MINERALOGRAPHIC INSPECTION OF SPECIMENS OF ORE FROM THE WATERLOO MINE

A report submitted during the fourth year of the course in Mining Engineering at the University of British Columbia

Peter M. Stiles

PETER M. STILES

APRIL 21, 1955

DEPARTMENT OF GEOLOGY
UNIVERSITY OF BRITISH COLUMBIA

CONTENTS

	Page
Introduction	1
Regional Geology	1
The Waterloo Mine	4
Local Geology	5
Mineralographic Inspection	5
Summary	11

ILLUSTRATIONS

	Page
The Lightning Peak Map Area	2
Plate #1 - Exsolution Textures Exhibited by chalcopyrite	7
Plate #2 - Mineral Association	10

PREFACE

This paper is the result of a mineralographical inspection of a group of polished sections taken from specimens collected at the Waterloo Mine. These specimens are part of the collection of the Geology Department of the University of British Columbia.

The introduction and geological features were taken from a paper published by C. E. Cairnes, "Lightning Peak Area, Osoyoos District, British Columbia", in the G. S. C. Summary Reports of 1930.

The help received from Dr. R. M. Thompson and S. Papezyk in the mineralographic inspection, and from J. A. Donnan in the preparation of polished sections was very much appreciated.

Introduction

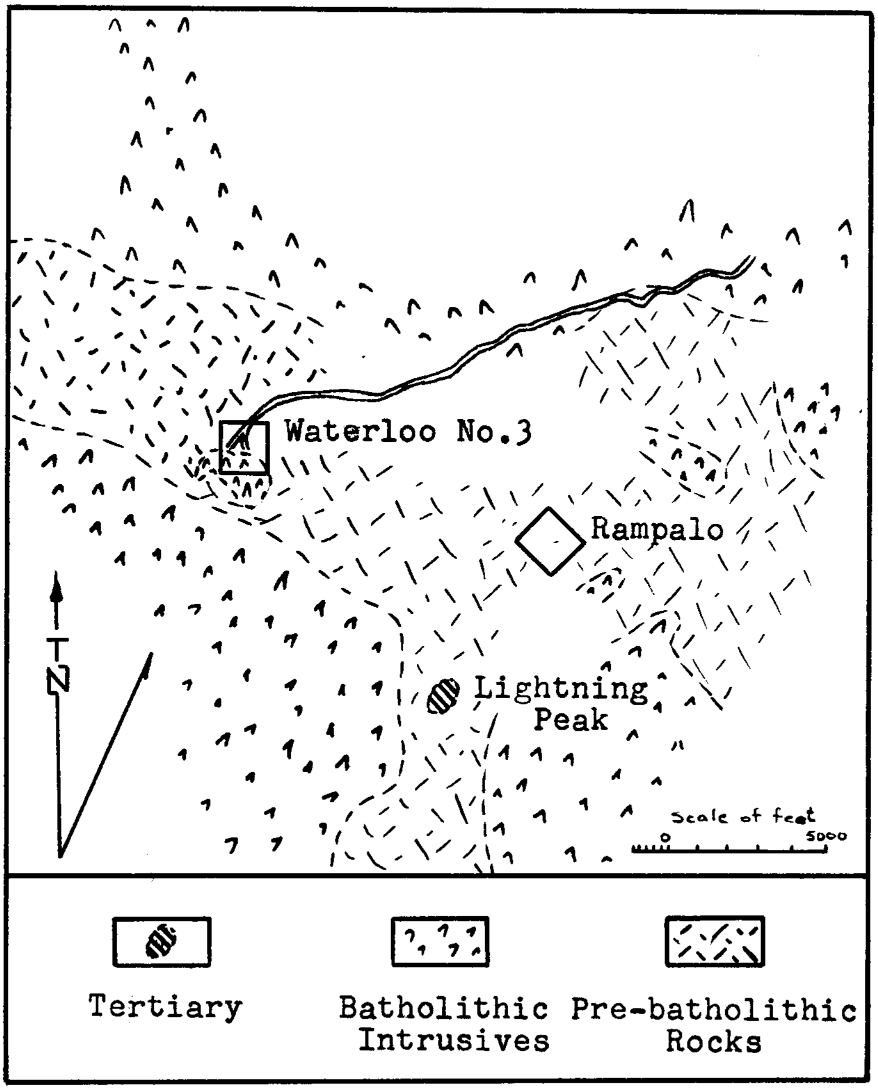
The Waterloo Claims are situated in the Lightning Peak area of the Osoyoos Mining Division of Southern British Columbia. Lightning Peak is a member of the Monashee mountains which comprise a part of the mountain system between the Columbia Valley on the east and the Interior Plateau on the west. Relief in this area ranges from 5000 feet above sea-level in the valleys to 7,035 feet at the summit of Lightening Peak itself. The property is situated at the headwaters of Rendell Creek at the terminus of a tractor road leading 18 miles into the Lightning Peak area from the Vernon-Edgewood Highway.

