A Microscopic Examination of Ore from the Little Gem Mine, B. C.

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Geology 9.

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I. Introduction.

The Little Gem Mine is located in the Lilloett Mining Division of British Columbia. The property, consisting of eleven mineral claims and fractions, is situated on the eastern side of Roxey Creek, a tributary of Gun Creek. The workings are situated on the side of a ridge which rises to an elevation of 7,000 feet. At present two tunnels have been driven, one at an elevation of 6,400 feet and the other at 6,350 feet while considerable trenching work has been done as well.

The specimens used for the work were selected from a shipment of about thirty pounds received at the University.

II. Geology of Roxey Creek.

The local rock formation consists of a biotite quartz diorite, medium-grained in texture and light-greenish in color, Near the mineral deposits it is altered to a speckled reddish rock. This alteration is the result of weathering and leaching by surface water. The diorite, in the form of a tongue about 2,000 feet wide and about 2.5 miles long, joins a larger body of diorite which covers the Gun Creek valley. Typical Bridge River formations consisting of andesites and lava flows, are found surrounding the

diorite. A larger body of fine-grained, dark green serpentine borders the diorite on the northwest. The serpentine closely resembles an olivene basalt and except along contacts, little alteration has taken place. Numerous aplitic dikes traverse the quartz diorite and seem to follow closely a brown weathered dike of ferruginous carbonate. Small sections of greenstone are found in a few places in the diorite.

III. Ore Occurrences.

All the known ore bodies appear to be lenticular in shape. At present two veins, believed to be from the same ore body, are being developed. The foot-wall vein which can be traced on the surface for about 50 feet, dips about 90° and trends east to west. The vein varies in width from a few inches to nearly 6 feet at the upper end. The surrounding diorite is not altered to any extent.

The hanging-wall vein lies parallel to the foot-wall vein and about seventeen feet southerly. This vein can be traced on the surface for a distance of 90 feet and underground shows an average width in excess of 6 feet. No appreciable alteration has taken place in the vicinity of this ore body.

Masses of quartz and feldspar are scattered throughout the ore bodies. A shear varying in width

from 6 to 12 feet, strikes in an east-west direction. The shear which can be traced on the surface for a distance of about 2,000 feet is low in values. Small amounts of arsenopyrite and cobalt bloom, found where small dikes cut the main shear, indicate the possibility of finding ore at depth.

IV. Reagents.

As well as the standard reagents used in this type of work four special reagents as outlined in Mr. Thompson's work, were made up.

(1) Aqua regia + Co, Ni, As, S.

The solution contained;

Co	1.82	grams
Ni	1.82	"
As	2.25	"
S	1.00	"

The metals were placed in a 150 c.c. beaker, 20c.c. of aqua regia added and the mixture was then warmed. To enable the solution of as much sulphur as possible 25 c.c. of nitric chlorate mixture ~~was~~ were added and the solution taken to dryness over night on a low plate. The residue was then taken up with 20 c.c. of aqua regia, warmed for one hour and filtered through an asbestos filter into a 40 c.c. reagent bottle.

(2) Aqua regia + Co, As, S.

(4)

Co 1.82 grams

As 2.25 "

S 1.00 "

The constituents were dissolved in 20 c.c. of aqua regia as before.

(3) Aqua regia + Fe.

Sufficient Iron wire was dissolved in 20 c.c. of aqua regia to saturate the solution.

(4) Aqua regia + Fe, As, S.

A saturated solution of arsenopyrite in aqua regia was prepared and the excess filtered off.

V. Etch Tests.

As all specimens examined appeared to be the same, differing only by the presence or otherwise of small inclusions, a detailed description of all tests made is not given. Sections were all etched for 20 seconds except where otherwise noted.

(1) Groundmass.

Concentrated HNO_3:-

Because of its rapid action this reagent was only left on the sections for 10 seconds. The groundmass was etched black and after buffing a distinct prismoidal structure could be seen.

1 : 1 HNO_3

This reagent left a differential

blue and brown tarnish on the surface. This tarnish was easily removed by buffing. There is a possibility that two different minerals were present as the borders between the two different colored tarnishes seemed to etch slightly.

Aqua regia + Fe

At times a blotchy brown stain was observed. This test was not definite enough to be considered as a positive reaction.

(2) Inclusions

Concentrated HNO_3

This reagent gave a black etch in 10 seconds.

1 : 1 HNO_3

With 1:1 HNO and all reagents containing aqua regia the inclusions were etched black.

