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THE STORY OF THE RAY MINE

The Ray Mine of the Kennecott Copper Corporation is today producing copper at the rate of over one hundred million pounds per year, but it has reached that stage after more than forty-five years of continuous technical development and operating economies. Its success did not come because the State of Arizona handed it a mountain of copper ore and said "Here lie untold riches; all you have to do is dig it out". Application of brains and the investment of much capital were first required before the mountain would give up its riches.

History

Ray is about eighty miles east and slightly to the south of Phoenix and about the same distance north of Tucson, in what is called the Mineral Creek Mining District. This district was organized by silver prospectors in 1873. A five-stamp mill was built in 1880 by the Mineral Creek Mining Company. There is a record of some copper mining being undertaken by the Ray Copper Company in 1883. The next note was of small scale operations in 1898. In 1899 the Ray Mine was acquired by an English Company, the Ray Copper Mines, Ltd., capitalized at 260,000 pounds sterling. This company built a 250-ton mill at Kelvin and blocked out ore at the mine. It failed because of inadequate sampling. See last Page

About this time, 1899, Daniel C. Jackling was doing some pioneer mill testing of a low-grade porphyry ore at Bingham, Utah. He proved to the satisfaction of interested capital that by the introduction of large scale open-pit mining, and the erection of a concentrator, he could mine and treat rock containing two percent copper (40 lbs. per ton), recover 25 to 28 lbs. of copper for every ton treated, and concentrate it to a profitable smelting feed. Mr. Jackling's success in Utah started the search for similar large ore-bodies in Arizona. In 1906, his associates Philip Wiseman and Seeley Mudd obtained options at Ray, and in 1907 Mr. Jackling started extensive development work on the Ray property. The

Ray Consolidated Copper Company was organized, and a thorough program of churn-drilling was undertaken, in order to determine the amount and grade of ore it would be possible to mine on a large scale. About 50,000,000 tons of 2 per cent ore were blocked out, and Mr. Louis S. Cates was placed in charge of operations. Mr. Cates developed the mining system to be used at Ray, and it later became the first copper mine in the world to produce 8,000 tons or more of ore per day by caving methods.

Geology of the Ray Ore Deposit

The geology of the Ray District has been excellently described by F. L. Ransome.* For the non-technical lay reader, the following may serve as a thumb-nail description of the deposit with a glossary added to define some of the more technical terms.

The ore deposit is a secondary enrichment of disseminated chalcocite,1/ associated with and partially replacing primary pyrite2/ in the district's chief rock, known as Pinal schist3/ and also to a slight extent, in intruded porphyries. It is generally referred to as being a low-grade porphyry deposit. The orebody proper is a flat-lying mass, irregular in outline, and of variable thickness. The long axis extends roughly east and west for about 7,000 feet. It ranges in width from about 200 feet at the center to over 2,000 feet near the eastern and western extremities. The central constriction divides the ore into two sections which are called the "Eastern ore-body" and the "Western ore-body". The thickness of the ore as determined by drilling and development averages about 120 feet and ranges from 15 to more than 400 feet.

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* U.S.Geological Survey Prof. Paper 115,1919; U.S.Geological Survey Folio 217,1923.

1/ Chalcocite - Copper Sulphide - a secondary mineral containing 80% copper, and 20% sulphur.

2/ Pyrite - Iron Sulphide - a primary mineral, containing 47% iron and 53% sulphur.

3/ Schist - a metamorphosed sedimentary rock.

The area of oxidized capping[4] is somewhat more extensive than that of the ore, but has the same general shape. Around the margin of the ore many of the drill holes pass directly from the oxidized capping into the unaltered primary protore[5] The thickness of the capping varies greatly but its average is about 225 feet.

Intrusions of porphyries[6] produced numerous small irregular fissures which were permeable to the ore solutions, downward flowing waters that had picked up copper in the oxidized capping and deposited their copper load on the primary pyrite in what is now the ore-body. The replacement of the pyrite was not always complete. This phenomenon is interestingly shown by examination of minute (200-mesh) particles of what appear to be pure chalcocite under the microscope but when further pulverized disclose a kernel of pyrite within a chalcocite shell.

Under the greater portion of the Eastern ore body a diabase[7] sill that slopes gently to the east and north was more highly mineralized than was the surrounding schist. Chalcopyrite[8] associated with the pyrite makes this diabase considerably higher in copper than the corresponding primary schist protore, but it was not of economic importance until recently, when open-pit operations and metallurgical improvements converted it to a profitable ore.

Concentration

Because the proposed concentrator would need a good source of water and a large tailings disposal area, it was decided to locate the mill near the junction of the Gila and San Pedro Rivers, where there was a broad valley as well as good

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4/ Capping - Leached material overlying the ore body. Also called overburden.
5/ Protore - Metallized rock of a grade too low to be classed as ore.
6/ Porphyries - Intrusive igneous rocks with distinct crystals embedded in finer grained material.
7/ Diabase - Intrusive igneous rock - dark gray or greenish colored - even textured.
8/ Chalcopyrite - Copper - Iron Sulphide - a primary mineral containing 30% iron, 35% sulphur and 35% copper.

water possibilities. An eight-section mill was constructed, and production of copper started in 1911. A railroad was built from Ray to connect with that of the Arizona Eastern Railroad at Ray Junction, eight miles away. From there the ore was hauled eighteen miles to the mill by the Arizona Eastern Railroad. A subsidiary of the Ray Consolidated Copper Co., called the Ray and Gila Valley Railroad hauled the ore from the mine to Ray Junction. The copper company also had to construct three miles of track from the Arizona Eastern Railroad at Hayden Junction to the mill. By this time, the millions of dollars required for mine development and mill and railroad construction were exhausted, and the American Smelting and Refining Company, assumed the task of constructing the needed smelter, the Smelting Company contracting to smelt the copper company's concentrates and ship the blister copper back to the A. S. & R. Co. Refinery at Perth Amboy, N. J. The smelter was located near the mill in the new town of Hayden, Arizona.

It was late in 1912 before the mill reached its projected capacity of 8,000 tons daily, and with copper at sixteen cents, the Ray Mine made a profit. Of course, at this time, it could merely begin to return something on the enormous investment. The first dividend was paid in June, 1913. By this time about 30 miles of underground work had been done, simply for exploration, and about 80,000,000 tons of ore developed. This large development was necessary to assure a reasonable return on the large amount of capital expended in the erection of mills and works. Remember the failure of the English Company because of inadequate sampling.

