A good beginning on a new problem. No estimate attempted of silver distribution. This would be helpful.

THE MINERALOGRAPHY OF GRAY ROCK

A report submitted in partial fulfilment of the Geology 9 course.

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Table of Contents

List of Illustrations

THE MINERALOGRAPHY

OF

GRAY ROCK

Introduction

The following is a report on the study of Gray Rock ore. The chief objects of the study were to ascertain the mode of occurrence of the silver and copper, and to determine to what extent they would be separable from the antimony by concentration methods.

Laboratory procedure consisted of cutting, mounting, and polishing sections of ore from different parts of the property. The minerals were determined by their physical properties, and by microchemical methods.

The writer wishes to express his appreciation of the co-operation and assistance given by Dr. H. V. Warren, of the Department of Geology, University of British Columbia, under whose supervision this work was done. The writer is grateful to Mr. R. Thompson and Mr. D. Carlisle, assistants in the Department of Geology, for their welcome suggestions and criticisms.

Location

In the Lilooet Mining Division this prospect, consisting of fourteen claims, is held by the Gray Rock Mining Syndicate. The property is located at the head of Truax Creek, the original camp-site being situated at the foot of Mount Truax, south 30 degrees east from its summit. The prospected area, ranging in elevation from 6,000 to 8,000 feet, lies to the south and south-east of Truax Creek, on the steep to precipitous rocky ground above timber line, in the edge of which the temporary camp is at 6,100 feet elevation. Between this point and the Bridge River Crossing, at 2,125 feet elevation, the Truax Creek Valley is generally well wooded. There are two small lakes at the eastern and western end of the claims, the eastern one being about 2,000 feet long and 600 feet wide. From this lake, a creek falls abruptly through a height of 600 feet to Truax Creek below.

Geology

The showings contained within an area roughly 600 feet long, measured easterly-westerly, by 1000 feet wide, are located on rock bluffs and rock-strewn slopes, the exposed ground being separated by rock-slides or ice spurs, descending northerly towards the creek from glaciers filling depressions in the irregularly-serrated summits, which, rising to 8,000 feet elevation, form the background.

The deposits occur in a system of roughly parallel fissure-veins cutting a complex assemblage of metamorphosed rocks of the Bridge River series, and included are dykes from the adjoining batholith. The stratified formation, striking westerly with steep southerly dips, includes grey quartzites, a hard competent rock in this location, frequently sericitized; siliceous sericitic schist; dark pyritized schist; silicified metamorphosed limestone lenses; and intercalated altered volcanic flows, partly silicified. Dyke-types cut by the fissures include granite, quartz diorite, and quartz latite. The rocks of the Bridge River series form a wide band lying between two roughly parallel-trending areas of quartz diorite of the Bendor batholith.

Mineralogy

The following minerals have been identified in the polished sections that were examined: (1) stibnite, (2) tetrahedrite, (3) covellite, (4) chalcopyrite, (5) galena, (6) pyrite, (7) cervantite (?), (8) quartz, and (9) country rock.

Stibnite

Most of the stibnite is massive, free from visible impurities or intimate association with other metalliferous minerals. Some of the massive stibnite which shows heavy stressing is veined by very fine veinlets of covellite. The stibnite is mostly associated with quartz, which it replaces.

In the heavily-weathered surface showings, the stibnite has been altered to a yellow oxide in which small amounts of covellite are found. In the disseminated zone, stibnite is found veining pyrite.

The stibnite was positive to the KOH etch test and was distinguished from the tetrahedrite by its anisotropism when inspected under crossed Nicols.

Tetrahedrite

In none of the specimens examined does tetrahedrite appear in large or well-formed crystals. Most of the tetrahedrite occurs between well-formed crystals of quartz, and is accompanied by covellite in varied amounts.

Tetrahedrite does not occur along with the massive deposit of stibnite, but in zones where mineralization is disseminated, the two minerals are frequently found together.

The tetrahedrite is distinguished from the stibnite by a very slight color difference, and by the isotropism of the tetrahedrite. Microchemically determined, the presence of copper, antimony, and silver, as well as the absence of arsenic, disproved the previous suggestioned by Dr. O'Grady that the grey copper was tenantite. Spectrographic confirmation by Mr. Carlisle showed the presence of arsenic to be very minor, whereas antimony was quite prominent.

