NEW INSIGHTS TO THE GENETICS, AGE, AND CRYSTALLIZATION OF GROUP IIC IRON METEORITES. H. Tornabene, C.D. Hilton, R.D. Ash, and R.J. Walker; Department of Geology, University of Maryland, College Park, Maryland, 20742, USA (hopet@umd.edu)

Introduction: The IIC "magmatic" iron meteorite group ostensibly consists of eight members. Early study of the group characterized it as having moderate Ni and volatile siderophile element abundances, compared with other magmatic irons [1]. Recent studies of genetic isotopes, based on nucleosynthetic variations for certain elements (e.g., Mo, W), have shown that the group is enriched in ^{94}Mo, ^{95}Mo, and ^{97}Mo consistent with the group being of the carbonaceous chondrite (CC) genetic type [2]. Further, those IIC irons that have been examined are characterized by larger positive ^{183}W nucleosynthetic anomalies than other CC group irons, and the IIC meteorite Wiley has been reported to have an even larger positive ^{183}W anomaly [3] than the other IIC meteorites. Collectively, the previously reported siderophile element abundances and the complexities in genetic isotope compositions make this group worthy of additional study.

Samples: The IIC group consists of: Ballinoo, Cratheús (1950), Darinskoe, Kumerina, Perryville, Salt River, Unter Mässing and Wiley. Samples of Ballinoo (USNM 3284), Kumerina (USNM 5711), Perryville (USNM 428), Salt River (USNM 1131), and Wiley (USNM 1328) were obtained from the Smithsonian Institution, National Museum of Natural History, USA. Unter Mässing (MPK 3074A) was obtained from the Senckenberg Forschungsinstitut und Naturmuseum, Germany, and Cratheús (1950) was obtained from the Museu Nacional/UFRJ, Brazil. Darinskoe was obtained from Geological Museum of the Geological and Geophysical Institue of the Siberian Branch, Russia.

Methods: Siderophile element concentrations were obtained by laser-ablation using a *New Wave* UP213 ultraviolet laser coupled to a *Thermo Finnigan Element 2* inductively coupled plasma mass spectrometer at the University of Maryland. High precision highly siderophile element (HSE; Re, Os, Ir, Ru, Pt, Pd) data were also obtained by isotope dilution coupled with standard separation and mass spectrometric techniques [e.g., 4]. For this study, Mo, Os, Ru and W isotopic data were determined using thermal ionization mass spectrometry.

Results: A CI normalized plot of HSE (**Fig. 1**) reveals that most IIC irons are characterized by relatively flat, similarly shaped patterns. The greatest variations in concentrations are found for Re and Os. Limited variations in Re/Os are reflected in ^{187}Os/^{188}Os ratios ranging only from 0.12380 (Darinskoe) to 0.13388 (Unter Mässing). There is little crossing of patterns for most of the group, consistent with these meteorites being related by modest crystal-liquid fractionation from the same melt. The exception to this is the pattern for Wiley. For reasons discussed below, we conclude Wiley is not a group IIC iron meteorite.

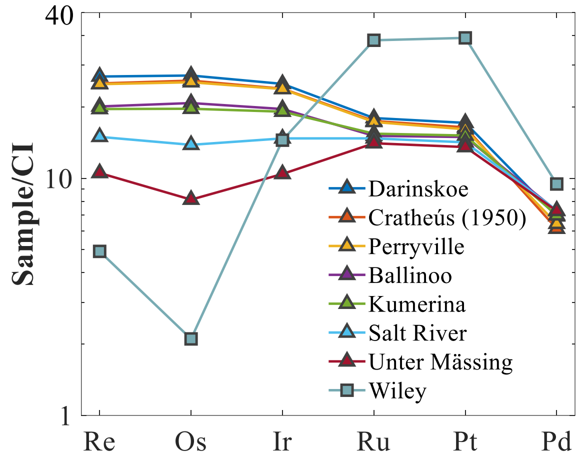

Figure 1. CI normalized HSE data for IIC irons obtained by isotope dilution. Note that the pattern for Wiley differ substantially from the remaining IIC irons.

