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RUDDOCK CREEK - C.I.M. PRESENTATION

INTRODUCTION

This presentation is mainly a description of the Ruddock Creek property - a large lead-zinc deposit in southeastern British Columbia about sixty miles north of Revelstoke. The unravelling of the complex geology of this deposit has helped to establish the following principles:

(1) The sulphide mineralization which is rich in iron and zinc, with lesser amounts of lead, silver and copper, occurs as a layer or series of layers within one metasedimentary unit and is probably originally a sedimentary formation or very closely associated genetically with one formation.

(2) On the property the sulphide layer is known to extend over a few tens of square miles. Other deposits in the Shuswap complex (Jordan River, Big Ledge, King Fissure-Colby Wigwam) have similar characteristics but detailed work does not support the correlation of the sulphide layer and adjacent formations regionally.

(3) The sulphide bearing formations at Ruddock Creek, as at the other Shuswap deposits, are calcareous, micaceous, and quartzitic schists and gneisses and are adjacent to one or more relatively pure marbles.

(4) In spite of the close geological control of mineralization in regional prospecting for this sort of deposit in the Shuswap complex, mapping of the structure and stratigraphy are of less value than the more direct methods of conventional and geochemical prospecting.

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(5) In determining the size and grade of any of these deposits a detailed knowledge of the structure and "stratigraphy" is essential.

(6) The Shusap deposits contain vast amounts of metal, but an economically viable deposit has yet to be found. The Ruddock Creek deposit is one of the most attractive being explored at the present time.

DESCRIPTION

Slide 1: The Ruddock Creek deposit is on the northwestern flank of the Frenchman Cap gneiss dome in metasedimentary rocks in the lower amphibolite facies of regional metamorphism. The dome consists of a central zone of core gneiss surrounded by a metasedimentary group of rocks which at some levels are injected or have been transformed into sheets of pegmatite. The Ruddock Creek deposit is in one of these pegmatite zones.

The metasedimentary rocks are complexly and isoclinally folded. Two or more phases of folding are recognized and on the property the fold axes of all phases of folding trend and plunge to the west. The plunge increases and the folds become more open and change in style from the east on the culmination of the dome toward the west on the flank.

Slide 2: Shows Gordon Horne Peack (3,200M) from the Ruddock Creek property and the alpine character of the area.

Slide 3: The showings on the property are scattered across recently glaciated alpine slopes which transect the plunge of the folds obliquely and cause a complex and bewildering pattern of outcrops. The main or E zone is the easternmost showing at an elevation of 7,600 feet, followed toward the west by F, G, M, T and U,V, and R which are not visible from the viewpoint of the slide.

Slide 4: Shows two composite vertical diagramatic cross sections looking west down the plunge - one near the eastern edge of the property and the other in the western part. It shows the formations without the ubiquitous pegmatite. The formations consist of a non-calcareous unit in the core of the fold and a calcareous unit on the flanks. The sulphide layer is within the calcareous unit, close to the non-calcareous unit. The calcareous unit consists of medium to fine grained biotite schist, biotite, feldspar gneiss and minor calcareous gneiss. It contains no recognizable markers. The calcareous unit contains mica schist, calcareous gneiss, biotite silmonite schist and a number of layers of grey or white marble, a few tens of feet thick.

Slide 4 is a structural interpretation based on detailed company mapping, careful measurement and delineation of minor folds, tracing and projection of axial surfaces and formations through areas of pegmatite and cover. Two phases of folding are recognized with essentially parallel axes. Phase 1, which controls the distribution of the formations is essentially isoclinal with a folded axial plane which on the average is nearly vertical. Phase 2 folds are more open, recumbent, generally concentric with axial planes dipping at a low angle to the west. Folds of both phases become more open toward the west.

The sulphide layer occurs as lenses a few feet to several tens of feet thick, which are complexly and disharmonically folded within themselves, but generally conform to the style of the major folds. The mineralized zones, F, G, T, U, V, R, and Q, are on the limbs of the Phase 1 fold, associated with Phase 2 folds and are not thickened by structure. Zone M is within a gently dipping area

of thrust faulting and is mainly very fine grained mylonite. The E zone is at the hinge of the Phase 1 fold, is "thickened" and constitutes the main "orebody". It is in this zone that the most complete characteristics of the sulphide zone are displayed.

