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Pyrometasomatic Iron-Copper Deposits on the West Coast

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THE coast and islands are the site of many of the new mining developments in British Columbia. Five mines will start producing ore in 1962 (Kennedy Lake, the F.L. at Zeballos, Jedway, Coast Copper, and Sunro) and at least two others (Tasu and Bugaboo) have outlined substantial tonnages of proven ore and may produce in the near future. In addition a number of prospects of real importance are currently in early stages of exploration and some of these are completely new discoveries. This is quite a change from the situation as it was only four years ago. I do not intend to discuss the factors that have brought about this change nor do I intend to dwell on the individual properties which are well known to most of you. Instead I would like to consider some common aspects of the pyrometasomatic iron-copper deposits: their setting, some general characteristics, and some aspects of prospecting for them. Three producing mines (Texada, Empire, and Nimpkish), four of the mines coming into production in 1962 (Kennedy Lake, Jedway, Coast Copper, and F.L.), and two principal prospects (Tasu and Bugaboo) are of this type. Hence they domniate the mining scene on the coast at present, even though some of the other types of copper and iron deposits may be more important.

The pyrometasomatic iron-copper deposits on the coast have been known and accurately described for a long time. These deposits are formed of magnetite and skarn minerals with some iron and copper sulphides. Although magnetite is commonly the principal product a gradation exists to deposits in which chalcopyrite is the more valuable mineral. Most of the "new" mines were known as significant mineral occurrences well before this Chamber of Mines was constituted. Kennedy Lake has the nearest claim to being a new discovery as ore had not previously been found on the property even though a magnetic anomaly was described in the Annual Report of the Minister of Mines for 1902. Other deposits like the Jessie at Jedway were known but were thought of as relatively minor occurrences until recent exploration. The general nature of the deposits was described by McConnell, Young and Uglow, Swanson, Gunning, and others, who stressed their replacement origin, their skarn envelope, their relation to dioritic intrusives, and the ubiquitous presence of limestone. Bacon and Black were the first to emphasize that much of the replacement was of volcanic rocks adjacent to limestone. Jeffery gave a good review of the deposits as recently as last fall. Thus it would seem that there is not much left to say, and that those who have been thinking about these deposits have all been through the same course of study and presumably have reached similar points of view. With this in mind I will discuss some factors that have not been fully treated.

Firstly, the major deposits so far described are not associated with just any limestone — they are associated with one particular limestone. This is the Upper Triassic limestone called the Quatsino formation on Northern Vancouver Island, the Kunga on the Queen Charlotte Islands, and the Marble Bay on Texada Island. The stratigraphic succession is not everywhere identical but it is very similar throughout, and the Early Mesozoic geological history of coastal British Columbia can be summarized as follows. Prior to deposition of the limestone a great pile of uniform basaltic pillow lavas was extruded all along the present coastal area, and this period of volcanism seems to have closed abruptly in the early Upper Triassic. The period that followed was unique in its lack of volcanism and of tectonism (faulting, folding, clastic deposition, etc.) and was a time during which the greatest limestone of the whole western eugeosyncline was deposited. Volcanism was renewed sporadically and at separate localities during the latest Triassic in some places, and the Early Jurassic in others so that the limestone is overlain in some areas by dark thin-bedded argillites and in others by fragmental volcanic rocks. By the Middle Jurassic volcanism was again universal, but produced younger volcanic rocks that are characteristically fragmental and more andesitic than those underlying the limestone.

Most of the known major ore deposits are in the uppermost part of the older volcanic rocks, called the Karmutsen on Northern Vancouver Island, and many continue into or have adjacent bodies in the basal part of the limestone. Such deposits include Tasu, Jedway, the Old Sport or Coast Copper, Nimpkish, Iron Hill, the Lake orebody of Texada, and possibly the Iron Duke and Kennedy Lake. On the other hand some deposits are in the base of the younger volcanic rocks (Bonanza formation) at the upper contact of the limestone, including the F.L. at Zeballos, the Merry Widow orebody at the Empire mine, and possibly Yreka. Finally, the Texada orebodies other than the Lake and the Kingfisher orebody at Empire may be entirely within the limestone but near the top or bottom of it.

Other types of iron and copper deposits exist and pyrometasomatic deposits in other settings are known,

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does not extend for at least the same distance below the level.

