Preferential light Cd isotope condensation in 1 bar experiments

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Condensates enriched in the light isotopes are expected for partial kinetic condensation [e.g. 1]. Natural examples may include isotopically zoned metal grains in CB chondrites [2] and Zn, Ga and Cd isotopes in CAIs [3,4,5]. However, no experimental evidence for light isotope enrichment due to partial kinetic condensation exists [e.g. 5].

Here, the Cd isotope compositions of condensates from a combined evaporation-condensation experiment have been determined in order to evaluate stable isotope fractionation associated with condensation (and to better understand the high ambient gas pressures and variable oxygen fugacities for Cd isotope fractionation during evaporation). Using a 1-bar vertical tube furnace with gas-mixing capability, Cd was evaporated at approximately 1580 K from Anorthite-Diopside eutectic composition melts and subsequently re-condensed onto Al_2O_3 plates placed within the furnace tube. Two experimental series were conducted, one in air, and one in a CO-CO_2 mixture yielding $\log fO_2 = -11.3$. Relative Cd abundances along the Al_2O_3 condensation plates were determined using an XRF scanner. Cadmium isotope analyses on leachates from the condensation plates were determined by MC-ICP-MS.

Kinetic theory predicts a stable isotope fractionation for $^{114}Cd/^{110}Cd$ (in ‰) of $1000*(\alpha-1) = -3.7$ and -4.3 for kinetic condensation from air and the CO-CO_2 gas mixture, respectively. Indeed, a Rayleigh condensation model yields estimates for the light isotope enrichment in instantaneously formed condensates relative to the vapor phase with $1000*(\alpha-1)$ as predicted for air, and somewhat lower (~ -2.5) for CO-CO_2. The expectation from kinetic theory, that light isotopes condense preferentially due to higher collision frequencies is thus confirmed experimentally.

[1] Richter et al. (2004), *GCA* **68**, 4971–4992. [2] Weyrauch et al. (2018), *GCA* **246**, 123-137. [3] Luck et al. (2005), *GCA* **69,** 5351-5363. [4] Wombacher et al. (2008) *GCA* **72**, 646-667. [5] Kato & Moynier (2017), *EPSL* **479,** 330-339.

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