A good deal of geology with too little mineralogy in it.

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GEOLOGY 9

MINERALOGY OF THE PARADISE MINE

WINDERMERE, B.C.

By

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April, 1944
University of British Columbia

Fifth Year,
Geological Engineering.

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GEOLOGY 9

MINERALOGY OF THE PARADISE MINE

WINDERMERE, B.C.

LOCATION

The Paradise Mine is in the Windermere district of the Golden Mining Division in southeastern British Columbia. The mine is at an elevation of eight thousand feet on the northwest side of the basin at the head of Spring Creek, a small northerly tributary of Toby Creek. The mine is nineteen miles by road from Lake Windermere station of the Kootenay Central Railway. The road to the property extends from the station through the town of Windermere, eleven miles up Toby Creek to Pinehurst, and from there eight miles up the steep mountainside, in a series of switchbacks, to the mine camp at 7,450 feet elevation.

HISTORY

The property was staked in the summer of 1899 and was taken over by H. C. Hammond of Toronto, in 1900. Development work was carried on and shipments of ore were made till 1906. From 1906 to 1914 the property lay idle but in 1915 was reopened by R. Randolph Bruce and under his management the property was a small steady producer till 1926. In 1926 the mine was purchased

BY THE VICTORIA SYNDICATE OF LONDON, ENGLAND. IN 1927 THE ERECTION OF A 50-75 TON CONCENTRATOR WAS COMMENCED. THIS MILL, WHICH WAS LOCATED IN THE BASIN, WAS OPERATED WITH VARYING SUCCESS AND DISAPPOINTMENT UNTIL THE SUMMER OF 1928, WHEN EXPERIMENTAL WORK HAD DEMONSTRATED AND SOLVED MOST OF THE METALLURGICAL DIFFICULTIES. THE MINE AND MILL, HOWEVER, WERE CLOSED IN NOVEMBER, 1928, AND PARTS OF THE HEAVY MILL MACHINERY WERE MOVED TO PINEHURST, WHERE IT WAS PROPOSED TO RECONSTRUCT THE MILL. THE GENERAL TREND OF A REDUCTION IN THE PRICE OF LEAD STOPPED THIS RECONSTRUCTION AND ALSO FORCED THE CLOSING OF THE MINE. IN 1942 THE SHEEP CREEK GOLD MINE COMPANY PURCHASED THE PROPERTY FROM THE VICTORIA SYNDICATE. DURING THE LATTER PART OF 1942 AND THROUGH THE SUMMER OF 1943, THE MINE WORKINGS WERE CLEANED UP AND RETIMBERED. PROSPECTING FOR MORE ORE BY DIAMOND DRILLING WAS STARTED IN SEPTEMBER 1943, AND IT IS BELIEVED THAT THIS DRILLING WILL CONTINUE IN 1944.

GENERAL GEOLOGY

THE COUNTRY ROCK OF THE REGION IN THE VICINITY OF THE MINE INCLUDE A GREAT THICKNESS AND VARIETY OF UNFOSSILIFEROUS, METAMORPHIC, SEDIMENTARY ROCKS OF LATE PRECAMBRIAN AGE. THEY CONSIST OF QUARTZITES, SLATES, MAGNESIAN AND NON-MAGNESIAN LIMESTONE, AND CONGLOMERATE. THE ROCKS COMPRISE TWO SERIES SEPARATED BY A MARKED ANGULAR UNCONFORMITY. THE OLDER OF THE TWO IS THE PURCELL SERIES, CONSISTING OF MAGNESIAN LIMESTONE, SLATE AND QUARTZITE. THE YOUNGER IS THE WINDERMERE AND CONSISTS OF TWO WELL DEFINED DIVISIONS: THE TOBY CONGLOMERATE AND AN UPPER KNOWN AS THE HORSETHIEF FORMATION, CONSISTING OF VARIOUS COLORED SLATES, QUARTZITE,

