

Trace element substitution mechanisms in olivine

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Understanding the chemical composition of the mantle is key to understanding the evolution and composition of the Earth. Olivine is volumetrically the most important silicate phase in the Earth's upper mantle and understanding the mechanisms by which trace elements partition into olivine is essential before a complete description of this part of the Earth can be made.

In order to test the applicability of Henry's Law to trace element distribution behaviour between olivine and melt as a function of trace element concentration, and place important constraints on the dominant substitution mechanisms responsible during trace element incorporation in olivine we have performed a series of isothermal crystallisation experiments in a 1 atm furnace where olivine and coexisting melt were synthesised in a relatively simple synthetic chemical system. The objective of these experiments was to measure the relative concentrations of impurity trace elements in olivine and coexisting melt as a function of trace element dopant concentration. Mineral and quenched melt compositions were determined in situ using electron microprobe and LA-ICPMS analyses.

Our results demonstrate that the addition of sodium to the synthetic starting materials imparts a significant influence on the uptake of further trace elements in olivine. Furthermore, the results of our sodium-doped experiments contradict trends between dopant concentration and trace element partition coefficient observed in previously published experimental studies (Colson, 1988). We show how a thorough understanding of the important substitution mechanisms by which trace elements are incorporated into olivine is essential when data are extrapolated to conditions in the early Earth history.

Reference

Colson, S. et al., 1988. *Geochim. Cosmochim. Acta* **52**, 539–553.