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The key role of mica during igneous concentration of tantalum: implications for exploration for rare metal deposits

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Tantalum is crucial element for modern high-tech applications. Tantalum is mined from pegmatites and Ta-rich leucogranites – appogranites. Origin of Ta enrichment in these intrusions remains poorly understood. Ta-rich intrusions share number of geochemical features such as high Ta/Nb ratios and low content of Ti, LREE and Zr. These features can be traced to non-ore-bearing fractionated granite series. Modelling of fractional crystallization of biotite and muscovite demonstrate that the process produces a decrease of the Nb/Ta ratio and a decrease the Ti content in the melts. Crystallization of rutile, titanite and ilmenite has opposite effect on melt composition: it decreases both Nb and Ta contents and increases the Nb/Ta ratio hence rendering these melts to unproductive for formation of Ta deposits. Saturation of Ta minerals such as columbite-tantalite occurs only at latest stages of magmatic evolution and is unlikely to be primary driving force for Nb-Ta fractionation.

This mica fractionation model has direct implications for exploration for rare metal deposits. Large volumes of magma are needed for formation of highly enriched fractionated melt and hence Ta deposits tend to be associated with large granitic batoliths. The deposits are likely to be associated with granitic intrusions that have undergone extensive biotite and muscovite over prolonged period. Intrusions that show significant rutile, titanite or ilmenite fractionation are unlikely to produce Ta-rich melts.