(18)

A LABORATORY EXAMINATION OF ORE SPECIMENS FROM CENTRE STAR AND YANKEE GIRL MINES

BY

DONALD M. McKINNON

'0005-

THE UNIVERSITY OF BRITISH COLUMBIA

SUBJECT .....

.....

.....

PROBLEM NO. ..... DATE .....

NAME .....

S. D. & W. LTD., VANCOUVER, B.C.

44/50

A LABORATORY EXAMINATION OF ORE SPECIMENS

from the

CENTRE STAR and YANKEE GIRL MINES

A REPORT SUBMITTED FOR CREDIT IN GEOLOGY 1X

b y

D.M. McKinnon

1937.

C O N T E N T S

A LABORATORY EXAMINATION OF ORE SPECIMENS

from the

CENTRE STAR and YANKEE GIRL MINES

INTRODUCTION:

Specimens of ore from the above mines have been supplied the writer by Dr. H.V. Warren. The purposes of this examination will be as follows:

(1) To discover the minerals present.
(2) To determine the paragenesis with special attention to the association and vertical distribution of gold.

At the outset it must be stated that this report is essentially the result of laboratory study. Many criteria necessary for a complete investigation of ore genesis are to be found in the larger relationships, particularly those encountered in the field. Such may often be more convincing and of more value than microscopic observations, but do not enter into the province of this paper.

THE MINERAL DEPOSITS[1]:

Location -

The Centre Star and Yankee Girl mines are situated near the town of Ymir, Kootenay District, B.C. The two mines are one and one half miles apart.

General Geology -

The ore deposits of both mines occur in the contact zone of a granodiorite phase of the Nelson batholith. This intrusive, genetically related to the ore bodies, is thought to be of Upper Jurassic age and contacts the Pend 'Orielle series of argillites, quartzites, and schists, assigned to the late Pre Cambrian. The ore occurs in fissure veins, and is for the most part found within the Pend 'Orielle rocks near tongues of the Nelson granodiorite. However, a t the Yankee Girl mine the veins are known to enter the intrusive also.

Ore Bodies -

The veins are mined for their gold content though silver, lead, and zinc values also are present. The minerals present are quartz, pyrite, aphalerite, galena. Pyrrhotite also is present at the Centre Star mine. No copper mineral is found at either mine.

1. - Information taken from C.G.S. memoir 191 - W.E. Cockfield.

THE MINERALOGY OF THE CENTRE STAR AND YANKEE GIRL ORES:

The following minerals were identified in the primary ore specimens:

Pyrite Sphalerite Galena Quartz

Also found in the Wesko ore are minor quantities of pyrrhotite and one small patch of covellite is observed in one specimen. No significance is attached to the fact that these minerals are not also found in the Yankee Girl ore as the suite of specimens from this mine is probably not representative.

In weathered specimens of ore all degrees of oxidation are observed. Most oxidized specimens have a spongey, open texture. Many solution cavities formed in the quartz are filled with indigenous limonite, and secondary lead minerals after galena. Upon chemical analysis the latter was found to contain both carbonate and chloride. No secondary zinc mineral is found.

Pyrite (FeS_2) -

This mineral is generally found in irregular masses in quartz and occurs to a lesser extent in sphalerite, galena and pyrrhotite. As a general rule, pyrite develops crystal form in quartz and galena but does not in pyrrhotite and sphalerite. In the latter minerals embayment of their borders is common. Textural relations suggest two generations of pyrite have occurred. The first and most important was with quartz. The second accompanied galena.

Sphalerite (ZnS) - Variation in the nature of the sphalerite is noted. It grades from a chocolate brown variety to a hard black type, probably containing isomorphous iron. The fact that sphalerite often embays pyrite borders suggests an origin for the iron in the latter type. Sphalerite is observed in veinlets in quartz, in shattered areas of pyrite, and in intimate intergrowth with galena. Mutual contact relations between sphalerite and galena are commonly present and sphalerite may occur in rounded inclusions in galena veinlets. (Figs. 6, 7, 10)

Galena (PbS) - This mineral appears as graphic intergrowth with sphalerite and pyrrhotite, and as veinlets in quartz, sphalerite, and pyrrhotite. Some pyrite and quartz probably accompanied deposition of galena. (Fig. 8)

Pyrrhotite(Fe_xS_{x+1}) - Pyrrhotite is observed only in specimens from the Centre Star mine. It occurs both as intergrowths with galena and rounded inclusions in galena. (Specimen W-1)

Quartz (SiO_2) - This mineral is the chief gangue constituent. It is milky to bluish in color and is a common mesostasis between pyrite grains. It may occur as irregular fragments with rounded or scalloped borders in galena, sphalerite, or pyrrhotite. Since quartz has a conchoidal fracture, such border patters do not imply contemporaneity of the quartz with its surrounding mineral. That a second generation of quartz did occur is suggested by its association with galena and pyrite in veinlets in sphalerite. (Fig. 8)

FIG 1 SPECIMEN Y3

Typical appearance of ore at end of first mineralization period. Pyrite has been fractured and healed by quartz.

