UNITED STATES DEPARTMENT OF THE INTERIOR
Harold L. Ickes, Secretary

BUREAU OF MINES
R. R. Sayers, Director

War Minerals Report 423

SALT CHUCK MINE
KASAAN PENINSULA, PRINCE OF WALES ISLAND
SOUTHEASTERN ALASKA

Copper, Palladium

WASHINGTON: 1945

The War Minerals Reports of the Bureau of Mines are issued by the United States Department of the Interior to give official expression to the conclusions reached on various investigations relating to domestic minerals. These reports are based upon the field work of the Bureau of Mines and upon data made available to the Department from other sources. The primary purpose of these reports is to provide essential information to the war agencies of the United States Government and to assist owners and operators of mining properties in the production of minerals vital to the prosecution of the war.

WAR MINERALS REPORT
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W.M.R. 423 – Copper, Palladium July 1945

SALT CHUCK MINE
Kasaan Peninsula, Prince of Wales Island
Southeastern Alaska

SUMMARY

In August 1943, the Bureau of Mines completed surface and underground sampling and underground core drilling at the Salt Chuck mine at the head of Kasaan Bay, Prince of Wales Island, Southeastern Alaska.

Exploration indicated 44,600 short tons of ore containing 0.61 percent copper, 0.014 ounce gold, 0.11 ounce silver, and 0.017 ounce palladium and platinum per ton, and in addition 44,600 tons of ore of approximately the same grade was inferred.

Beneficiation tests by the Bureau indicated that the ore is amenable to concentration by flotation and that a marketable concentrate containing copper, gold, and palladium can be produced. A mill near the mine could be utilized if extensive alterations and repairs were made.

No further work on this property by the Bureau is proposed at this time.

INTRODUCTION

The Salt Chuck mine, at the head of Kasaan Bay, Prince of Wales Island, Southeastern Alaska, was examined in August 1942 by an engineer[1] of the Bureau of Mines and two geologists[2] of the Federal Geological Survey. Between December 1942 and March 1943, the Geological Survey[3] made an extended study of the mine and prepared surface and underground geologic maps.

A consultant[4] of the Bureau of Mines examined the mine in April 1943.

Surface and underground sampling and underground core drilling conducted by Bureau engineers[5] was completed in August 1943. Representatives[6] of the Geological Survey examined all drill cores and interpreted structural data revealed by the drilling.

1 Robert L. Thorne.
2 John C. Reed and R. N. Goddard.
3 H. R. Gault and Clyde Wahrhaftig.
4 J. G. Shepard.
5 Stephen P. Holt, Andrew W. Tolonen, and Earl L. Fosse.
6 L. A. Warner and C. D. Bressler.

LOCATION AND ACCESSIBILITY

The Salt Chuck mine is at lat. 55° 38' N., long. 132° 33' 30" W., on the east bank of the Salt Chuck, a salt-water inlet at the head of Kasaan Bay, Prince of Wales Island, Southeastern Alaska. The mine is 10-1/2 miles by Forest Service trail northwest of the village of Kasaan and 43 miles northwest by water from Ketchikan. The general location is shown on figure 1.

Kasaan has a store, post office, elementary school, and a cannery. Except when the cannery is operating during the salmon-fishing season in July and August, the community consists of less than 50 persons, mostly native Indians.

Ketchikan, a city of about 6,000 people, is a seaport on the Inside Passage waterway 750 miles north of Seattle. Regular steamer service at frequent intervals is supplied by the Alaska Steamship Co., Northland Transportation Co., Canadian Pacific Railway Co. Steamship Service, and Canadian National Lines.

The ocean freight rate quoted by steamship companies on ore or concentrate from Ketchikan or Kasaan Bay to points on Puget Sound is $4.50 a ton plus longshoring charges for loading and unloading. It is reported that marble and limestone were shipped from Dall Island to Seattle in barges for $0.90 a ton and that copper ore and concentrate were shipped from Salt Chuck to Tacoma in small motor ships for $1.50 a ton, the ships bringing mill, mine, and camp supplies on the return trips. To allow for increased labor and other costs, the figure of $2.50 per ton for freight is used for estimating purposes in this report.

Ketchikan is the best local source for food and mining supplies, lumber and labor.

PHYSICAL FEATURES AND CLIMATE

The mill and camp buildings, which are at sea level along the shore of the Salt Chuck, are about half a mile south of the ore deposit, which is on a wooded knoll at an altitude of 400 feet. Terrain, in the vicinity of the deposit, is low, covered with dense underbrush and partly wooded with spruce and hemlock timber and a little cedar. Some of the timber is suitable for mining purposes.

The climate, typical of Southeastern Alaska, is mild, temperature rarely dropping below 0° F. in winter or rising above 90° F. in summer. Precipitation is reported to average about 150 inches a year, mostly in the form of rain. Snowfall seldom exceeds 6 to 8 inches a year, but during the winter of 1942, said to have been unusually severe, 24 inches of snow was measured at an altitude of 400 feet in December, and temperature remained below 0° F. for 10-day periods.

