THE GEOLOGY AND ORE DEPOSITS OF FRANKLIN CAMP, B.C.

By R. W. Brock, Ottawa, Ont.

(Toronto Meeting, 1907).

The steady increase in the mineral production of British Columbia, which, last year, is estimated to have exceeded $26,000,000.00, the dividends now being paid, not by one concern but by a considerable percentage of the operating mines, the continued increase in the demand for copper and the corresponding great advance in its price, the opening up of new territory by railway construction, the general prosperity throughout the commercial world, have all contributed to a revival of outside interest in mining in this Province, and to restore that confidence which, since the collapse of the '97 boom had been withdrawn. This renewal of interest will find expression in the reopening of properties now lying dormant in the older districts and in the birth of new camps. Portents of this are not lacking. One of the first districts to benefit by this improvement in conditions is what may be termed the hinterland of Grand Forks.

The town of Grand Forks is situated in Yale district, at the Forks of the Kettle River, the Eastern entrance into the Boundary Creek District. Its chief industry is the large smelting works of the Granby Company which treats all the ores from their Phoenix mines, located on the mountains a few miles to the west of the town.

A short distance up the north fork of Kettle are several small mineralized areas that were partially developed some years ago, but which have been neglected the last few years. Farther up stream, on the East Branch of the North Fork, forty-three miles from Grand Forks, is Franklin Camp. It was located by Franklin MacFarlane, for many years a trapper on this stream. His discoveries and those of some friends, attracted prospectors and in 1900, a little colony of them were busy in this camp. During the

same summer a reconnaissance survey, which included Franklin Camp, was made on behalf of the Geological Survey by the writer and Mr. W. W. Leach. The results of this survey were embodied in the West Kootenay map sheets published by the department.

But the camp had come into notice too late to be benefitted by the boom. Moreover, it was three days journey by pack train from Grand Forks, there was no immediate prospect of transportation facilities, and none was prepared under these conditions to buy surface showings at boom prices. During the last two seasons however, some attention has been paid to the district north of Grand Forks. Last summer a wagon road was constructed to the camp bringing it within eight hours stage journey from the railway, and work was begun on a branch railway from Grand Forks up the North Fork to Franklin. Several townsites had been platted, and hotel and store accommodation provided.

Some of the salient points in the geology and topography are shown on the map, taken from the West Kootenay Sheet of the Geological Survey. Many of the geological boundaries represented are only approximate as when the reconnaissance was made the country was to a large extent timbered. Since that time the district has been burnt over and the rocks and ledges are now much better exposed; but as my visit last summer was restricted to one day, nothing could be done toward revising the boundaries. The present paper is based largely on observations made during the reconnaissance.

The geology of the camp is somewhat complicated. The oldest recognized rocks are sedimentary, often greatly metamorphosed. Among these the most conspicuous when not too highly altered, is limestone. It is metamorphosed to crystalline limestone and lime silicate hornfelds. The latter is sometimes a green and sometimes a compact, broken up, light-colored, porcelain-like material, resembling a baked argillite. When alteration to silicates has been uneven and incomplete, a breccia-like or conglomerate-like rock results, with the green silicates sometimes as the matrix, with limestone rests and sometimes as the nodules, with an unaltered limestone matrix. The limestone and its alteration products occupy a larger area than represented by the limestone coloring on the map. Some argillites occur in this series, and closely associated are some greenstones. Large masses of gray Nelson granodiorite is intrusive in these basal rocks. Both these formations are intruded by small masses of a gabbro-like rock and a porphyritic syenite distinguished by its long reddish feldspar crystals. Towards the west, forming the West Branch divide is a light acid granite (Valhalla Granite) intrusive in the above series, and to the East a pink, alkali-syenite, also later than, and intrusive in the above formations. Numerous porphyry dykes from these intrusives traverse the older rocks.

At many points overlying the previous formations is a series of Tertiary rocks. These consist of quartzite-like, gritty tuffs with coarse conglomerate bands, conglomerates and ash beds, and overlying these again, lava flows with some inter-leaved ash rocks. The conglomerates hold pebbles and boulders of the older rocks particularly of the granodiorite, limestone, greenstone and an older, finer-grained conglomerate. These range in size from a half inch to two feet in diameter. The conglomerate appears to cover a greater area than represented on the map, reaching in places to the North Fork bottom. It is cut by dikes from the alkali syenite and from the volcanic rocks.