Slide 5: Shows part of the E zone which is massive fine to medium grained dark brown sphalerite pyrrhotite associated with lenses of marble, siliceous marble and calcsilicate gneiss. "Squirts" of medium grained galena, lenses of coarse purple to colourless fluorite, and white barite are present. Because of the complex folding it is difficult to recognize systematic variations in sulphide layers that might be related to stratigraphy.

Slide 6: On the limbs of the Phase 1 fold as displayed in the other showings, the sulphides are generally very fine grained with rolled knots of quartz.

Slide 7: In the M zone, intense late(?) interbed slippage or thrust faulting has milled the sulphides into very fine grained locally folded layers with abundant knots of quartz.

Slide 8: The property was discovered in 1960 by a party of prospectors under the direction of Earl Dodson of Falconbridge Nickel Mines Limited. It was drilled, sample and mapped in the summers of 1961 and 1962 and detailed mapping and drilling of the E zone in 1963 delineated more than a million tons of "ore" grading 10 per cent combined zinc and lead. This block is east of a steep westerly dipping fault down thrown on the west. The E zone controlled by the sulphide layer and the Phase 1 fold plunges consistently at 27 degrees toward 285 degrees. Drilling west of the fault has picked up attractive mineralization on plunge and work in 1975 and 1976 by Cominco, who

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optioned the property from Falconbridge, has been to extend the E zone on plunge with deep drilling.

Slide 9: Shows the Cominco drill in August 1976.

DISCUSSION

(a) Regional Stratigraphy - I have been asked to comment on the stratigraphic correlation of the lithologic succession associated with the Ruddock Creek sulphide zones. Up to the time my studies of the Shuswap lead-zinc deposits were concluded in 1970 no positive correlations were possible. The Wigwam deposit, southeast of Revelstoke, is in the lower Cambrian Badshot formation but it is more like a Salmo lead-zinc deposit in a Shuswap metamorphic and deformational environment. Distinctive quartzites and marbles at the Jordan River lead-zinc deposit, a few miles northeast of Revelstoke, resemble the Badshot-Hamill litholigies but my study of the regional geology failed to establish a regional stratigraphic succession because the fold structure is too complex to rationalize within the area studied. Likewise the Ruddock Creek study encompassed only a few thousand feet of rocks and no distinctive markers, such as Hamill-like quartzites, were encountered. Too little information was available at Big Ledge or King Fissure (Colby) to be able to make correlations - in fact all the evidence available led to the conclusion that although the deposits are closely confined stratigraphically they are not in the same lithologic succession and probably not in the same time-stratigraphic unit.

(b) Genesis of the sulphide layer - There is no direct evidence on the origin of the sulphide layer except that it is part of the sedimentary sequence, forming one of the most distinctive marker beds. Probably it is syngenitic or diagenetic but subsequent

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metamorphism and deformation has obliterated direct evidence. There are no obviously volcanic rocks within the succession although it is possible that thin layers of amphibolite gneiss which occur locally may be of volcanic origin - slim evidence for volcanagenic source of the sulphides.

(c) Pegmatites - Swarms of granitic sills and dykes ranging from fine grained quartz diorite to leucocratic pegmatite form irregular masses through the metasediments. They have been emplaced passively without distorting or displacing the wallrocks. Some are themselves deformed. They place a significant and unpredictable constraint on the continuity of the sulphide layer.

(d) Structural and metamorphic response of the sulphides - The sulphide layer seems to have been subject to all the metamorphism and deformation. The surrounding rocks have recrystallized and developed mineral assemblages characteristic of normal metamorphic suites. The sulphides, however, appear to have deformed cataclastically and only locally have they recrystallized. In folding, layers within the sulphide layer have been bent and broken in chaotic fashion forming disharmonic folds.

Selkirk Ptarmigan Mines Limited and was optioned by the present company in 1963 for exploration. A description of the property has been given in past Annual Reports.

The work done in 1963 included a geological and geophysical survey, and a crew of six men drilled 10 diamond-drill holes totalling 650 feet on the surface and in the mine. The work was under the direction of D. R. Morgan, geologist.