In the early days of the Ray mill operations, the method of concentration then in vogue was crushing and grinding with gyratory crushers, rolls, and chilean mills, to about 1/16" size. This in order to free the particles of copper mineral from the worthless portion of the rock. This mineral, being heavier than the rest of the rock crushed to the same size, had the property of sinking in water faster than the lighter particles, and when subjected to a shaking action on tables

equipped with riffles, the copper mineral was separated (concentrated) from the worthless portion (the tailings) and became high enough in grade, to make a suitable smelter feed. This process was known as gravity concentration. Naturally grinding the ore to 1/16" size resulted in sliming or pulverizing a considerable portion of the copper mineral, which became too fine to permit taking advantage of its relative specific gravity and was lost into the tailings flowing over the table riffles. The result was a recovery of not over seventy percent of the original copper in the ore.

In 1914 and 1915, technical research developed a process for increasing the recovery of copper sulphide (which constituted the greater proportion of the copper mineral in the Ray ores). This process (called the Flotation Process) was the reverse of the gravity concentration process, in that it floated the heavy sulphide mineral, and sank the light worthless material, making a successful separation and a higher grade concentrate. This was accomplished by aerating the ore pulp, adding oil which performed the function of converting the air bubbles into a stiff froth, and at the same time attaching itself to the copper sulphide particles, for which it had an especial affinity, due to the metallic surface of the mineral. The air bubbles, so filmed and so coated with the copper mineral, rose through the pulp and floated off the sides of the flotation machine. The worthless earthy material in the pulp flowed through the machine to waste.

As the flotation process increased copper extraction from sixty and seventy percent to about ninety percent, this revolutionary advance in metallurgy converted what had been originally classed as waste into pay ore, increasing enormously the developed mine tonnage, and radically extending the life of the mine. Where originally two percent was the yardstick for ore classification, the measure has been gradually reduced to one percent.

The last few years have shown similar advances in mining technology, especially in the operation of open-pit mines. These advances have permitted

the removal of larger proportion of overburden, and the economical handling of lower grade ores. There again the Ray mine benefited, and additional tonnage was placed in the Ray reserves. Kennecott Copper Corporation, which had taken over the Ray mine in 1937, decided in 1948 to conduct open-pit operations on a section of the ore-body, in conjunction with the underground mining. The daily tonnage of the latter was reduced to 5,000 tons, and the open-pit was developed to produce 10,000 tons daily. The mill was enlarged to handle 15,000 tons, by the addition of four large ball-mills. Incidentally, ball-mills had long since taken the place of the old chilean mills, and rod-mills had replaced the rolls for fine-crushing and grinding, and both changes played their part in improving the economy of the mill operation. Finer grinding was accomplished which freed more mineral for flotation recovery.

Final conversion of the Ray Mine from an underground to an open pit operation was completed toward the end of 1954 and all underground mining was terminated January 28, 1955.

Another source of income from the mine might be mentioned here, and that is the precipitation of copper, from mine waters, on scrap iron. With the caving system of mining, the ore chutes are sealed off as soon as the oxidized capping or the broken protore begins to appear in the ore drawn from the chutes. This leaves a large amount of low-grade, copper bearing broken rock in the mine which is subjected to a slow leaching by downward percolating waters. These copper-laden waters are pumped out of the mine and passed over de-tinned scrap iron which precipitates the copper as cement copper. The copper precipitates, carrying eighty percent copper, are dried and shipped to the smelter at Hurley, New Mexico, where they are fire-refined. These precipitates accounted for the production of a half-million to a million pounds of copper monthly.

Leaching of the caved areas of the old underground workings was begun in 1955, and is resulting in the recovery of increased amounts of precipitate copper. Production of this copper in 1955 was 7,546 tons, as compared with 3,644 tons in 1954. In 1956, it was increased to 14,934 tons, or 2½ million pounds per month.

Improvements such as the open-pit development, additions to the concentrator, and power development, cost the Company over five million dollars in the period of conversion to open-pit mining. Other millions had been spent in the earlier years when flotation took the place of gravity concentration, when ball-mills were substituted for chilean mills, and later when rod-mills took the place of the fine-crushing rolls.

Mill metallurgy was improved in 1956 by the finer grind made possible by the larger ball mill motors installed during the year.

At Kennecott's new research center in Salt Lake City, a method has been developed to increase the amount of copper recovered from the refractory ore of the company's Ray division. This method indicated that recovery could be increased by 12 percent, and a five million dollar installation at Hayden was decided upon. The process involved the production of sponge iron and sulphuric acid from the pyrite which up to now had been rejected in the mill tailings. The acid is to be used in dissolving the oxidized copper in the ore, and the sponge iron is to precipitate the dissolved copper; the resultant precipitation of metallic copper is to be floated in the mill circuit.

Progress has been made on the $40,000,000 program, announced at the last annual meeting of stockholders, for increasing the productive capacity of the Ray Division by 20,000 tons of copper annually. Plans for relocating the various surface facilities to permit enlarging the pit, and for expanding the capacity of the mill are well advanced. The program also provides for the construction of a smelter to process the copper concentrates and precipitates produced at this division. This work has previously been done by a custom smelter on a cost-plus basis. The smelter is scheduled for completion in 1958.

All of which demonstrates the constant need of setting aside a portion of profits in order to keep abreast of technical progress. It would have been economic suicide to have distributed one hundred percent of the Company's earnings in the form of dividends, and then have no money to spend on keeping up to date.

And so we have seen how Mr. Jackling started to develop the Ray mine in 1907, and how the mining company finally started to make money late in 1912. During these five years, the Company had expended $15,600,000 in churn-drilling, shaft-sinking, driving underground workings, building a railroad and a concentrator, together with all the other industrial buildings required for such a big undertaking. In addition to all this, the American Smelting & Refining Co. had to build a three-million dollar smelter to take care of the mining company's product, and it also placed a five-million dollar refinery at the service of the mining company, for copper concentrates and even blister copper are not the end-product of the project. During all this time, there were many periods when the mining company lost money, due to the low market price of copper, which after all was one of the hazards the mining industry had to face, a hazard over which the mining company had no control. The problems were not all geological, metallurgical and mechanical; there were labor and business problems to be handled. For example, the depression of the thirties caused a complete shut-down of four years' duration which came close to a complete abandonment of the Ray property. It took large expenditures to keep the underground workings in half-way decent condition for future resumption of operations. Furthermore, the oxidation of the exposed mineral in the miles of underground openings resulted later in reduced recovery by the flotation process, which has been successful only in treatment of clean sulphide mineral.

The total production of copper, gold and silver since the beginning of operations by the Ray Mine in 1911, through the year 1956, was approximately as follows:

Total Tons Ore Mined	107,316,278
Net Pounds Copper Produced	2,467,000,000
Net Ozs. Gold Produced (approx.)	31,000
Net Ozs. Silver " (approx.)	2,600,000

The Kennecott Copper Corporation's reports do not segregate the Ray Mine's financial operations from the combined operations of the company's huge holdings, but assuming Ray has averaged slightly less than three cents profit per pound of copper, for the payment of dividends over its 45 years of operation, the Ray mine has probably contributed 70 million dollars toward Kennecott's dividends. This would be slightly less than ten percent annual return on the original 15.6 million dollar investment. Not a fabulous return, but when one considers the enormous wealth in copper, gold and silver (over 460 million dollars) which has been created out of this tiny section of Arizona, it is a truly fabulous tale.

