Nucleosynthetic Osmium Isotope Anomalies in Enstatite and Rumuruti Chondrites. D. van Acken[1,2], A.D. Brandon[1] and M. Humayun[3], [1]University of Houston, Dept. of Earth and Atmospheric Sciences, Houston, TX 77204 (dvanacken@uh.edu, abrandon@uh.edu) [2]NASA-JSC, 2101 NASA Parkway, MS KR, Houston, TX 77058, USA, [3]National High Magnetic Field Laboratory and Dept. of Earth, Ocean and Atmospheric Science, Florida State University, Tallahassee, FL 32310, USA (humayun@magnet.fsu.edu).

Introduction: Past studies revealed deficits of s-process generated Os nuclides in bulk analyses of low grade ordinary and carbonaceous chondrites [1-3]. Negative isotopic anomalies in ^{186}Os, ^{188}Os, and ^{190}Os were ascribed to the presence of digestion-resistant presolar grains, most likely SiC [1-3].

Enstatite and Rumuruti chondrites are the most reduced and oxidized chondrites, respectively, and may thus represent opposite boundaries of the chondrite formation region within the solar nebula with respect to presolar grain survival. The presence of s-process anomalies in enstatite and Rumuruti chondrites could thus help to further constrain nebular heterogeneity, presolar grain distribution, and mixing efficiency in the solar nebula. In this abstract, the first high-precision Os measurements of low-grade enstatite and Rumuruti chondrites are presented.

Methods: After digestion in borosilicate glass Carius tubes and standard Os extraction procedure with HBr/CCl_4, samples were loaded onto single Pt filamantes and measured in multidynamic mode on a ThermoFinnigan Triton. Concentrations of Os and Pt, necessary to correct for radiogenic ingrowth of ^{186}Os by decay of ^{190}Pt, were determined on a different aliquot from the same homogenized sample. Osmium was measured in static mode on a ThermoFinnigan Triton at JSC, Pt was measured on a Varian 810 quadrupole ICP-MS at the University of Houston.

Results: Several low-grade enstatite chondrites show deficits in s-process isotopes, most evident in ^{186}Os (Fig. 1,2). Negative isotopic anomalies of up to 170 ppm have been observed in EH4 Indarch, EH3 MET 01018, EH3 GRO 95517, EL3 PCA 91020, and EL3 MAC 88136. Other low-grade enstatite chondrites as well as all EL6 chondrites from this study show isotopic composition identical within error to the solar average as defined by the average of ordinary chondrites [1].

Rumuruti chondrites show both deficits (EET 96026, PRE 95410) and enrichments (PCA 91002, PRE 95411) in s-process isotopes. Two other enstatite meteorites, the ungrouped enstatite chondrite QUE 94204 and the aubrite Shallowater, have solar composition.

Discussion: Deficits in s-processes in some low-grade enstatite chondrites are similar as those seen in ordinary and carbonaceous chondrites [1-4]. While there are few prior results, mostly EL6 chondrites, to compare the data from this study to, there is good agreement between measurements reported here and previous analyses of EL6 Yilmia and EL6 Daniel's Kuil [1,2] (Fig. 2). While there is some discrepancy for EH4 Indarch between this study and [1] and [3], the overall tendency of a negative ^{186}Os anomaly can be reproduced.

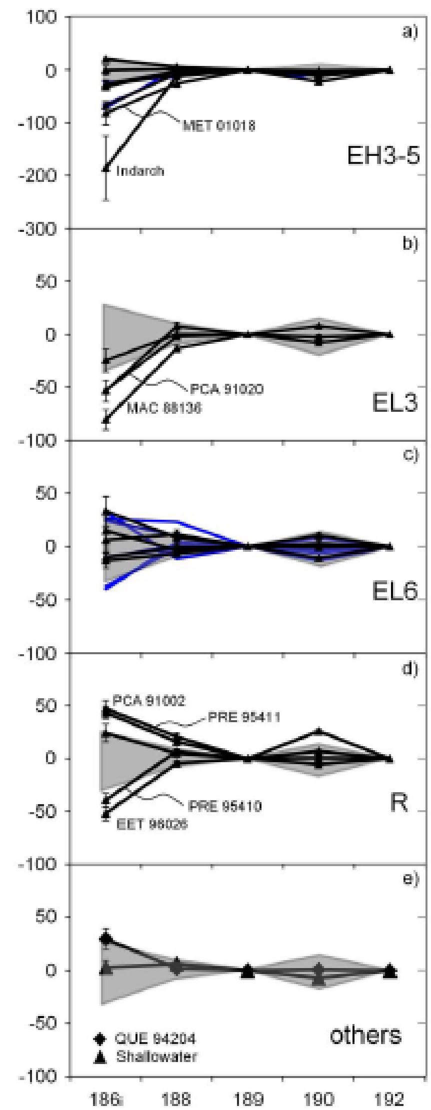

Figure 1: normalized high precision Os isotopic compositions assorted by groups. Error bars are the 2 sd for the individual measurements, grey shaded area represents 2 sd of the standard, blue: samples from [1-3]