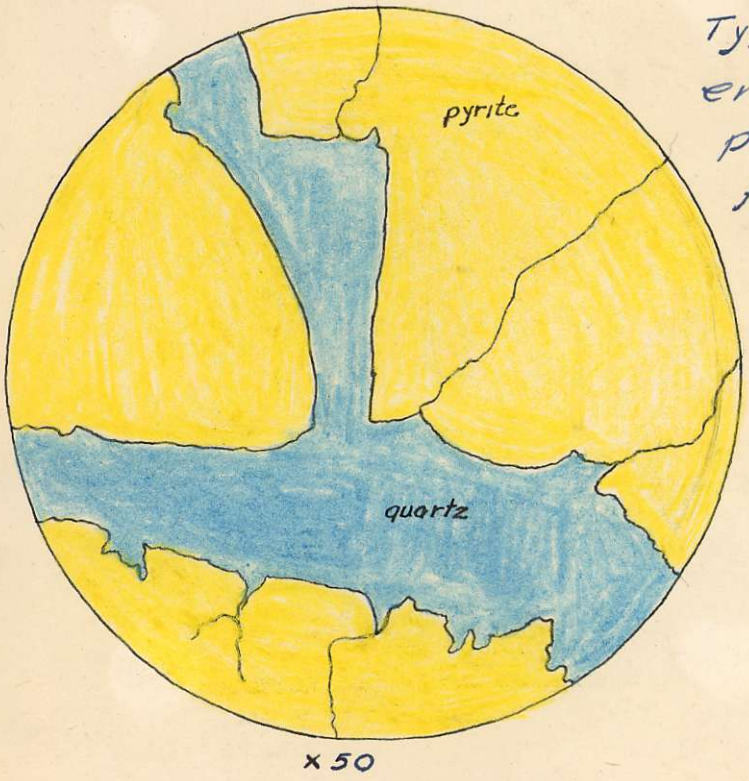
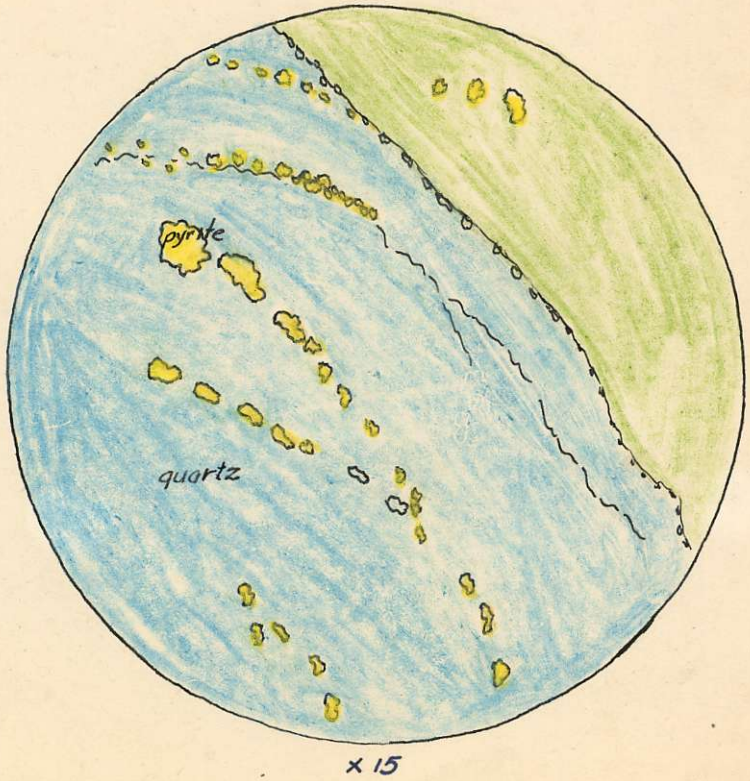


FIG 2 SPECIMEN W4

Pulsatory deposition of pyrite and quartz is suggested. Quartz laminae and pyrite grains are arranged parallel to the borders of a fragment of wall rock.



