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GEOLOGICAL SURVEY

WASHINGTON

THE SALT CHUCK COPPER-PALLADIUM MINE, PRINCE OF WALES ISLAND, SOUTHEASTERN ALASKA

By

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INTRODUCTION

The Salt Chuck copper-palladium mine is on a salt-water lagoon at the head of Kasaan Bay, Prince of Wales Island, southeastern Alaska, about 43 miles by water northwest of Ketchikan (see fig. 1). The lagoon, known as the Salt Chuck, opens into Kasaan Bay through a very narrow channel and can be entered by small boats and barges from an hour or so before until an hour or so after high tide. Steamers can operate to within about 5 miles of the entrance to the Salt Chuck. The lagoon is deep enough in some places for small boats to remain in it at low tide.

The property includes a large number of claims and two millsites, all unpatented, which extend north from the shore at high tide. A mill is located at the head of the lagoon and the mine is about half a mile north of the mill on a knoll nearly 400 feet above tide water. Power for the mill is generated partly by water and partly by Diesel engine. The mill has not been operated since early in 1941, but it is understood that with some improvements, it can be put in operating condition.

Timber suitable for general mine and camp use is available near the mine.

Short descriptions of the Salt Chuck mine are given by the Wrights 1/, Knopf 2/, Wright 3/, Campbell 4/ and Mertie 5/. In 1930 the Solar Development Company examined the property and put in seven diamond-drill holes.

During the winter of 1942-43, H. R. Gault and Clyde Wahrhaftig made a 3½-month examination of the mine, mapping the accessible mine openings, the geology of the mine and vicinity, and studying the cores from the Solar Development Company's drill holes. A preliminary report 6/ was prepared for Federal War Agencies.

1/ Wright, F. E., and Wright, C. W., The Ketchikan and Wrangell mining districts, Alaska: U. S. Geol. Survey Bull. 347, pp. 125-126, 1908

2/ Knopf, Adolph, Mining in southeastern Alaska, 1910: U. S. Geol. Survey Bull. 480, p. 101, 1911.

3/ Wright, C. W., Geology and ore deposits of Copper Mountain and Kasaan Peninsula: U. S. Geol. Survey Prof. Paper 87, p. 99, 1915.

4/ Campbell, D. G., Palladium in Alaska lode deposits: Min. and Sci. Press, vol. 119, pp. 520-522, 1919.

5/ Mertie, J. B., Jr., Lode mining in the Nuneau and Ketchikan districts: U. S. Geol. Survey Bull. 714, pp. 121-127, 1921.

6/ Gault, H. R., and Wahrhaftig, Clyde, The Salt Chuck copper-palladium mine, Prince of Wales Island, southeastern Alaska, War Minerals Report for Federal War Agencies. (restricted, June 1943).

In the summer of 1943, the Bureau of Mines carried on an exploration program at the Salt Chuck mine which included the diamond-drilling of 13 holes. C. T. Bressler was assigned as the Geological Survey representative to cooperate with the Bureau of Mines during its drilling program.

This report summarizes the results of the Geological Survey's 3½-month field investigation and the geological interpretations of the diamond-drilling done by the Solar Development Company and by the Bureau of Mines.

MINE DESCRIPTION

The mine openings consist principally of three levels and a large glory hole which narrows downward into smaller glory holes and the No. 1 stope (see figs. 2 to 5). The levels and glory holes are connected by numerous raises, ore chutes, and stopes. The portal of the lowest, or 300, level (see fig. 5) is about 100 feet above high tide and approximately 1,300 feet from the mill ore-bins. The main drift of the 300 level is 1,380 feet long. The west drift of the 300 level is turned west at 1,000 feet from the portal, and the 315 and 316 drifts are turned west at 1,150 feet. Another drift is turned east 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 east and south.

The 200 level (see fig. 4) 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 directly with the 300 level by a raise from the 314 drift which opens into the 200 level on the east side. The

200 and 300 levels are also connected by a corkscrew raise from the 311 drift which enters the 308 stope on the south side, and a short raise at the northeast corner of the 308 stope which leads to the southeast end of the 200 level. The 200 level is connected with the surface by a raise starting from a point near the raise from the northeast corner of the 300 stope. This raise from the 200 level to the surface is almost vertical and was not examined. Another raise starts from near the south end of the north drift of the 200 level and reaches the surface between the glory hole and the stripped area on the north ore body.