The lava beds, which occupy the higher levels, show in places basaltic jointing. Some beds are rich in gas pores, the latter often containing agate, calcite or zeolites. The intrusive rocks have profoundly altered the older formations over considerable areas, and incidentally ore-deposits have been developed in the latter.

The deposits so far uncovered present several more or less distinct types.

1. Those in which the gangue consists of country rock altered to green lime-silicates such as hornblende, epidote, garnet (generally reddish) with quartz and calcite. Such deposits, since they are especially apt to occur in the (altered) limestone may be, for convenience, called the limestone type.

Deposits of this class differ in the relative amounts of their metallic minerals and using this as a basis, may be sub-divided into—

(a) Pyritic Type,—The metallic minerals consist predominantly of pyrite and chalcopyrite.

(b) Magnetitic Type,—The metallic minerals consist predominantly of magnetite with some copper and iron sulphides.

(c) Galena Type,—The metallic minerals consist of galena, blende and chalcopyrite—This type occurs on the McKinley near types a and b; the silicate minerals are not prominent in the exposures on this lead, the crystalline limestone often abutting against the sulphides.

2. Chalcopyrite or pyrite deposits with molybdenite, calcite and quartz in crushed zones, fractures, fissures or near contacts. Replacements or substitution of the minerals of the country rock by ore is usually conspicuous. Grandiorite or porphyritic syenite formed the country rock in all deposits of this type seen by the writer. For convenience, then, these may be referred to as the granite type.

3. Quartz veins, in which quartz is the dominant mineral accompanied by galena, blende, pyrite, chalcopyrite, molybdenite arsenopyrite, etc.

The most extensively developed claim is the McKinley, on which approximately $30,000 has been expended in surface improvements, trenching, tunnelling and diamond drilling. On the north slope of McKinley Mountain in a band of crystalline limestone, running north across Franklin Creek to Franklin Mountain, four leads have been uncovered. The strike of the leads has not been definitely determined but they appear to be lying transversely to the direction of the limestone band—here about 300 feet wide. Along these leads the limestone is more or less changed to epidote, hornblende and garnet. The lowest lead, exposed by an open cut shows a heavy development of magnetite with some pyrite and chalcopyrite. The latter, while somewhat disseminated in small specks, show a tendency to accumulate in veinlets in the magnetite. Diamond drilling, which was in progress on this shewing, was said to be demonstrating a fair sized body of ore.

The second ledge outcrops for a width of about 30 feet but the dip is at a low angle southwest. It shews a heavy development of galena and blende as well as chalcopyrite. The lime silicates are only sparingly developed here, the crystalline limestone being often in direct contact with the galena. Only open cuts have been made in this lead. The grade of ore is stated to be high, particularly in silver. The third ledge, in which the chief work has been done, holds iron and copper pyrites with a considerable amount of the gangue minerals. It is supposed to be about 40 feet wide, dips 45° S, and has been traced for 300 feet.

The main working is a tunnel. About 100 feet in, a cross-cut has been run westward 104 feet, the last 80 feet of which is in ore. 214 feet in the tunnel 15 feet of ore is encountered (No. 4 lead). This ore is like that of No. 3, except that it contains less pyrite and more chalcopyrite.

Average assays of the largest ledge are said to run about 2.5% copper, and about $2.00 in gold and silver.

The McKinley Company was also testing the Banner claim on Franklin Mountain by diamond drilling. This claim has not been seen by the writer since 1900. At that time a strong, very wide lead of quartz, mineralized with galena blende and chalcopyrite was exposed.

