90/50

Geology 409

MINERALOGRAPHY OF THE LITTLE GEM PROSPECT

by

H. Stuart McColl

Geological Engineering

University of British Columbia

1st Class R.M.T.

March 1949

CONTENTS

ACKNOWLEDGEMENTS

Various persons have assisted the author at one stage or another in the preparation of this report. In particular the author would like to thank Dr. J.S. Stevenson of the British Columbia Department of Mines for his counsel in the selection of specimens for study and in the identification of the minerals present in the ore; Dr. R.M. Thompson of the Department of Geology for assistance in the examination of the polished sections; Dr. K.D. Watson of the Department of Geology for invaluable aid in the identification of minerals in the thin sections; and Mr. J. Fyles and Mr. J. Donnan of the Department of Geology for assistance in the preparation of the thin sections.

Geology 409

MINERALOGRAPHY OF THE LITTLE GEM PROSPECT

INTRODUCTION

This report is the result of field and microscopic examination of the ore minerals present in the Little Gem Prospect. The writer spent three days in August and September, 1948, assisting in a detailed examination of the prospect to substantiate reports of the occurrence of radioactive minerals. The examination of thirteen polished sections and two thin sections was conducted in the laboraties of the Department of Geology at the University of British Columbia during the spring term of the 1948-1949 session.

LOCATION

The Little Gem consists of a group of eight claims near the head of Roxey Creek, a tributary of Gun Creek which flows into the Bridge River two miles west of Minto on the Bridge River Highway. The prospect is approximately twelve miles by road and four miles by horse-trail from Minto. The present workings, consisting of two adits and several opencuts, lie between 50 and 700 feet below the summit of a 7000 foot ridge forming the eastern flank of Roxey Creek.

HISTORY

In 1934 B. Ball discovered erythrite float on the present Little Gem property, traced the float to its source, and staked the first claims. Since then various interests have engaged in work on the property, endeavoring to recover the fairly rich gold and cobalt content. However, a process for treating an ore so heavily charged with arsenides was not developed until recently by the present owners, J.M. and R.R. Taylor. An ammonia leach has been developed which will remove the arsenic and leave a high cobalt concentrate while also allowing for the recovery of the gold by cyaniding.

In late July, 1948, E. Johnson visited the Little Gem with a portable Geiger-Mueller counter and detected radioactivity in the ore. A party from the British Columbia Department of Mines visited the prospect in late August and again in September to confirm the presence of radio-active minerals, take samples, and collect specimens for further study.

GENERAL GEOLOGY

Lenses of arsenides in a gangue of predominantly quartz and allanite lie more or less in alignment in an east-west trending carbonate zone in medium-grained quartz diorite. The quartz diorite is typical of the Bendor intrusive of late Mesozoic or Cenozoic age (1). It was thought by previous investigators that the arsenide lenses were related to the carbonate zone, along which some shearing has occurred. It is now contended that these lenses were emplaced prior to shearing and subsequent carbonatization of the quartz diorite. There are numerous similar carbonated shear zones along the same ridge, none of which has been found mineralized. The association of mineralization with carbonatization is, in this case, presumed to be coincidental. Perhaps the lenses formed a zone of weakness and localized shearing---in one observed instance a lens is offset an undetermined distance by a strong shear.

The arsenide lenses have indefinite contacts with the quartz diorite. In general, they may be said to have a core, or nucleus, of heavy mineralization which blends into the quartz diorite over a zone of disseminated mineralization from six inches to several feet wide. The association of high-temperature arsenides, often of quite coarsely crystalline texture, with coarsely crystalline quartz, orthoclase feldspar, allanite, and apatite, and the occurrence of uraninite, suggests that the deposit was emplaced at a quite high temperature and has the textural features of pegmatite.

MINERALOGY

A. Introduction

Thirteen polished sections and two thin sections of the ore were examined. The minerals were determined by microscopic examination, using etch tests, but optical and physical properties of the various minerals were largely relied upon.

B. Megascopic Examination

The hand specimens collected can be classified into two types---those almost entirely composed of arsenides, and those consisting of arsenides disseminated in bleached "granite" ~~and for~~ and/or quartz and allanite. The former, or "heavy" type of specimen contains predominantly a dense to coarsely crystalline, tin-white mineral indistinguishable from arsenopyrite. Quartz and feldspar occur in minor amounts, often coarsely crystalline. Molybdenite was noticed to occur as streaks through the arsenide. Occasionally apatite crystals occur in radiating bundles in the heavy arsenides. The individual crystals of apatite are up to five inches in length by one-quarter inch in cross-section.

