	1,946	8.37	210	163	77.62	5.84:1	2.00	227	2.28	258	
Total		189,176	39.25	9.59	1,289.90	28,830	202.93	4,408	3,459	1,363.06	116.82	43.57	4,895	45.30	5,066	
Average ...		11,128	2.31	0.56	75.88	1,696	11.94	259	203	80.18	6.87:1	2.56	288	2.66	298	

Composite lot, 29,094 lb., 11.86% Cu, 20% Fe, 25% S, 39.5% SiO₂.

RECAPITULATION: 300-FT. LEVEL.

Per cent copper in crude ore as per above average shovel-sample	2.56	Lb. copper in composite lot (29,094, at 11.86% Cu)	3,451.00
Per cent copper in crude ore as per above average mill-heads	2.31	Lb. copper in concentrate as per above statement	3,459.00
Per cent copper in crude ore as per lb. copper in crude ore (4408÷189,176)	2.33	Lb. copper in crude ore as per above statement	4,408.00
Per cent copper in crude ore as per lb. copper in shovel-sample (4895÷189,176)	2.58	Lb. copper lost in tailing (4408—3451).....	949.00
Per cent copper in crude ore as per lb. copper in map-average (5066÷189,176)	2.67	Per cent apparent extraction as per above average	75.88
Per cent copper in tailing as per above average	0.56	Per cent actual extraction as per above average	80.18
Per cent copper in tailing as per lb. copper lost (949÷189,176)	0.50	Per cent actual extraction as per lb. copper (3459÷4408)	78.48
Dry lb. concentrates produced as per above statement	28,830.00	Per cent actual extraction as per lb. copper in composite lot (3451÷4408)	78.29
Dry lb. concentrates produced as per composite lot	29,094.00	Per cent actual extraction as per lb. copper in shovel-sample (3451÷4895)	70.44
		Per cent actual extraction as per above average map-average (3451÷5066)	68.12
		No. of lineal feet of cross-cuts mill-tested.....	840.00
		Lb. crude ore milled per lineal foot.....	225.00

rial, but upon the concentrate it was found that the results were erratic and always low, although in some cases the variation was very slight. Sixteen of the lot-samples were sent to the Tennessee Copper Co. to be assayed by the electrolytic method. By this method lots No. 2 and 3 were found to contain 1.65% and 1.92%, respectively, more copper than our assays showed. Of the 16 samples sent to the Tennessee Copper Co., 15 ranged from 0.61 to 2% higher in copper than we had been able to get by the cyanide assay on the ground in Nevada. It is possible that some of the variation between the map-average and the mill-head may have been due to the fact that there was a certain amount of soluble copper in the water, which was precipitated upon the iron through the mill, or went down the canyon with the tailing.

I believe unquestionably that in the large mill now being built these results will be materially bettered, as it was not possible to treat the products of various sizes from our classifiers as we would like to have done, nor was it practicable to put in re-grinding machines for re-grinding the coarser products, owing to the fact that the fall between the top of the mill and the bottom of the canyon was limited, and that it was not practicable, for these preliminary experiments, to put the mill elsewhere. We found it impossible to install intervening V tanks, settling boxes, classifiers, etc., as would certainly be necessary to secure the best results. It seems fairly evident from the results of these experiments that a large mill should yield above 75% extraction. This being the case the cost to the Nevada Consolidated Copper Co. of its copper, taking into consideration the steam-shovel work at Copper Flat, and the caving at Ruth, should not exceed 7½ or 8c. per pound sold in New York. Assuming a recovery of 30 lb. per ton, we would have on a 15c. copper market, 7c. per pound profit, or \$2.10 per ton of ore. Assuming 15,000,000 tons of actual ore blocked out in the property, this would give a net earning capacity of something over \$30,000,000, or figured upon the present outstanding stock, plus the 200,000 shares reserved for conversion of railway bonds, and 300,000 reserved for conversion of mining bonds, or a total of 1,600,000 shares, a net dividend of approximately \$20 per share from ore now developed. In addition to ore now developed, or actually blocked out by drifts, cross-cuts, and raises, bore-holes have demonstrated the existence of a probable tonnage which, when blocked out, promises to greatly exceed the tonnage already developed.

In addition to this the Company has an acreage unprospected far in excess of the area known to contain ore, all within the porphyry area, and all possibly ore-bearing. The developed ore lies entirely in the Ruth, Fraction Tunnel Site, Blair, Eureka, Star of the West, and Star claims. The total holdings of the Company comprise 63 claims, giving it the heart of the district and an ore-bearing area in excess of the combined area of all the other companies operating on the mineralized belt. It would be foolish to attempt to forecast the ultimate tonnage that may be developed.

While this article has been in preparation, the concentrating and smelting plant has gone into commission, and preliminary results seem to confirm the work of the experimental mill in every respect. The roasters are doing more than expected of them, and the reverberatory furnace is approximating the best Anaconda practice.

CONCRETE BOATS AND BARGES.

*An interesting little item has appeared in the newspapers and technical journals from time to time concerning a concrete boat made in France some years ago. Barges and pontoons of cement were also constructed on the Tiber by Messrs. Gabellini, of Rome. It is stated that concrete in this application as in building construction, has many advantages. The method of construction is simple and the boats are quickly made, at less cost than those of wood or steel. They will stand very rough usage, are practically indestructible, and, of course, are fireproof. It is also said that the smooth surface of the cement-finish offers less resistance than wood, and that the bottoms do not foul easily or collect seaweed. Consequently they are easy to clean. In case of damage to any portion of the boat repairs are quickly and cheaply made with cement or concrete. A comparison of cost with steel barges has shown that the concrete boat can be constructed at half the cost and that in the matter of maintenance the cost is about a fourth or a third less.

As examples of the boats constructed the 'floating chalet' for the Rome Rowing Club was built in 1897 on pontoons, and has a length of 67 ft. with a beam of 21 ft. The posts and roof are of concrete, re-inforced with expanded metal. The *Liguria* is a barge of 150 tons, and was constructed by Messrs. Gabellini in 1905. Since January, 1906, she has been working in the harbor of Civita Vecchia, near Rome. In October, 1905, she was towed from Rome down the Tiber to the sea. She was also towed to Genoa and Savona, after which she was towed back again to Genoa and Civita Vecchia. A 100-ton barge was constructed on order of the Italian Government in 1906. She was tested in the military harbor of Spezia, and was so successful that a contract was placed for four more on the same lines. These particular barges have a double sheet, forming watertight compartments, and are practically unsinkable. Their dimensions are 51 ft. long by 16 ft. beam. Smaller pontoons have been built in large numbers. In America concrete boat-building is an entirely undeveloped enterprise, but that it offers great possibilities would seem to be indicated by the success attained in Italy.

Metallic vapors begin to condense at temperatures depending upon the vapor-tension curve of the metal and the amount of other uncondensable gas with which it is mixed. These intermixed gases reduce the pressure upon the metallic vapor, and lower the temperature at which the vapor becomes saturated. The phenomenon is exactly analogous to the 'dew point' of air and the precipitation of rain.

* Abstracted from *Cement Age*, June, 1908.

STEAM SHOVEL IN COPPER MINING, ELY, NEVADA.

Written for the MINING AND SCIENTIFIC PRESS
By F. S. PHEBY.

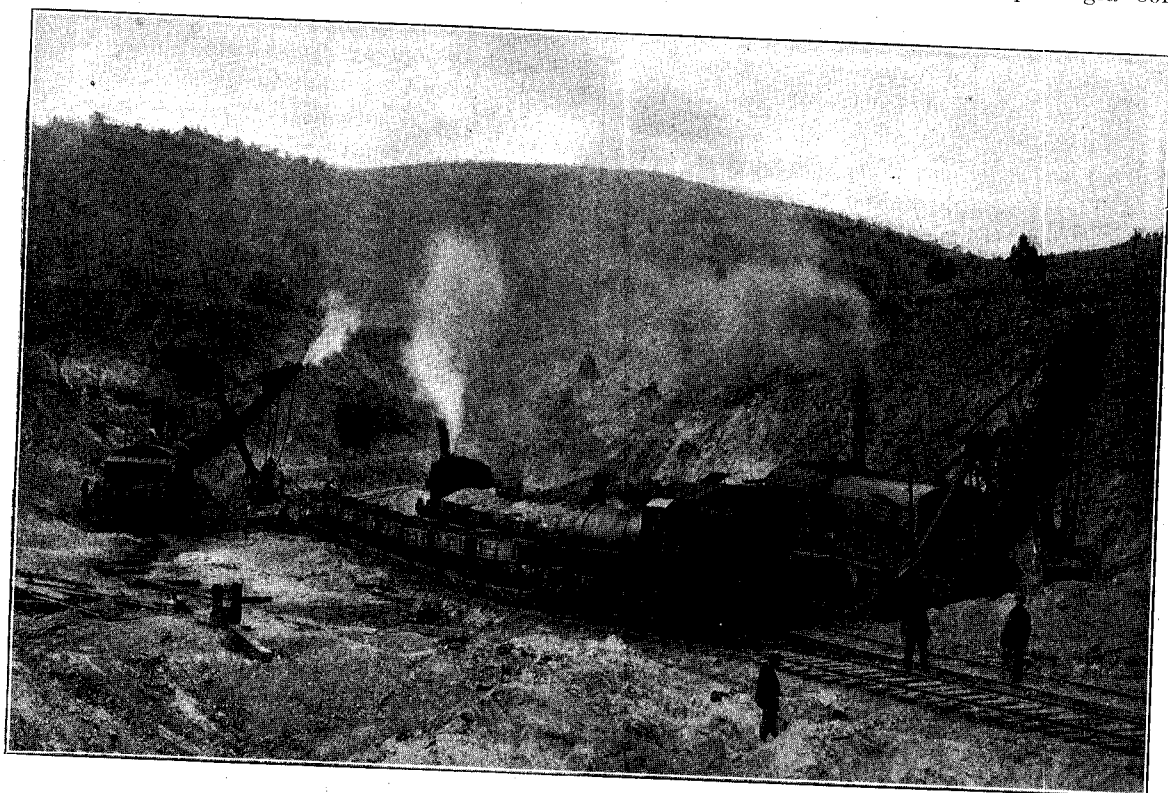
The steam shovel has been introduced in copper mining by the Nevada Consolidated Copper Co. at Ely, Nevada. Four shovels are in use, weighing 95 tons each, three working in overburden and one in ore. Shovels of $2\frac{1}{2}$ cu. yd. capacity, now employed, will soon be replaced by shovels of 5 cu. yd. capacity. Recently one shovel, working 9 hours, handled 2800 cu. yd. Two shovels shown in the cut herewith are working in overburden. The man in the foreground stands on the rim of the ore pit, which is 22 ft. deep. The track shown is laid entirely on ore, by means of which the thickness of the overburden may be

DETERMINATION OF MOLYBDENUM IN WULFENITE.

By J. C. EVANS.

*The following method has for its object the determination of molybdenum in wulfenite or other ores containing lead. The procedure consists in getting the ore into solution by the proper re-agents, the precipitation of the iron and lead as sulphides, the separation of molybdenum as sulphide, and its subsequent determination as lead molybdate, either gravimetrically or volumetrically. The method in detail is as follows:

From 0.5 gram to 5.0 grams of ore, depending on the amount of molybdenum contained, is digested in hydrochloric acid; nitric acid is afterward added and the treatment with hot aqua-regia continued



Steam Shovel Mining Copper Ore, Ely, Nevada.

readily appreciated. It varies from 8 to 24 ft. Only a small amount of overburden has yet been removed; the entire amount to be cleared is nearly 3,000,000 cu. yd. and it is estimated to overlie not less than 15,000,000 tons of ore, having an average thickness of about 200 ft. On the left wall of the pit may be seen a drill in operation. Holes from 50 to 70 ft. are drilled for blasting. While the ore is exceedingly soft, and may be crushed in the hand when thoroughly disintegrated, shoveling is, nevertheless, materially aided by blasting. The overburden is greatly discolored by iron oxides, but only occasionally by copper. The line of demarcation between the ore and the overburden is as distinct as is that between a red and a white band. The cars shown are of $3\frac{1}{4}$ cu. yd. capacity, but are to be replaced by larger ones. Those carrying the ore to the concentrator have a capacity of 50 tons, twenty making up a train. The cost for handling a ton of material does not exceed 55 cents.

until all soluble constituents of the ore are in solution; after one or two evaporations with nitric acid to expel all chlorides, the mixture is cooled, diluted with distilled water, and a slight excess of ammonia added. Ammonium sulphide is added, drop by drop, and when all the iron, lead, and other metals are converted into sulphides, a few c. c. excess are added, and, after stirring, the mixture is allowed to stand in a warm place until all the iron and lead sulphides have settled. It is then filtered, and washed with a solution containing a slight amount of ammonium sulphide. The precipitate is dissolved in a hot mixture of equal parts of nitric acid and bromine water, the iron and lead being reprecipitated by ammonia and ammonium sulphide to insure the removal of all the molybdenum. The combined filtrates, which show a deep brown color if much molybdenum be present, are slightly acidified with hydrochloric acid and a rapid stream of hydrogen sulphide gas is

*From the *Western Chemist and Metallurgist*, December 1907.

COPPER MINING AT ELY, NEVADA.

Written for the MINING AND SCIENTIFIC PRESS
By COURTENAY DE KALB.

The name of Ely was not transferred from Vermont to Nevada. The classic little copper mine in the Green mountains, never large, but never exhausted, had nothing to do with naming the spot in the Steptoe valley that has risen suddenly to fame. Many years ago, the abundant water and excellent pasturage in this valley led to the establishment of a cattle ranch by one Ely from "down in Maine," and Ely's Ranch became simple Ely. In course of time, minerals were discovered. First came lead ore, containing silver. Lead is still mined in the district and is shipped to Salt Lake City. Next gold attracted notice. The Chainman mine once gave promise of acquiring a reputation, but the mill, dragged 140 miles from the railroad, has succumbed to rust instead of wear. This is at Lane City, on the road up the gorge to Copper Flat, the scene today of magnificent operations in the gigantic modern way. Close to this great open-cut is the Keystone copper mine, memorable only for a tragedy in which a mine manager shot four menacing workmen several years ago. This mine, like others around it, was a failure. A large dump betokens extensive workings underground; to the Nevada Consolidated Copper Co. this dump of gray slacking monzonite is commercial ore, and will one day go to the mill, when the excavations extend that far; to the Keystone capitalists it was 'waste,' and typified discouragement. It depends on the point of view what kind of an enterprise is set in motion. The disseminated ores of Ely to the first group of miners signified the possibility of enriched veins, from which they hoped a product might be obtained that would pay the enormous costs of old-time methods. The second group, urged by the courage and inspired by the foresight of Mark L. Requa, instead of seeking ore to match a method, adapted a method to the ore available, and the result is one of the greatest copper enterprises in the world. The shares of the Nevada Consolidated, which could be bought during the late panic at \$6, are now close to \$20: The capital stock consists of 1,600,000 shares, of a par value of \$5 each. So clearly was the future greatness of the property proved that the capital stock and other securities realized a sum of \$3,122,710 in excess of par value for the benefit of the company's treasury. The total capital liability on the books today is charged at approximately \$14,400,000. This finds its warrant in a body of developed workable ore of 20,000,000 tons. The reserves blocked at present represent only a fraction of the area available. Prospecting by Keystone drills is proceeding rapidly; this is a swift and exceedingly economical method of prospecting. The ordinary drill, such as is used in testing auriferous gravel, is employed; the prospect holes extend to 300 and 400 ft., according to the topography, but the hole is usually started with a diameter of 10 inches, so as to finish at 6 in. The speed varies from 25 to 40 ft. per diem, and the cost ranges from 75c. to \$1.25 per foot. This work is locally called 'scouting'. The testing already

done shows an average copper content for the 20 million tons developed, of 1.9%, this being the figure stated officially by Pope Yeatman, the consulting engineer for the company.