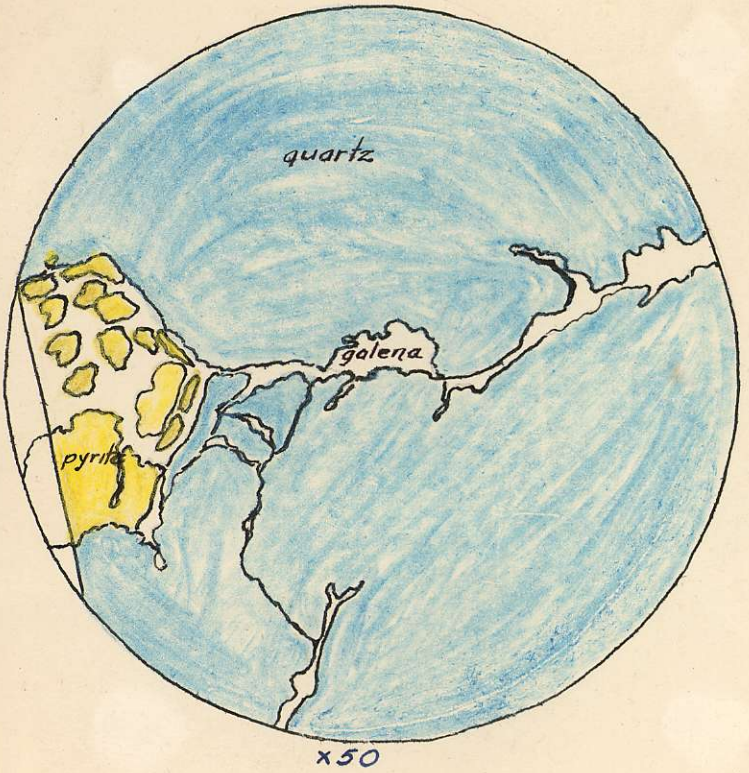
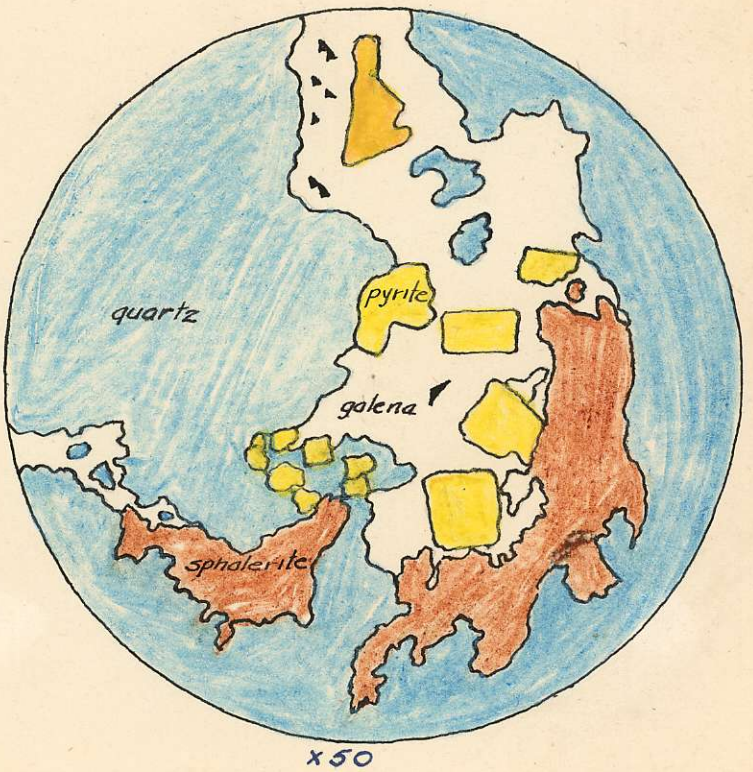


FIG. 3 SPECIMEN W3

Illustrates the deformation unconformity between first and second mineralization periods. Galena veinlet cuts quartz and a pyrite cube.

FIG 4 Specimem W3

Sphalerite, galena, pyrite, veining quartz. Note euhedral development of pyrite in galena.