The disseminated type consists mainly of gangue minerals with varying concentrations of arsenides.

Where they have been oxidized at the surface, both types show rather spectacular oxidation products. Erythrite is quite common, rosettes about one-thirty-second inch in diameter often are found coating the surface, or in cracks near the surface. Where molybdenite is conspicious, a brilliant yellow "dusty" mineral occurs. This is presumed to be molybdic ochre. One of such specimens, when placed under ultra-violet light, was noticed to glow a bright emerald green. The material which gave the fluorescence is pale tan in color and has been tentatively assumed to be autunite, or some related secondary uranium mineral, because of these properties and because the specimen gave a high reading on the Geiger-Mueller counter.

Calcite sometimes occurs with the erythrite as a crust on an exposed surface.

Allanite appears as a black,greasy mineral, much like hornblende. It was determined by thin section study.

C. Microscopic Examination

The following minerals were determined in the polished sections by microscopic methods, and chemical analyses: uraninite, a mixture of arsenides---arsenopyrite, cobaltian arsenopyrite, and loellingite, also chalcopyrite and molybdenite. No native gold was observed in any of the sections.

In addition to the minerals mentioned, allanite, orthoclase feldspar, chlorite, zoisite, and quartz were observed in two thin sections made of the gangue.

All the minerals mentioned were observed under ordinary magnification.

1. Uraninite

Uraninite occurs fairly abundantly in some sections, in others not at all. It occurs as steely-grey, subhedral to euhedral crystals in clumps or as disseminations of individuals in the gangue, or, more rarely, in the arsenides. The uraninite is quite difficult to recognize in the gangue under ordinary light but shows up very well under polarized light, since it is isotropic. When the sections have been cut normal to a crystallographic axis, the form of the crystal is that of a cube modified by an octahedron. In age the uraninite is the first mineral to have crystallized and appears to have suffered no replacement by the later minerals. It is contained in crystals of allanite, in arsenides---in one instance the arsenides cuts across a concentration of uraninite (plates 7 and 8), and in quartz. Chiefly, the uraninite is found in association with allanite and the arsenides.

An alteration halo can often be seen outlining uraninite, especially when the uraninite is in allanite, over a width ranging between the radius and the diameter of the enclosed crystal. In several instances, fractures were seen to radiate from the uraninite crystals into the gangue (plates 2,3 and 4). This phenomenon was also observed with the few crystals enclosed in arsenides (plate 6). In regard to the radial shattering of the rock matrix enclosing radioactive minerals, uraninite especially, Ellsworth (2) says that it probably is initially due to stress induced by increase in the volume of the radioactive minerals as a result of atomic and molecular rearrangement necessitated by the disintegration of uranium and thorium. Volume increase of radioactive minerals from the effects of atomic disintegration has been shown by Ellsworth to be probably due chiefly to auto-oxidation which must occur when uranium in the lower form of oxidation is present.

2. Arsenide

The arsenide mixture consists of loellingite and of arsenopyrite which may have a cobalt content high enough to form the cobaltian variety danaite or glaucodot, since arsenopyrite probably forms a series with glaucodot, the variety highest in cobalt (3). Cobaltian arsenopyrite and normal arsenopyrite cannot be satisfactorily distinguished optically. Similarly, arsenopyrite and loellingite are difficult to distinguish. Both have the same tin-white color, are strongly anisotropic with the same colors, and often occur together. Various refinements in technique have been said to give satisfactory methods for separating the two, but the writer was not convinced with the results he obtained. A relatively new procedure (4) was tried which gave definite results. Concentrated nitric acid quickly etches both loellingite and cobaltian arsenopyrite (danaite) a dark grey and further precipitates white octahedra of arsenious oxide on loellingite. Dilute nitric acid etches loellingite a dark grey and brings out relief and grain structure, but does not affect cobaltian arsenopyrite. These effects were observed on the sections studied.

