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COPPER BULLION CLAIMS
RUA COVE, KNIGHT ISLAND ALASKA

BY

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ABSTRACT

The Copper Bullion claims are near Rua Cove, about midway in the east coast of Knight Island, Prince William Sound. The property consists of 18 claims controlled by F. H. Dickey, of Seattle, Wash. Development includes numerous open-cuts, 2,850 feet of tunnel and crosscuts, and a number of diamond-drill holes.

The rocks of Rua Cove are of igneous origin and probably of late Mesozoic age. Three distinct types of igneous rocks have been recognized.

Mineralization occurred in a shear zone, with sulfide minerals replacing the country rock along fault and fracture planes.

Reserves of ore with an average content of 1.25 percent or more of copper are: Measured ore, 25,000 tons; indicated ore, 1,125,000 tons; inferred ore, 264,000 tons or more. It is estimated thta the shear zone contains also several million tons of ore with an average content of about 0.6 percent of copper.

INTRODUCTION

During the summer of 1943 the Geological Survey, as part of its program of war-minerals investigations, examined several copper deposits in the Prince William Sound area. The deposit at the Copper Bullion claims, Rua Cove, Knight Island (see fig. 11), is one of the largest of the copper deposits in the Prince William Sound area and therefore was examined in considerable detail. The work was done under the direction of F. H. Moffit, who was in charge of all the copper investigations of the Geological Survey in the Prince William Sound area.

The writers spent the months of July and August 1943 at Rua Cove, investigating the ore deposit and related geology; mapping the tunnels (see pl. 23), open-cuts, and the outcrops of ore; and making a topographic map (see pl. 24) of the area.

Rua Cove is an unsheltered indentation about midway in the east coast of Knight Island. The geographic position of U. S. Mineral Monument No. 8, located on Bullion claim No. 5, is latitude 60°20′33″ N., longitude 147°39′24″ W.

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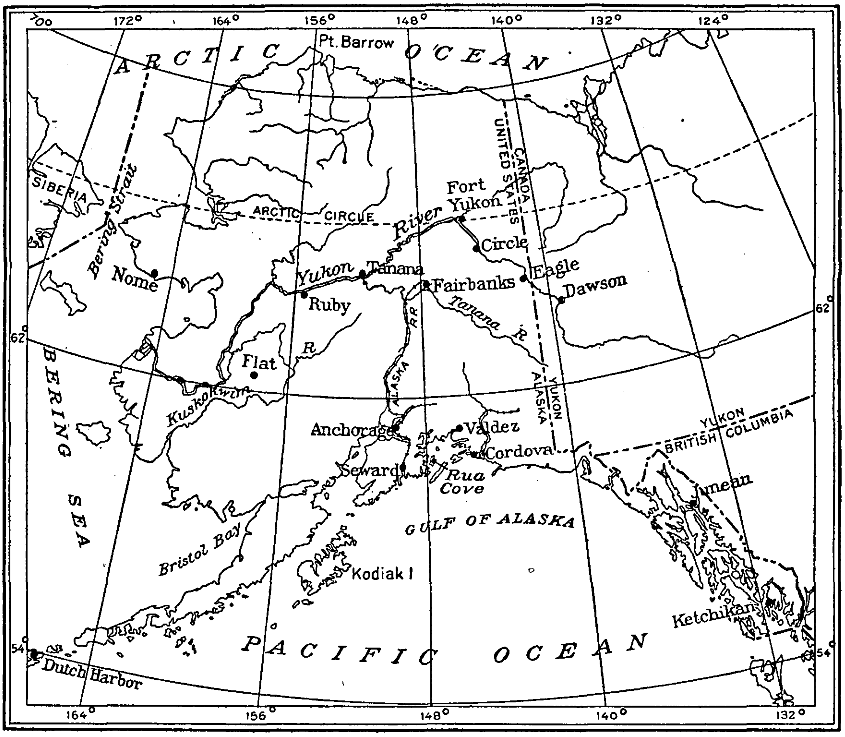

FIGURE 11.—Sketch map of Alaska showing location of Rua Cove, Knight Island, Prince William Sound.

