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The Hidden Creek Ore-Bodies

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INTRODUCTION

THE Anyox Plant of the Granby Consolidated Mining, Smelting and Power Company, Limited, is situated on and near the shores of Granby bay, a natural harbour off Observatory inlet, 90 miles north of Prince Rupert, British Columbia.

The Hidden Creek mine, with the portal of its main haulage adit at 385 elevation, is 8,000 feet from the north end of the bay. The Bonanza mine, 250 feet above sea level, is 4,000 feet up Bonanza creek, which empties into the west side of the bay; the Granby Point quartz mines are at the water's edge at the entrance of the harbour; the Golskish mine is a few thousand feet down the inlet from Granby Point; and the worked-out Rambler quartz quarry is 6,000 feet from the west shore of the bay.

The smelter, concentrator, by-product coke plant, shops, town, etc., are situated around the northerly end of the harbour. Falls creek flows into the bay at the northwest corner. Hydraulic plants developing 14,000 horsepower are grouped about the mouth of the creek.

GENERAL GEOLOGY

The ore deposits which give rise to this compact and economical mining and concentration unit are in a remnant of argillites and greenstones caught up in the granitic rocks of the Coast Range batholith (1).

The 'argillites', or the Goose Bay formation of McConnell, consist of a series of metamorphosed argillites and other fine, well bedded, black, brown, and grey sediments. These rocks are much folded, the general trend of the major folds being southwest-northeast. No fossils have been found in the argillites, so there is uncertainty as to the age of the formation, but, from lithological similarities, they are believed by Dolmage to be closely related to the Lower Jurassic rocks of the nearby Kitsault River formation.

The Anyox greenstones belong to the Bear River formation, which "consists of massive and fragmental greenstones with a few interbedded layers of fine argillaceous tuff and impure limestone" (Dolmage). The Anyox greenstone mass extends from near Anyox to Portland canal on the west, a distance of seven miles, and from north to south measures about eighteen miles.

The argillites lie to the east of the greenstone. The contact has a general east of north, west of south trend, but is irregular in detail. The greenstone-

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(1) Bibliography: McConnell, R. G., Geol. Sur. Can., Memoir No. 32.
Dolmage, Victor, Geol. Sur. Can., Summ. Report, Part A, 1922.
Minister of Mines Reports, British Columbia.