The Assay Branch of the British Columbia Department of Mines made analyses of approximately thirty channel samples for iron, cobalt, arsenic, sulfur, nickel, molybdenum, and soluble and insoluble gangue, besides the usual gold, and in this case, uranium assays. Nickel and molybdenum were found to be either absent in all samples or present only in insignificant amounts. The analyses were corrected for the gangue and brought up to 100 per cent for comparison. The results given below are typical of what was obtained:

Sample	Co %	Fe %	As %	S %	Total %
A	1.5	33.0	49.0	16.5	100.0
B	6.4	22.8	69.0	1.8	100.0
C	6.0	27.0	62.7	4.3	100.0

The high sulfur content and the low cobalt and arsenic content of sample A suggest that the mineral is arsenopyrite. (In nearly all analyses of arsenopyrite some cobalt is present). The relatively high cobalt and arsenic content and the low sulfur content of samples B and C suggest the mineral loellingite. In these two samples the iron and sulfur content is too high, and the cobalt too low, for the mineral to be safflorite. Since safflorite and loellingite are two distinct minerals and the analyses more closely approach the composition of the latter, it is suggested that the main cobaltian mineral is loellingite.

As the author found that the loellingite and arsenopyrite are indistinguishable by ordinary optical methods he has used the term "arsenide" to include both minerals.

The arsenide shows a characteristic radiating structure on a cut surface, fingers of the mineral penetrating the gangue. Under the microscope it is seen to be highly fractured, but often the fractured pieces are only slightly out of position (plate 9). Quartz appears to have filled the fracture spaces, but not to have replaced the arsenide, for the broken fragments have sharp, clean edges that can be projected to fit into one another like pieces in a jig-saw puzzle. Examination of the thin sections showed that the arsenide is, in some cases, restricted to the boundaries of euhedral crystals of allanite, and therefore later than the allanite.

Already mentioned in the section dealing with uraninite is the radial shattering apparent in arsenide immediately surrounding uraninite.

3. Chalcopyrite

Only in one section was chalcopyrite found, and then only in a very minor amount. It appears to have formed contemporaneously with the arsenide or immediately after (plate 10).

4. Molybdenite

Molybdenite occurs in minor amount through much of the arsenide, often associated with uraninite. Its relation to the arsenide is not quite understood since only one section showed any significant amount. Well terminated "spears" of arsenide penetrate a matrix of the molybdenite. The situation may be explained by one of three alternatives:

1. Molybdenite is replacing arsenide.

This seems unlikely because of the unreplaced features of the arsenide.

2. The arsenide grew in a matrix of molybdenite.

3. The arsenide was surrounded by later molybdenite which filled fractures but did not replace the arsenide.

There appears to be little evidence of undue strain in the molybdenite which would likely be the case if crystals of arsenide were to form. Therefore the author favours the third alternative, that of later, unreplacing molybdenite.

5. Allanite

Allanite was determined in thin sections. It occurs as euhedral crystals showing extreme pleochroism and appears to be pre-arsenide in age. It has been shattered to a certain extent and in places largely replaced by quartz, but its crystal form is still easily recognizable.

6. Chlorite

Chlorite of two types was seen in thin section, one type with a fibrous texture and the other occurring in spherulitic masses. The chlorite is post-allanite and post-arsenide in age. Spherulites can be seen growing from the crystal edges of allanite, but not replacing it.

7. Quartz.

Quartz appears to have been the latest mineral introduced. It can be seen veining or cementing the fractured arsenide and replacing allanite.

8. Zoisite

Zoisite occurs in a very minor amount as subhedral crystals that appear to be contemporaneous with the arsenide.

9. Orthoclase

Small amounts of cloudy orthoclase occur. The relationship of the orthoclase to the other minerals is obscure.

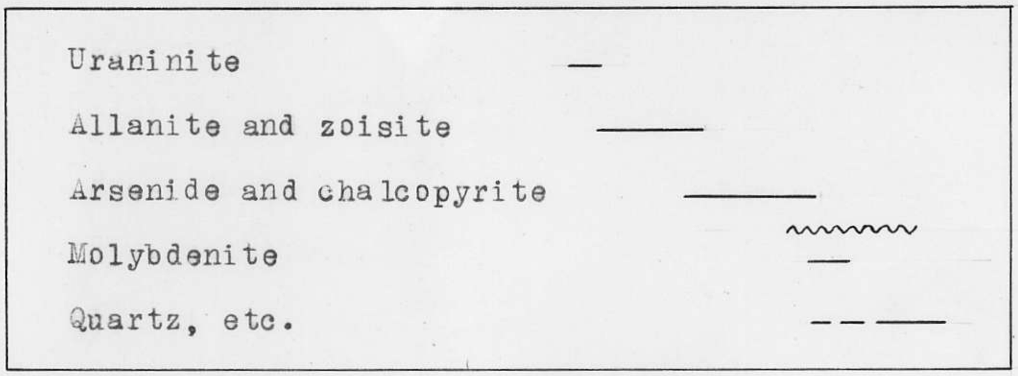
D. Paragenesis

From what has been recorded in the foregoing description of the minerals, the following paragenesis is suggested.

