The Key Role of Mica in Concentration of Tantalum During Magmatic Fractionation of Granites

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Ta-rich intrusions are important sources of rare metals (Ta, Li, Rb, Cs, Sn, and others): however, their origin remains poorly understood. Granitic rocks associated with Ta deposits share number of important geochemical features such as low Nb/Ta ratios and low content of refractory elements (Ti, LREE, Zr). These rocks are formed by magmatic fractionation of non-ore-bearing granites. Comparisons of compositional trends in Ta-rich melts with experimental studies demonstrate that fractional crystallization of micas, both biotite and muscovite, can produce a decrease in Nb/Ta ratios in melts and also decrease Ti content in the melt. Crystallization of rutile, titanite, and ilmenite has opposite effect on melt composition: it decreases content of both Nb and Ta and increases Nb/Ta ratio in the melt, thus rendering these melts unproductive for formation of Ta deposits. Saturation of Ta minerals such as columbite-tantalite occurs only at latest stages of magmatic evolution and unlikely to be a primary driving force for Nb-Ta fractionation. The mica fractionation model for the genesis of Ta deposits has direct implications for exploration for rare metal deposits. Large volumes of magma are needed for formation of highly enriched fractionated melt. Hence, Ta deposits are associated with large granitic batholiths. The deposits are likely to be associated with granitic intrusions that crystallized biotite and muscovite over prolonged period of magmatic fractionation. Intrusions that precipitated significant rutile, titanite, or ilmenite are unlikely to produce Ta-rich melts. The model predicts that intrusions associated with Ta deposits will have distinctive geochemical and petrological features that can be used in exploration.