Tantalum isotope compositions in terrestrial and meteoritic materials

M. PFEIFER[12*], C. MÜNKER[12] AND N. S. LLOYD[3]

[1]Institut für Geologie und Mineralogie, Universität zu Köln, Germany (*correspondence: m.pfeifer@uni-koeln.de)
[2]Steinmann-Institut für Geologie, Mineralogie und Paläontologie, Universität Bonn, Germany
[3]Thermo Fisher Scientific, Bremen, Germany

Tantalum consists of two isotopes (180 and 181 amu) with ^{180}Ta being the rarest stable isotope in the solar system. Interestingly, ^{180}Ta is only stable as an isomer in its excited state. Thus, it hardly survives at harsh stellar conditions, which in turn are needed for its production [1]. The exact nucleosynthetic contributions from both p-process and branching of the s-process pathway are still debated [2]. A comparison of Ta isotope compositions with those of other heavy elements with known nucleosynthetic anomalies (e.g. 3-[5]) can help to solve this issue. Isotope ratio measurements are analytically challenging, because the natural ^{180}Ta/^{181}Ta (ca. 0.00012) is very low. Here we report the first high precision Ta data for terrestrial rocks from diverse settings and for meteorites, also including refractory inclusions.

All geological samples and bulk meteorites are indistinguishable from our terrestrial AMES Ta standard. In contrast, one refractory CAI from the Allende CV3 meteorite displays a resolvable lower ^{180}Ta/^{181}Ta isotope ratio.

The homogeneity of terrestrial materials comprising a range from primitive mantle melts to evolved ore deposits suggests only minor stable Ta isotope fractionation on Earth within our typical analytical uncertainty of ca. 3.5 e-units. Therefore, mass dependent nuclear effects related to melting processes are regarded unlikely for explaining the CAI signature. Nevertheless, evaporation in the high-temperature environment of CAI formation cannot completely be ruled out, even for refractory elements. Alternatively, metastable ^{180}Ta may have been de-excited by γ-ray flux from the young sun. However, such effects have not been observed for other nuclides in meteorites. We therefore prefer a nucleosynthetic origin for the Ta isotope anomaly in the CAI, supporting the view of a compositionally heterogeneous solar nebula at the time of CAI formation. The inherited Ta isotopic signature is assumed to stem from presolar material that most likely had either an r-process excess or a p-process deficit.

[1] Mohr *et al.* (2007) *Phys. Rev. C* **75** (**1**), 012802(R). [2] Travaglio *et al.* (2011) *ApJ* **793** (**2**), 93. [3] Qin *et al.* (2011) *Geochim. Cosmochim. Acta* **75**, 7806-7828. [4] Burkhardt *et al.* (2012) *ApJ* **753**, L6. [5] Elfers *et al.* (2015) *Min.Mag,* this volume