CIM Trans. X (1907), pp. 188-194

THE EMMA MINE.

(By FREDERIC KEFFER, Greenwood, B.C.)

(Toronto Meeting, 1907.)

Among the low grade mines of the Boundary District the Emma is in a way unique, in that the magnetite, which constitutes the main portion of the ore body, has persisted from the grass roots to at least the 250 level in a practically continuous vein or deposit; and also in that the vein stands vertically so far asexplored.

In the other low grade mines of the district magnetite is a frequent constituent of the ores, but its occurrence is most erratic, the deposits being irregular, varying in size from a few ounces to masses of thousands of tons, and frequently dipping (so far as any dip is observable) entirely at variance with the general dip of the ores with which they are associated.

A characteristic case was that of a body of magnetite of exceptionally good value found on the 300 level of the Mother Lode mine, which lay perfectly flat, being about 20 by 100 feet in area, but only 7 to 8 feet thick, and which was encased in barren eruptive rocks.

In the Emma (save in Quarry No. 1 where a slip has thrown the ore about 25 feet to the south east) the magnetite continues unbroken to a point some 200 feet below the surface, where diamond drilling has found what is seemingly another slip, throwing the ore again a short distance to the southeast. Diamond drilling on the 250 level has recently located the ore near the shaft.

The Emma ores are found along the contact of eruptive rocks and limestone, which limestone is here like an extensive "island" surrounded by eruptive flows. These latter rocks are of the general types characteristic of the Boundary District, analysis of which usually lie between the limits of:—

Silica	30 to 40 per cent.
Iron	15 to 25 per cent.
Lime	10 to 20 per cent.
Magnesia	0 to 5 per cent.
Alumina	5 to 15 per cent.
Alkalies	0.5 to 2 per cent.

001194

To the east of this "island" of limestone are several pyrrhotite deposits, the most prominent of which is that occurring on the "Mountain Rose" mineral claim. This pyrrhotite is extensively mined for use as sulphur flux, it being sometimes essential in order to reduce the grade of copper matte, thereby avoiding unnecessary slag losses, which accompany matte running over 50% copper. This sulphur ore consists of pyrrhotite, together with varying proportions of lime, alumina and silica, but with little or often no magnetite, in striking contrast with the Emma ores, which contain little or no pyrrhotite.

On the Emma, to the south of the limestone "island," occurs a body of magnetite, which where mined was some 20 by 100 feet in area. This ore was followed to a depth of about 25 feet, where it was cut off by a slip, beyond which no further work has been done. But little pyrrhotite was found in this place.

To the west of the limestone island occurs the main ore body of the Emma mine, which ore has been developed by quarries and drifts for some 575 feet, shown in plan and section on the accompanying map.

Most of the ore next the east wall of the deposit (which here runs about 5 degrees east of north) is magnetite, but minor bands of garnetite also occur. Along the northwest wall, however, the magnetite for the most part is next a garnet zone, which (where crosscut by diamond drilling on the 150 level) passes into a bluish and very silicious rock beyond which the drill was not pushed.

In other places the magnetite stands directly against snowy white crystalline limestone, which latter rock, when near the ore, frequently carries masses of magnetite and chalcopyrite embedded within it, this mineralization extending sometimes several feet into the limestone in diminishing ratio. In other cases, however, the line between this limestone and the ore is clear cut. The garnet zone is about 20 to 25 feet thick and in places carries sufficient copper to pay for mining.

More or less epidote also occurs along both walls of the ore. The magnetite frequently includes masses of crystalline lime spar, which are almost always accompanied by enrichments of copper. The garnet zone includes considerable magnetite scattered through the rock in crystals and little patches.

On the surface to the north of the workings the magnetite gives place to garnet ore well mineralized with copper pyrites. Still further north (about 1000 feet) the garnet again crops for several hundred feet carrying good values in copper, but now dipping to the west about 70 degrees. The copper and gold contents of the ore show decided increase on the 150 level as compared with the ore mined in the quarries. Following are analyses and assays on two lots of several thousand tons each.