April, 1957

RAY COPPER MINES 1896

Territorial report of the Governor

A group of copper-bearing claims, some 18 in number, with several mill sites, have been considerably prospected but are not now being worked. They are known as the Ray mines, and are on and around Ray Hill, 6 miles from Riverside, Pinal County. The ore is largely in masses and beds, in a decomposed felsitic rock, and is in an oxidized condition. The deepest opening does not exceed 100 feet, but there is an aggregate of 1,270 feet of level and 560 ft. of pits & winzes, mostly on ore.

Information from MINE INSPECTOR'S OFFICE - August 15, 1957

PEARL HANDLE & WEST PITS Mineral Cr. Dist. 5-21-57
Ray, Ariz.

KENNECOTT Cu Co., 161 E. 42nd St., New York, N. Y.

Cu 1,500,000 tons 233 men.

L.A.S.

1-20-58 - FPK

KENNECOTT-RAY DIVISION

"NEW RAY" designed for 5,000 population, start on 600 homes in April.

John W. Galbreath Development Co., through new Arizona subsidiary will build them.

THOMPSON, TOWLE & CO.

MEMBERS OF THE NEW YORK STOCK EXCHANGE
MEMBERS OF THE BOSTON STOCK EXCHANGE
MEMBERS OF THE CHICAGO STOCK EXCHANGE

25 BROAD STREET, NEW YORK
50 CONGRESS STREET, BOSTON
CABLE ADDRESS:
THOMPTOWLE

RAY CONSOLIDATED COPPER COMPANY

KELVIN, ARIZONA

OFFICERS.

SHERWOOD ALDRICH, President — D. C. JACKLING, Vice-Pres. & Gen. Mgr. — E. P. SHOVE, Sec. & Treas.

DIRECTORS.

SHERWOOD ALDRICH, D. C. JACKLING, E. P. SHOVE, A. CHESTER BEATTY, C. M. MACNEILL, SEELEY W. MUDD, SPENCER PENROSE, CHARLES HAYDEN

EXECUTIVE COMMITTEE.

D. C. JACKLING, Chairman — A. CHESTER BEATTY — SEELY W. MUDD

Authorized and Issued Capital, $10,000,000 — 1,000,000 Shares — Par $10

The few bonds, which have not yet been converted and are still outstanding, are included in the above capitalization.

Cash on hand approximately, $4,000,000.

LOCATION AND AREA.

The Ray Consolidated Copper Company's property may be classed as one of the largest of the low grade so-called porphyry copper mines in the United States. Although the property is not producing, it has long since passed out of the prospective stage and has at the present time more than 40,000,000 tons of ore in the developed reserves.

The property, which comprises about 1,000 acres of mining ground, is situated at Ray, Arizona. The mine is connected with the town of Kelvin, a station on the Southern Pacific R. R., by the Company's broad guage railway, six miles in length.

GEOLOGY.

The ground of the Ray Consolidated is so located as to cover practically the entire width of a belt of altered schist and granite porphyry. The total length of the mineralized area along its strike is approximately 2½ miles, and at its western boundary, which adjoins the Gila Copper Co, it is over a mile in width. The ore occurs as chalcocite finally disseminated or in seams interlacing through the schist. The leached zone varies from 70 to 400 feet deep and averages 242 feet. This grades suddenly into the secondary ores which average 2.25% copper and extend to an average depth of 118 feet.

MINE.

Development: The present Company began active development about two and a half years ago and since that time the workings have been greatly extended, shafts sunk and a vigorous drilling campaign inaugurated which has resulted in developing enormous ore reserves.

It has been decided by the management to equip the property for a daily production of 6,000 tons, and a large amount of construction is now being done.

A main two-compartment working shaft has been sunk and is being equipped with electric hoists capable of handling 6,000 tons in sixteen hours. This shaft is to be used solely for the hoisting of ore, an inclined shaft on an easy grade having been driven for the purpose of handling men and supplies.

On coming from the mine the ore will be crushed and stored in 20,000-ton steel bins, now under construction, and then dumped directly into broad gauge cars for transportation to the mill.

The ore bodies, which are not adaptable to steam shovel mining owing to the thickness of the overburden, will be worked underground by the top slice caving method.

Drilling: The Ray Consolidated property has a large amount of well-located virgin territory. Eight drills are now in operation at the mine further proving up the known ore bodies and prospecting the new ground. By this drilling and the underground method of development two to three million tons of ore are added to the reserves monthly. The drilling is carried on in a most systematic manner, the holes being put down 200 feet apart. It is important in connection with this method to know that raises from the underground workings have been driven along the drill holes and actual samples taken and that these check the drill samples with great accuracy.

Ore Reserves: The total amount of ore in reserve, December 1, 1909, amounted to 41,502,871 tons, averaging 2 25% copper, of which the following is a summary:

Total Acres	Total Tons	Average per cent. Copper	Average thickness of the Ore	Average thickness of the capping
105	41,502,871	2.25	113.5 feet	242 feet

It is important to note that the limits of the ore have not yet been determined in any of the groups and that the total area of commercial ore is being continually increased. In addition to the 41,502,871 tons of developed ore there is a large tonnage of probable ore of which no estimate is made by the management.

During the past six months development work has been confined principally to changing the probable ore into actual tonnage in sight. For example: In the early summer there were some twenty million tons of developed ore and eighteen million tons of probable ore. This latter tonnage has now been sufficiently opened up to be classed as fully developed ore.

EQUIPMENT.

Concentrator: The present milling equipment consists of a 200-ton plant located at Kelvin on the banks of the Gila River. As this plant is insufficient to handle the desired tonnage, it has been decided to erect a new steel concentrator with an initial capacity of 5,000 tons per day and to add more units as the development of ore proceeds. The new mill will be located on the Gila River at Winkleman, fourteen miles from Kelvin, which is on the main line of the Southern Pacific, with which Company the Ray Consolidated has a low freight rate. It is stated that the cost of transporting the ore from the mine to the mill will be approximately 16 cents per ton.

The concentrator is to be composed of eight units of which the first two or three will be placed in operation by January, 1911, after which date the others will follow rapidly.

The excavation has been made for a 5,000-ton plant, and the foundations are now being erected and structural steel delivered. This plant, while designated as of 5,000 tons capacity, is expected to treat 6,000 tons per day.

Experiments on the ore indicate a ratio of concentration of 17 tons into 1. A saving of 70% and better has actually been attained on ore of average grade.

Power Plant: Power is to be generated from steam at a plant located near the mill. It is the intention to convert this power in electricity and transmit same to the mine. This plant will be ample to supply the concentrator and smelter as well as the mine.

