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Indium diffusion in granite melts: Indications of indium mineralization

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Indium is a critical metal often recovered as a byproduct of various granite-related deposits. In view of its extremely low abundance in the Earth's crust, indium must undergo enrichment of >1000 from magmatic source regions to ore deposits. The diffusivity of indium in silicate melt controls the efficiency of indium enrichment, yet there is currently no experimental constraint on indium diffusivity. In this study, indium diffusion in granitic melts with up to 6.5 wt% H_2O were investigated at 1073 - 1873K and 0.5 - 1 GPa in a piston-cylinder apparatus, using both diffusion couple approach and indium sheet dissolution approach. Indium concentration curves in the recovered samples were determined using LA-ICP-MS, and indium diffusivities were extracted by error function fitting of the curves. The experimental results show that indium diffusivity increases about 2842 times when the melt water content rises from 0 to 6.5 wt% at 1473K and 1 GPa, 34 times when temperature rises from 1473K to 1873K in the anhydrous melt under 1 GPa, and 3 times in anhydrous melt from 1 GPa to 0.5 GPa at 1673K. The diffusion of indium is among the slowest, with $D_{Mo} < D_{In} \approx D_{Sn} << D_{H2O} < D_{Cu} \approx D_{Ag}$. Considering the high partition coefficients of indium between biotite/amphibole and granite melt (36 and 0.6 - 16, respectively), slow indium diffusion can significantly restrict indium incorporation into these minerals, especially at reduced melt H_2O content. Therefore, less indium is taken away by fractional crystallization of these minerals in I-type granites, which is favorable to late-stage indium mineralization. The striking resemblance between indium diffusion and tin diffusion could contribute to co-genetic indium-tin mineralization.