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. The ore chute which empties into the stope below glory hole No. 1 is connected with the 200 level by a short winze from the west drift of the 200 level. Several openings and old ore chutes connect the 201 stope with the No. 1 stope. An ore chute and another opening at the east end of the 201 stope lead to the 308 stope.

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 under glory holes No. 2 and No. 3 respectively. A raise and an ore chute, now filled with broken rock, connect the No. 1 stope at the 100 level with the 200 level near the northwest side of the stope under glory hole No. 1.

The 100 level is 90 feet above the 200 level. All that remains of the workings on the 100 level is a 120-foot tunnel extending from the surface to the northeast wall of glory hole No. 1, the wall opposite stope No. 1.

An ore chute from the north ore body passes under the raise between the 200 level and the surface and empties into a girzzly on the north side of the 200 level below glory hole No. 1.

HISTORY AND PRODUCTION

The Salt Chuck mine, originally called the Goodro mine and also known as the Joker group, 7/ has been operated intermittently since about 1907. The mine was first operated by the Goodro Mining Company at intervals from 1907 to 1916. In 1918 the ownership changed, and the mine was operated until 1920 by the Salt Chuck Mining Company. From 1924 to 1926 the property was operated by the Alaska Palladium Company under the direction of J. E. Chilberg. Since 1935 the Salt Chuck mine has been controlled by the Alaska Gold and Metals Company under the direction of A. L. Howard. The mine was operated intermittently from 1935 to 1941. Since 1941 no ore has been mined.

7/ Wright, F. E. and Wright, C. W., op. cit.

The property was first developed by open cuts and a glory hole. Later a crosscut 90 feet below the surface (100 level) was driven to handle ore from the glory hole. From the 100 level, a 100-foot winze was sunk and drifts were driven from the bottom of the winze (200 level). By 1919 the long 300 drift was completed and since then has been used as the haulage-way.

Total production to 1941, estimated from incomplete records, has been slightly more than 300,000 tons of milling ore. The greater part of the production has been from pyroxenite ore. The first shipment of ore is reported to have been made in 1907. From 1907 until 1918 about 10,000 tons of ore were shipped 8/. Palladium was not known to occur in the ore until early in 1918 8/.

The approximate average tenor of ore produced, estimated from production records available to the Geological Survey is: copper, 0.9 percent; gold, 0.025 ounce per ton; silver, 0.12 ounce per ton; and palladium, 0.053 ounce per ton. The amount of platinum recovered is negligible. The tenor of the early shipments of ore, estimated from records available to the Geological Survey is: copper, 4.0 percent; gold, 0.10 ounce per ton; and silver, 0.60 ounce per ton. Mr. A. L. Howard, present operator of the mine, reports that the pyroxenite ore that has been mined averages 0.94 percent of copper, 0.04 ounce of gold per ton, 0.15 ounce of silver per ton, and 0.065 ounce of palladium per ton. The precious metal recovery has averaged about 67 percent according to Mr. Howard. In 1935 additional recoveries of copper and the precious metals were made by re-treating some of the old tailings.

GEOLOGY

The ore deposits are in pyroxenite and gabbro which form part of a large body of instrusive rocks at the head of Kasaan Bay 9/. The pyroxenite and gabbro are large irregular masses (see fig. 1).

In the mine and the area immediately adjacent to it, the upper surface of the gabbro forms a steep southeast 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

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8/ Campbell, D. G., op. cit.

9/ Wright, C. W., op. cit. pl. XV.

pyroxenite and pyroxenite lobes jut into gabbro. Such projections of pyroxenite and gabbro are more abundant and the trough is narrower away from its bottom in the southern part of the ground opened by the mine near the start of the 311 drift. In this part of the mine gabbroic pyroxenite rock and alternating zones of gabbro and pyroxenite 1 foot to 5 feet thick occur between massive pyroxenite and massive gabbro so that the location of the boundary as shown on figure 5 is approximate. In general, elsewhere in the mine, the boundary between gabbro and pyroxenite is placed within a zone not more than 1 foot wide.

The portal of the 300 level tunnel is in gabbro. At about 40 feet in from the portal pyroxenite is exposed and the 300 drift continues in pyroxenite for 620 feet to a point where gabbro is again exposed. This gabbro is part of the same gabbro body as that at the southern limit of the 300 drift shown in figure 5.

North of the glory hole, across a muskeg area (see fig. 1), is a group of knolls and hills underlain by greenstone. Greenstone also crops out near the north and east sides of the lake east of the glory hole. The contact of the greenstone and gabbro is concealed.