PEBBLED CONGLOMERATE AND NON-MAGNESIAN LIMESTONE. INTRUSIVE INTO THESE SEDIMENTS ARE A GREAT MANY SCHISTOSE, GREENSTONE DYKES AND SILLS OF DOUBTFUL AGE THAT ARE THOUGHT TO BE PRECAMBRIAN. THESE DYKES AND SILLS ARE PARTICULARLY ABUNDANT IN THE PARADISE BASIN. THE NEAREST GRANITIC INTRUSIVE TO THE MINE IS APPROXIMATELY TWELVE MILES NORTHWEST ON HORSETHIEF CREEK. THERE ARE JUST TWO GRANITIC INTRUSIVES IN THE WINDERMERE AREA; THE ONE ON HORSETHIEF CREEK AND THE OTHER WEST OF FARNHAM CREEK, A TRIBUTARY OF HORSETHIEF CREEK.

STRUCTURAL GEOLOGY

THE ORE DEPOSIT OCCURS IN THE GREY, SILICEOUS MAGNESIAN, CRYSTALLINE LIMESTONE OF THE MOUNT NELSON FORMATION. THE STRUCTURES IN THE PARADISE BASIN SHOW THAT THE BELTIAN ROCKS HAVE BEEN FOLDED INTO ANTICLINES AND SYNCLINES, STRIKING NORTHWEST AND PLUNGING APPROXIMATELY TWENTY-FIVE DEGREES IN THAT DIRECTION. THE LIMESTONE BAND, IN WHICH THE DEPOSIT OCCURS, LIES IN A MAJOR ANTICLINAL FOLD WHICH HAS BEEN BROKEN ON ITS WEST SIDE BY A FAULT WITH A DOWN THROW TO THE WEST. WITHIN THIS MAJOR FOLD ARE A NUMBER OF MINOR FOLDS WHICH HAVE GREATLY FRACTURED THE LIMESTONE.

THE LIMESTONE (1) BEDS WITHIN THE MINE VARY IN COLOR, THICKNESS AND HARDNESS. THE MOST PREVAILING COLOR IS BLUE-GREY BUT THERE ARE A NUMBER OF DARK GREY TO BLACK BEDS. THE THICKNESS OF THE BEDS RANGES FROM FOUR INCHES TO TWENTY-FOUR INCHES WITH AN AVERAGE THICKNESS OF ABOUT FOURTEEN INCHES. THE HARDNESS

(1) MEANS HERE -- SILICEOUS MAGNESIAN LIMESTONE

SHOWS MARKED DIFFERENCES, PARTICULARLY NEAR THE SLATE CONTACT. A NUMBER OF LAYERS COULD NOT BE MARKED BY A KNIFE WHILE ADJACENT LAYERS COULD BE SCRATCHED. THE GENERAL STRIKE AND DIP OF THE LIMESTONE BEDS ARE WITH THE STRUCTURE WHICH IS FORTY DEGREES NORTH-WEST AND DIPPING TEN DEGREES TO FIFTY-THREE DEGREES NORTHEAST.

INTERBEDDED WITH THE LIMESTONE ARE A NUMBER OF BLACK TO GREY BEDS OF SLATE. THESE SLATE BEDS ARE VERY LENTICULAR AND RANGE IN THICKNESS FROM ONE-HALF INCH TO TWO FEET.