Smelter: The management has decided to erect its own smelter, which will be located about a quarter of a mile from the concentrator. This plant will be sufficient to handle the concentrates from the mill.

COST OF PRODUCTION AND EARNINGS.

Careful estimates by the Company's engineer places the cost of producing copper at 9 cents per lb. on a daily output of 5,000 tons.

On this basis there should be produced 50,000,000 lbs. of copper per annum and if the mill treats 6,000 tons per day, as is expected, 60,000,000 lbs. should be produced annually at a cost estimated at 8¾ cents per lb.

On the above assumptions we have the following earnings and earnings per share at the various copper metal prices:

			Copper at 13c. per Lb.		Copper at 14c. per Lb.		Copper at 15c. per Lb.	
Tons of Ore Treated Daily	Estimated Annual Production Lbs.	Estimated Cost	Earnings	Earnings per share	Earnings	Earnings per share	Earnings	Earnings per share
5,000	50,000,000	9c.	$2,000,000	$2.00	$2,500,000	$2.50	$3,000,000	$3.00
6,000	60,000,000	8¾c.	2,550,000	2 55	3,150,000	3.15	3,750,000	3.75

THE ABOVE INFORMATION HAS BEEN OBTAINED FROM WHAT WE REGARD AS RELIABLE SOURCES, AND WHILE WE DO NOT GUARANTEE IT WE BELIEVE IT TO BE ACCURATE.

January, 1910.
Statement No. 3.

FORM C. O. 23

UNITED STATES SMELTING REFINING AND MINING COMPANY

SALT LAKE CITY, UTAH

COPY

For Mr Brough

Ray mine

Superior, Arizona
August 10, 1949

Mr. A. G. Kirkland
Manager of Western Mines
U.S. Smelting Refining & Mining Co.
Salt Lake City 13, Utah

Dear Sir: St. Anthony Mining and Development Co., Tiger, Arizona
Ray Consolidated Copper Company, Hayden, Arizona

Visits were made this day at the St. Anthony and Hayden mills.

The mill of the St. Anthony Mining and Development Company, Ltd., is probably the only one of its kind in the southwest. Sulphide lead-zinc and oxidized lead ore is milled simultaneously in parallel grinding and processing sections. About 100 tons of oxide and 350 to 400 tons of sulphide ore are milled per operating day. The operating schedule is now 11 days on and 3 off. Wage rates are about 10¢ per hour less than was ours. They work Tuesday through Friday, with one day at overtime.

Sulphide ore heads carry low values in Au, Ag and Cu, with 4 to 5 percent lead and 5 to 6 percent zinc. Oxide heads carry about 0.03 oz Au, 0.50 oz Ag, 3 to 3.5 percent lead and 4 percent zinc, most of the latter being oxidized and non-recoverable.

Successful operation of these sections is entirely dependent upon segregation of ores underground. This had not been done on the day of my visit and the sulphide circuit was in rough condition.

I will not go into detail on the two operations as Mr. Givens, Mill Superintendent, supplied me with a flowsheet showing the separate circuits and I have a published account of the oxide operation. A fair amount of the galena is in massive form so feed to the sulphide circuit is passed over vibrating screens

decked with 6 mesh cloth, these screens closing the primary grinding circuit. Screen undersize is roughly sized in a launder spits and sent to 3 Deister tables which take off a finished lead concentrate. This product assays close to .04 Au, 5.5 Ag, .50 Cu, 67% Pb and 4.5% Zn. Table tails and mids are ground in the secondary mill for flotation.

Cleaning and recleaning of lead and zinc concentrate is practiced. Flotation lead concentrate assays close to 67% Pb and 6% Zn. A considerable amount of slow floating galena carries over into the zinc concentrate so this product is also tabled, the lead streak being cut for return to the classifier. Final zinc concentrate assays 54 to 55% zinc.

Processing of lead oxides is by flotation alone. While cerussite is the principle economic mineral, galena, wulfenite, vanadinite and anglesite are present in varying, but important amounts. Recovery of lead in this circuit has averaged close to 90% on 3% lead heads while recovery of Au and Ag has been close to 85%. Oxidized Zn is no problem; but sulphide Zn wrecks the operation. The sulphide responds to promoters for lead. If zinc depressants are added they destroy the effect of lead promoters. Vanadinite and wulfenite are prominent in the concentrate. Mr. Givens is not sure about the anglesite content.

The plant is an old one, as is most of the equipment except the Denver cells. From the standpoint of arrangement there is little to imitate. Tailing disposal methods are quite similar to ours up to the change we made last spring. Disposal cost is comparable to ours. Other costs are unknown.

Kennecott Copper at Hayden

Ore is delivered to this mill after being crushed to 3/4" at the mine. Four 9' x 12' rod mills are now installed, each taking 2800 to 3000 tons per day

of this 3/4" feed and reducing it to practically all through 8 mesh with about 10% circulating load, the latter being obtained with a locally designed tramp oversize trap. Rod mill product is reduced to 70% minus 200 mesh in two stage ball milling and classification.

The mill is notable for the absence of fine crushing and screening equipment such as is found in so many mills and which was in this one at an earlier date. The change to fine crushing with rod mills resulted in a 7.5% reduction in costs back in the thirties. Reasons other than sticky feed induced the change.

The economic mineral is preponderantly chalcocite, accompanied by some pyrite. A little milk of lime is added to the rod mills, but most is added to the third stage grind where the heaviest concentration of pyrite is formed. Locally made "Raconite", a butyl xanthate is the only promoter. Roughing is done in callow type cells while Fags are used for cleaning and recleaning.

Seven men and a foreman constitute a shift operating crew, including the filter plant. Tailing is laundered, unthickened, to the high point of the disposal area and diverted alternately to very large divisions of river bottom land. Rims are pushed up by a dozer after a division has been filled and allowed to dry. There is no return of water and none is skimmed, the areas being so large that it evaporates. Cost of disposal is negligible.

- - -

F. V. Brough

PVB:ab

Typed at SLC
from pencil copy
August 15, 1949

cc: Mr. Mulock (2)
Mr. Brough

OFFICE OF

RAY CONSOLIDATED COPPER COMPANY

MAY 22, 1909.

Mr. SHERWOOD ALDRICH,
President, Ray Consolidated Copper Co.,
Colorado Springs, Colorado.

DEAR SIR:

Complying with your recent suggestion that a general statement concerning the properties of the Ray Consolidated Copper Company be prepared for the information of stockholders, we beg to submit the following:

PROPERTY AND LOCATION

The Company owns about 1,000 acres of lode claims in the Mineral Creek Mining District, at the old camp of Ray, Pinal County, Arizona. About 600 acres of this ground is patented, and patents are under way covering the remainder.