1. Uraninite
2. Allanite and zoisite
3. Arsenide and chalcopyrite

   Period of fracturing
4. Molybdenite
5. Other gangue minerals and quartz

Diagram of Paragenesis



SUMMARY AND CONCLUSIONS

1. The ore consists of uraninite in a massive and disseminated mixture of fractured arsenides, loellingite and arsenopyrite, ~~and~~ in a gangue of allanite, quartz, and smaller amounts of chlorite, zoisite, and orthoclase.
2. The uraninite occurs as euhedral crystals in irregular disseminations in the allanite and arsenide.
3. No gold was observed. It is stated (4) that the gold particles, when observed, are only a few microns in size, and occur irregularly distributed throughout the arsenide.
4. The association of such high-temperature minerals as uraninite, arsenopyrite, loellingite, and molybdenite, with gangue minerals typically found in pegmatites---- allanite, apatite, and zoisite, plus the lenticular shape and textural features of the arsenide--allanite zones, suggest that the deposit was formed at quite high temperatures, and may be considered as pegmatite.

BIBLIOGRAPHY

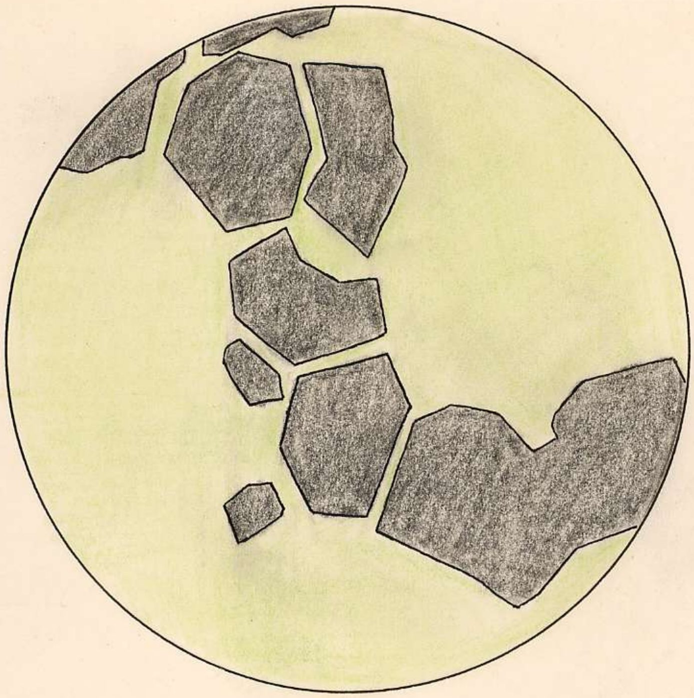
(1) Cairnes, C.E. "Geology and Mineral Deposits of Bridge River Mining Camp, British Columbia", G.S.C. Mem. 213, 1937, pp. 37,38.

(2) Ellsworth, H.V. "Rare-element Minerals of Canada", Economic Geology Series No. 11, p. 88

(3) Palache, C. Berman, H. Frondel, C. Dana's System of Mineralogy, 7th Ed., vol. 1, 1946

