Absolute isotopic composition of molybdenum reference materials using double spike MC-ICP-MS

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Molybdenum isotope abundance measurements have enabled unique insights into the study of oxic conditions in the oceans [1], high-temperature hydrothermal ore deposits [2], and the heterogeneity of molybdenum in the early solar system [3]. Useful interpretations are only possible when isotopic compositions are reported relative to commonly available reference materials. Chemical processing of samples can alter isotopic composition, so it is important to test methods on matrices of known molybdenum isotopic composition and concentration.

At present, researchers are using a variety of commercially available and in-house standards. Recently, Wen *et al*. measured the relative isotopic composition of five reference solutions and proposed using NIST SRM 3134 as the delta zero reference for molybdenum [4]. However, the absolute isotopic compositions of these standards were not reported and none of the chosen materials were in a natural matrix.

In this study, we have determined the absolute isotopic composition of molybdenum in a variety of reference materials including NIST SRM 3134, BCR-1, BCR-2 (basalt), USGS SCo-1 (shale), SRM 1547 (peach leaves), Johnson-Matthey pure Mo metal rod, and SCP Science Mo PlasmaCal. Measurements were made using a Thermo Scientific Neptune MC-ICP-MS. Instrumental fractionation was corrected by measuring a mixture of the sample with a fully calibrated double spike. The fractionation correction assumed an exponential fractionation law and used computational root finding methods to solve for the fractionation due to chemical processing and instrumental mass bias.

[1] Barling *et al*. (2001) *EPSL* **193**, 447–457. [2] Mathur *et al*. (2010) *Miner Deposita* **45**, 43–50. [3] Dauphas *et al*. (2002) *ApJ*. **565**, 640–644. [4] Wen *et al*. (2010) *J. Anal. At. Spectrom*. **25**, 716–721.

Chemical and isotopic composition of Cenozoic hornblende-bearing basalts from the Rhön area (Germany)

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Primitive, alkaline mafic volcanic rocks provide important information about the chemical composition of the Earth's mantle. The source of intra-continental volcanic rocks are either the subcontinental lithospheric mantle, the asthenospheric upper mantle or upwelling mantle material (mantle plumes). In contrast to the asthenosphere, the lithospheric part of the mantle has been isolated from the convecting part and may have had a complex geological history of ancient depletion and enrichment events.

Unusual hornblende-bearing basanites from the Rhön area (Central European Volcanic Province; CEVP) are mostly primitive to differentiated volcanic rocks (Mg#: 65-45, Ni: 190-60 ppm, Cr: 400-100 ppm) with higher TiO_2, lower MgO contents and slightly lower Ce/Pb ratios (15-20) at a given SiO_2 content relative to other alkaline rocks from the CEVP. Rare Earth element patterns show LREE enrichment but only moderate depletion in HREE relative to primitive mantle. Rare earth element patterns can be reproduced by about 4 to 8 % partial melting of a spinel peridotite containing 10 % of modal amphibole. In multi-element diagrams, the basanites are enriched in Nb, but depleted in Rb and K relative to the neighboring elements, compatible with partial melting with residual amphibole.

Incompatible trace element abundances and ratios and Nd and Sr isotopes overlap those of other volcanic rocks from the CEVP. Initial $^{87}Sr/^{86}Sr$ ratios range from 0.7034 to 0.7040 at almost constant initial $^{143}Nd/^{144}Nd$ of ca. 0.51279-0.51285 (εNd of +3.3 to +4.6). The Sr and Nd isotope data suggest that contamination of the lavas with the ambient lower crustal rocks is relatively minor (< 5%). The variable Sr at constant Nd isotope compositions could also result from melting heterogeneous sources with variable Rb/Sr ratios as a result of mantle metasomatism. Based on their high TiO_2 but low MgO, elevated $^{87}Sr/^{86}Sr$ ratios and low Ce/Pb ratios relative to other basanites from the CEVP, the hornblende-bearing basanites appear to contain a signifcant proportion of the lithospheric upper mantle.