

Fractionation of Cd isotopes during evaporation and condensation at atmospheric pressure

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Stable isotope effects due to high temperature evaporation of volatile and refractory elements into vacuum have been extensively studied. In contrast, isotope fractionation related to condensation or evaporation at high ambient pressures received little attention (e.g. [1] [2]), Yet, higher pressures are relevant for terrestrial volcanism, tektite formation and possibly even for cosmochemistry (e.g. [3]–[5]).

Using the mechanically assisted equilibration technique [6], evaporation of Cd from a silicate melt into CO-CO₂ and air at ~1300°C and atmospheric pressure was studied. The results show that the loss of volatile elements can proceed with only marginal isotope fractionation under reduced conditions. The observed vapor-melt fractionation for $\delta^{114/110}\text{Cd}$ corresponds to only -0.1‰, compared to -17.7‰ calculated from Grahams Law. This may be explained by the accelerated evaporation rate due to the low oxygen fugacity [7] and/or lower net isotope fractionation due to isotope exchange between melt and vapour [8].

Cadmium leached from condensation plates retrieved from inside of the furnace muffle tube reveals a light Cd isotope enrichment in condensates closer to the melt surface and heavier Cd isotope compositions at the top. The fractionation factor between vapor and condensate corresponds to -1.8 to -3.5‰, roughly in accordance with the fractionation expected for diffusion through the ambient atmospheres. To our knowledge this is the first time that experiments are in accord with the isotope fractionation during condensation predicted from kinetic theory.

[1] Uyeda *et al.* (1991) *EPSL* **107**, 138–147. [2] Richter *et al.* (2002) *GCA* **66**, 521–540. [3] Baker *et al.* (2009) *GCA* **73**, 6340–6359. [4] Humayun & Clayton (1995) *GCA* **59**, 2131–2148. [5] Galy *et al.* (2000) *Science* **290**, 1751–1753. [6] Dingwell *et al.* (1994) *GCA* **58**, 1967–1974. [7] Nagahara & Ozawa (1996) *GCA* **60**, 1445–1459. [8] Davis & Richter (2014) *Treatise on Geochemistry* **1**, 335–360.