Regional Geology

The hard rock formations of the area may be conveniently described under four main headings - tertiary basalt, minor intrusives, batholithic intrusives, and pre-batholithic rocks.

The tertiary basalt forms the upper 200 feet or so of Lightning Peak, and being in this elevated position is not in evidence anywhere else in the district.

The minor intrusives of interest are only those of a more acid composition. These acidic intrusives are commonly associated with



The Lightning Peak Map Area

mineralized veins and have been looked upon with favour in mining operations. Hand specimens rarely show appreciable amounts of dark minerals and seem to be very largely composed of quartz and feldspar.

The batholithic intrusives occupy a large part of the Lightning Peak area. The northern half is occupied by a porphyritic granite which is a grey coarse-grained aggregate of quartz and feldspar with 5 to 10 per-cent of ferromagnesian minerals - chiefly biotite. The southwestern sector is made up largely of a granite-diorite complex. Feldspar constitutes a somewhat greater proportion of the rock than quartz. In the southeastern part of the map area pink granite is widely exposed. This rock carries abundant quartz, commonly smoky, and contains less of the dark minerals as compared with the other batholithic members. It is notably deficient also in sulphides and other metallic minerals.

The pre-batholithic formations occupy a large part of the central area of the map district. They occur chiefly within a helt averaging a mile or more in width and extending in a general east-west direction. These formations include a variety of both sedimentary and volcanic rocks but all have been much altered. Locally the structures are complex, but the general structure seems to be that of a syncline plunging westerly or northwesterly. Geologic relationships indicate that the southeastern exposures of lavas are the oldest and these are succeeded by coarse, then fine-grained tuffaceous rocks, and limestones.

The Waterloo Mine

The first claim was staked in the district in 1897. The Waterloo No. 3 claim which became the Waterloo mine was staked in 1903. Two small shipments were made the first year, one of which ran 669 ounces of silver, $1030 in gold, and 45 percent lead.

No further shipments were recorded until 1918 when 9,381 pounds of ore were taken by packhorse to Edgewood and shipped to the Trail Smelter. The shipment netted $3,244.53, or slightly over $690.00 per ton. In 1919, 13 tons were shipped averaging 500 ounces of silver and about 5 percent lead. In 1920, 22 tons of high-grade silver-lead ore were packed out assaying approximately the same as the shipment made the previous year.

Between 1929 and 1930 three shipments amounting to 110 tons were made averaging 450 ounces of silver and the third running 7 to 9 dollars in gold.

The workings at the Waterloo Mine include four adits which, in order from east to west and from highest to lowest, are No. 1, 1120 feet long; No. 2, 250 feet long and 24 feet below No. 1; No. 3, 40 feet long and 52 feet below No. 2; and No. 4, 10 feet long and 36 feet below No. 3. These adits are driven in on the main waterloo vein zone which outcrops down the slope below No. 1 adit. The slope of the surface is fairly steep being about 25° from No. 1 to No. 4 adit levels.

