Goldschmidt 2021 Abstract
https://doi.org/10.7185/gold2021.7487

Partitioning of chalcophile elements between olivine, pyroxenes, garnet and silicate melt at 1.5–3 GPa and 1280–1500 °C

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Although the major element contents of mantle melts of low and moderate degrees of melting are reasonably well-established, the behaviour of many trace elements during partial melting and fractional crystallization is still poorly constrained. In this study we are aiming to experimentally determine the partitioning of chalcophile elements into abundant silicate mineral phases of the upper mantle for comparison with partitioning into low abundance sulfide. As partition coefficients (*D*) are simultaneously dependent on pressure, temperature, and phase composition, experiments covarying these variables were conducted. Pressure and temperature were covaried close to the peridotite solidus, at pressures of 1.5-3 gigapascals (GPa) and temperatures of 1280-1500 °Celsius (C) being employed on synthetic basaltic compositions containing twenty trace elements including REE, Y and the chalcophile elements (Ni, Cu, Zn, Cd, In, Sb, As, Ag and Tl). Experiments were performed in the piston-cylinder apparatus in graphite capsules using both open capsules and capsules contained within welded Pt outer capsules.

The quenched products were analysed using the electron microprobe and by LA-ICP-MS for trace elements. Experimental crystal-melt partition coefficients were determined for olivine (Ol), clinopyroxene (Cpx), orthopyroxene (Opx), and garnet (Grt) close to the peridotite solidus. We used the data of McDade et al. (2003) at 1.5 GPa and unpublished data of McDade at 3 GPa on partitioning of the REE and Y as controls on the quality of the data.

We find that Tl is incompatible in all 4 silicates *D*~0 and that Cu, In and Sb have partition coefficients of ~0.06 into olivine while Cd partitions somewhat into Cpx (*D*~0.5) and Opx (0.2). *D* for Zn into olivine is ~1.0 with values of Zn into Cpx and Opx being 0.4 and 0.5 respectively. Indium has *D* values into Cpx and Opx of 0.1-0.2 while the partitioning of Sb into all 4 phases is negligible. We use the measured values to estimate the relative influences of silicates and sulfides on trace element abundances during mantle partial melting.

[1] McDade, P., Blundy, J. D., & Wood, B. J. (2003). Physics of the Earth and Planetary Interiors, 139, 129–147.