

CONTROLS ON THE SATURATION OF SN-NB-TA- ZR-HF MINERALS IN GRANITIC MELTS

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Experiments on the solubilities of cassiterite, manganocolumbite, manganotantalite, zircon and hafnon in per-alkaline to peraluminous granitic melts at 750-1035°C and 2 kbar were conducted to determine the conditions at which magmatic mineralization can occur, and to place constraints on interpreting variations of trace element ratios in granitic rocks. Solubilities of these minerals are strongly dependent on the ASI ratio. In peralkaline melts tin is dominantly quadrivalent, and at oxygen fugacities of FMQ-0.6 to FMQ+3.5 cassiterite solubility decreases from roughly 10 to 4 wt% SnO₂. In metaluminous and peraluminous melts tin is dominantly divalent at reduced conditions, and cassiterite solubilities range up to ~1 wt% SnO₂. At oxygen fugacities FMQ+2.5 in these melts tin is dominantly quadrivalent, but cassiterite is saturated at ~700 ppm Sn. Oxidation is thus a viable depositional mechanism. Columbite-tantalite and zircon-hafnon solubilities also increase from metaluminous to peralkaline melt compositions. The pairs, columbite- tantalite and zircon-hafnon have virtually identical molar solubility products in peralkaline melts. However, in metaluminous and peraluminous melts manganotantalite is more soluble than manganocolumbite and hafnon is more soluble than zircon. The activity coefficients of Ta and Hf in the melt are thus lower than those of Nb and Zr, respectively. From this relationship the decrease of Nb/Ta and Zr/Hf observed in highly evolved peraluminous melts can be explained by crystal fractionation. Columbite-tantalite solubilities also increase with Li and F contents of the melt and Nb-Ta mineral saturation is likely either preceded by Li-F-silicate crystallization, or occurs at very low temperatures in evolved granitic systems.