In addition to the mining property at Ray, the Company owns a large tract of land admirably located for mill-site purposes, including about 200 acres of mill sites at the town of Kelvin. The latter is a station on the Phœnix & Eastern Railroad, which is a branch of the Southern Pacific System. Kelvin is 81 miles east of Phœnix, and is situated on the north bank of the Gila River. The location of the mines at Ray is six miles north of Kelvin, on a small but continually flowing stream, known as Mineral Creek. Kelvin and Ray are connected by a narrow-gauge railroad, owned by the Company.

As indicating the character and genesis of the ore deposits, we have deemed it best to include in full a summarized report by Mr. Henry Krumb, the engineer, who, since our most active operations began, has had general charge of the technical work in connection with our churn drilling and other development operations. His report, which has been made as brief as possible in stating the facts, is as follows :

SALT LAKE CITY, May 22, 1909.

Mr. D. C. JACKLING,
Chairman Executive Committee,
Ray Consolidated Copper Co.,
Salt Lake City, Utah.

DEAR SIR :

I herewith beg to hand you a brief description of the property of the Ray Consolidated Copper Company, and a summary of the results of the development to May 15th, 1909.

GEOLOGY

The mineralized belt in which the properties of the Ray Consolidated Copper Company are located, consists of an area of highly altered and silicified schist. The belt has a length, east and west, of about two miles, and a north-and-south width of about one mile. The greater part of this area is covered by claims owned by the Ray Consolidated Copper Company.

The silicified schist is cut by dikes, sills and laccoliths of granite porphyry and diabase. Within the area of the mineralized belt and the zone of secondary enrichment, all rocks, whether schist granite porphyry or diabase, are about equally mineralized. Near the contact of schist and diabase, there is usually a streak of higher grade of ore.

The mineralization consists of a uniform dissemination of copper minerals through the mass of the rock and of small seams and veinlets of mineral running in all directions.

The genesis of the ore deposit is similar to that of the copper-bearing porphyry deposits of Bingham and Ely. Near the surface is the oxidized zone from which most of the copper values have been leached. This zone is from 70 to 400 feet thick, averaging 217 feet, and is underlain by an enriched zone in which the copper, leached from the oxidized zone above, has been redeposited principally in the form of chalcocite, although chalcopyrite is universally

present, and occasionally native copper, the latter especially in the upper parts of the ore body in certain sections. This zone, which forms the commercial ore body, averages 100 feet in thickness. It is underlain by the primary ore zone, carrying low copper values in the form of cupriferous pyrite.

DEVELOPMENT

There are approximately 20,000 feet of shafts, drifts, raises and tunnels on the Ray property. The major part of this work, or about 17,000 feet, has been driven in what is known as Ray Hill on three levels, about 50 feet apart. Generally speaking, the results of sampling these underground workings corroborate the results obtained by churn drill holes drilled in this area.

The whole property has been divided into blocks 200 feet square by co-ordinates. At each corner of the developed squares, churn drill holes have been drilled through the enriched zone to the primary formation below. Up to May 15th, 151 holes have been completed, having an average depth of 377 feet, or a total footage of 57,000 feet.

A sampler is continually stationed at each drill, and it is his sole duty to take care of the sampling. Every possible precaution has been exercised to obtain reliable results. The drill sludge, consisting of finely ground rock, slimes and water, has been check-sampled in different ways—always giving approximately check results. The assaying of the samples is being continually checked by outside assayers.

A number of drill holes have been cut by underground drifts, and raises have been driven alongside of other drill holes. After such raises were completed large samples were moiled from the groove of the drill hole in the side of the raise. Samples taken from raises in the above manner averaged 2.69% copper, against 2.48%, the average of the drill sludge samples representing the same sections.

Similar results have been invariably obtained where underground drifts have cut drill holes, the samples taken in the drifts averaged uniformly higher than the drill samples from the same sections. Further checking by drifts and raises will be carried on until the results of a considerable percentage of all the drill holes has been checked.

ORE RESERVES

Of the 151 drill holes completed to May 15th, 122 show commercial ore. Of these, 106 holes are located in six groups, viz.: Parson-Ray, Diorite, Mineral Creek, Consuelo, Sharkey and Mathias-Hall. By connecting up the holes in each group by straight lines, I estimate there is developed a total of 21,000,000 tons of ore, having an average assay value of 2.30% copper.

No ore has been allowed beyond the exterior boundaries of completely drilled blocks formed by lines connecting holes not in excess of 200 feet apart, and the estimate of 21,000,000 tons is, therefore, an estimate of the ore completely blocked. Twelve and one-half cubic feet per ton has been used in the calculations.

In arriving at the average grade of the ore, all high or erratic assays have been cut, also whenever considerable caving from the side of the hole has taken place, assays have been reduced.

As previously stated, the check-sampling indicates that the ore is of higher grade than shown by drill samples.

The total acreage developed is sixty acres. The acreage of each group, together with the tons of ore developed, and the average grade of the ore, is as follows:

Group.	Acres.	Tons.	Per cent. Copper.	Thickness of ore.	Thickness of capping.
Parson-Ray,	41.72	14,457,286	2.33	99.4	205
Diorite,	1.93	375,247	2.46	55.9	192
Mineral Creek,	6.27	1,377,423	2.37	63.0	230
Consuelo,	0.83	513,280	2.32	178.2	340
Sharkey,	6.22	2,425,863	2.43	111.9	231
Mathias-Hall,	3.55	1,928,142	1.74	155.8	202
TOTAL,	60.52	21,077,241	2.30	100.0	217

No ore has been allowed in the estimate of developed ore beyond straight lines connecting holes. By allowing some ore beyond these lines, and by making moderate allowance for the ore shown by scattering holes, I estimate there are 18,000,000 tons of partially developed ore in addition to the 21,000,000 tons of completely developed ore.

Drilling operations were originally started in different sections of the mineralized belt, and the results indicated apparently independent ore bodies. As drilling operations were extended, the gaps between some of the ore bodies were closed up, proving continuous ore. The Ray and the Parson ore bodies have already been joined, and the gap between the Diorite ore body and the Ray ore body will soon be closed. Continuous ore has been proven between the Mathias-Hall and the Sharkey ore bodies. These two groups, which are on the west end of the property, are about one mile from the center of the Parson-Ray-Diorite developments. Between these developments on the extreme ends of the property, two smaller groups—the Consuelo and Mineral Creek—lying more nearly in the center of the property, have shown substantial ore bodies, which are being continually extended.

This brief description of the relative location of the different groups gives some idea of the probability of largely increased tonnages by further development work, as the limits of the ore body have not been determined in any of these groups.

Respectfully submitted,

HENRY KRUMB.