HISTORY AND DEVELOPMENT

Development of the property was begun in 1908 by Charles Rua and J. J. Bettels. In 1912 Fred Liljegren patented Copper Bullion claims Nos. 1 and 2. By the end of 1916 a cabin had been built, and total development consisted of numerous open-cuts, and a tunnel 365 feet long with 4 crosscuts 5, 35, 35, and 60 feet long. About 1916, W. A. Dickey acquired control of the property. During the following decade development work was carried on by Mr. Dickey, with the result that by 1926 several buildings had been erected, a water-power plant and a compressor had been installed, and underground development then totaled about 1,750 feet of tunnel and crosscuts.

In 1926 the Kennecott Copper Corp. sampled and assayed the ore exposed in the underground and surface workings. The tunnel, crosscuts, and open-cuts were mapped by C. W. Poy.

The Solar Development Co., a subsidiary of the Consolidated Mining and Smelting Co. of Canada, Ltd., took an option on the Copper Bullion claims early in 1929, but dropped it in May 1930. Development work done by this company included the repairing of the camp and roads, installation of a 350 cubic foot Diesel compressor plant, and erection of a bunkhouse 24 feet wide and 36 feet long. The tunnel was extended 670 feet, and a second tunnel 590 feet long was driven about 200 feet below the first tunnel. (See pl. 23.) Further underground work consisted of 2,324.5 feet of diamond drilling. Projections of the drill holes are shown on plate 23. The ore body was thoroughly sampled and assayed.

In 1943 the property consisted of 2 patented claims and 16 unpatented claims controlled by F. H. Dickey, of Seattle, Wash.

The Copper Bullion claims were first described by Grant and Higgins.[1] They state that the tunnel was driven in greenstone containing a few stringers of pyrrhotite and chalcopyrite, and that these stringers are probably part of the same ore body exposed 400 feet above the tunnel.

The most comprehensive report on the property is that of Johnson,[2] who believed that the ore body of the Copper Bullion claims is "a linked system of mineralized shear zones inclosing large horses of unsheared, unmineralized country rock." He states that at an altitude of 750 feet the ore body pinches out beneath the overlying greenstone flows. Brooks and Capps,[3] however, state that "some evidence of the fissure and of copper mineralization is traceable to the top of the cliff, 1,500 feet above the mine workings."

Moffit[4] visited the property during the summer of 1923. At that time he made a pace and compass traverse of the tunnel and crosscuts, and also examined the outcrops and open-cuts. He noted that although the ore body appears to be cut off by a fault striking N. 10° W. and dipping 70° E. in the cliffs above the 700-foot open-cut, it nevertheless continues on the mountain above the cliffs.

GEOGRAPHY

Rua Cove forms the eastern margin of a basin-like depression bounded on the north, west, and south by steep mountains. (See pl. 24.) Iron Mountain, on the north side of the basin, contains the ore body. The eastern slope of Iron Mountain rises at a nearly uniform but steep grade from sea-level to an altitude of approximately 2,145 feet. Its southern side, where the prospecting work has been done, rises in a series of steep slopes and vertical cliffs. South of the cove a mountain about 1,750 feet high delimits the basin. West of the cove the floor of the basin reaches an altitude of about 600 feet at a lake

[1] Grant, U. S., and Higgins, D. F., Jr., Copper mining and prospecting on Prince William Sound, Alaska: U. S. Geol. Survey Bull. 379, p. 92, 1909.

[2] Johnson, B. L., Mining on Prince William Sound, Alaska: U. S. Geol. Survey Bull. 662, pp. 213–214, 1918.

[3] Brooks, A. H., and Capps, S. R., The Alaskan mining industry in 1922: U. S. Geol. Survey Bull. 755, pp. 28–29, 1924.