$FeCl_3$

This reagent etched the inclusions to a slight degree and brought out the outline.

A table of all etch test results is given below as well as one compiled by Mr. E. Thompson of Toronto.

Table of Etching Reactions*

Minerals	Conc. HNO_3	1;1 HNO_3	3:10 HNO_3	$FeCl_3$	A.R. + Fe	A.R.+ FeAsS	A.R.+ CoAsS	A.R. + Co NiAsS
Arsenopyrite	dk. grey etch	Irid. dk. brown remains	-	-	Ft. br. rubs clean	-	-	-
Cobaltite	-	-	-	-	-	-	-	-
Rammelsbergite	dk. grey remains	dk. grey remains	lt. br. remains	dk. br. remains	lt. br.	lt. dk. remains	lt. br. remains	-
Loellingite	grey diff. remains	grey diff. remains	-	ft. br. remains or neg.	lt. dk. br. diff. or neg.	-	lt. dk. br. diff. remains	-
Safflorite	dk. grey remains	dk. grey remains	ft. br. remains	-	-	-	-	Lt. br. diff. remains

All these minerals are anisotropic.

A.R.- Aqua regia $3HCl:1HNO_3$

*Taken from " A Qualitative and Quantitative Determination of the Ores of Cobalt, Ont." by Mr. Ellis Thompson. - Economic Geology, Vol. 25, No.5, 1930.

Reagent	Groundmass	Inclusions
Con. HNO_3	Dark grey prismoidal	Black
1:1 HNO_3	Diff. etch	Etch
3:10 HNO_3	-	-
A.R.+Co,Ni,As,S	-	Etch
A.R.+Co,As,S	-	Etch
A.R.+Fe,As,S	-	Etch
A.R.+Fe	-	Etch
HCL	-	-
$FeCl_3$	-	Slight Etch
KCN	-	-
$HgCl_2$	-	-
KOH	-	-

Using polarized light the inclusions extinguished four times per revolution of the microscope stage. In some sections the inclusions were elongated and seemed to be parallel to each other.

Dr. H.V. Warren using a high-power Leitz microscope, found that these inclusions etched slightly with 3:10 HNO_3. Dr. Warren also found a few bright inclusions which gave negative results with 3:10 HNO_3 and $FeCl_3$. The author was unable to find any of these inclusions so these reactions could not be verified.

With a magnification of 1,300 diameters Dr.H.V. Warren found that the gold appeared in the inclusions.

The particles of gold were approximately 1-10 microns in size and appeared only in the inclusions which etched with $FeCl_3$.

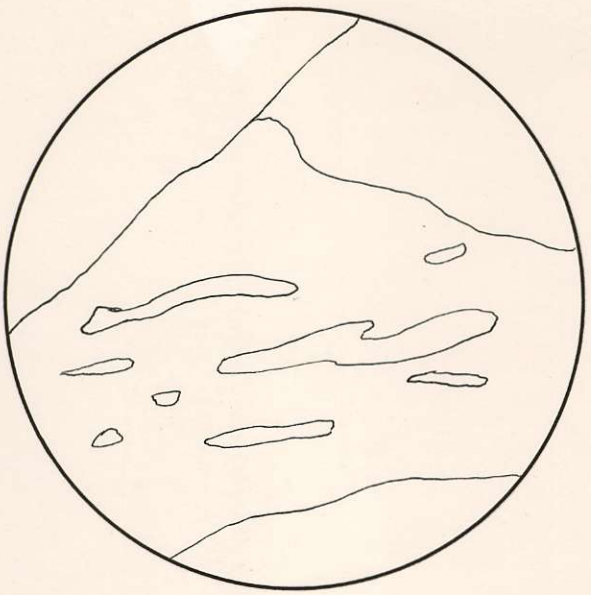
Both ground mass and inclusions were found to be anisotropic. Twinning was noted numerous times in the ground-mass. The polarization colors were mainly a light blue to a purple-brown and brown. Varying shades of grey were found as well. The inclusions varied from a light blue to a straw brown color. It was found necessary to use polarized light to find the inclusions as they blended with the ground-mass under ordinary light.

All microchemical tests performed on specimens, picked at random, showed the presence of cobalt and iron.

