New Insights on the Structural and Geological Setting of the World-Class Musselwhite Gold Deposit, Superior Province, Northwestern Ontario

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Abstract

The Musselwhite mine is a world-class gold deposit hosted by amphibolite facies Algoma-type banded iron formation (BIF), comprised in the Mesoarchean North Caribou Lake greenstone belt, Superior Province. The deposit is located 2km west of a major fault zone that defines the tectonic boundary with the Island Lake Domain. Multiple occurrences of dm to m scale refolded F_1 folds, along with S_0 and S_1 geometries, indicate the presence of megascopic F_1 folds which are strongly overprinted by D_2 in the immediate mine area. Stratigraphic reappraisal and ongoing U-Pb geochronological work indicates that the mine sequence is inverted, the deposit occurring along the overturned limb of a map-scale F_1 syncline which axis lies to the South of Opapimiskan Lake. The bulk of the ore is hosted by the Northern BIF and occurs as stratabound pyrrhotite-rich replacements and associated silica flooding of the silicate BIF with local discordant syn-tectonic grey quartz ± pyrrhotite veins. The ore zones are associated with D_2-related to high strain zones concentrated along hinges (T Antiform and PQ Deeps) and strongly attenuated fold limbs (e.g. Lynx Zone) of tight shallowly northwest-plunging F_2 folds. The layered anisotropy induced by competent BIF horizons embedded in less competent mafic and ultramafic volcanic rocks strongly influenced rheological response to deformation, both at macro and microscopic scales, and hence played an important role in gold-bearing fluid flow, ore formation and distribution. Volcanic rocks proximal to the ore zones display a strong biotite alteration. The high-grade ore zones are associated with iron carbonates, Ca-amphiboles and hedenbergite and display a metasomatic-metamorphic layering with ~50% coarse almandine garnet porphyroblasts, intergrown with fine grained, bladed grunerite-cummingtonite (5-10%) and biotite (≤10%) aligned sub-parallel to the S_2 foliation. Because such mineral assemblage is also found regionally their careful characterization close to the ore is instrumental in uncovering the hydrothermal footprint of the deposit.