THE STRATIGRAPHY, STRUCTURAL GEOLOGY AND GEOCHEMISTRY OF THE FOX LAKE MASSIVE SULFIDE DEPOSIT

A Thesis
Presented to
The Faculty of Graduate Studies
University of Manitoba

In Partial Fulfillment
of the Requirements for the Degree
Master of Science

by

Philip Eugene Olson

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ABSTRACT

The Fox Mine was a Proterozoic copper-zinc, volcanogenic massive sulfide deposit located in northwestern Manitoba. It was hosted by tholeiitic and calc-alkaline, sodic series volcanic and associated sedimentary rocks. The area has undergone middle amphibolite grade metamorphism.

The deposit comprised two major massive sulfide lenses, produced by separate hydrothermal vents. Both displayed typical metal zonation with lowermost copper-rich stringer ore, central massive copper-rich ore and uppermost stratified zinc rich ore. The lenses were laterallly continuous with altered felsic metavolcanic rocks. The western extension is obscured by thick accumulations of siltstones and pyritic mudstones. A thin horizon of iron formation coincides with the eastern extension.

The structural evolution of the Fox Mine area involved subvolcanic plutonism, early isoclinal folding (F1), tight E-trending shear folding (F2) followed by a period of faulting and shearing (D3) that segmented and offset the sequence of strata.

The orebody occurred on the overturned limb of an early, sub-horizontally plunging, isoclinal fold. Altered felsic metavolcanic rocks 800 meters south of the mine constitute a similar geological environment. They represent a detached, folded (F2) repetition of the favorable stratigraphy.

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FOX MINE (1970-1985)

On the 29th of November, 1985, milling operations at the Fox Mine ceased. Ore milled to closure totalled 11,958,182 tonnes grading 1.82% copper and 1.78% zinc. With many fond memories, I bid adieu to an old 'friend' and respectfully submit this thesis.

ACKNOWLEDGEMENTS

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The author wishes to acknowledge the significant contribution Sherritt Gordon Mines has made to the fruition of this project. Financial assistance, logistical support, access to information and computing facilities, meaningful discussions and moral support were provided by the management and staff of Sherritt Gordon Mines. Over a period of ten years, discussions with I.M. Plummer, R.G. Fernandez, R.F. Sawyer, J.M. Plecash, W.A. Jealous, A. Prus, R. Morin, B.R. King, and Dr. S. Amor enabled the author to formulate this interpretation of the Fox Mine area. Very capable assistance was provided during the 1984 field season by Mr. T. Giles.

The author also wishes to acknowledge the guidance and instruction offered by the Department of Geological Sciences staff at the University of Manitoba. Comments and criticisms by advisors, Drs. W.C. Brisbin and N.M. Halden always proved constructive. The enthusiasm for petrography demonstrated by Dr. A.C. Turnock proved a constant source of inspiration.

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Finally, I wish to express my sincerest appreciation to my wife, Catherine, and children, Justin and Laura, for their sacrifices of a personal nature.

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CHAPTER I

INTRODUCTION

1.1 BACKGROUND, LOCATION AND ACCESS

In his economic assessment of the Dunphy Lakes area, M. S. Stanton (1949) made the following innocuous statement in the final paragraph of his report:

> "About 1,000 feet northwest of Fox Lake, a sparse dissemination of fine pyrrhotite occurs in a small exposure of recrystallized dark-grey very impure garnetiferous quartzite. A magnetic anomaly was also noted in the immediate vicinity. No surface workings were observed" (p. 34).

Twelve years later, exploration crews in the employment of Sherritt Gordon Mines Limited confirmed the existence of a massive sulfide deposit approximately 300 meters northwest of Fox Lake. By July of 1965, diamond drill crews had outlined 11,153,636 tonnes of ore grading 1.74% copper and 2.35% zinc. Feasibility studies based on these drill results culminated in a production decision and in May of 1970, the first ore was skipped at Sherritt Gordon's Fox Mine.

For the next fifteen years, production levels at the Fox Mine were maintained near its design capacity of 2,750 tonnes per day. Published mining reserves dated December 31, 1984, included 632,893 tonnes averaging 1.802% copper and 2.418% zinc.

These reserves were exhausted by routine mine production during 1985. The final ore was processed on November 29th. Tonnage milled to closure totalled 11,958,182 tonnes grading

1.82% copper and 1.78% zinc.