Small fine-grained basaltic dikes, 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.

The pyroxenite is dark green and coarse grained and contains a pyroxene, probably augite, as the principal constituent. The pyroxenite also contains minor amounts of feldspar. Magnetite is a common accessory mineral, locally making up almost 10 percent of the rock. Chlorite and epidote are common alteration minerals in the pyroxenite. The typical gabbro is dark gray and coarse-grained, containing feldspar and pyroxene in about equal proportions. The gabbroic pyroxenite contains more feldspar than the normal pyroxenite, but less than the typical gabbro. South and west of the glory hole, the gabbro apparently grades into a lighter and finer-grained rock which for the purpose of mapping is called diorite (see fig. 1). An altered gabbro, lighter colored than the typical gabbro, and containing appreciable amounts of pyrite, is exposed in the northern 140 feet of the 300 drift, at the north end of the north drift on the 200 level, and in several drill holes (see fig. 6).

The greenstone is a fine-grained dark green or brown rock locally containing phenocrysts of augite and fragments of porphry. Throughout the mine and vicinity are bodies of altered pyroxenite and gabbro, and gabbro and pyroxenite pegmatite.

Many faults with small displacements can be traced through the mine. Some of these faults are 4 inches to 24 inches thick and in the area of the mine workings contain considerable carbonate and chalcopyrite in addition to fault gouge.

These faults appear to fan out northwestward 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 many fractures are present throughout the mine and some contain carbonate veins, aplite or very thin basic dikes. All faults that cut the gabbro-pyroxenite contact displace it for short distances.

The gabbro and pyroxenite appear to be almost contemporaneous differentiates of the same magma. The gabbro is considered to be slightly younger and to have intruded the pyroxenite.

ORE DEPOSITS

General statement

The principal ore mineral at the Salt Chuck mine is bornite. Small amounts of chalcopyrite are locally associated with the bornite. Chalcopyrite is the principal sulfide mineral in the ineralized fault zones. Small flakes of native copper are widespread throughout the mines but are too few to be economically important. Chalcocite and covellite have been reported as alteration products, 10/ and copper carbonates stain some weathered surfaces and fractures. Associated with the copper sulfides are recoverable amounts of gold, silver and palladium, as well as a little platinum.

Pyroxenite ore and gabbro ore are recognized. In the higher-grade pyroxenite ore the rock is cut by many small fractures extending in all directions, some of which are slickensided but show little displacement. The bornite is irregularly distributed as disseminated grains and patches along the fractures and in the rock between the fractures. In the lower-grade pyroxenite ore the rock is more massive and the 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 sulfide minerals are finer grained and more uniformly distributed through it. The gabbro ore is less fractured than the proxenite ore, and the sulfide minerals are not restricted to fracture surfaces.

The drill holes and the mine exposures indicate that the bornite within the ore bodies is very irregularly distributed. The ore is in small shoots randomly arranged in the ore bodies with lean and barren rock between them.

The glory holes and stopes (see figs. 2, 3 and 4) probably represent the general positions and shapes of the ore bodies which have been mined. In detail the ore bodies probably were smaller than these openings suggest and contained ore shoots and barren zones. Several small patches of ore in stope walls and small pillars represent remnants of these shoots.

10/ Knopf, Adolph, op. cit.

The ore bodies were more or less pod-shaped, generally with their longest dimensions pitching steeply southeastward. The ore bodies are smaller and more irregular in the southern part of the main workings. Descriptions of the ore which has been mined suggest that the ore was richest near the center of each shoot.

North ore body

The gabbro that crops out northwest of glory hole No. 1 (see fig. 3) contains disseminated bornite and some chalcopyrite and is known as the north ore body. The ore is 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 leading to the surface between the north ore body and the glory hole from the 200 level. The downward continuation of the gabbro of the north ore body is exposed in the north drift of the 200 level. Bornite occurs as scattered grains in the otherwise typical gabbro and in gabbro containing disseminated pyrite only near their contact at the north end of this drift. Normal gabbro and gabbro containing pyrite are also exposed in the northern part of the 300 drift below the north ore body but no bornite is recognized there. These exposures on the 200 and 300 levels suggest that the north ore body extends only to about the 200 level.

Middle ore body

The ore exposed between the 300, 313, and 314 drifts (see fig. 5) here called the middle ore body, apparently is the continuation of the ore mined from stopes No. 3 and No. 4.