[4] Moffit, F. H., personal communication.

three-fourths of a mile inland. (See pl. 25.) West of the lake are craggy mountains.

Snow remains in the gullies of the high mountains throughout the summer, and melt water runs into the lake. A small stream running from the lake could furnish a moderate amount of water power.

High precipitation, in the form of rainfall in summer and snowfall in winter, is characteristic of the Rua Cove area. The annual precipitation is greater than 100 inches, and in exceptional years, such as 1912, may amount to nearly 200 inches.[5]

Vegetation is luxuriant and covers the mountain slopes with a dense growth of brush and trees. The trees suitable for mine timbers and for building purposes are spruce and hemlock. Alders are abundant, especially in the gullies and other sheltered spots.

GENERAL GEOLOGY

Rocks of igneous origin, including lava flows, tuffs, and agglomerates, are especially well developed at Knight Island. These rock types have not generally been differentiated as separate units, and the term "greenstone" is applied to any or all of them, and to some intrusive rocks that resemble them.[6] The island is composed largely of greenstone locally interbedded with shale; south of Snug Harbor and Mummy Bay older slates and graywackes predominate. The sedimentary rocks, probably of Mesozoic age, are cut by intrusive greenstones which are probably of late Mesozoic age.

According to Johnson,[7] the greenstones of Prince William Sound range in color from light gray through shades of green to greenish-black, and in texture from fine-grained to coarse-grained The composition ranges from that of andesite and diorite to that of gabbro, diabase, and peridotite.[8] In most places they are considerably altered. Lavas with porphyritic and diabasic textures, as well as amygdaloidal and pillow lavas, occur in the area.

At Rua Cove three distinct types of greenstone were recognized and were mapped in the tunnels. (See pl. 23.) Probably the most abundant type is a fine-grained greenish to almost black rock. Chemical action of circulating waters has altered this rock considerably, especially the more highly schistose parts. A study of thin sections indicates that the original rock consisted chiefly of feldspar microlites, small grains of anhedral augite, and perhaps some grains of ilmenite. These minerals have been altered to penninite chlorite, prehnite, clinozoisite, and leucoxene with dark cores that may be

[5] Moffit, F. H., The occurrence of copper on Prince William Sound, Alaska: U. S. Geol. Survey Bull. 773, p. 143, 1925.
[6] Moffit, F. H., op. cit., p. 145.
[7] Johnson, B. L., unpublished manuscript: see Moffit, F. H., op. cit., p. 146.
[8] Moffit, F. H., op. cit., p. 146.

ilmenite. Stringers of quartz are common in this type of greenstone.

The second type is a blocky dark-gray porphyritic rock. This rock forms the walls of the first 400 feet of the lower tunnel. Locally in the tunnel walls are exposed what probably are sections of lava pillows of this type of greenstone. Rims of more altered, finer-grained greenstone surround the pillows and fill the interstices between them. A study of thin sections shows that the porphyritic greenstone is composed chiefly of large labradorite phenocrysts in a groundmass of altered glass (palagonite) and feldspar microlites. Grains of pyroxene are in the less altered rock. The rims of the pillows and the interstices between them are composed largely of palagonite. Clusters of prehnite and feldspar microlites are present in the rims and interstices. Veinlets of clinozoisite are abundant. Blocks of porphyritic greenstone are exposed in the upper tunnel and appear to have the same composition as the porphyritic greenstone in the lower tunnel but are generally less altered.

The third type of greenstone at Rua Cove is a medium-grained gray-green rock having the composition of quartz diorite. Euhedral grains of augite are distributed in a groundmass of plagioclase, either labradorite or andesine, and quartz. Alteration products are penninite chlorite, prehnite, and clinozoisite.

