Summer Essay

on

Dolly Varden Mine Ore Deposit.

S. Keen

by.

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Sc. '22

1921.

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Note.

Maps - in envelope at back.

Illustrations - at back.

Rock & Mineral Specimens - Drawer A20.

Dolly Varden Ore Body

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Introduction.

The facts for this paper were collected by the writer during an examination of the Dolly Varden mine, in the summer of 1921, while acting as assistant to Dr. G. Hanson of the Geological Survey of Canada.

Geography

The Dolly Varden mine is located in the Upper Kitsault River valley, of the Naas River Mining Division. It is situated about sixteen miles north of the town of Alice Arm, and lies on a steep hillside at an elevation of 1700 ft. above mean sea level, and 700 to 800 feet above and on the west side of the Kitsault River.

Accessibility

The Grand Trunk Pacific and Union Steamship lines maintain weekly communication between Alice Arm and Vancouver. A narrow gauge railway extends from the head of the Arm to the mine, a distance of seventeen miles.

Topography

The region is mountainous, with elevations up to 5500 feet above sea level, and lies

on the eastern border of the Coast Range batholith. It is drained entirely by the Kilsaulet River, which has its source in a glacier, and flows south with an average grade of about one and a quarter percent. The streams which enter the river are mainly small, but because of their steep grades and therefore high velocity, they have been able to carve out abrupt narrow gorges in the rock. The flat country is badly drained, being marshy and dotted with small lakes. This is due to recent glaciation. The valley slopes are steep, and at the Dolly Varden mine, owing to a change in the formation of the rock, the river has been able to carve out a precipitous canon in the rock.

General Geology

Classification of formations

The rocks are classified tentatively as follows, in order of age:-

1. Intrusive Rocks - Diabase Dikes.
   Diorite.
2. Sedimentary Series - argillites, and S.S. which is tufaceous in places.
3. Fragmental Rocks - Volcanic breccias & tuffs.

The region is underlain by metamorphosed volcanic breccia and sediments, much folded and faulted. They are cut by and

are therefore older than the Coast Range batholith; their age is probably lower ? Jurassic.

The structure is complicated by a large number of faults. Most of the larger ones strike a little east of north, but the smaller ones, like those at the Dolly Varden mine, strike and dip in various directions

Fragmental Rocks.

This group of rocks is almost entirely volcanic in origin, and consist of tuffs and breccias of agglomerate character, which are probably many thousands of feet in thickness, evidently representing the product of a long continued period of volcanic activity.

The formation is exposed over nearly two-fifths of the Upper Kitsault area.

The breccia is composed of irregular purple and green masses of an andesitic character, and metamorphosed to such an extent that greenstone is a good field name for it. The original character of the rock is not usually evident to megascopic observation, but where weathering has taken place, differential action of kaolinization

brings angular fragments of slightly different texture or composition into prominent contrast, and the origin of the rock is made apparent.

The rocks of this formation are not distinctly banded or bedded, and are very uniform in composition and texture over large areas.

Economic features.

This formation is the country rock of the majority of the mineral deposits of the Upper Kitsault area, which are in the form of veins or irregular areas.

Two main types of deposits are found in it. One carrying the principal values in silver, such as the Dolly Varden mine, and Moose, Wolf and Tonic mineral claims. The other carrying values in copper, with some gold and ~~sperhaps~~ silver, such as the Red Bluff, Vanguard and Homestake mineral claims.

Sedimentary Series

This group of rocks consists of a thick argillite series, alternating in places with coarse clastic beds and bands. These rocks overlie the fragmental rocks, and, are fossiliferous near their base, containing pelecypods and a

large number of belemnites.

This formation is exposed over the other three fifths of the Upper Kilsault area.

The principal rock of this series is a black argillite, which can be cleaved into a slate in places, but as a rule the usual parting is along the original bedding planes. ~~It~~ varies in texture from a hard fine-grained compact rock to a granular one in which the grains are distinctly visible. The color varies slightly with the texture, becoming lighter in color with increasing coarseness.

Bands of tufaceous sandstone occur with them in places. They consist of angular and rounded grains, mainly of quartz and feldspar. In some cases this rock has been altered to a fairly compact quartzite.

The argillites are folded composite, with the general strike a little west of north, and dipping at all angles.

Economic features.

The argillites are cut by a number of quartz veins and silicified shear zones, irregularly mineralized with sulphides, and carrying slight gold and silver values.