Covellite

The covellite is of very late occurrence and is supergene. It intrudes the minute fissures of all the heavily stressed minerals. The primary copper mineral from which the covellite originated has not been definitely ascertained, but chalcopyrite and tetrahedrite are both likely sources.

Covellite occurs with equal intimacy in stibnite and tetrahedrite and often replaces them. It almost completely envelops any chalcopyrite that is present.

There is no reason to believe that covellite will persist to depth, but its nomadic characteristics, particularly in the fine veinlets in the stibnite, will present a definite metallurgical problem.

Covellite was identified by its hardness, its shade of blue, and its blackening under the KCN etch.

Chalcopyrite

The age of chalcopyrite is indeterminate because it is found only along with covellite and country rock, both of which it preceded. It is quite probable that the chalcopyrite is the primary mineral from which the covellite came. Such being true, the chalcopyrite should occur to a greater extent at depth. Two small crystals may be observed in the briquet of concentrate 17b. The association of covellite and chalcopyrite are shown in figure 2.

Galena

The galena is anhedral and is associated with pyrite, which it veins, and quartz, which it replaces. Its occurrence was observed in only one of the sections examined.

Galena was determined by its characteristic triangular pits, its galena-white color, its isotropism, and was confirmed by the positive reaction to the $FeCl_3$ etch.

Pyrite

The euhedral crystals of pyrite are of early deposition. Most of the crystals have been badely fractured, showing that they had been heavily stressed during the quartz deposition.

Pyrite is veined by tetrahedrite, galena, covellite, quartz, and stibnite, and occurs only in the disseminated portion of the deposit. It was identified by its hardness, its brass color, and by the pyritohedral form of its crystals.

Antimony Oxide (Cervantite?)

This is definitely a surface phenomenon and is quite visible to the naked eye on section 3. This was at first mistaken for country rock, but microchemical tests showed it to contain antimony.

To ascertain more information about this oxide, the tails of a flotation test were superpanned and the oxide collected at the tip. Spectrographic analysis by Mr.

Thompson showed as major, antimony; as minor, iron, lead, silver, traces, cadmium, zinc, arsenic, copper, and titanium. In a flotation tail that assayed 1.24 per cent antimony, the ratio of oxide to sulphide was two to one.

Quartz

The quartz is of early deposition and, as evidenced by the symmetry of crystal orientation, cooled under a minimum of stress. Megascopic examination of the ore indicates quartz to comprise 60 to 75 per cent of the bulk of the samples submitted. Quartz is found in intimate contact with every other mineral except chalcopyrite.

Country Rock

This was deposited about the same time as the tetrahedrite, and is observed veining and replacing the disseminated stibnite. This material is relatively unimportant as it constitutes a very small part of the sections examined.

Elements Unidentified as Minerals

Silver

Silver occurs in tetrahedrite in sufficient concentration to give a positive microchemical test. It also occurs in stibnite and the antimony oxide, as was determined by spectrographic analyses, but could not be identified by microchemical tests.

Arsenic

Arsenic occurs in minor quantities in the tetrahedrite and stibnite. Careful and prolonged examination of a crystal of stibnite under 1275 magnifications showed no trace of arsenopyrite. A microchemical test of a sample ground from the surface of the section showed no arsenic, but a spectrographic analysis gave a positive result. The crystal was pulverized and assayed 0.32 per cent arsenic and 56.2 per cent antimony. Quartz inclusions in the crystal reduced the assay values.

Type of Deposit

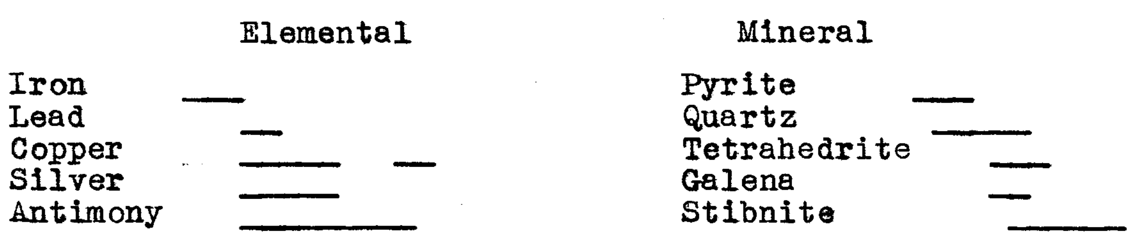
The partially-open structure outlined by the well-developed quartz crystals (see plate 1) suggests that the deposit was at one time a vein with fairly well-developed comb structure.