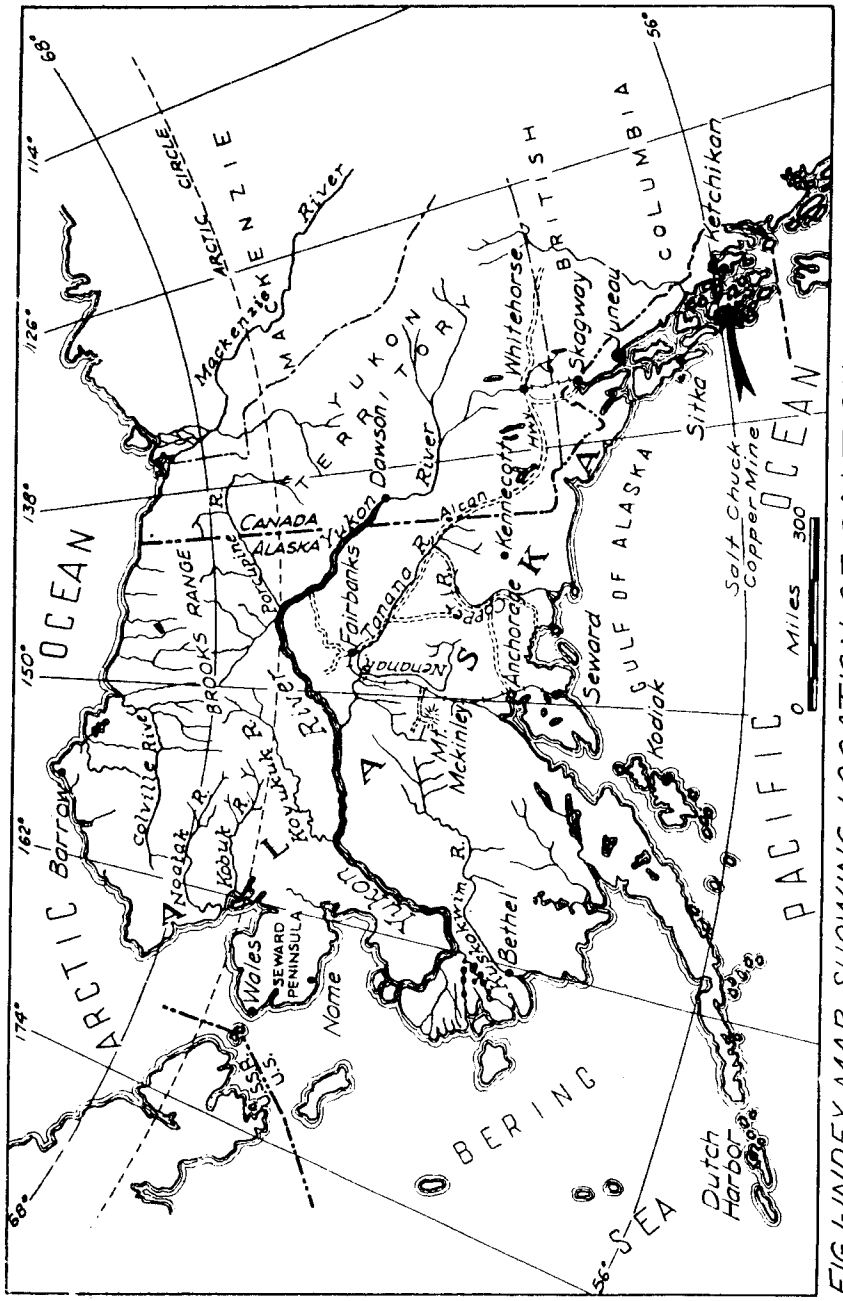

FIG. 1-INDEX MAP, SHOWING LOCATION OF SALT CHUCK COPPER MINE

Mining operations have been conducted at Salt Chuck throughout the year, with men properly housed. Shipping to and from Seattle is feasible throughout the year in vessels moving along the ice-free Inside Passage.

LABOR AND LIVING CONDITIONS

Under peacetime conditions, labor is reported to have been plentiful and wages reasonable. At present (1945) skilled labor is scarce and all wages are high. The hourly wage being paid for common labor is $1.015 an hour; mechanics, miners, and carpenters receive $1.20 to $1.50 an hour for 40 hours weekly, with time-and-a-half for work over 40 hours.

Because of the mild climate, living conditions are good, although the excessive rainfall is trying to men working outdoors.

A cookhouse and residences and cabins sufficient to house a crew of 30 to 40 men are on the property. Some of these buildings are in need of extensive repair, but they can be made serviceable.

HISTORY AND PRODUCTION

The deposit, first known as the Goodro or Joker prospect, was located in 1905 by Charles Goodro, who operated it at intervals from 1905 until 1915, making small shipments of ore during that period. The ore, sorted by hand, is reported to have contained 4 percent copper, 0.15 ounce gold, and 0.15 ounce silver a ton. The presence of palladium in the ore was not known during that period of operation.

J. A. Chilberg bought the property in 1915 and formed the Salt Chuck Mining Co. A mill with a capacity of 30 tons of ore a day was built, and an adit tunnel was driven for 1,200 feet to intersect the ore body 300 feet below its outcrop. In 1923, the capacity of the mill was increased to 130 tons a day.

In 1923, the company was reorganized by Chilberg under the name of Alaska Palladium Mining Co., and the capacity of the mill was increased to 300 tons a day. This company suspended operations in 1926.

The property was then purchased at a marshal's sale by John Koel, of Ketchikan, and optioned in 1929 to the Solar Development Co., a subsidiary of Consolidated Mining & Smelting Co. of Canada, Ltd.

The Solar Development Co. diamond-drilled seven holes, with a total length of 985 feet, from underground locations in the Salt Chuck mine. Results were not encouraging. The Solar Development Co. relinquished its option in 1931.

The present owners of the property, the Alaska Gold & Metals Co., operated the mine from 1934 to 1941, inclusive. From early in 1941 to date (January 1945) it has been idle.