The Jersey ore body lying about 1000 feet west of the East Jersey is a separate and distinct zone. It has been tested by 21,882 feet of surface diamond drilling, 3,700 feet of underground drifting, and 16,176 feet of long hole percussion drilling. The average grade varies between 0.78 and 0.84% Cu. depending on the cut-off grade. Mineralization is much the same as in the East Jersey and the same northeasterly trends are still much in evidence. On Fig. A., the shape of the zone is roughly circular being about 900 feet in an east-west direction and 800 feet in a north-south direction. This circular shape owes its existence to the irregular arc shaped contact between the Guichon quartz diorite and the Younger Complex. Although pyrite occurs in only minor amounts, it is more abundant on the east side of the zone. From Fig. B it will be seen that the centre of the induced polarization anomaly lies near the eastern margin of the zone and not directly over the ore body. The probable explanation is that the amount of total sulphide is greater on the east side than elsewhere. Although the copper sulphides occur both as disseminations and fracture fillings, the former appear to be the dominant mode of occurrence. Metal values are much more uniformly distribnted than in the East Jersey although locally there are some high grade zones. Actually, the Jersey body is a zone of stronger copper mineralization encompassed by a much larger and weaker zone. Towards the margins, the values gradually decrease and the walls are therefore assays walls. Increase in copper prices could easily extend the present pit walls and add substantially to the ore tonnage. In contrast, the contacts between waste and ore are sharp in the East Jersey and the copper values more erratically distributed. Alteration is pervasive and the rock is generally greenish in color due to abundant chlorite. In the highly altered sections the rock appears to be mainly quartz, chlorite and sericite. As in the other mineralized zones there is a strong affinity of the copper sulphides for the mafics minerals, biotite, hornblende and chlorite. Locally breccia is strong but the whole zone appears to have a weakly shattered or mottled effect and there does not appear to be any appreciable difference in copper values between the brecciated and unbrecciated rock. Again, this is in contrast to the extreme brecciated areas seen in the East Jersey and with which the better mineralization appears to be associated. That faulting has influenced deposition is shown by the Jersey Fault. This is a strong northerly trending gouge filled structure with a steep westerly dip. Strong mineralization occurs on both sides of the faults for a distance of 200 feet.

Structural elements such as intrusives, breccia, pervasive alteration as well as mineral distribution shows a similar north to northeasterly trend suggesting that all were controlled or influenced by the same deep-seated zone of weakness.

The main zones of mineralization lie close to the Guichon-Younger Complex contact. While this contact is somewhat generalized and shewn as a rather smooth line, it actually is very irregular and complex. At these localities the rocks prior to the development of the breccia were shattered and jointed. This is evidenced by the tabular nature of some of the fragments. Subsequent mineralization took place in these fractured and brecciated areas. Not all the breccia is mineralized and in most cases mineralization extends beyond the boundaries of those that are.

As to the formation of the breccia there is some disagreement. Dr. Carr has suggested that it resulted from the explosion of the dacite porphyry (P-3) under special conditions. He bases his opinion on the fact that the breccia matrix resembles the quartz porphyry (P-3) and that breccia is developed along them or at their terminatlons. Since no quartz diorite porphyry (Crowded porphyry) fragments have been recognized he believes that the breccia was formed before the intrusion of lhe Crowded porphyry. Drs. White, Thompson and McTaggart, on the other hand, have suggested that the matrix is composed of comminuted rock material and that gases escaping through the breccia have redistributed the fine matrix material. Both, however, agree that the breccia is an intrusive breccia and not a fault breccia.

It seems plausible that the final explosion along pre-existing faults resulting in somewhat tabular shaped breccia masses trending in a direction of the guiding faults. The final result being areas of intense breccia adjacent to the faults with less disturbed ground away from the faults. Depending on the closeness of the faults will depend the size of the brecciated area. This is suggested as a possible explanation to account for those brecciated masses alternating with areas of undisturbed or weakly disturbed rocks.

Both Deer Valley and Witches Brook appear to be fault controlled. Due to absence of suitable markers, the amount of displacement along known or inferred breaks is not known although the trend of electromagnetic conductors suggest that some of the faults are left handed.

For prospecting in the Highland Valley area, the following guides will be found helpful in the search for mineralization: north to northeasterly trending faults, breccia, porphyries (particularly the P-3 type) and alteration of rock types. Careful attention should be paid to the Guichon-Younger quartz diorite contact.

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Mining Alumni Annual Meeting

The Provincial Institute of Mining Alumni Association, a non-profit organization of former students at the Provincial Institute of Mining, Haileybury, Ontario, will hold its annual meeting May 5th, 1962. Registration will commence at 9:00 a.m. in the Haileybury Hotel. Anyone seeking further information should contact J. O. Wolf, Vice-President, Box 54, Timmins, Ontario.