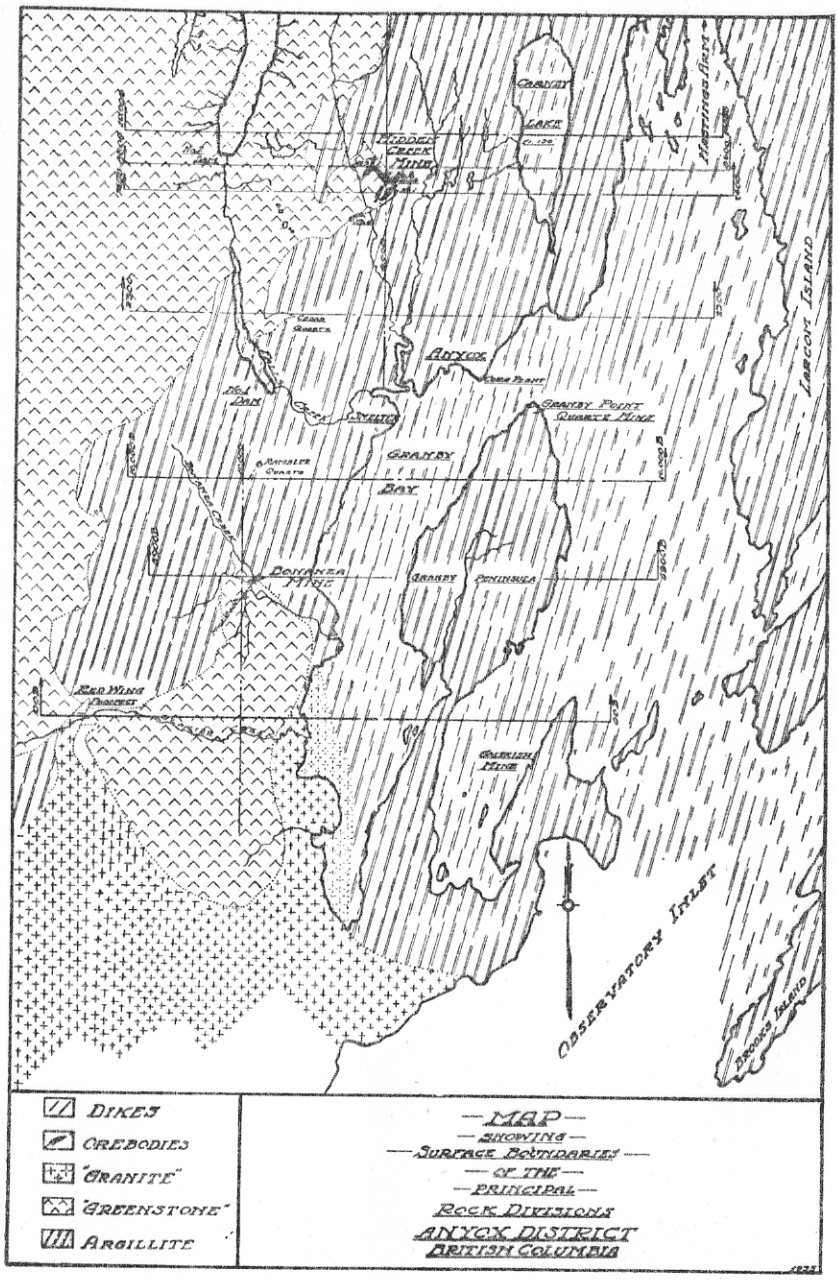
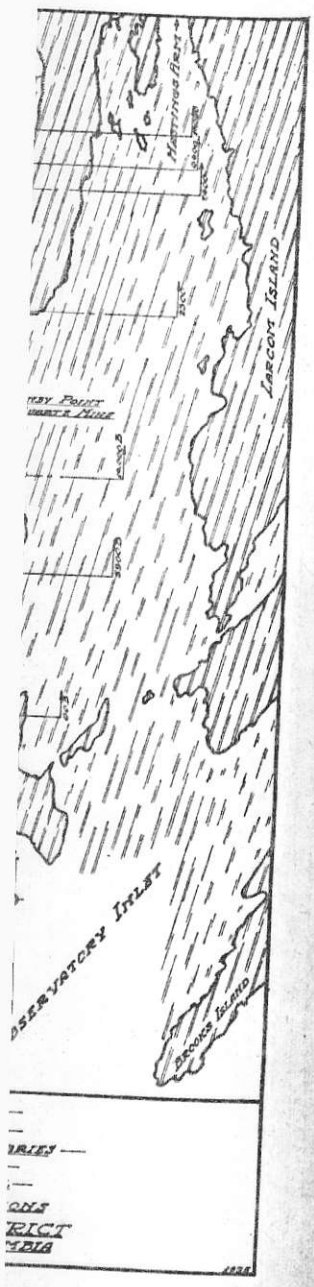


Figure 1.

Scale: 1 in. = 8,000 ft.