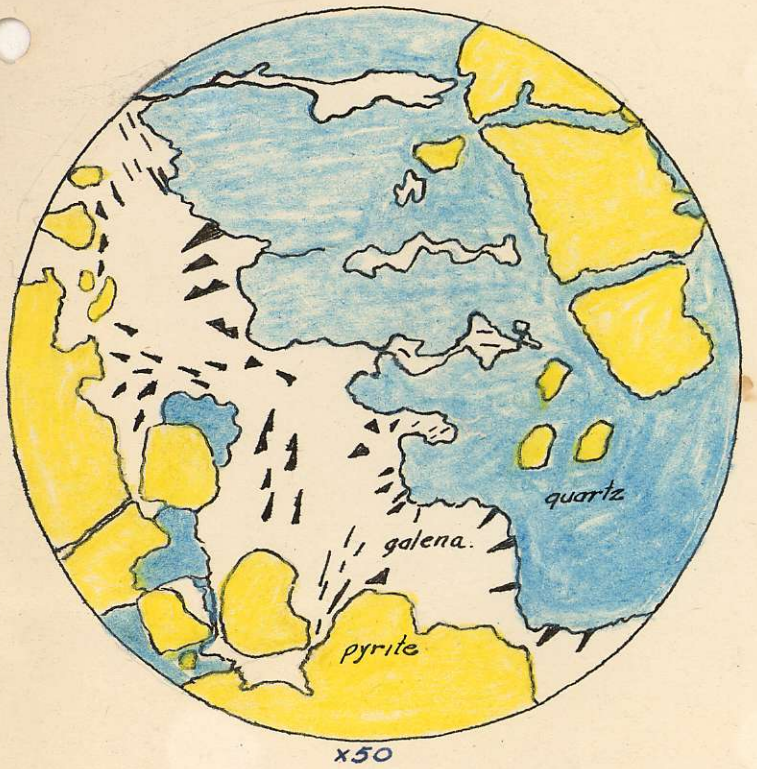


FIG. 5 SPECIMEN W2

Illustrates fracturing of pyrite and healing by quartz. Galena veins the quartz. Galena cleavage traces parallel to quartz and pyrite boundaries suggests this is the youngest mineral.

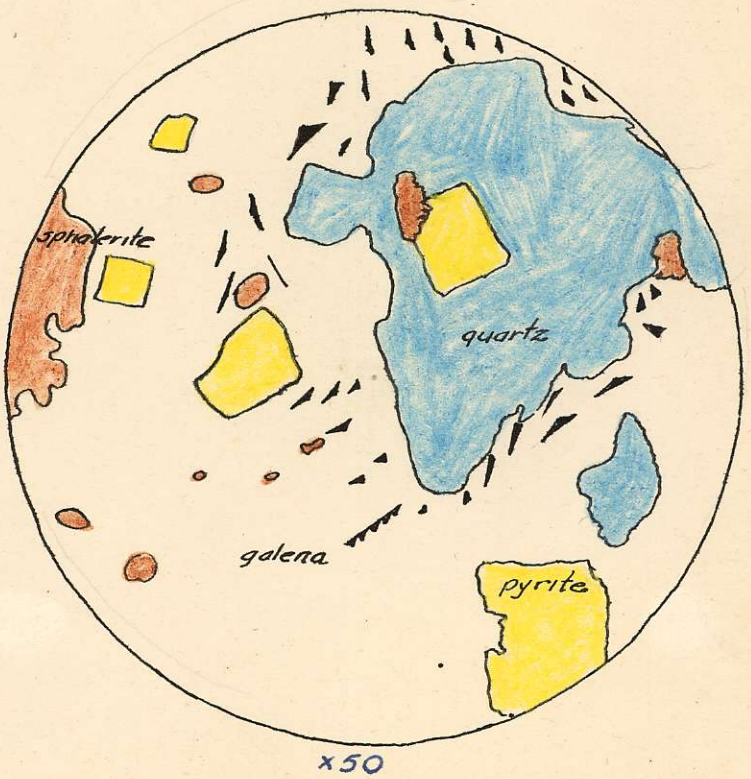
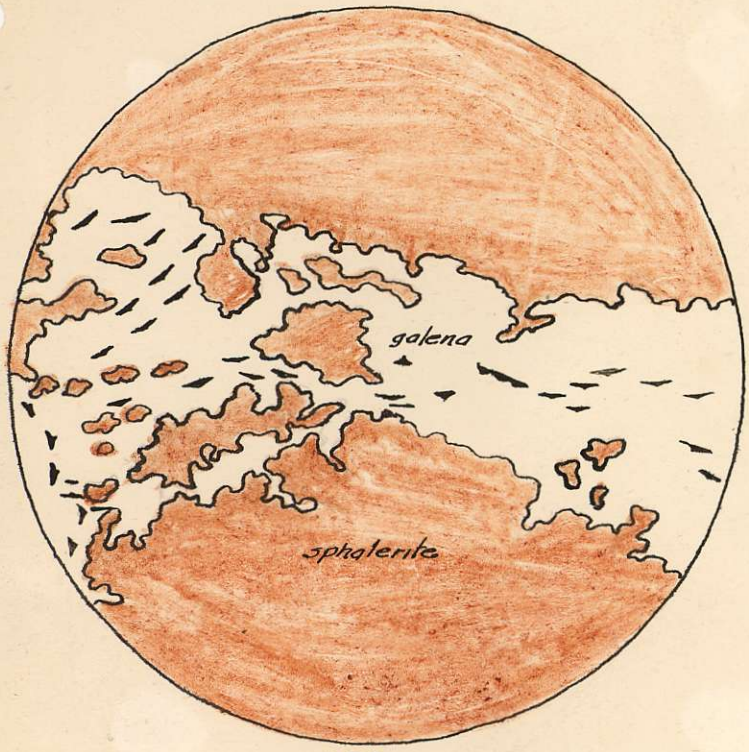