No. 2 adit is connected with No. 1 and the surface by a raise and stopes. All the ore shipped to date has come from this region which outcrops below No. 1 adit.

Local Geology

A large proportion of the rock in the vicinity of the workings is crystalline limestone associated with bodies of highly metamorphosed, commonly greenish, rocks presumably of volcanic origin.

The main Waterloo "vein" is a strong mineralized shear zone averaging about 4 feet in width. This shear zone, so far as it has been developed, intersects mainly crystalline limestones but hands of brownish shaly sediments a few inches thick also occur. The zone also cuts two or more acid dykes, and a plug of granodiorite about 25 feet in diameter at the 250 foot region of the second level.

The shear zone although mineralized along its entire investigated length, has yielded relatively restricted economic mineralization. This economic region with a length of about 40 feet at the surface, extended to No. 2 adit level below which its extent has been only slightly investigated. The high grade ore from this region has been mostly stoped out. It included conspicuous amounts of native silver, argentite, ruby silver, stephanite, and grey copper associated with argentiferous galena and sphalerite. These minerals reportedly occurred in lens-like masses and in stringers accompanied by a varying proportion of gangue minerals - cheifly calcite.

Mineralographic Inspection

Since the origin of the specimens is unknown excepting that they are from the Waterloo Mine, a correlation of one with the other may be misleading and probably impossible. For this reason each section will be discussed separately.

Section #1

Pyrargyrite	Limestone
Chalcopyrite	Chlorite Alteration
Pyrite	Quartz
Sphalerite	Calcite
Galena	
Native Silver	

The hand specimen from which the section was taken shows abundant, massive, blue-grey ruby silver and sphalerite. Some native silver is also visible. The gangue is essentially limestone which shows chloritic alteration, plus appreciable amounts of smoky quartz and calcite.

Under the binocular microscope small amounts of galena were noted and these only in the sphalerite, Small stringers of chalcopyrite were also visible.

From the unpolished surface of the specimen exposed by the saw cut it was possible to determine some of the mineral associations.

Small quartz veinlets cut the sphalerite but quartz seems to act as host to the ruby silver. The calcite may have occurred contemporaneously with the ruby silver as it shows only slight corrosion where it borders the ruby silver. The limestone shows only narrow penetrations of ruby silver and these are probably along small pre-existing fractures indicating possible preferential replacement of the quartz.

Under the microscope the ruby silver showed a ruby red internal reflection, a blue grey colour, a massive texture, a hardness of B+, a red streak, and apparent isotropism. Together with the above information and confirmative etch tests the mineral was found to by pyrargyrite.

In one portion of the section, a rim of chalcopyrite was observed in the pyrargyrite along an edge. This chalcopyrite exhibited a graphic exsolution texture resembling a eutectoid intergrowth indication contemporaneous deposition in solid solution. (see plate #1) Small blebs of native silver are also evident in the pyrargyrite and particularly in the section showing the exsolved chalcopyrite. Other examples of this exsolution texture were subsequently found in the section.