According to the unusually complete records kept from the beginning of mining to the spring of 1941, a total of 326,000 tons of ore containing

6,200,000 pounds copper has been produced from this deposit. Average analysis of the ore was 0.95 percent copper, 0.036 ounce gold, 0.17 ounce silver, and 0.063 ounce palladium per ton.

The latest operating company, Alaska Gold & Metals Co., reported 80,000 tons of ore produced from 1934 to 1941, which yielded 1,356,381 pounds copper, 1,861 ounces gold, 8,756 ounces silver, and 3,115 ounces palladium. Mill recovery was 85 percent copper, 68 percent gold, 72 percent silver, and 65 percent palladium. The ratio of concentration was 45 to 1.

PROPERTY AND OWNERSHIP

The property consists of 23 lode mining claims and 2 mill sites. These claims were surveyed for patent in 1920 by H. P. Crowther, U. S. Deputy Mineral Surveyor, but patent proceedings were not carried to conclusion.

The Alaska Gold & Metals Co., A. L. Howard, president, holds title to the property subject to a mortgage held by John Koel of Ketchikan, Alaska.

ORE DEPOSIT

Gault and Wahrhaftig, of the Federal Geological Survey,[7] describe the ore deposit as follows:

> The ore deposits are in pyroxenite and gabbro, which form part of a large body of intrusive rocks at the upper end of Kasaan Bay.[8] The pyroxenite and gabbro are large irregular masses which have been intruded according to no known pattern, although observed contacts generally dip steeply to the south.
>
> In the mine and the area immediately adjacent to it, the upper surface of the gabbro forms a steeply pitching trough, which is filled with pyroxenite. The walls of the trough are nearly vertical and in places are overturned. Fingers and lobes of gabbro jut into pyroxenite and pyroxenite into gabbro. Southeast of the mine the strike of the gabbro-pyroxenite contact on the surface swings from about N. to about E. The fingers and lobes of pyroxenite are more prominent and the pyroxenite is narrower in the southern part of the ground opened by the mine away from the bottom of the trough. Some evidence indicates that similar structures probably are present elsewhere in the area.
>
> North of the glory hole, across a muskeg area, is a group of knolls and hills underlain by a brecciated porphyry which has been called augite porphyrite.[9] The contact between the

7 Gault, H. R., and Warhaftig, Clyde, the Salt Chuck Copper-Palladium Mine, Prince of Wales Island, Southeastern Alaska: Geological Survey, unpublished report, 1944.

8 Wright, Charles Will, Geology and Ore Deposits of Copper Mountain-Kasaan Peninsula, Alaska: Geological Survey Prof. Paper 87, 1915.

9 Stewart, R. H., Report on the Salt Chuck Mine, Dec. 2, 1921. (Private report furnished by A. L. Howard.)

"augite porphyrite" and the gabbro north of the glory hole is concealed beneath the muskeg. Small basic dikes, probably basalt, and thin, light-colored dikes, possibly aplite, cut the other rocks. Basic dikes are exposed in the western part of the mine at intervals from the surface to the 300 level. These may be parts of a single dike.

A number of faults with small displacements can be traced through the mine. They are 4 inches to 24 inches wide and in the area of the main workings contain, in addition to fault gouge, considerable carbonate and chalcopyrite. These faults appear to fan out northward toward the trough from the narrow part of the pyroxenite body, which fills the gabbro trough in the vicinity of the south end of the main workings. Other small faults and fractures are present throughout the mine, and some contain carbonate veins, aplite, or very thin basic dikes. Wherever observed at the gabbro-pyroxenite contact, the faults displace the contact. Known displacements are small.

The gabbro and pyroxenite appear to be almost contemporaneous differentiates of the same magma. The gabbro seems to be a little younger and to have intruded the pyroxenite.

The principal ore mineral at the Salt Chuck mine is bornite. Small amounts of chalcopyrite are locally associated with bornite. Chalcopyrite is the principal sulphide in the mineralized fault zones. Small flakes of native copper are widespread throughout the mine but are economically unimportant. Chalcocite and covellite have been reported as alteration products,[10] and copper carbonates stain some weathered surfaces and fractures. Associated with the copper sulphides are gold, silver, and palladium in recoverable amounts, as well as a little platinum.

Pyroxenite and gabbro ore are recognized. The pyroxenite ore is massive pyroxenite with unevenly distributed, small to large, irregular grains of bornite. Bornite commonly occurs on fracture surfaces without penetrating far into the pyroxenite.

The gabbro ore is generally of lower grade than the pyroxenite ore, and the sulphide grains are smaller and more evenly distributed through it.

The glory holes and stopes probably represent the general positions and shapes of the oreshoots which have been mined. In detail, the shoots probably were smaller than thus represented and contained barren zones. A number of small patches of ore in stope walls and small pillars represent remnants of these shoots. The oreshoots are more or less pod-shaped, with their longest dimensions pitching steeply southeasterly. The oreshoots seem to become smaller and more irregular in the southern part of the main workings. Descriptions of the ore as it was mined suggest that the ore was richest near the center of each shoot.[11]

Gabbro crops out northwest of glory hole No. 1 (fig. 2). The gabbro there contains disseminated bornite and some chalcopyrite and is known as the north ore body. The ore is