On the Maple Leaf claim on the north-east slope of Franklin Mountain, copper ore occurs in the reddish porphyritic, syenite near and along its contact with the basal formation. The mineralization is confined almost exclusively to the intrusive rock. Fractures in this syenite are filled with seams of chalcopyrite and pyrite or with green malachite resulting from the alteration of the copper ore by atmospheric weathering or surface water, and in addition there is marked selective replacement of the minerals of the syenite by the sulphides. The colored constituents are more readily replaced, so that where the action has not been excessive the prominent feldspar crystals may be found lying in a sulphide base. Where the replacement has been more extensive, the feldspars are attacked, and finally the whole mass of rock becomes sulphides. At several points along the contact, which is generally covered with wash, wide stretches of the more or less mineralized syenite have been uncovered. About 400 feet back from the contact, an open cut has exposed a lode 4 feet wide of fairly well mineralized rock.

The Gloucester group, now being worked under bond by the Dominion Copper Company, was not visited. On the G. H. claim of this group is a ledge of magnetite, with a little pyrite and chalcopyrite. In places it is at least forty feet wide, and it has been traced several hundred feet. It seems to lie wholly in the grey granodiorite. On the Gloucester was a good showing of copper ore, with pyrite, molybdenite, calcite, and quartz, with grey granodiorite on one side at least, but the country rock is badly altered. Development here is made more difficult by some faults which have been encountered.

On the south slope of Tenderloin Mountain, several copper lodes were seen during the survey of the district. They occurred in the gray granodiorite, in fractures, or crushed zones. In the latter, the rock is sometimes crushed to a sort of nodular structure, the more highly triturated material of the rock wrapping round the ball-like rests of unbroken material. In these crushed zones, particularly along well marked fracture planes, the mineralization by copper and iron sulphides is quite heavy.

In addition to the claims mentioned, a large number are held, on which deposits of one or more of the types mentioned, have been discovered. Most of the claims spoken of lie within an area 3 x 1½ miles, and an area 8 miles long by 1 to 4 miles wide—covering both sides of the river, would embrace most of the discoveries so far made. There are possibilities, however, in this camp over a somewhat longer and a much broader area—all that ground lying within the encircling, recent acid or alkali eruption rocks, for all the older rocks of the camp, the altered basal rocks, the granodiorite, gabbro and porphyritic syenite are mineralized and lode bearing. Lodes of the first type are likely to occur in the continuation of the limestone band northward from the McKinley, and in other limestone or altered limestone areas. Contacts seem promising points for prospecting, and in addition to the contacts, shear or crush zones in the massive rocks. From what has been seen of the acid granite, and the pink alkali syenite (Rossland alkali syenite) and the Tertiary lavas, both here and elsewhere in this part of the Province, it is altogether unlikely that workable deposits, at all events of the described types, will be found in these rocks, but the older formations along their contacts, and along dykes from them is good ground to prospect.

In its geology and the nature of its ore deposits it bears a strong resemblance to the Boundary Creek district. The main rock formations are common to both, as are deposits of types I a and b, and 3, the main difference being that in the Boundary sulphur is less plentiful so that pyrrhotite is found in place of pyrite, and iron oxides are more prominent.

