Regional Metamorphism and Deformation of the North Caribou Belt (W. Superior Province) and the Relationship with the Lode Gold Mineralization at Musselwhite Mine

É. Gagnon[1], D.A. Schneider[1], K. Hattori[1], J. Biczok[2]
[1]Department of Earth Sciences, University of Ottawa, Ottawa, ON, Canada; [2]Goldcorp Canada Ltd., Musselwhite Mine, Thunder Bay, ON, Canada

Abstract

The Archean North Caribou greenstone belt (NCGB) in northwestern Ontario is the nucleus of Canada's Superior Province. This 3.0-2.7 Ga metavolcanic-metasedimentary belt is host to an orogenic Au deposit at the Musselwhite mine. Ore is being extracted from garnet-magnetite-grunerite facies banded iron formations and resides in synclinal keels and their sheared limbs. Our existing understanding of the metamorphic history of the belt is limited to a reconnaissance metamorphic study conducted in the 1980's. Their results indicate that the western part of the greenstone belt displays a pattern of increasing metamorphic grade from chlorite zone dominantly along the south to localized occurrences of garnet + staurolite + cordierite ± sillimanite along the northern margin. These metamorphic "highs" are spatially coincident with magnetic highs, which may correlate to intrusive units within the greenstone belt, and thus, a pattern that is suggestive of contact metamorphism. The eastern belt is characterized by a more complex metamorphic assemblage due to prolonged reactivation of a crustal-scale shear zone (Totogan shear zone). The absence of clear metamorphic aureoles, few intrusive bodies, and no significant magnetic highs suggest that the deformation disturbed the primary metamorphic pattern. Prevailing models suggest that the external batholiths comprising the North Caribou terrane were emplaced at structural levels coeval with peak metamorphic conditions: 540-600°C and 6-7 kbars in the NCGB (at the mine), and 620-640°C and 6.7-7.5 kbars in the batholiths. This is in contrast to recent models of the Hemlo greenstone belt along the north shore of Lake Superior that illustrate oblique slip in shear zones, which may indicate synchronous vertical and horizontal tectonism. Moreover, our field observations and those of Kalbfleisch (2012 UOttawa MSc.) indicate dominantly subhorizontal lineations (fold axes, stretching minerals). A quantitative microstructural investigation involving electron back-scatter diffraction methods of the main north-south trending decametre-hectometre scale shear zones that project along strike to the deposit are under investigation to further distinguish between vertical and horizontal tectonism during ore deposition. Preliminary results strongly support a horizontal-dominated model, and suggest the shear zones are possible pathways for mineralizing fluids. Quartz shows intense recrystallization in a water-saturated environment that manifests as subhorizontal L-tectonites within the center of the shear zones, with strain decreasing away from the fault core. We will couple the microstructural analyses to thermobarometric analyses to further constrain P-T conditions during deformation, therefore identifying hydrothermal versus thermal signatures. Resolving the metamorphic history is important in determining the timing and origin of the mineralization.