(4) Warren, H.V. Thompson, R.M. "Mineralogy of Two Cobalt Occurrences in British Columbia", Western Mines, May 1945, p. 38

plate 1

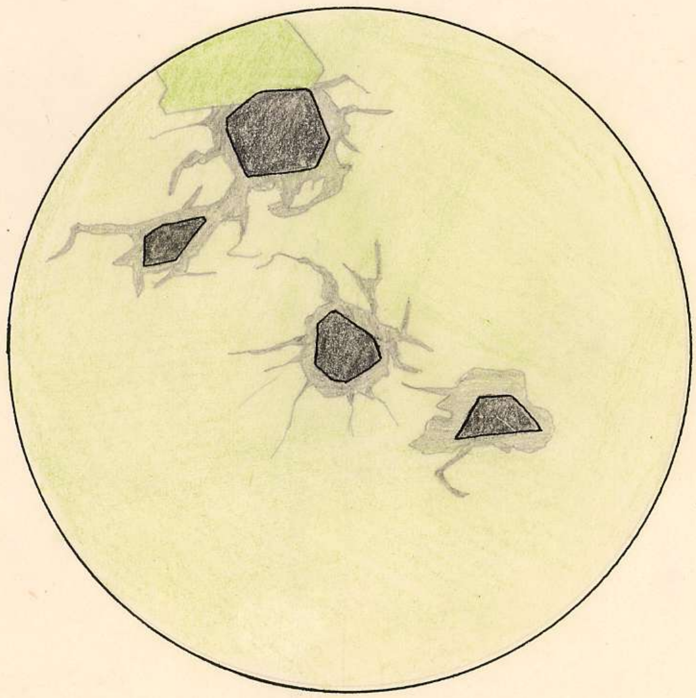


Polarized
light

x 170

Clump of uraninite crystals in gangue

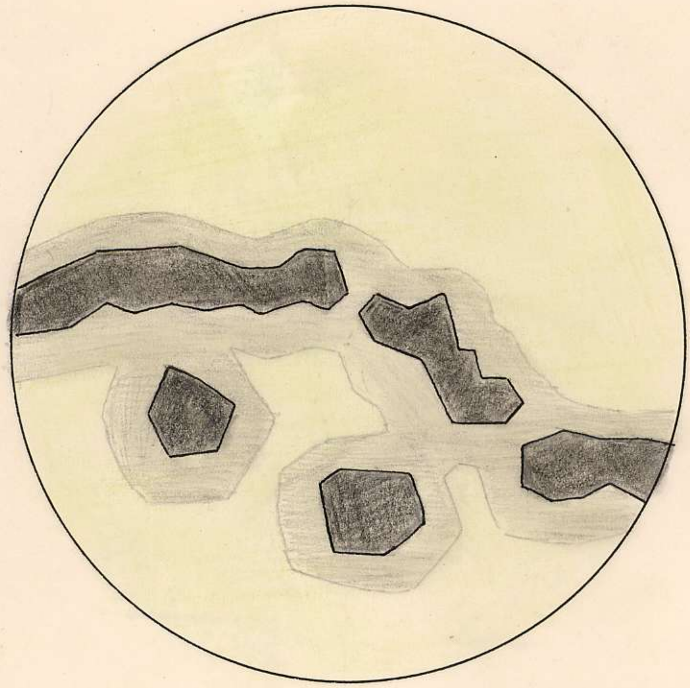
Plate 2



x 70

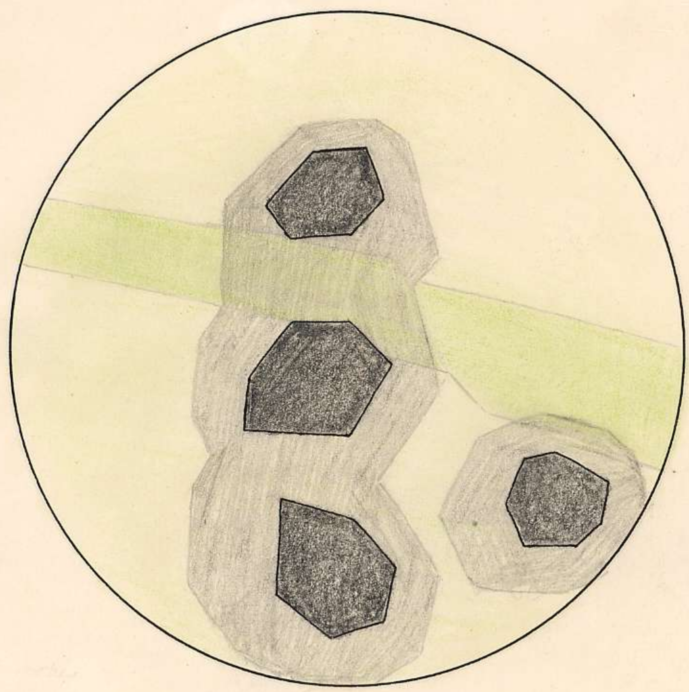
Radial shattering and "haloes" in gangue surrounding uraninite crystals