VI. Assay Results.

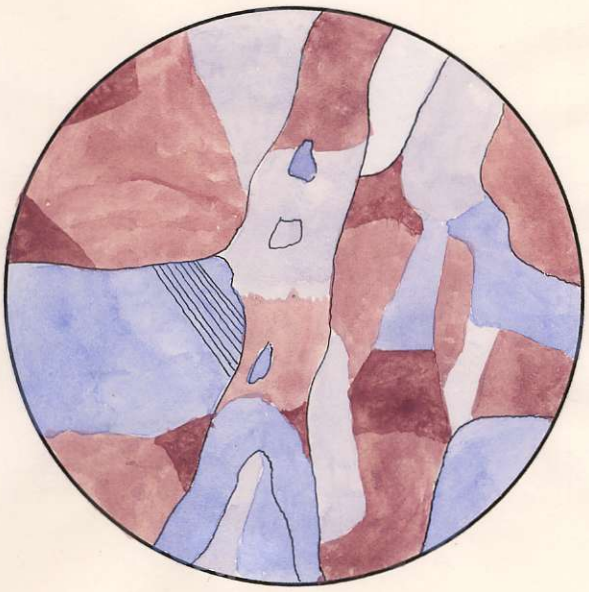
A head sample of the ore was taken and gave the following results:

Co	6.8%
Ni	0.5%
Fe	22.1%
As	39.0%
S	14.1%
Insol.	11.4%
Total	93.9%
Gold	1.46 Oz. per ton



x 100

Diagram showing the parallel arrangement of the inclusions, after etching with FeCl



x 100

This diagram shows the variety of colors seen with polarized light as well as twinning

Samples 1,2 and 3 used for assaying were picked out after the polished sections had been made up. They were chosen to correspond as closely as possible with the sections. Polished sections were made and assays were run on samples. 1 (1), 2(1) and 4 at the same time so the results should be more representative.

Section	Description	Co	Ni	Fe	As	S	Total
1	Showing inclusions Yellowish color and cleavage noticed	0.77	-	40.1	43.6	18.5	102.9
2	Showing inclusions Dense grey color	8.9	-	25.9	45.2	21.8	101.8
3	Apparently same as #1	0.90	-	36.0	42.3	20.1	99.3
1 (1)	Apparently same as 1 & 3	4.3	0.08	31.5	45.5	17.3	98.7
2 (1)	Same as 2	8.7	0.04	26.4	40.5	16.2	91.8*
4	"Treeish" structure apparently due to the gangue.	9.9	0.2	24.3	46.1	16.9	97.4

*Contained some insoluble material.

Gold assays were as follows:

Section	Au(oz/ton)
1	2.05
2	2.15
3	1.58
4	2.10
6	2.10

VII. Conclusion.

The etch tests on the inclusions correspond very well with those for loellingite. The discrepencies may have been caused by the solutions not corresponding exactly with those of Mr. E. Thompson.

The etch tests on the groundmass gave similar results to those of arsenopyrite but the assay results check very closely with those given for the mineral danaite.* This mineral is a cobaltiferous arsenopyrite with assays as follows:

Variety	Co	As	S	Fe	Total
Skutterud	9.01	46.76	17.34	26.36	99.47
Skutterud	4.75	47.45	17,78	30.91	100.89
Franconia	6.45	41.44	17.84	32.94	98.67
Copiopo	5.84	44.30	20.25	30.21	100.60

From the results it will be seen that sections 2, 2 (1), and 4 correspond very closely with danaite. The assay of section 3 checks fairly well with that of arsenopyrite but it also seems to be a mixture of numbers 1&3. It is quite probable that the specimens could be a mixture of arsenopyrite and danaite in varying proportions.

No definite statement regarding the inclusions could be made. It was first thought that there would possibly be some connection between the inclusions and

* Page 99, " Descriptive Mineralogy", by Dana, John Wiley & Sons, 1914.

the amount of cobalt in the ore but no evidence to substantiate this could be obtained.

The author feels that the results were not as satisfactory as they might have been but, as time was limited, it was not possible to carry it out further tests.

Acknowledgments.

The author wishes to thank Dr. H. V. Warren of the University staff under whose direction this work was carried out. Without his generous assistance and helpful suggestions, many of the above results would not have been obtained. To Mr. P.Davis who super-panned many of the samples used for assaying, the writer extends his thanks. The help of Mr. P, Leckie-Ewing of the 5th Year Metallurgical Engineering class who also worked on this ore, is also appreciated.

The geology and ore occurrences were taken from Mr. R.R. Taylor's summer essay, "The Little Gem Mine" by kind permission of the author.