ECONOMIC GEOLOGY

The Rua Cove deposit is similar to other copper deposits of Prince William Sound. It is simple in mineral composition, consisting chiefly of sulfides of iron and copper, and simple in form. The gangue consists of greenstone and some quartz. Mineralization occurred in and adjacent to faults and fracture planes in a shear zone. Pyrrhotite is by far the most abundant sulfide mineral. Chalcopyrite and sphalerite are present as veinlets and grains in the pyrrhotite. The sphalerite mineralization, however, is too slight to be of economic significance. Polished sections of the ore show that the paragenetic sequence of the ore minerals was pyrrhotite, followed by sphalerite, and then chalcopyrite.

It is believed that the ore deposit at Rua Cove was formed largely by replacement of sheared greenstone rather than by filling of open cavities. Indications of origin by replacement at Rua Cove, similar to those in the shear-zone deposits at nearby Ellamar,[9] are: (1) Absence of comb structures, or vugs, in the deposits; (2) lack of crystal forms of the sulfide minerals; (3) fine-grained texture of the sulfide minerals; (4) gradual transition from masses of solid sulfide minerals to slightly mineralized horses and large masses of greenstone.

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[9] Capps, S. R., and Johnson, B. L., the Ellamar district, Alaska: U. S. Geol. Survey Bull. 605, p. 76, 1915.

The ore deposit is in a zone of prominent shears which appears to be similar to the "expanded shear zone" at Latouche.[10] The mineralizing fluids and deposition of ore were apparently restricted to the shear zone. Locally the shear zone contains small bodies of solid sulfide minerals. Mineralization, however, was greatest near the walls of the zone, where the sheared greenstone was completely replaced.

Similar deposits elsewhere on Knight Island show that the deposition of sulfide minerals took place during a protracted interval of volcanism, but the exact time of deposition is not known.[11]

The general strike of the shear zone at Rua Cove is N. 15° E., but local divergences of several degrees have been noted. The dip ranges from 80° E. to 60° W., but in most places it is between 80° W. and vertical. In the upper tunnel the zone is about 200 feet wide and is apparently delimited on the west side by faults. Drill-hole records indicate that the east side of the shear zone is also delimited by faults. A lens of solid or nearly solid sulfide minerals, in most places 30 to 50 feet thick but elsewhere pinching out or increasing to 100 feet, is next to the hanging or west wall. (See pl. 23.) This lens strikes N. 25° E., dips 60° NW., is about 400 feet long, and is terminated at the northern end by a fault striking N. 80° W. and dipping 50°–60° NE. Most of the rest of the shear zone, east of the lens of ore, consists of mineralized sheared greenstone and horses of barren massive greenstone. Exposures of ore in crosscuts east of the tunnel and drill-hole records indicate that a system of narrow ore lenses parallel to the footwall or a large lens including a zone of barren greenstone lies next to the east wall of the shear zone. (See pl. 23.) The ore extends for about 400 feet along the strike of the shear zone, but its vertical extent is not known.

On the surface, four open-cuts at altitudes of 550, 620, 675, and 705 feet expose sulfide ore. These open-cuts and other exposures indicate a lens of solid sulfide minerals striking about N. 25° E. at the surface. Where exposed, the west contact of this ore body dips 60° NW. The lens appears to increase in width from a few feet at an altitude of 550 feet, to 50 feet at an altitude of 705 feet. It extends up the face of a cliff above the 705-foot open-cut to an altitude of 750 feet, where it is cut off by a fault striking about N. 10° W. and dipping 50°–60° NE. Although the strike of this fault is not the same as that of the fault cutting off the ore in the upper tunnel, it may, nevertheless, be an upward extension of the fault in the tunnel. In both places the dip is the same, and a projection down the dip of the fault in the cliff would intersect the level of the upper tunnel approximately where the ore at that level is cut off by a fault.

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[10] Bateman, A. M., The Beatson mine, Alaska, in Ore deposits as related to structural features, p. 147, Princeton University Press, 1942.

[11] Moffit, F. H., op. cit., p. 157.

