

Ph.D. THESIS PROPOSAL AND PROGRESS REPORT
THE FARO MASSIVE SULPHIDE DEPOSIT, ANVIL RANGE, YUKON TERRITORY

INTRODUCTION

The dissertation area is situated in the Anvil Range of the central Yukon Territory north of the Pelly River and the Tintina Trench. The core of the Anvil Range is underlain by Cretaceous granodiorite and porphyritic quartz monzonite that form the Anvil Batholith. A sequence of Proterozoic and Palaeozoic strata flanks the batholith and the Faro, Vangorda and Swim conformable, massive zinc - lead sulphide deposits occur within a lithologically restricted part of the Hadrynian and/or Cambrian portion of this sequence (Templeman-Kluit, 1968; Aho, 1969). These deposits are unique in that they are the only ones of their kind found so far in the Selwyn Basin. The Faro orebody is economically the most valuable mineral deposit discovered to date in the territory.

Mining interest in the area dates back as far as 1953 when the Vangorda Creek deposit was discovered by Alan Kulan. Subsequent drilling outlined a massive sulphide deposit of 22 million tons. Kerr Addison Mines Ltd. located a 10 million ton deposit at Swim Lake in 1964. In 1965 Dynasty Explorations Ltd. discovered the 65 million ton Faro orebody. Anvil Mining Corporation Ltd. was incorporated in December 1965 to continue exploration, develop the orebody and produce concentrates. Production began in late 1969.

Calcareous quartz muscovite schist, calc-silicate gneiss, biotite-muscovite schist and phyllite, massive sulphide, amphibolite and later granitic to gabbroic intrusions are the main lithologies in the vicinity of the Faro deposit. The Hadrynian and/or Cambrian strata have undergone varying degrees of regional metamorphism from low grade (sericite) at Swim to intermediate grade (chlorite) at Vangorda to moderate grade (biotite, andalusite) at Faro. These units were internally deformed to various degrees and in different styles during probable Cambro-Ordovician deformation (Templeman-Kluit, 1968). The deformational pattern appears to have culminated with the intrusion of the Anvil Batholith and the formation of the doubly plunging Anvil Arch which was superimposed on older structures.

The Faro massive sulphides are enclosed in a mainly metasedimentary sequence. However, rocks of volcanic affinity do exist. Theories of origin for the deposit range from epithermal replacement by hydrothermal solutions related to the Tintina Trench (Aho, 1969; Gondi, 1969; Karvinen, 1970; Templeman-Kluit, 1968) to syngenetic (Templeman-Kluit, G.S.C. Bull., in press).

The geologic, metamorphic and structural relationships of the rocks in the Faro area have not previously been examined or described in detail. However, a thorough understanding of the geology, stratigraphy and deformational history of these rocks is essential in unravelling the environmental control for sulphide deposition in Anvil Range and in developing a model for the origin of deposits of the Faro type. The Faro orebody is an excellent

Page three

example of a metamorphosed stratiform massive sulphide deposit and lends itself to a study of the effects of metamorphism of these types of deposits. Principles gained from the study of the Faro deposit will be extremely helpful in the exploration of similar strata elsewhere in the Anvil Range where little work has been done to date.

Several authors have described the geology of the Anvil district in the past (Dawson, G.M., 1887; Johnston, J.R., 1935; Campbell, R.B., 1949-1954, 1967; Roddick, J.A., and Green, L.H., 1961). The most recent work in the area was undertaken by D.K. Templeman-Kluit of the Geological Survey during 1968-1969. He mapped a 600 square mile region centered roughly on the Faro area and assigned a Hadrynian and/or Cambrian age to the massive sulphide host rocks through correlation with similar strata found elsewhere in the Selwyn Basin. His report provides the geologic framework for the Faro area.

Reports by several company geologists have been written regarding structure, geology and ore potential of part or all of the thesis area (Gondi, 1969; Gondi and Hampton, 1971; Karvinen, 1970; Roberts, 1971; Jennings and Jansens, 1972).

Additional areas of research to those proposed here are currently being undertaken in the Faro area (Appendix A).

THESIS OBJECTIVES

The objectives of the thesis are:

- 1) To provide a detailed description of the geology of the Faro area. This will include geologic mapping of an 8 square mile belt to determine the stratigraphic succession of rocks in the vicinity of the Faro orebody;
- 2) To determine the metamorphic history of these rocks as defined by isogradic reactions;
- 3) To undertake a geometric analysis of the sulphides and host rocks to determine their structural history. The relation between structural and metamorphic events as well as their effects, if any, on the sulphide fabric will be investigated;
- 4) To identify all sulphide mineral species and determine their textural relationships to help define their history;
- 5) To determine the presence and nature of any mineralogical, morphological, chemical and textural zonation (lateral or vertical) within the deposit;
- 6) To investigate the chemistry and trace element geochemistry of the ores and host rocks to try and determine the protoliths of the host rocks and the presence of any sulphide/country rock geochemical halos;
- 7) To determine the primary environmental control for sulphide deposition and thus develop a model for the origin of these types of deposits that can be applied elsewhere in the Anvil Range.