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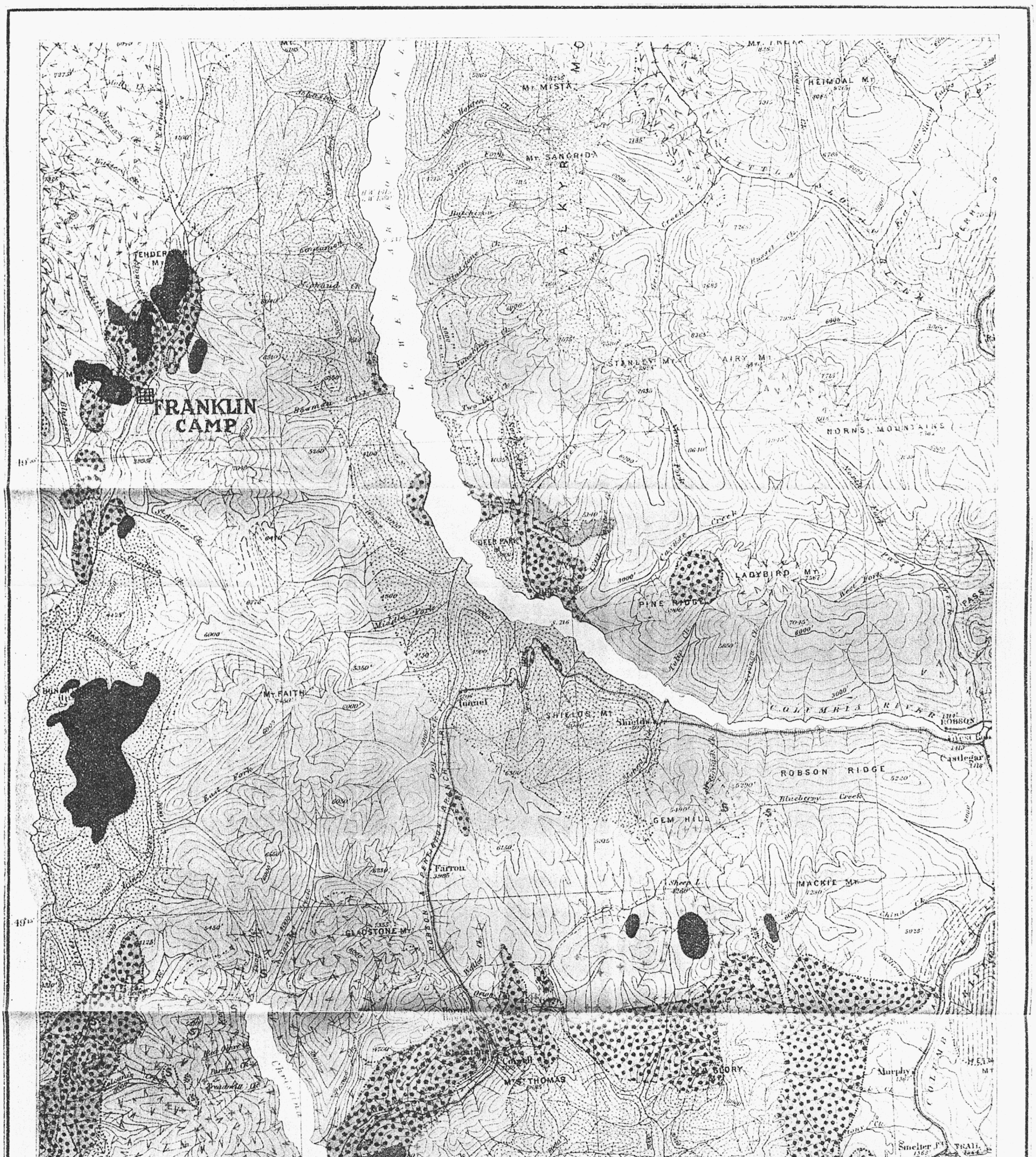


Section of West Kootenay Map published by Geological Survey of Canada showing position of Franklin Camp and relation of Rocks at the ...

Deposits of Type 1 are connected with contact metamorphism by intrusive rocks—and are to be explained by the influence of heat, together with mineral-charged waters or vapors given off by the cooling intrusive magma upon the country rocks. Such emanations ascend as best they are able by all sorts of channels, among which fissures and fracture planes are likely to be important. The rock along these channels usually exhibits characteristic alteration produced by these mineralizers and is often replaced by the mineral matter carried by them for some distance on either side of the channel—especially when complex fractures enable the solutions to wander into the rock and expose a great number of surfaces to attack. It will be evident that contact metamorphic action will not be confined to the immediate contact of the intrusive rock (indeed may be absent there) but may be irregularly distributed, according to the physical and chemical characters of the neighboring country rock, the distance below the surface, temperature and other precipitating conditions. There may be expected to be transitions between contact metamorphic deposits and ordinary lodes or veins and such have been found in a number of places. Deposits of Type 2 ore probably to be regarded as such—as are also the deposits of the Rossland Camp now being mined. Deposits of the contact metamorphic type seem to be widespread in Southern British Columbia, not only in Boundary and Franklin, but in other districts as well, and will, no doubt, be recorded from a great many localities.

From descriptions of copper and magnetite deposits in the Similkameen, Kamloops and the coast, it would appear to the writer that examples occur in these localities. On the outskirts of the Rossland Camp the same type occurs, and transitional types to ordinary lodes and veins are widely distributed.