The commercial ore bodies developed, as above described in Mr. Krumb's report, are being very rapidly extended. The detailed reports from which this summary is compiled are made up monthly and each Member of the Executive Committee is thus kept familiarized with the work to an extent enabling us now to fully approve Mr. Krumb's estimate. There are 11 drills in continuous operation and the rate of development for the past three months has averaged over 4,000,000 tons per month. It is the purpose to continue active development operations for some time to come, and there is no reason to believe otherwise than that rapid increases of ore reserves will follow. Of the 1,000 acres of mining claims owned, about 500 acres display the same character of rock and surface indications as the areas in which developments have been and are now being carried on, and a great part of this acreage promises the development of commercial ore deposits.

Underground work is also being vigorously prosecuted, partially in the way of independent exploration, including the checking of drill holes, and partially in blocking out ground, particularly in the Parson-Ray ore body, in connection with mining ore for the experimental concentrating mill, which has been in operation for several months.

On account of the thickness of the capping or leached zone, overlying the ore bodies, it will probably be impossible to mine much, if any, of these ore bodies by methods other than underground mining. Such mining as has been done, however, in connection with development and in supplying ore for the experimental mill, has proven that the character of the ground is such as to make it well adapted to cheap methods, such as what is known as the "caving system," or some of its modifications. It is possible that certain small areas may be worked by open cut methods with steam shovels or otherwise.

METALLURGICAL FEATURES

The ores of this property are well adapted to the ordinary concentration methods applying to similar well-known deposits at other places; in fact, rather better adapted than is usual, for the reason that a considerable percentage of the copper contents exists in seams and veinlets in moderately large particles, which are readily freed by comparatively coarse crushing, from the accompanying gangue. As has been previously stated, the Company owns and is operating a small mill at Kelvin. This plant, built by previous owners, several years ago, while of obsolete design, has been partially remodeled for experimental purposes, and has been in operation now for several months. The plant is too small, badly constructed and equipped, to operate profitably at the prevailing prices of copper, but on varying rates of tonnage up to 200 tons per day, its operation has, notwithstanding the ill-adapted arrangement and apparatus, been pro-

ductive of such technical results as insure a satisfactory recovery in the concentration of these ores. Results so far attained indicate a ratio of concentration of 17 to 20 tons of ore into one ton of concentrates, and the grade of concentrates produced approximate 27% to 30% copper.

Plans are now being prepared for the construction of a new steel concentrating plant having an initial capacity of 3,000 tons per day, although it is the purpose to continue construction after it is once in progress, until the plant, as completed, shall have a capacity of not less than 4,000 and probably 5,000 tons per day.

The character of construction and the metallurgical methods to be applied to the ore will not differ materially from those used in connection with the operation of similar properties in the Bingham and Ely districts. It is intended that active construction on this plant will be commenced before the end of July, and we believe the first portion of it should be in productive operation within about eighteen months. An electric power plant will be built in connection with the concentrating plant having capacity sufficient to furnish power at the mines as well as to operate the mill, and the matter of also building a smelter to provide smelting facilities for the ores and concentrates of our Company, and probably those of others in this vicinity, is having favorable consideration, although it may be decided to arrange for the reduction of these products temporarily at some one of the existing smelters in the vicinity. The original equipment plans of some months ago did not contemplate the building of a smelter, and not larger than a 2,000-ton concentrating plant was then discussed, but the very rapid increase in ore reserves in the past few months has indicated the desirability of equipping on a much larger scale at once.

TRANSPORTATION

The narrow-gauge railroad now existing between Kelvin and the mines has been resurveyed and relocated, and the work of replacing it with a standard-gauge line and equipment is now in progress. As before stated, the length of this railroad is six miles. The new line is being laid with 80-pound steel and will have a maximum grade of 1.5%. It is the intention to provide steel cars and the heaviest type of motive power, thus insuring the most economical and reliable character of operation in the transportation of ores from the mines to the mills.

GENERAL REMARKS

Generally speaking the situation of the property, and the circumstances that will surround its operations are to be considered favorable. The climate is such as to admit of outdoor operations the year round, and possesses none of the disadvantages of severe Winter weather or heavy snows. The ore bodies lie at such a horizon that there is little or no water to contend with, and the ores are of such a nature and exist in such large bodies that they can be mined with more than usual economy as to cost. Transportation facilities, already insured, are all that could be desired. An excellent mill site has been provided; which being located near the Gila River, gives assurance of a plentiful supply of water for all purposes, and taken altogether, the conditions are such as indicate economies of operation not materially different from those applying to similar deposits in other and less isolated sections. A careful analysis of estimated costs, considered in connection with the known costs applying to other similar deposits warrants the assumption that, on a 4,000-ton per day basis, the cost of copper will not exceed nine cents per pound. If it should be decided not to build larger than a 4,000-ton plant at this time, the Company should be producing at the rate of 40,000,000 pounds of copper per annum before the end of next year, and, if a 5,000-ton plant is provided, the production should not be less than 65,000,000 pounds per annum, when the plant is in full operation, in which case the above estimated cost per pound would be substantially reduced.

Respectfully submitted,

D. C. JACKLING, *Chairman;*
A. CHESTER BEATTY,
S. W. MUDD,
} *Executive Committee.*

Apr. 12, 1958
AIM+ME Meeting, Geologic Div, at Ray.

A BRIEF HISTORY OF THE RAY DISTRICT

The Mineral Creek Mining District, which includes the Ray area, was organized by silver prospectors in 1873. In 1880 the Mineral Creek Mining Co. built a five-stamp mill, then in 1883 the Ray Copper Co. took over and built a 30-ton copper furnace. The ore of the area was described as principally native copper. There was little activity until 1898 when the claims were purchased by the Globe Mines Exploration Company, (Ltd.), of London. The following year the ground was acquired by the Ray Copper Mines, (Ltd.), another British Company.

During the first year of its existence the new company founded the town of Kelvin and erected a 250-ton mill there. Ray and Kelvin were connected by a 7 mile narrow gauge railroad, various shops and offices were erected, and a 344 ft. shaft was sunk at Ray. Supplies were transported by steam traction engine 43 miles from Red Rock, the nearest shipping point on the railroad. There was no mining activity between 1901 and 1905.

D. C. Jackling was attracted to the district in 1906. The Ray Copper Co. and Gila Copper Co. were organized to acquire the English Company's holdings; they were merged as the Ray Consolidated Copper Co. in 1910. Other companies to become active in the district in 1906 and 1907 were the Arizona Hercules Copper Mining Co., Kelvin Calumet Mining Co. and Ray Central Mining Co.

The properties of all these Companies were acquired by the Ray Consolidated Copper Co. through the years. A mill was placed in operation at Hayden during 1911 and production started from the mines at Ray. In 1912 a smelter was built by A.S.& R. at Hayden. In 1924 Ray Consolidated Copper acquired the Chino Copper Co. in New Mexico. In 1926 the Nevada Consolidated Copper Co. absorbed the Ray Consolidated holdings and these holdings were later absorbed by Kennecott Copper Corp.