METHOD OF STUDY

- 1) Preparation of a pit map defining the stratigraphic sequence and the geometry and age relationships of metamorphic fabric elements in rocks exposed in the pit. The outcrop in the pit will provide information on the deformational history of the rocks that can be applied to the Faro area and the Anvil Range. Definition of major structural features will also aid in day to day mining problems.
- 2) Preparation of geologic and structural maps of the Faro area combined with petrographic investigation of mineral assemblages in the rocks encountered.
- 3) Mineralogical, chemical and textural study of the massive sulphides. Electron microprobe analysis will be used to determine unknown phases present. Computerized investigation of all diamond drill hole analyses will be undertaken to determine the presence of gross chemical zonation within the deposit. Both within-layer and across-layer zonation will be investigated. The presence of zoned sulphides will aid in structural interpretation and an understanding of mineralogical and textural features will aid mineral beneficiation.
- 4) Chemistry and trace element geochemistry of the host rocks. Whole rock chemical analyses will help define the volcanic or sedimentary nature of the sulphide host rocks. Bedrock geochemical data from rocks above and below the ore horizon

may contribute to the understanding of the origin of the rocks especially in defining the presence or absence of a controversial "bleached" zone believed to have formed through reaction with epigenetic hydrothermal solutions during ore emplacement (Aho, 1969). Knowledge of the presence of any geochemical halos about the Faro orebody would be beneficial to further exploration programs within the Anvil Range.

DATA COLLECTION AND SAMPLE PREPARATION

- 1) A total of 495 rock samples have been collected from representative lithologies encountered in the Faro area during two summers of geologic mapping. A topographic map 1" = 400", containing the Faro Grid System, was used for geologic and sample control.
- 2) An additional 70 samples have been collected from the Faro pit using a surveyed contour map 1" = 100' as control.
- 3) 30 drill holes have been logged and sampled.
- 4) A total of 46 polished thin, 83 thin and 41 polished sections have been prepared from the above samples of ore and host rocks.
- 5) 22 whole rock analyses each for 9 elements have been received for rock samples within the Faro area. These analyses obtained by Anvil Mining Corp'n.

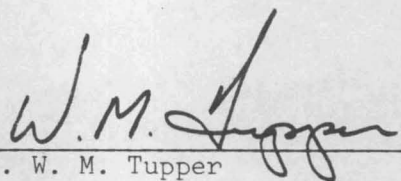
- 6) 256 whole rock plus trace element geochemical analyses each analysed for at least 14 elements have been received from 4 diamond drill holes -- 2 intersecting ore and 2 from barren rock. These analyses courtesy of D. F. Sangster of the Geological Survey of Canada.
- 7) Complete diamond drill hole logs and assay data from all 135 holes through the Faro sulphides and host rocks plus logs for numerous additional holes in the Faro area are on file.
- 8) 30 analyses of barite content within massive sulphides have been received.

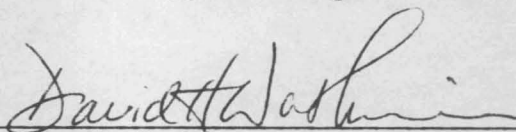
WORK TO DATE

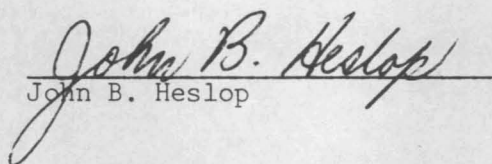
- 1) The Faro pit and surrounding area has been mapped in detail in cooperation with Dave Jennings (Research Geologist). This work defined a new and workable stratigraphic and structural picture for the Faro area.
- 2) Study of the chemical zonation of Ag, Pb, Zn and Cu within the deposit has been completed.
- 3) A preliminary investigation of the mineralogy of the sulphides and silicates has been undertaken. Substantial quantities of barite have been found, several previously unreported sulphide minerals identified and a number of silicate minerals verified.
- 4) A review of the literature has been made.

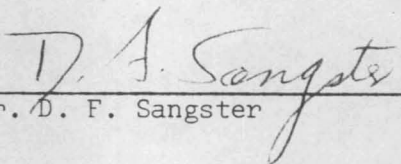
FUTURE WORK

- 1) Complete geologic and structural maps of the Faro pit and surrounding area. This includes replotting of field data and making stereographic projections of all structural data.
- 2) Petrography of the sulphides and silicates to define their mineralogy and coexisting phase relations.
- 3) Process whole rock chemical and trace element data.
- 4) Add 1972 diamond drill hole assay data to zonation picture and determine the relationship of barite to this zonal sequence.
- 5) Analyse several additional samples from selected diamond drill holes to define the existence of any primary geochemical halos around the orebody.


Dr. W. M. Tupper


Dr. D. H. Watkinson


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Dr. D. F. Sangster

November 27, 1972

APPENDIX A

- 1) Penny Morton (M.Sc. candidate, U.B.C.) is studying geochemical dispersion patterns in soils in the Faro area and their relation to bedrock geology.
- 2) Peter Le Couteur (Ph.D. candidate, U.B.C.) is studying lead isotope ratios in the ores and K/Ar dating of the regional metamorphism.
- 3) Dr. Campbell (Dean of Science, University of Calgary) is studying sulphur isotopes of coexisting sulphides and pyrrhotite - sphalerite geothermometry.
- 4) Dr. D. F. Sangster (Geological Survey of Canada) is studying sulphur isotopes from coexisting sulphides and sulphates.
- 5) Dr. D. Jennings (Research Geologist, Anvil Mining Corporation) is studying a number of aspects of Anvil Range geology, especially the regional macroscopic structure and stratigraphy of the Faro to Swim Lake belt.