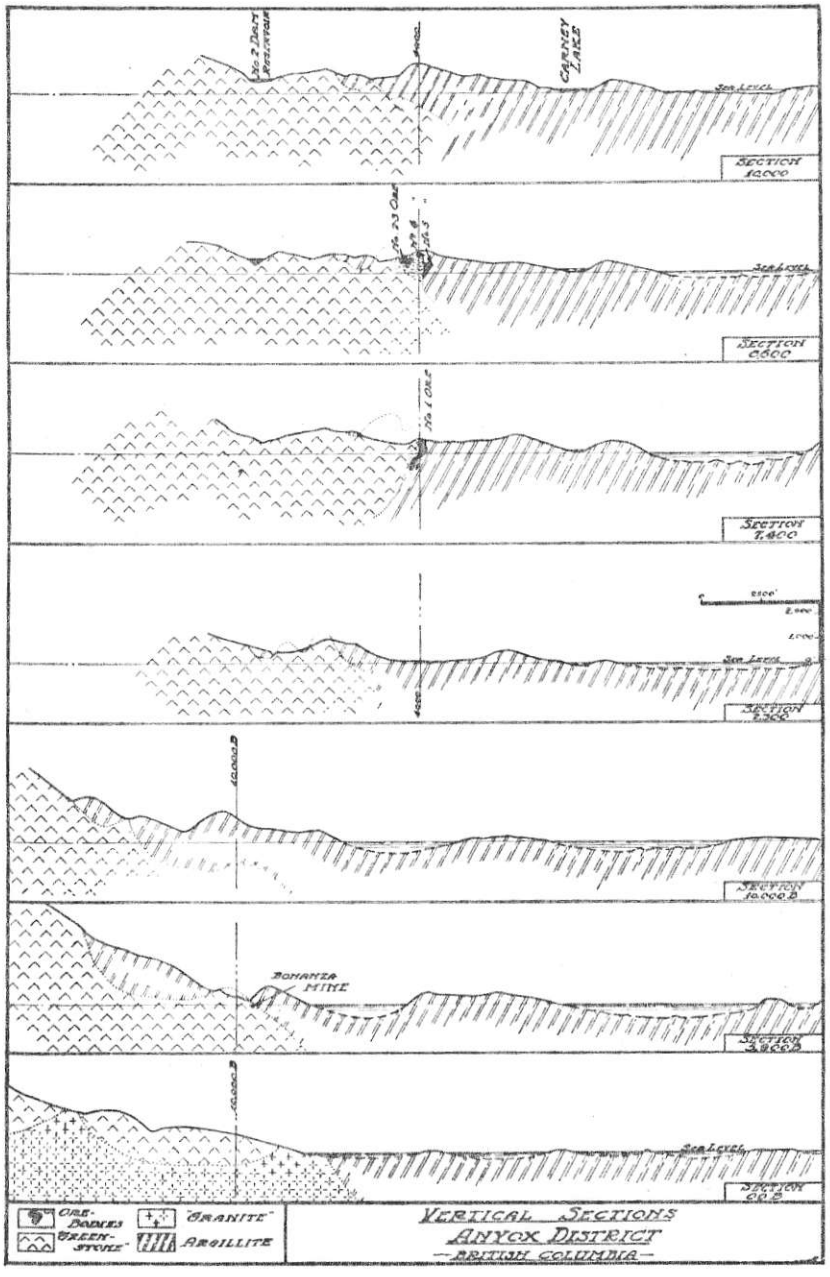


Figure 2.

Scale: 1 in. = 8,000 ft.

argillite mass is surrounded by granodiorite of the Coast Range batholith, and that rock is presumed to underlie the older rocks; but in the Hidden Creek Mine area, the granodiorite has not been encountered.

Uncertainty exists as to the true relationship of the greenstones and the argillites. By some, they are regarded as members of the same series of bedded rocks. By others, the greenstone is regarded as an intrusive rock. Certain aspects are best explained by one hypothesis, others by the alternative theory. The relationship existing about the centres of mineralization at Hidden Creek and Bonanza mines undoubtedly points to an intrusive origin for the greenstone. At Hidden Creek, cross-cutting is indicated, and at Bonanza there are clean-cut examples of cross-cutting of the argillites by greenstone. At Hidden Creek the cross-cutting is masked by the development of a thick silicified transition zone in which it is difficult to tell where the argillites end and the greenstone begins.

At other points along the twelve-mile contact, conformability is suggested, as the contact appears to parallel the bedding of the little-altered argillites, and, if there is cross-cutting, it is not readily apparent. But even so, the existence of the greenstone in sill-like form is not precluded.

Dykes are common along the margins of the Coast Range batholith and are present in probably all of the ore deposits related to it. When geologist for the Granby Company, J. A. Bancroft gave considerable attention to correlating dyke exposures and intersections in workings and diamond-drill holes at Hidden Creek. Within the ore-zone proper, he numbered over one hundred dykes, and without the ore-zone are scores of others. Of the dykes, Bancroft says: "A vast multitude of dykes traverse all the other rock types of the area. In general, the more massive or faintly foliated phases of the altered porphyrites (greenstones) resisted fracture much more readily than the comparatively brittle and stratified argillites, and hence dykes are much more numerous in these portions of the area underlain by the Granby Bay argillite series than within the area of greenstone. . . The vast majority are less than three feet in width; while a few of them are between twenty-five and forty feet wide. . . Some of the dykes extend for hundreds of yards, maintaining constant strike and remarkably uniform width" (see Figure 3, on which dyke No. XIX is shown).