Intrusive Rocks

Dykes have been intruded into the fragmental and sedimentary formations. They vary in composition from a dioritic rock to a diabase. Some of the dykes are amygdaloidal, and the larger ones are porphyritic towards their centres, the diabase dykes containing phenocrysts of feldspar.

Economic Geology.

History of Production

The Dolly Varden mine at present is owned and operated by the Taylor Engineering Company.

The first report of any kind ~~on it was~~ made in 1913 in the Minister of Mines Report.[1] In 1919 with the completion of the railway from the wharf to the mine, the Dolly Varden began to ship ore, but closed down in December 1920 due to the drop in price of silver. In the summer of 1921 the mine opened up long enough to draw out and ship the ore remaining in the stopes, then closed down.

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① Minister of Mines Report - B.C. - 1913.

Production.①

Year.	ore in tons	Silver in oz.
1919	6,709	423,952.
1920	93 (sorted ore)	82,298
	27,944	749,340

General Character of Deposit

The Dolly Varden vein is a silver-lead-zinc deposit formed prior to the intricate faulting by replacement along a fissure zone in volcanic breccia classified in this paper under "Fragmental Rocks".

Result is a vein averaging about twenty feet thick, striking east and dipping steeply to the north. It is cut by numerous diabase dikes varying from a few inches to fifteen feet in thickness.

Cross faults, that cut the vein, have divided it off into blocks, the horizontal component of the shift being two hundred feet in one instance.

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① Minister of Mines Report - B.C. - 1919 & 1920

Mineralogy

The gangue consists of quartz, and silicified country rock in various stages of replacement, minor amounts of calcite, a little jasper, and barite.

The metallic minerals are native silver, argentite, galena, sphalerite, pyrite, ruby silver, and limonite.

Calcite is found in small cross fractures in the hanging wall.

Barite is found in the western extension of the vein and in the 500-level.

Native silver occurs as leaves and wire in fractures in the vein material and country rock.

Argentite is found associated with the native silver.

Galena is fine grained and slightly argentiferous, and is associated with the gray one.

Sphalerite occurs in small amounts.

Pyrite is the most abundant sulphide present, and probably forms about eight per cent of the vein by weight. Some of it at any rate appears to be later than the galena & sphalerite.

Deposit.

The vein has been cut in many places by reverse faults which have offset it, cutting it up into blocks. The fact that purple breccia forms the hanging wall rock, and green breccia the footwall

rock has simplified the locating of these blocks, which would otherwise have been costly, because the surface is densely wooded and covered with a thick mantle rock. This faulting has also complicated the mining methods because each block must be mined separately.

The vertical components of the shifts, due to lack of structure in the rock, could not be determined.

The reason for the absence of high grade silver minerals in the western extension of the vein, may perhaps have been due to this reverse faulting, which elevated the western block with respect to the eastern block sufficiently for glacial action to have eroded off this rich sulfide zone, leaving the low grade ore, which is somewhat similar to that found in the 500 level (elev. 1910 ft) exposed on the surface.

Native silver occurs as leaves and wire, and is confined to cracks and fissures in the vein, along which descending meteoric waters could easily penetrate. It has not been found in the unfractured material, and therefore represents a second stage in the mineralization.

There is considerable limonite, and a strong downward movement

of water in the fractures.

Native silver and argentite abruptly cease at about two hundred and fifty feet below the surface in the deposit.

There are no rock formations younger than the Jurassic in this area, hence the Cretaceous and whole of the Tertiary were periods of erosion. G. A. Young[1] states that: "From miocene times onwards, the Cordilleran region was apparently subjected to regional uplifts and depressions.... Tertiary was a time of active erosion."; and S. J. Schofield[2] says: "In reviewing the geological history of British Columbia we find that Miocene and Pliocene were periods of prolonged erosion, interrupted by intervals of slow uplift so that secondary enrichment was possible during these periods."

Examinations of other mines, the Premier[3] for example, have shown that secondary enrichment in Northern B.C. is possible.

① Brock, R.W & Young, G.A. - Geology & Economic Minerals of Canada - 1909 - P. 125

② Schofield, S. J. - C. I. M. M. - Aug. 1921 - P. 714

③ Schofield, S.J. & Hanson, George - Summary Report - 1920 A - P. 11 A.

Native silver and argentite are distinctly supergene minerals.[1]

Alteration of Wall Rock.

