The Distribution of Au, Ag, Pt and Pd in the Fe-Ni-Cu Sulfide Deposits at McCreedy West Mine on the North Range of the Sudbury Igneous Complex

A. E. Beswick
Department of Earth Sciences, Mineral Exploration Research Centre,
Laurentian University, Sudbury, Ontario, Canada
e-mail: tonybeswick@sympatico.ca

The McCreedy West (MCW) deposit is one of a number of magmatic Fe-Ni-Cu sulfide ore bodies lying within the Levack Embayment on the North Range of the Sudbury Igneous Complex (SIC). The mineralization can be traced continuously from blebby, disseminated, streaky and massive lenses of pyrrhotite-rich ores, hosted by basal norites and sublayer along the basal contact of the SIC, into chalcopyrite-rich veins within the footwall rocks up to 1000' below that contact (Hoffman et al., 1979, Can. Min. v.17).

Examination of the Fe-Ni-Cu-S relations in the MCW deposit, using atomic ratio diagrams (Beswick, 2002, Econ. Geol., accepted), reveals the ore compositions to be distinctly bimodal (Fig.1). The Cu-poor population (#1) show trends consistent with fractionation of pyrrhotite (Mss) while the Cu-rich footwall population (#2) show trends consistent with fractionation of chalcopyrite (Ccp), followed by pentlandite (Pn). Vein terminations are commonly characterized by bornite (Bn) bearing assemblages.

A 'connecting' trend also exists linking these two populations, as indicated by a line joining the two open squares labelled L1 and L2 in Figure 1, which is consistent with sulfide liquid immiscibility between those two compositions.

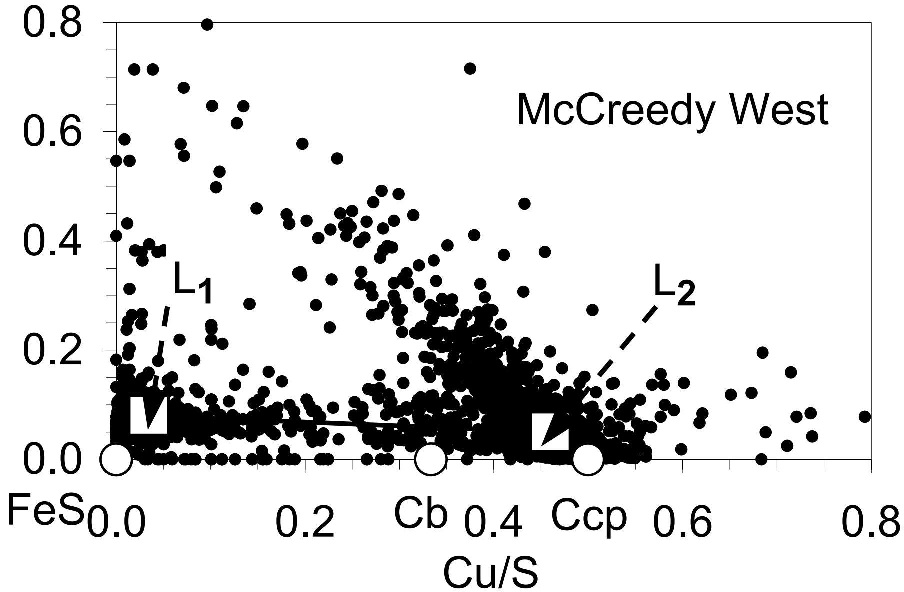

Figure 1. *Atomic ratio plot of Ni/S vs Cu/S for MCW ore samples (small open circles). L1 and L2 (open squares) represent a conjugate pair of immiscible sulfide melts. Compositions of the main minerals involved are represented by large open circles.*

