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GEOLOGY OF DUNCAN MINE AND VICINITY

by J. Richardson

LOCATION

Duncan Mine is located along the west shore of the large peninsula on the east side of Duncan Lake. Duncan Lake lies in the northernmost wide part of the Purcell Trench and is 14 miles north of the north end of Kootenay Lake. It is 50' higher in elevation than the latter lake. The mine site is

(1) Show composite areal photo on screen.)

connected to the village of Howser, at the southwest corner of the lake, by 13 miles of road.

Geologically the Mine lies within a major structural belt in southeast British Columbia, which has been named the Kootenay Arc by Hedley. This structure trends in a general northerly direction and has an arcuate form concave eastward. It extends from

(11) Show copy of G.S.C. regional map on Screen.)

north of Revelstoke to south of the International Boundary.

HISTORY

In 1893 a zinc showing was discovered and staked on the north bank of Glacier Creek and in 1922 the Lakeside claims were staked near the present mine site. Cominco drilled the Glacier Creek showing in 1927 and commencing in 1951 Lardeau Lead & Zinc (under the direction of Newmont Corporation) explored this showing with underground work and drilled the Lakeside showings. In 1955-56 Bunker Hill also drilled the Lakeside showings.

In 1957 Cominco acquired an option from Joe Gallo and associates to explore his large group of claims extending from Glacier Creek to near the north end of the peninsula. Following a comprehensive geological study in 1957, Cominco extended the drilling to test the ore down the plunge and were successful in indicating substantial mineralization. Underground work was started in 1959 and completed in 1960 and established the existence of commercial quantity of ore. The underground work consisted of 3,000' of drifting and about 2,000' of cross cutting in four parallel crosscuts spaced 1,000' apart.

GENERAL GEOLOGY

(The general geology of the Duncan area will have been discussed by Fyles in the first paper of the session. A few pertinent points will be discussed here to show where the Duncan Mine fits into the general geological picture.)

((111) Show Plan "General Geology, Lardeau Area", 1" = 2 mi.)

Wherever the Kootenay Arc has received sufficient study (and as J. Fyles stated in the preceding paper) the dominant structural features are found to be large closed folds. The Duncan Mine area proves no exception to this general statement. Our field work during the past three years has shown that large scale folding causes the Badshot limestone to be repeated several times across the area between the Duncan and Lardeau Rivers. The folds trend N 20° W and plunge from 7° to 10° in this direction. They are generally steep and isoclinal. To the south these folds are cut by the Fry Creek Batholith which is probably an apophysis of the large Nelson Batholith occurring west of Kootenay Lake.

The lead/zinc/pyrite deposits of Duncan Mine are located in the eastern limb of one of the above-mentioned folds. This fold has been studied to a greater extent than any of the others and we have named it the Duncan Anticline. The large syncline flanking the Duncan Anticline on the east is called the Eastern syncline.

((111) Show Plate 111 again.)

DESCRIPTION OF FORMATIONS

All of the layered rocks in the vicinity of Duncan Mine are of lower Palaeozoic age. Their stratigraphic sequence are shown in Table I.

(1V) Show Table I.

This is essentially the table of formations established by Fyles and Eastwood in the Ferguson area 35 miles to the northwest of Duncan Lake, but for the Duncan area we have made a number of minor changes. These are:

1. We give the name Glacier Creek formation to the local equivalent of the Mohican formation.
2. We remove the Glacier Creek formation from the Hamill group. This places the top of the Hamill group at the base of a prominent recry-

stallized limestone band. The Glacier Creek formation is a mixture of limestones, impure quartzites, schists and dolomites. This mixture is essentially a transition from the major quartzite sequence (Hamill) to the major limestone unit (Badshot).

3. Fyles now groups the Ferry Lode and Bunker Hill formations into one formation, the Index. We find it more convenient to retain the two former formational names in our map area.

HAMILL GROUP

The oldest rocks in the area belong to the Marsh Adams formation of the Hamill Group of Lower Cambrian age. This formation consists of gray to white micaceous quartzite and micaceous schist. We have done little work in these rocks except along the upper contact and this contact has proved to be a valuable marker for determining structure.

GLACIER CREEK FORMATION

This formation consists of thin, distinctive bands of recrystallised limestones, schists, dolomites and impure quartzites which conformably overlie the Hamill Group. The lower part of the formation consists of limestone and spotted schists whereas the upper part is mainly interbedded dolomites and impure quartzites. For our mapping purposes we have divided this formation into 15 members. Since the total thickness of the formation is only about 300', you will realise how thin are some of these members. Over the five miles of strike length which we have mapped in some detail the relative thicknesses and continuity of these members are remarkably consistent. Very few of them are terminated, stratigraphically or structurally, throughout the map area.

The uppermost member of the Glacier Creek formation is a very conspicuous one up to 50' thick called the Green Schist. This member has been a valuable aid in determining structure.

(V) Show trace element chart for Glacier Creek formation and Truman Member and explain.