Mining methods underground and metallurgical processes at the mill underwent a slow but constant improvement. The Ray Mines were the first underground operation to produce 8000 tons of ore per day by the block caving method.

There was a brief shut-down of mining operations in 1921. Operations were again shut down during the depression between 1933 and 1937.

In 1938 the first unit of a modern precipitating plant was placed in operation. The plant has now expanded to six units which handle 2000 gallons of solution per minute, from underground workings and waste dumps.

During 1948 it was decided to mine the remaining ore by open pit methods. The Isbell Construction Company stripped waste from the Pearl Handle Pit under contract from 1948 to 1952. First ore was mined by open pit methods in 1950. The capacity of the Mill at Hayden was increased to 15,000 tons a day. A new Crushing Plant was built at Ray to handle the pit ore. Ore from the pit was gradually increased and from the underground mine decreased, until February 1, 1955, when underground mining was discontinued.

To increase recovery of non-sulphide copper in the ore, a Leach-Precipitation-Flotation Plant (L-P-F Plant) has been built at Hayden at a cost of over $5,000.000. This involves a special flotation section for recovery of previously rejected pyrite. This is roasted to produce sponge iron and sulphuric acid. The acid is used to leach the ore in the Mill feed and remove the soluble copper which is then precipitated on the sponge iron and recovered by flotation.

During 1956, work was started on an expansion program to increase production capacity to 22,500 tons of ore a day. A new Smelter is being constructed at Hayden to treat the concentrates which have previously been treated by the American Smelting and Refining Company.

Reference: Ransome - U.S.G.S. Professional Paper #115
1919, 1923

Notes from Mr. Leroy Hoyt

The Ray Orebody

Foreword.

The geology of the area was first described by Ransome in 1919, later revised by him in 1923 in U.S.G.S. Professional Paper #115. It is a wonderful piece of work that still remains essentially correct. Valuable contributions to the Ray geology were later made by Spurr and Cox (private report, July 1909), C. L. Hoyt (private report, 1938) and Otis M. Clarke, (Arizona Geological Society Guidebook, 1952).

In the present work, the constant supervision of Mr. Donald D. Smythe, his continued advice and personal study of the deposit have largely increased our knowledge on the major structures with, as a result, a substantial increase in ore reserves.

The progressive policy observed by Mr. A. P. Morris, General Manager, keeps pace with the geological work by a well-planned and systematic drilling program, well worth mentioning.

Location.

Ray is located at the foothills of the Dripping Spring Mountains on Mineral Creek which flows South into the Gila River.

Geology. 1. Stratigraphy

The Stratigraphic sequence is first reviewed and the most important rocks are here briefly described. The basement consists of the Pinal Schist, old pre-Cambrian in age and contemporary to the Vishu Schist in the Grand Canyon. The formation generally shows a northeast-southwest schistosity, dipping to the NW from 30 to 60 degrees. Many local folds are observed in this formation which is composed of metamorphosed sedimentary rocks, generally showing an alternation of shaly and quartzose layers, and of intrusive rocks like rhyolite and what is locally called "amphibolite-schist".

The color of the Pinal Schist is generally gray with a bluish hue outside of the mineralized area turning naturally into different shades of brown within it.

The Apache group unconformably overlies the Pinal Schist and is also pre-Cambrian. The lower part of it is mainly composed of the Pioneer formation, generally a shale, the Barnes conglomerate, and the Dripping Spring quartzite. These rocks show in the vicinity of Ray a regional trend slightly east of north with a low dip, 10 to 20 degrees eastward.

The Pioneer formation, the Dripping Spring quartzite, and the Pinal Schist are at times quite difficult to differentiate, be it in the field on the surface geology, or in the examination of drill-core.

The tan-colored Mescal limestone is next in the sequence and is often seen in conjunction with dark brown basaltic flows that covered it.

The Troy quartzite, Cambrian in age, follows.

All these formations are abundantly found East of Ray.

The Martin, Escabrosa and Naco limestones of Paleozoic age occur only on the top of the Dripping Spring Range and do not appear near the orebody.

Long before Laramide time, heavy faulting occurred and incompetent rocks such as the Dripping Spring quartzite, were broken and fractured. Diabase was intruded shortly after, lifting the separate masses of quartzite and filling all existing fissures.

A specific fracture trending NNW and SSE with a dip of 45 degrees to the East has been filled with diabase: it is now conspicuously visible in the pit. To the East of Mineral Creek there is considerable diabase, some existing as sills between members of the Apache group and other portions underlying the whole series as an extensive mass. Another series of irregular fractures exhibit the same trend but they occur more vertically; in this group we have the Ray fault and the Mineral Creek fault.

Porphyry next intruded the area. The Teapot Mountain porphyry came first, exhibiting well formed felspar and quartz phenocrysts, and it was followed by the Granite Mountain porphyry. It appears that this latter porphyry forced its way through fractures that trend in an opposite direction to those previously noted;

it is found along a NE-SW trend irregularly intruded but it also shows here and there as small stocks.

One interesting observation is the fact that the Teapot Mountain porphyry occurs North of an East-West line passing approximately through the pit, while the Granite Mountain porphyry definitely shows South of that line. Copper mineralization occurred simultaneously or slightly after the intrusion of the Granite Mountain porphyry.

After a presumably long interval of time, during which erosion and also secondary enrichment occurred, the country was covered by tertiary flows, tuffs, and conglomerates: Whitetail conglomerate, dacite flow, Gila conglomerate, then tuffs and volcanic breccias.

These are the main formations that we encounter in and around the Ray orebody.

2. Structure.

A major fault zone, particularly complex near Ray, extends along Mineral Creek exhibiting a Northwest-Southeast trend. It seems to show an en-echelon pattern with successive downthrows to the East, almost all steep.

The movement along this major fault area has been estimated by Ransome, Cox and Spurr, to amount to 1500 ft. and even 2000 ft. It started before Laramide time with a relative downthrow of the east block, later alternated with an upthrow and finally with a renewed and important downthrow again of the eastern area.

Recent Tertiary movement is well shown by the conspicuous offset observed in the dacite flow: some remnants occur on the Teapot Mountain to the Northwest at 4400 ft. elevation while a larger mass of dacite occurs near town (best seen at the bridge) at 2050 ft. elevation and more. Another obvious indication of this large offset is obtained from a look at the geologic map. It shows a solid area of Pinal schist west of the fault zone without any of the later sediments. This contrasts with later sediments found to the east, ranging from the Cambrian up to the Tertiary.

It is worth mentioning that while the west block has been disturbed relatively little, the eastern one shows a broken assemblage of formations that Ransome justly calls a mosaic. It is fortunate that stratigraphy can partially assist in deciphering this jumble; the Barnes conglomerate is of particular help here as a faithful and conspicuous marker.

