Elements behavior and zinc isotope fractionation in mafic rocks upon evaporation processes in a redox-controlled atmosphere

PONS MARIE-LAURE[1,2*], PACK ANDREAS[3], KLEINHANNS ILKA C.[1], WENZEL THOMAS[1] AND SCHOENBERG RONNY[1]

[1]Dept. of Geosciences, Universität Tübingen, Germany
[2]CEREGE, Aix Marseille Université, Aix-en-Provence, France (* dr.marie.laure.pons@gmail.com)
[3]Dept. of Isotope Geology, Universität Göttingen, Germany

In this study, we quantified the depletion of major and trace elements of four rock standards (3 basalts and 1 andesite) upon high-temperature evaporation in a controlled atmosphere, at contrasting redox conditions. We also performed Zn isotope measurements on experimentally-obtained evaporation residues. Small silicate spherules (44 samples; ~2mm diameter) were formed by melting rock standard powders by CO_2-laser heating. These spherules were placed in an aerodynamic levitation apparatus under a controlled gas flow [1], in oxidizing (pure O_2) or reducing (H_2+N_2 mix) conditions, and evaporated through laser heating to varying extents (from ~1 to 70% evaporation). A piece of each residual spherule was sampled to perform EPMA imaging and major element analyses and the rest was digested for trace element and isotope measurements. Results show incomplete homogenization of the samples at low evaporation rates and, in reducing conditions, metal droplets indicating segregation of metal from silicate melts. Major element evaporative loss patterns show no difference between oxidizing and reducing experiments. The evaporation rate of trace elements seems to be depending on the SiO_2 content of the melted material, and redox-sensitive trace elements such as Cr or V show slightly different loss patterns depending on the redox state of the controlled atmosphere. The Zn isotopes preliminary results are consistent with a Rayleigh distillation evaporative loss of light Zn isotopes, with $\Delta^{66}Zn_{residue\text{-}initial} = \delta^{66}Zn_{residue} - \delta^{66}Zn_{initial}$ reaching up to 1.5‰ for a loss of 90% of the initial Zn and reflect patterns observed in natural samples that experienced evaporative loss: trinitites, tektites and lunar basalts [2-5]. Our results will be extremely useful to calibrate isotopic fractionation in such samples and help us decipher its extend during evaporation processes.

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