The trace elements are remarkably similar in kind and quantity, and for this and other reasons we do not hesitate to correlate these rock units. (Glacier Creek and Truman).

BADSHOT FORMATION

Overlying the Glacier Creek formation is the well known Badshot formation. The better known occurrence of this formation has been mapped as a broad and continuous band of limestone extending from east of Revelstoke to Crawford Bay on Kootenay Lake. It has been described as a grey, crystalline, well banded to massive, sometime siliceous limestone. In the Duncan Lake area it outcrops on the peninsula about 2-1/2 miles west of the prominent band, where it is on the west limb of the Eastern Syncline.

In the intervening distance

(11) Show 1" = 2 mi. regional map again.

it has undergone a lithological change, for here the formation consists essentially of dolomite and chert instead of the typical recrystallized limestone. In detail, the formation consists of five members which maintain continuity over a strike length of at least five miles. They total 300' to 400' in thickness. The basal member is a 10' - 20' band of recrystallized limestone conformably overlying the Green Schist member of the Glacier Creek formation. The next member is a dolomite band up to 120' thick. It is a very fine-grained and dense and typically streaked or banded by variations in shades of grey or by irregular sub-parallel black lines. This streaking and banding is a structural feature and is either cleavage or shear banding depending on its intensity. The dark bands are segregations of carbon which have been brought to a common orientation paralleling the local foliation.

The member overlying the dolomite is an incompetent mixture of gray phyllite and white crystalline limestone only 5' to 15' thick.

The next member in the sequence is the economically important upper dolomite which is from 40' to 60' thick. Megascopically, it is virtually identical to the Lower dolomite.

The uppermost member is a band up to 150' or more thick of recrystallized chert. This unique rock consists of solid, extremely fine-grained silica with a pronounced gneissic texture in shares of gray. Thin sections show that this color marking is an expression of mylonitization and accompanying variations in the concentration of finely disseminated carbon. Petrographic and chemical details by Muraro suggest that it was not a detrital sediment but rather a chert chemically or colloidally deposited.

ORIGIN OF THE DOLOMITE

The Duncan Mine dolomite is megascopically similar to that at the H.B. Mine. At the latter locality the dolomite is thought to be of secondary origin. However, in the Duncan area the Badshot formation, in part, consists of two broad bands of dolomite separated by a narrow (1' to 20') band of limestone. The calcareous band occurs uninterruptedly in the same stratigraphic position for a strike distance of about five miles. This suggests that the Duncan dolomite is of primary or more probably early diagenetic origin, because the narrow limestone band could not remain unaltered over this great distance in the intense dolomitising environment which would be necessary to alter completely the remaining 90% of the carbonate rocks in this formation.

A very common, if not invariable, characteristic of secondary dolomite is its medium to coarse crystalline texture. The dolomite at both Duncan Lake and H.B. Mine can only be described as fine-grained to massive. This, then, can be used as additional evidence for the primary origin of the dolomite.

PERRY LODE AND BUNKER HILL FORMATIONS

The two formations immediately overlying the Badshot formation will be mentioned briefly. They are the Perry Lode and Bunker Hill formations. Each of them is over 1,000' thick. The Perry Lode is the lowest formation in the Lardeau Group and it overlies the Badshot conformably. It consists of a mixture of fine-grained, thinly banded, highly carbonaceous sediments, consequently the color is consistently dark gray to black. On the basis of lithology and stratigraphic position the Perry Lode is correlated with the Emerald argillite which conformably overlies the Reeves limestone in the Salmo area.

The Bunker Hill formation conformably overlies the Perry Lode formation. This formation is essentially all a light green to gray-green, very fine-grained, well foliated phyllite. It can be correlated with the Upper Laib of the Salmo area.

IGNEOUS ROCKS

The only igneous rocks occurring in the immediate vicinity of Duncan Mine are sill-like bodies of amphibolite and serpentine up to 200' thick in the Perry Lode and Bunker Hill formations.

STRUCTURAL GEOLOGY

The general structures in the vicinity of Duncan Mine are a series of primary, steeply dipping, isoclinal shear folds which plunge WNW at about 10°. The amplitudes of these folds are unknown but the wave lengths are approximately one to three miles. Their axial planes are curved surfaces, concave to the west. That is, the primary folds have been rolled about secondary axes that are parallel to the axes of the primary folds. This results in the primary folds being bent into a larger recumbent fold open to the west. All of this folding appears to be the result of a single prolonged period of stress.

(V1) Show Muraro's Fig. 10.

In the immediate Mine area the folds consist of the relatively broad Eastern Syncline, the Duncan Anticline, and two lesser known folds on Lavina Ridge west of the latter structure.

Much more is known about the Duncan Anticline than any other fold. This structure has been traced for 18 miles along strike from the Duncan peninsula to Fry Creek Batholith.

(V11) Show regional Map 1" = 2 mi. again.

FAULTING

Faulting is not common. Some strike faults are known in the mine area. They will be described later.