THE ORE BODY AND THE COUNTRY ROCK ARE CUT BY A NUMBER OF FAULTS THAT HAVE A CLOSE ASSOCIATION WITH THE BEDDING. ON THE LOWEST LEVEL, NEAR THE No. 2 ORE-BODY A NUMBER OF FAULTS WERE OB-SERVED DIPPING SIXTY-FIVE TO EIGHTY-FIVE DEGREES NORTHEAST. THESE FAULTS ON STRIKING THE SLATE DID NOT PASS THROUGH, BUT WERE DE-FLECTED INTO THE SLATE. OTHER FAULTS, HAVING FAIRLY FLAT DIPS, HAVE CUT THE SLATE BANDS AND THEIR SHEARING ACTION HAS EVIDENTLY DRAGGED SLATE WITH THEM INTO THE LIMESTONE SO THAT NOW THE FAULT PLANES ARE WELL MARKED BY SEAMS OF BLACK SLATE GOUGE. A THIN POROUS LAYER BETWEEN THE LIMESTONE BEDDING PLANES SHOWS THAT THERE HAS BEEN SLIPPING OF THE BEDS DUE TO FOLDING. THE GENERAL IM-PRESSION OBTAINED WAS THAT FAULTING HAS NOT DISCONNECTED THE ORE SHOOTS.

J. F. WALKER, IN MEMOIR 148 (C.G.S. P.46) STATES THAT "THE ORE-BODIES OCCUR IN A GREY, SILICEOUS, MAGNESIAN, CRYSTALLINE LIMESTONE BENEATH THE UPPER WHITE QUARTZITE OF THE MOUNT NELSON FORMATION." THIS STATEMENT IS TRUE WHEN APPLIED TO THE LIMESTONE BAND IN THE BASIN BUT AT THE MINE, CROSS-CUTS DRIVEN INTO THE HANGING WALL, SHOW THAT IT IS A STRIKINGLY UNIFORM GREY CALCAREOUS

SLATE. THE RESULTS FROM A PRELIMINARY SURVEY UNDERGROUND OF THE CONTACT BETWEEN THE SLATE AND LIMESTONE SUGGESTS AN UNCONFORMITY; BUT ON THE SURFACE, ALTHOUGH THE CONTACT WAS NOT SEEN, THE STRIKE AND DIP OF THE SLATE SEEMS TO CONFORM WITH THE STRIKE AND DIP OF THE LIMESTONE. THE FOOTWALL OF THE LIMESTONE IS NOT SEEN UNDERGROUND BUT ON THE SURFACE IT IS INDICATED TO BE MASSIVE WHITE QUARTZITE.

MINERALOGY

INTRODUCTION

IN THE PREPARATION OF THIS REPORT FOUR SAMPLES OF ORE FROM THE TWO KNOWN ORE-BODIES WERE EXAMINED.

No. 1246 -- A SAMPLE ON THE LOWEST LEVEL OF THE PRIMARY SULPHIDES OF No. 2 ORE-BODY.

No. 1216 -- A SAMPLE FROM THE TRANSITION ZONE OF THE OXIDIZED AND HYPOGENE ORES OF No. 2 BODY.

No. 1251 -- A SAMPLE FROM No. 1 ORE-BODY NEAR THE CONTACT OF THE OREBODY AND THE LIMESTONE.

No. 1243 -- A SAMPLE FROM A RAISE CONNECTING THE LOWEST LEVEL AND AN UPPER INTERMEDIATE LEVEL.

POLISHED SECTIONS WERE MADE OF SAMPLES OF THE ORES, QUOTED ABOVE. EACH OF THESE SECTIONS WERE EXAMINED UNDER THE MICROSCOPE AND THE FOLLOWING DETERMINATIONS AND INFORMATION WAS OBTAINED.

MINERALS IDENTIFIED

SEVEN MINERALS WERE POSITIVELY IDENTIFIED IN THE ORE EXAMINED. THESE ARE PYRITE, GALENA, SPHALERITE, TETRAHEDRITE, COVELLITE, QUARTZ, CARBONATE (DOLOMITE? SIDERITE).

Pyrite

Pyrite is the most abundant metallic mineral present and is associated with all the minerals identified in the polished sections. Lack of evidence of either quartz or pyrite veining or replacing one another suggests contemporaneous deposition.

Galena

Galena is the next most abundant metallic mineral and was found in all sections. Galena was seen veining and replacing quartz, pyrite, sphalerite and tetrahedrite.