	Gold	Silver	Copper	Silica	Iron	Lime	Sulphur
Quarry	.007 oz.	.06 oz.	.52%	16.5%	43.6%	12.1%	1.1%
150 Level	.031	.06	1.28	14.9	40.7	14.4	1.7

So that this ore, which was at first mined solely as an iron flux, has, under the conditions obtaining in the Boundary, become intrinsically valuable as well.

The average thickness of the magnetite deposit in the upper workings is some 18 feet, but on the 150 foot level the ore widens materially, being in places 40 feet across exclusive of the garnet ore zone. A fair average thickness of the workable ores of the mine would be 25 feet. Below are given analyses of the garnet zone, the silicious bluish drill cores beyond the garnet, the general country and also the white crystalline limestones, the rock lying immediately east of the magnetite and an approximate average of the general eruptive rock of the district. Alkalies, magnesia and other constituents present in small quantities are not included:—

	Silica	Iron	Lime	Alumina	Sulphur
Garnet Zone............	26.8	23.5	32.6	12.0	1.5
Bluish Drill Core beyond Garnet..............	63.6	5.3	4.5	16.9	.52
Limestone Country Rocks.	18.3	2.3	43.9	5.6	.00
White Crystal. Limestone..	7.6	.8	56.0	.3	.12
Rock next the Magnetite on the East..	38.5	6.5	27.6	19.3	.47
Eruptives.............	35.0	20.0	18.0	15.0	

It is evident from these analyses that the limestone and eruptives contain in sufficient measure all the constituents necessary for the formation of the garnet and magnetite zones. That these latter rocks were produced by the hot water gases and water carrying dissolved mineral derived from the eruptives, reaching upon the adjacent limestones through replacement and recombination, can hardly be doubted.

It is seen from the analyses of the ore that the sulphur present is very small, barely more than sufficient to form the copper pyrites present.

Iron sulphides are of rare occurrence, and it seems certain that the magnetite was deposited as such, and did not result from the alteration of sulphides. This view is borne out by the fact that as a rule magnetite crystals and not iron sulphides are found in the garnet zone, however far removed from the main body of magnetite. The crystalline limestone found next the magnetite in the mine is considerably purer than the main portion of the limestone formation.

The accompanying photographs of rock sections from the Emma throw an interesting light on the formation of the deposit.

Fig 1.

Fig. 1 is a specimen of garnet ore, and shows a limestone in the course of alteration to a garnet rock. Some calcite remains, but it has mainly been replaced by garnet together with a little quartz. Copper pyrites run through the mass in irregular strings and bunches, and there are also some bits of magnetite.

Fig. 2 represents a rock from the 150 ft. level, in which all the original mineral has been replaced by plagioclase, feldspar and