FIG. 6 SPECIMEN Y1

This figure suggests that deposition of sphalerite was accompanied by solution of pyrite, deposition of galena by precipitation of pyrite. Note: first generation pyrite cube in quartz has been attacked by sphalerite. Pyrite borders in galena are smoother.



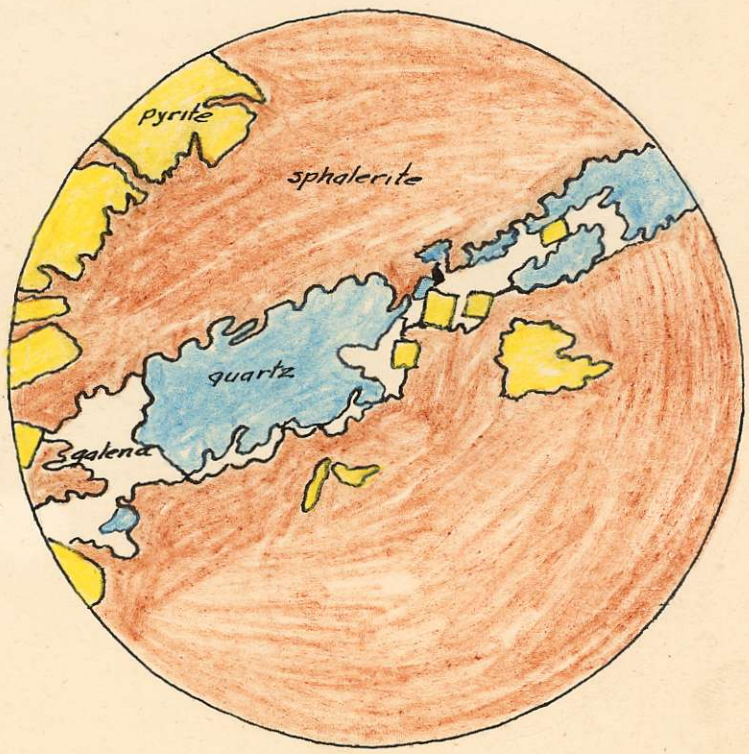
x50

FIG. 7 SPECIMEN Y1.

Galena veinlet in sphalerite Note the mutual boundary relationship between the two minerals.

FIG 8 SPECIMEN Y1

A second generation of quartz and pyrite is suggested by this veinlet of galena, quartz, and pyrite, cutting sphalerite. Note the euhedral development of the pyrite in the veinlet.



x50

FIG 9 SPECIMEN Y2

Appearance of one peculiar pyrite "veinlet" cutting sphalerite. The embayed nature of the pyrite borders suggests that it is the older mineral.