The orebody, and particularly its limits, is largely controlled by structural factors. To the west, the West End fault appears definitely to indicate a structural termination. To the north the situation may be similar. The southern limit seems to be indicated by a rather sharp fade-out. Similarly to the east we are inclined to believe in a gradual fade-out beyond the fault zone.

The orebody can thus be represented roughly on a map by an irregular ellipsoid 8000 ft. long and 1500 ft. wide elongated along a direction east-west. This does not mean that this is a solid ore body: for instance, between the old Pearl Handle pit and the West pit the intervening hill, that is now being gradually stripped away, is almost all waste. The west block contains three major coordinate faults almost at right angle. Whenever they cut through the ore body there is no large offset in the latter.

It will be difficult for a long time to determine for certain which are the faults that pre-date or post-date mineralization; most of them probably antidated mineralization then recurrence of movement during and/or after mineralization blurred the whole picture.

Without any doubt the later fault movements have influenced the supergene orebody: for instance, the oxidation zone in the eastern block is much deeper than in the western zone because the water-table has followed the downward movement of that bloc.

A major structure observable in the pit is an over-thrust fault oriented N20W, dipping 15 degrees East. This truncated the main diabase dike, displacing its upper body toward the west; no remnant of the upper body has been found yet as it is probably all eroded. The lower body has been dragged close to the fault and extends irregularly toward the west as an elongated tongue.

The westward displacement along this thrust fault is indicated in section by an offset (known from drill-hole data) of parts of the porphyry mass existing east of the pit. The amount of displacement might amount to a few hundred feet.

3. Mineralization.

The three formations seen in the pit are the diabase, a dark-gray color, the schist ranging from a light pink to a reddish brown and the porphyry often lighter in color.

Hypogene mineralization occurs more conspicuously in the diabase under the form of chalcopyrite and pyrite. The rock is fractured and broken, although fine-grained and dense. It is hard to break, hard to drill and hard to crush; however it crumbles easily by disintegration after a few months of exposure in the air. A hammer blow breaks it along pre-existing fractures and each new blow breaks it along more tiny fractures all of which are mineralized. This mineralization does not extend far away from the fracture, perhaps a tenth or 2 tenths of an inch. It is not truly disseminated therefore, and it could better be called reticulated for example, as E. N. Pennebaker labeled it (verbal communication).

It is difficult to distinguish chalcocite in this dark rock and the amount of supergene enrichment is now well known.

The schist in the pit usually shows chalcocite as copper mineral either as tiny specks or as veinlets. This is understand-

ably secondary because we are still in the supergene zone.

In the schist also, we can detect the same "reticulation" in mineralization as noticed in the diabase.

The porphyry in the pit shows chalcopyrite, pyrite and secondary chalcocite; much of the chalcopyrite and the pyrite have indeed been already replaced.

Gold and silver in minute quantity accompany the copper minerals with some molybdenum.

Native copper has been one of the copper minerals frequently found in the Ray ore zones. Cuprite sometimes under the form of chalcotrichite with its delicate hairlike crystals, is also abundant in places.

4. Alteration.

Little hydrothermal alteration as such seems to have affected the diabase. The schist, on the other hand, exhibits much more alteration although less than at other mines, such as Chino, etc. Sericitization is the main phenomenon and it occurs generally along with mineralization; it is well displayed in the whole western portion of the Pearl Handle Pit. Some silicification mainly along faults also shows at places. It has been repeatedly observed in field specimens from the pit and outside, that a small bleached zone of sericitization occurs on either side of pyrite veins but the phenomenon does not occur along quartz veins.

Another type of alteration connected with thermal metamorphism is seen in the pit west of the diabase: this is the occurrence of larger masses of a siliceous rock quite sericitic, grayish and fine-grained, occasionally still showing remnants of schistosity. It breaks, however, like diabase with a similar occurrence of mineralization, often then having a darker grayish color.

Two such occurrences have been found. One shows in the diabase, near its underface, north of the pit, where it looks more like a stoped mass of schist in the diabase. The other, quite extensive, shows on the west side of the pit below but adjacent to the diabase. The occurrence seems in this case to be more of a transitional type. The color is generally light gray, sometimes whitish gray showing a marked contrast with the dark diabase to the east and the brown reddish schist further west. Thin sections made from this rock showed it to be a sericitized quartzite.

The porphyry, mainly found east of the pit, displays some alteration mainly in the plagioclase felspars. It has a pinkish appearance and shows well-formed biotite books, shiny and well crystallized. Here too, we see that along pyrite veinlets there is a bleached sericitized band on either side. These bands are wider here than in the schist, often 1 or 2 inches wide in total. The color becomes creamy-tan.

To the south of the pit we also find a transitional zone between schist and porphyry this time where the two rock characteristics have been blended together.

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5. Origin of the Ore.

There is much speculation about this question. It appears, however, that one of the small stocks of Granite Mountain porphyry is much more broken and shattered than others; it is located east of the present pit and on the Ray fault within the ore body.

A well shattered porphyry stock in the middle of a heavy fault zone, accompanied by a general rustiness of the rocks in the area, seems a valid criteria for good porphyry copper. The presence of diabase, as is seen in other mines of the vicinity, is an additional favorable factor influencing the orebody.

J. Wertz

(Paper presented at the Spring Meeting AIME, Geology Division, Ray, Arizona on April 12, 1958).

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NEW HAVEN OFFICE, CENTER ST.
DETROIT, MICH. OFFICE, 116 GRISWOLD ST

July 9, 1909.

W. R. Defty, Esq.,

Phoenix, Ariz

Dear Sir:

We enclose herewith copy of a circular recently issued by the Ray Consolidated Copper Company to its shareholders, and also a circular which we have issued on the Gila Copper Company. The holdings of these companies are adjoining properties.

We are able to vouch for the accuracy of the statements contained in the Ray Consolidated circular, a perusal of which furnishes the most convincing testimony that this is destined to become one of the world's biggest producers of the red metal.

The shares of Ray Consolidated are today selling at around $17, and we are strongly of the opinion that about one year hence they will have practically doubled in value, for which reason we strongly advise their purchase.

It is yet too early to discuss with any degree of accuracy along the same lines the Gila Copper, which we believe, however, will render an excellent account of itself. The location of this property would indicate that it will be found to contain an enormous ore tonnage.

We think very well indeed of the shares of the Chino Copper Company and are not hesitating in recommending their purchase around $8, the present selling price. We believe this stock will rise considerably higher during the current year.

We issue a weekly market letter, and if desired will enter your name on our list that it may reach you regularly. We will be glad to advise you from time to time regarding the above or any other mining stocks, their prospects, outlook, etc, while in the event of your entering the market, we should be pleased to be favored with the execution of your orders.

Yours truly,

Hayden, Stone & Co.

SJB-EM

B.