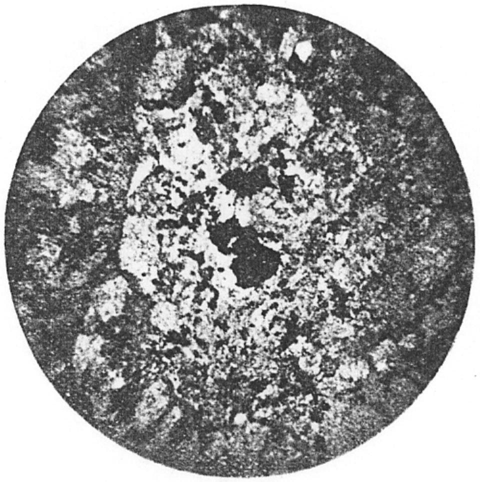
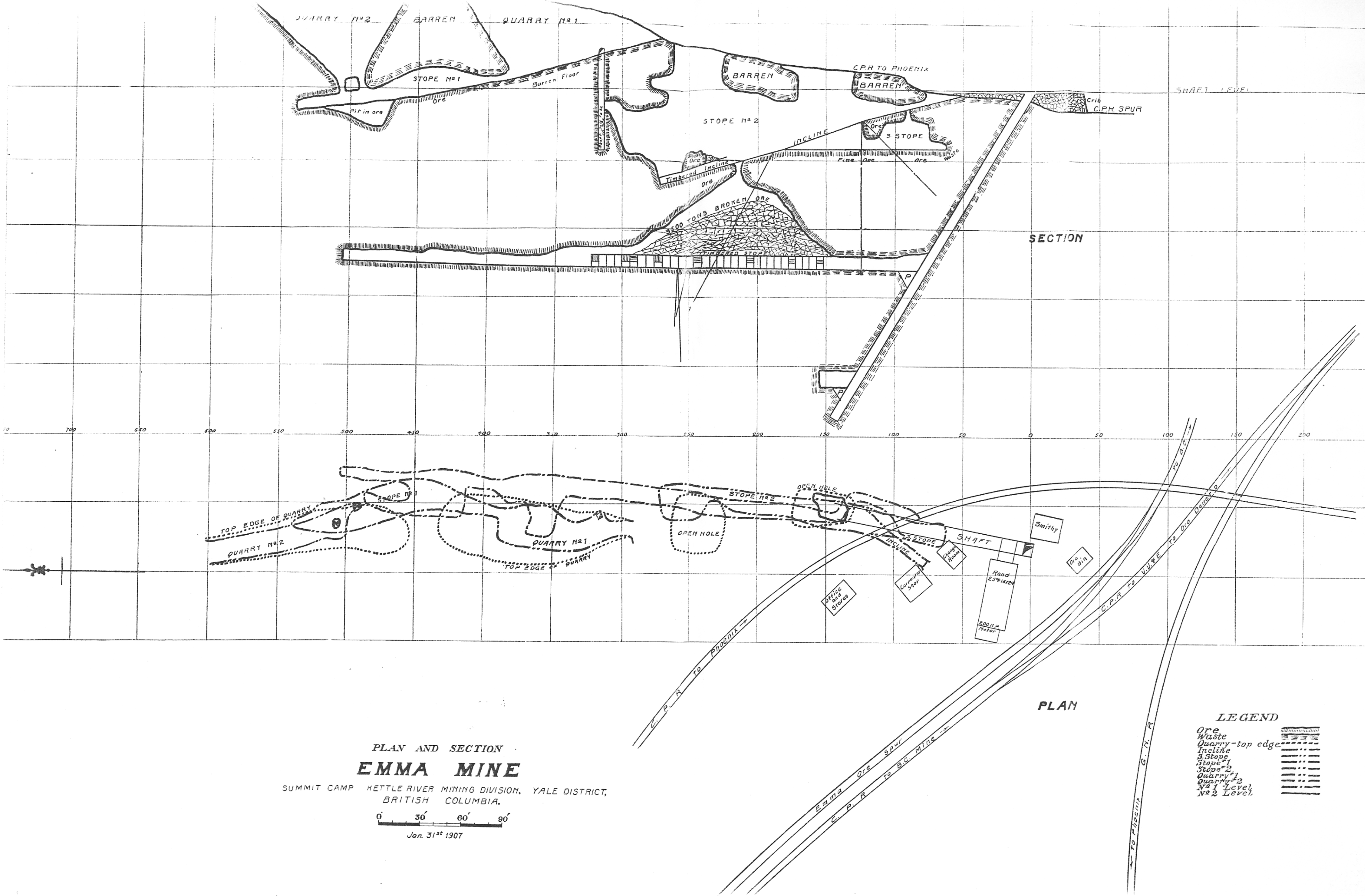


Fig. 2.

actinolite, together with some copper sulphides. This rock is probably an altered eruptive rather than a limestone replacement.

Fig. 3.

Fig. 3 is a section of the rock which cuts off the Emma deposit on the south. It is schistose through great pressure, and is



PLAN AND SECTION

EMMA MINE

SUMMIT CAMP KETTLE RIVER MINING DIVISION. YALE DISTRICT, BRITISH COLUMBIA.

Jan. 31st 1907

mainly composed of feldspar and hornblende. A few crystals of iron sulphide are also present.

Fig. 4 is from near the ore on 250 level, 40 feet north of the Emma shaft and like Fig. 1 shows limestone in the course of conversion to garnet.

