

A PROPOSED ORE CONTROL AT THE CORONATION MINE
DERIVED FROM EXAMINATION OF THE
QUANTITATIVE MINERALOGY

A Thesis
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of
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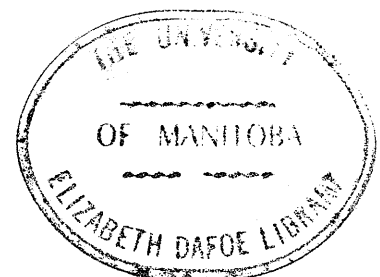
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ABSTRACT

Mineralogical cross-sections of ore bodies on the 300 foot, 600 foot and 900 foot levels of the Coronation Mine have been interpreted in terms of centres of mineralization. The maximum concentration of chalcopyrite occurs closest to these centres, of pyrite and pyrrhotite at some distance from the centres, and of magnetite furthest removed from the centres.

A hydrous halide fluid model is established. Attempts to explain the observed mineralogy by the action of temperature gradients on the fluid model were unsuccessful. Likewise the action of diffusion alone on the fluid model cannot explain the observed mineral distribution. The concept of attenuation is introduced wherein the rate of diffusion of a particle species is related to the product $e^2\sqrt{M}$, the attenuation coefficient, where e is the particle radius, and M its molecular weight. Attenuation, acting on the fluid model alone, will not produce the observed mineral distribution, but when considered together with the action of temperature gradients, the observed mineralogy can be well explained by the combined effects of these two processes on the assumed fluid model.

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PART 1.

RESULTS

Chapter 1

INTRODUCTION

This study is part of a comprehensive investigation into the general geology, geophysics and origin of the Coronation Mine ore body, located some fourteen miles southwest of Flin Flon, Manitoba. Different organizations are carrying out individual projects under the direction and co-ordination of the Geological Survey of Canada. This thesis proposes a possible ore control based on an examination of the quantitative mineralogy. One hundred and ninety-four specimens from twenty-two diamond drill holes on the 300 ft., 600 ft. and 900 ft. levels were examined using a Swift automatic point counter and reflecting microscope.

It is emphasized that the proposed ore control is not necessarily the control that actually existed. Other controls may explain the observed mineralogy equally well or better, but have not been considered in this thesis.

Chapter 2

GENERAL GEOLOGY

The geology of the mine and the surrounding area has been studied by E. L. Faulkner and the following is a summary of his observations (E. L. Faulkner, 1964, personal communication).

The ore body occurs in a sequence of massive altered dacites, andesites and andesite breccias, with some pillow lavas. The average strike is northwest, the dip 75° southwest and the rocks face east. The ore body consists of varying amounts of massive to disseminated pyrite, pyrrhotite and chalcopyrite with minor amounts of magnetite and sphalerite in a series of ore shoots within a concordant shear zone some 900 feet long, 1000 feet deep and up to 200 feet wide. The ore body may be divided into three general sections.

1. The northern section, consisting of massive high grade sulphides, with slight wall rock alteration.
2. The central, low grade section of disseminated and massive sulphides.
3. The southern section, consisting mainly of disseminated sulphides with extensive wall rock alteration.

Each ore shoot plunges to the south at 80° , approximately the same as lineations in the near surface rocks.

The mineralization, wall rock alteration and shearing are closely related.

The wall rock alteration is complex and consists mostly of chlorite, hornblende, garnet and tremolite-actinolite, with some zones containing cordierite and anthophyllite. The alteration is best developed in the southern section, where recrystallization is coarse and skarn like. In the northern section the alteration is patchy and fine grained.

Gangue minerals are very rare and are confined to quartz, quartz-epidote, quartz-carbonate or carbonate infillings of minor fractures formed after the main mineralization.

Intrusive rocks are present, in the form of dikes and irregular masses of porphyritic rocks and diorite masses which pre-date the ore, and a few post ore fine grained mafic dikes. A large syntectonic granodiorite intrusion outcrops within a quarter of a mile of the mine.

Chapter 3

PREPARATION OF SPECIMENS

General

Each specimen was crushed and sieved and the fraction between 28 and 200 mesh was retained. This fraction was mounted in plastic and the specimen was ground, polished and stained before counting.

The specimens consisted of split E-size diamond drill core, in places skeletonized, but usually complete. A small portion of core was retained for later polished section examination, wherever possible. Care was taken to ensure that the retained material approximated the bulk composition of the sample.