The strike, dip, width, and content of the lens of solid sulfide minerals on the surface are nearly identical with those of the lens of ore along the west wall of the tunnel. Furthermore, if the ore body exposed in the open-cuts were projected down the dip, it would intersect the level of the upper tunnel along the line of strike of the ore lens next to the hanging wall It is therefore believed that the ore on the surface and the ore along the west wall of the tunnel are parts of the same lens of sulfide minerals. Because the south end of the lens is exposed in the tunnel about 125 feet north of the south end of the lens exposed on the surface, it appears that the lens pitches about 55° to the north. Downward extension of this lens to at least 200 feet below the level of the tunnel is indicated by diamond-drill records, but at this level the lens appears to pinch northward and southward from diamond-drill hole No. 2. (See pl. 23.)

Two open-cuts, at altitudes of 1,000 feet and 1,250 feet, reveal ore in sheared greenstone. The ore zone at the latter place is 40 feet wide. The strike of the shear zone at both localities is N. 10°–15° E., and the dip is about 80° W. It seems, therefore, highly probable that this shear zone is a continuation of that on which the tunnels below were driven. The fault cutting off the ore at an altitude of 750 feet may have displaced westward the north end of the ore body.

Many small faults and one major fault that brings quartz diorite into contact with mineralized greenstone show that tectonic movements followed the deposition of the ore. A system of minor faults striking approximately east and dipping northward at a small angle is especially prominent. Several small blocks of porphyritic greenstone are present in the walls of the upper tunnel. The localization of these blocks obviously took place after the period of mineralization, because the contacts between them and the mineralized greenstone are faults which transect the bodies of sulfide minerals in the greenstone. These blocks were probably parts of the main body of porphyritic greenstone exposed in the lower tunnel.

RESERVES

Assay records show that most of the ore carrying more than 1 percent of copper is localized near the hanging walls and footwalls of the shear zone, especially near the hanging walls. These higher-grade parts of the ore body and the ore in the open-cuts have an average content of about 1.25 percent of copper and about 40 percent of iron. The lower-grade parts of the ore body have an average content of about 0.6 percent of copper. It is estimated that the sheer zone contains several million tons of this lower-grade ore.

In evaluating the ore reserves at Rua Cove, only ore averaging 1.25 percent or more of copper was included. The ore in the lens extending from the surface to a depth of 200 feet below the level of the upper tunnel is considered indicated ore. Calculations of the volume of this lens are based on average known and inferred dimensions of the ore body, as follows:

	Length (feet)	Width (feet)
Surface	210	35
Upper tunnel	400	45
200 feet below upper tunnel	560	25
Average	390	35

Pitch length 660 feet.

This lens contains about 9,000,000 cubic feet, or approximately 1,125,000 tons of ore, if it is assumed that 8 cubic feet of ore weighs 1 ton. Drill-hole records indicate that the lens of ore decreases in width and pinches northward and southward at a level 200 feet below the upper tunnel. No data are available, however, to indicate the dimensions of the ore body below the drill holes, and no estimate is made of ore below the holes.

Of the 1,125,000 tons of indicated ore a small part is well enough exposed to be considered measured ore. About 800 square feet of such measured ore is at the surface, and about 19,200 square feet is on the upper-tunnel level. Assuming a vertical measured extent of 10 feet at each place, about 25,000 tons of measured ore is present.

The ore in the lens near the east wall of the shear zone is considered to be inferred. This lens is probably 400 feet long and may have an average thickness of 20 feet. Its vertical extent is arbitrarily inferred as half its length. The inferred ore aggregates 200,000 tons.

There is no evidence to prove, or disprove, an extension along the strike of the ore in the 1,250-foot open-cut, but because the deposit there appears identical to that in the tunnel, it seems justifiable to infer the presence of considerable ore. The length of the ore body is assumed to be 4 times its width, and its vertical extent half of its inferred length. An ore body of these dimensions (40 by 160 by 80 feet) contains 64,000 tons. The actual tonnage of ore around the 1,250-foot open-cut, however, may be much greater.

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