

Using garnet to record mineralization in a BIF hosted orogenic Au deposit

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The origin of Archean banded-iron formation (BIF) hosted Au deposits is enigmatic and remains highly controversial. Although they are classified as an orogenic Au deposits, the origin of the fluids (magmatic vs. metamorphic) is still in discussion. In an attempt to resolve this debate, we present major and minor element compositions of garnet determined by LA-ICP MS and EPMA, from the Musselwhite deposit in the North Caribou greenstone belt, Western Superior Province. The deposit occurs within meta-(chemical) sedimentary rocks, which are enveloped by amphibolite grade mafic to ultramafic rocks. Samples were collected from auriferous garnet-grunerite schist, footwall and hanging wall schist in the mine, as well as auriferous schist from north of Opapimiskan Lake. A sample was also collected from the non-mineralized chemical sedimentary bed that is continuous 24 km from the deposit. Major elements of garnet from mineralized rock show Mn-rich cores (18-25 % Sps component) and Mg (8-15 % Pyp component) and CaO rich rims. The latter is atypical for normal growth zoning in garnet. Mineralized samples show high Eu/Eu* values ranging from 6.34-1.26 in the ore zone in the mine to ~1 to 2.98 from north of Opapimiskan Lake. Low Eu anomalies occur in the non-mineralized sample (Eu/Eu* = 0.706-2.19). The majority of garnet grains show high HREE concentrations with a mean (Sm/Lu)_{CN} value of 1.6 and low LREE ($\Sigma\text{HREE}/\Sigma\text{LREE} = 41$). Rims of garnet from mineralized samples show large variation in Ni/MgO from ~0.14 to 15.5, and Y concentrations from ~0.89 to 198 ppm. The high Ni and low MgO are recorded in the core of these grains from the ore, whereas their rims show low Ni. Trace element zonation in garnet from the non-mineralized rocks is minor compared to the auriferous samples. The data suggest that garnet growth was contemporaneous with the precipitation of pyrrhotite and chalcopyrite; both sulfides are closely associated with the introduction of Au. Gold-bearing fluid was derived from rocks during metamorphism or extensive alteration of mafic rocks as reflected by variably high Eu/Eu* values and calcic rich rims in the garnet crystals in the mineralized rocks. Results presented here indicate that garnet effectively records the history of hydrothermal activity associated with Au deposits and the data are consistent with metamorphic fluid as the principle transporter of Au at the deposit.