"The dykes include a great variety of interesting rock-types—diorites, diorite-porphyrites, malchites, gabbro-diorite porphyrites, diabases, kersantites, bostonites (felsites), minettes, quartz porphyries, aplites, pegmatites, etc. . . That the dykes have been successively injected is shown by the frequency with which they intersect each other; in some localities, one can distinguish dykes of at least five successive ages. . . None of the dykes display any tendency to foliation, and hence it is concluded that all of them were injected subsequent to the development of foliation and schistosity in the greenstones. . . All of the dykes are later than the ore deposits. Where they traverse the ore-bodies, their contacts are sharply defined and they display no evidence of having been bathed by silica and sulphide waters. In some instances they include angular fragments of ore and silicified wall-rock".

In mining, it has been possible in some places to leave the dykes standing, but thousands of tons of dyke-rock have been mined. Due to their tendency to maintain constant strike and dip, dykes have been of use in locating drifted and unsurveyed diamond-drill holes, and in a general way in pointing to

possible favourable ore structures. There are many dykes without ore, but no ore without dykes.

FOLDING AND FAULTING

The trend of the major folds in the argillites is east of north and west of south. In the Hidden Creek Mine area, transverse folds are developed on the westerly limb of the general fold nearest the greenstone. I explain these structural conditions by imagining the original more or less horizontal argillite beds as compressed from east to west, causing the major folds; and at nearly the same time, by an action resembling bending in the horizontal plane, transverse folds or wrinkles were developed on the major folds. Some of the transverse folds are gentle, some are sharp and overturned. Where sharp, there was a tendency to over-riding and the structures are complicated. It is in such areas the maximum mineralization is found.

The greenstones made their way into the zones of greatest deformation in the argillites. Later and less intense folding caused foliation and schistosity in the greenstone, and the argillites were again deformed. Where massive, the greenstone resisted folding and the foliation is weak or lacking, but in the vicinity of the ore-bodies, where the greenstone is a projection from the main body, it was rendered schistose and the way prepared for silicification and metallic mineralization.

Since the rocks have been twice deformed, signs of faulting are to be expected, but except for minor slippage representing adjustment along folds, no faulting with material displacement has been proved. Three zones of intense brecciation are known: (*a*) a zone between No. 2 and No. 3 ore-bodies, formerly regarded as a fault which made No. 3 an upthrow segment of No. 2. The writer believes this zone was caused by pre-ore folding; (*b*) the northeasterly contact zone of the Bonanza porphyrite body and the argillites shows intense crushing and some brecciation. Work to date has not shown whether it is a result of close folding of rocks of differing competency or true faulting; (*c*) a like zone exists where the contact crosses Falls creek.

THE ORE-BODIES

The sulphide ore-bodies at Anyox are due to replacement of both greenstone and argillites, where folding has provided favourable structures. Silicification which accompanied the deposition of the sulphides is more widespread than the metallic mineralization. Iron pyrite is the most abundant sulphide, followed by pyrrhotite, chalcopyrite, zinc blende, and galena, of which the total amount is very small. Pyrite crystallized first, zinc blende next, and pyrrhotite and chalcopyrite followed. In No. 4 ore-body, regular veins of pyrrhotite and chalcopyrite cut through the massive iron pyrite.

Gold and silver values are low on the average, shipments to this time having assayed about 0.005 ounces of gold and 0.30 ounces of silver to the ton.

No. 1 and No. 5 ore-bodies, for practical purposes taken as separate units, are in reality parts of a zone made up of lenses of ore with partings of argillite of varying degrees of silicification, in the upper parts, and silicified greenstone at the roots. This 1 – 5 zone, somewhat crescent shaped in plan, occupies the southeasterly and easterly part of the Hidden Creek porphyrite-argillite contact zone. At the 450 horizon, the length of the 1 – 5 zone is