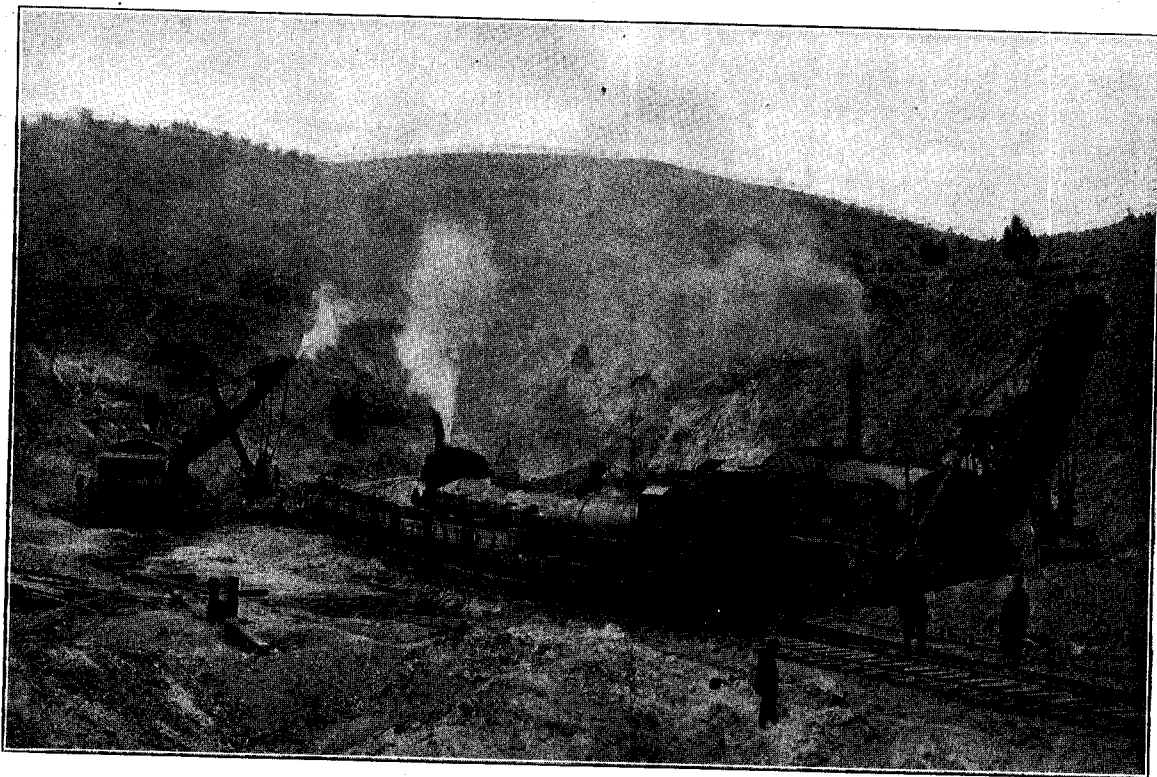
The earlier testing of these deposits was done by the ordinary methods of shaft-sinking and level-driving. This was mainly at the Ruth mine, on the eastern side of the mass of impregnated monzonite. An account of the tests, and the vindication of the churn-drill method by its faithful agreement with sampling in many lots of several hundred tons in the Ruth mine, will be found in an article entitled 'Experimental Mill of the Nevada Consolidated Copper Company', by M. L. Requa, published in the MINING AND SCIENTIFIC PRESS of July 18, 1908.

The area of the ground owned by the Nevada Consolidated Copper Co. is 850 acres, consisting of 63 claims. Closely related for purposes of operation and treatment is the Cumberland-Ely, where 12 claims have been partly developed. The orebody there is narrow, and of higher grade, yielding from 3 to 4% copper. Associated with these companies are the Steptoe Valley Smelting & Mining Co., with magnificent works, still being enlarged, at the new town of Smelter, 22 miles away. Here water is abundant, and ample precautions have been taken not to become involved in legal embarrassments over fume. Finally, the Nevada Northern Ry. Co. was organized, and a line was built to the Southern Pacific at Cobre, 140 miles north of Ely. A ramification of shorter lines around Ely opens up the ore-producing territory and gives access to the works at Smelter. Each corporation is operated on entirely independent lines. Beyond these corporations lie other financial intricacies, the American Smelters Securities Co. holding indirectly a controlling interest on behalf of the American Smelting & Refining Co. Thus the enterprise constitutes a notable enrichment of the holdings of the Guggenheims.

The geology of the ore deposit was studied by Andrew C. Lawson, professor of geology in the University of California; a monograph entitled 'The Copper Deposits of the Robinson Mining District, Nevada', was published in 1906, as a bulletin of the Department of Geology in the State University. No preceding studies had interpreted the interesting phenomena presented at Ely. Under conditions that were practically those of a reconnaissance Mr. Lawson has done work that has stood the test of subsequent development, so that his report on this property has been a splendid example of the practical importance of the economic geologist. In brief, a mass, or batholith, of monzonite porphyry is found intruding Devonian and Carboniferous rocks, the latter consisting of limestone. The intrusive rock appears upon the surface at Copper Flat and at the Ruth mine. The area between is overlaid with limestone, and this covering exists continuously around the porphyry, portions of which are also overlaid by a more recent flow of rhyolite. This has raised the question as to the probable extension of the copper in workable amount beyond the limits of the exposed area, especially under the rhyolite capping. A concentration by secondary enrichment has resulted

from leaching where the monzonite has lain open to meteorological influences. The enrichment has been feeble, to be sure; nevertheless it has made all the difference between ore and valueless rock. The upper portion of the porphyry has been impoverished by leaching, and constitutes an overburden from 50 to 70 ft. thick, containing 0.75% or less of copper. The re-precipitation occurred at a former water-horizon which has since been lowered. Hence the change from the overlying oxidized lean rock, with its prevailing yellowish tinge, to the bluish-gray enriched ore below, is as abrupt as if the two had been artificially severed. Below this line of division, however, the copper content presently shows a decrease in depth, and the quantity gradually sinks to about 1 per cent. The depth to which extraction may continue depends, in consequence, upon the price of cop-

was early foreseen, and it has fulfilled the expectations of those who fathered the enterprise. The cost of the ore in the cars ready for transportation to Smelter is about 40c. per ton, including its proportion of the cost of stripping overburden. The actual digging and loading costs only about 11c. per ton. One 70-ton and three 95-ton Bucyrus steam-shovels are used. The larger shovels, with $3\frac{1}{2}$ cu. yd. dip-pers, equal to 7 tons of ore per dipper, will dig as much as 800 cu. yd. per day. A shovel-crew comprises an engineer at \$175 per month, a crane-man at \$125, a fireman at \$90, and 6 pitmen at \$2 per day. The cost of explosive used on the overburden will not exceed 4c. per cubic yard. A shovel will comfortably load 2500 tons in 9 hours, and it can fill one car of 55 tons in 4 minutes. The banks worked in the overburden are at present about 50 ft. high, and



Mining With Steam-Shovel at Ely.

per and the extent to which mining and reduction of the ore at Ely can be cheapened. An interesting phenomenon at Copper Flat is the vertical division of the deposit by an almost dike-like zone of silicious ore, out-cropping on the surface and cutting the deeper orebody. This contains copper to the extent of 3%, and even 4%, in the form of silicate and carbonate. It was originally suggested that this so-called 'carbonate' ore would need to be treated by a leaching process, but the metallurgists of the Steptoe Valley S. & M. Co. have done better than that. The proportion of silica is so high, being about 80%, that in this material, donated by Nature as a bonus with the mine, they have an ideal converter-lining. This cupriferous silica, available at certainly no more than 65c. per ton laid down in the works, is an important assistant in the economical treatment of these ores.

The method of mining adopted at Copper Flat is by steam-shovel. The adaptability of the steam-shovel

in the ore 40 ft. The open-cut is 800 ft. long by 400 ft. wide, and is being excavated in two benches, with railroad track making a loop around the head of the cut, so that trains always make the circuit, thus obviating loss of time from switching in and out of the loading places. Much of the ore is soft and requires little or no blasting, but the overburden is hard and needs shattering by heavy blasts. Holes for this purpose are drilled with Keystone churn-drills, using a 6-in. bit. No casing is required. The holes are placed from 25 to 30 ft. from the edge of the bank, and 30 ft. apart. The hole is first 'sprung', or chambered, with dynamite, from $\frac{1}{2}$ to 2 boxes of 40% grade being used, according to the hardness of the rock. If the ground is relatively loose the hole is then charged with 60 kegs, of 25 lb. each, of Dupont FF black powder; if the rock is firm and dense, the hole is loaded with 15 to 20 boxes of 40% dynamite. The volume moved by such a blast is approxi-

mately 2400 cu. yd. Work had been abandoned during the financial crisis, but stripping overburden was resumed in March. Since that time, approximately 300,000 tons of sulphide ore have been mined and shipped to Smelter. This applies only to Copper Flat, and is exclusive of tonnage shipped from the Veteran mine of the Cumberland-Ely. Drilling is proceeding westward to establish the persistence of the orebody in that direction. In horizontal distance these tests have shown its continuance 1800 ft. beyond the present open-cut, and the cut will have several banks or terraces below the existing floor. This will give an idea of the magnitude of the operations. It was hinted that banks 100 ft. high might be attempted, which would, of course, be in disregard of occasional mishaps, when a shovel and crew might be buried by a slide. No extraction of ore is taking place at the Ruth mine. The amount cheaply available at Copper Flat is enough to feed the mill, as it now stands, to its full capacity, and concentration of work and traffic at one point naturally affords superior advantages in regard to economy.

The Veteran mine, which is practically part of the same general scheme of operations in spite of pertaining to a company having a separate corporate existence, is an underground working. The overburden here is too thick to admit of stripping. That form of caving known as 'top-slicing' is being introduced. Enough has been done to demonstrate its applicability to local conditions. The ground is laid out by cross-cuts and lateral drifts in blocks 50 ft. square. Raises are then driven to the overburden at the four corners of the blocks. The slicing is carried across each 50-ft. block, and a floor of boards laid as the work progresses, to serve as a mat to hold the overburden when it settles, and to keep it from mixing with the ore below. The height of face on the upper slice is 8 ft., but the subsequent lower slices will be 10 ft. The next slice will be worked carefully under the broken overburden, the mat being caught and held in place by timber sets of 12 in. square caps, and round stulls of Oregon fir. As the system had only been introduced experimentally, no data concerning costs were available. Fifty experienced cave-miners had just been brought from Minnesota. The output of the Veteran is intended to be 1500 tons daily. Four of the 12 claims on the orebody will be worked from this one shaft. The charge made by the railroad on ore from the Veteran mine to Smelter is 30c. per ton in 300-ton lots.

A vertical 3-compartment main shaft, with manway, serves the Veteran mine. The compartments are 5½ by 6 ft., with one compartment 5½ by 9 ft. for convenience in lowering timbers. The shaft is surmounted by a wooden head-frame 110 ft. high, with 12-ft. sheaves over which run 1¼-in. steel cables. The total height of lift is 600 ft. Hoisting is done in automatic-dumping 5-ton skips made by the Atlas Car & Manufacturing Co. of Cleveland, Ohio. A cage is also used for raising and lowering men; this is operated by a special steam hoisting-engine, designed and built by the Exeter Machine Works of Pittsburg. The ore-skips are operated by a 300-hp. General Electric Co.'s induction motor,

rated as 3-phase, type 1-14, form M, 60 cycle, for 290 amperes and 550 volts. The hoist itself was built by the Denver Engineering Works and has 6-ft. drums, working in counterbalance. A current of 40,000 volts is transmitted from the power-house at Smelter, and is stepped down to 600 volts for the hoist.

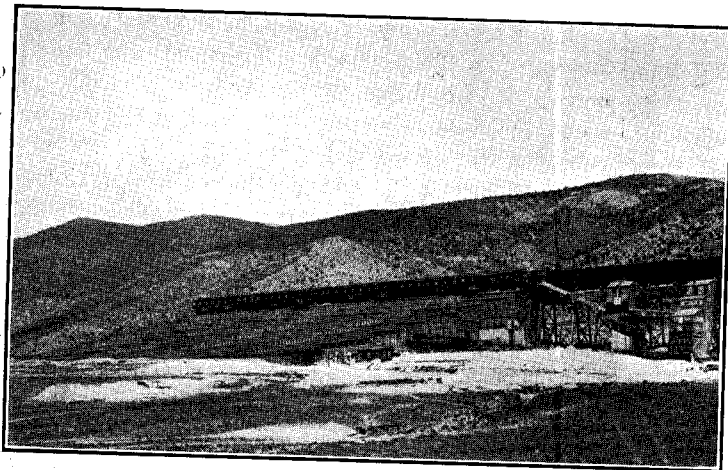
The geology of the region is of great interest, but the details are accessible in Mr. Lawson's published report, and will not be reviewed here. Attention, however, may be called to the fact that indications are favorable for the existence of contact copper deposits between the porphyry and the limestone; these possibilities have not been developed. It is expected, however, that ore available for blast-furnace smelting will be found. The limestone contains many large masses of silver-bearing limonite, which would furnish valuable flux for silicious copper ore. That the silver-lead and gold ores will be locally utilized in time seems probable. Developments are disclosing larger amounts of galena than had been previously suspected. These deposits constitute a distinct belt north of the monzonite, and lie in the Ruth limestone, which is the upper member of the Carboniferous rocks occurring in this district. The Ruth limestone is 500 ft. thick, and is underlaid by 1000 ft. of Areturus shaly limestone, succeeded downward by 1500 ft. of Ely limestone. Thus there may be possibilities for lead-mining at considerable depths below the present known occurrences in the Ruth limestone. Some deposits of lead-ore are also being worked in a small way on the great ridge that separates Steptoe from Duck Creek valley. These small mines, which are now shipping ore to Salt Lake City, are almost directly above the reduction works at Smelter. The gold deposits are confined to the Paleozoic rocks, which are represented by 1000 ft. of White Pine shale, on which the Ely limestone rests conformably. Below this comes the Nevada limestone, at least 1000 ft. thick. These are of Devonian age. The gold ores are often basic, and to some extent may be used as flux if blast-furnace smelting should develop at this point, and it has been hinted that some concentrating gold ore exists.

Surrounding the great mines are others of varying promise. The Giroux Consolidated is well known, having been long before the public. Underground mining is practiced here, and it would seem that the policy of the company has been too much to insist upon the importance of its rich ore rather than to face the larger elements of the problem presented in the utilization of masses of low-grade ore by the cyclopean methods that are now changing the character of copper mining in so many parts of the world. The Giroux undoubtedly has rich ore, but it seems unfortunate that no energetic effort is being made to open what may prove so large a mine that the high-grade masses will only be looked upon as something to sweeten the output. Many prospects are being worked, as always happens around every enterprise of magnitude. Despite their reputation, the Guggenheims have not taken everything in sight at Ely. Combinations of outlying properties may lead to the creation of important neighbors for the Nevada Consolidated and the Cumberland-Ely.

Present Conditions at Ely

STAFF CORRESPONDENCE

The principal operations of the Nevada Consolidated Copper Co. are at Copper Flat, seven miles from Ely, Nevada, where five Bucyrus steam-shovels, with 3½ and 5-cu. yd. dippers, are loading into cars 240,000 tons per month of mill ore, and in like manner disposing of a great tonnage of overburden. In performing this work eight 45-ton locomotives, and one of 60 tons, are in use. The main pit, which is the centre of operations, is nearly 2000 ft. long, 1000 ft. wide at the top, and 180 ft. deep from the highest rim to lowest part of the excavation. The shovels are operating on four terraces. The long diameter of the pit lies north and south, the track-age for the ore trains entering from the north; the pit has drainage in the same direction into an arroyo. The work at the head-end of the pit is extending toward a limestone hill, and will be continued south to the contact of porphyry with this limestone. The greatest progress of the shovels, however, is west-



Steptoe Concentrating Plant, Ely District.