plate 3



x 130

plate 4



x 130

Alteration haloes in gangue surrounding uraninite crystals

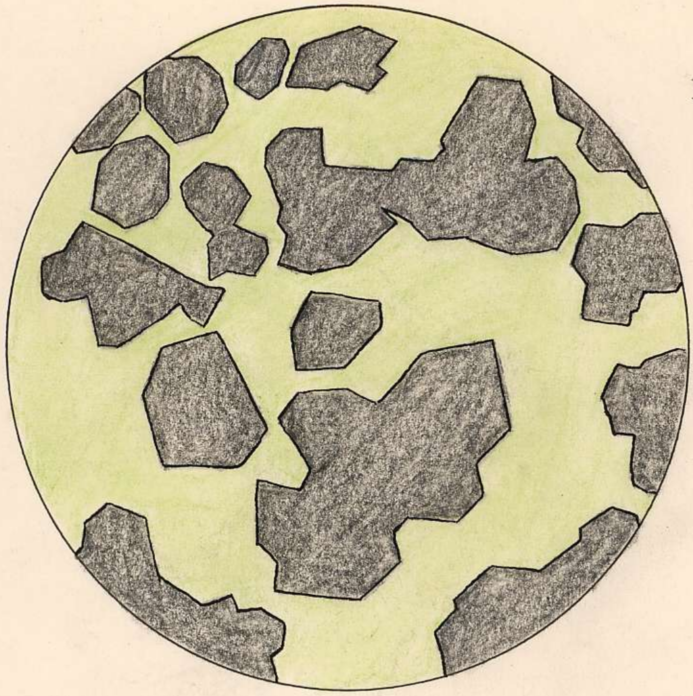


plate 5

polarized
light

x 170

Uraninite crystals in gangue

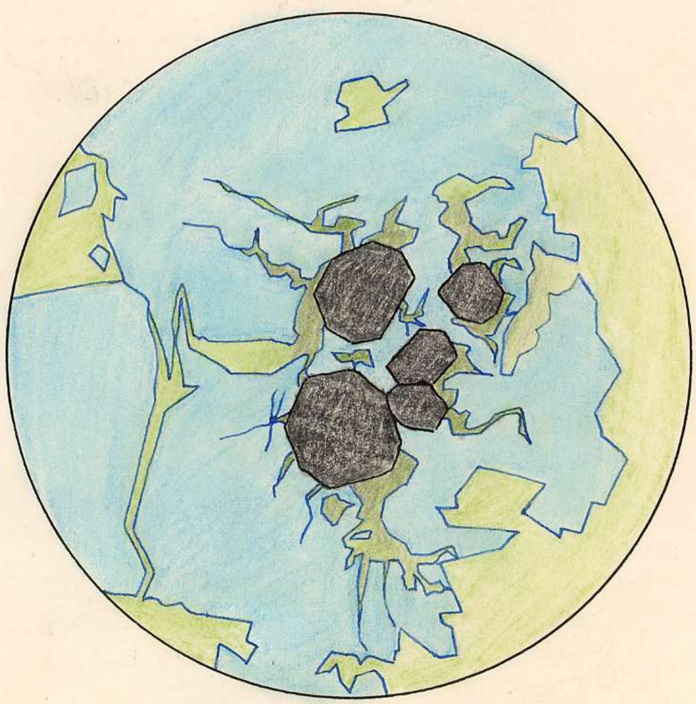


plate 6

x 70

Uraninite crystals enclosed in arsenide, showing radial shattering.