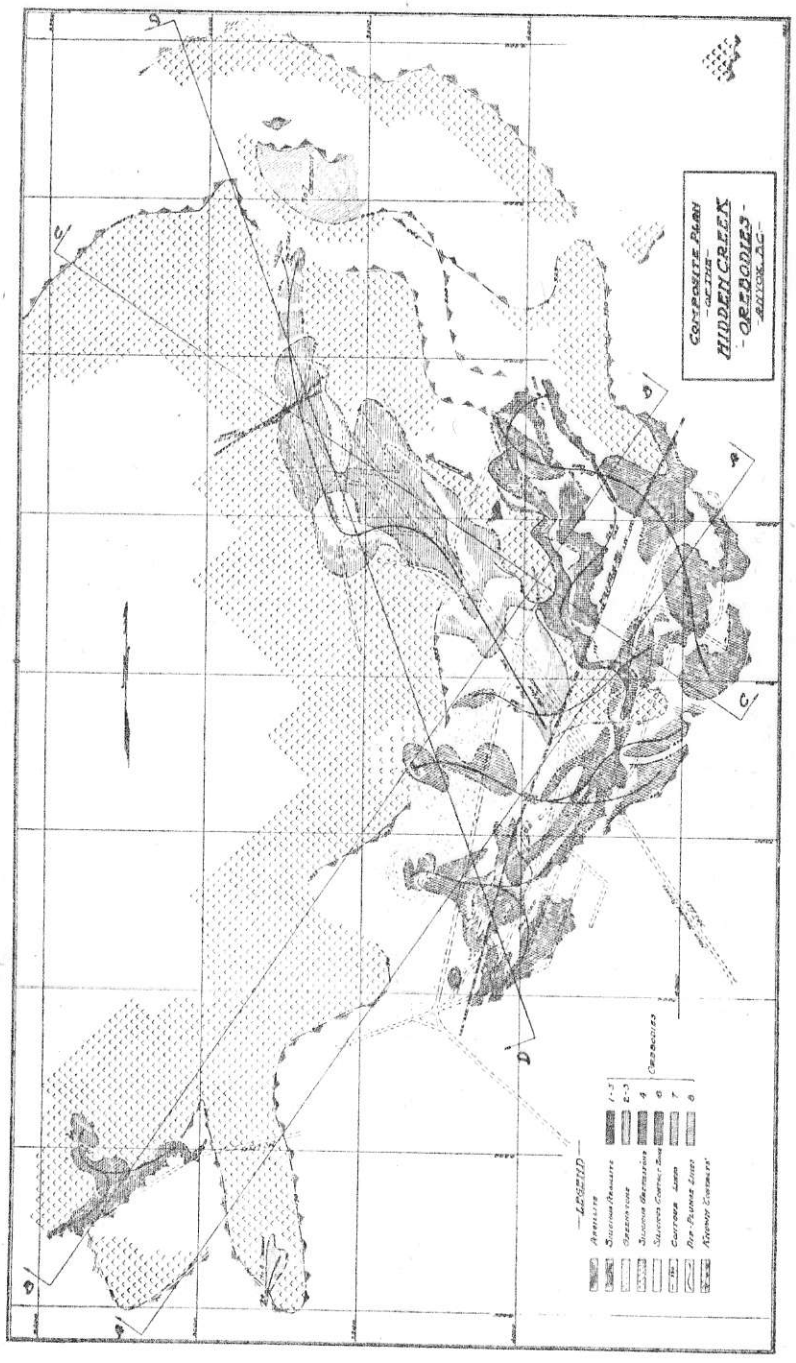


Figure 3.

Scale: 1 in. = 600 ft.