10 Mertie, J. B. Jr., Lode Mining in the Juneau and Ketchikan Districts: Geol. Survey Bull. 714, 1921.

11 Howard, A. L., and Shepard, J. G., personal communications.

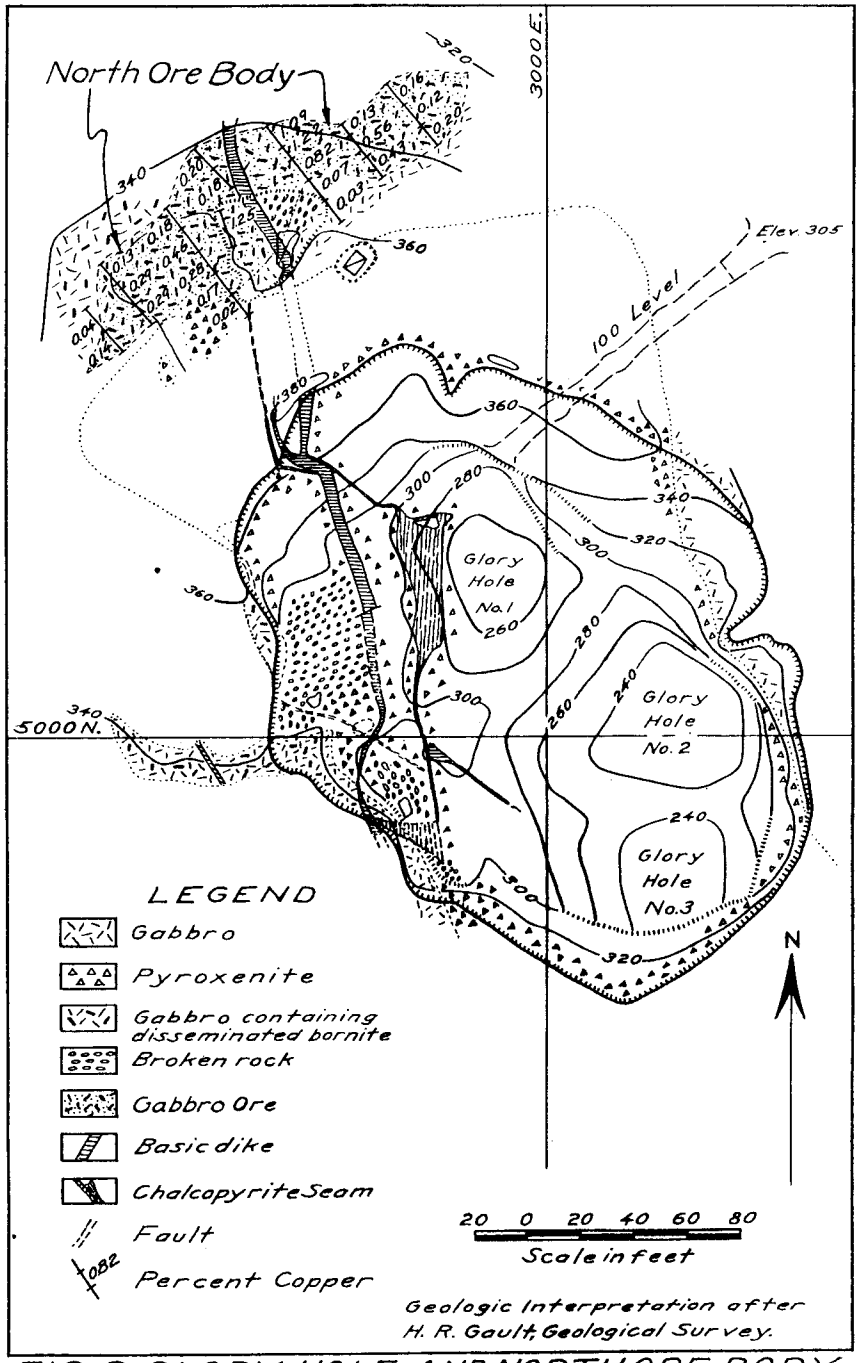

FIG. 2-GLORY HOLE AND NORTH ORE BODY

leaner toward the edges of the outcrop, and barren gabbro is exposed in the ore chute connecting the north ore body with the 200-level. Low-grade ore is exposed in portions of the raise from the 200-level to the surface between the north ore body and the glory hole. Scattered bornite grains are present in otherwise typical gabbro and in the gabbro containing disseminated pyrite near their contact at the north end of the north drift on the 200-level.

The Solar Development Co. drill hole No. 2 cut about 60 feet of ore which apparently is the continuation of the ore between the 300, 313, and 314 drifts, herein called the middle ore body.

The gabbro on the southeast of 311-drift just east of the gabbro-pyroxenite contact, designated the southeast ore body, appears to be the continuation of the gabbro ore on the south side of the 308-stope.

At the south and west end of the glory hole and the old No. 1 stope the gabbro contains disseminated bornite, but the estimated copper content is less than 0.5 percent (fig. 2).

A number of surface outcrops east and west of the mine have been reported to contain bornite, and some of them were examined. South and east of the glory hole, near the gabbro-pyroxenite contact, scattered bornite grains are present in the gabbro. An occasional grain of bornite is present in a ledge of pyroxenite near the two small gabbro areas 400 feet SSE of the glory hole. This pyroxenite ledge is almost directly above the end of the southeast or 311 drift. Several trenches and prospect holes in pyroxenite 400 feet to 600 feet SSE from the glory hole are reported to contain bornite. A few grains of bornite were seen in specimens which presumably came from these trenches. The pyroxenite also contains a little bornite a few hundred feet farther to the east.

Several gabbro outcrops 400 feet to 700 feet west of the glory hole contain scattered grains of bornite, and it occurs also in the pyroxenite area south of Lake Three.

