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The Hidden Talents of Quartz and Mica: Indicating Metallogenic Potential in A-Type Granitic Systems

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Many minerals have been used as mineralisation vectors; however, there are few vectors for Sn and other critical metals hosted in granites. Quartz and mica are ubiquitous in granitic assemblages and are promising candidates as tools in mineral exploration. The Zaaiplaats Tin Field (ZTF) of the Bushveld Complex is a well-known expression of endogranitic Sn-mineralisation and is used in a comparison of mineralised and unmineralised A-Type granites. The ZTF comprises the Nebo Granite at the base that grades into the Bobbejaankop Granite then the Lease Granite, which forms the cupola. These granites exhibit an increasing degree of hydrothermal alteration respectively, with mineralisation restricted to the Bobbejaankop and Lease phases.

Trace elements in quartz can record the evolution of a granite and the point of fluid-saturation. The quartz from the ZTF exhibits an increase in Al/Ti and Ge/Ti ratios from the base to the cupola, illustrating sequential fractionation and increasing fluid-rock interaction. The quartz exhibits a shift from a magmatic fractionation-controlled to a hydrothermally-controlled system, identifying the point of fluid-saturation and the most fractionated, and potentially mineralised, lithologies. Comparing the mica compositions from the ZTF with other mineralised and unmineralised A-Type granites highlights differences in their evolution and metallogenic potential. Mineralised and unmineralised granites display distinct mica characteristics. The ZTF and other mineralised granites exhibit a Fe-Li trend of trioctahedral micas and a common occurrence of alteration-associated dioctahedral micas. In contrast, unmineralised granites have Mg-rich trioctahedral micas and a lack of dioctahedral micas. Differences in mica chemistry, evolution, and alteration affect the presence of volatiles and sequestration of metals, such as Sn. Therefore, mica compositions indicate the potential of an A-Type granitic system to have developed late-stage mineralisation. Using these minerals in concert can inform mineral exploration by indicating the degree of fractionation and metallogenic potential of a granitic system.