CONSOREM
Consortium de recherche en exploration minérale

2013-08: Interpretation of sterile massive sulphide bodies

Massive pyrite and pyrrhotite zones generate significant geophysical anomalies during exploration for volcanogenic massive sulphides (VMS). This project aimed to establish whether it was possible to distinguish between intersections of massive pyrite/pyrrhotite associated with economic mineralisation (Cu-Zn) and a completely sterile body. More specifically, are we able to predict the presence of economic mineralisation near sterile areas? This question is critical at the early stages of exploration.

Answers to this question are provided by a detailed analysis of the volcanogenic massive sulphides of the Flin Flon camp. The Geological Survey of Canada provides a database of more than 150 analyses of massive sulphides from 40 mineralised zones, including former mines, showings and completely sterile bodies. Sixty (60) elements were analysed using Li-tetraborate fusion and ICP-AES for major elements, 4-acid digestion and ICP-MS for minor and trace elements, and INAA for As, Au, Hg and Se.

From this database, a multi-element diagram is proposed showing the field of economic deposits with zinc and copper affinities (figure 1). The selected elements are the elements that are usually present in trace amounts in pyrites of volcanogenic mineralising systems (e.g.: Matagami, Bouchard-Hébert, Horne, etc.). When these fields are compared to the patterns of samples from sterile bodies or from occurrences, three elements can be used to discriminate metal-bearing deposits: Tl and Sb for mineralisations of zinc-bearing affinity, and Se for mineralisations with copper-bearing affinity. These elements are enriched by at least an order of magnitude in the presence of nearby economic mineralisation. The enrichment is found in all VMS environments tested in this study. The three elements are part of a volatile group (low melting point) and their use necessitates special precautions when dissolving the samples to avoid their volatilisation (typical during the fusion process).

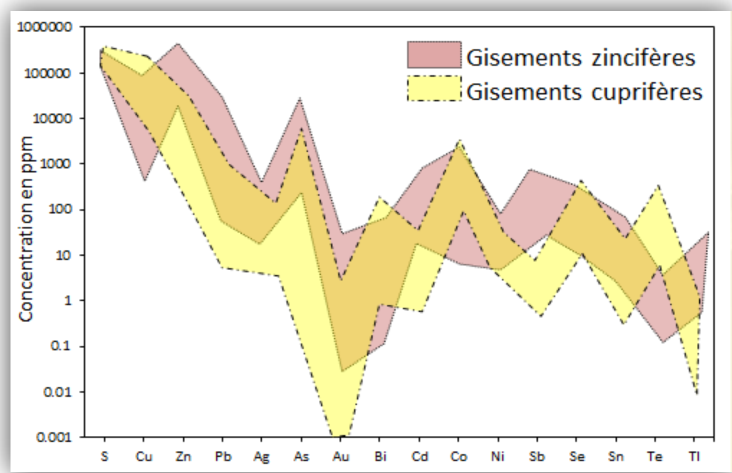

Figure 1. Multi-element diagram showing the composition fields of economic massive sulphides of the Flin Flon Camp.

The three elements show a similar physico-chemical behaviour (solubility, transport, etc.) to economic minerals (Zn and Cu), but seem more mobile in hydrothermal fluids and are likely to be fixed in sterile sulphides (in particular pyrite). In addition, Sb and Tl have ambivalent behaviour patterns. Consequently, they can behave as both chalcophile and lithophile (Tl) or siderophile (Sb) elements. This behaviour enables them to be incorporated in both sulphide and some silicate structures (for example, Tl into pyrite and sericite). This behaviour opens up particularly interesting perspectives for using volatiles in exploration (recognising alteration halos associated with economic mineralisation, dispersion in a secondary environment, etc.).

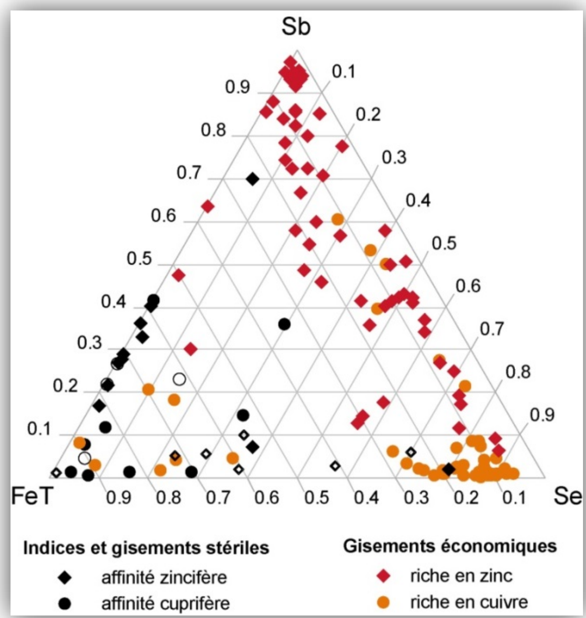

Figure 2. Ternary phase diagram for identifying economic deposits (zinc and copper), occurrences and sterile bodies in the Flin Flon Camp. Open symbols represent samples from more recent deposits (Phanerozoic).

Project 2013-08: Summary	
Objectives	• To establish the characteristics controlling the presence of mineralisation. • To establish the relationship between sterile and economic bodies. • To develop tools for determining the presence of economic mineralisation.
Results and Innovations	• Construction of a multi-element diagram including the signature (as fields) of economic deposits with zinc and copper affinities. • Demonstration of 3 discriminant elements: Sb-Tl for zinc deposits and Se for copper deposits. • Proposal for a method for analysing volatile elements. • Using trace element signatures of massive sulphides. • Using volatile elements in exploration.