Goldschmidt 2022 Abstract
https://doi.org/10.46427/gold2022.12002

High Temperature experimental and isotopic investigations of Zn during sulfur-bearing magma degassing

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Moderately volatile metal elements like Zn in basaltic magma could have been efficiently transported in a volatile-enriched (i.e. sulfur) gas phase [1, 2] during the magma ascending, whereas the vaporisation process may fractionate elements and their isotopes between gas and liquid [3]. However, the effect of sulfur on the volatitlization of Zn, including chemical and isotopic compositions, has yet been systematically investigated. Here we present an experimental approach to test the effect of sulfur on the evaporation of Zn by comparing chemical and isotopic compositions of both run-products of S-doped and S-free Zn silicate melt evaporation experiments in $f(O_2)$-controlled, water-free gas mixing systems at 1 bar.

Several evaporation experiments were conducted to simulate Zn degassing in S-bearing and S-free silicate melts with a temperature gradient of 1200-1400 °C, a $f(O_2)$ range from δFMQ = -6 to oxygen fugacity in the air, and a time duration from 10 to 30 min. Diffusion-limited evaporation processes are only observed in high-temperature experiments (above 1250 °C), according to the in-situ elemental data. The results indicate that the volatility of Zn in silicate melts depends on temperature, $f(O_2)$ and gas composition, and the evaporating rate of Zn incerases with decreasing $f(O_2)$ and increasing temperature, while the Zn isotopic fractionation factor between gas and melt remains unchanged ($\alpha = 0.9975$). Besides, the bearing of sulfur in the silicate melt may have strong effect on the volatilization of Zn under reduced $f(O_2)$ conditions, with less Zn remaining and larger $\delta^{66}Zn$ relative to starting materials. Our experiments shows that the degree of Zn degassing in S-bearing conditions does not correlate with its 50% condensation temperature, and the findings may be extended to a wide range of processes in terrestrial and planetary environments.

[1] Edmonds et al. (2018), *Nat-Geo 11*(**10**), 790-794; [2] Renggli and Klemme (2020), *JVGR* **400**, 104929; [3] Sossi et al. (2020), *GCA* **288**, 316-340