

Experimental in-situ monitoring of metal vaporisation from molten enstatite chondrite

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Evaporation and condensation can cause chemical fractionation in planetary processes, such as volatile element depletion and refractory element concentration. Therefore, interpreting observed element abundance patterns in planetary objects necessitates robust tools to distinguish solar nebula condensation, post-nebular volatilization produced by collisions and heating, and element fractionation in the core [1]. Experimental investigations of these processes are thus needed but are complicated by the fact that, in kinetic evaporation experiments, element depletion is only investigated in terms of mass balance, in which the composition of the starting material is compared to that of the refractory residue [2]. However, in such approaches, the gaseous phase is lost. Here, we present a novel method that enables to analyse the emitted vapour in real time, as the sample is heated. This method can be applied on a wide array of systems, from solar nebula to volcanic fumaroles.

The device consists of a high temperature furnace coupled to a quadrupole ICP-MS. Experiments were conducted on two enstatite chondrites (EL6 Hvittis and EH3 Sahara 97158). Sample powders were placed in a graphite crucible in the hot spot of the furnace and were step heated up to 1500°C. All experiments were performed under highly reducing conditions. Upon heating, the vaporised elements were continuously extracted, simulating near-fractional degassing, and were brought to the ICP-MS plasma torch in an argon flux. With our method, almost all elements from the periodic table can be analysed.

After the experiments, recovered sample contained quenched glass, enstatite, metal and Fe- and Ca-sulphides. Refractory element emission was monitored and fractionation amongst the lanthanides and the actinides was observed. Combining in-situ vapour monitoring and post-experiment phase identification and analysis allows to identify the carrier phases for the volatilised elements.

[1] Siebert et al., (2018) EPSL 485:130-139; [2] Sossi and Fegley (2018) Rev Mineral Geochem 84(1):393-459.