Southeast ore body

The gabbro ore in the southeast or 311 drift just east of the pyroxenite-gabbro contact (see fig. 5) designated as the southeast ore body, appears to be the continuation of the gabbro ore exposed on the south side of the 308 stope.

Other bornite occurrences

At the southwest end of the glory hole (see fig. 3), in parts of the No. 1 stope and in a raise in the roof of the 201 stope at its west end, bornite is disseminated through the gabbro. The pyroxenite at the upper end of the ore chute connecting the west end of the 201 stope with the No. 1 stope (see fig. 2) also contains scattered bornite grains. These bornite occurrences are near the contact and may represent lean portions of the ore body mined out in the western part of the 201 stope.

A number of outcrops east and west of the mine have been reported to contain bornite but not all of them were examined (see fig. 1) because of lack of time. South and east of the glory hole near the gabbro-pyroxenite contact, scattered bornite grains are present in the gabbro. Sparse grains of bornite are present in a ledge of pyroxenite near the two small gabbro areas 400 feet S.55°E. of the glory hole (see fig. 1). This pyroxenite ledge is almost directly above the end of the southeast or 311 drift (see figs. 2 and 5). Several trenches and prospect holes in pyroxenite 400 feet to 600 feet S.65°E. from the glory hole are reported to contain bornite. A few grains of bornite were seen in specimens which presumably come 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, (see fig. 1) contain scattered grains of bornite. Bornite is disseminated in the pyroxenite outcrop about 2,100 feet west of the glory hole.

Two small adits, about 1,400 feet southwest of the glory hole are in gabbro. The upper adit, which is partly caved is about 30 feet long and entirely in gabbro. The lower adit is 115 feet long and has 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.

About 1 mile southeast from the Salt Chuck mine bornite occurs in diorite at the Steven's prospect (see fig. 1). This is not the same Steven's prospect shown by the Wrights 11/ as west of the glory hole. The bornite-bearing rock is exposed in a trench and a small pit. The bornite occurs as irregular stringers and small masses which fill fractures some of which also contain aplitic material.

These small magnetite bodies 1 foot to 2 feet across and at least 20 feet long are exposed southeast of the glory hole. One body is in pyroxenite and the other two are in gabbro. They are not of economic importance.

Structures influencing ore deposition

The deposition of bornite in the ore bodies apparently was controlled by the gabbro-pyroxenite boundary and by fractures and faults in the steeply pitching, pyroxenite-filled gabbro trough. The pyroxenite in the mine and immediate vicinity may represent a local center of differentiation. The bornite was deposited from rising thermal fluids, which presumably were differentiates of the same parent magma. The bornite was deposited in the pyroxenite after it was fractured.

11/ Wright, F. E. and Wright, C. W., op. cit., fig. 4.

The ore-bearing fluids followed the contact and spread into the fractured pyroxenite and into less-fractured gabbro. The more prominent fault zones, which are now metallized principally with chalcopyrite, seem to have been the main channels for the dispersion of the copper-bearing fluids to the smaller faults and fractures and thence to the microscopic fractures reported by Mertie 12/. The ore shoots are not bounded by the main fault zones but instead seem to lie near them.

The bornite in gabbro and pyroxenite east and west of the glory hole is generally near a gabbro-pyroxenite contact. The configuration of the contact at these places appears similar to the configuration of the boundary in the mine.

Fault zones comparable in size to those in the mine cut many outlying outcrops but the faults distant from the mine are not mineralized, or are only slightly mineralized with carbonate and sulfide minerals. This lack of mineralization of outlying faults suggests that bornite mineralization of pyroxenite and gabbro away from the mine is not of great significance.

GEOLOGIC INTERPRETATION OF DRILLING TESTS

The drilling program of the Solar Development Company apparently was intended to explore the extent of ore at the 300 level and the continuation below the 300 level of the ore between the 300, 313 and 314 drifts. The cores from holes drilled by that company were logged and the directions of the drill holes were determined by the Geological Survey in the winter of 1942-1943. The exploration recommended by the Geological Survey 13/ was designed to test the north ore body between the 200 level and the surface, the middle ore body below the 300 level and the southeast ore body above and below the 300 level. The drilling program of the Bureau of Mines in general followed those recommendations and also included four holes drilled from the end of the west drift on the 300 level.

12/ Mertie, J. B., Jr., op. cit. p. 125.

13/ Gault, H. R., and Wahrhaftig, Clyde, op. cit.

