

Evaluation of Osmium Nucleosynthetic Anomalies and Cosmic Ray Exposure in Bulk Meteorites

KIRAN S. ALMAS AND RICHARD J. WALKER

University of Maryland

Evidence of nucleosynthetic anomalies has been recorded for extraterrestrial materials in numerous elements. These anomalies can serve as genetic markers that distinguish between inner and outer Solar System materials, designated as non-carbonaceous chondrite (NC) and carbonaceous chondrite (CC) type, respectively, and may be caused by heterogeneous mixing or processing of presolar componentry from diverse sources early in Solar System history. By contrast, studies of the siderophile element Os have revealed no anomalies in bulk meteorites, except for in ureilites, indicating homogeneous incorporation in the bulk composition of most planetesimals across the Solar System. Despite evidence for isotopic homogeneity among bulk planetesimals, large internal isotopic variations within low metamorphic grade chondrites are well-documented.

Given the lack of resolved nucleosynthetic anomalies, Os isotopic variations have been leveraged to monitor the effects of cosmic ray exposure (CRE) on isotopes of other siderophile elements, including the radiogenic isotope ^{182}W , which is used for dating metal-silicate segregation events. This practice relies on the assumption that no nucleosynthetic anomalies are present in Os isotopes; this assumption is revisited in this study by applying a multistatic N-TIMS method that allows for highly precise measurement of key Os ratios. Among the samples analyzed are CC and NC iron meteorites with low presumed CRE histories, an ordinary chondrite, a carbonaceous chondrite, and a terrestrial Os-Ir-Ru alloy.

Data for 2 NC-type iron meteorites show no resolved anomalies. By contrast, a modest yet resolved excess in $\mu^{189}\text{Os}$ is reported, with an average of +7 ppm for 7 CC-type iron meteorites. This finding is symptomatic of an *s*-process deficit/*r*-process excess and is consistent with a small nucleosynthetic effect in meteorites from the outer Solar System. An excess of up to +20 ppm in $\mu^{190}\text{Os}$ is also observed. Correlations between $\mu^{189}\text{Os}$ and $\mu^{190}\text{Os}$ deviate from predicted *s*- and *r*-process mixing lines, with most meteorites plotting on a line with a steeper slope. The finding of nucleosynthetic anomalies in Os isotopes affects how CRE corrections are made for CC-type meteorites. When accounting for these anomalies, revised ^{182}W ages are up to 1 Myr younger for some CC-type iron meteorites than previously interpreted.