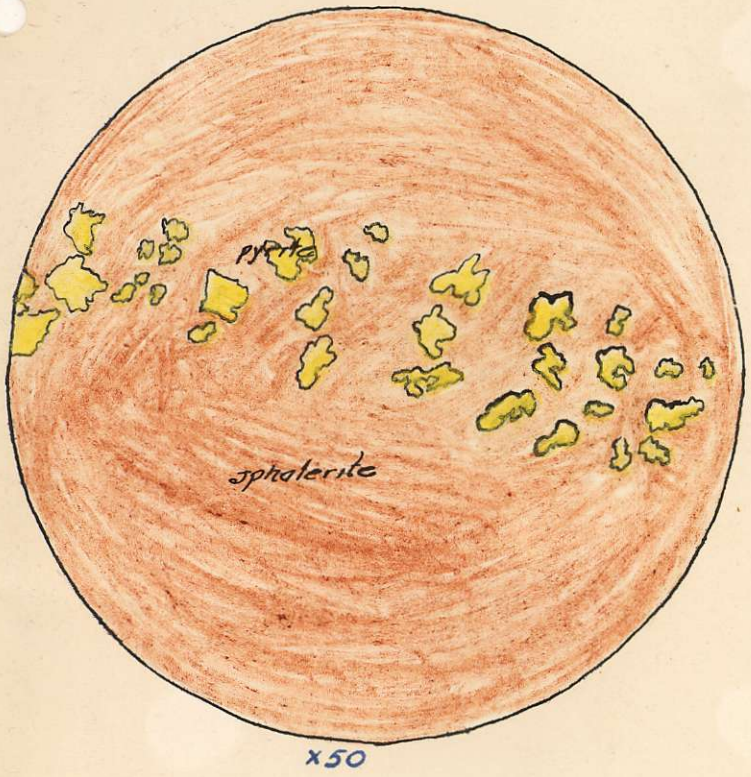
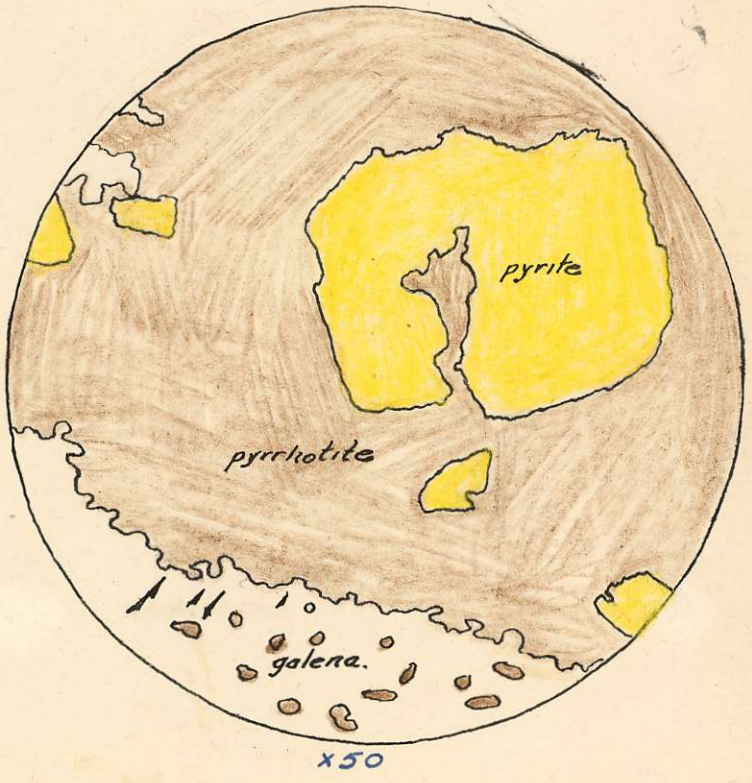
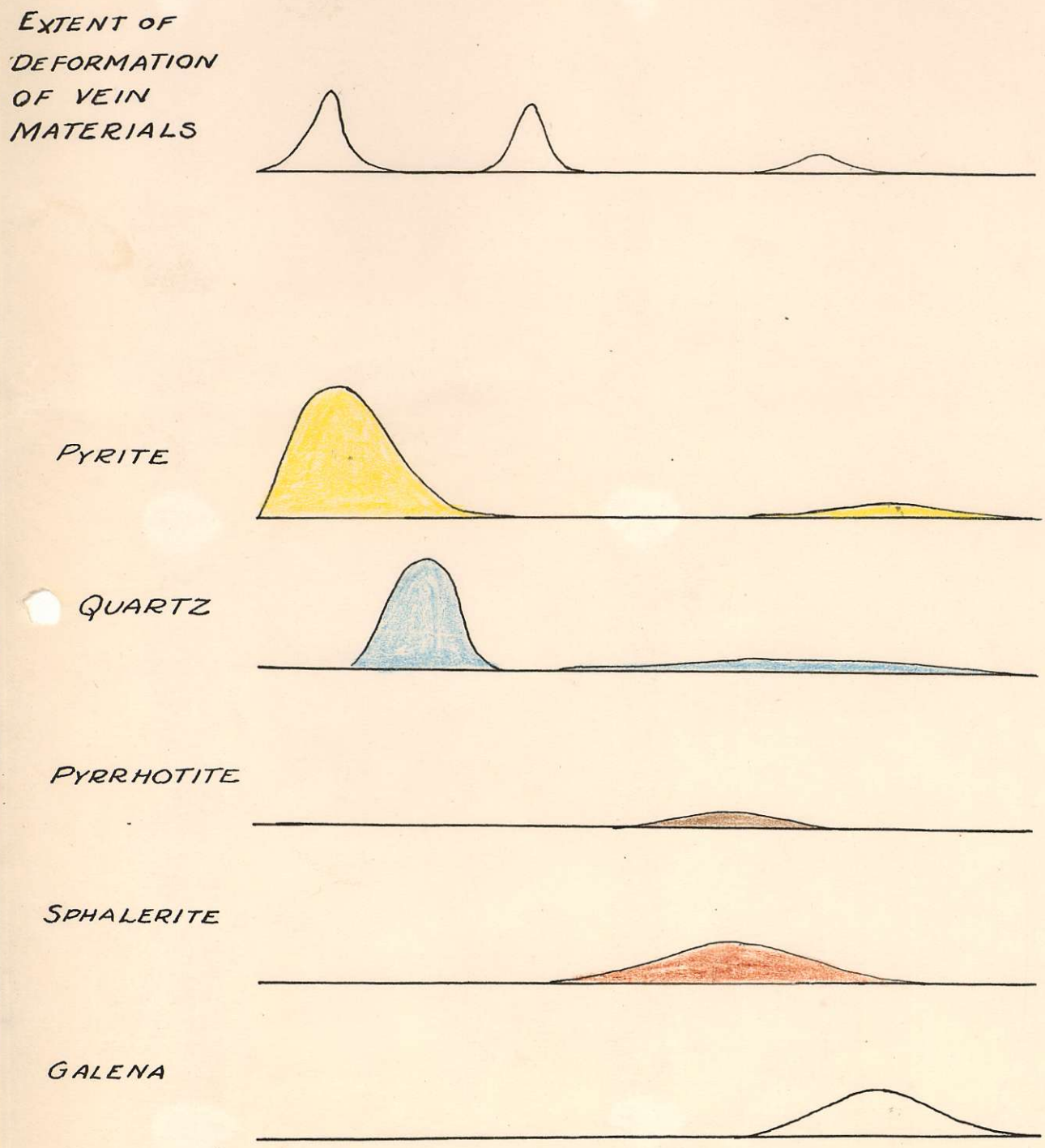