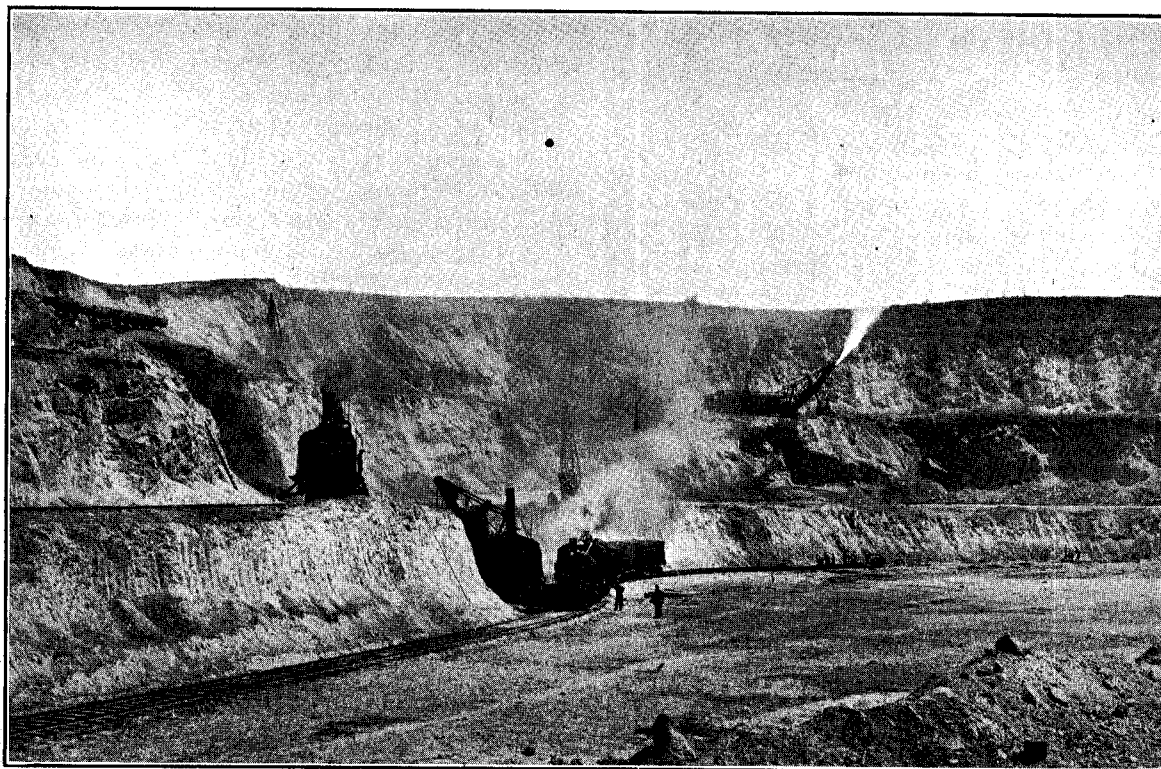
erly, or in a lateral direction. The overburden, the greater part of which is taken to the waste dump, is 85 ft. thick. The rock in certain shoots of this porphyry capping, containing 75 to 80% silica, and 2 to 4% copper, is sent to the smelting plant and used for converter lining. The defined ore stratum, below the overburden, carries 80% silica, 3.5 iron, 2.1 copper, and 0.5 lime. The copper is disseminated through the gangue as chalcocite, and is considered a secondary enrichment of the monzonite-porphyry. The ore is 200 to 300 ft. deep, as was demonstrated by churn-drill work in the vicinity of the main pit. The body of ore against which steam-shovels are now working is about 60 ft. deep, although the pit is being made deeper. A second pit is being opened a short distance west from the one above described, where two new steam-shovels will be put in operation, the result of which will be to increase the tonnage of ore that can be shipped to the concentrating plant at McGill.

The milling and smelting plants are operated by the Steptoe Valley S. & M. Co., a subsidiary of the Nevada Con. The Nevada Northern Railroad Co., whose main line extends from Cobre to Ely, with

one branch from Ely to the mines of the district, and another to the mill and smelter, is another subsidiary. The concentrating mill is built in eight sections, two sections making a unit, with a rated capacity of 750 tons daily per section; but this capacity has been greatly exceeded. It is stated that as high as 10,500 tons have been put through in 24 hours. With only seven sections now in operation the plant already handles between 8000 and 9000 tons per day. The ore is first passed through McCulley gyratory crushers. There are 8 sets of 15 by 36-in. coarse rolls, and 16 sets of 14 by 36-in. fine rolls, Allis-Chalmers type. In each section are 68 Wilfley tables and 48 A.-C. vanners; four elevators, 12-ply, 20-in.; four 6-ft. Huntington mills and one Garfield Chilean mill; eight Steptoe classifiers; eight 2-mm. revolving screens and two ½-mm. screens for de-watering; and 46 Callow tanks. The Steptoe classifier is a modification of the one devised by Pope Yeatman, as shown in Richard's 'Ore Dressing'. The modification, which effects radical changes, was made by Geo. F. Waddell, mill superintendent, and his staff. These classifiers receive the re-ground material from the Huntington and Chilean mills, and the middling from the first-floor tables, also the undersize of the 2-mm. trommels. They effect classifications for different sets of tables and vanners, each set receiving its classified product through a particular spigot. The result is said to be greater efficiency and speed in this branch of the work. Another change in the practice here consists in taking out No. 1 trommel, which was formerly used to take up an undersize before wet-crushing in coarse rolls. This trommel having been taken out, the entire feed of the mill passes direct to the coarse rolls, which operate dry instead of wet as formerly. This change has served to increase the capacity, makes a steady feed possible,

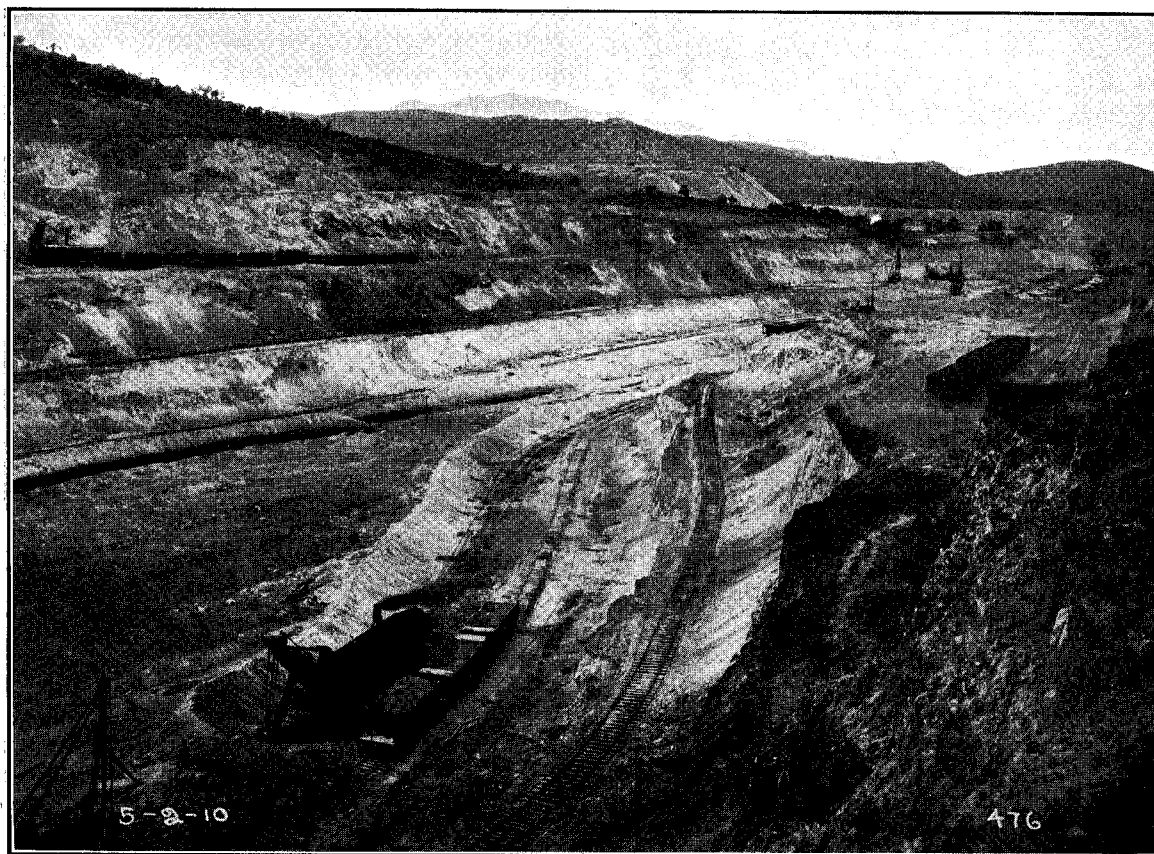
with no choking of rolls. The change from wet to dry crushing, as applied to the coarse rolls only, and the installation of the Steptoe classifiers, are said to have resulted in adding 60% to the capacity of the mill. The process becomes a wet one after the pulp passes through the coarse rolls, of which there is one set to each section. With the proposed increase in mill capacity, that is expected to come with the increased ore supply from the mines, it is thought that ore may be put through the mill at the rate of one ton per minute per section. A tonnage recorder, which works as a meter, and devised by Fred Curtis, the chief sampler, indicates to the superintendent, or foreman, just what tonnage is passing through each section each hour. The mill concentrates approximately ten tons into one.

The concentrate is delivered to the 16 McDougall roasters in Atlas hopper-bottomed steel cars, each of 10 tons capacity, the cars of concentrate being weighed on track scales. The roasters are of the Anaconda type, set in two parallel rows, the calcined product discharging into calcine hoppers, and from these it is taken hot to the reverberatory furnaces in closed cars. There are five reverberatories,



Steam Shovels at Copper Flat, Ely, Nevada.

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Copper Flat, Nevada Consolidated, Ely, Nevada, Looking North.

each 19 by 110 ft., the waste heat from which is passed into eight Sterling and two Babcock & Wilcox boilers, the steam from which is utilized in the power-house and in heating the concentrator building during the winter season. The reverberatory slag is skimmed off and granulated in waste water from the mill and discharged through a launder on the flat below the plant. The matte is taken to the

converter building in steel matte-pots, and poured into the converters through cast-iron runners. There are four stands of converters, with three shells to each stand. The converter slag, after being skimmed off into truck-pots, is taken hot to the reverberatories for re-smelting. It is tapped out of the pots through a cast-iron spout into the furnaces. The converter lining, consisting of silicious copper ear-

bonate ore, is dried therein by the ashes from the reverberatory furnaces, consisting of partly consumed coke and coal. C. B. Lakenan, general manager for the company, states that in April the concentrators made a saving of 71.84% of the copper content, and that the smelting process resulted in an extraction of 95% of the copper in the concentrate. This ore carries 40c. per ton in gold and 2.1% copper.

A new Nordberg horizontal cross-compound blowing engine, to supply the blast for the converters, was installed in the power-house in February, and at the time of my visit it was undergoing acceptance tests. The steam cylinders are 26 by 56 by 48 in.; the air cylinders, 54 by 54 by 48 in., the low-pressure cylinders being steam-jacketed. The receiver is of the re-heating type. The engine is rated at 18,000 cu. ft. of free air per minute; speed, 75 r. p. m.; guaranteed duty, 1.28 lb. steam per 100 cu. ft. of free air compressed to 17 lb. The fly-wheel is 20 ft. diam., weight 52,000 lb. The steam is supplied at 150 lb., and superheated 100° to a temperature of 465°F. The engine is equipped with a Wheeler condenser and Wheeler-Edwards air-pump; an oil-filter system, whereby the bearings are kept flooded with oil. The old blowing engines heretofore in use will be kept in reserve. A system of air-coolers for the roasters, to replace the water coolers, is being installed. It consists partly of fans operated by electric motors.

The reverberatory ash, containing 70% fixed carbon, 20 ash, 5 volatile matter, and 5% H₂O, is used as fuel under the boilers in the power-house. The converter building is being extended to afford more room, and an additional reverberatory furnace is being built. In obtaining data herein, I am under obligations to C. B. Lakenan, general manager; S. S. Sorrenson, chief engineer; R. E. H. Pomeroy, assistant superintendent of smelter; Lindsay Duncan, mechanical engineer; George F. Waddell, mill superintendent; F. W. Solomon, mill foreman; and Fred Curtis, sampler.

The Boston-Ely Mining Co., the principal stockholders in which are residents of Boston, has 20 patented claims a short distance northwest from the Veteran holdings of the Nevada Con. The shafts of the two are about 1700 ft. apart. E. W. Ralph, manager for the Boston-Ely, states that, in sinking their shaft to a depth of 1160 ft., the first 865 ft. was in unaltered limestone, below which was intrusive material. Some leached material was found at the end of a cross-cut driven 215 ft. from the shaft at the depth of 710 ft. The contact of limestone and jasperoid was cut at 800-ft. depth by driving a 95-ft. cross-cut. This contact, which has a dip 53°, was cut by the shaft at 865 ft., and at this place copper carbonate was found. At 1127½ ft. a cross-cut was driven north to the contact, where a winze was sunk 150 ft., following the dip of the contact, obtaining sulphide material, running 25 to 30% iron, 50 to 60 silica, 10 sulphur, and 12 to 15 lime. The intention is to continue sinking on the contact. The hoisting has been done with gasoline power thus far, but this probably will be supplanted by a steam plant.

The Ely Central Copper Co. is sinking and developing at its Eureka and Clipper shafts. The for-

mer is situated 400 ft. east of the main pit of the Nevada Con.; the latter is 4000 ft. to the west, in limestone. The Eureka shaft is believed to be on the same east-west ore-zone as that of the Nevada Consolidated's Copper Flat pit, but the most of its Eureka group lies east of the fault plain, where the orebody, if found, will be at much greater depth. The shaft is now down 475 ft. At 462 ft. a streak of carbonate ore was obtained, some of which assayed 15.5% copper; this was on the fault-plain contact. At 465 ft. some iron-copper sulphide was found. A cross-cut was driven east at the 470-ft. station to the contact and an incline is being sunk thereon. Some driving is also being done north and south on the plane of contact. The character of the ore obtained in small stringers seems encouraging. The Clipper shaft has been sunk 205 ft. on what appears to be a fissure in the limestone, having a north-south strike, a dip of 60° west, of undetermined width. The gangue is lime and jasperoid, carrying iron and copper, consisting of carbonates in the cropping. The 3-compartment shaft cuts through the vein on the dip of the latter between the surface and the 180-ft. point. Sinking will be continued to a depth of 300 ft., and from this station a cross-cut is to be driven to the vein, which will be explored at that depth; in the hope of finding there a more concentrated orebody. There is a considerable flow of water here, requiring the good pumping facilities which have been installed. The plant contains three steam boilers and a small capacity hoist. The management of the Ely Central is now in the able hands of Lee Glockner.

N. A. McGill has leased the Southern Cross claim of the Chainman group, also the dumps of the entire group, and the Chainman mill. He is putting the mill in order for crushing, amalgamating, and cyaniding, and intends treating some of the dump material as well as ore from the mine. A 72-ft. raise has been made from the 400-ft. adit, and a drift has been run 200 ft. from the top of the raise to tap the orebody from which mill-ore is to be taken. Sam Cocroft has charge of the mill.

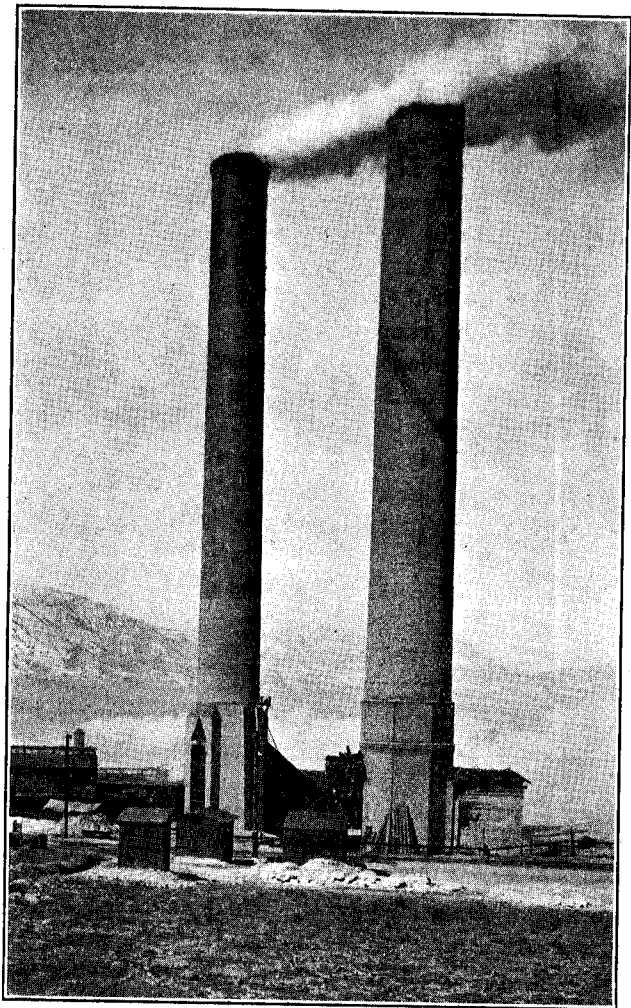
WORLD'S OIL OUTPUT

The world's oil industry is a constantly growing one, with the United States the largest producer, with an annual output more than double its closest competitor, Russia. The 1909 production is estimated at 281,000,000 bbl., compared with 278,000,000 the preceding year, and 262,000,000 in 1907. The output of this country last year fell off 10,000,000 to 170,000,000 bbl., but all of the other principal producers showed substantial gains. The world's production for three years is given below:

	1909. bbl.	1908. bbl.	1907. bbl.
United States	170,000,000	180,000,000	166,000,000
Russia	55,000,000	52,500,000	62,000,000
Galicia	15,000,000	11,000,000	8,000,000
Rumania	9,000,000	8,000,000	8,000,000
Dutch East Indies..	21,000,000	16,000,000	10,000,000
India	5,000,000	4,500,000	4,000,000
Mexico	3,000,000	4,000,000	2,000,000
Miscellaneous	3,000,000	2,000,000	2,000,000
Total	281,000,000	278,000,000	262,000,000

Razing the Steptoe Valley Stack

By D. BOYD-SMITH, Jr.