Crushing and Sieving

The specimens were first coarsely crushed to the size of a pea using an iron pestle and mortar. The coarse crush was then fed into a rotary pulverizer, and the process continued until the proportions were about: > 28 mesh, 1 part; 28-200 mesh, 6 parts; < 200 mesh, 2 parts. The coarse fraction was discarded and the medium and fine fractions were kept and labelled. Although the pulverizer produced much dust, (the loss during crushing being up to 10% in a few cases) it was by far superior to the small stamp mill used initially, in that it was

much faster, and produced a higher proportion of medium fraction grains. Chemical analyses of medium and fine fractions show little evidence of differential crushing of minerals, due to varying hardness, or preferred sieving due to cleavage; see Table I below.

TABLE I
CHEMICAL ANALYSES OF
MEDIUM AND FINE GRAINED FRACTIONS
AFTER CRUSHING ¹

Sample	Cu	Fe	Zn
A medium	20.9	27.6	0.8
fine	20.2	30.4	0.6
B medium	2.3	24.0	0.7
fine	2.3	24.5	0.4
C medium	6.0	25.6	0.6
fine	7.2	27.4	0.6

¹ Analyses performed by Manitoba Mines Branch.

A certain amount of metallic iron was introduced into the samples during crushing, but was not troublesome, as the iron particles have a very distinctive curved and feathered appearance, and when stained, react violently and produce a brown halo.

Mounting, Grinding and Polishing

Two different plastics were used for mounting; Ward's Bioplastic, which was used initially, and Quickmount. The latter was found to be more satisfactory than Bioplastic as it is easier to handle, quicker setting and allows greater coverage of the polished surface.

The mounted specimens were first ground on a steel lap using #400 and #600 carborundum powders, until more than one grain thickness had been removed. The specimens were then polished on cloth laps using 6 μ and 1 μ diamond paste and magnesium oxide powder. The specimens mounted in Bioplastic were susceptible to plucking of the grains, particularly chalcopyrite. This problem was largely eliminated by the use of Quickmount.

Staining

Staining was necessary, for rapid point counting, as immediate visual identification is imperative. Pyrite and magnetite were particularly difficult to distinguish from pyrrhotite and sphalerite in unstained sections.

The stain used was 20% silver nitrate solution (Gaudin, 1935). The colours obtained are slightly different to those described by Gaudin and are as follows:-

Chalcopyrite	- sky blue - peacock blue, bright.
Pyrite	- tan to buff, bright.
Pyrrhotite	- deep blue to pinkish blue, med. - bright.
Sphalerite	- white, bright.
Magnetite	- unchanged.
Iron (from Pulverizer)	- reacts violently, giving brown halo and bright white stain.

Counting

A Swift automatic point counter was used, and approximately 1000 points were counted for each specimen. Of these only 35-45% were on mineral grains, the rest falling on the plastic mounting medium. Attempts to increase the proportion of mineral grains counted by lengthening the setting time of the plastic were unsuccessful, apparently because the grains were in too close contact.

However this proportion is adequate for the great majority of specimens (see Chapter 4).

Chapter 4.

METHOD OF STUDY

General

The present, observed mineralogy of any ore body is the final result of the action and interaction of various physical and chemical processes, which have culminated in the exposure of the ore body. It is to be expected that conditions generally will not have been uniform, either in space or time. Such processes as uplift and erosion are not considered here; rather the intent is to attempt to deduce the nature of the processes which have led to the present mineral assemblages.

None of the phenomena usually attributed to secondary enrichment of the ore are observed at depth in the Coronation Mine; hence, all results and discussion will refer to the primary period of ore formation, or, more correctly, to the last stage of such a period. Whatever the origin of the deposits, the variation in physical and chemical conditions will in general result in mineralogical inhomogeneity. The conditions should not vary in a completely random way, however, but should be governed by physical, chemical and geological principles, and therefore should vary in some accountable manner.

The ore bodies of the Coronation Mine are generally elongate in a direction parallel to the regional shearing. Therefore mineralogical variations in the ore body can be referred to variations in physico-chemical conditions along two axes, one parallel to the elongation, and one perpendicular to it. Further, it would be expected, from geological considerations, that the major variations in conditions will have been perpendicular to the direction of the shearing. Shear zones are eminently suited to the introduction of hydrothermal fluids, or may act as centres for metamorphic differentiation.

It seems, therefore, that the most promising approach is to study the cross sections of the ore bodies, and to attempt to relate the variations in mineralogy to a set of conditions which could have produced it.

The obvious unit to consider is one ore body. The variations in conditions cannot be expected to be smooth and continuous, as they should be ideally. Local inhomogeneities in the original rock mass (structural, textural and compositional) will produce variations in conditions, which will tend to obscure the fundamental mineral variation pattern, which is what is sought. The overall pattern of physico-chemical conditions, and hence the mineralogy, will in general have superimposed upon it