A Re-Os isochron for the IIC group defines an age of 4538 ± 140 Ma (**Fig. 2**). This age is similar to the Re-Os ages of other iron meteorite groups [4, 5]. The only IIC iron that plots resolvedly off the isochron is Darinskoe, of which both aliquots of the meteorite plot slightly below the isochron. The Darinskoe data likely reflect minor open-system behavior of Re-Os.

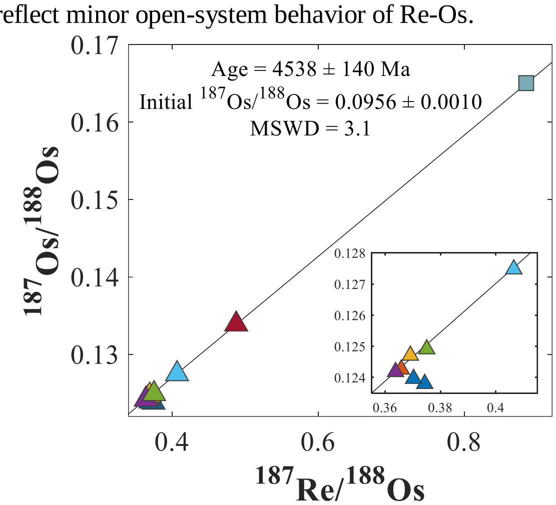

Figure 2. ^{187}Re/^{188}Os vs. ^{187}Os/^{188}Os isochron plot for IIC iron meteorites. Symbols are the same as in Fig. 1. The inset shows the cluster at the bottom of the figure.

As recognized by [2], the IIC irons have the most anomalous Mo and Ru isotopic composition of any iron meteorite group previously reported. The IIC irons and Wiley have Ru mass independent "genetic" isotopic compositions that are broadly similar to other irons with CC type genetic affinities. All of the IIC irons analyzed for μ^{100}Ru (Ballinoo, Darinskoe and Perryville) are characterized by the same negative value of approximately -110, and consistent with CC type irons reported by [6] (**Fig. 3**). The IIC iron represented in this study by Perryville has the greatest enrichment of ^{97}Mo and plots resolvedly off the cosmic correlation for non-carbonaceous (NC) and CC groups [6], as does Wiley.

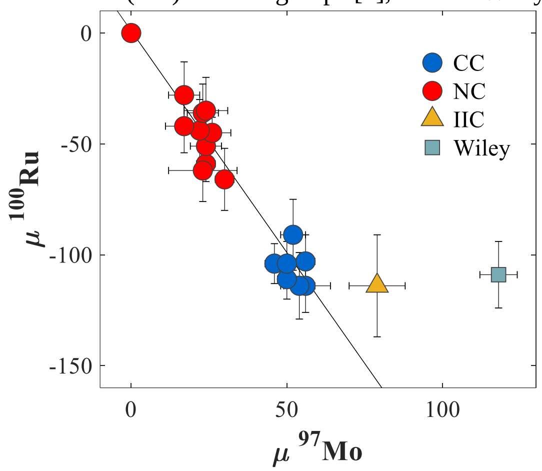

Figure 3. μ^{97}Mo vs. μ^{100}Ru for IIC irons, Wiley and NC and CC groups from [6,7] for comparison.