It has not been absolutely determined for Franklin Camp what intrusive rock has been responsible for the metamorphism and mineralization. The possibilities are the granodiorite, the alkali syenite, and the undiscovered or unrecognized plugs or dykes which gave vent to the lavas. The first is in closer proximity to the deposits in large exposed areas, but the second is well represented by large dykes; of the third, as no information is at hand, nothing may be said. The granodiorite is itself deformed and mineralized; the alkali syenite at certain points in this section is responsible for mineralization and seems to have been injected just prior to the great period of ore formation. Both these rocks are present in the districts in southern British Columbia visited by the writer, which are characterized by this class of deposits. At present, the balance of the evidence seems to be rather in favor of the alkali syenite as the metamorphosing rock. In the Boundary district the large syenite porphyry dykes seem to have been furnished the mineralizers.(1) In a recent monograph (2) Lindgren ascribes the origin of the Clifton-Morenci contact deposits to porphyry dykes.

The contact metamorphic deposits, while distinguished by Von Goddick in 1879, have only in recent years been recognized as an important type, found in a large number of copper gold districts, but an extensive literature on the subject is now being rapidly accumulated.(3)

Of the more important deposits of this class may be mentioned some of the Clifton-Morenci copper deposits, Arizona (4) the copper deposits of Cananea, Mexico (5), and the gold copper deposits of many other parts of Mexico. In Eastern Ontario, the writer has recognized examples of this type.

Since limestone has been found to be the country rock of most of the contact metamorphic deposits hitherto described and consequently seems to be the rock most susceptible to this mode of alteration, and since in its impurities it contains many of the elements necessary to form with the lime the observed gangue

(1) Preliminary Report on the Boundary Creek Mining Dist. Summary Report G. S. C., 1902, p. 90-136.

(2) Prof. Paper, 43, U.S. G. S.

(3) As examples the following may be cited. The Character and Genesis of Certain Contact Deposits. W. Lindgren, Genesis of Ore Deposits, A. I. M. E., p. 716, T. A. I. M. E., Vol. XXXI.

Copper Ores and Garnet in Association, W. P. Blake, T. A. I. M. E., XXXIV, p. 886.

Limestone Granite Contact Deposits of Washington Camp, Arizona, W. O. Crosby, T. A. I. M. E., XXXVI, p. 626.

Ore Deposits at the Contacts of Igneous Rocks and Limestones, and their Significance as Regards the General Formation of Veins. J. F. Kemp, Economic Geologist, Vol. II, p. 1.

Die Kieslagerstatten Roros Sulitelma und Rammelsberg. J. H. L. Vogt, also Genesis of Ore Deposits, A.I.M.E., 1902, p. 648. Zeilschiep for Prak. Geologie, 1894, p. 177, 464, and 1895, p. 154.

(4) Lindgren, U. S. G. S., pp. 43; and T.A.I M. E., Vol. XXXV, p. 511.

(5) Ore Deposits near Igneous Contacts, Weed, T. A. I. M. E., Vol. XXXII., p. 715.

minerals, the inference has been widely drawn that such deposits are peculiar to limestone contacts. This fact has even been included in various definitions of this type of deposit. Many authorities (Rosenbusch, Barrell, Zirkel Klockmann) hold that the results are due to the alteration of impure limestones through heat alone and that there has been no addition of material, by waters and vapors, at all events none to go towards the formation of the typical gangue minerals. Others as Michel Levy, Vogt, Lindgren, Kemp and Blake bring forward facts to show that some of the material of these minerals has been introduced by emanations from the intrusive lava. In the Boundary Creek District the evidence is wholly in support of the latter view, (6) and the same seems to be true in Franklin Camp.

In many places the limestone is altered to marble, except in the mineral bearing zones. These mineralized zones have not the accordance in strike, nor the regularity in distribution that impure bands in a limestone formation would possess. The ores must certainly have been introduced, and there is good reason for believing that the iron and silica of the silicates have been as well. Moreover, these deposits are not confined in these districts to limestone as a country rock.(7) In the Boundary Creek District the writer has shewn that even the granodiorite is mineralized to some extent in this way and that in it garnet zones are developed. A fuller description of this formation of garnet in granodiorite will be given in a paper shortly to be published. Kemp in a recent paper (8) describes the formation of a similar mineral bearing garnet zone in granite porphyry at White Knob, Idaho. In Franklin Camp, the magnetite ore of the Gloucester Group, according to notes taken in 1900, occurs in the granodiorite, and some of the copper ores of the camp also have this as their country rock.