Data on the Solar Development Company and the Bureau of Mines drill holes are given below.

Description of diamond-drill holes, Salt Chuck mine

Drill Hole	Length in feet	Bearing	Inclination	Ore body
B3	87.0	S 6° W	∠2° 15'	
B4	118.0	S 76° W	∠3° 15'	
B5	114.3	N 33° W	∠3° 00'	
B12	68.0	N 1° W	∠4° 15'	
BA	83.0	N 35° W	-57°	Middle
BB	140.0	N 67° W	-45°	Middle
B13	48.3	due N.	-45°	Middle
B14	94.0	S 1° E	-42°	Southeast
BE	165.0	S 26° W	-49°	Southeast
B15	96.5	S 45° E	-25°	Southeast
B16	183.5	N 35° E	-42° 30'	Middle
B17	206.0	N 33° W	∠27°	North
B18	149.0	N 28° W	∠30°	North
S2	188.0	N 16° E	-40°	Middle
S3	201.0	N 15° E	-38°	Middle
S4	102.5	N 40° W	flat	
S5	180.0	S 30° E	-40°	
S6	154.0	S 31° W	flat	
S7	54.0	S 44° W	flat	
S8	109.0	N 35° E	flat	

The limits of the north ore body (see fig. 4) are inferred from the data obtained from drill cores and exposures on the surface and in the mine. The north ore body is cut by the Bureau of Mines' drill holes B17 and B18 (see fig. 4). These two holes show the approximate location of the upper and lower boundaries of the north ore body and with the surface exposures (see fig. 3) indicate the dip of the boundaries. They also indicate that the width of the ore body between the surface and the 200 level, in a northwesterly direction, is about the same as the width of the ore body exposed at the surface. At the west end of the stripped area (see fig. 3) the gabbro contains only scattered grains of bornite. At the east end bornite is rather uniformly disseminated through the gabbro. The west limit of the north ore body is drawn approximately under the west end of the stripped area. The east limit is inferred to extend a short distance beyond the east end of the stripped area.

It is unfortunate that the ground below the east end of the stripped area was not tested by a drill hole. Although it has previously been stated that the north ore body continues only to about the 200 level

(because of certain exposures on the 200 and 300 levels) there are no mine workings east of these exposures and scattered bornite gains occur in gabbro near the portal of the 100 level (see fig. 3). It is possible that the north ore body may pitch at a moderate angle to the east and continue beyond its inferred limit in that direction.

In the drill holes inclined below the 300 level (see fig. 6) it is apparent that bornite-bearing rock generally occurs along short stretches of the drill holes rather than continuously, even within the inferred limits of the ore bodies. Thus a hole could be drilled in an ore body which would show no ore although ore might be near the hole along much of its extent (see hole A, section 12, fig. 7). Similarly holes could be drilled whose cores would show considerable ore and yet the ore shoots cut by the holes might be quite narrow (see hole B, section 12, fig. 7).

The middle ore body is cut by drill holes S2, BA, B13, B16, and BB. The inferred limits as interpreted from the data obtained from the drill cores and mine exposures are shown in figures 6 and 7. Hole S2, shows more ore than any of the other holes from the 300 level. The configuration of the middle ore body as nearly as can be determined from the drill holes is that of a tabulan pod-like body, with its long dimension extending northwest-southeast and pitching to the south (see section through DDH A, fig. 6 and sections 2-8, fig. 7). The distribution of ore shoots within the ore body is uncertain but comparison of the sections in figures 6 and 7 with one another indicates that some shoots may be sheet-like bodies about parallel to the long direction of the body. The northeast ore body is smaller than the middle ore body, and is cut by drill holes B14, B15 and BE. Hole B15 contains small amounts of copper along much of its extent, as is indicated by the analyses and seems to lie near the eastern boundary of the ore body. Drill hole S5 is barren and tests the ground east of the middle ore body and below part of the southeast ore body.

Drill holes S6, S7 and S8 test the ground approximately below the bornite-bearing exposures at the surface over the end of the 311 drift. Traces of bornite in gabbro occur in hole S6 only. This gabbro is probably part of the gabbro containing scattered bornite in the 311 drift about 10 feet south of the collar of hole S6.

Drill holes B3, B4, B5 and B12 explore the west side of the pyroxenite lying in the gabbro trough at the 300 level. Holes B5 and B12 contain bornite; hole B12 contains about 20 feet of pyroxenite ore. The fault zone at the end of the west drift contains some native copper and bornite. The ore in hole B12 is perhaps a continuation in depth of the bornite-bearing zone at the southwest end of the glory hole and in the roof of the 201 stope.