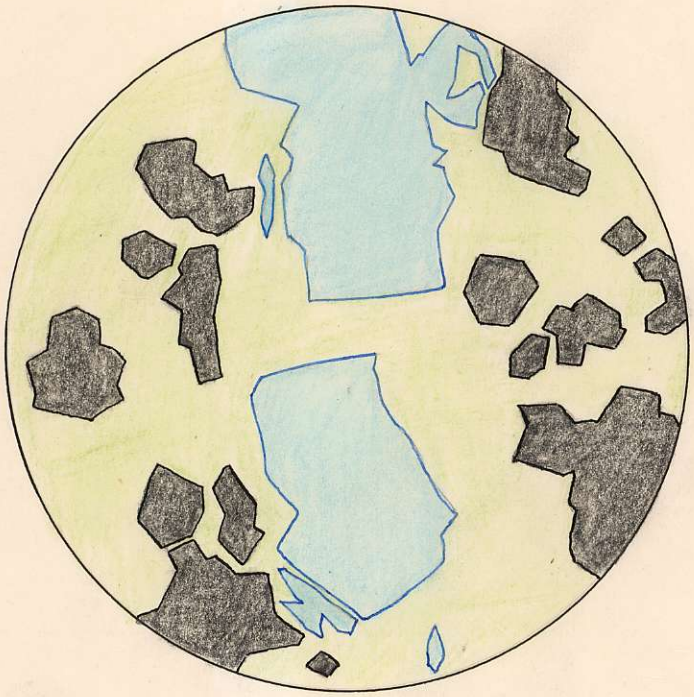


plate 7

x 70

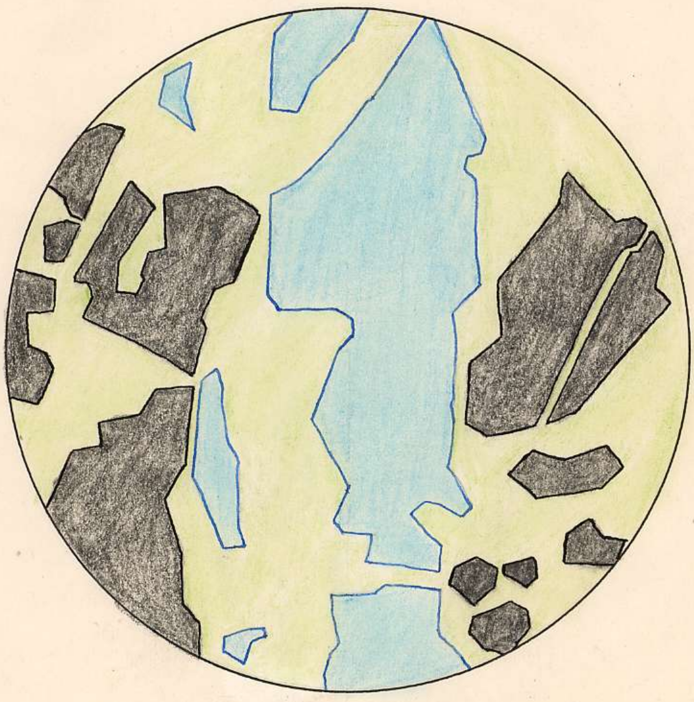


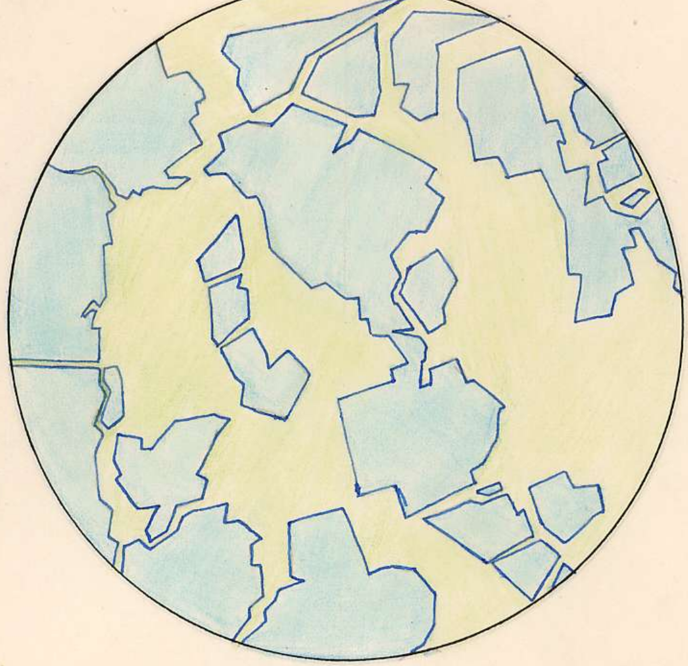
plate 8

x 70

Vein of arsenide cutting across clumps of uraninite crystals.
Note offsetting of arsenide due to later movement.

plate 9

x 70



Arsenide in gangue showing slight offsetting due to late movement.

plate 10

x 70

Chalcopyrite in arsenide.