REVELSTOKE

Lead-Zinc

King Fissure, S.B., C.R., and Deby*

(51° 118° S.E.) This property, known as the River Jordan lead-zinc property, consists of 16 Crown-granted claims owned by Jordan Mines Limited and 11 recorded claims owned by Bralorne Pioneer Mines Limited. The office of both companies is 355 Burrard Street, Vancouver. The property is on the upper northern slope of Mount Copeland, about 12 miles northwest of Revelstoke. Mineralization consists of an aggregate of fine-grained pyrite, pyrrhotite, galena, and sphalerite disseminated in a single layer of metamorphosed sedimentary rock in a sequence of schists and gneisses. There are two mineralized layers which strike eastward and dip at moderate angles to the south and which join at both the western and eastern ends of the property. They are thought to have the form of a syncline plunging at a low angle to the east, but the structure has not been determined with certainty. The property has been described by C. Riley in a paper in Transactions of the Canadian Institute of Mining and Metallurgy for 1961, pages 268 to 272.

The mineralization, well exposed in cliffs and outcrops between elevations of 5,800 and 7,500 feet, has been known for many years. Exploratory work since about 1950 has been mapping, trenching, and sampling. In 1963 five holes with a total length of 4,929 feet were diamond drilled to test the continuity of the mineralization in depth. The holes were steeply inclined, and the longest was 1,500 feet. Two holes intersected both lodes several hundred feet from their outcrop. The camp was serviced by helicopter from Revelstoke, and a trail to the property constructed during previous exploratory work was not used.

Eight men were employed under the direction of D. H. James, geolgist.

[References: *Minister of Mines, B.C.*, Ann. Repts., 1956, p. 114; 1958, p. 53; *C.I.M.M.*, Trans., Vol. LXIV, 1961, pp. 268–272.]

RUDDOCK CREEK

Lead-Zinc

If, In, and To (Falconridge Nickel Mines Limited)†

(51° 118° N.W.) Exploration office, 1112 West Pender Street, Vancouver 1. Alex. Smith, manager; H. R. Morris, geologist in charge. About 94 claims are held by record on the southern slopes of Gordon Horne Peak, a 9,500-foot summit between the head of Ruddock Creek, which flows east into the Columbia River, and Oliver Creek, which flows north and west into the Adams River. The main showing is at the head of Ruddock Creek, at an elevation of 7,600 feet.

A tent camp at 7,000 feet was serviced entirely by helicopter, from a supply depot on the Big Bend highway 65 miles north of Revelstoke. Geological work continued in 1963, and 12,093 feet of diamond drilling was done in 25 holes. This included the main showing and showings nearly 3 miles to the west on the steep slope above Oliver Creek.

* By James T. Fyles.
† By M. S. Hedley.

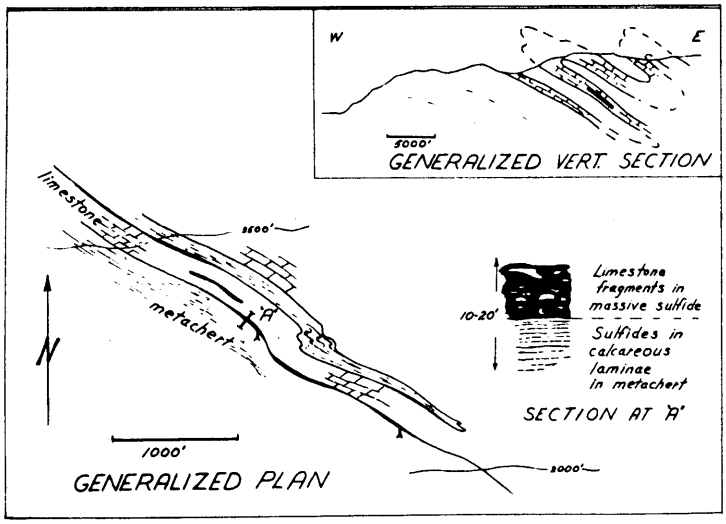

Figure 15-4

Insert is diagramatic interpretation of structure at Wigwam. Black bar represents area mapped by plane table and shown in the generalized plan. Black conformable lenses in plan are sulphide zones.