Drill hole S4 shows the continuation northwestward at the 300 level of the gabbro containing disseminated pyrite.

RESERVES

Grade

The analytical data furnished by the Bureau of Mines and the Solar Development Company of samples of the ore remaining in the mine are presented in table 1.

Table 1

Analyses of ore; Salt Chuck mine

Channel samples (see figs. 3 and 5)

Sample	Location	Ore body	Length of sample in feet	Cu (%)	Au (oz. per ton)	Ag (oz. per ton)	Pt. group (oz. (per ton)
B-T (1)	Surface	north	15	1.25	0.01	0.15	
B-1 (2)	311 drift	southeast	10	tr.	0.01	0.10	none
B-2	"	"	10	0.33	0.015	0.12	none
B-3	"	"	10	0.56	0.015	0.14	0.015
B-4	"	"	10	0.84	0.01	0.10	0.03
B-5	313 drift	middle	6	2.31	0.15	0.93	0.11
B-6	300 level	"	15	0.30	0.01	0.10	tr.
B-7	314 drift	"	6	0.64	0.05	0.25	0.05

(1) Sample taken by R. L. Thorne, Bureau of Mines, 1942 (see fig. 3).
(2) Samples B-1 through B-7 taken by S. P. Holt and R. L. Thorne, Bureau of Mines, 1942 (see fig. 5).
Analyses of samples B-1 through B-7 by Smith and Emery, Los Angeles.

Miscellaneous samples

B-8 (1) mill heads	0.77	0.02	0.18	0.015
B-9 concentrates	35.45	0.88	5.64	1.22
B-10 tailings	0.13	0.01	0.11	tr.
Glory hole ore (Campbell) (2)	1.92	0.07	0.17	0.41
150-foot level (Campbell) (2)	1.08	0.07	0.24	0.184
Concentrate (Campbell) (2)	43.81	1.17	4.60	3.54

(1) Samples B-8 to B-10 taken by S. P. Holt and R. L. Thorne, Bureau of Mines, 1942.
Analyses of samples B-8 through B-10 by Smith and Emery, Los Angeles.
(2) Campbell, D. G., op. cit.

Solar Development Co. drill holes (see fig. 6)

Sample	Location	Ore Body	Length of sample in feet	Cu (%)	Au (oz. per ton)	Ag (oz. per ton)
S-1	DDH No. 2	middle	3	0.24	tr.	tr.
S-2	"	"	5	1.14	0.03	0.25
S-3	"	"	5	0.39	0.02	0.12
S-4	"	"	5	nil	tr.	tr.
S-5	"	"	5	0.49	tr.	0.12
S-6	"	"	5	0.90	0.04	0.24
S-7	"	"	5	0.28	tr.	tr.
S-8	"	"	1	5.50	0.06	1.30
S-9	"	"	0.5	1.04	0.04	0.48
S-10	"	"	5	1.02	tr.	0.10
S-11	"	"	5	0.22	tr.	0.10
S-12	"	"	5	0.79	tr.	0.20
S-13	"	"	2.5	0.60	0.01	0.17

Bureau of Mines drill holes (see figs. 1, 5 and 6)

Drill hole	Ore body	Footage along hole	Cu (%)	Composite sample Cu percent	Au (oz. per ton)	Ag (oz. per ton)	Pt. group (oz. per ton)
BA	Middle	20-25	1.73)				
"	"	25-30	1.50)				
"	"	30-35	0.58)	1.15	tr.	0.20	0.13
"	"	35-40	1.03)				
"	"	40-45	0.93)				
"	"	65-70	0.55				
B4		50-55	0.15	0.15	0.005	0.09	0.015
B5		35-40	0.18	0.018 (2)	tr.	0.09	0.018
B12		25-30	1.40)				
"		30-35	0.63)				
"		35-40	0.20)	0.65	0.035	0.61	0.052 (3)
"		40-45	0.35)				
B13	Middle	5-10	0.25)				
"	"	10-15	0.50)				
"	"	15-20	2.53)	0.86	0.025	0.46	none
"	"	20-25	0.20)				
"	"	25-30	0.83)				
"	"	30-35	0.68)				

(1) Analyses of Bureau of Mines drill cores by Smith and Emery, Los Angeles.
(2) Percent of Cu in composite as reported; reason for difference with percent of Cu in core not known.
(3) Palladium indicated.