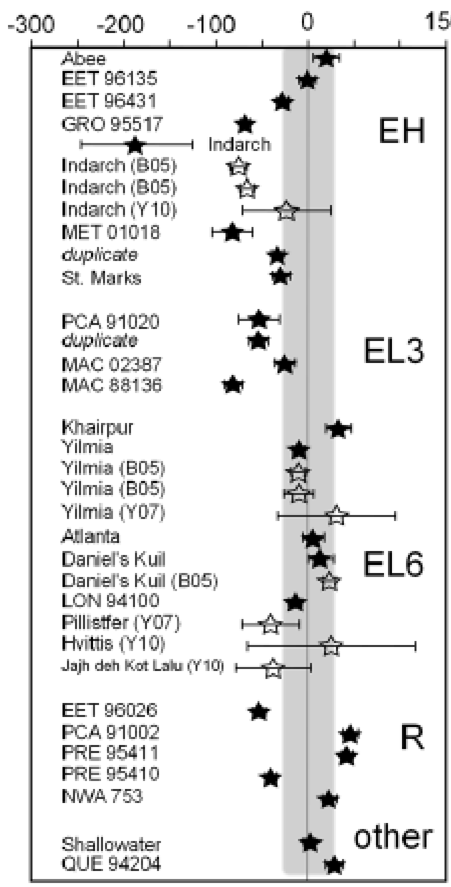

Figure 2: overview of μ_{186i} arranged according to increasing metamorphic grade with lowest grade at the top of each chondrite type. Grey bar: 2 sd external precision as determined by standard measurements centered around bulk solar values of $\mu_{186i} = 0$ as defined by the average of ordinary chondrites [1], individual error bars for each sample represent 2 sd internal precision. Open symbols: data from [1-3].

The present results strengthen the view that observed isotopic anomalies result from non-digestion of acid-resistant presolar grains, most likely SiC [1-4]. The presence of such a phase in meteorites from all chondrite groups studied so far suggests homogeneous distribution throughout the entire formation region of chondrites. In this case, the absence of anomalies, as observed in all chondrites of grade 5 or 6, and some grade 3 and 4 chondrites, reflects thermal or metamorphic destruction of presolar grains as the s-process carrier, and hence availability of the isotopically anomalous Os in digestible phases. The irregular distribution of isotopic anomalies within grade 3 meteorites suggests that some of these samples have experienced conditions favoring breakdown of presolar grains, while others retained their original presolar grain budget. Additionally, some R chondrites show excess s-process Os, which may hint at heterogeneous distribution of s-process Os towards the boundaries of the chondrite formation region.

Modeling shows that deficits in s-process isotopes as expressed by negative anomalies in ^{186}Os, ^{188}Os, and ^{190}Os can be balanced to solar values of 0 by addition of a few ppm of a highly s-process enriched component with an Os signature as generated in AGB stars [5] and an Os concentration of about 750 ppb. This is in agreement with observed abundances of SiC in enstatite chondrites [6] and in reasonable agreement with the scarce measurements of trace elements in SiC single grains, using Ru as a proxy and assuming chondritic Os/Ru [7].

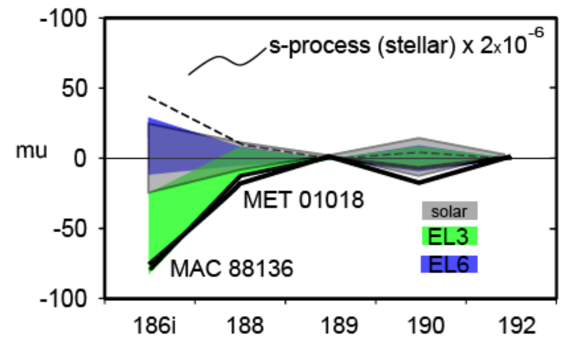

Figure 3: normalized high precision Os isotopic compositions for s-process component deficient EL3 MAC 88136 and EH3 MET 01018 in comparison with solar values (grey,[1]), EL3 (green) and EL6 (blue) samples (μ values). Also shown is the complementary pure s-process composition according to the stellar model by Arlandini et al. [5]

In summary, the presence of up to 5 ppm of SiC as an acid-resistant carrier phase for s-process enriched Os is sufficient to explain apparent s-process deficits deduced from Os isotopic anomalies of low-grade chondrites. The fact that these anomalies persist throughout all chondrite groups, and thus over a wide region of formation in the solar nebula between 1 and 3 AU [8,9], suggest homogeneous distribution of s-process enriched presolar grains across the chondrite formation region.

References: [1] Brandon A.D. et al. (2005) *Science*, *309*, 1233-1236. [2] Yokoyama T. et al. (2007) *EPSL*, *259*, 567-580. [3] Yokoyama T. et al. (2010) *EPSL*, *291*, 48-59. [4] Reisberg L. et al. (2009) *EPSL*, *277*, 334-344. [5] Arlandini C. et al. (1999), *ApJ*, *525*, 886-900. [6] Huss G.R. and Lewis R.S. (1995), *GCA*, *59*, 115-160. [7] Kashiv Y. et al. (2001), *LPS XXXII*, Abstract #2192. [8] Shukolyukov A. and Lugmair G.W. (2004), *GCA*, *68*, 2875-2888. [9] Alexander C. O'D. et al. (2001), *Science*, *293*, 64-68.