THE STACK (ON THE RIGHT) BEFORE RAZING.

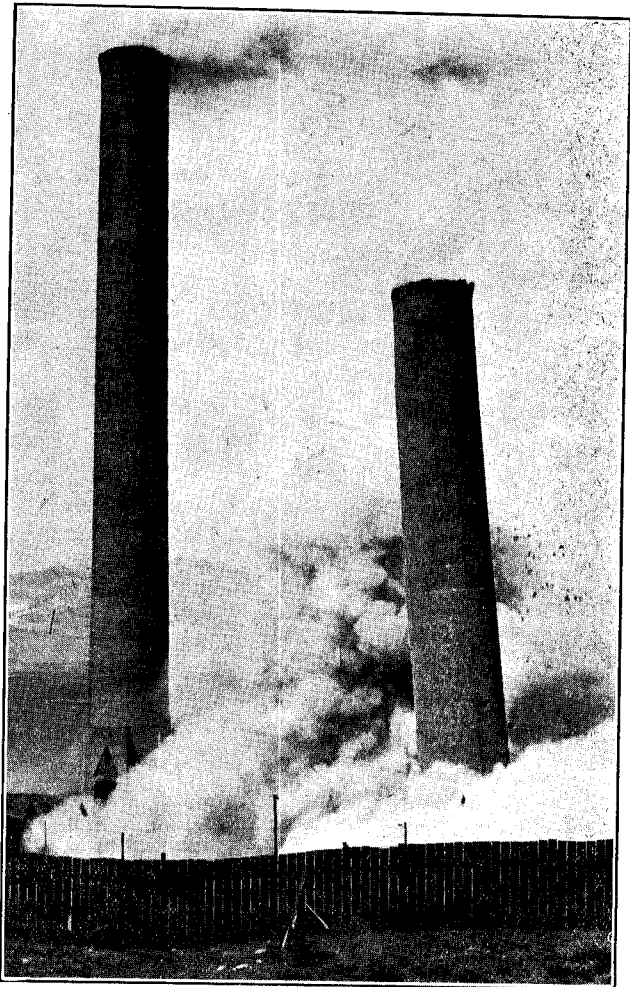
For the past two years the stack for the roaster building of the McGill plant has been in very bad condition due to the action of the acid in the smoke. This action has continued slowly but none the less surely for some time past, and through its eating effect on the brick had caused parts of the stack to fall; in some cases brick fell inside and either stopped the draft entirely or so impaired it that other arrangements had to be made to take care of the smoke until the débris could be removed. Finally the conditions reached that point where it was deemed advisable to build a new stack. This work was started and completed under the direction of S. S. Sorensen, the chief engineer, and under the direct supervision of Alma Ek as engineer in charge. On the completion of the new stack it was decided to destroy the old one, and this work was given to J. D. Watson, civil engineer for the company, under whose supervision the plans were laid and successfully carried out as herein described. The stack was originally 250 ft. in height

with an inside diameter of 18 ft., the thickness of the walls varying from 13 in. at the top to 50 in. at the bottom as is shown in Table I.

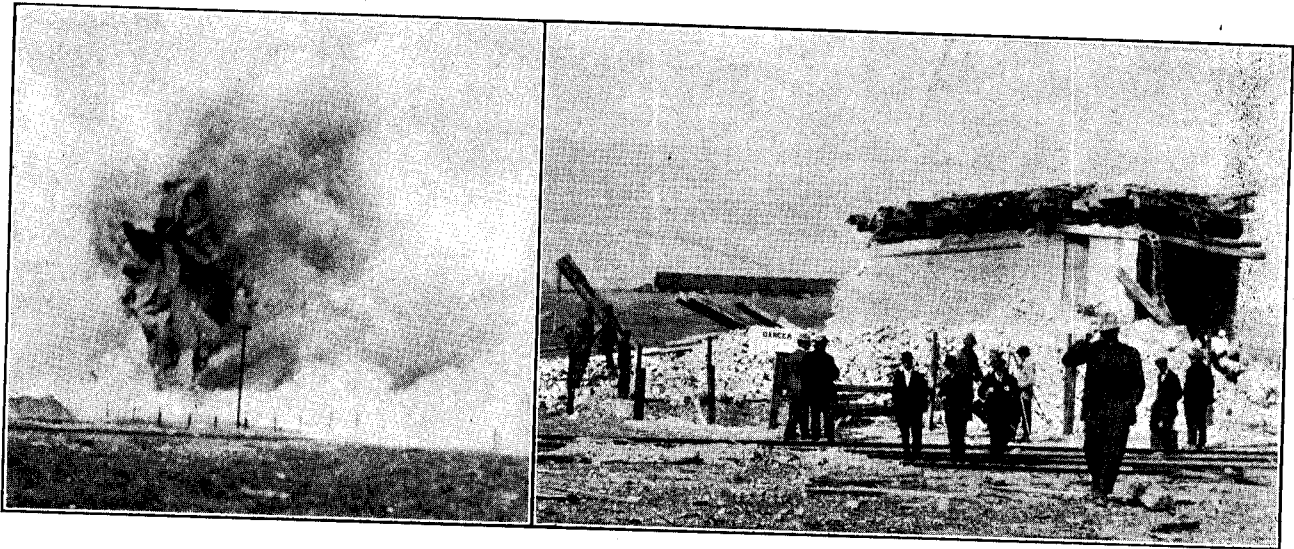
TABLE I

From base up 40 ft. 30 to 50 in. due to octagonal shape.			
Next 10 ft.....	27 in.	Next 10 ft.....	19 in.
" 10 ft.....	25 in	" 40 ft.....	17 in.
" 10 ft.....	23 in.	" 60 ft.....	15 in.
" 10 ft.....	21 in.	" 60 ft.....	13 in.

At the time of its destruction the stack had been eaten away until it was only 190 ft. high with a thickness of approximately 10 in. at the top, and it is quite logical to expect that the same amount of decrepitation had taken place on the inside throughout its entire height. On the south side of the stack and 20 ft. above the concrete foundation, there was an opening 10 ft. wide and 15 ft. high, from the top of which started a series of cracks ranging from 10 to 50 ft. in length and extending to the top. The north and east sides were in approximately the same condition. The west side, however, showed a consid-



TELESCOPING EFFECT PRODUCED BY THE EXPLOSION.



COLLAPSE AND REMAINS OF STACK AFTER DYNAMITING.

erably worse condition than any of the other three. On this side small cracks, such as were on the other sides, started at the base and extended upward to within 50 ft. of the top where the largest crack in the stack began. This crack gradually widened until at the top there was an opening from 3 to 3½ ft. wide. Due mainly to this crack on the west side there was a very pronounced swelling in the last 40 or 50 ft. when viewed from the north to south, but not so noticeable from the east and west.

The stack at the time of its destruction was estimated to weigh approximately 2,016,000 lb., and from this weight the following method of dynamiting was decided on by Mr. Watson as that best suited to the conditions. Eleven holes were drilled 7½ ft. above the concrete foundation, as is shown in the sketch, and of the sizes shown in Table II.

TABLE II

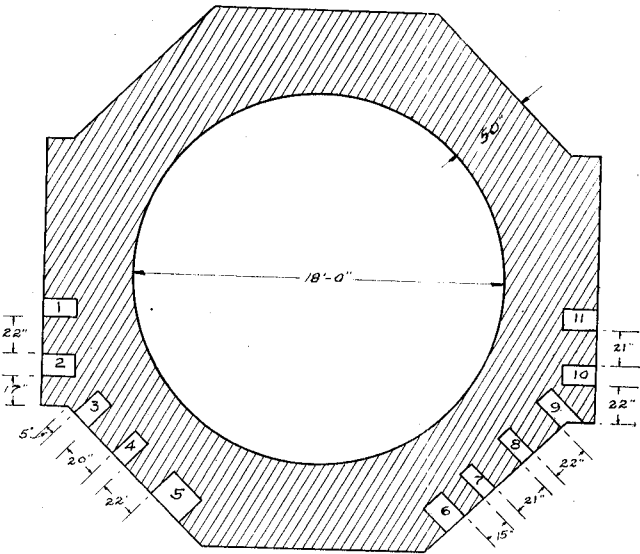
Hole No.	Width, in.	Height, in.	Length, in.
1	11	9	23½
2	13	9	24
3	12	8½	24
4	12	8½	24
5	24	6½	24
6	14	9½	25
7	9½	9½	22½
8	9½	9½	23
9	12	9½	23
10	12	7	22
11	12	6¾	23½

It was decided that approximately 200 lb. of Hercules E.L.F. 40% would be sufficient to do the work, and how well calculated the amount was is graphically shown by the photographs. The holes were loaded in the following manner. Each hole was first loaded with its apportioned share of powder, in the middle of which was a stick containing an electric detonator with a 35-ft. lead. The detonator was inserted about 3 in. into its stick of powder. After each hole had been loaded in the manner above stated, great care being taken to see that the powder was in

a most compact mass, a black plastic converter mud was used to wad the holes. This was tamped thoroughly around the powder and out to the surface of the stack, making a very solid charge. The amounts of powder placed in each hole, together with the total, are shown in Table III.

TABLE III

Hole No.	Powder, lb.	Hole No.	Powder, lb.
1	14.0	7	8.5
2	16.3	8	12.9
3	13.3	9	23.7
4	13.8	10	13.8
5	26.2	11	13.1
6	34.5		
Total		190.1	



PLAN OF STACK SHOWING ARRANGEMENT OF HOLES FOR FIRING.

The electrical connections for firing the blast were made by R. E. Middagh, chief electrician for the company, and were as follows: The eleven holes were connected in series and then to a line running approximately 500 ft. to a switch connected to the 110-volt lighting circuit. This switch was equipped with plug

fuses, which were not put in until the last minute in order that under no condition would there be an accident due to premature explosion.

When everything was ready, on March 1, the word was given and the switch was thrown, setting off one of the most successful shots of its kind ever fired.

The way in which the stack fell is well worth mentioning. From pictures taken at the time, some of which accompany this article, it seems that the shot blew out the entire base above the concrete foundation and up about 30 ft. The stack then fell straight down until its lower edge hit the foundation, at which time it seems to have telescoped on itself, making one of the most spectacular and successful falls on record. It is well to record here that in spite of the apparent bad condition of the stack in general, and the top in particular, that practically no cracks appeared until it had started to telescope; neither was much of the top loosened, although some little of the latter did fall. The entire stack fell in a pile about 50 ft. in diameter, with the exception of a few bricks which scattered to a distance of about 80 ft., due chiefly to the force of the explosion.

The new stack situated 145 ft. west by south and the two oil reservoirs situated 100 ft. north by east were not damaged. Two bricks fell through the roof of these reservoirs and constituted the entire damage done by the shot except for the destruction of some light wires which were in the danger zone and were not attempted to be saved.

Mining in the Choco District, Colombia

The gold-mining district extends from the junction of the Negua and Atrato rivers south to the mouth of the San Juan. Almost all the deposits are alluvial. There is only one large company at work in the field, formed with British capital, which is extensively sampling with drills and tunnels on the Condoto river, an affluent of the San Juan.

Most of the gold and platinum exported is obtained by native women, working two or three hours per day. They use the antiquated ground-sluicing process as a preliminary to get rid of the coarser gravels and then with their *bateas* separate the metals from the sand and gravel. The *batea* is a wooden pan, shaped like a very shallow inverted cone 18 in. diameter and 3 in. deep at the centre, with two small handles or knobs on the rim. The women handle the *bateas* with great dexterity, throwing off the gravel and sand by a rotary motion and leaving the gold and platinum dust in the common centre. Another method of mining that is extensively employed by these women is diving into 3 or 4 ft. of water for the sand and gravel containing the metals and bringing it up in the *baras*. This method is usually more remunerative than the sluicing process.

The gold workings have existed for centuries, but little has been done in the development of the district. The river gravels were being washed by the Indians

long before the advent of the Spaniards, and this region furnished much of the gold that was carried back to Spain. In those days the value of platinum was unknown, and when the Indians brought the metal down to the Spanish headquarters in Quibdo the platinum was thrown away. Large finds of this discarded metal have been made recently in Quibdo, and frequently the earth excavated for foundations has yielded sufficient platinum to pay for putting up the building. The natives were beginning to pave even the streets, thus uncovering large amounts of mud, which was injurious to health. A decree was therefore promulgated in 1913 prohibiting any further washing of earth in the streets of Quibdo.

Besides the *batea*, the only tools used are the *almocafre* and the *barra*. The former is a kind of hoe 4 in. wide, tapering in a curve to a sharp point that extends back toward the operator. The handle is approximately 18 in. long and 1 1/4 in. diameter. This tool costs 80c. to \$2, the price depending upon whether it is made of iron or steel. The *barra*, which takes the place of a pick, is a small iron or steel crowbar, 1 1/4 in. diameter and 32 to 40 in. long. A *barra* of iron with a point of steel costs \$1.20 to \$2, while one entirely of steel costs \$2.80 to \$3. The price of a *batea* varies from \$1 to \$2. All the tools are locally made except a few of the *baras*. Since every woman in the mining district is a miner, it might be advisable for American tool manufacturers to investigate this market. Better quality tools could doubtless be sold in the Choco at lower prices than those quoted, but the styles offered should be identical with the ones now in use.

By a law that went into effect in 1910, foreigners are not allowed to denounce or purchase mines in the Choco, but mining property can be leased for a long period or obtained on other advantageous terms. It is expected that within a few years mining on a large scale will be begun in this district. Even under the primitive mining conditions of today the Choco stands second only to Russia as a producer of platinum and the prospects under improved methods are considered favorable.

Mining prospectors should come supplied with shovels, picks, tools, canned goods, guns, and ammunition, as it might be difficult to obtain anything but fresh provisions in Quibdo at reasonable prices. Laborers can be hired for 50 to 70c. and canoes for 20c. per day.—Daily Consular Report.

Banking and blowing-out iron blast-furnaces have quite different meanings. The former refers to an interruption in the making of pig iron, for a day or a week or two, when the furnace is filled with coke and kept at a red heat by a light blast. This costs only a few hundred dollars. When a furnace is to be idle for a month or more, it is emptied and allowed to get cold. Blowing-out costs several thousand dollars, and every furnace must be blown-out once in three years or so for relining.

Mining at the Nevada Consolidated

By P. E. McDonald

Comparatively little has been written about the mines of the Nevada Consolidated Copper Co. During the nine years that the company has operated, the best reading of what has been done is contained in the statements of the president and consulting engineer as published in the annual reports to the stockholders. These reports have chronicled the cost of mining by steam-shovel in open pits, and the amount of ore in reserve after each year's extraction. The ore reserve has always been a critical factor, and has militated against buying of the stock as an 'investment,' as was widely done with Utah Copper shares. In 1906, when Mark L. Requa delivered his address at the driving of the last spike of the Nevada Northern railway, which bridges the 150 miles from the mines and smelter of the Nevada Consolidated near Ely to the main lines of railway to the north, he said, "to justify the building of the railroad required the development of millions of tons of ore; I think you will agree with me that we are justified when I say that there is developed at Copper Flat and at Ruth sufficient ore to supply the reduction plant for at least ten years." At that time the assured ore was computed at 14,432,962 tons averaging 1.97% copper. Since the beginning of operations to the present time the company has produced and sold 400,000,000 lb. of copper, yet the recoverable developed ore on December 31 last was estimated at 50,525,289 tons of 1.652% copper, assuring a life of at least 15 more years. That is, at the end of the mine's allotted 10 years of life, after producing a good deal more copper than had been estimated, there still remains an ore reserve more than three times larger than the orebody as originally limited.

As is seen by the accompanying table of yearly ore estimates, the company is in the best position since its inception.