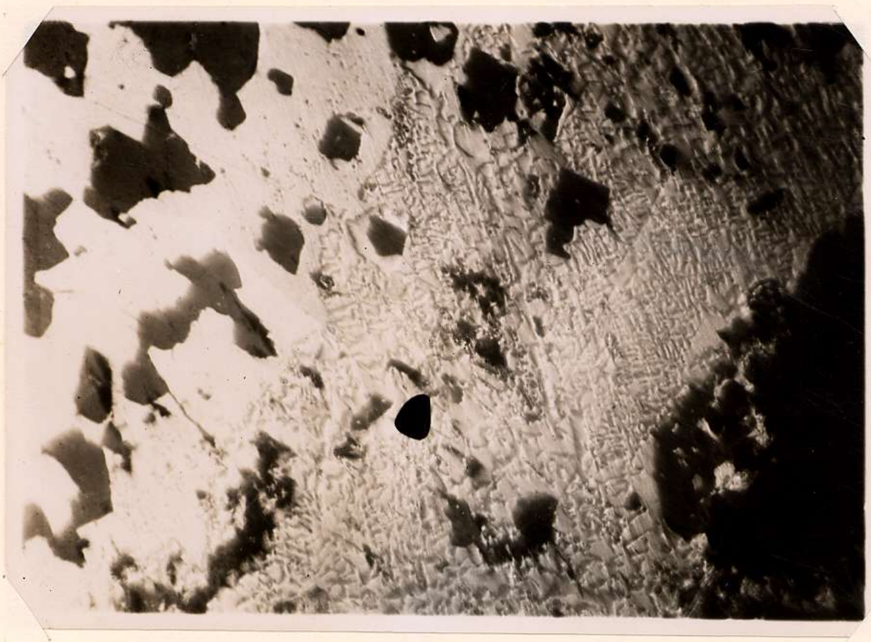


Plate #1 Exsolution Textures
Exhibited by chalcopyrite

There seems to have been two depositions of quartz. The second appears to be associated with the mineralization either as a carrier or as an avenue for replacement. The former possibility seems to more likely. This host quartz occurs as pitted veins and enlargements containing metallic mineral inclusions, whereas the original quartz presents a smooth and almost unblemished surface. This is particularly evident around pyrargyrite inclusions where the host quartz shows bright red internal reflection and the original quartz shows none.

Veins of the host quartz may be followed and pyrite, sphalerite, chalcopyrite, native silver, and pyrargyrite deposition may be seen. Small inclusions of galena are visible in the sphalerite identified only by the blue cast under crossed nicols.

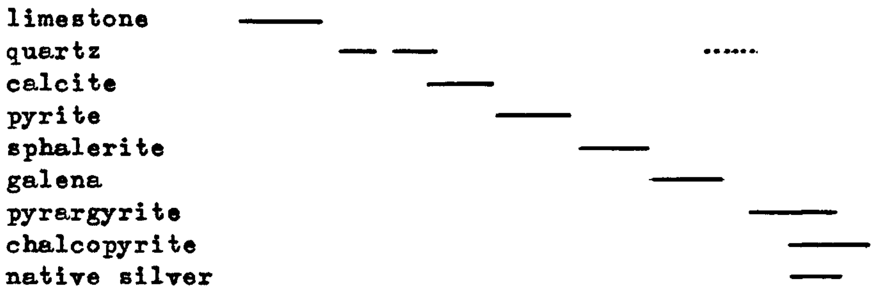
Section #2

This section was taken from the same specimen as section #1. Somewhat more galena is in evidence in this section. Galena was definitely identified by characteristic triangular pits. At one point in the specimen quartz veining sphalerite also veined galena. Galena appears to be replacing sphalerite, and in one instance pyrargyrite was seen replacing galena.

The sphalerite demonstrates a coarse mosaic testure due to faint indications of twinning. The galena present is in the order of 50 microns in size.

A stringer of chalcopyrite is visible in a quartz vein cutting the sphalerite which indicates it is later than the sphalerite but either preferentially replaces quartz or occurs with it. Chalcopyrite also occurs as veinlets in sphalerite.

Paragenetic sequence exhibited by sections 1 and 2;



Section #3

The specimen from which this section was taken was a small piece of massive sulphide showing galena, pyrite, sphalerite, and a fine--grained grey metallic mineral. The hand specimen submitted was found with the one from which the sectien was taken and appears to have originated from the same section of the mine.

The same gangue minerals as exhibited by the former sections are visible in the hand specimen. In contrast to the other sections strong pyritization is evident. A copper stain, indicating the presence of perhaps chalcopyrite, appears on the specimen.

