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SULPHUR ISOTOPE AND TRACE ELEMENT GEOCHEMISTRY OF SULPHIDE MINERALISATION IN THE BIRCH-UCHI GREENSTONE BELT, NORTHWESTERN ONTARIO

by

PHILIP KENNETH SECCOMBE

A Thesis
Presented to the Faculty of Graduate Studies
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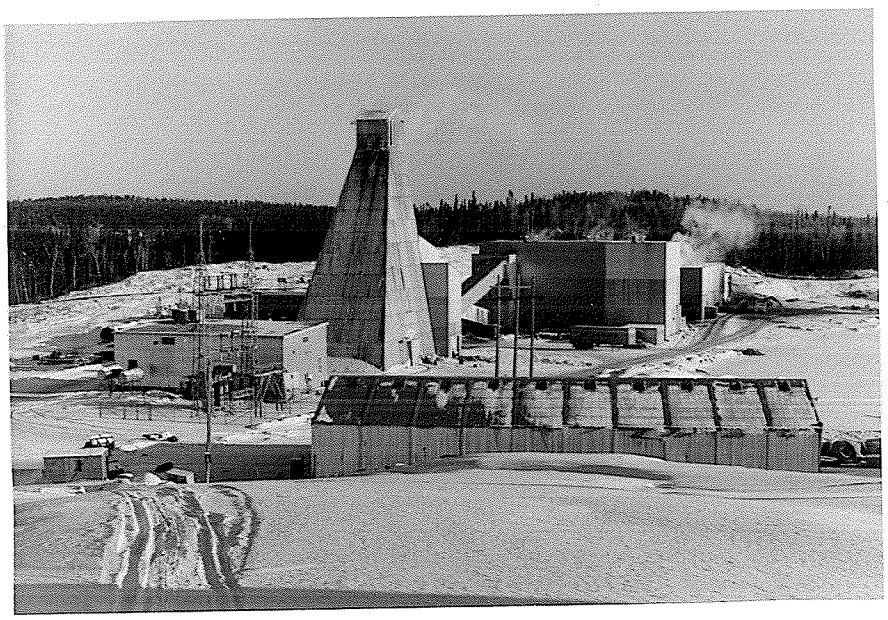

South Bay Mines, Confederation Lake

ABSTRACT

Sulphur isotope and trace element data are presented for sulphides from the South Bay Mines (Uchi) massive pyrite-sphalerite-chalcopyrite orebodies and sub-economic and barren sulphide mineralisation in the Archean Birch-Uchi metavolcanic-metasedimentary belt of northwestern Ontario.

δS^{34} values of ore sulphides from South Bay Mines exhibit a narrow (2 permil) range and proximity to zero permil. A statistical study indicates that the South Bay ore sulphides are similar to sub-economic sulphides in host rocks of comparable acid volcanic lithology. Sulphides from other prospect areas demonstrate a broad (greater than 6 permil) spread in isotopic values, and averages generally removed from, and commonly lighter, than zero permil. Isotopic temperatures obtained for co-existing sulphides from a number of areas indicate equilibration temperatures in the range 250°C to 350°C.

The trace metals, Ag, Sn, and Cd, and to a lesser extent, high In and high, but variable Co:Ni ratios characterise both the ore association and several of the sub-economic deposits. Excellent representation of ore affinity is obtained from selected plots of sulphide δS^{34} values and major and trace metal content. A general trend

towards S^{34} depletion corresponding to a decrease in host rock silica content is interpreted as evidence of a sulphide-host rock relationship and the operation of a magmatic isotopic fractionation effect.

Chemical studies of wallrock from the South Bay deposit indicate migration and anomalous values for all major elements and analysed metals in the vicinity of the orebodies. Chemical and mineralogical changes show a spatial relationship to ore and are considered to represent superimposed features.

The bulk of the sulphur from all areas is volcanogenic and of an isotopic composition related to the chemical composition of the parent magma. Sulphides from the barren prospect areas, although they may have suffered minor remobilising effects due to subsequent metamorphism, are believed to have formed syngenetically as volcanic exhalative accumulations. The ores, and sulphides of sub-economic prospect areas showing similar isotopic distributions, represent epigenetic hydrothermal deposits that contain sulphur and ore metals of remobilised volcanogenic origin. At South Bay, ore deposition took place under the influence of a falling temperature gradient in a region of structural control. Incorporation and partial re-equilibration of syngenetic pyrite from the volcanic wallrocks accompanied ore emplacement.

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CHAPTER 1

INTRODUCTION

In the period since 1949, following publication of the fundamental work of Thode, Macnamara and Collins, studies of the distribution of sulphur isotopes in natural environments have become increasingly important. An upsurge in the application of the method commenced just over a decade ago as a result of a re-evaluation of the capabilities of the technique and the development of new high-precision instrumentation, and sulphur isotope studies are now commonplace adjuncts to investigations in the field of sulphide ore genesis.

Many studies relate to individual deposits, and a number are directed towards the correlation of isotope distribution patterns of genetically similar deposits, however, a detailed regional comparison has not been made previously between an economic ore deposit and bodies of low-grade or barren mineralisation existing within a similar geological environment.

This study then was designed to investigate the distribution of sulphur isotope values from sulphide showings throughout a major portion of the Birch-Uchi greenstone belt of northwestern Ontario; a typical greenstone belt in an