Drill hole	Ore body	Footage along hole	Cu (%)	Cu (%)	Composite samples Au (oz. per ton)	Ag (oz. per ton)	Pt. group (oz. per ton)
B-14	Southeast	5-10	0.85				
"	"	10-15	1.48	1.26	0.020	0.03	0.013
"	"	15-20	1.33				
B-15	Southeast	0-5	0.12				
"	"	5-10	0.08				
"	"	10-15	0.08				
"	"	15-20	0.13	0.16	0.005	0.62	tr.
"	"	20-25	0.15				
"	"	25-30	0.20				
"	"	30-35	0.33				
"	"	35-40	0.20				
"	"	45-50	0.45				
"	"	50-55	0.10				
"	"	55-60	0.18	0.18	tr.	0.05	0.005
"	"	60-65	0.10				
"	"	65-70	0.20				
"	"	70-75	0.15				
"	"	90-96.5	0.10				
B-16	Middle	35-40	0.05				
"	"	40-45	0.08				
"	"	45-50	0.05				
"	"	50-55	0.08	0.07	tr.	0.04	0.015
"	"	55-60	0.05				
"	"	60-65	0.05				
"	"	65-70	0.08				
"	Southeast	150-155	0.88				
"	"	155-160	1.85				
"	"	160-165	1.55	1.39	0.050	0.20	none (1)
"	"	165-170	2.15				
"	"	170-175	0.50				
B-17	North	50-55	0.20				
"	"	55-60	0.28	0.23	none	none	none
"	"	60-65	0.20				
"	"	70-75	0.30				
"	"	75-80	0.23				
"	"	80-85	0.20				
"	"	85-90	0.25	0.28	none	none	none
"	"	90-95	0.35				
"	"	95-100	0.23				
"	"	100-105	0.23				
"	"	105-110	0.35				

(1) Palladium indicated.

Drill hole	Ore body	Footage along hole	Cu (%)	Composite sample Cu (%)	Au (oz. per ton)	Ag (oz. per ton)	Pt. group (oz. per ton)
B17	North	110-115	0.15				
"	"	115-120	0.52				
"	"	120-125	0.35				
"	"	125-130	0.30	0.33	tr.	0.13	none
"	"	130-135	0.25				
"	"	135-140	0.33				
"	"	140-145	0.30				
"	"	145-150	0.45				
"	"	150-155	0.23				
"	"	155-160	0.30	0.25	none	tr.	none
"	"	160-165	0.23				
"	"	165-170	0.15				
"	"	170-175	0.20				
"	"	175-180	0.13				
"	"	180-185	0.08				
"	"	185-190	0.10				
"	"	190-195	0.13				
"	"	195-200	0.10				
"	"	200-205	0.10				
B18	North	4-10	0.25				
"	"	10-15	0.20				
"	"	15-20	0.20				
"	"	20-25	0.20				
"	"	25-30	0.35				
"	"	30-35	0.41	0.43	0.010	0.03	none
"	"	35-40	0.66				
"	"	40-45	0.45				
"	"	45-50	0.80				
"	"	50-55	0.58				
"	"	55-60	0.45				
B18	North	65-70	0.38				
"	"	70-75	0.98				
"	"	75-80	0.55				
"	"	80-85	1.10	0.91	0.010	0.19	none (1)
"	"	85-90	1.12				
"	"	90-95	1.41				
"	"	95-100	0.80				

(1) Palladium indicated.

Drill hole	Ore body	Footage along hole	Cu (%)	Cu (%)	Composite sample Au (oz. per ton)	Ag (oz. per ton)	Pt. group (oz. per ton)
B18	North	100-105	0.94				
"	"	105-110	0.18				
"	"	125-130	0.30)				
"	"	130-135	0.10)	0.19	tr.	0.25	none
"	"	135-140	0.18)				
BE	Southeast	90-95	1.30)				
"	"	100-105	3.20)	2.28	0.04	0.41	none (1)

(1) Palladium indicated.

Because the percentage of core recovered from drill holes in the Salt Chuck mine is in general 80 percent or more it is assumed that the analyses of the drill cores are representative of the material cut by the drill holes. The weighted average of metals contained in the ore, calculated from the analyses of the drill cores and channel samples are given in table 2. The average copper and precious metal content of the total volume of rock within the inferred limits of the ore bodies is also given in table 2. Of the drill core analyses only those which lie within the inferred limits of the ore bodies are used. The average tenor of copper for the middle ore body includes the analyses of the Solar Development Company drill hole No. 2. The average gold and silver tenors are calculated from the analyses of the Bureau of Mines' composite and channel samples and the Solar Development Company's drill hole No. 2. The average tenor of the platinum group is calculated from the Bureau of Mines' samples. In view of the comparatively few analyses for the platinum group, the average tenor given in table 2 for the north ore body, at least, may be too small.