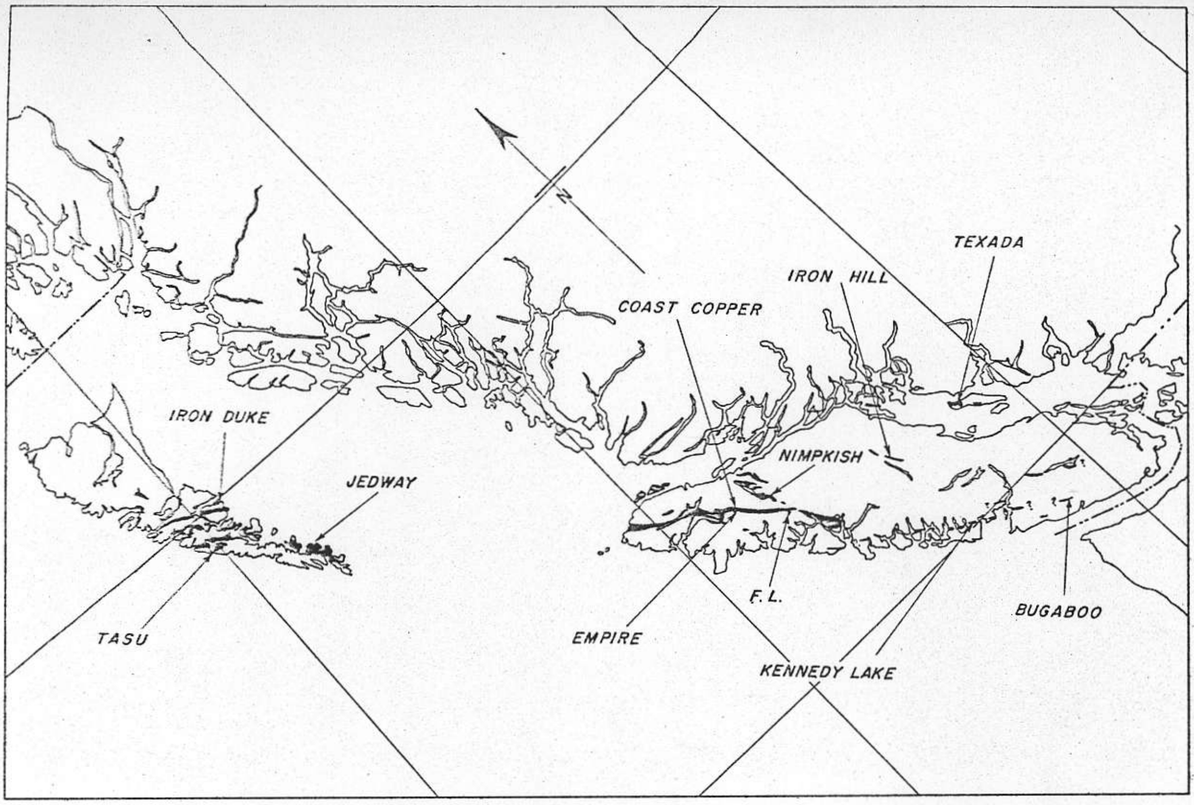

Figure 1 showing distribution of Quatsino and equivalent formations.

nevertheless the margins of the Upper Triassic limestone are undoubtedly a prime target for exploration. Possibly there are those who would attribute the remarkably narrow stratigraphic distribution of these deposits to a syngenetic origin. To me this restriction is a natural result of the preponderance of this particular limestone on the coast. Figure 1 shows what I know of the distribution of the Quatsino and its equivalent formations. The thin-bedded sedimentary rocks above the massive limestone are generally included with the limestone as in some places they have not been mapped separately. Large parts of Vancouver Island and the mainland coast have not been geologically mapped in the detail necessary to outline the limestone, and in these areas I have indicated only the possible continuations.

Secondly I would like to speculate on the significance of the replacement by skarn and magnetite of greenstone in preference to limestone, and the related problem of the proximity to limestone of those bodies which are in greenstone. Research is being conducted that will probably tell us something of the net additions and subtractions to the chemistry of the significant rocks. Field observation and rough calculation indicate that in the skarn zones there must be a net addition to the greenstone of calcium as well as iron. The addition of calcium might be quite unrelated genetically to the addition of iron and yet may have been the reason for the replacement of the greenstone by the iron. One can easily imagine a geological device that would provide added calcium. Uplift above sea level at any stage prior to mineralization would cause deposition of calcite in interstices and vugs of the adjacent greenstone by percolating surface waters. This process could take place also in greenstones above the limestone if there had been sharp folding prior to or during uplift as has been the case at the F.L. and Merry Widow orebodies.

Thirdly, one of the common characteristics of these deposits, and one that has not received enough attention, is the fact that one may travel miles through Karmutsen or Bonanza or equivalent formations and only rarely see a feldspar or quartz-feldspar porphyry dyke or sill, but in the immediate vicinity of almost every orebody such rocks are abundant. In some cases the porphyries are important host rocks whereas in others they appear to resist replacement even though they are clearly pre-ore. As yet I have no idea of their significance but am convinced of their importance.

I will conclude with a few remarks about prospecting. Aeromagnetic surveys by government and large mining corporations have been flown over some, but I am fairly sure not all, of the areas of interest. We all know the deficiencies of fixed wing flying in areas of considerable relief. The targets are so small that one-quarter mile flight line spacing may not be close enough to indicate a significant orebody. The effects of topography are many, not the least of which is the erratic ground clearance. For example, if the theoretical ground clearance is 500 feet in country where 40 degree slopes are common you can be sure that in places the actual ground clearance is at least twice that figure. A deposit at the surface in such a place would only have the effect of one buried 500 feet. This kind of variation which is common on the coast would be completely unacceptable in flat country. Interesting problems in interpretation must result when ground clearance is maintained and rocks with significantly higher than normal magnetic susceptibility are at the same height or above the aircraft. Nevertheless some important anomalies have been found by these methods in the favourable setting. The attempt to avoid some of the difficulties of terrane clearance by using helicopters has resulted in some improvement, but not as much as could be wished and to fly the whole area of interest in even a reconnaissance manner would take large sums. An earth bound prospector with one of the light, cheap, hand-held, Finnish magnetometers working in the right area has certain real advantages.