	Tons	Copper %
Sept. 30, 1907	14,432,962	1.97
Sept. 30, 1908	20,000,000	1.94
Sept. 30, 1909	29,000,000	1.94
Sept. 30, 1910	40,360,823	1.70
Dec. 31, 1911	40,853,371	1.66
Dec. 31, 1912	38,853,551	1.67
Dec. 31, 1913	39,108,590	1.65
Dec. 31, 1914	41,020,296	1.68
Dec. 31, 1915	50,525,289	1.652

The following general considerations can be stated: a great deal more ore has been proved available than was at first estimated; the grade of ore has been somewhat lower than was anticipated; although many economies and improvements have been effected by the operating staff, the proportion of copper recovered from the ore has been less than 70%. However, it is quite evident that the judgment of F. W. Bradley, J. H. Mackenzie, and Mark

L. Requa, who developed the enterprise, of J. Parke Channing, who interested capital in it, and of Pope Yeatman and C. B. Lakenan, who have directed its management, have been splendidly vindicated.

Regarding the low proportion of extraction, it was remarked recently by a pessimistic critic* that the companies operating the 'porphyry copper' mines of the West have nothing in particular of which to be proud. He argued that "an enormous quantity of cupriferous material is rushed through mills, and sufficient copper is caught to pay temporary dividends. The copper has been taken out and sold, largely to foreigners, at an alleged profit of from two to three cents per pound, and in doing this nearly two pounds of copper have been wasted for every three pounds recovered." It can be stated, in answer to this, that the proportion of copper recovered at the disseminated copper mines is now being decidedly increased. This is a result of the introduction of operating economies by the staffs at the reduction works, and of the saving grace of the new metallurgical aid, flotation. In the figures quoted by Mr. Austin in the above criticism of 'big business' he gave the recovery of copper at the Nevada Consolidated in 1912 as 66%; this has been increased to 70.18% for 1915 and probably will be improved further for 1916, when the refinements of the flotation process have been adjusted. To illustrate the bettered copper recovery of the porphyry mines, the Inspiration mine made a 79.95% recovery in 1915, the Miami 75.17%, while Utah Copper, Ray, and Chino, the recoveries of which ran from 50.6 to 57.4% in 1910-'11-'12, rose to 66.04, 67.88, and 67.86% in 1914. Still higher recoveries are possible, but not profitable, at this time; however, the flotation process is bound to raise the proportion recovered—some authorities predict as much as 10%.

Nevada Consolidated compares with the other porphyry coppers as follows, the figures being for operations in 1915: the grade of ore mined, 1.54% copper, was the lowest of any of the six companies except the Utah Copper, which was 1.434%, Chino and Miami being highest with 2.155 and 2.17% respectively. As to size of output Chino, Ray, and Nevada Consolidated each produced between 62,000,000 and 69,000,000 lb. of copper. The Nevada Consolidated mined the largest tonnage of ore, 3,081,520 tons, except Utah Copper, which mined 8,494,300 tons; these figures compare well with those of the Mesabi range iron mines. The Nevada Consolidated paid the largest amount in dividends, \$2,999,185, next to Utah Copper's \$6,904,082.

It is interesting to note, as pointed out by the financial

*W. L. Austin on 'Big Business,' M. & S. P., July 24, 1915.

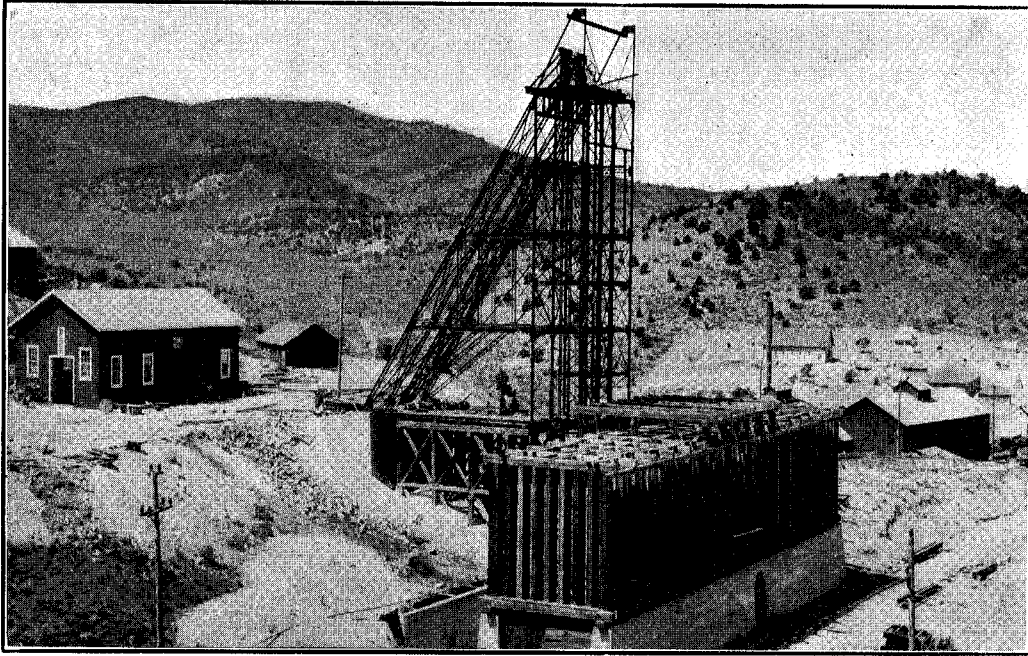
press, that the shares of the porphyry copper mines have not attracted the same sentimental interest in trading on the stock exchanges, in proportion to their dividends, as, for instance, the Anaconda. Either the great disseminated orebodies, mostly worked by steam-shovels in open pits, do not appeal to the share-buying public to the same extent as the Michigan or Montana coppers, or perhaps the personality of the controlling interests of the porphyries does not inspire the same confidence as those concerned with the mines at Butte, Bisbee, or Calumet. Of course, the predictions of 10 years ago that the porphyry coppers would swamp the market with 5-cent copper did not materialize. In 1915 their total cost per pound of putting electrolytic copper on the Atlantic seaboard varied from 7.12c. in the case of Chino to 9.42c. for

Mudd, Spencer Penrose, E. P. Shove, W. Hinckle Smith.

CHINO COPPER Co.: C. M. MacNeill, president, D. C. Jackling, managing director, Charles Hayden, K. R. Babbitt, A. Chester Beatty, Sherwood Aldrich, Mark L. Sperry, Arthur J. Ronaghan, W. Hinckle Smith.

INSPIRATION CONSOLIDATED COPPER Co.: William B. Thompson, president, Joseph W. Allen, John F. Alvord, Thomas F. Cole, Edmund C. Converse, William E. Corey, Charles A. Corliss, Philip L. Foster, Eugene Meyer, Jr., Louis D. Ricketts, William G. Rockefeller, John D. Ryan, Charles H. Sabin, William B. Thompson, William D. Thornton, Albert H. Wiggin.

MIAMI COPPER Co.: Adolph Lewisohn, president, J. Parke Channing, vice-president, J. H. Susmann, Sam A. Lewisohn, Theo. L. Herrmann, B. Hochschild, William



THE RUTH MINE OF NEVADA CONSOLIDATED, AT RUTH, NEVADA.

Ray, with Nevada Consolidated at 8.23c. and Utah Copper at 7.48c. These costs include "all possible charges, such as shipping, refining, marketing, legal expense, taxes, plant, and depreciation charges." The personnel of the boards of directors of the six porphyry coppers is a matter of general interest. It is as follows:

UTAH COPPER Co.: C. M. MacNeill, president, D. C. Jackling, managing director, Charles Hayden, Spencer Penrose, K. R. Babbitt, Murry Guggenheim, S. R. Guggenheim, S. W. Eccles, William Loeb, Jr., W. Hinckle Smith, John Hays Hammond, Wm. B. Thompson, Frank A. Schirmer, Eugene Meyer, Jr., Kenneth K. McLaren.

NEVADA CONSOLIDATED COPPER Co.: S. W. Eccles, president, D. C. Jackling, vice-president, C. M. MacNeill, Murry Guggenheim, S. R. Guggenheim, Judd Stewart, W. Hinckle Smith, Charles Hayden, W. E. Bennett, J. N. Steele, Wm. B. Thompson.

RAY CONSOLIDATED COPPER Co.: Sherwood Aldrich, president, D. C. Jackling, managing director, A. Chester Beatty, Charles Hayden, C. M. MacNeill, Seeley W.

H. Nichols, Walter T. Rosin, F. W. Estabrook, Hermann Sielcken.

In the way of practical mining, the Nevada Consolidated is somewhat different from the other porphyries. An important bearing upon its mining methods is occasioned by the comparative softness of the orebodies as compared, for instance, with the harder ore of the Ray mine. Again, the copper is found more uniformly disseminated through the ore, unlike the bunchy aggregates of copper sulphide in the Utah Copper monzonite. The large amount of iron sulphide has always been a troublesome difficulty in the concentrating. This has reacted against the efficient concentration of the ore at the mill. Regarding this, the consulting engineer, Pope Yeatman, said in his last report: "the average per cent copper contained in the concentrates was appreciably greater in 1915 than in 1914, being 6.14% in 1914 and 7.77% in 1915." Even this figure, 7.77%, is evidently very low, contrasting with 41.91% at Miami and 32.67% at Inspiration. However, Nevada Consolidated is the only

one of the six porphyry mines that smelts its own ore, so its low-grade concentrate is less of a disadvantage.

The Nevada Consolidated has been an open-cut mine worked by steam-shovels. But during recent months the mining of the Ruth orebody, which is a half-mile from the pits, has been started by underground methods, and the 14,000,000 tons there will be extracted by a modified 'caving' system. By reason of the deeper overburden on this orebody, it was estimated that the cost of stripping and working by pits would be greater than by underground methods. The ore at the Ruth is of comparatively high grade, being 2.35% in copper.

The starting of underground mining at a mine where open-pit work has been the practice attracts a different set of men. Surface-work is largely a problem in rough-and-ready railroading. The qualities necessary in the employees are forceful 'get-there' leadership, some skilled mechanics, and a gang of common laborers. At the underground mine a different note predominates, and the individualistic characteristics that distinguish underground metal-miners are apparent in the faces seen. The large proportion of young men at the Ruth mine is especially noticeable. The decision to extract the Ruth orebody by underground mining, rather than by pits and steam-shovel, gives point to the opinion of some engineers who think that if the Utah Copper Co. were to open its mine anew, it would be done by underground mining because of the higher cost of the pit work than had been estimated.

It is scarcely fair to compare the mining costs of mines in different stages of their history, but for an approximate comparison the following figures are interesting. The mining cost at the Nevada Consolidated in 1915, practically all from open pits, was 15.24c.; added to this is a 'redemption cost' for the removal of overburden, varying from 15 to 30c. per ton of ore at the three pits of the company. At the Utah Copper, where open-pit work by steam-shovel accounted for practically all the ore produced in 1915, the cost of mining was 24.41c. per ton, of which 7.50c. represents charges for stripping. At Chino, also open-pit, the cost of mining ore in 1915 was 19.47c.; the charge for stripping is not given. At Ray Consolidated, where underground mining is done, the cost of mining in 1915 was 58.97c. per ton; which includes all fixed and general charges. At Inspiration, an underground mine, the mining cost for 1915 was 68c. per ton, which includes 20c. per ton of calculated charge for development by drifts, raises, and haulage-ways. At Miami, an underground mine, the mining cost in 1915 was \$1.01 per ton, of which 31c. was for development and 70c. for mining.

The Ruth orebody is a nearly flat slightly-dipping wedge or lens, several hundreds of feet in length and width, and about 125 ft. thick on average. The greatest depth of ore from surface is 500 ft. In many ways this mass of soft copper ore is similar to the iron deposits of the Mesabi range, and the problems incident to its economical extraction are nearly identical. A difference lies in the fact that this copper mine is dry, as compared

with the torrents of water that complicate underground mining in Minnesota. A vertical shaft has been sunk in rock several hundreds of feet from the orebody and the levels marked off by drifts at regular intervals.

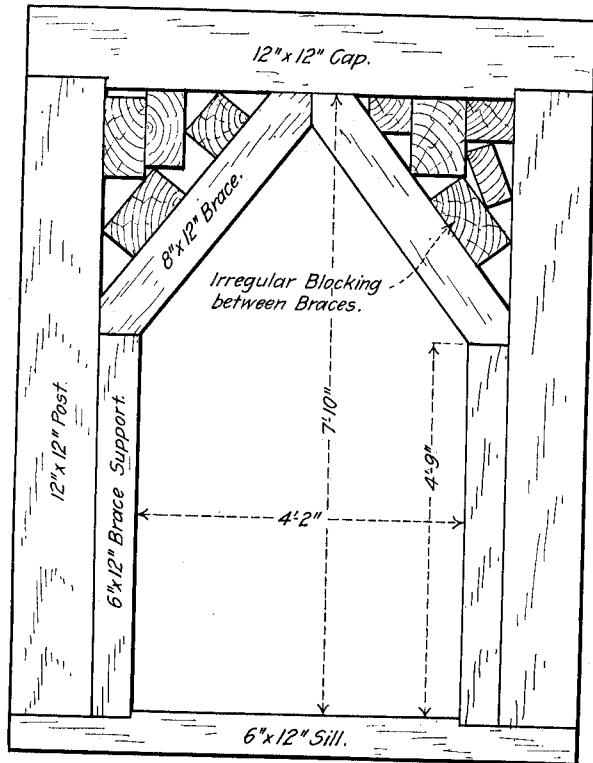
The stoping is done by a combination of the Ray system of room-and-pillar mining, by shrinkage and caving, with a branched-raise method on the lower levels. The Ray system is more suitable for hard ore, so it has been found advisable to employ it at Ruth only in a modified way. The general principle of the Ray method, it will be recalled, is to over-hand stope a number of comparatively small shrinkage-rooms, with pillars of ore between, which are later extracted by caving; the idea being that it is easier to cave the orebody in a checker-board of small operations, where the work can be watched and directed carefully, than to engage in a wholesale method such as block-caving. Incidentally, the worth of the system of stoping at Ray was questioned by Professor F. W. Sperr in a recent article[†] on stoping methods, when he suggested that block-caving might have found excellent adaptation there. Above the 300-ft. level in the Ruth mine, caving by the Ray method has been generally applied. A good deal of difficulty was encountered in holding up drifts in such soft ground, where heavy angle-braced timbering only lasts a few weeks before it becomes crushed. The character of this orebody is not unlike that of an old compacted stock-pile; it is crumbly and broken to an extreme degree. Below the 300-ft. level, inclined raises have been put up from the 500-ft. or main tramming level. From these raises, branches are extended near the top, so that eight branches, at 12½-ft. centres at their tops, feed into one loading-chute. All raises are inclined, because the ore runs better, not blocking itself as it would in vertical raises. The long main raises are on a 50 or 60° incline, the short branched raises are 45°. Careful surveying is necessary to bring the tops of the raises at the properly spaced interval, 12½-ft. centres, so that practically no shoveling or wheelbarrowing of ore need be done. All raises are timbered closely with heavy squared timbers (not the ordinary loose cribbing)—a considerable item of expense. As regards this method of stoping by branched raises, the following is quoted from a recent article on 'Mining by Branched Raises' by F. W. Sperr:[‡] "Soft ore has a greater tendency to pack in chutes at a high angle, as well as to hang up in chutes at lower angles. The best angle for the worst ores is 65°, but some ores run freely at 45°. With hard ore, not so much trouble is experienced from packing in vertical raises; therefore the raises are made vertical in places for convenience of arrangement. Accessibility to the vertical chutes for the purpose of relieving the tendency to pack, can be more readily provided where the branches are inclined throughout their entire length, than in the case where they are partly vertical."

Robert Marsh, Jr., the general mine superintendent of the Nevada Consolidated, summed up the advantages

[†]M. & S. P., February 19, 1916.

[‡]M. & S. P., May 20, 1916.

and disadvantages of mining such a soft heavy orebody by saying: "It is economical in powder and air, but it is necessary to count on the ground falling wherever it has any chance; it is not uncertain ground, for it will always fall; the caving of the overburden must be done according to some regular plan, or it will get mixed with the ore; it can be caved along a horizontal plane or on a slope, but care must be taken not to cave tongues of overburden into the ore." A recent incident at the mine was the raising of a 500-ft. incline from the tramming-level to surface, in order to get a small stock-pile of ore that was extracted in sinking an old incline shaft. This stock-pile could not be reached handily by teams on sur-



ANGLE-BRACED TIMBERING IN THE RUTH MINE, WHICH BECOMES CRUSHED IN A FEW WEEKS.

face, as it lay over a ridge of rough ground. It will be taken down the long raise, trammed to the shaft, and hoisted in the usual way.