Discussion: Wiley has similar Ir, Ga, Ge and Ni to the other IIC irons [1]. This explains why it was classified as a IIC iron. However, the HSE pattern for Wiley strongly diverges from the other IIC irons, except for Ir and Pd. Although its Re and Os concentrations could be accounted for as a result of extensive crystal-liquid fraction from a melt that generated the other IIC irons, its Ir, and especially Ru and Pt abundances are not consistent with this type of model. Our results suggest that Wiley is unlikely to have formed from the same parental melt as the other IIC. The discrepant HSE pattern, coupled with the enrichments in ^{94}Mo, ^{95}Mo, ^{97}Mo, and ^{183}W relative to all other iron meteorite groups, strongly suggests that Wiley is not a IIC iron, and may indicate formation from a domain in the Solar nebula consisting of materials that were genetically distinct from CC and NC precursor materials. If this interpretation is correct, then there are only seven identified group IIC irons.

Variations in HSE abundances among the members of the *bonafide* IIC group can be well accounted for by a fractional crystallization model assuming initial S and P concentrations of 12 and 4 wt %, respectively. The model traces an evolution path for the IIC irons where Darinskoe and Unter Mässing represent solids crystallized after 10 and 20 % fractional crystallization, respectively (**Fig. 4**).

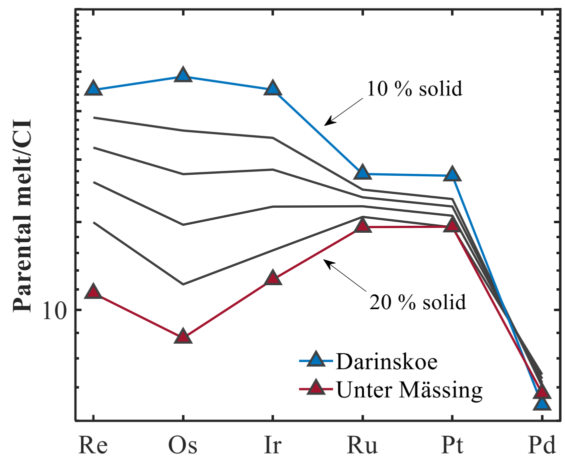

Figure 4. Plot of calculated CI normalized HSE generated by fractional crystallization at 2 wt % increments.

Abundances of HSE calculated for the parental melt suggest a composition with generally chondritic relative abundances of HSE ~10 higher than in bulk ordinary chondrites (**Fig. 5**). If this melt was representative of the parent body core, the core would likely have comprised ~10% of the mass of the IIC parent body.

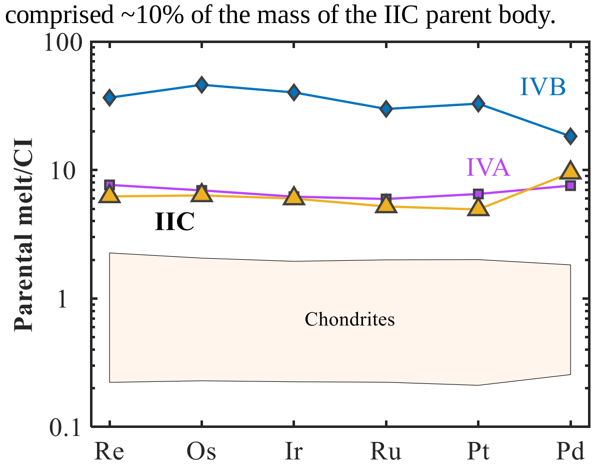

Figure 5. Plot of calculated melt concentrations of HSE for the IIC irons and for comparison, IVA [4] and IVB [5] irons.

References: [1] Wasson J.T. (1969) *Geochim. Cosmochim. Acta* **33**, 859-876. [2] Poole et al. (2017) *EPSL* **473**, 215-226. [3] Kruijer T.S. et al. (2017) *PNAS* **114**, 6712–6716. [4] McCoy et al. (2011) *Geochim. Cosmochim. Acta* **75**, 6821-6843. [5] Walker et al. (2008) *Geochim. Cosmochim. Acta* **72**(8), 2198-2216. [6] Bermingham et al. (2018) *EPSL* **487**, 221-2229. [7] Hilton et al. (2018) *LPSC (2018)*, #1186.