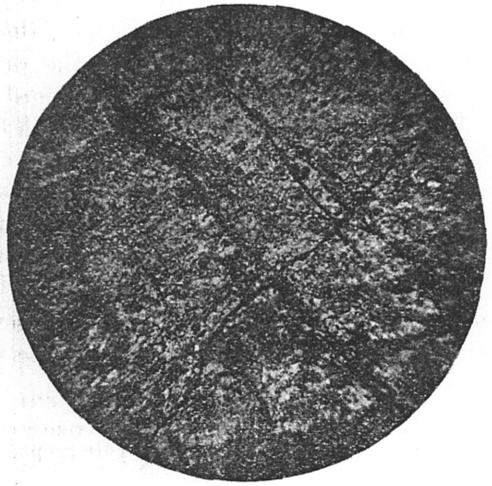


Fig. 4.

Some pyroxene is present in small grains, and all the calcite which remains is in minute lines running through the rock.

The sections are magnified 25 diameters.

Mining.—Owing to the vertical position of the deposit, mining here is a much simpler problem than in most of the Boundary mines. The shaft is a two compartment incline, angle 60 degrees. Across the drifts are placed heavy stulls supported by posts, the stulls and posts in the widest portions of the drift being often 30 inches in diameter.

The stulls are placed 5 feet apart, and are covered with 8 to 12 inch pole lagging. Chutes are provided at convenient intervals, they being at the opening 3½ to 4 feet wide by 2 to 2½ feet deep, so as to allow large rocks to pass. The ore is broken down on the timbers to the level above, only the swell being drawn from the chutes, which swell amounts to about 40%. After the level above is reached the stopes can be drawn at will, and, commencing at the point furthest from the shaft, the timbers can be removed if in condition to be used elsewhere. In commencing a stope it of course is necessary to first raise to the level above to secure ventilation. In portions of the work where bodies of crystalline limestone or poor garnet ore are found these are left as pillars to reduce the cost of timbering. The ore is so heavy, averaging from 8 to 8½ cubic feet to the ton when in place, that timbering must be of the heaviest description to bear the weight above, which weight owing to the vertical walls rests almost entirely on the timbers. Power is supplied from the Bonnington Falls electric plant some 85 miles distant, the machinery at the mine consisting of a 12 drill cross compound Rand compressor driven by a 200 H.P. motor, together with a hoist now driven by compressed air, but which will shortly be replaced by an electric hoist. There is also a steam driven X Ingersoll straight line Class A Compressor, capacity about 8 drills, which machine is held as a reserve.

There have been shipped from this mine to date some 93,500 tons of ore.

NOTE.—Rock sections were furnished through the courtesy of Dr. Frank D. Adams of McGill University, who also made a petrographic examination of them.

FURTHER OBSERVATIONS RELATIVE TO THE OCCURRENCE OF DEPOSITS OF COPPER ORE ON THE NORTH PACIFIC COAST AND ADJACENT ISLANDS, FROM THE SOUTHERN BOUNDARY OF BRITISH COLUMBIA TO THE ALASKAN PENINSULA.

By W. M. BREWER, Victoria, B.C.

(Toronto Meeting, 1907.)

Since the paper* submitted by the writer to the Institute and read at the Quebec Meeting, in March, 1906, the writer has had further opportunities of investigating this subject. The result of these observations has confirmed more fully the view that the classification of the various deposits of copper ore as noted in the previous paper, are substantially correct.

They are as follows:

1. Bornite ore accompanied by some carbonates, chalcocite, and at the deeper levels chalcopyrite, which occurs in contact deposits between crystalline limestone and igneous rocks, usually felsite associated with which is garnetite.

2. Chalcopyrite ore which occurs sometimes with magnetite but often in a quartz matrix in deposits of lenticular structure in fissures in the basic igneous rocks.

3. Chalcopyrite ore usually in a magnetite matrix which occurs as contact deposits between crystalline limestone, slate or schist, and igneous rocks.

4. Chalcopyrite ore occurring in association with iron pyrites, barite or heavy spar, and a small percentage of lime which has only been found up to date in a schist country rock.

5. Pyrrhotite ore carrying low copper values sometimes in a gangue composed of a high percentage of epidote, garnet amphibole and some calcspar, which occurs either in fissures in basic igneous rocks, or else at the contact of crystalline limestone and the igneous rocks.

* Journal Canadian Mining Institute, Vol. IX, p. 39.