^{187}Re-^{187}Os, ^{190}Pt-^{186}Os ISOTOPIC AND HIGHLY SIDEOPHILE ELEMENT SYSTEMATICS OF GROUP IVA IRONS.

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Introduction: We have recently completed ^{187}Re-^{187}Os and ^{190}Pt-^{186}Os isotopic and elemental studies of the two largest magmatic iron meteorite groups, IIAB and IIIAB [1]. These studies revealed closed-system behavior of both isotopic systems, but complex trace element behavior for Re, Pt and Os in group IIIAB. Here we examine isotopic and trace elemental systematics of group IVA irons. The IVA irons are not as extensively fractionated as IIAB and IIIAB and their apparently less complex crystallization history may make for more robust interpretation of the relative partitioning behavior of Re, Pt and Os, as well as the other highly siderophile elements (HSE) measured here; Pd, Ru and Ir [e.g. 2].

An additional goal of our continuing research plan for iron meteorites is to assess the possibility of relating certain ungrouped irons with major groups via trace element modeling. Here, the isotopic and trace element systematics of the ungrouped irons Nedagolla and EET 83230 are compared with the IVA irons.

Analytical Methods: Chemical separation techniques used were similar to previous studies [e.g. 1]. Blanks for Re, Pt, Os, Pd, Ru, and Ir averaged 7, 50, 2, 10, 10 and 1 pg, respectively. Osmium measurements were accomplished via negative thermal ionization mass spectrometry (*Sector 54*). The isotope dilution measurements of all other elements were done via static multi-collector ICP-MS (*Nu Plasma*) using faraday buckets. Fractionation was monitored and corrected via interspersal of samples with standards. All concentration data are $\pm$0.2% or better.

Results: Concentrations of HSE are generally similar to those reported previously for IVA irons [e.g. 2-4](Table 1). Also, as has been previously noted, the range of concentrations of HSE is considerably less than for IIAB and IIIAB irons, and there is only an approximately 2x increase in ^{187}Re/^{188}Os ratio from the least to most fractionated IVA irons.

Discussion: A ^{187}Re-^{187}Os isochron regression for the 12 IVA irons yields an age of 4545 ± 70 Ma (MSWD = 4.5) and initial ^{187}Os/^{188}Os = 0.09526 ± 0.00070. This age is 81 Ma older than the problematic isochron reported previously [3]. The new age is consistent with IIAB, IIIAB and IVB isochron ages [1,3] all of which require early solar system core formation and crystallization. There is no isotopic evidence for relatively late-stage open system behavior, as suggested by one previous study [3]. Unlike for IIAB and IIIAB, there is insufficient spread in ^{190}Pt-^{186}Os to enable generation of a meaningful isochron with current resolution (Table 1).

Chondrite normalized HSE patterns for the IVA irons form a continuous trend consistent with Re, Os, Ir, Ru and Pt behaving as compatible elements during metal crystallization (Fig. 1). Palladium is the only incompatible element among the group measured.

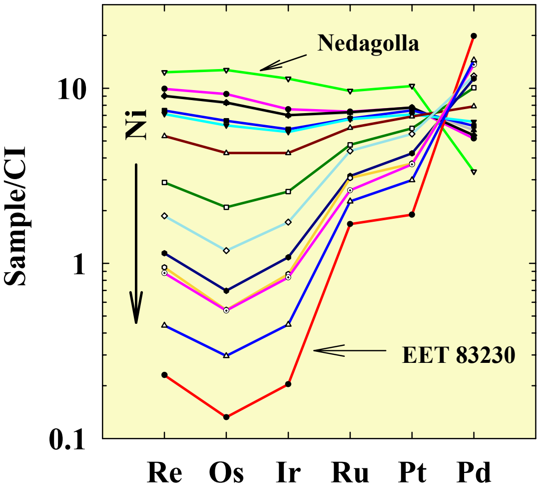

Fig. 1. CI chondrite normalized abundances of HSE for IVA irons. Note that although Nedagolla and EET 83230 are not classified as IVA irons, their patterns are consistent with early formed (Nedagolla) and late formed (EET) solids in the crystallization sequence from low to high Ni.

Of note, the patterns for the least fractionated (e.g. lowest Ni) IVA irons are only moderately fractionated with respect to chondrites (Fig. 1). The most significant deviation from chondritic is depletion in Pd. Given the apparent consistent incompatible element behavior of Pd, and the assumption that we do not have a sample of the very first solids to form in this core, the new results suggest an even greater depletion in parent body Pd than suggested by Fig. 1. One interpretation of this depletion is that the IVA parent body accreted from materials that formed at sufficiently high temperatures the relatively volatile Pd was partially excluded. Depletions of more volatile elements, such as S, Ge and As have also been noted for IVA [2]. Alternately, the parent body may have been heated and lost volatile elements [2].