Table 2

Average grade of material in ore bodies; Salt Chuck mine.

Bornite-bearing material	Cu %	Ounces per ton Au	Ag	Pt group
North ore body	0.55	0.004	0.08	none
Middle ore body	0.92	0.025	0.26	0.004
Southeast ore body	0.50	0.008	0.23	0.004
For total inferred volume of:				
North ore body	0.50	0.0035	0.073	none
Middle ore body	0.31	0.0084	0.087	0.0013
Southeast ore body	0.22	0.0036	0.10	0.0018

Tonnage

The limits of the ore bodies as shown in figures 4 to 7 are inferred from data obtained from the drill cores and mine exposures; from observed and inferred geologic features such as the relationship between ore deposition and fractures and the position of the gabbro-pyoxenite boundary in the mine; and from the size, shape, attitude, and from distribution of mined ore bodies as indicated from the stopes and glory holes. These limits are not considered to be the limits of bornite occurrences. The depth of the middle and southeast ore bodies is inferred to be about that of the lowest point reached by the drill holes. Small amounts of bornite have been observed or reported at several places in the mine other than those in the three ore bodies, such as at the end of the west drift on the 300 level, in drill hole B12, and in the 311 drift, but geologic evidence at hand does not warrant inferring ore bodies at these places.

The approximate tonnage of material within the inferred limits of the ore bodies as calculated from the sections in figures 4 and 7 are; north ore body, 168,000 tons; middle ore body, 61,000 tons; and southeast ore body, 22,000 tons. However, not all of the material included within the ore bodies contains bornite, as is indicated by the drill holes. Assuming that the distribution of bornite-bearing rock in the drill holes is representative of the distribution of bornite-bearing rock in the ore bodies, then the ratio of tons of bornite-bearing rock within each ore body to the tons of rock within the limits of each ore body respectively, should be the same as the ratio of the total footage of bornite-bearing rock in each ore body to the total footage of the drill holes in each ore body. Using this ratio of footage of drill holes, the tonnages of bornite-bearing rock in the north ore body is 153,000 tons, the middle ore body, 20,000 tons, and the southeast ore body, 10,000 tons.

Using the same assumptions made in calculating the tonnages of bornite-bearing rock in each ore body and the weighted average of copper contained in the ore, the estimated tonnages of material containing 0.2 percent, 0.4 percent, 0.6 percent, 0.8 percent and 1.0 percent or more of copper in each ore body are given in table 3. In considering the tonnage figures it should be kept in mind that the ore shoots within each ore body are irregular in size and distribution.

Table 3

Tonnage and grade of ore; Salt Chuck mine

Ore body	Metal	Total inferred volume	All bornite bearing rock	Cut-off-point (percent of copper) 0.2	0.4	0.6	0.8	1.0
North	Tons	168,000	153,000	121,000	40,000	23,000	20,000	8,600
	Cu %	0.50	0.55	0.65	0.83	1.05	1.09	1.23
	Au	0.0035	0.004	0.005	0.01	0.01	0.01	0.01
	Ag	0.073	0.08	0.07	0.10	0.18	0.18	0.15
	Pt. group	none	none	none	none	none	none	none
Middle	Tons	61,000	20,000	20,000	16,000	12,500	9,700	6,800
	Cu %	0.31	0.92	0.92	1.03	1.20	1.51	1.76
	Au	0.0084	0.025	0.025	0.03	0.031	0.032	0.033
	Ag	0.087	0.26	0.26	0.31	0.32	0.33	0.28
	Pt. group	0.0013	0.004	0.004	0.004	0.004	0.004	0.006
Southeast	Tons	22,000	10,000	6,000	4,200	2,500	2,500	1,600
	Cu %	0.22	0.50	0.81	1.14	1.42	1.42	1.46
	Au	0.0036	0.008	0.015	0.016	0.016	0.016	0.02
	Ag	0.10	0.23	0.09	0.031	0.058	0.058	0.03
	Pt. group	0.0018	0.004	0.013	0.013	0.013	0.013	0.013

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