Sphalerite

Sphalerite is of the dark brown variety, with well developed cleavage. It occurs fairly abundantly in all sections. The sphalerite was noticed cutting the gangue carbonate in section 1251 and in the same section veining the tetrahedrite. Photographs were taken of sphalerite cutting the tetrahedrite and replacing the pyrite.

Tetrahedrite

Tetrahedrite is found only in section 1251. This mineral could be identified in the section by the naked eye. Under the microscope the colour of the mineral is steel gray and the surface rough or hackly. The tetrahedrite is veined by sphalerite and contains elongated blebs of galena. A micro-chemical analysis indicates that the tetrahedrite is silver-bearing.

Covellite

Covellite fringes a number of pits in the tetrahedrite. The mineral was found only in or on the boundaries of the tetrahedrite and is evidently secondary.

Cerrusite?

Cerrusite? is noted working along the cleavage cracks of the galena. On etching with H.Cl the galena tarnishes and the replacing mineral shows signs of effervescence. Cerrusite is the most abundant of the secondary ores of the Paradise and was formed by the alteration of the galena; therefore the mineral in the cleavage cracks is thought to be cerrusite.

Quartz

Quartz is found in all sections. Its relation to the pyrite has already been described. The quartz is of two ages. This fact is brought out more clearly in thin sections that were made of a sample containing the wall-rock and the ore.

The thin sections show a wall-rock of fine grained cherty magnesian limestone cut by veins of quartz.

Carbonate (Dolomite, Siderite, Ankerite) ?

This gangue material is abundant in three of the sections. It has a slightly darker colour than the quartz which it cuts. The hardness is above the carbonate minerals but this can be explained by the presence of fine grained quartz (second generation quartz). Different samples of carbonate were tested for iron and manganese and it was found in section 1251 that the gangue carbonate contained

IRON AND MANGANESE (ANKERITE?). ONE SAMPLE GAVE A TEST FOR JUST IRON AND ANOTHER NO IRON OR MANGANESE.

IN SPECIMEN 1251 SPHALERITE VEINS THE CARBONATE BUT THE GANGUE CARBONATE WAS ALSO FOUND CUTTING AND REPLACING SPHALERITE, QUARTZ, GALENA AND PYRITE. THE CARBONATE THEN, SEEMS TO HAVE A WIDE RANGE OF DEPOSITION, DEPOSITING BEFORE THE SPHALERITE DEPOSITION AND CONTINUING THROUGHOUT THE SEQUENCE.

SILVER MINERAL ?

SILVER OR A SILVER MINERAL IS PRESENT AS SHOWN BY SPECTROGRAPHIC ANALYSIS AND ASSAYS. THE SILVER MINERAL WAS NOT IDENTIFIED BUT UNDER THE TWO THOUSAND MAGNIFICATION, BLEBS OF A BLUE MINERAL WERE SEEN THAT MAY HAVE BEEN ONE OF THE SILVER MINERALS.

TIN MINERAL ?

