Geologic Setting, Mineralogy, and Geochemistry of the Paleoproterozoic Photo Lake VMS Deposit, Snow Lake, Manitoba

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The Photo Lake deposit at Snow Lake, Manitoba, is a Cu-Zn-Au-Ag volcanogenic massive sulfide (VMS) deposit that occurs within the Chisel sequence of the Snow Lake arc assemblage of the Paleoproterozoic Trans-Hudson Orogen. It consists of two stacked massive sulfide lenses; a Cu-rich lens 1 (5.71 wt% Cu) and a Zn-rich lens 2 (10.98 wt% Zn). The Photo Lake deposit differs from most VMS deposits in the Chisel sequence because of its high average Au grade (4.9 g/t at Photo Lake versus 0.4 to 1.8 g/t in the Chisel, Chisel North, Lost and Ghost deposits). As such, an understanding of the processes responsible for Au enrichment at Photo Lake is critical for further exploration in the area. Field mapping, ore petrography, sulfur and lead isotopes of the ores, and trace element geochemistry of the ores and minerals associated with Au at the Photo Lake deposit are used to determine the processes responsible for Au enrichment. Gold occurs in mercurian electrum and is associated with magnetite in lens 1 and with gudmundite (FeSbS), galena, and cassiterite in lens 2. At the deposit scale, Au grades exhibit a strong positive correlation with Cu in spite of potential metal remobilization during deformation associated with peak, middle almandine-amphibolite facies, regional metamorphism. This indicates that Au was introduced into the system at the time of chalcopyrite precipitation during the main VMS mineralizing event. This also suggests that Au was dominantly transported as $AuCl_2^-$ in a high temperature, low pH hydrothermal fluid. Locally, Au exhibits a positive correlation with Zn in lens 2, suggesting that Au was also present in lower temperature hydrothermal fluids and was precipitated throughout the duration of deposit formation. Gold enrichment at Photo Lake may be due to one or a combination of: (1) boiling of the hydrothermal fluid in order to facilitate a large precipitation of gold; (2) an input of magmatic volatiles into the hydrothermal system; and (3) a hydrothermal fluid composition that was favourable for high Au solubility and transport.