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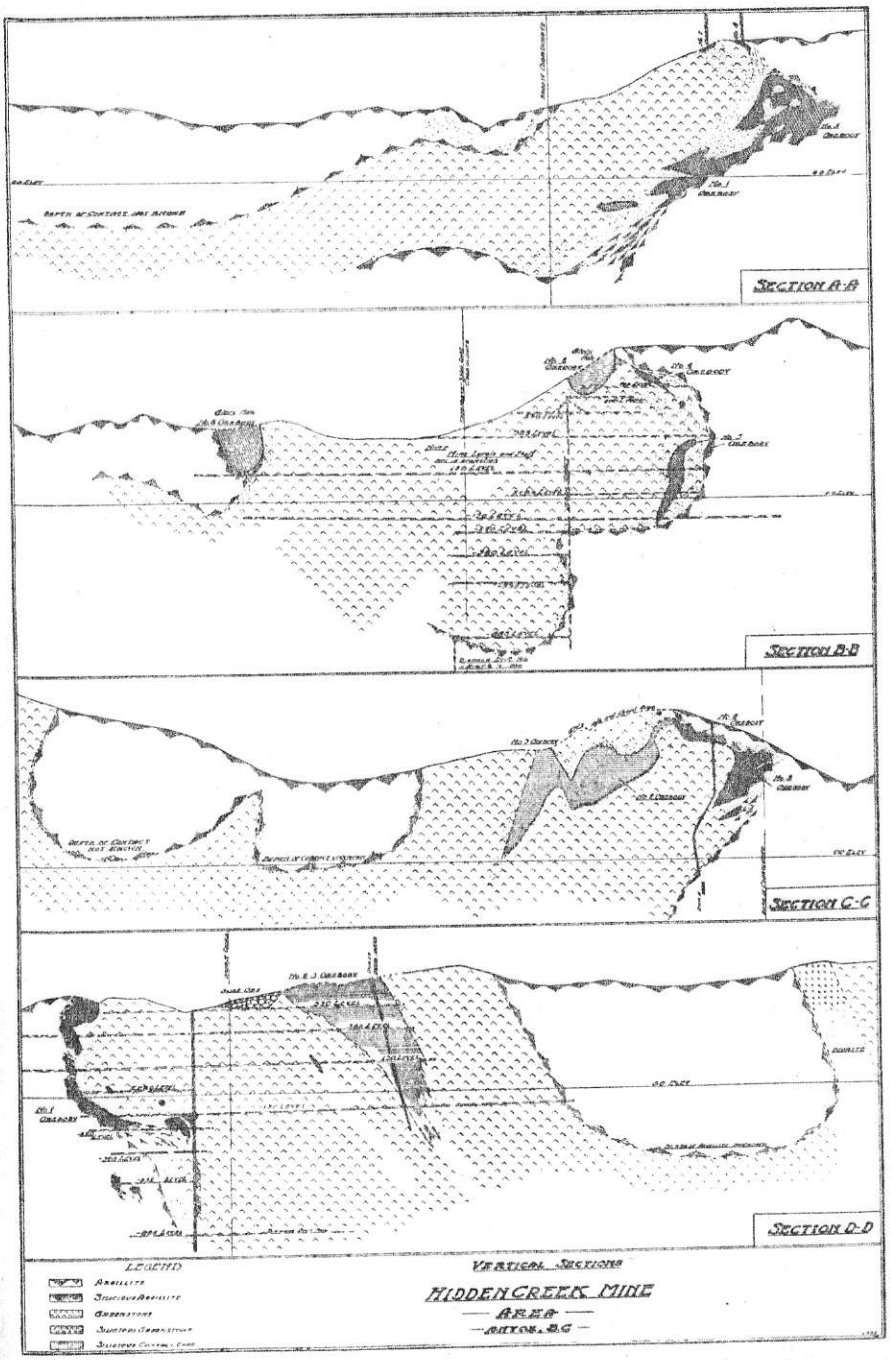

Figure 4.

Scale: 1 in. = 1,200 ft.

roughly 1,900 feet and the greatest width about 135 feet. The highest point of outcrop is at 780 feet. From this high point, the outcrop falls away in the southwest, but, by reconstruction, one can logically conclude that the original top of this zone of sulphide lenses was several hundreds of feet higher. Erosion has removed large quantities of ore and revealed the roots of other lenses. To the north of the high point, the lenses plunge beneath the argillite cover, drilling through which outlined No. 5 ore-body, some years after mining had been started in No. 1 ore-body.

No. 1 ore bottoms at the −535 horizon, but sulphide mineralization continues somewhat below this. No. 5 ore bottoms somewhat above the −120 elevation, but the low-grade siliceous pyrite root extends to greater depths. As shown in Figures 3 and 4, the upper parts of the lenses of the 1 - 5 zone hug the underside of the prong of greenstone and in their lower parts root themselves in the siliceous and foliated greenstone. Above the 150 level, the lenses overlap and make a continuous ore-zone, but below that level they divide, the No. 1 lenses trending down dip to the west and the No. 5 lenses plunging to the northwest.

To January 1st, 1934, 8,816,579 tons of rock assaying 1.6 per cent copper had been shipped from No. 1 ore-body. Of this total, 6,704,470 tons was ore, assaying 1.91 per cent copper; the remainder was low-grade 'dilution' and dyke rock. Some 8,600,520 tons, carrying 1.85 per cent copper, have been developed in the lenses of No. 1 ore-body.

From No. 5 ore-body, 2,692,865 tons of 2.37 per cent material had been shipped to January 1st, 1934, of which 2,364,940 tons assayed 2.64 per cent copper. A total of 2,750,000 tons, carrying 2.57 per cent copper, have been developed in this ore-body. Until this year, when some caving took place, the great open-stope, from which nearly 2,700,000 tons of material had been removed, remained as a cast of the ore-body.

