European Mineralogical Conference
Vol. 1, EMC2012-724, 2012
European Mineralogical Conference 2012

Distribution of heavy p-process isotopes in extraterrestrial materials: Reconciling uniform ^{174}Hf with ^{180}W heterogeneities

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Iron meteorites carry excesses of p-process ^{180}W with respect to terrestrial materials, which correlate with the accretion ages of the parent bodies (Schulz et al., 2010, 2011). The favoured explanation for these excesses is nucleosynthetic heterogeneity in the early solar system, in which case also other heavy p-process isotopes are expected to show anomalies in extraterrestrial materials. We therefore investigated the relative abundance of ^{174}Hf, the first lighter stable p-process nuclide next to ^{180}W, in silicate materials of different ages and from different regions within the inner solar system. All samples were measured with high-precision MC-ICPMS in setup with standard sample and X-skimmer cone, typically consuming ~60 ng Hf at precisions of ±70 ppm (2σ). In order to successfully correct for interference by isobaric ^{174}Yb, we optimised the existing hafnium purification protocol by Münker et al. (2001). Mass bias corrections were made based on different hafnium isotope ratios in order to monitor unlikely s- and r-process heterogeneities and deviations caused by secondary neutron capture reactions. It is found that relative abundances of ^{174}Hf, as well as of other non-radiogenic hafnium isotopes, for enstatite chondrites, H and L ordinary chondrites, one CV chondrite, eucrites, and one lodranite sample are indistinguishable from terrestrial materials. A silicate inclusion of the El Taco IAB iron meteorite and one EL6 chondrite (Pillistfer) exhibit higher ^{174}Hf/^{177}Hf ratios, namely 190 ±72 ppm and 210 ±75 ppm respectively. These ratios correlate with higher ^{178}Hf/^{177}Hf ratios (18±5 and 21±5 ppm, respectively) and are therefore likely to reflect secondary neutron capture on ^{177}Hf that is related to the high iron content of these particular materials (Sprung et al., 2010). Together, the presented sample suite indicates a uniform distribution of ^{174}Hf in the solar system. Two possible scenarios can reconcile this conclusion with a nucleosynthetic origin of ^{180}W excesses, namely (1) the original carrier phases of ^{174}Hf and ^{180}W were different; or (2) existing ^{174}Hf heterogeneities were homogenised by the time of parent body formation of the analysed silicates. An alternative explanation would be that ^{180}W excesses are not of nucleosynthetic origin and result from a different process that did not affect ^{174}Hf abundances. A possible process is secondary neutron capture, but we did not identify plausible pathways for the production of ^{180}W. We therefore prefer the two scenarios of nucleosynthetic origin of the anomalies, and aim distinguishing between them by determination of ^{174}Hf in older sample materials than those analysed so far.