Nucleosynthetic Isotope Anomalies in Palladium from IAB, IVA and IVB iron meteorites

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Introduction

Nucleosynthetic anomalies have been reported in Mo and Ru from bulk chondrites, achondrites and irons [1]. The origin of these anomalies may represent spatial and/or temporal heterogeneity in the sources that supplied material to the nascent solar nebula, and/or may have been enhanced by chemical processing within the solar nebula. Like Mo and Ru, Pd is a siderophile element but, in contrast to the refractory siderophile elements studied for isotopic anomalies (Mo, Ru), Pd is not refractory during nebular processing. Here, we present new precise Pd isotope ratio measurements of IAB, IVA and IVB iron meteorites to better understand the physical and chemical processes that created planetesimals from correlated nucleosynthetic isotope anomalies preserved in these bodies.

Experimental

All Pd isotopic compositions were analyzed on the Thermo Neptune™ MC-ICP-MS (NHMFL) in 100 ng/mL aliquots in 2% HCl. The IVB iron meteorites were measured with an ESI SIS™ or APEX™ sample introduction system in low resolution and static mode. Later measurements of the IAB and IVA during a separate session were made with a CETAC Aridus™ sample introduction system in medium resolution in static mode. The measurements were made with Thermo SuperJet8.2 Ni and Spectron T1001 Ni-X skimmer cones. All Pd isotope ratios were normalized to ^{108}Pd/^{105}Pd 1.18899 using the exponential law for mass bias correction. All data are given in epsilon notation (ε) as deviations from the terrestrial Pd isotope composition. Possible minor isobaric interferences from Ru (^{101}Ru) and Cd (^{111}Cd) were simultaneously monitored on the MC-ICP-MS.

Results and Discussion

The 3 IAB iron meteorites exhibit uniform values for ε^{104}Pd, ε^{106}Pd, and ε^{110}Pd of -0.1, 0.0, and +0.1 ε, respectively, but are not resolved from the terrestrial standard by more than $2\sigma_{mean}$. The new IVB iron meteorites show a uniform ε^{110}Pd anomaly around +0.5 ε. In Gibeon (IVA), a positive ε^{110}Pd anomaly of +0.3 and a negative ε^{104}Pd anomaly of -0.2 ε is resolved from the terrestrial standard. The correlated nucleosynthetic effect in Pd (Fig. 1) is about half the magnitude of that predicted from Ru and Mo. This discrepancy is most likely due to a different host of the Pd anomalies than of Ru and Mo anomalies. The correlation between Pd and Mo isotope anomalies shows that processing of presolar mineral carriers in the solar nebula played an important role in preserving nucleosynthetic anomalies, the details of which remain to be worked out. In this, Pd isotopes have proven an important new tool.

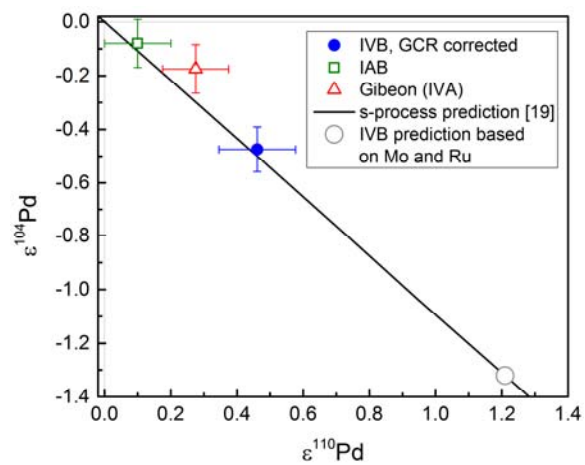

Fig.1 Nucleosynthetic anomalies in Pd in three iron meteorite groups. Black solid line depicts the relationship an s-process deficit would have on ε^{104}Pd and ε^{110}Pd.

Conclusions

The correlation between Pd and Ru/Mo isotope anomalies shows that processing of presolar mineral carriers in the solar nebula played an important role in preserving nucleosynthetic anomalies, the details of which remain to be worked out. In this, Pd isotopes have proven an important new tool.

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References

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