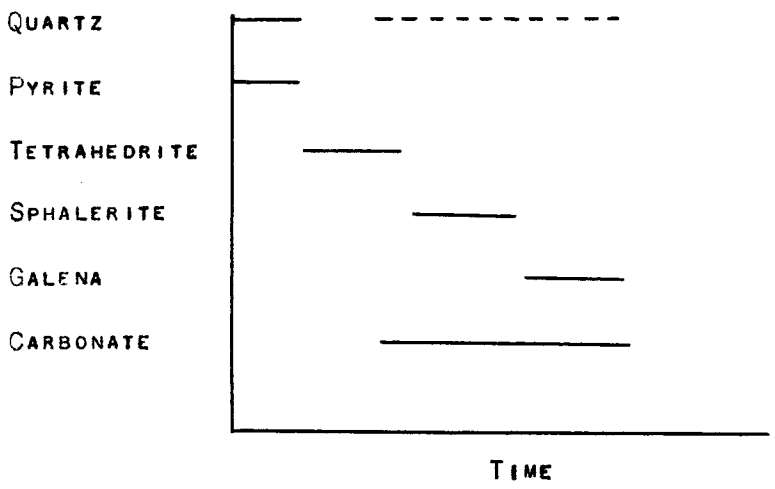
SPECTROGRAPHIC ANALYSIS SHOWED THE PRESENCE OF ABOUT .10% TIN IN PURE SPHALERITE. UNDER TWO THOUSAND MAGNIFICATIONS, IN SECTION 1243, ROD LIKE FORMS AND NUMEROUS BLEBS OF A LIGHT TAN MINERAL WERE SEEN IN THE SPHALERITE. THE SIZE OF THIS MINERAL VARIED FROM SUB-MICROSCOPIC TO TEN MICRONS. THE MINERAL SHOWED WEAK ANISOTROPISM AND WAS THOUGHT TO BE STANNITE.

CHALCOPYRITE ?

SPECTROGRAPHIC ANALYSIS INDICATED THE PRESENCE OF A COPPER BEARING MINERAL. UNDER THE TWO THOUSAND MAGNIFICATION A MINERAL WAS FOUND WHICH WAS THOUGHT TO BE CHALCOPYRITE.

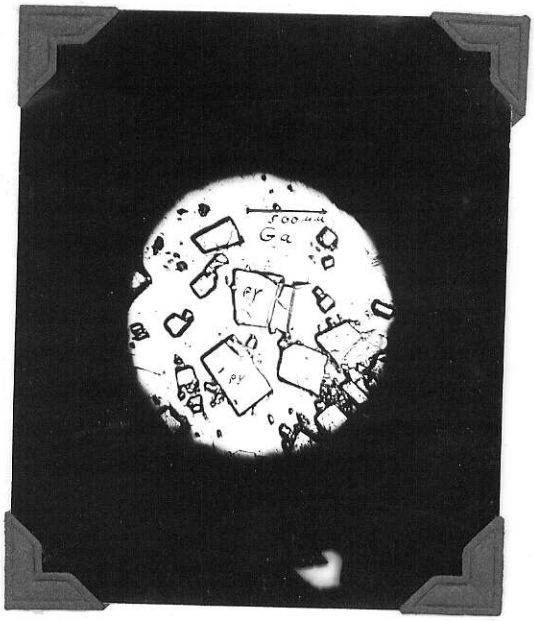
PARAGENESIS

THE SUGGESTED PARAGENESIS AS RECORDED BY THE DESCRIPTION OF THE HYPOGENE MINERALS.



MINERAL	$FeCl_3$	KCN	$HgCl_2$	KOH	HCL	HNO_3	POL. COLORS	MICRO-CHEMICAL	OTHER PROPERTIES
PYRITE	NEG.	NEG.	NEG.	NEG.	NEG.	NEG.	BRASS YELLOW	--	
GALENA	IRIDESCENT	---	---	---	TARNISH	BLACKENS EFFERVES-CENCE	GALENA WHITE	LEAD	TRIANGULAR PITS
SPHAL-ERITE	---	---	---	---	---	TARNISH	GREY	ZINC	~~REFLECTED LIGHT~~ INTERNAL REFLECTION
TETRA-HEDRITE	---	---	---	---	---	---	GREY WHITE	COPPER ANTIMONY SILVER	
COV-ELLITE	---	STAINS BLACK	---	---	---	---	BLUE	---	
QUARTZ	---	---	---	---	---	---	DULL GRAY		