Apparently the quartz mineralization filled a fairly open fissure under conditions of low pressure, which indicates relatively shallow depth. This agrees with the generally accepted opinion that stibnite deposits usually belong to the epithermal group of mineral deposits; that is, they were formed under conditions of low temperature and pressure.

Paragenesis

Pyrite was the earliest mineral to crystallize. It was highly stressed and fractured during the deposition of quartz which followed. Then came galena and tetrahedrite, and, although no contact between these two has been evidenced, their mode of deposition is similar, and their deposition may be considered as contemporaneous, or nearly so. The tetrahedrite is of earlier deposition than the stibnite. The fact that the comb structures in the quartz are filled with tetrahedrite, and not stibnite, indicates the precedence of tetrahedrite (see plate 1). Stibnite is found veining pyrite and replacing quartz and is considered of relatively late deposition.

The last to deposit was the supergene covellite, which is found veining pyrite and the fissures in quartz. Covellite replaces stibnite and tetrahedrite (figure 2). As chalcopyrite is found only in contact with covellite and country rock, both of which it preceded, its age relative to other minerals has not been ascertained. The following is a suggested chart of the paragenesis of the ore body.



Significance of Observations to the Metallurgy of the Ore

The presence of 0.5 per cent copper, arsenic, lead, in a flotation concentrate is allowable without penalty. A premium is paid for concentrates containing more than 50 per cent antimony, but no compensation for silver in a stibnite concentrate is made. The Engineering and Mining Journal, March 1944, reports a method whereby antimony, silver, and copper may be recovered from an argentiferous tetrahedrite concentrate by a sodium sulphide leach, followed by electrolysis.

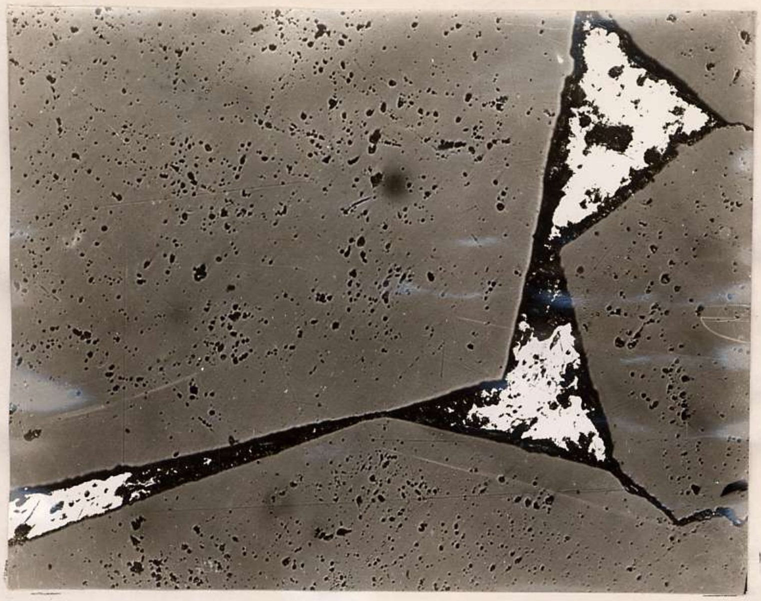
Examination of the polished sections shows that successful metallurgy will depend upon the separation of the tetrahedrite and covellite from the stibnite, and marketing an antimony-copper-silver concentrate, and a high-grade antimony concentrate with a minimum of impurities.

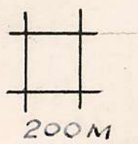
As the arsenic is contained in the stibnite, no separation of these two may be expected. Thus, the arsenic content will increase with the grade of the stibnite concentrate. As the stibnite also carries some silver, the recovery of silver will be limited to that in the tetrahedrite. The copper problem should improve with depth with the expected disappearance of covellite. The recovery of antimony should improve slightly at depth with the disappearance of the non-floatable oxide.

The following chart of micron sizes will assist the determination of the amount of grinding required.

	Size in Microns		
	Average Size	Smallest	Largest
Stibnite	Massive	---	Massive
Pyrite	150	18	450
Tetrahedrite	350	30	750
Covellite	50	10	150
Quartz	Massive	10	Massive
Galena (one piece)	1.65 mm.	---	---
Chalcopyrite	--	5	40 (briquet)

PLATE 1





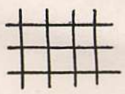
Tetrahedrite invading a quartz comb structure, later replaced by covellite.

