

The behavior of mineral inclusions at a reacton interface

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Geochemical processes are often modelled using partition coefficients of trace elements between coexisting phases that are allegedly in chemical equilibrium with respect to one another. Partition coefficients are estimated by quantifying the solubility of the respective elements in the coexisting phases, which is commonly done using Electron Probe Micro Analyzer (EPMA) or Laser-Ablation Inductively-Coupled-Plasma Mass-Spectroscopy. Yet, these methods do not suffice to resolve whether an element is actually dissolved in the crystal lattice or present in the form of nanometer sized mineral inclusions. We performed a coupled Field Emission Gun-EPMA – Secondary Electron Microscope – Scanning Transmission Electron Microscope study on a chemically heterogeneous igneous corundum (Crn) single crystal. What appears to be a chemical Nb- Ti zoning on the micrometer scale, turns out to be a complex mineral inclusion distribution zoning on the nanometer scale. Corundum areas that appear to be Nb-rich have abundant Nb-bearing nano-inclusions, whereas Ti-rich domains have larger needle-shaped rutile inclusions. Moreover, Crn-melt reaction produced a polycrystalline spinel corona around Crn. We investigate the behavior of mineral inclusions at the corundum-spinel reaction interface. In particular, changes in the Nb-Ti distribution across the phase boundary are correlated with dissolution and recrystallization of the Ti-oxide nano-inclusions at the interface. The nature of pre-existing nano-inclusions in certain Crn growth zones controls the inclusion behavior at the reaction front and the Ti-oxide distribution in the spinel corona.