The rock-drilling practice is somewhat different from that of a hard-ore mine. Seven or eight 6-ft. holes are employed in driving, making 45 ft. of drilling per cut. A record of fast driving was made in the development of the mine when 476 ft. was achieved in one month by two miners (one per shift) and four trammers, a total of six men. A light mounted one-man drill was used. But, after making this whirlwind record, the type of drill was found not adapted to this soft ore, and has been discarded. It was not that the rock was too hard for the drill, but that it was too soft. Being designed for a harder rock, the parts of the drill were too strong for this work and quickly wore themselves out by getting stuck in the soft rock and breaking the rotating device.

The mounted hammer-drill is well liked here. This is interesting, as such a type of drill is not supposed to be

at its best in soft rock, because clayey cuttings are apt to choke the circulation of water. The mounted hammer-drill, such as the Leyner, is generally best in medium-hard rock, but in this mine the ore, while soft, is not clayey. As to stoper drills, the underground foreman remarked that he had tried thoroughly the products of two well-known manufacturers. Both did good work at the start, but one wore much better than the other, so he is putting in that type. Robert Marsh, the general mine superintendent, had a word to say about too many automatic devices on rock-drills. "They are likely to be valuable only for salemen's arguments," he remarked.

A mechanical ore-loader of the Halby type is being tried underground at the Ruth mine; it is too early to say if it will be a success. This machine loads tram-cars in drifts by electric power; it is manufactured at Marquette, Michigan. No candles are allowed in the Ruth mine, on account of fear of fire in the dry timbering. Carbide lamps are used with good satisfaction. The problem of giving the men what they want in their dinner-pails, so that individual taste is provided for, is solved by a modified 'cafeteria' arrangement. The men walk along where the foods are served, and each one's lunch is put up according to his preference. Such consideration for the men is well advised; good food promotes effective work.

At the pits, the operation of getting loaded cars out and empty cars in; of efficient steam-shoveling; and of drilling and blasting, have been perfected to an admirable degree under the direction of E. E. Vanderhoef. Churn-drills, or 'well-drillers,' of the Keystone type are employed to drill 6-in. vertical holes along the benches, usually to 30 or 50 ft. depth. These holes are put down 5 ft. deeper than the bench-level below, to make sure that the steam-shovels will not have to dig in unbroken rock. An iron funnel and long canvas hose are used to facilitate dropping the 'sticks' or cylinders of dynamite in the holes. Several kinds of dynamite and black powder are used as the various types of blasting may require. The holes are sprung or enlarged several times before being filled with explosives. Drift-blasting is only occasionally considered necessary. The 'well-drillers' give excellent results and appear adapted both for mining of the soft ore and for the stripping of overburden. These machines are used also to churn-drill to a depth of 500 ft. for exploring the orebody in advance of the mining. They are moved on their own wheels, but at times are transported on railroad-cars for longer distances. At the copper mines at Chuquicamata, Chile, where the ore is much harder, the churn-drills for blasting are said to have been superseded by tunnel-blasting, the 'tunnels' being driven by hand. We shall have some notes on this shortly from Howard W. Moore, with drawings showing how the tunnels are loaded.

The Nevada Consolidated is on the Lincoln highway, which extends from New York to San Francisco. A sign-board on a rather indifferent piece of road in front of the mine, in the midst of mountain peaks and sagebrush flats, is labelled 'to New York.'

The Geology and Ore Deposits of Ely, Nevada

By ARTHUR C. SPENCER.

Précis by JOHN B. HASTINGS

***STRUCTURAL GEOLOGY.** The Ely quadrangle is in the Great Basin area of eastern Nevada, which is characterized generally by long north and south mountain ranges and intervening valleys, each five to ten miles wide, and as much as 140 miles long. These ranges are late Tertiary areas of elevation and depression.

The district may be regarded as a shallow north-south syncline, with rude flanking arches, disturbed by unsystematic dislocation from early to late geologic time, contrasting with the orderly north-south faults determining the larger topographic structure. The syncline is something like the depression made by the body in a bed and the higher sides and presumably on the edges of the bed-faults marking the eastern and western scarps of the range. The exposed sedimentaries forming the area are: Carboniferous, Pennsylvanian, the Arcturus limestone, exposed 400 ft., Ely limestone 2500 ft.; Mississippian, the Chainman shale 250 ft., Joanna limestone 100-400, Pilot shale 200; Devonian, the Nevada limestone 4000; Ordovician, the Eureka quartzite 150 ft., and the Pogonip limestone, exposed 1400 ft. They have been greatly disturbed by faulting, and to a less extent by folding, so their areal distribution is very irregular. Since the close of the Carboniferous it has been a land area.

MONZONITE INTRUSION. The six uppermost of the eight formations in one place or another have been invaded by monzonite porphyry. The intrusion of the monzonite, one-half to one mile wide by seven miles long, from east to west across the syncline, occurred at the close of the Jurassic, or post-Jurassic, and though the rock may differ in appearance and composition, it is thought, from the latest mine development, that it all belongs to a single igneous epoch.

ALTERATION OF THE ROCKS. The heat and the emanations from the intrusions altered the adjacent sedimentaries for a few hundred to 2500 ft. from the contact, the effect decreasing with remoteness. Finally, after cooling and crystallization, the monzonite was itself metamorphosed and mineralized, by continued ascent of solutions, especially along a wide middle band. These solutions, from first to last, introduced silica, sulphur, iron, and potassium, also copper, lead, zinc, gold, and silver, more of the latter minerals into the porphyry in the final stages than previously into the sedimentaries. Carbon di-oxide is believed to have been plentifully present, but if the solutions were originally acid through attacking the rocks they would become alkaline or neutral and then deposition of the metallic minerals would take place.

Alteration of the limestone consisted principally of one simple crystallization and the loss of carbonaceous blue and black coloring, making a fine-grained marble; of metasomatic replacement by quartz and sometimes chalcedony, yielding jasperoid, presenting prominent rusty outcrops; of development of lime-bearing silicate minerals, commonly garnet and tremolite, but also white and brown mica, pyroxene, epidote, and scapolite; and of the formation of pyrite and pyrite-magnetite bodies, with some pyrrhotite, chalcopyrite, sphalerite, galena, molybdenite, and hematite. The altered limestone, shale, and porphyry are all impregnated with 2 to 10% pyrite, and with chalcopyrite from nearly nothing upward. The shale altered to pyritiferous hornstone. Microscopically they show felty or finely granular wollastonite, epidote, calcite, pyrite, and magnetite. Sometimes pyrite was introduced synchronously with pyritization of the monzonite.

In the monzonite alteration, much of the rock was greatly seamed by quartz and sulphide-bearing veinlets, or by films of pyrite; but other portions are quite or nearly free from such filling, yet both kinds of material are thoroughly altered in bulk, and are generally highly impregnated with pyrite, accompanied by chalcopyrite. The solutions that caused the alteration penetrated so deeply that after being metamorphosed large masses of porphyry, essentially lacking in fracture-filling, carried chalcopyrite in such quantities that a slight enrichment has been adequate for their conversion into commercial ores. However, the content of chalcopyrite in the metamorphosed porphyry is ordinarily higher where the rock was considerably crushed and filled with quartz prior to its complete alteration than when the only alterations were those due to permeation into the rock. Perhaps also the rock-minerals have undergone somewhat more complete alterations where vein-stuff occurs than elsewhere. All things considered, the order of the mineralization seems to have been: (1) permeation of the rock by solutions capable of producing alteration; (2) formation of veinlets, usually of quartz, or of quartz with a little orthoclase and biotite, carrying distributed pyrite and chalcopyrite. Some of the veinlets carry a medial film of pyrite; (3) the deposition of pyrite films in joint-fractures. These three sorts of mineralization may be observed together in material from the open pits of the Nevada Consolidated Co., from the Butte-Ely shaft, and from the porphyry mine of the Giroux Co. In other material from the same localities, and from the Veteran mine, the first and second alterations are noted without the third; in material from Weary Flat and from the Eureka shaft on the Ely Central property, the second

*Abstract from U. S. G. S., Prof. Paper No. 96, 1917.

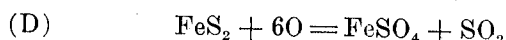
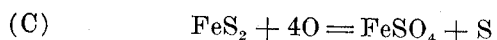
and third alterations are most prominent, and in material from the McDonald-Ely shafts in the eastern part of the district alterations which seem to be related to the third class are mainly in evidence. The alterations of the porphyry, which are of the greatest interest in the formation of copper ores of the disseminated type, are those that have been produced through the permeation of the rock-mass by magmatic solutions. These alterations comprise, in different stages, the progressive destruction of hornblende, of plagioclase, and of magnetite, and the formation in their stead of mica, including the white variety of felty habit commonly called sericite, and a brown variety allied to biotite, the deposition of pyrite and chalcopryrite, and also of calcite. Pyrite and chalcopryrite occur mainly in the altered ground-mass, but are also found in the sericitic aggregates and rarely in the large orthoclase crystals. The ground-mass of the thoroughly altered porphyry has a granulated appearance quite distinct from that of the normal rock. In extreme alteration the rock is a felt of sericite flecked with grains of sulphide and of quartz.

LATE VULCANISM. In the Tertiary, probably in Pliocene time, vulcanism was again active in north-east Nevada, and though little has withstood erosion, tuffs and rhyolite probably covered nearly the whole Ely quadrangle. White to gray fragmentary tuffs, evidently from explosive eruptions, occur in the rhyolite area north of Lane valley, between the upper part of Robinson canyon and Lyon spring; they have been quarried for building purposes one-half mile west of Keystone, where the railroad leaves the canyon, and between Ruth village and Copper Flat. Black obsidian overlies the tuffs north of Lane valley and near the railroad spur west of Star Pointer. Lastly older and younger rhyolites were extruded, being purple or red massive rocks with grains of black quartz and sanadine phenocrysts, west of Liberty pit, between Copper Flat and Star Pointer, and north of Lane valley, while lighter colored, platy, fluidal rocks, are also found north of Lane valley and on the north side of Keystone hill. The former older flows are known, which are as much as 468 ft. thick, as demonstrated in the Eureka shaft of the Ely Central, while the later flows may be 300 feet.

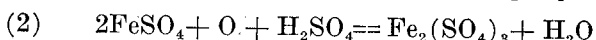
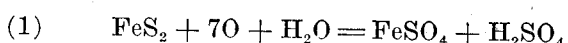
QUATERNARY CLIMATIC CONDITIONS. The Quaternary was marked by alternating wet and dry climates over Nevada, Utah, and Idaho, evidenced by the formation of all of the great geologic lakes, of which Salt Lake is now a diminutive remnant. Once it was 800 ft. deeper than at present, and extended to within 30 miles of Ely. This prehistoric enlargement is designated Lake Bonneville. The dry and wet changes are: (1) pre-Lake Bonneville epoch, characterized by an arid climate, and marked by an accumulation of alluvial deposits, which flank the mountain masses; (2) first flooding of the basin as a result of increased humidity; (3) dessication from aridity of climate; (4) second flooding, indicating humidity; (5) present epoch of aridity. During the first the alluvial cone was dropped at the mouth of Steptoe creek,

there being insufficient water to carry it farther; in the second the creek was larger and, cutting through the cone, distributed its load in the lower valley; the third was not quite so dry as the first, and its cone, more widely spread, was formed farther out in the valley, and has since been obliterated by erosion and further deposition. However, traces of changes corresponding to the third, fourth, and fifth are not quite definite. Steptoe cone is terraced 150 to 40 ft. above the present floodplain, the upper bench probably resulting from the lateral erosion of a perennial stream during the second, and the lower bench the same during the fourth and fifth stages. The present dry climate is reflected by the clogged condition of Robinson valley below Keystone, where loose debris fills the channel to depths of 30 to 80 ft., and also in the conical piles of alluvium at the mouth of steep side gulches.

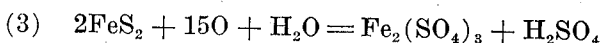
ORIGIN OF THE CHALCOCITE OR SECONDARY ENRICHMENT. Metallic sulphides are easily decomposed by oxygenated waters, but the amount of oxygen the Ely mine water could carry downward would not be sufficient during the age of the earth to affect the amount of oxidation that has taken place. As this really has transpired other explanations must be sought. The first step is the easy circulation of air through the porous capping, continually replacing oxygen depleted from the descending percolating waters. The incomplete oxidation thus effected is indicated by Gottschalk and Buehler, changing the pyrite into ferrous sulphate, sulphur, and sulphur dioxide. Oxidation by free oxygen takes place as follows:



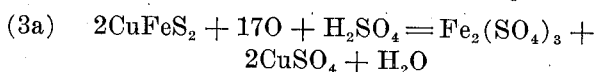
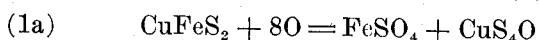
With water and a higher oxidation into ferric sulphate, with generation of sulphuric acid, the reactions would be:



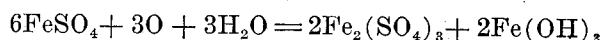
Then, from (1) and (2):



For chalcopryrite, analagous to (1) and (2):

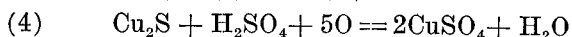


Part of the ferric sulphate formed decomposes to basic iron sulphates and hydrated iron oxide.

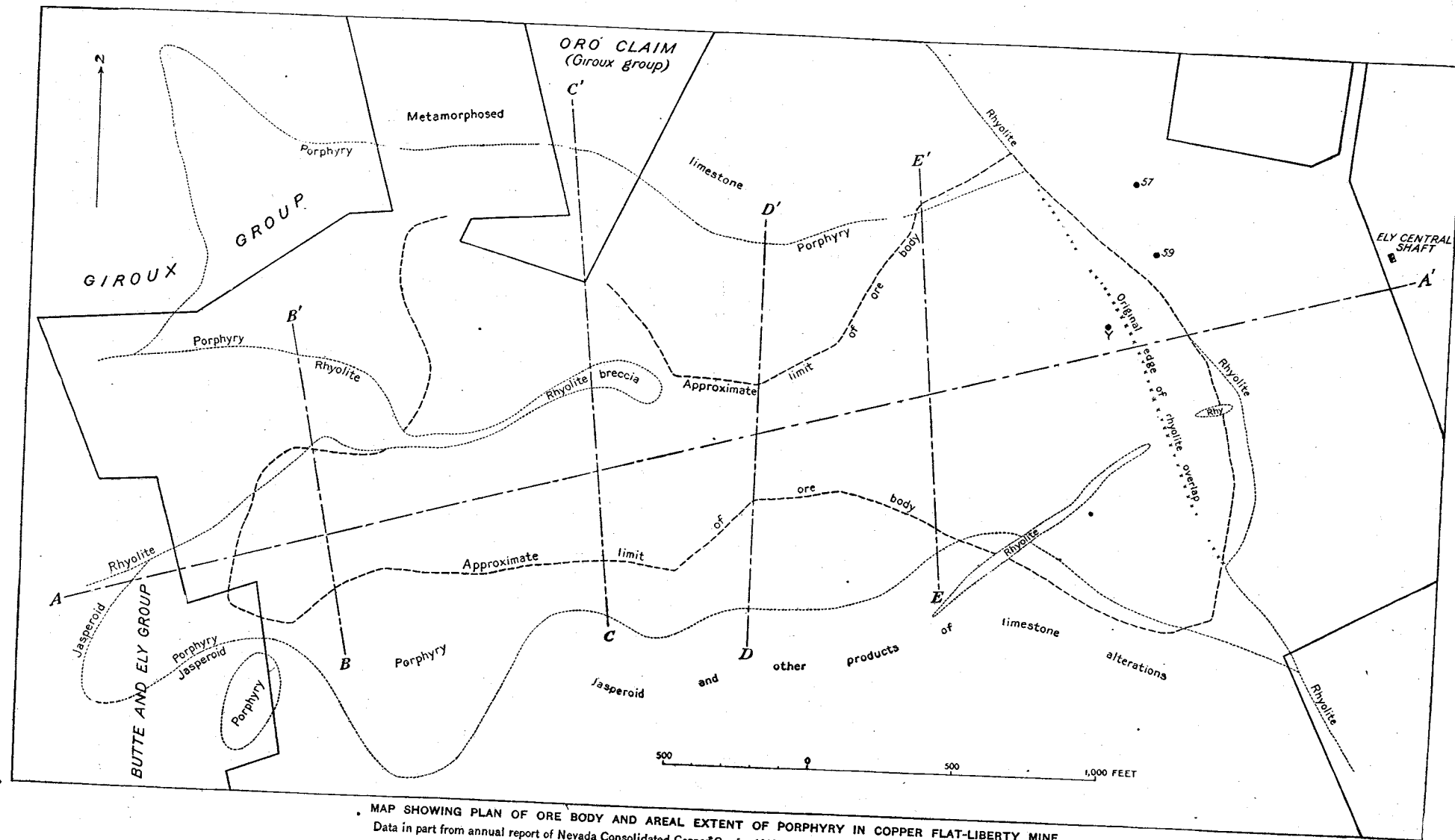


and part may descend to attack pyrite, chalcopryrite, and chalcocite.