The highest outcrop of the No. 2 - 3 ore-body is at 930 elevation. With No. 4, this ore-body sprawled over the top of the greenstone spur at the higher levels and finally, like the lenses of No. 1 and No. 5, 'dug in', and the roots are imbedded in the schistose greenstone. Mining has been carried to the −120 horizon, but sulphide mineralization persists to −300 elevation.

Measured on its pitch axis, the ore-body has a length of 3,000 feet, and, reconstructing again, one can imagine hundreds of feet were removed by erosion.

To the beginning of this year, this ore-body had supplied 8,842,139 tons of rock carrying 1.4 per cent copper, of which 6,460,980 tons assayed 1.75 per cent. To this time, 7,500,000 tons of 1.70 per cent material have been developed. Above the 530 level, the ore in that part called No. 2 was largely heavy sulphide, but in the levels below is mineralized greenstone schist.

No. 4 ore-body, of which a large part is high-grade pyrite carrying little copper, is spread out on top of the greenstone below an argillite cover. The ore-body, more than a thousand feet long, in plan, has a waving outline due to the 'corrugations' in the floor and roof. The 'corrugations' are in turn due to rather gentle rolling. At the north end, the ore-body plunges in accord with the dip of the greenstone.

Some 467,200 tons of 1.47 per cent copper ore have been developed in No. 4 ore-body. There is also a large tonnage of pyrite carrying over 40 per cent sulphur and a small amount of copper; 45,000 tons of such material has been shipped to the sulphuric acid works.

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No. 6 ore-body is a contact-type ore-body similar to No. 1 and No. 5. A series of short billowy rolls in the argillites make the ore structure. A total of 486,650 tons of 2.40 per cent copper ore has been developed in the small lenses, whose aggregate length is 600 feet at the 360 horizon. Below that elevation, the ore-body tapers rapidly by drawing in at both ends, and at the 180 elevation the ore leaves the contact zone, flattens in dip, and imbeds itself in the schistose greenstone.

No. 7 lens is the most northerly of the known contact sulphide lenses. As it is made up of pyrite and pyrrhotite carrying little copper, it has as yet only been outlined by diamond drilling; but it is probably a half-million-ton lens of sulphide.

No. 8 ore-body is a small contact-type lens occupying a minor structure on what appears to be a protruding edge, rather than prong, of the main greenstone mass. Not a great deal has been done with this ore-body. It may prove to be a connecting link in a chain of lenses following the deeply covered margin of the greenstone mass which is supposed to exist between the Bonanza and Hidden Creek bodies of porphyrite.

SHIPMENTS

Shipments to the smelter from the Hidden Creek mine were first made in 1914, and, except for two short interruptions, they have since continued on an ever-increasing tonnage scale. In the first full year, 470,417 tons of ore was smelted. By 1923, the tonnage had increased to 838,000 tons. In 1924, the first shipments went to the new concentrator and production passed the million-ton mark. In 1929 production amounted to 1,582,000 tons, and in 1932 to 1,641,037 tons. The total to January 1st, 1934, is 21,133,588 tons containing 693,181,686 pounds of copper. Production this year, to September 1st, has been 1,152,997 tons, and for the full year may reach the 1,750,000-ton mark. Since 1930, all ore has been concentrated.

Compiled analyses of the shipments show the compositions tabulated below. Heavy sulphide ore is from Nos. 1, 4, 5, and 6 contact ore-bodies; siliceous ore from the margins of Nos. 1 and 5; No. 2 and No. 3 from the ore-bodies named; and mill-ore includes all types.

TYPE OF OF ORE	TONNAGE SAMPLED	Cu %	Insol. %	SiO_2 %	Iron %	Lime %	Sulphur	Alumina %	Magnesia %
Heavy Sulphide	6,510,129	2.16	24.6	21.8	30.3	5.6	31.2	3.3	1.3
Siliceous	440,577	0.87	58.8	52.0	15.6	4.7	13.5	6.7	2.6
No. 2	2,065,288	2.28	41.1	33.1	30.4	4.4	23.0	9.0	4.8
No. 3	90,164	1.40	49.7	41.5	20.3	2.8	11.1	10.6	5.7
Mill-ore	9,386,203	1.27	47.3	38.4	21.9	3.7	16.1	9.0	3.3
Mill-ore, 1933	1,404,519	1.19	50.2	40.2	20.6	3.9	14.5	9.1	4.4