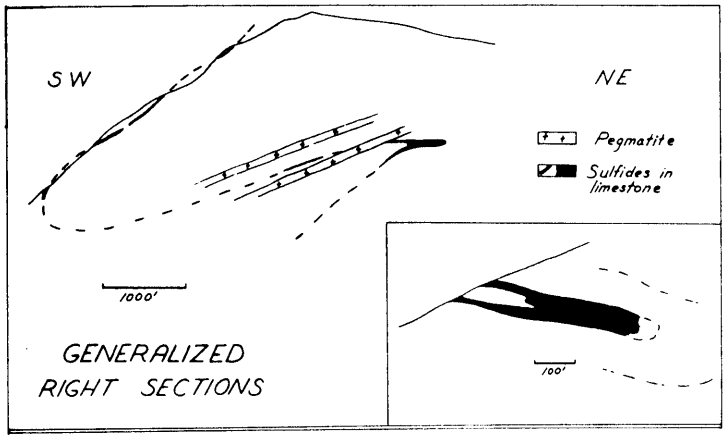

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Figure 15-5

Sketches of generalized right sections at Ruddock Creek. Sulphide-bearing limestone outlines structure.

Ruddock Creek

The structure at Ruddock Creek is illustrated by Figure 15-5. The sulphide-bearing carbonate unit, probably in the staurolite or sillimanite grade of metamorphism, forms a large recumbent fold which plunges into the hillside. The nose of the fold is a thickened, swirled mass of fine–and coarse-grained, dark sphalerite mixed with augen of quartz and silicates. The attenuated limb contains sections of carbonate mylonite peppered with very fine-grained sphalerite.

Plate 15-V shows part of the thickened nose of the fold. The dark mineral in the coarse-grained areas is sphalerite. The finer-grained areas are mixtures of pyrrhotite and sphalerite and appear to be zones of intense flowage. Plate 15-VI shows a polished section of this fine-grained material. Sphalerite and carbonate exhibit strong flow features around quartz and silicate grains.

Ruddock Creek constitutes the final example of post-ore metamorphism. Admittedly the evidence is more obvious here than in the Salmo district.

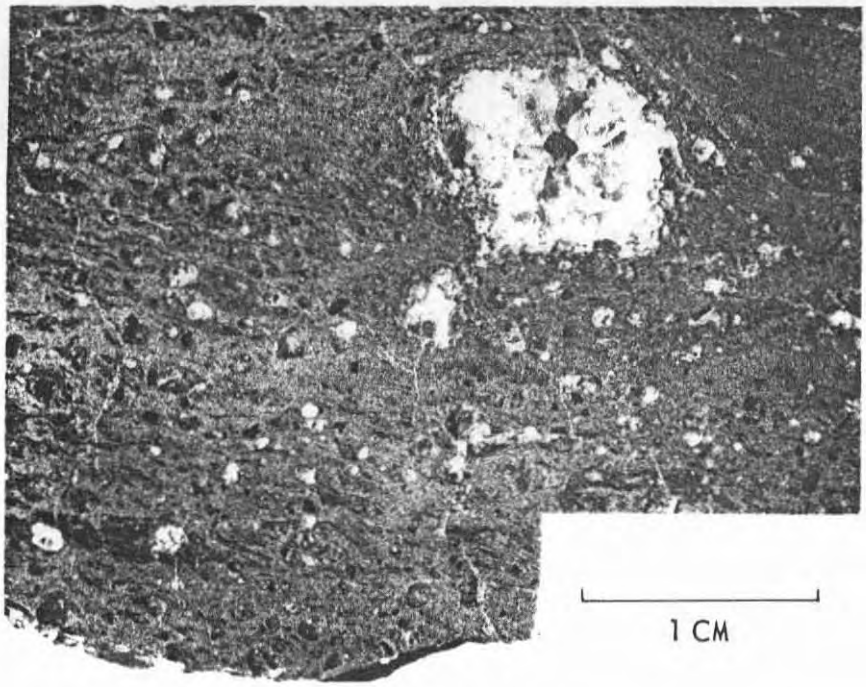

Plate 15-VI

Polished surface of fine-grained dark material in Plate 15-V. Matrix of very fine-grained sphalerite, pyrrhotite and carbonate displays flow lines around augen of quartz and silicates. Black spot in center of large quartz grain is galena.

SUMMARY AND CONCLUSIONS

In summary several points deserve emphasis. Minor pyrrhotite occurrences show an obvious correlation with local thermal metamorphism. In regions of medium-and high-grade regional metamorphism pyrrhotite is a major constituent and the dominant iron sulphide. Equally important is the fact that the shape of the deposits becomes smoother and more conformable in areas dominated by flow folding. The lack of evidence that the sulphides at Salmo and Duncan Lake are younger than the folding is a critical point. The manner in which these features apply to the occurrences described above strongly suggests that these deposits existed prior to regional metamorphism.