The descending sulphuric acid and ferric sulphate solutions quickly encounter chalcocite, and if free oxygen remains chalcocite is decomposed into cupric sulphate.



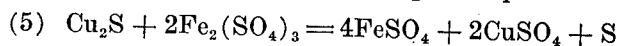
It may be assumed this uses the last of the free oxygen,



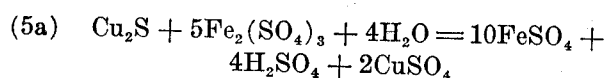
MAP SHOWING PLAN OF ORE BODY AND AREAL EXTENT OF PORPHYRY IN COPPER FLAT-LIBERTY MINE.
Data in part from annual report of Nevada Consolidated Copper Co. for 1913. A-A', etc., Lines of sections shown in Plate XII

but ferric and cupric sulphates remain, both capable of oxidizing sulphides; the ferric being more easily reduced might almost all become ferrous before the cupric became an oxidizing agent.

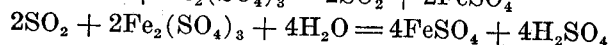
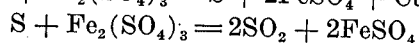
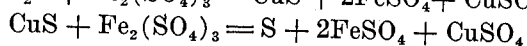
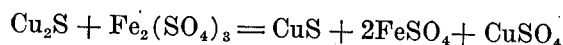
OXIDATION BY FERRIC SULPHATE. Where chalcocite and other sulphides occur together, especially as at Ely, where chalcocite coats pyrite and chalcopyrite, chalcocite is the first mineral attacked, and protects the others. Vogt gives an equation for the change of ferric sulphate and chalcocite into ferrous and cupric sulphates:



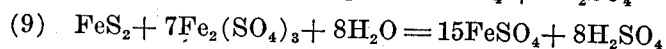
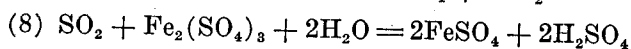
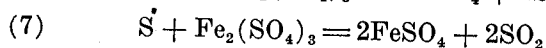
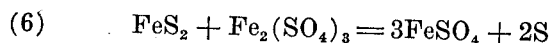
Sulphur might react with more ferric sulphate and form sulphur dioxide (7), and dioxide with more ferric and produce sulphuric acid (8), leading to an equation of Weed's:



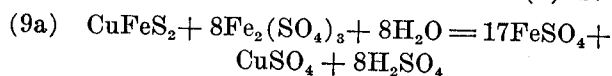
(5a) may be regarded as summarizing the following steps in oxidation:



Ferric sulphate may be considered as acting on pyrite about as follows (6), (7), and (8) leading up to (9), and (9) comparable to (1).



For chalcopyrite an expression similar to (9) is:



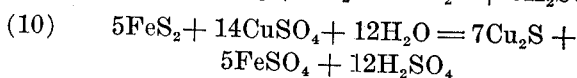
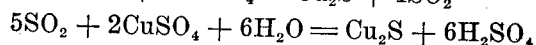
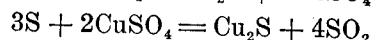
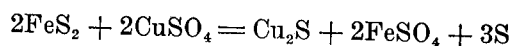
After allowing for great irregularities in the under surface of the oxidized capping in contact with the sub-jacent ore due to fractures in the latter, in which occasionally the chalcocite appears unattacked, the decomposing power of the downward moving waters, as dependent on free oxygen, appears generally to be spent in a shell of, say, 3 ft. thick, though impoverishment may continue considerably deeper through ferric sulphate reacting on chalcocite, as in (5) and (5a).

Therefore it may be concluded: (1) so long as descending surface waters can acquire free oxygen, or contain ferric sulphate, they will strongly decompose metallic sulphides; (2) where chalcocite, pyrite, and chalcopyrite are present, chalcocite will be largely, perhaps fully, decomposed before the others are attacked; (3) the decomposition of chalcocite, chalcopyrite, and pyrite reduces the ferric salts; (4) their decomposition tends to produce sulphuric acid; (5) decomposition of chalcocite and chalcopyrite furnish cupric sulphate.

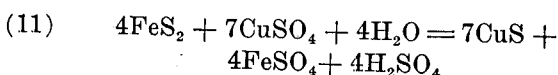
OXIDATION BY CUPRIC SULPHATE. The descending waters do not now contain free oxygen and very little

ferric sulphate, but they carry ferrous and cupric sulphates and sulphuric acid. The cupric sulphate survives because at ordinary temperatures, and in acid solution, it is less readily reduced than ferrous sulphate. Dilute sulphuric acid at ordinary temperatures without oxygen does not decompose chalcocite, and probably does not attack chalcopyrite or pyrite. Cupric sulphate, at high temperatures, reacts with chalcocite to form covellite and cuprous sulphate, and the former, on cooling, decomposes, precipitating metallic copper. Cupric sulphate attacks chalcopyrite and pyrite at ordinary temperature, forming ferrous sulphate and sulphuric acid, and a copper sulphide is deposited.

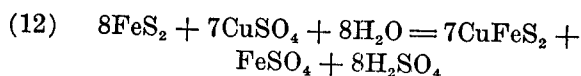
The suggested equations are: pyrite to chalcocite through cupric sulphate, as:



Next, pyrite to covellite:

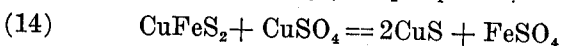
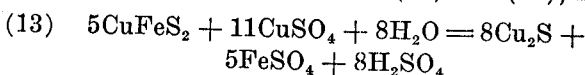


And pyrite to chalcopyrite:



These complete reactions may require steps through minerals intermediate between pyrite and chalcopyrite and between chalcopyrite and chalcocite.

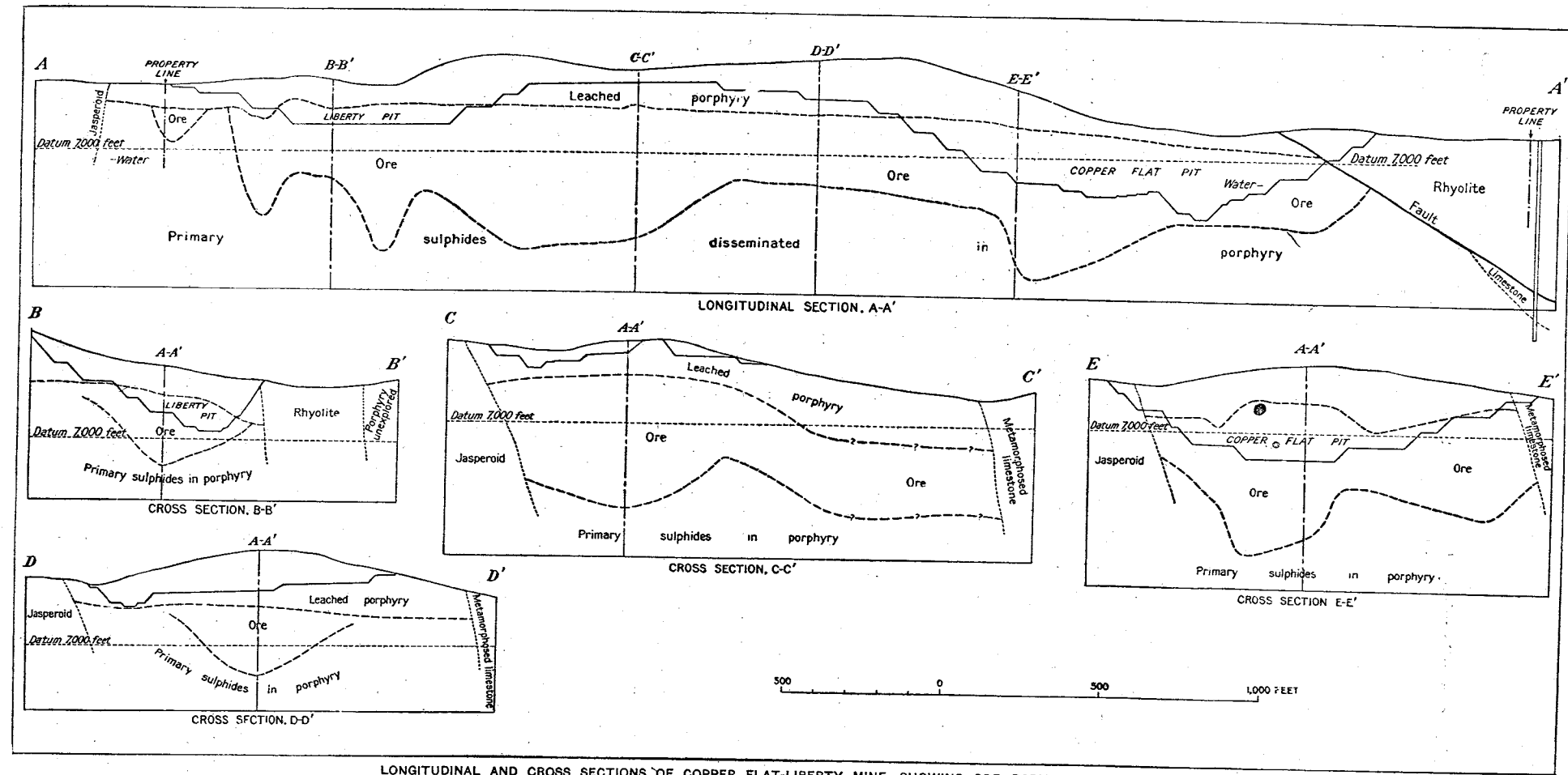
A summary of equations, from chalcopyrite to chalcocite and to covellite, analogous to (10) and (11), is:



Detailed examinations of polished surfaces and thin sections show that in the Ely mines, though chalcocite replaces pyrite, if chalcopyrite is present it is the mineral mostly affected.

GEOLOGIC AGE OF THE CHALCOCITE ENRICHMENT. The transfer of copper from the upper to the lower portions of the porphyry, as described, has kept pace with the erosion of hundreds, perhaps thousands, of feet of the intrusion, but probably the erupted Pliocene rhyolites covered the ore-belt, making a long interval of abeyance during its removal, and there has been little erosion since the beginning of the pre-Lake Bonneville epoch; therefore it is judged that practically all the secondary copper of the present enriched orebodies is due to conditions during late Pliocene time, but re-distribution of the metal has been going on since then, gradually lowering the top of the orebodies.

CHARACTER AND EXTENT OF THE ORE DEPOSITS. The productive ore is a chalcocite enrichment of pyrite monzonite porphyry, bringing the original 0.5% copper in the chalcopyrite as high as from 1 to 3%. The orebodies are



LONGITUDINAL AND CROSS SECTIONS OF COPPER FLAT-LIBERTY MINE, SHOWING ORE BODY AND EXCAVATIONS.
For position of sections see Plate XI. Data mainly from annual report of Nevada Consolidated Copper Co. for 1913.

irregular layers that lie beneath highly oxidized products of weathering and rest on entirely unweathered material, similar to the ore but without chalcocite. They occur medially along an east-west monzonite intrusion seven miles long, and one-half to one mile wide. The ore is a uniform light gray rock, from innumerable black specks of chalcocite, or of chalcopyrite and pyrite coated with chalcocite, but mainly the former, and its coverings are very much heavier. The white portion is quartz, orthoclase, and sericite; fresh yellow pyrite also occurs. Most of the pyrite that is coated with chalcocite is less than half a millimetre in diameter, while that not coated is mainly large and in bunches and seams. The only non-metallic mineral developed during the enrichment is kaolinite from orthoclase, and this is rare. An unusual appearance is black reticulating films of pyrite crushed by movement into dust, and coated with chalcocite.

In 1913, 80,000,000 tons of copper ore, with a small gold and silver content, including ore already mined, had been proved in this area. The 10th Annual Report of the Nevada Consolidated Copper Co. states that by December 31, 1916, they had developed in their own ground, 89,766,723 tons containing 1.6% copper, of which 21,773,606 tons, containing 1.67% copper, had been milled. To the first figure should be added 800,000 tons, on account of the Veteran mine. The latest tonnage developments are below the zone of distinct secondary enrichment, and, as a result of investigation, are thought to be primary.

Space prevents a description of minor ore occurrences in the jasperoid and shale, and in off-shoots from the main body in the porphyry. It is intimated that there is a definite east to west line of fracturing of the monzonite, which allowed the ascension of mineral-bearing solutions from depth, greater in volume than those contained in the intrusion itself.

REVIEWER'S REMARKS. It is hardly probable that the Nevada Consolidated ground covers more than half the possibilities of the district. The geologic and topographic surveys were finished in 1910, and the report issued in November 1917. Is there room here for criticism? The Chainman vein was a continuous channel in the limestone, as developed say 1000 ft. long, 20 ft. wide, and sometimes 200 ft. deep, and uniform in appearance. It was a mass of rounded boulders and interstitial filling of silica, probably other non-metallics, magnetite, some lead carbonate, all deep red from abundant limonite. The persistence of the rounded boulders, from the size of a marble to 6 ft. diam., passing through the Chainman into the Joanna ground attracted everybody's interest; it was suggested that the creek once followed the lead, it being perfectly understood that the erosion was chemical and not by attrition. The best ore in large quantity averaged \$4.50 gold, but small areas were richer. Above the lime there were also areas of shale metasomatically replaced by quartz; the bulk stoped probably averaged higher than \$10. At the time of my examination in 1894 there was a remnant left in the bottom of an old stope. The metasomatism was interesting in its delicate complete-

ness; the shale, almost entirely silicified, looked unchanged except for a glisten. The ore left was about 50 ft. long, 8 ft. wide in the centre, 3 ft. at each end, and it assayed \$40 in gold, but it continued only about 10 ft. deeper, terminating without faulting in a conchoidal fashion against the big low-grade vein. The best ore was thus silicified shale, presumably Chainman shale. Possibly similar bodies yet may be found below the Joanna limestone in the Pilot shale. From here I was called to Monkey Wrench (afterward named Delamar, Nevada), and there I saw another phase of metasomatic replacement of quartzite by silica. One thousand tons had been shipped from the Discovery stope to Salt Lake, yielding \$100,000. While sorting to this grade the owners had collected a few pounds of the best specimens. There was nothing to show its richness except spots in the quartzite made by the new silica, looking as if it had been wet with water.

It is always interesting to find important work like this referring geologically to the solid foundations of the 40th Parallel-Survey carried across the West by James D. and Arnold Hague, and S. F. Emmons, with Clarence King as their chief, whose charm of character seems depicted in the massive yet graceful tomes and atlas of the report. I asked Mr. Emmons how they managed to do it, just out of college, when there was not too much known of geology by anybody. He said, "We learned as we went; we taught ourselves by studying the structures."

Possibly some who may read this paper may not be familiar with Salt Lake and the history of the former Lake Bonneville. Should they ride from Ogden to Salt Lake City, they will easily note terraces along the hill-sides denoting levels of the ancient lake 400 and 800 ft. above the present one. Before the Bonneville monograph was published I went with others over some of the remains of the old lake from Bear River, Idaho, southward, with G. K. Gilbert. He took us up the steep hillsides 400 ft. above Salt Lake, to show scarps in the terrace-gravels marking displacements by recent faults, assuring us that the upper bench which looked so near was really 400 ft. higher, as we could easily verify by following him there, but all were willing to take his word. Going over the immense bars formed by the old lake, and replying to flattering comments on his perspicuity, Mr. Gilbert laughingly protested, "Just a longshoreman; you don't need to be much of a geologist."

Monzonite is defined in the report, with reference to the feldspars, as a rock with equal amounts of orthoclase and plagioclase. Thus simplified it might be distinguished from granite, gabbro, and other rocks in the field; in fact granite is becoming scarce. Orthoclase is sometimes pinkish, but more often is only opaque as compared with plagioclase, and, on the latter, fine lines of multiple twinning may usually be detected.

AN INTERFEROMETER is an instrument that makes use of the optical properties of gases, and is suitable for analyzing a binary gas mixture.