The hanging wall rock, a purple breccia, has not been altered to any appreciable extent, the wall being free from the ore.

In the footwall rock, a green breccia, there has been considerable impregnation by pyrite, and, to some extent, silicification. It has been altered in color from dark green to grey. This zone of disseminated pyrite extends for several feet from the ore.

Origin of the Ore and Conclusions.

The absence of typical high temperature and low temperature minerals in the ore in the 500 level, that is below the rich sulfide zone, indicates a probable replacement at intermediate temp. and pressure. The silicification and impregnation of the wall rock with pyrite shows that the ore was introduced by solutions.

S. J. Schofield,[2] from an analogy with other deposits in this district, states that the Dolly Varden ore-deposit was formed in the Upper Jurassic, and is

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① Lindgren, Waldemar - Mineral Deposits - 2nd ed - P. 884 - 1919.

② Schofield, S. J. - C. I. M. M. - Aug 1921 - P. 710-711.

linked with the closing stages of the coast range.

The diabase dykes in the Dolly Varden deposit do not bear any relation to the ore. They were intruded prior to the intricate faulting, and do not bear any relation to the high grade silver minerals either, and evidently did not ~~pinch out~~ the deposit, nor give off the later silver minerals.

There are at least two periods of faulting in this area, one period preceding the mineralizing solutions and thru which they ascended and formed veins, and one period later than the mineralization which has aided secondary enrichment. It is quite probable therefore that the Dolly Varden vein was also formed along a fault or shear plane at the contact of the green and purple breccia; through which the mineral bearing solutions ascended. The hanging wall shows signs of movement, being slickensided, but whether this was before or after the period of mineralization is not definitely known and can only be surmized.

It is fairly conclusive that the native silver, and probably argentite + most of the ruby silver, are secondary minerals deposited

by descending meteoric waters, and that they form a secondary sulphide zone in the deposit. This zone would be formed during the Tertiary. Pleistocene glacial action has then eroded off the leached, oxidized, and perhaps some of the enriched zones.

The method of solution and precipitation of the silver, in secondary form, is explained by H. C. Cooke① as follows: "Enrichment of a primary silver deposit is brought about by reactions of silver or its sulfides with the sulfides of iron and their product of oxidation .... sulfuric acid and ferric sulfate (derived from oxidation of pyrite) exerts a powerful solvent action both on silver sulfide and on its companion sulfides, such as galena, chalcocite, orpiment, and stibnite. Of these silver sulfide is the least affected." And further he says: "a mixture of sulfuric acid and ferric sulfate has a powerful action on metallic silver .... Equilibrium in silver bearing solutions between ferric, ferrous, and silver sulfates is such that the reduction of ferric solution to the ferrous condition by any means will rapidly precipitate the silver in metallic form"

① Cooke, H.C., Journal of Geology, Vol XXI. 1913 P. 1-28

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Dolly Varden Mine.

No. 3. Glory hole looking west.
This shows the hanging wall of the 301-fault (see plan of surface at back) which has cut off the ore body

looking West at the Dolly Varden mine from across the Kitsault River at about 2000 ft elevation.
White patch in centre is the D. V. mine.

General Geol. & topography of Upper Kitsault Valley.

Structure in Argillite

Kitsault Glacier
The source
of the
Kitsault River

West fork glacier
Illustrating the
U-shaped valleys
carved out by glaciers

General topography
of the Upper Kitsault
valley.
Looking north
from an elevation
of about 3500 ft.

Maps.

1. Plan of Surface D.V. Mine
2. Plan of 200 Level D.V. Mine
3. Cross Section E & W from "


Sketch
of
Dolly Varden Surface
Legend
Purple Volcanic breccia
Green do do
Dykes
Ore
Faults
25 ft Contours - Datum Mean Sea Level.
Scale - 1" rep. 40 ft.
by R.W. Goranson
1921.
Mag. Declination 30°28'.
(Note - 500 Level elev. 1410 ft)
True North.
N
inches
centimetres
Glory Hole No. 1
Glory Hole No. 2
Glory Hole No. 3
Open Cut
Bluff
Rock Bluffs
Portal 200 Tunnel
Portal 300 Tunnel
Portal 400 Tunnel
Roadway
Offices
Bunk House
Mess House
Cut

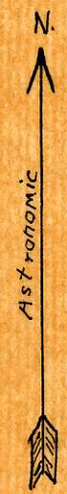
Plan of 200 Level Dolly Varden Mine

Legend.

