

Crystal/melt partitioning of volatile and non-volatile elements during peridotite melting: Implications for mantle fractionation

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Mineral/melt D values for the partitioning of H₂O, F, Cl, C, P and S between experimentally-produced peridotite minerals and basanitic melts (produced at 1025-1190 °C and 1.0-3.5 GPa) were determined by a combination of secondary ion mass-spectrometry (SIMS) and mass balance relationships between melts and starting materials. D values for H₂O are 0.0064-0.0164 for clinopyroxene, 0.0046-0.0142 for orthopyroxene, 0.0015-0.0016 for olivine, and 0.0016-0.0022 for garnet. Although less information was obtained for the other volatiles, F is significantly more compatible than H₂O in peridotite minerals, whereas Cl and C are significantly less compatible. S also has small but appreciable solubilities in amphiboles and micas, but not in pyroxenes, olivine or garnet. D_{H₂O} for pyroxenes correlates positively with ^{iv}Al but negatively with H₂O concentrations in melts. The latter effect is consistent with popularly accepted speciation models for dissolved H₂O in silicate melts. D_{H₂O}/D_{Ce} for clinopyroxene increases as the radius of the M2 site decreases. Because the latter decreases with increasing pressure and temperature, relatively hot and/or deeply derived melts should be enriched in Ce relative to H₂O when compared to melts from cooler and shallower mantle sources. When combined with previously published D values for non-volatile elements (obtained for the same experiments) our data are consistent with previously inferred compatibilities of volatile and non-volatile elements during peridotite melting and related mantle fractionation.