MINE GEOLOGY

The mine itself is located midway along the west side of the large peninsula in Duncan Lake. Structurally it lies in the eastern limb of the Duncan anticline and near its crest.

(V111) Show Fig. 16 on Projector or D.M.S. 1.

The anticline is a tight, crumpled, isoclinal fold with a nearly vertical axial plane. The fold axis plunges northwesterly at about 10°. Two normal faults, parallel to one another and about 500' apart, slice through the crestal region of the anticline at a small angle to the axial plane. They dip steeply west and the west sides have dropped relatively about 700', most of the movement being in this component. In age they are post-mineralization. They are tight structures and are recognized mainly be truncation of strata.

Sulfides occur in four roughly tabular bodies called No. 5, No. 6, No. 7 and No. 8 Zones. All except No. 6 Zone lie in the Badshot formation east of the No. 1 Fault. No. 6 Zone lies in a slice of the Badshot immediately west of this fault. The host rocks are dolomite and chert. The most abundant metallic minerals are pyrite, sphalerite and galena. Pyrrhotite is minor and minute amounts of chalcopyrite, marcasite, ruby silver and meneghinite are known. Calcite is the dominant gangue mineral.

The most important control of mineralization in the mine is the contact between dolomite and chert. A nearly continuous thin layer of sulfides occurs along this contact and ore shoots occur as narrow lenses, plunging north at about 7° to 10° within this sulfide sheet.

(Show D.M.S. 6.)

DESCRIPTION OF THE ORE ZONES

No. 7 Zone is the most important ore body and is the only one developed by underground workings. No. 5 Zone has essentially the same characteristics as No. 7, but No. 6 and No. 8 are somewhat dissimilar.

No. 7 Zone is a thin, near-vertical sheet averaging about 17' in width. Its long axis plunges 7° at N 20° W along the contact between chert and dolomite. It is about 400' high and has been explored by drifting for a distance of 3,000'. The sulfides occur as very fine minerals in a coarse breccia of dolomite and chert cemented by calcite and sheared parallel to the foliation of the surrounding rocks. In detail, richer ore shoots are defined by congruous isoclinal drag folds with amplitudes up to 10' which plunge 7° northerly with the general structure. Some of these folds have been traced along the drift for more than 200'. Frequently there is a considerable increase in the lead content of the ore in the arches of these folds. Surrounding the ore zone nearly everywhere is a zone, from 1' to 10' wide, of low grade zinc (about 2%) and iron. Therefore the limits of the ore zone are defined by assay boundaries in many cases.

(Show D.M.P. 9.)

No. 5 Zone lies in en echelon position below and to the south of No. 7 Zone and on the same structure. It is separated from No. 7 Zone by about 200' of low grade mineralization. The structural and mineralogical characteristics are the same as in No. 7 Zone.

No. 6 Zone is the largest known sulfide body at Duncan Mine. However, it is essentially a pyrite zone and contains only about 2% Zn and 0.5% Pb. The mineralization here occurs in and around a tightly compressed syncline of chert on the west limb of the Duncan anticline which has been dropped relative to its former position by the movement on the Muraro No. 1 Fault.

No. 8 Zone is a small lens of ore confined to the lower dolomite band of the Badshot formation. Mineralization in it consists of abundant pyrite, sphalerite and very little galena. The zone lies about 100' west of No. 7 Zone. It dips east at a lower angle than the host dolomite. Very little is known about the ore controls. It does appear, however, that mineralization of ore grade occurs only where the dolomite member is thicker and darker than normal. This thickening is due to drag folding.

Show samples of (1) Chert.
(2) Dolomite.
(3) Mineralization.

GRADE OF THE DEPOSITS

The ore zones previously described are narrow, but very long, low grade deposits. Their grade is lower than that of the relatively nearby Bluebell Mine and is similar to the grade of the more distant Salmo deposits. Here, however, the lead:zinc ratio is greater than that in the Salmo deposits and, as in the latter area, the grade of silver in the ore is negligible.

ORIGIN OF THE ORE

The lead and zinc replacement deposits of the Lardeau area were believed to owe their origin to emanations from granitic rocks which no doubt underlie the whole area as extensions of the Nelson and Kuskanax batholiths. However, evidence for hydrothermal activity at Duncan Mine is scarce. There is, at least now, no recognizable hydrothermal alteration alteration associated with the ore deposits.

Another possible origin of the ore minerals is migration from a source bed. However, work by Muraro has shown that concentrations of Cu, Pb and Zn in four carbonate bands from near the base of the Perry Lode formation (the most likely source bed) seems to be too low to support a possible migration of these metals from the surrounding highly carbonaceous formation into underlying carbonate members of the Badshot formation.

Recent work by Muraro suggests that the deposits are of the telethermal type in that they were probably deposited under conditions of low intensity, possibly by rising hydrothermal solutions from an unknown widespread source at depth and that they were deposited prior to structural deformation and granitic intrusion. This appears to be the best explanation for the origin of the Duncan ores and possibly other similar ores in the Kootenay Arc.

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