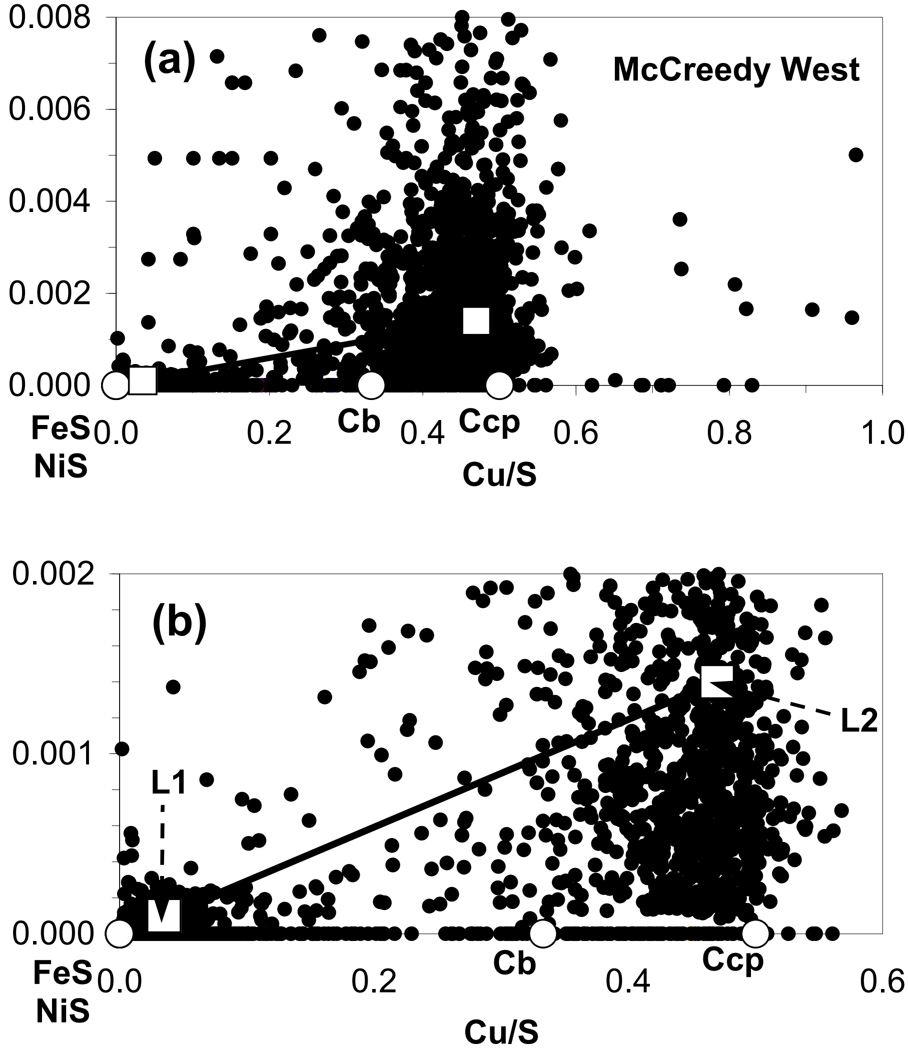

Figure 2a and b. *Atomic ratio plot of Pt/S vs Cu/S for MCW ore samples (small open circles) at two different scales. L1 and L2 (open squares) represent the same conjugate pair of immiscible sulfide melts plotted in Figure 1. Compositions of the main minerals involved are represented by large open circles.*

Data for Au, Ag, Pt and Pd in the MCW deposit samples indicate strong enrichments for all four metals in L2 relative to L1 with DL2/L1 values estimated to be approximately 25, 23, 14 and 18 respectively (see Fig. 2a). Enrichments of all four precious metals in the Cu-rich population are further enhanced by fractionation of chalcopyrite from L2 , which also enriches the derivative liquds in Ni (see Fig. 1), to the point where pentlandite (or Ni-rich pyrrhotite) fractionation begins. Pn fractionation reverses that process for Au, Pt and Pd and drives liquids toward bornite bearing assemblage compositions ($0.5 < Cu/S < 1.25$) as precious metal contents decrease. In the case of Ag, however, relationships are less clear and it appears that the fractionation of Pn from L2 derivative liquids continues to cause Ag enrichment, after Ni-depletion has occurred, and Cu-enrichment resumed, driving liquid compositions towards Bn bearing assemblages. These relationships are demonstrated for Pt/S in Figure 2; similar relations and trends are also found in atomic ratio plots involving Pd and Au.