Two small adits about 1,400 feet SW of the glory hole are in gabbro. The upper adit is partly caved but is about 30 feet long and entirely in gabbro. The lower adit is 115 feet long, with two short side drifts and two winzes now filled with water. About 15 feet from the face of the lower adit is a gabbro-pyroxenite contact, which at the surface is a short distance north and uphill from the adit portal. Low-grade gabbro ore is exposed for about 30 feet along the adit walls near the contact.

SAMPLING AND ANALYSIS

During 1930, the Solar Development Co., while it held the property under lease and option, diamond-drilled 7 holes with a total length of 988.5 feet.

In August 1942, an engineer of the Bureau of Mines took a sample across 15 feet of the north (gabbro) ore body at the surface. In December 1942, the Bureau of Mines cut 7 channel samples on the 300 level, at the same time taking a general mill-head sample from ore in mill bins, a sample from concentrate sacked in storage, and a general sample from the tailing pond.

In June and July 1943, the Bureau of Mines diamond-drilled 13 holes for a total length of 1,553.5 feet from underground stations on the 200 and 300 levels of the Salt Chuck mine.

Sludge from core drilling was carefully collected, dried, split, and analyzed by the Territorial Assay Office at Ketchikan, Alaska. Cores were split and analyzed by a private concern in the States.

The analyses for copper of sludge and core samples from holes drilled by the Bureau of Mines were adjusted by the Longyear method. Method of adjustment, if any, of analyses shown for solar development (S. D.) holes is not known. It is probable that the results shown for those holes are for cores only.

Cores from Bureau of Mines drill holes were composited, and composite samples were analyzed for copper, gold, silver, and platinum-group metals.

The so-called "north ore body" was sampled by means of channel samples cut 2 by 4 inches in cross section. Twenty-three samples with a total length of 222 feet were cut from the outcrop of this deposit. The result of analyses of these samples are shown on figure 2.

Two short adits 1,400 feet southwest of the glory hole had been driven to develop an outcrop of gabbro containing disseminated bornite. Four channel samples 2 by 4 inches in cross section, with a total length of 34 feet, were cut along the east wall of the lower of these adits. Average analyses of the three ore bodies and weighted average of all ore is as follows:

Ore body	Copper, percent	Gold, oz/ton	Silver, oz/ton	Platinum group, oz/ton
North	0.452	0.01	0.08	0.02
Middle	.946	.024	.269	.015
Southeast	1.043	.025	.130	.005
Weighted average, all ore	0.61	0.014	0.11	0.017

Because of the low content of the platinum-group metals in the samples analyzed, accurate determinations could not be made of the relative percentages of palladium and platinum, but previous experience of the operating company, as given by A. L. Howard, manager, was that the palladium-platinum ratio in the ore was generally about 10 to 1. [12]

ORE RESERVES

Considering the 300,000-ton production of this mine, present ore reserves are very small. There is no measured ore reserve. Indicated ore is estimated as follows:

12 Howard, A. L., The Salt Chuck Mine, Kasaan Bay, Prince of Wales Island, Alaska: Unpublished report, Jan. 7, 1935.

Ore body	Tons
North	31,840
Central	5,660
Southeast	7,075
	44,575

Inferred ore reserves may be considered equal to the indicated ore; therefore the total inferred ore is estimated at 44,600 tons. Total indicated and inferred ore is 89,200 tons. The grade of indicated ore is estimated as 0.61 percent copper, 0.014 ounce gold a ton, 0.11 ounce silver a ton, and 0.017 ounce platinum metals a ton.

DEVELOPMENT

Mine development is described by Gault and Wahrhaftig[13] as follows:

> The mine consists principally of three levels and a large glory hole which narrows downward into three smaller glory holes and the old No. 1 stope. The levels and glory holes are connected by numerous raises, ore chutes, and stopes. The 300 or lowest level is about 105 feet above high tide. The portal is approximately 1,300 feet from the mill ore bins, and the main or 300 drift is 1,380 feet long.
>
> The west drift is turned westerly from the 300 drift at 1,000 feet from the portal, and the 315 and 316 drifts are at 1,150 feet. Another drift turned easterly from the 300 drift, 1,050 feet from the portal and rejoins the 300 drift about 1,160 feet from the portal. From this easterly drift, the 311 or southeast drift and the 312, 313, and 314 drifts extend easterly and southerly.
>
> The 200 level is 110 feet above the 300 level and includes remnants of several drifts around the small glory holes as well as a north drift, a west drift, and a drift along the east side of the mine. The 200 level is connected with the 300 level by a raise from the 314 drift, which opens into the 200 level on the east side. The 200 level is connected with the surface by a raise from a point near the north end of glory hole No. 1 and reaches the surface between the glory hole and the stripped area on the north ore body.
>
> A "corkscrew" raise from the 311 drift enters the 308 stope on the south side, and a short raise at the northeast corner of the 308 stope leads to the southeast end of the 200 level. From this point on, the 200 level, an almost vertical raise, reaches the surface on the southeast side of the glory hole. This raise was not examined during the Geological Survey examination.
>
> A third raise from the 300 level, at the intersection of the 300 and 314 drifts, opens into a small grizzly chamber, which connects with the stope directly below glory hole No. 1. Two ore chutes, one emptying into this stope and the other into the grizzly chamber, connect with the 201 stope. Several openings and old ore chutes connect the 201 stope with the old No. 1 stope. An ore chute and another opening at the east end of the 201 stope lead to the 308 stope.

