

Boninite ascent rates constrained using chromite crystal chemistry: Observations of experimental products applied to the extrusive sequence of the Troodos Ophiolite

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Boninites are rare high magnesium andesites that often contain trace chromites that form early. These melts continue to crystallize a significant volume of silicate minerals. Magmatic differentiation drives chromite out of equilibrium with the residual melt with respect to both divalent and trivalent cation proportions. To simulate this process, we have performed internally heated pressure vessel experiments, providing insights into the processes of crystal-melt re-equilibration through time. While Fe-Mg exchange equilibrates the tetrahedrally coordinated divalent cations in chromite in < 6 hours, equilibration of trivalent cations in octahedral coordination with residual melts is slow. Our experimental results show chromite Al concentrations are ubiquitously lower, and Fe²⁺/Fe³⁺ values are ubiquitously higher than modelled equilibrium values, indicating that there was insufficient time for significant Al and Fe³⁺ incorporation to occur at the expense of Cr. Similar observations can be made for natural chromite compositions in the extrusive sequence of the Troodos ophiolite. Based on a simple model of diffusive equilibration, we estimate that the core of a microphenocrystic chromite 60 μm in diameter (size of natural microphenocrysts: 50-500 μm; Cameron, 1985) may take up to 500 years to equilibrate under conditions analogous to the physiochemical state of melt at the time of eruption. For the extrusive sequence, this implies an ascent rate of boninites greater than 16 m/year for disequilibrium textures and compositions to be preserved.

Cameron, W.E., 1985. Petrology and origin of primitive lavas from the Troodos ophiolite, Cyprus. *Contributions to Mineralogy and Petrology* 89, 239-255.

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