

## Nucleosynthetic Mo and W isotope anomalies in Murchison leachates

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Nucleosynthetic isotope anomalies at the bulk meteorite scale exist for several elements (e.g., Ti, Mo, Ru) and most likely reflect incomplete mixing of diverse presolar components in the solar nebula [e.g. 1]. These isotope heterogeneities contrast with uniform and terrestrial isotope composition for other elements (e.g., Hf, W, Os [2]). Constraining why planetary-scale nucleosynthetic isotope anomalies exist for some elements but not for others can provide clues to understanding the early evolution of the solar nebula. To address this important issue we obtained Mo and W isotope data for acid leachates of the Murchison chondrite. About 16 g of Murchison was sequentially digested using acids of increasing strengths. Aliquots of these leachates were previously analysed for Os isotopes [3]. Here, in addition, the acid-resistant residue was completely digested after fusion with a laser.

The Mo and W isotope data, obtained by MC-ICP-MS at ETH Zurich, reveal large anomalies that correlate with each other as expected from nucleosynthetic theory [4] and can be accounted for by variable amounts of s-process Mo and W. A regression of <sup>182</sup>Hf-decay corrected W data in  $\epsilon^{182}\text{W}-\epsilon^{186}\text{W}$  space yields an initial  $\epsilon^{182}\text{W}$  consistent with the solar system initial value [5]. The Mo and W anomalies do not correlate with Os isotope anomalies reported for the same samples [3], indicating that Mo and W are hosted in different carriers than Os. This can explain why planetary-scale isotope anomalies exist for Mo but not for Os. Furthermore, the well-correlated Mo and W isotope anomalies in the Murchison leachates combined with the observation that planetary-scale isotope anomalies exist for Mo but not for W suggests that Mo and W are hosted in distinct but chemically similar carriers. The different patterns of planetary-scale nucleosynthetic anomalies thus seem to reflect the presence of distinct generations of presolar dust that have been homogenized to different degrees.

[1] Dauphas *et al.* (2002) *Astrophys. J.* **565**, 640-644.  
[2] Yokoyama *et al.* (2007) *EPSL* **259**, 567-580 [3] Reisberg *et al.* (2009) *EPSL* **277**, 334-344. [4] Arlandini *et al.* (1999) *Astrophys. J.* **525**, 886-900. [5] Burkhardt *et al.* (2008) *Geochim. Cosmochim. Acta* **72**, 6177-6197.

## Oxygen fugacity-dependence of zircon-melt trace element partitioning

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A common feature of terrestrial igneous zircons is a marked excess of Ce over La and Pr, and a deficit of Eu relative to Sm and Gd. This Ce anomaly is attributed to the presence of Ce<sup>4+</sup>, and this Eu anomaly attributed to the presence of Eu<sup>2+</sup>; all other REE occur exclusively as M<sup>3+</sup>. Therefore, the magnitude of these anomalies may record the oxygen fugacity ( $f\text{O}_2$ ) at which the magma crystallised. It is often unclear, however, whether the Eu anomaly reflects directly the Eu oxidation state ratio of the melt from which the zircon crystallised, or whether the Eu content of the melt was depleted by fractional crystallisation of plagioclase (or other Eu<sup>2+</sup>-bearing minerals) prior to zircon growth. The present study presents the first systematic data on the dependence of zircon-melt REE partitioning on  $f\text{O}_2$ .

Synthetic zircons were grown at 1 atmosphere from a flux-free melt of 'natural' composition, over a range of 14 log units in  $f\text{O}_2$  (IW-4 to QFM+6). The resulting crystals were characterised by cathodoluminescence and analysed by secondary ion mass spectrometry (SIMS) and laser ablation ICP-MS for P, Sc, Ti, Y, REE, Hf, Th and U.

Increasing  $f\text{O}_2$  results in the Ce and Eu anomalies becoming more and less pronounced, respectively. There is a narrow  $f\text{O}_2$  range over which both anomalies were observed; however the two anomalies do not covary in the same manner as natural samples. Therefore, either partitioning depends strongly on temperature and/or melt composition, or most natural samples suffer removal of Eu from the system before zircon saturation. The Ce and Eu data will be combined with direct determinations by XANES (X-ray absorption near edge structure) spectroscopy of the effects of  $f\text{O}_2$ , temperature and melt composition on the redox state ratios of Ce and Eu.

The partitioning of Sc, Y, other REE and Hf is  $f\text{O}_2$ -independent, as expected. The presence of P in the melt does not affect partitioning. Ti partitioning remains constant, indicating that Ti<sup>3+</sup> (likely to represent 10-20% of Ti at the most reduced conditions studied) shows similar partitioning behaviour to Ti<sup>4+</sup>. The U/Th ratio of zircon varies systematically over more than one order of magnitude with  $f\text{O}_2$ .