Under the microscope the polished section shows all the visually discovered minerals. The fine-grained grey mineral was recognized by its grey colour, hardness of B+, and strong green to red anisotropism as polybasite.

Plate #2 illustrates the mineral association. The polybasite and galena present smooth mutual boundaries indicating contemporaneous deposition. The sphalerite contains inclusions of galena and chalcopyrite and is veined by quartz. The pyrite has been replaced by all succeeding minerals. Both types of quartz as discovered in section #1 are present. No pyrargyrite was present in the section.

Plate #2 Mineral Association

Paragenetic sequence exhibited by section #3 and its hand specimen;

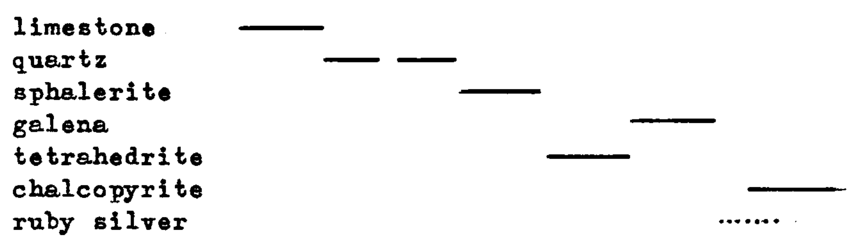
limestone	———								
quartz		———							
calcite			———						
pyrite				———					
sphalerite					———				
galena						———			
polybasite						———			
chalcopyrite							———		

Section #16

This section accompanied the tray of hand specimens and was selected because it shows the occurrance of tetrahedrite. Where evident it is undergoing replacement notably by galena and also by chalcopyrite. It occurs mainly in veins with quartz and in some places replaces sphalerite. Sphalerite also shows replacement by galena and chalcopyrite.

The two types of quartz mentioned under section #1, are again in evidence and the small amount of ruby silver present is associated with the pitted variety. No pyrite is present.

The paragenetic sequence exhibited by section #16;



Summary

Pyrargyrite — $3Ag_2S.Sb_2S_3$

Pyrargyrite occurs as a massive replacement of quartz and also in fine fissures in limestone. Minor amounts occur in blebs in sphalerite. It is intimately associated with chalcopyrite along its boundary with quartz in some instances.

Chalcopyrite - $CuFeS_2$

Chalcopyrite occurs both as an exsolution constituent with pyrargyrite and as a massive replacement of quartz and to some extent of preceeding sulphide mineralization. It is considerably more abundant in the massive form as found in Section #16, where it accounts for about 5 percent of the mineralized area of the section.

Pyrite FeS_2

Pyrite is generally exhibited in minor amounts excepting in Section #3, where it makes up approximately 30 percent of the section occurring as coarse-grained pyrite. In this case it appears that it may have acted as host for the mineralization along with quartz.

Sphalerite - ZnS

Sphalerite occurs in a coarse-grained massive form occurring after pyrite as shown in Section #3. Its position with respect to pyrite in the other sections is not evident. All occurrances show fairly strong replacement by later sulphides mainly, galena.

Galena - PbS

The occurrances show that galena deposition occurred at the expense of the already deposited sphalerite. It is a minor constituent except in Section #3 where it accounts for about 40% of the surface of the section. In section #16 it strongly replaces tetrahedrite.

Polybasite - $8Ag_2S.Sb_2S_3$

Polybasite appears to have been deposited contemporaneously with galena. It is only evident in Section #3 accounting for about 10 percent of the area of the section.

Tetrahedrite - $5Cu_2S.2\ (Cu,Fe)\ S._2Sb_2S_3$

Tetrahedrite was only noticed in Section #16. Here it is shown replacing sphalerite but itself being strongly replaced by notably galena and chalcopyrite.

Native Silver - Ag

The small amounts of native silver visible were always associated with pyrargyrite. It occurs as blebs about 10 microns in size.