If this suggestion is true it is probable that some of the deposits in northern Washington offer the closest approach to the original nature of all the deposits. An important step in the evaluation of the proposed theory will be the determination of the factors, including time, which bring about annealing in sulphides and consequent destruction of strain features.

REFERENCES

Fyles, J. T., and Hewlett, C. G., 1959; Stratigraphy and Structure of the Salmo Lead-Zinc Area; B. C. Dept. of Mines, Bull. no. 41.

Fyles, J. T., 1964; Geology of the Duncan Lake Area Lardeau District, British Columbia; B. C. Dept. of Mines and Petroleum Resources, Bull. no. 49.

Hedley, M. S., 1955; Lead-Zinc Deposits in the Kootenay Arc; Western Miner and Oil Review, v. 28, no. 7.

Muraro, T. W., M.Sc. Thesis unpublished, Dept. of Geological Sciences, Queen's University, Kingston, Ontario.

Lead-zinc mineralization, consisting dominantly of sphalerite, occurs in schists and gneisses of the Shuswap terrain. Mineralized layers, which in places indicate remarkable continuity, appear to be bedded and are involved in intricate folding of the layered rocks. Though contorted, the rocks in general dip to the southwest at moderate angles, more or less parallel to the hillside. There is much post-mineral intrusive pegmatite that occurs as sills and dykes, and as sheets that also dip southwest with the hillside. The sheets are as much as 150 feet thick, and much layered rock has been obliterated by the pegmatite in the general area.

Mineralization of ore grade contains about five times as much zinc as lead, although in submarginal material the two metals may be about equal in amount. The ore is associated with quartz, and the better-grade material consists of abundant dark sphalerite spotted finely with grains and small clots of quartz that in at least some instances appear to consist of crushed aggregates. Pyrrhotite is about the only other sulphide. Fluorite, barite, and epidote are associated with the ore zone.

The main ore zone extends on surface for about 600 feet along the central part of a fold that has been referred to as a syncline but is actually a flat compressed crumple open to the south. The hinge line of the crumple plunges flatly in the same direction as the common lineation of the area, north 70 degrees west. The ore has been followed down dips of 35 to 40 degrees by diamond drilling to the hinge line, a distance of about 500 feet. The ore in the main zone is as much as 40 feet thick and has the appearance of a greatly thickened layer, repeated in the crumple. A second, much thinner, ore layer lies 15 to 30 feet outside the first.

Detailed mapping and diamond drilling have demonstrated a considerable tonnage of ore containing about 10 per cent zinc in holes drilled within a few hundred feet of the outcrop of the ore. Drilling farther afield, to follow westward down the plunge of the ore in the axial zone of the fold (where it is thickest), failed to locate ore beyond a north-trending fault which apparently drops the ore zone down on the west. The deepest hole was drilled to a depth of some 1,900 feet.

The ore appears to follow a horizon which is closely associated with a band of grey to white marble a few feet thick. The marble is itself in places sparingly mineralized. The ore horizon is siliceous, but it is not certain how much of the quartz represents original quartzite and how much may have been introduced. The ore is in places limy. In spite of excellent exposures, the ore structure cannot be traced continuously because of the pegmatite sheets. A locus of sphalerite mineralization, for the most part about 4 feet thick, has reportedly been traced for some 3 miles, over the ridge of Gordon Horne peak at 8,000 feet elevation, round to the north of the peak, and down the steep westerly slopes above Oliver Creek. A large fold is indicated to lie north and west of the crumple of the main showing, and it is presumably this fold that changes abruptly the direction of surface trace of mineralization west of the main showing, from westerly to northerly.

The main mineralization has the appearance of a bedded layer, for the most part about 4 feet thick, which is involved in the regional complex folding and, because of the folding, is locally greatly thickened, particulary in the core of the flat crumple in the main showing. The origin of this ore is of very great interest, as the nature of the occurrence determines not only the problems of development, but greatly affects the techniques of search for new deposits. Whatever the age of the mineralization and its ultimate origin, it is plain that it is older than the pegmatite sheets and plain also that it has to some extent been involved in the complex folding characteristic of the Shuswap terrain.