13 See footnote 7.

> A fourth raise from the 300 level connects the 313 drift with two small stopes below the 308 stope and with the No. 5 stope. The No. 4 and No. 5 stopes are inaccessible but are directly below glory holes No. 2 and No. 3, respectively. A raise and an ore chute, now filled with broken rock, connect the hole No. 1 stope on the 100 level with the 200 level in the vicinity of the stope under glory hole No. 1.
>
> The 100 level is 90 feet above the 200 level. All that remains of this level is a 120-foot adit from the surface to the northeast wall of glory hole No. 1 across the glory hole from the old 100-level stope (No. 1 stope). An ore chute from the north ore body passes under the raise between the 200 level and the surface and empties onto a grizzly on the west side of the 200 level below glory hole No. 1.
>
> The positions of inaccessible drifts and stopes have been inferred from sections and maps by Lane[14] and from information gathered during the present examination.

Workings are in fair to good condition. Track and air lines on 300 level were repaired where necessary and used during the core-drilling program of the Bureau of Mines in July 1943. The air line to the 200 level also was repaired and used at that time.

Timbering, mostly around chutes and raises, was nearly all standing in July 1943 but would have to be replaced before the mine could be operated again.

The rock is hard and stands well, so that very little timbering is needed to support ground. Several faults, generally small, with 4 to 24 inches of gouge, were noted in the glory hole and stopes. A larger fault at the end of the west drift on the 300 level strikes easterly and is probably the same as that cut by the 300 main adit at the collar of drill hole SD 2 and in drill hole US 11. This fault has 10 feet of gouge and breccia, but the ground is firm and requires no timbering.

The mine is wet, water coming mostly from the heavy rainfall, which seeps down from the glory hole and other workings open to surface. No large open water courses were noted in the mine, and only a small amount of water flows from drill holes. Trouble from water is not to be expected if winzes are sunk short distances below the 300 level, although pumps will have to be provided to take care of normal flows.

EQUIPMENT

Power-plant equipment consists of 5 semi-Diesel and full-Diesel engines having a total capacity of 635 horsepower. Of this total, 220 horsepower is electrically connected and the remainder is belted to ball mills and flotation units. A Pelton wheel, driven by water from Goodro Lake under 180-foot head, develops 60 horsepower for about 9 months each year.

14 Lane, T. P., Private maps and sections furnished the Geological Survey by the Bureau of Mines. Maps and sections dated 1925.

Diesel-oil storage is provided by four steel tanks with a total capacity of 16,000 gallons. There are two air compressors - one a single-stage, class E. R. 1, size 14 by 12 inches and the other a converted steam compressor of similar size and type. Both of these have been belted to Pelton wheels, and one of them is so set that, by a change of the belt, it can be driven by an electric motor.

Ore was transported from the 300 level of the mine in eleven 40-cubic foot, gable-bottom, side-dumping ore cars plus a number of smaller cars. Haulage was by a Mancha storage-battery locomotive of 4-1/2-ton capacity. Transportation to the mill was completed by 1,200 feet of surface tram.

A blacksmith shop near the portal of the 300-level adit contains a forge, drill sharpener, and all necessary hand tools. Drifter, stoper, and jackhammer drills, though in fair to good condition, are mostly obsolete types.

Other shop equipment, including a blacksmith forge, lathe, and drill press, are set up in the mill building.

There is a small but well-equipped assay office. Sample crusher and pulverizer are set up in the mill. Much of the assay equipment, especially the furnaces and glassware, are now in poor condition. Milling equipment includes:

1 7-foot by 36-inch Hardinge ball mill.
1 8-foot by 48-inch Hardinge ball mill.
3 Wilfley sand pumps.
2 3-inch Krogh sand pumps.
1 4-inch Krogh sand pump.
6 K. & K. flotation machines.
1 15- by 7-foot Dorr thickener.
1 9- by 15-inch Blake-type jaw crusher.
1 Symons disk crusher.
1 14- by 55-inch Traylor gyratory crusher.
3 Allen sand cones.
Conveying, feeding, and screening equipment.
Mill buildings in fair condition adequate to house above equipment.

Most of the power-plant and mill machinery is in fair to good condition, except such articles as rubber hose and belting, which must be replaced before the mill can be operated. The Blake crusher is broken and too small for the job. The flotation machines are obsolete. A new Britannia-type, deep-column, flotation machine, nearly completed, was intended to replace the three old K. & K. machines.

Camp buildings include cook house, several dwellings, superintendent's residence, office building, warehouse, and about 15 cabins. Nearly all of these are usable but require extensive repairs.

RESULTS OF ORE TESTING BY BUREAU OF MINES

During the investigation of the Salt Chuck mine herein reported, it became apparent that additional information on the factors controlling successful concentration of the ore to marketable products was desirable.

Accordingly, one sample of mine ore and four samples of mill tailing were obtained and shipped to the Bureau of Mines laboratory at Rolla, Mo., for testing.

Mine Ore

The mine ore consisted of magnetite, bornite, sparing amounts of chalcopyrite and malachite, and a very small amount of pyrite in a pyroxenite gangue.

The bornite and chalcopyrite were fairly well-liberated by 48-mesh grinding. Considerable magnetite was locked at 65-mesh and some at 100-mesh, but very little remained locked at 150-mesh.

The pyroxenite gangue of the mine ore and mill tailing consisted of augite, talc, biotite, epidote, calcite, and fine veinlets of quartz.