The development work already done in Franklin Camp is limited and shallow, so that it is not known how the values, particularly the copper values, will hold out in depth, nor is it yet

(6) Preliminary Report on the Boundary Creek District, R. W. Brock, Summary Report, G. S. C., 1902, p. 90,-136.

(7) Op. Cit., page 107, also Journal Can. Min. Inst., 1902, p. 369.

(8) Econ. Geol., Vol. II, p. 1.

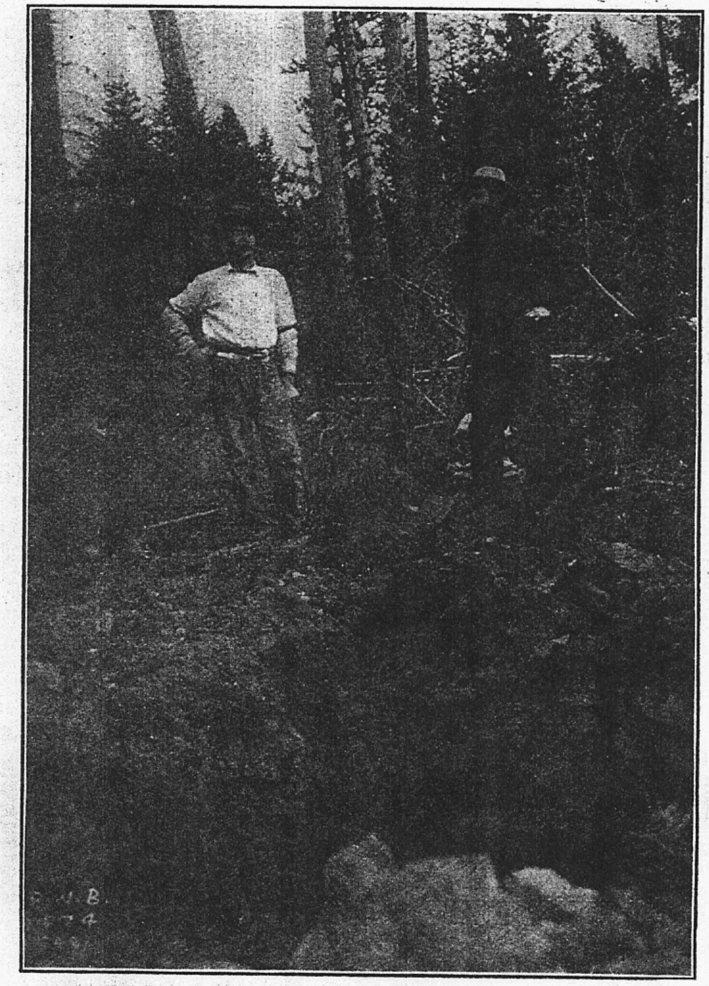
demonstrated that a large tonnage of low grade ore can be minatained. To prove these points requires extensive development and time. While good values have been found on some of the lodes it will probably be on low grade ore that the success of the Camp must depend. The results on the McKinley, so far, seem to be encouraging.

While nothing can yet be said of the extent and value of the mineralization, while it is yet too early to state that any one of the prospects is going to be a good mine, it may be said that the camp possesses many of the earmarks of a mineral-bearing district and that in kind, whether or not in degree, in the nature of its ores whether or not in extent, it takes its place in a goodly company of mining camps, among which its neighbor, the Boundary Creek District is not the least important.