FIG 10. SPECIMEN W1

This figure suggests that pyrrhotite is later than early pyrite. Note the mutual boundary patterns and emulsion structure between galena and pyrrhotite.



GRAPHICAL REPRESENTATION OF SUGGESTED PARAGENESIS



ASSAYS:

In order to determine the mode of occurrence of the gold the following samples were picked out under the microscope and assayed. Polished sections were made in some cases of the ore from which the samples were taken.

From Yankee Girl Ore:

Pure pyrite of the first generation, in contact with quartz (Specimen Y-3,Fig 1.)	..... 0.08 oz.
Pure sphalerite (Specimen Y-1, Fig.8)	..... trace
Pure galena (Specimen Y-4)	..... 0.64 oz.
Pure pyrite, in contact with galena and sphalerite (Specimen Y-2)	..... 1.80 oz.

From Centre Star Ore:

Fine mixture sphalerite, galena, pyrite, quartz. (typical primary ore)	..... 0.09 oz.
Fine mixture sphalerite, galena,pyrite, quartz,pyrrhotite. (Fig.10,specimen W-1)	..... 0.16 oz.
Oxidized ore, mostly limonite and quartz	..... 1.20 oz.

PARAGENESIS:

The following paragenesis is suggested. It must be kept in mind, however, that the separation between the various stages of mineralization is not as sharp as this method of presentation implies, and there is undoubtedly a certain amount of overlap between successivemineral invasions.

(1) Introduction of pyrite and quartz.

(2) Deformation of quartz and pyrite followed by deposition of sphalerite, pyrrhotite and some galena.

(3) Slight deformation and continued deposition of galena with minor amounts of pyrite and quartz.

CONCLUSIONS:

The primary ore in both mines consists of zinc, lead and iron sulphides with quartz.

The deposits belong to the mesothermal zone of deposition.

