THE Zr-Mo-Ru-Pd CORRELATION: EVIDENCE FOR INCOMPLETE CONDENSATION AROUND AGB STARS AND SELECTIVE PROCESSING OF STARDUST IN THE SOLAR NEBULA. M. Ek[1*], A. C. Hunt[1] and M. Schönbächler[1], [1]Institute for Geochemistry and Petrology, ETH Zürich, Clausiusstrasse 25, 8092 Zürich, Switzerland. *Mattias.ek@erdw.ethz.ch

Introduction: Correlated nucleosynthetic variations in Mo and Ru isotopes are reported for most major meteorite groups [1-4]. This correlation was recently extended to include Zr isotopes [5]. Nucleosynthetic isotope variations in meteorites are generally interpreted to arise from selective dust processing of *s*-, *r*- and *p*-process components in the early solar nebula by e.g. grain sorting [6-7] or thermal processing [5,8]. It has been shown that the Zr-Mo-Ru correlation can be explained by distinct depletions of *s*-process materials in the respective meteorite parent bodies relative to the Earth [1-5].

Palladium, like Mo and Ru, is a siderophile element, however, Pd is less refractory (Tc = 1324 K com-pared to 1551-1590 K for Mo and Ru [9]). It has six isotopes and includes one p-process isotope, the low abundance isotope 102Pd, rendering Pd suitable for nu-cleosynthetic investigations.

A recent study of the Pd isotope compositions of IVB iron meteorites reported that the nucleosynthetic offsets in Pd isotopes were smaller than those predicted by admixture of a pure s-process component that matches the nucleosynthetic Mo and Ru isotope variations [10]. These authors attributed the smaller offsets in Pd, compared to Mo and Ru, to the selective destruction of the Pd carrier phase by thermal processing in the solar nebula.

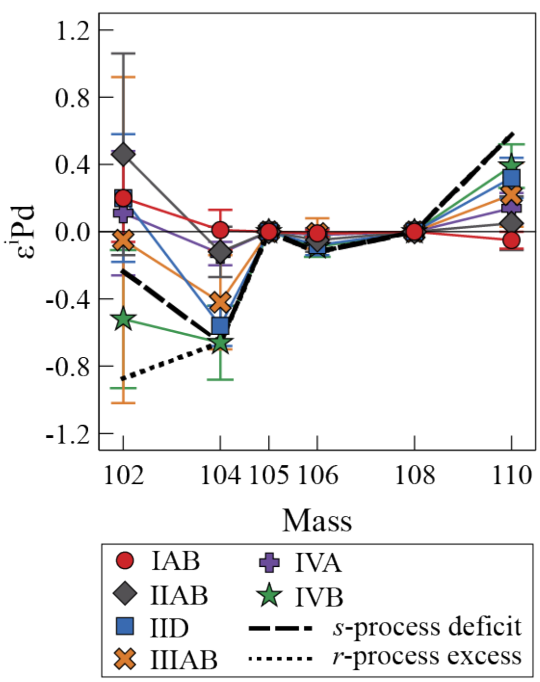

Figure 1. The Pd isotope composition of the IAB, IIAB, IID, IIAB, IVA and IVB iron meteorite groups after correction for cosmic ray effects. The *s*-process deficit/*r*-process excess lines were calculated using [17].

Here, we extend the Pd isotope data set to IAB, IIAB, IID, IIIAB, IVA, and IVB iron meteorites, correct these data for cosmic ray exposure (CRE) using Pt isotopes and compare the Pd results to those reported for Mo and Ru isotopes of the same meteorite groups. This allows us to test whether the Zr-Mo-Ru correlation extends to Pd isotopes and provides valuable insight into the origin of nucleosynthetic variations in our so-lar system.

The analytical procedure follows that described in [11-12]. A short summary is given in the following. After digestion, Pd and Pt were separated from the same sample aliquot by means of an anion exchange column [12]. The Pd fraction was further purified using a second anion exchange column with HF [11]. The Pd isotope compositions were analyzed on a Thermo Fisher Neptune *Plus* multi-collector ICP-MS at ETH Zürich. All data are internally normalized to $^{108}Pd/^{105}Pd$ = 1.18899 [13] and expressed in epsilon notation relative to the NIST SRM 3138 Pd standard.

Results: The mass-independent Pd isotope data for 24 iron meteorites from the IAB, IIAB, IID, IIIAB, IVA and IVB iron meteorite groups reveal a wide range of isotopic compositions. Palladium isotope variations within single groups correlate well with those in Pt isotopes [12,14-15]. Furthermore, the within-group Pd and Pt isotope variations are in good agreement with CRE effects predicted by the model of [16]. This suggests that within-group variations are due to CRE. After CRE correction the nucleosynthetic isotope composition of each group was determined (Fig. 1). The largest nucleosynthetic deviations in Pd isotopes were identified for IVB meteorites, while the IAB and IIAB groups are not resolvable from the terrestrial composition.

