

Cadmium stable isotope fractionation during evaporation into air and CO-CO₂

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We present cadmium stable isotope data for the experimental evaporation of Cd and other volatile elements from silicate melts at $\sim 1300^{\circ}\text{C}$, atmospheric pressure and variable $\log f\text{O}_2$ using a mechanically assisted equilibration technique (see Ertel-Ingrisch et al., this volume). These experiments provide further insight into stable isotope fractionation mechanisms and therefore aid in the interpretation of results from e.g. volcanic or meteorite samples.

Cadmium stable isotope data were obtained using a Neptune MC-ICP-MS. For the same sample set, the loss of volatile elements from the silicate melt samples has been quantified using an ElementXR sector-field ICP-MS and external calibration.

The vapor-melt isotope fractionation factors for $^{114}\text{Cd}/^{110}\text{Cd}$ correspond to -1.6‰ and -0.3‰ for the evaporation into air and CO-CO₂, respectively. Thus, the observed Cd isotope fractionation is much lower than previously observed for the evaporation into vacuum (-10‰) or calculated based on kinetic theory, i.e. due to differential translational velocities (-17.7‰).

Suppression of the Cd isotope fractionation probably results from partial back reaction from the vapor into the melt phase, caused by the atmospheric pressure. Cadmium forms a monatomic vapor, therefore the evaporation of Cd requires reduction. We suggest that the stronger suppression of the Cd isotope fractionation under more reducing conditions is best explained by pre-reduction in the melt phase. The reduced Cd may then be easily lost to the vapor phase without much isotope discrimination. This suggestion is consistent with the faster loss of Cd in this experiment (see Ertel-Ingrisch et al., this volume).

The above observations show, that metal stable isotope fractionation related to evaporation can be strongly suppressed by the presence an atmosphere and does not require high partial pressures of the respective elements in the adjacent gas phase. This observation may be useful for the interpretation of volatile metal isotope data for terrestrial and extraterrestrial materials.

Our ongoing study will likely address other stable isotope systems, temperature effects and stable isotope fractionation during recondensation onto Al₂O₃ condensation plates along a temperature gradient.