In the primary ore gold is associated with galena and less so with pyrite. Gold carried by galena tends to deposit on pyrite boundaries.

Conclusions cont'd:

Secondary enrichment of gold may have occurred. Cockfield[1] identified manganite in the oxidized zone. The writer found chloride in a chemical analysis of secondary lead minerals in the oxidized zone. If MnO_2 and HCL were present together at some time during the oxidation period, the essential solvent for gold would have been formed.[2]

If secondary enrichment of gold has occurred, this zone will probably be shallow where pyrrhotite is present, since this mineral is a most effective precipitant of gold from solution.

Gold values decr ease at depths below the influence of surface solutions.

DESCRIPTION OF POLISHED SECTIONS:

From Centre Star Ore

SPECIMEN W-1 - Pyrite, galena, sphalerite, pyrrhotite and quartz are the minerals present. Pyrrhotite and sphalerite are irregular bodies and rounded inclusions showing a very complete mutual boundary relationship with the galena in which they appear. Pyrite occurs as fragments and less often as cubes. In the former type the borders of some grains are excessively etched, and galena, sphalerite and pyrrhotite were observed in cusps and fractures in the pyrite. Galena cleavage traces tend to parallel pyrrhotite and pyrite borders. Quartz occurs in minor amounts, as irregular grains with curved or scalloped borders, in the sulphides.

SPECIMEN W-2 - Pyrite,galena, sphalerite and quartz are the minerals present. Fractured pyrite, with interstitial quartz sphalerite and galena, composes most of the specimen. Sphalerite and galena occur as veinlets in the quartz and as patches in the pyrite. It is noticeable that pyrite usually shows greater embayment when in contact with sphalerite than when in contact with galena. Replacement is also suggested by the fact that cusps are formed by the later sulphides along quartz-pyrite contacts, and ghost crystals of pyrite are found in both sphalerite and galena.

SPECIMEN W-3 - Pyrite, galena, sphalerite and quartz are the minerals present. Quartz, the most abundant mineral, contains cubes and fragments of pyrite. Both pyrite and quartz have been fractured, and galena, with some sphalerite, has formed a filling. Pyrite cubes with smooth borders were observed in the galena, though islands and bays ofgalena in pyrite were noted also. Galena cleavage traces tend to parallel the quartz boundaries of the veinlets in which galena appears.

1. - Cockfield W.E. "Lode Gold Deposits of Ymir-Nelson Area" G.S.C. Memoir 191.
2. - Emmons, W.H. "The Enrichment of Sulphide Ores" U.S.G.S. Bulletin 529.

Description of polished sections cont'd:

SPECIMEN W-4 - Pyrite, quartz, chlorite are the minerals present. Quartz, containing pyrite grains, makes up most of the specimen. If the specimen is held at the proper angle to the light, different laminae of quartz will be seen parallel to the borders of the chloritized area. Pyrite grains in the quartz also show a similar parallel alignment.

From Yankee Girl Ore

SPECIMEN Y-1 - Pyrite, sphalerite, galena and quartz are the minerals present. Galena occurs as irregular islands and veinlets in sphalerite. The veinlets contain many rounded inclusions of sphalerite which may make up as much as fifty percent of the vednlet material. Pyrite occurs in sphalerite, galena and quartz. Pyrite shows the greatest effects of etching when in sphalerite. Cubes surrounded by galena show little embayment as a rule, though etched particles of pyrite are present.

SPECIMEN Y-2 - Pyrite, sphalerite, galena and quartz are present. The interesting feature in this specimen is the presence of an apparent veinlet of pyrite cutting sphalerite. A parallel, though less distinct veinlet of galena in pyrite and sphalerite parallels the pyrite "veinlet." Upon microscopic examination the pyrite "Veinlet" is found to consist of strung out pyrite fragments in the sphalerite. These fragments show no evidence of crystal form, are much embayed, and sphalerite is continuous in every direction around them.

SPECIMEN Y-3 - Pyrite, quartz, sphalerite and galena are the minerals present. Fractured pyrite, with interstitial quartz and minor amounts of galena and sphalerite, compose this specimen. The pyrite fragments, in places, appear to have been embayed and later filled by quartz.

SPECIMEN Y-4 - Galena, pyrite, quartz, and sphalerite are the minerals present. The specimen is practically pure galena. This mineral fills cracks in quartz fragments and its cleavage traces show a general parallel alignment with boundaries of quartz and pyrite. Pyrite occurs both as cubes and broken fragments in the quartz, and as fractured masses, showing little effect of etching, in the galena.