Experimental determination of Zn isotope fractionation during evaporation

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Zinc isotopes are relatively insensitive to fractionation during igneous processes, but readily fractionate during evaporation. Because the light isotopes of Zn preferentially enter the vapor phase, the residual solid becomes relatively enriched in isotopically heavy Zn. Thus, volatile depleted samples including tektites, fallout glass, and lunar rocks are typically relatively isotopically heavy compared to the Bulk Silicate Earth. Though the sensitivity of the Zn isotope system to volatile loss is widely known, the magnitude of isotopic fractionation associated with evaporation is poorly constrained. Without this knowledge, it is difficult to use the degree of Zn isotopic fractionation to quantify volatile loss from a sample. This is particularly relevant to recent attempts to use the Zn isotope ratio of lunar samples to constrain volatile loss from the Moon. To address this problem, we used a new double-spike technique to analyse the Zn isotope ratio in a series of glass samples that were heated to temperatures between 1600-2200°C and for durations of 1-120s. All experiments were performed at atmospheric pressure. Relative to the starting rhyolitic soil, the heated glass became depleted in volatile elements, including Zn, and this decrease in the Zn concentration was accompanied by an enrichment in isotopically heavy Zn by up to +1.1‰. Based on the relationship between Zn concentration and δ^{66}Zn, and using a Rayleigh fractionation model, we calculate a fractionation factor (α) of 0.9986. This fractionation factor is higher than had previously been estimated from analyses of tektites (α between 0.999-0.9997) but significantly lower than the theoretical α for Zn volatilization into a vacuum (0.985). We hypothesize that the fractionation factor is controlled by pressure, as has been recently shown for K isotopes. If true, this pressure control over α would need to be accounted for before using the Zn isotope ratio of lunar samples to estimate volatile loss from the Moon.

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