PLATE 1216

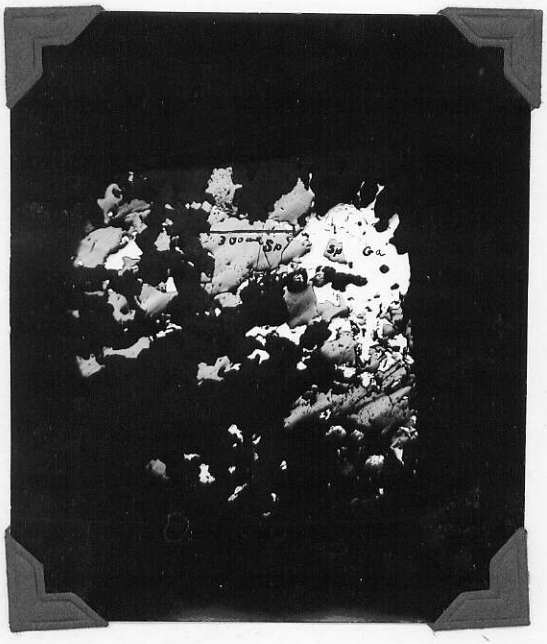


MAGNIFICATION x 20

GALENA VEINING AND REPLACING PYRITE

(SECTION 1216)

PLATE 1246



MAGNIFICATION x 30

GALENA REPLACING SPHALERITE

(SECTION 1246)

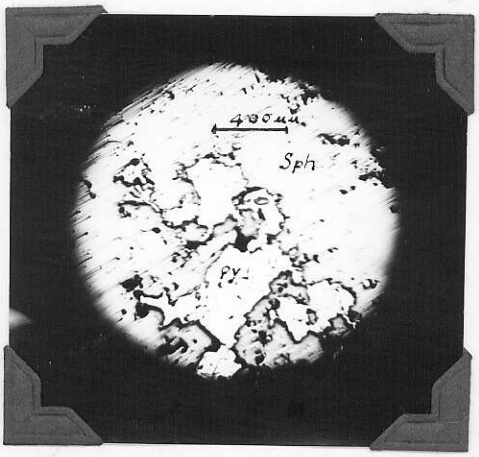
PLATE 1251

MAGNIFICATION x 34

TETRAHEDRITE REPLACED BY GALENA AND VEINED BY SPHALERITE.
COVELLITE SHOWS IN OUTER EDGES OF THE TETRAHEDRITE.

(SECTION 1251)

PLATE 1243

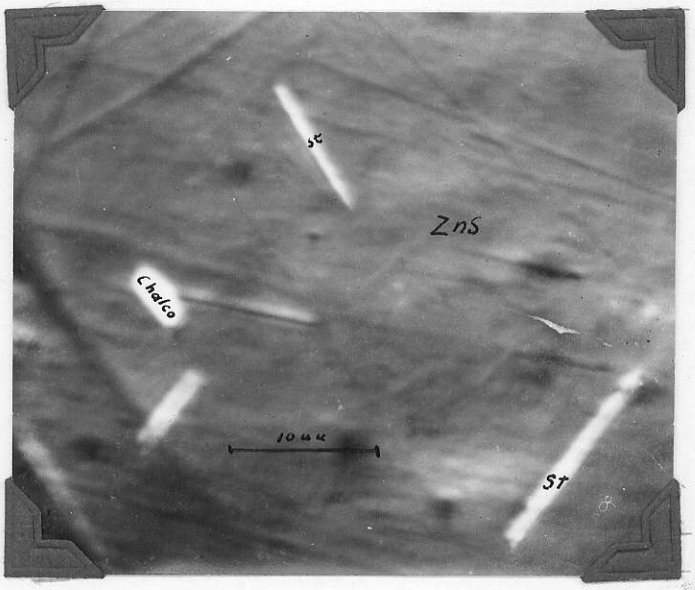


MAGNIFICATION x 24

SPHALERITE REPLACING PYRITE

(SECTION 1243)

PLATE 9



MAGNIFICATION x 2000

STANNITE RODS ?

AND CHALCOPYRITE ? IN SPHALERITE

SECTION 1243