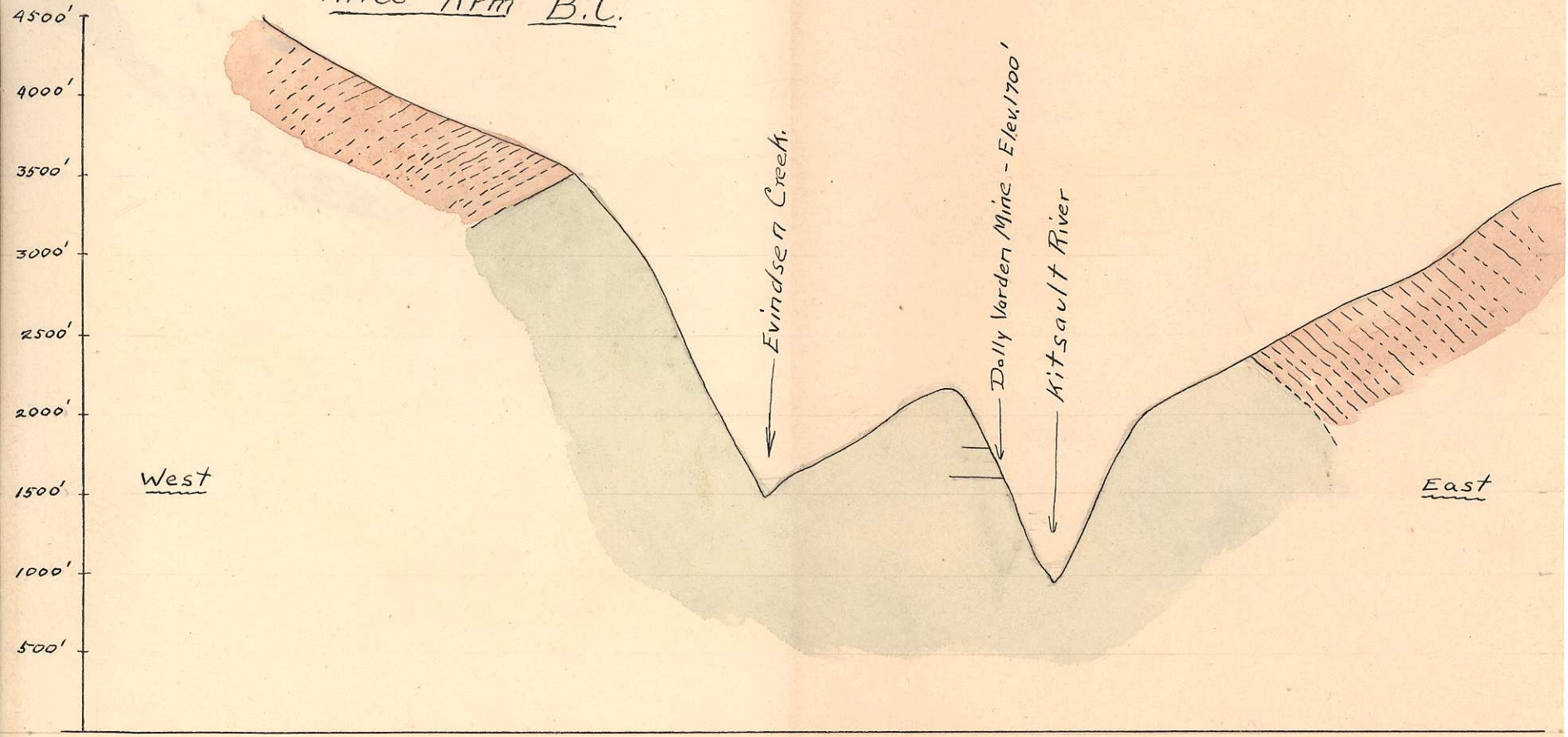
- Green breccia
- Purple breccia
- Diabase dikes
- Faults
- Raise

Scale - 1" rep. 40ft.

by R.W. Swanson
1921.



SKETCH
of
CROSS SECTION
East & West of Dolly Varden Mine
Alice Arm B.C.



Legend.

Argillite

Volcanic Breccia

Scale:
Horizontal - 1" rep 3061.2ft.
Vertical - 1" rep. 1000ft.
[Elevations - above Mean Sea Level.]

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1921.