Vanadium, which was detected chemically in both the mine ore and the mill tailing, was concentrated in the magnetite, but the vanadium mineral was not identified. Analysis of the mine ore sample is 0.68 percent Cu, 8.6 percent Fe, and 0.06 percent V_2O_5.

No gold, platinum, or palladium was detected spectroscopically in the samples, but a trace of silver was found. Fire-assay fusions were made on the mine ore and later on the composite mill tailing. Silver was inquarted in the charges, but the gold was not determined. The dore beads were analyzed spectrographically; a trace of platinum and a high palladium content were noted. The spectrographic analysis, however, does not indicate a high amount of palladium, as it was not noted in a spectrographic analysis of the ore or tailing.

The treatment procedure involved tests on the flotation of the copper minerals and magnetic separation of the iron minerals.

A portion of the ore was crushed to minus 10-mesh in a jaw crusher and rolls. A charge of minus 10-mesh ore was stage-ground in a pebble mill to minus 80-mesh. The pulp density was adjusted to 25 percent with grind water, and the charge was conditioned and floated in a mechanical-type subaerated flotation cell. The rougher concentrate was cleaned twice. Zeolite-softened water was used for grinding and flotation.

The flotation tailing was treated in a Davis tube to remove the magnetite. One ampere of current was used for 15 minutes. The combined results of flotation and magnetic separation were as follows:

Flotation and magnetic-separation results

Product	Weight, percent	Analysis, percent						Percent of total	
		Cu	Fe	V_2O_5	Insol.	P	S	Cu	Fe
Copper concentrate	1.21	45.7	9.3	*0.05	-	-	-	83.8	1.3
Copper middling. .	2.44	1.79	8.8	*.05	-	-	-	6.6	2.6
Copper tailing:									
Magnetic portion .	8.50	.02	61.7	.52	9.4	0.036	0.03	.3	62.6
Nonmagnetic portion	87.85	.07	3.2	*.05	-	.078	.10	9.3	33.5
Calculated head. .	100.00	0.66	8.4	-	-	-	-	100.0	100.0

* Less than.

Flotation operating data

Reagents	Pounds per ton of ore			
			Cleaner	
	Conditioner	Rougher	1	2
Potassium amyl xanthate	0.175	-	-	-
Methyl amyl alcohol . . .	.08	-	-	-
pH	-	7.9	-	-
Time, minutes	3	8	4	3

The iron in the nonmagnetic portion was largely in the ferromagnesian minerals.

Spectrographic analyses of the copper concentrate and the magnetic and the nonmagnetic portions of the tailing were made for silver, platinum, and palladium. The results were as follows:

Product	Ag	Pt	Pd
Copper concentrate	Low	Negative	Trace
Magnetic portion	Negative	Negative	Negative
Nonmagnetic portion.	Negative	Negative	Negative

This shows a silver and palladium concentration in the copper concentrate.

Using the same treatment procedure but grinding to minus 65-mesh recovered a copper concentrate containing 50.7 percent, an iron concentrate containing 62.7 percent, and a reject containing 0.08 percent copper and 3.4 percent iron. Thus, the 65-mesh grind gave slightly lower recoveries of copper and iron but slightly higher-grade copper and iron concentrates. The results of the tests suggest the flow sheet shown as figure 3.

A supplemental test was made to study the possibility of preparing an iron product suitable for the production of sponge iron by magnetic concentration.