The Sinking of the Alpha No. 2 Shaft at Kimberly, Nevada

By H. S. Munroe

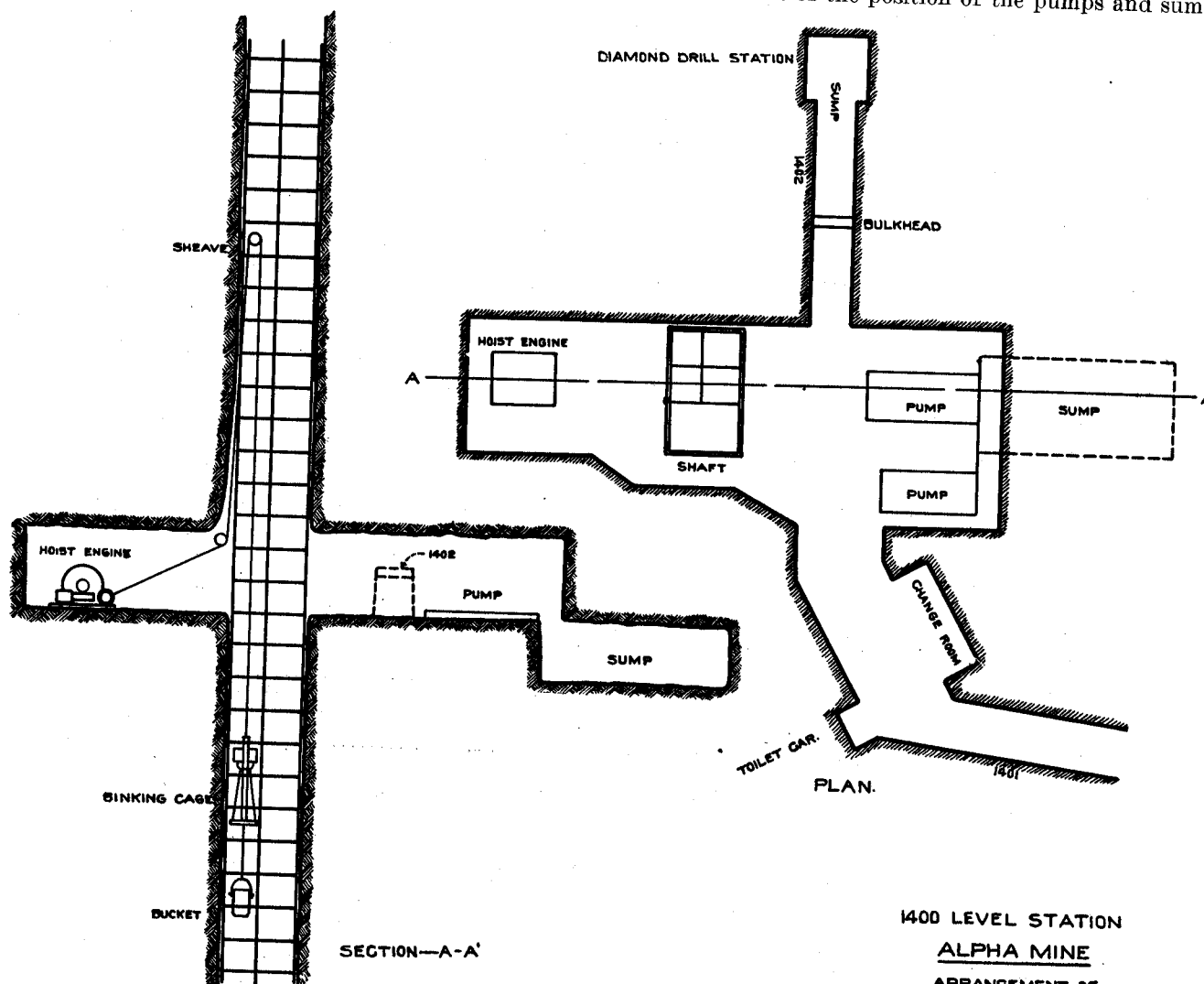
After a diamond-drilling campaign, by the Consolidated Copper Mines Co., conducted from the 1300 and 1400-ft. levels of the Alpha mine, it was decided to sink the main or No. 2 shaft from the 1400 to the 1800-ft. level.

On account of the extraordinary overhead expense involved in sinking from an underground station, and the delay such sinking would occasion to the normal operation of the mine, it was planned to get all possible speed on the job once the work was actually started: first, by providing and maintaining the best available equipment, and, second, by making the wage attractive on a sliding-scale contract so that the good men we hoped to provide would not only stay on the job but would take a lively interest in it, and, third, by making provision against delays that might be caused by the rather heavy flow of water in case of ordinary pump difficulties.

The rock in which this shaft is sunk is limestone, varying from a dense hard blocky phase to more shattered comparatively soft rock. In its shattered phases there is more or less silicification.

The water-level of the mine is at the 1000-ft. level and the normal flow from the 1400-ft. level is approximately 800 gal. per minute. Of this amount all but 100 gal. per minute originates in the altered ore-bearing zone, which is at an average distance of 500 ft. north of the shaft. The mine is kept free of water by compound-condensing steam-pumps, which are not over-capacity and are subject to occasional stoppage. To provide against delays occasioned by pump-stoppages, a concrete bulkhead with regulating-valves was established on the 1400-ft. level. This installation was utilized on five occasions during the four months of sinking.

On account of the position of the pumps and sump on



the skip side of the shaft on the 1400-ft. level, it was impossible to cut a loading-pocket on that side. Similarly, on account of the sinking-compartment (designated on the sketch as 'manway') and the pipe-way intervening between the sinking-station and the skip-ways, it was equally impossible to provide a pocket for direct loading into the skips from the sinking-station. It was necessary therefore to revert to the time-favored Butte custom of installing hinged doors at the collar of the sinking-compartment. The buckets were dumped directly into cars run onto these doors.

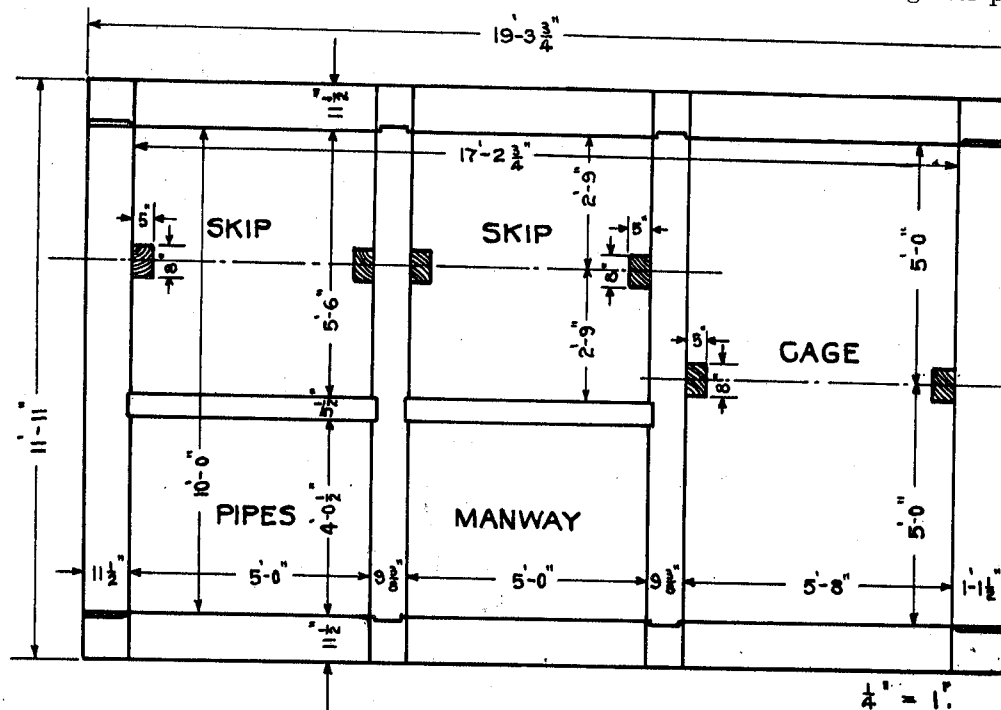
A 10 by 14-in. air-operated geared hoist with two 300-

ing and this mud was sluiced directly into the skips as provided for in the construction of the bulkhead.

The matter of personnel was given careful attention. A crew of 18 experienced shaft-men was picked for this work. It is an interesting fact that only two men changed during the entire period. These men worked on a sliding-scale contract and made attractive wages. The crew, per shift, consisted of six men in the bottom, one of whom was rated as a shift-boss and received one dollar per shift in addition to his contract wages. In addition, there were one pump-man, two bucket-dumpers, and one hoist-engineer per shift, all of whom worked on

day's pay. It is believed that the men in the bottom augmented, from their earnings, the pay of the others. There was excellent co-ordination of effort between the men on a given shift and keen, though friendly, competition between the three shifts. It would be hard to imagine more harmonious working conditions.

Sinking started on November 12, 1919, and was finished on March 5, 1920, the operation having proceeded without any delay worthy of mention and without any serious accident. Much credit for the net result is due R. B. Brown, mine foreman in charge of operations at the Alpha mine.



ALPHA No. 2 SHAFT. ACTUAL DIMENSIONS; TIMBERS SIZED

cu. ft. air-receivers was installed at the sinking-station. A specially designed light-weight sinking-cage with 12-ft. extension-shoes was provided. A 20-cu. ft. bucket, of which three were provided, was suitably suspended from the deck of the cage.

For drilling, Denver Rock Drill Co.'s No. 59 'Clippers' were provided. These drills were new at the start of the sinking and were taken on top and completely overhauled after each round. At least one spare drill was kept on the sinking-station during the drilling shifts to ensure against delays. No delay on account of drill failure was recorded.

Water from the bottom of the shaft increased from 40 gal. per minute at the start, to about 140 gal. per minute at the finish; it was pumped by No. 7 and 9B Cameron sinking-pumps, of which a spare was kept available on the sinking-station at all times. To provide for the settling out of the worst of the solids in the water from the shaft, the diamond-drill station shown as 1402 in the sketch, was converted into a sump by the construction of a bulkhead; from behind this bulkhead the water overflowed into the main pump-sump. The auxiliary sump filled with mud several times during the period of sink-

A statistical table covering this operation follows:

Feet advanced	400
Mine-shifts worked	312
Man-shifts worked (in bottom)	1,812
Total time:	%
Drilling	18.9
Blasting	7.3
Mucking	49.6
Timbering	16.2
Special	8.0
Holes drilled	3,354
Per foot of shaft	8.4
Per mine-shift	10.7
Per man-shift	1.85
Average depth	6.1
Maximum in any one shift	50.0
Feet of hole drilled	20,445
Per foot of shaft	51.1
Per mine-shift	65.4
Per man-shift	11.2
Maximum in any one shift	315.0
Buckets mucked	12,067
Per foot of shaft	30.2
Per mine-shift	38.7
Per man-shift	6.7
Maximum in any one shift	121
Feet timbered	400
Per mine-shift	1.28
Per man-shift	0.22
Sticks of Powder (1 by 8 in.; 40%) used	25,450
Per foot of shaft	63.6
Per hole	7.6
Per foot of hole	1.2
Blasting-caps (No. 8) used	6380
Per foot of shaft	16
Feet of fuse used	48,005
Per foot of shaft	120
Board feet of timber per foot of shaft	423

Copper Mining in Nevada.

By MARK L. REQUA.

*Ores that today present no difficulties from a metallurgical standpoint, twenty years ago were absolutely valueless. The conditions of today have been brought about by the experience that has been gained from the operations in the great copper camps of the West during the past decade, from Montana to Arizona, and from Utah to California. Had the problem that was presented to me on my first visit to this district been presented even five years previous, its solution would have been considered hopeless—in fact, I may say that the problems surrounding the working of these very low-grade ores have only been worked out satisfactorily within the last two years; and it is due to the Bingham district of Utah, more than to any other, that we have today absolute data based upon actual work, rather than empirical estimates.

The metallurgy of the high-grade gold and silver ores was successfully worked out upon the Comstock, and the smelting of lead ores at Eureka, but for the metallurgy of copper we must first of all turn to Montana, where the high-grade ores of Butte permitted extensive experimenting, the results of which have revolutionized the copper industry of the world. From Montana to Arizona, through the camps of Bisbee, Clifton, Morenci, and Globe; also at Granby, in British Columbia, and at Bingham, all with their varying problems, both of local environment and different mineralogical conditions, the metallurgy of copper has been worked out from the high-grade smelting ore, both oxide and sulphide, to the lean concentrating ores that are characteristic of Ely, and that are found in identical occurrences at Bingham and the Clifton-Morenci district of Arizona.

Fortunate, indeed, has it been for the West that the great deposits of high-grade ore yielded not only a profit with what now appears to have been the crudest of metallurgical appliances, but also permitted of extensive experiments, which, in their sequence, have made possible the profitable exploitation of low-grade bodies that bid fair in ultimate production to surpass the high-grade districts. Few people realize the evolution that has been taking place in the copper industry of the West during the past two or three years. The low-grade porphyry deposits which are being exploited at Bingham and Ely have come to be looked upon as the future source of the great copper output of the West, and, owing to their enormous tonnage, it is possible to forecast their production far beyond the life of the present generation.

It would be the height of folly to say that the methods of handling these ores have been perfected. We are today confronted at the first step of our process with a loss of from 15 to 20%, which is carried away in the tailing from our concentrators. I know of no field so promising for the winning of a large fortune as the perfecting of some method whereby the loss in concentration may be eliminated, or at least largely reduced. The smelting processes are much nearer perfection, but, with all that, it is safe to say that the plant which we are going to erect for the treatment of these ores will, within ten years, be obsolete. In fact, I believe that we shall, within five years, see changes that will materially alter our process in some of its most vital points. We are, however, building here at this time the very best plant that the combined knowledge of modern copper metallurgy is capable of producing, and I can say without fear of contradiction that, when finished and in operation, it will be the most modern and economical copper reduction plant in the world.

*Abstract from an address delivered at the driving of the last spike of the Nevada Northern Railway at Ely, on September 29, 1906.

The task of bringing this undertaking to successful fruition has not been an easy one. On my first visit, I saw only the signs of repeated failures; the efforts that had been made to wring profits from the rocks had been without success and my first day's inspection convinced me that, if there was to be success, it must be along lines radically different from those that had already been tried. After a week's study, the problem had resolved itself to a very simple one, save for the unknown factor that must be supplied in order to make the problem susceptible of solution. I saw before me a mineralized zone wherein the question of tonnage had even at that time, to my mind, been entirely eliminated. The unknown coefficient for which I was searching could only be determined by extensive development work; that coefficient was the average copper content of the porphyry in large masses. I had seen upon the surface streaks of high-grade ore that in themselves were interesting, but which did not hold forth prospects of a tonnage sufficiently large to justify the expenditure that I knew must be made in order to put the copper into marketable form. I saw in those early days that the only hope for this district was in developing tonnage of such magnitude and value as would justify the building of a railroad from the Southern Pacific. This meant the building of a line approximately 150 miles long, to justify which would require the development of millions of tons of copper-bearing ore. I had crawled down the Ruth mine 300 ft. on the incline and seen 40 ft. of a cross-cut that averaged approximately three per cent, with apparently no end in either direction. I had seen this same porphyry upon the surface leached of its copper, extending for hundreds of feet in width, and I knew that underground development would reveal enormous masses of this material, but I did not know what the copper content of it would be. It was, therefore, necessary first to develop this ore and determine its value not only sufficiently to justify the building of a railway, but sufficient in quantity to justify an enormous reduction plant, because profits could not be hoped for unless the ore was handled by the thousands of tons per day. Over a period of two years this prospecting work was carried on until a large tonnage of ore was developed. Even then, the railway was not justified, because there was no certainty as to what could be done with the ore in concentration. To determine this factor, a small experimental mill was built at the Ruth mine, which was operated during a period of three months, and most exhaustive tests and determinations made. The entire mine, in fact, was sampled by means of this mill; the results were compared, tabulated, and carefully scrutinized. That these results were satisfactory, is proved by the building of the Nevada Northern Railway, which was undertaken immediately after these mill-tests were completed.

In the meantime there had been effected the consolidation of the New York & Nevada and the White Pine properties under the name of the Nevada Consolidated Copper Co. At Copper Flat we had not been idle and the tonnage developed at Ruth is more than equaled by the tremendous body of ore at the Flat, whose limits have not as yet been defined. I think you will agree with me that we were justified in suspending development work, when I say that there is developed at Copper Flat and at Ruth ore sufficient to supply this reduction plant for at least ten years, with the largest part of our ground still unprospected, but giving every evidence of containing ore similar to that we have already developed. It was to meet this situation and afford means for working this ore that the Nevada Northern Railway was built.

PROCLAIM human equality as loudly as you like, Wileless will serve his brother.