WHITE-------Tetrahedrite

BLACK-------Covellite replacing tetrahedrite

GREY--------Quartz

PLATE 2



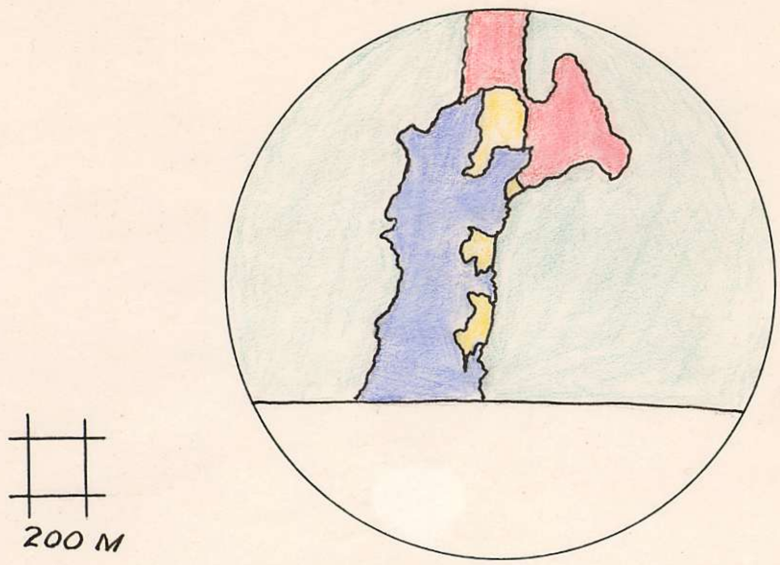
G----Galena

T----Tetrahedrite

Q----Quartz

Pyrite crystals interspersed in quartz

Figure 1



BLUE .... Covellite

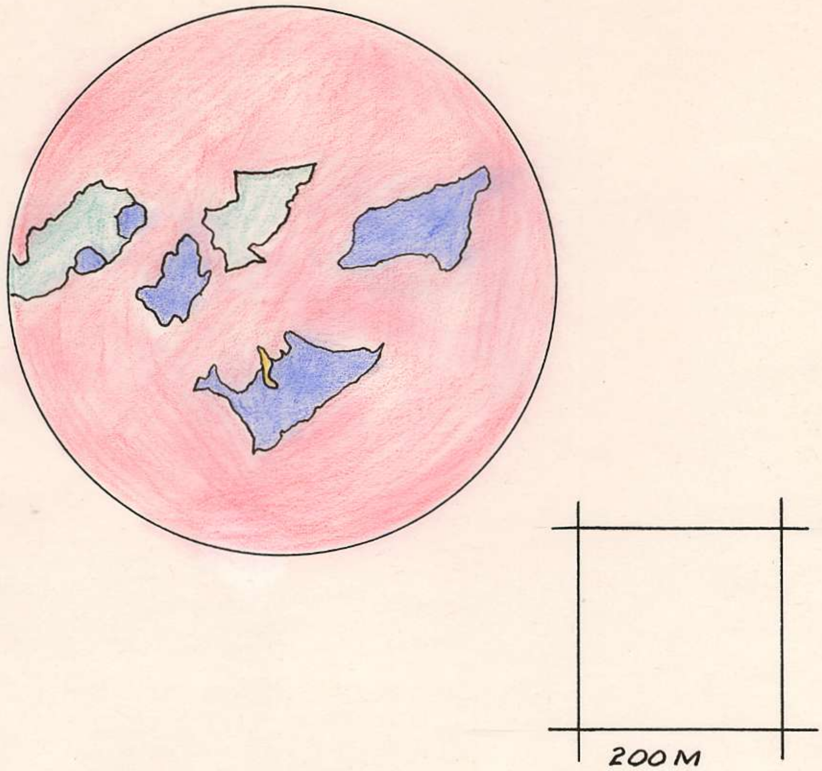
YELLOW .... Tetrahedrite

GREEN .... Stibnite

WHITE .... Quartz

RED .... Country Rock

Figure 2



Chalcopyrite in Covellite

BLUE .... Covellite

GREEN .... Stibnite

YELLOW .... Chalcopyrite

RED .... Country Rock