A plot of log[Re] vs. log[Os] for all IVA data gives a slope of 0.878±0.031 (2σ). This slope can be used to estimate the relative solid metal-liquid metal partitioning behavior of Re vs. Os. A model for crystallization is presented in Fig. 2 using initial D_{Os} and D_{Re} values of 1.88 and 2.0 (appropriate for the slope) and assuming modest increases in S content and corresponding increases in D values as crystallization proceeded [e.g. 3]. For this model, an initial Re concentration of 300 ng/g and a chondritic $^{187}Re/^{188}Os$ of 0.437 is also assumed. On the plot of Re vs. $^{187}Re/^{188}Os$ this model can account for most IVA compositions as primary solids, or mixtures of solids and equilibrium liquids (these are samples that plot between the liquid and solid tracks in Fig. 2). Neither Fuzzy Creek nor EET83230 (if it is a IVA) can be accounted for by this model. Mixing between early formed solids and late-stage liquids are also incapable of producing such compositions. Alternate interpretations must be pursued to explain such deviations from reasonable crystallization models.

Based on extremely low Ge, among other geochemical parameters, a previous study concluded that Nedagolla is not related to any major iron group [5]. The impressive fit of the HSE data for Nedagolla to IVA data (e.g. Fig. 1 & 2) suggests that it may be useful to reconsider magmatic pathways that could relate Nedagolla to IVA, perhaps as a very early-formed solid. If not related, it must be concluded that HSE in the parent body of Nedagolla were amazingly similar to IVA. EET 83230 is a good fit to IVA with respect to HSE, consistent with it being a high Ni IVA, as was previously suggested [6].

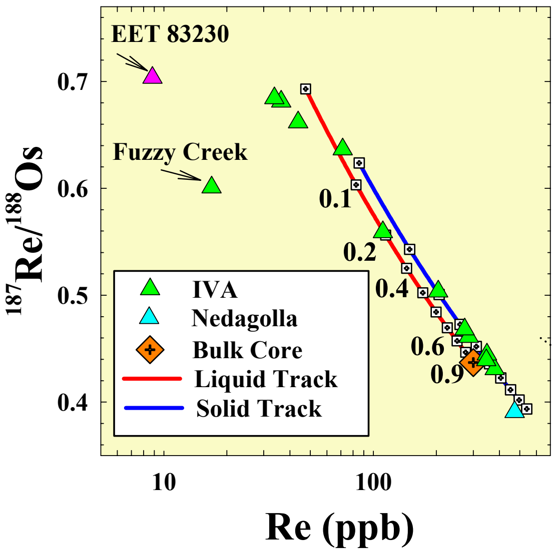

Fig. 2. Fractional crystallization model showing hypothetical liquid and solid tracks using parameters discussed in the text.

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Table 1. Isotopic and HSE concentration data for IVA irons and Nedagolla. Concentrations are in ng/g.

Sample	**Re**	**Os**	**Ir**	**Ru**	**Pt**	**Pd**	**$^{187}Os/^{188}Os$**	**$^{187}Re/^{188}Os$**	**Δ_{Os}**	**$^{186}Os/^{188}Os$**	**$^{190}Pt/^{186}Os$**
Ungrouped											
Nedagolla	472.7	5827.0	5165	6266	8840	1883	0.12628	0.3908	1.1	0.119840	0.001449
EET 83230	8.824	60.606	92.92	1089	1628	11169	0.14932	0.7035	-14	0.120017	0.02573
IVA Irons											
Jamestown	379.5	4245.1	3450	4770	6648	2902	0.12939	0.4308	0.8	0.119839	0.001496
Maria Elena	348.4	3777.6	3190	4703	6621	3242	0.13011	0.4445	-2.7	0.119843	0.001675
Yanhuitlan	345.9	3795.0	3193	4743	6656	3026	0.12977	0.4393	-2.0	0.119848	0.001676
LaGrange	285.3	2983.1	2656	4361	6414	3430	0.13146	0.4611	-2.2	0.119848	0.002055
Gibeon	272.9	2809.9	2560	4320	6088	3619	0.13215	0.4681	-0.9	0.119841	0.002071
Charlotte	204.1	1954.5	1941	3862	5922	4437	0.13465	0.5036	-3.7	0.119845	0.002897
Bushman Land	111.0	958.55	1170	3085	5062	5663	0.13943	0.5590	0.5	0.119859	0.005051
Steinbach	71.44	542.01	783.0	2846	4708	6626	0.14552	0.6365	0.6	0.119897	0.008316
New Westville	43.76	319.46	493.2	2047	3650	6394	0.14755	0.6617	1.2	0.119888	0.01094
Duchesne	36.32	248.77	395.4	1995	3193	7813	0.14882	0.6812	-1.4	0.119910	0.01229
Duel Hill	33.70	246.36	378.9	1695	3158	7673	0.14887	0.6843	-3.4	0.119907	0.01228
Fuzzy Creek	16.91	135.84	204.0	1469	2566	8142	0.14230	0.6009	-3.6	0.119980	0.01807

Δ_{Os} is the deviation of the $^{187}Os/^{188}Os$ of a sample datum from the IVA isochron in units of per mil.