Discussion: The nucleosynthetic Pd isotope data are consistent with an *s*-process deficit (Fig. 1) in agreement with the conclusions from neighboring elements, i.e. Zr, Mo and Ru [1-2,5]. The nucleosynthetic Pd data define a linear correlation with those reported for Mo and Ru from the same iron meteorite group (Fig. 2). However, the slope of the correlation is ~1/4th of that predicted by a pure *s*-process deficit calculated from solar Mo, Ru and Pd abundances. This is in agreement with the results of [10], which were based on IVB irons only. While Mayer and co-workers attributed this effect to thermal processing of dust in the solar system, we propose that the reduced slope of the (Mo-Ru)-Pd correlation reflects incomplete condensation of the more volatile Pd, relative to the refractory Mo and Ru, around asymptotic giant branch (AGB) stars, the site of *s*-process nucleosynthesis. Moreover, only a small fraction of the synthesized mass around AGB stars condenses within the envelope of the star itself. The majority of the mass is returned to the interstellar medium (ISM) in the gas phase [18]. This material returned to the ISM in the gas phase is thoroughly mixed with material from other nucleosynthetic sources and is thus incorporated into solids in the ISM without preserving a distinct *s*-process signature [19].

Only dust that condensed within stellar envelopes and escaped destruction in the interstellar medium could retain distinct nucleosynthetic compositions (called here stardust). The majority of this stardust in the solar nebula originated from AGB stars with only minor contributions from supernovae environments [19]. Selective processing (dust sorting or thermal destruction) of the isotopically homogenized ISM grown dust relative to this stardust can explain the *s*-process deficits observed for Zr, Mo, Ru and Pd and the resulting correlation.

Conclusions: Our preferred interpretation of the reduced slope of the (Mo-Ru)-Pd correlation is the incomplete incorporation of Pd into dust condensing around AGB stars because of its lower condensation temperature. The Zr-Mo-Ru-Pd correlation itself and the distinct isotopic composition of planetary materials is likely established within the protoplanetary disk due to selective processing of presolar dust.

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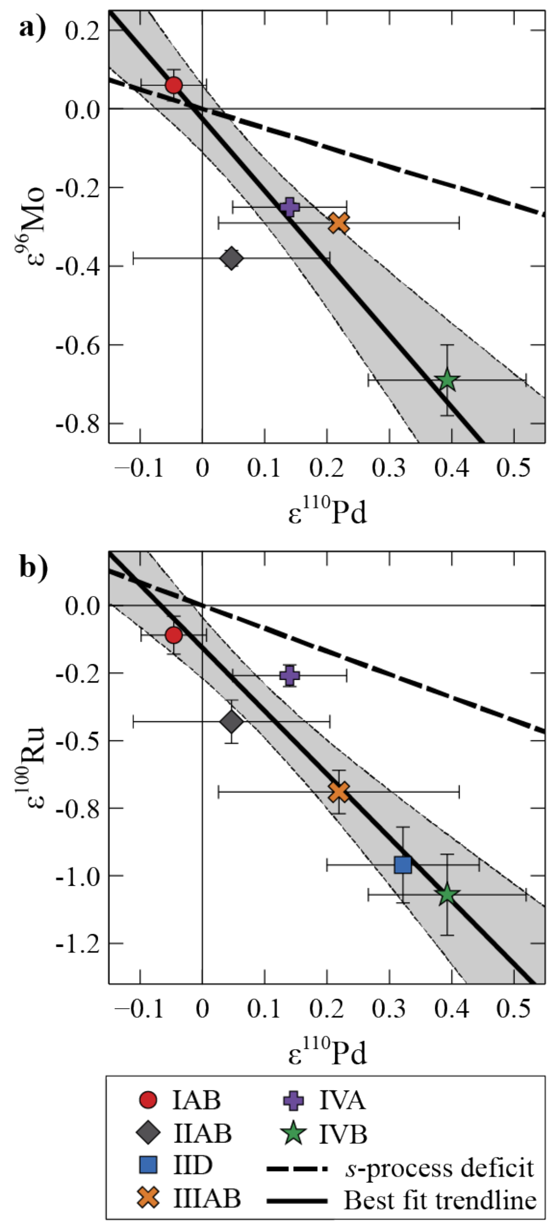

Figure 2. The CRE corrected ε^{110}Pd compositions for the IAB, IIAB, IID, IIIAB, IVA, and IVB iron meteorite groups versus a) ε^{96}Mo and b) ε^{100}Ru. The *s*-process model curve is calculated using [17] assuming solar abundances of Mo, Ru and Pd. ε^{96}Mo data are from [3], ε^{100}Ru from [2,20].