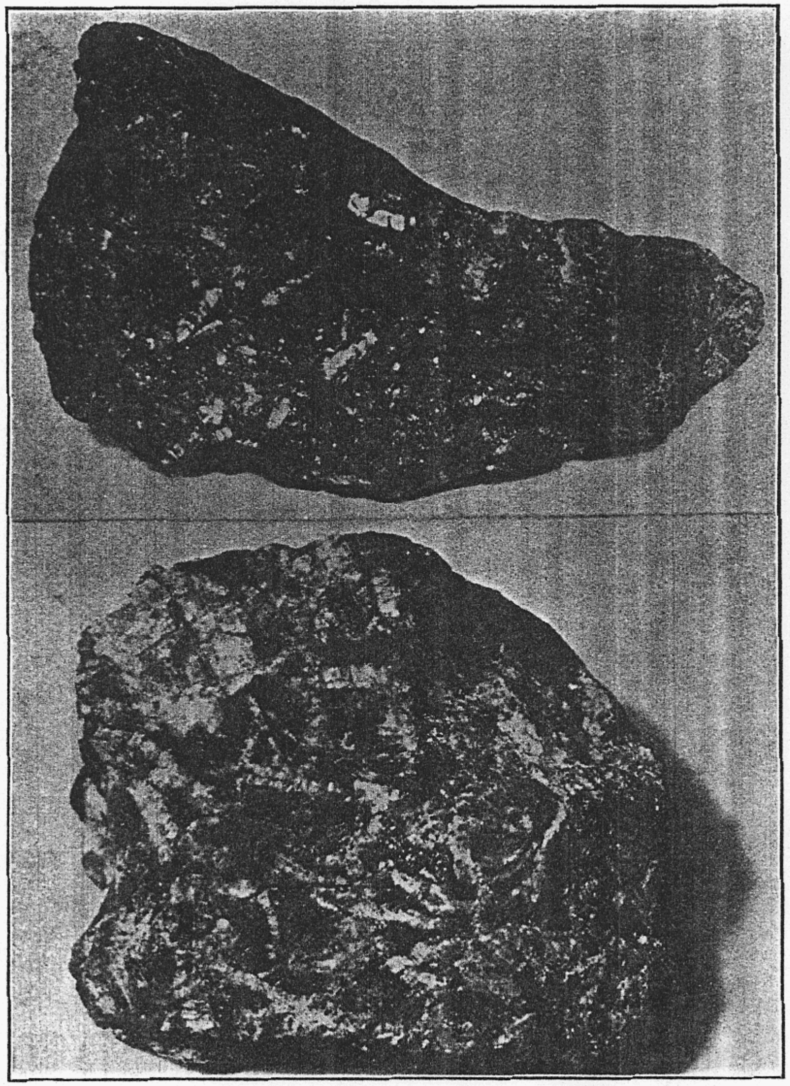
The expensive development work required in this camp will be greatly facilitated by the railway and when this reaches the camp, its possibilities will no doubt be tested as they deserve to be.

(1.) A Bunch-grass Hillside near Franklin Camp.

(2.) On the North Fork of Kettle River near Franklin Camp.



(3.) Prospect on the North Fork of Kettle River.



(4.) Ore in Porphyritic Syenite, Maple Leat Claim, Franklin, B.C. The light crystals are original feldspars, the dark ground mass is largely secondary chalcopyrite, which has replaced minerals of the syenite.

REVIEW OF PROGRESS IN THE MINERAL PRODUCTION OF BRITISH COLUMBIA.

By E. JACOBS, *Victoria, B.C.

(Toronto Meeting, 1907.)

British Columbia's total mineral production to the end of 1906 is shown by official records to have been $273,643,000. This production was apportioned as follows:—

Placer gold		$68,721,000
Lode Metals—		
Gold	$41,016,000	
Silver	25,586,000	
Lead	17,626,000	
Copper	35,546,000	
Iron and zinc	270,000	120,044,000
Total metalliferous		$188,765,000
Coal and Coke—		
Coal	$72,815,000	
Coke	6,520,000	
	$79,335,000	
Building materials, etc	5,543,000	
Total non-metalliferous		84,878,000
Grand total of production		$273,643,000

Reviewing several periods it is seen that from the time of commencement of mining operations in the Province to the end of 1886, the total value of production was $64,246,000, in the following proportions:—Placer gold, $53,797,000; coal, $10,449,-000. In the ten years, 1887-1896, a total of $37,809,000 was produced, this consisting of placer gold, $5,006,000; lode metals, $8,126,000; coal and coke, $23,537,000, and building materials, etc., $1,140,000. For the ten years, 1897-1906, the total was

* Editor *British Columbia Mining Record.*