Goldschmidt 2023 Abstract
https://doi.org/10.7185/gold2023.16521

Development of high-precision Sm isotope analyses by TIMS

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Samarium is a particularly useful rare-earth element (REE) for geochemical and cosmochemical applications but is often overlooked in favour of its prominent neighbour Nd. It is mostly known for its decay to Nd within the long-lived ^{147}Sm-^{143}Nd and the short-lived ^{146}Sm-^{142}Nd systems. Studies of these systems allows characterisation of silicate differentiation events and their timescales on Earth and other planetary bodies [e.g. 1]. Overall, Sm isotope compositions provide a wealth of information for cosmochemistry and beyond. The unique nucleosynthetic makeup of Sm enables investigations into *s*-, *r*- and *p*-processes. The heterogeneous distribution of such nucleosynthetically anomalous materials in the Solar System provides constraints on dynamics in the protoplanetary disk. Samarium is also a sensitive neutron capture dosimeter for cosmic ray exposure of silicate-rich meteorites [e.g. 2]. In addition, Sm is used in the nuclear industry in control rods and to monitor materials' provenance [e.g. 3].

We devised a new separation technique aimed at Sm isotope analyses using thermal ionisation mass spectrometry (TIMS). We evaluated mass spectrometric measurement techniques to increase the analytical precision. Large sample masses (≤ 1.5 g) are required for precise measurements due to the low concentration of Sm in meteorites to study nucleosynthetic anomalies. Therefore, we adapted previous protocols to isolate REE and other elements to maximise the recovery on these precious samples. Mass-independent fractionation during column chromatography was investigated and results show that high yields are necessary to avoid analytical artefacts. We also explored a range of parameters for thermal ionisation mass spectrometry (TIMS). We tested different filaments and deposition techniques that provided variable ionisation yields. Relative gains and cup efficiencies can significantly affect ultra-high precision isotope analyses but can be minimised using dynamic methods [4]. We developed static, multi-static and dynamic methods of analysis to compare their relative benefits and drawbacks and obtain the most precise and accurate measurements. Results will be presented at the conference.

[1] Frossard et al., 2022. Science 377, 1529-1532.

[2] Hidaka et al., 2000. Meteoritics and Planetary Science 35, 581-589.

[3] Shollenberger et al., 2021. Talanta 221, 121431.

[4] Garçon et al., 2018. Chemical Geology 476, 493-514.