The study to which this thesis pertains, was initiated in 1984 as a geological and geochemical assessment of the Fox Lake massive sulfide deposit prior to the cessation of mining operations. Although the final draft of this thesis was not available prior to closure, preliminary results were released in the Manitoba Department of Energy and Mines, 1984 Report of Activities.

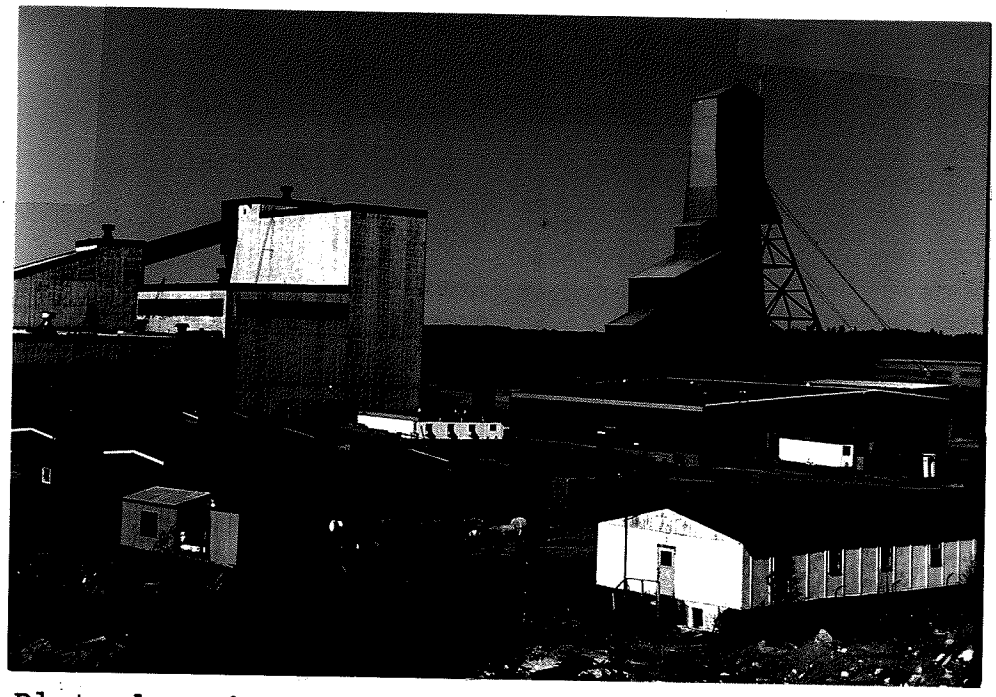

Plate 1: The Fox Mine as viewed from the south, with milling complex on the left and headframe on the right.

Fox Mine (Plate 1) is located in northwestern Manitoba, 20 kilometers east of the Saskatchewan provincial boundary, 45 kilometers southwest of the Lynn Lake townsite and 800 air kilometers northwest of Winnipeg (Figure 1). All weather access to the mine from Lynn Lake is possible via Provincial Highway #396. Lynn Lake is accessible by scheduled aircraft

service and Provincial Highway #396 by way of Thompson and by a branch-line of the Canadian National Railway via Cranberry Portage.

1.2 PREVIOUS WORK

The earliest geological map to include the Fox Mine area was the work of D. L. Downie in 1935. It was published as Geological Survey of Canada Map #343A covering the Granville Lake Map Sheet (West Half) on a scale of one inch equals four miles.

The next published geological work providing coverage of the Fox Mine area was by M. S. Stanton. It was released in 1949 as Manitoba Department of Mines and Natural Resources Report #48-4. This publication included the first detailed map (inch to half mile) for the Dunphy Lakes segment of the Granville Lake Mining District. In this report, Stanton separated the rocks of the Dunphy Lakes area into the Wasekwan and Sickle Series, consistent with the nomenclature of Norman (1933) and Bateman (1945). Meta- volcanic and volcaniclastic rocks composed the former group; immature, presumably younger metasedimentary rocks composed the latter. Significantly, Stanton noted several occurrences of coarse garnet-actinolite -cordierite-chlorite rock that he interpreted as hybrids resulting from impregnation by granitic material. Stanton did not elaborate on the structure of the Dunphy Lakes area. He cited the paucity of minor structures and facing direction indicators as limiting factors.