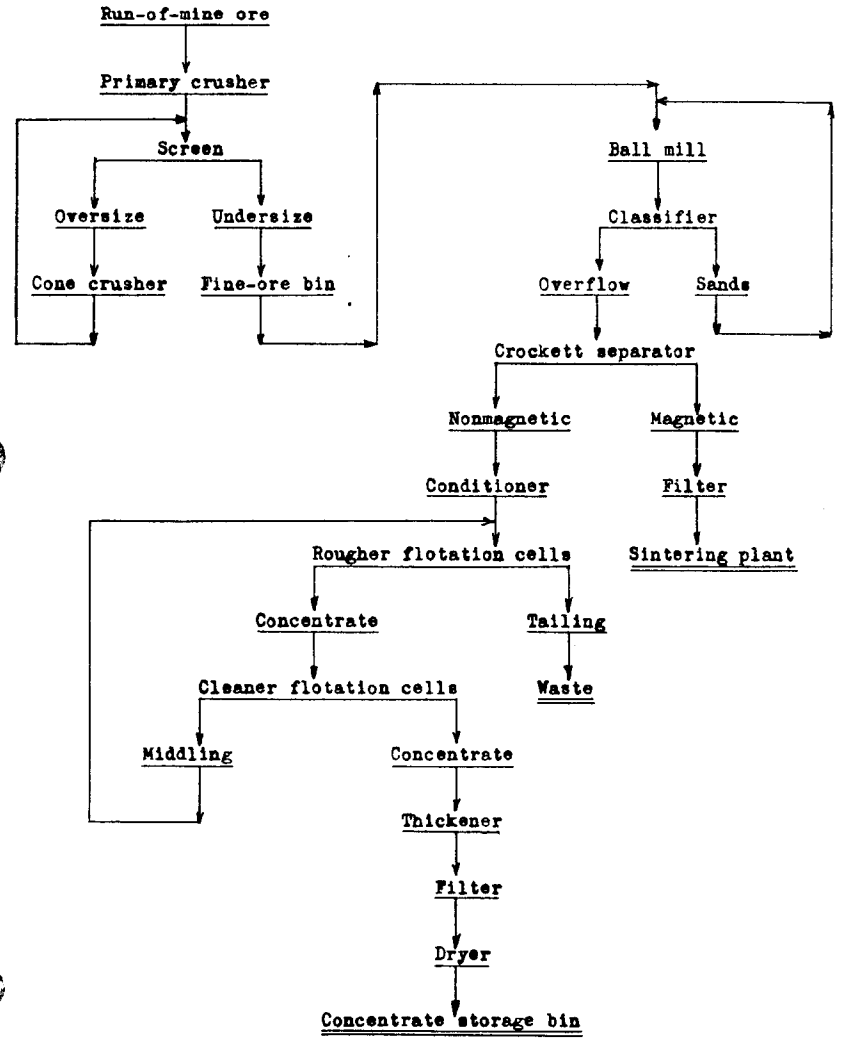

Figure 3. - Suggested flow sheet for Salt Chuck mine ore

The sample was ground to minus 200-mesh, which is the size necessary for liberation of the iron. The copper was floated from the mine ore previous to magnetic separation. The results of the tests are as follows:

Magnetic concentration of mine ore (flotation tailing)

Product	Weight, percent	Analysis, percent			Percent of total	
		Fe	Insol.	SiO_2	Fe	Insol.
Magnetic	7.32	68.7	4.2	1.14	60.1	0.4
Nonmagnetic	92.68	3.6	73.5	-	39.9	99.6
Heads, calculated.	100.00	8.4	68.4	-	100.0	100.0
Heads, analyzed.	-	8.6	-	-	-	-

The grade of the magnetic portions was improved by 200-mesh grinding, but open-hearth sponge-iron specifications as to insoluble were not met. Iron recoveries also were lower.

Mill Tailing

Four mill-tailing samples were obtained for metallurgical testing. The samples were analyzed separately and composited for metallurgical testing. Analysis of each sample and the composite are as follows:

Analysis, percent

Tailing sample	Cu	Fe	V_2O_5
No. 1	0.13	9.1	*0.05
No. 2	.20	8.3	*.05
No. 3	.08	9.1	*.05
No. 4	.10	9.0	*.05
Composite	.13	8.9	*.05

* Less than.

The mill tailing has been treated by flotation for the recovery of copper and was largely minus 35-mesh. Mineralogically, the composite tailing and the mine ore were the same. Most of the bornite remaining in the tailing was partly coated with malachite, and much of the residual chalcopyrite was locked with gangue. Locking of the magnetite was noted in sizes as coarse as 65-mesh.

Equal weights of the mill-tailing samples were composited for magnetic separation tests. The material, as received, was treated in a Davis tube to remove the magnetite. The product so separated contained only 56.8 percent iron. Microscopic examination of the magnetic portion showed that much gangue was locked with the magnetite at this size (approximately 35-mesh).

Another portion of the composite tailing was stage-ground wet in a pebble mill to minus 65-mesh and separated in a Davis tube by 2 amperes of current for 5 minutes, followed by 1 ampere for 10 minutes. The vanadium concentrated in the magnetic portion. Most of the iron in the nonmagnetic portion was in the form of ferromagnesian minerals. A little recoverable copper was released by the grinding. Results were as follows:

Magnetic separations results

Product	Weight, percent	Analysis, percent						Percent of total		
		Fe	Insol.	P	S	Cu	V_2O_5	Fe	Insol.	P
Magnetic portion.	10.0	66.0	5.5	0.028	*0.05	*0.05	0.56	74.6	0.7	2.6
Nonmagnetic portion.	90.0	2.5	82.1	.115	.08	.13	*.05	25.4	99.3	97.4
Calculated feed	100.0	8.8	74.4	0.106	-	-	-	100.0	100.0	100.0

* Less than.

Supplemental tests to study the possibility of preparing a product suitable for the production of sponge iron were undertaken on the mill tailing as they were on the mine ore previously described. The sample was ground to minus 200-mesh, which was the size necessary for liberation of the iron. The results of the magnetic-concentration tests are as follows:

Magnetic concentration of mill tailing

Product	Weight, percent	Analysis, percent			Percent of total	
		Fe	Insol.	SiO_2	Fe	Insol.
Magnetic	9.18	67.3	4.3	1.60	69.4	0.5
Nonmagnetic	90.82	3.0	81.3	-	30.6	99.5
Heads, calculated.	100.00	8.9	74.2	-	100.0	100.0
Heads, analyzed.	-	8.9	-	-	-	-

CONCLUSIONS

Surface and underground sampling, together with core drilling done by the Bureau of Mines, showed 44,600 tons of indicated ore with an average content of 0.61 percent copper, 0.014 ounce gold, 0.11 ounce silver, and 0.017 ounce palladium and platinum per ton. In addition, it is estimated that there is 44,600 tons of inferred ore of approximately the same grade.

Of three ore bodies examined, the north or gabbro ore body was shown to be low in grade and was not proved to extend below the 200 level. The middle and southeast ore bodies were shown to continue beneath the 300 level. They offer interesting possibilities for exploration by driving winzes in ore down from the 300 level.

As a result of ore-testing studies made in the Bureau of Mines laboratories on mine ore and mill tailings from the Salt Chuck mine, it has been determined that a high-grade copper concentrate and an acceptable iron concentrate may be recovered from the mine ore. Silver and palladium may be concentrated with the copper and vanadium concentrated with a magnetic portion of the iron.

A high-grade iron product was magnetically separated from a composited mill-tailing sample. Vanadium was also concentrated in the iron product.

No further work on this property by the Bureau of Mines is proposed at this time.

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