Biotite and white mica composition as a vector to ore zones: deciphering hydrothermal and metamorphic effects in the Canadian Malartic gold deposit alteration halo, Québec

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Canadian Malartic (8.94 Moz @1.06 g/t Au resource, 5.55 Moz Au historic production) represents a world-class example of an Archean large-tonnage, low-grade gold deposit in the southern Superior Province. It is located in contact with, and immediately south of the overall east-west trending Cadillac-Larder Lake fault zone (CLLFZ), marking the boundary between the Pontiac and Abitibi subprovinces.

Gold mineralization occurs as disseminated grains of native gold and gold-tellurides in thin quartz-biotite-calcite-microcline±pyrite veinlets with biotite (±microcline-calcite-pyrite) selvages, and in zones of pervasive potassic alteration. A zonal distribution of alteration features is centered on the structures that acted as preferential pathways for the hydrothermal fluids (*e.g.*, the E-W trending Sladen Fault, the NW-SE deformation zones). Proximal potassic alteration in metasediments is dominated by microcline, albite, quartz, F-rich phlogopite (Mg#>90), calcite, Fe-carbonates and pyrite. This alteration grades outwards into a transitional potassic-sericitic alteration shell characterized by relatively abundant Mg-rich biotite (Mg#>55), phengitic white mica, microcline, albite, calcite, quartz and pyrite.

As constituents of both the metamorphic and hydrothermal assemblages, biotite and white mica are ubiquitous in the district and thus offer good spatial distribution for defining mineral-chemical vectors to ore in the areas affected by hydrothermal activity. Their mineral chemistry (e.g., higher Mg# and F content of hydrothermal biotite) revealed to be a sensitive tool to monitor the ore-forming processes in the Canadian Malartic mineralized system.

Compositional trends are also observed in metamorphic micas at the regional scale. In the case of white micas, there is a steady trend from phengitic towards muscovitic compositions southwards from the deposit, which is indicated by a progressive increase in Al and decreases in Si and Fe+Mg; these relationships are also apparent from hyperspectral data. Preliminary metamorphic modelling suggests that these trends can be explained by the increase in metamorphic grade southward, from upper greenschist (at the contact with the CLLFZ) to mid-amphibolite facies. Tschermak substitution is inferred to be the main mechanism that accounts for the compositional variations in metamorphic micas. Interestingly, the partition coefficients of elements for which distribution between biotite and white mica is non-linear, *e.g.,* Fe and Mg (D_{Fe}^{*} and D_{Mg}^{*}), correlate with the distance southwards from the mineralized zones. This observation suggests a close relationship between Fe and Mg partitioning with increasing metamorphic grade.

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