COUPLED ^{182}W and ^{187}Re-^{187}Os ISOTOPIC CONSTRAINTS ON THE ORIGIN OF GROUP IIAB, IVA AND IVB IRON METEORITES. M.F. Horan, M.I. Smoliar, R.J. Walker and J.W. Morgan, Isotope Geochemistry Laboratory, Department of Geology, University of Maryland, College Park MD 20742

We determined the tungsten isotopic composition of samples from three groups of magmatic iron meteorites that have well-constrained crystallization histories and Re-Os isotopic systematics. Samples were chosen to span the range of Ni (and Ir and Os) contents present in each group. Consequently, the meteorites examined for each group are also likely representative of materials that formed over the entire crystallization sequence of each asteroidal core. The object here is to couple previously reported Re-Os isotopic composition data with new ^{182}W data for the same meteorites. ^{187}Re-^{187}Os isochrons provide ages for crystallization or diffusional closure for phases comprising asteroidal cores. They do not, however, provide the age at which metal segregated from silicate. For this task, the short-lived ^{182}Hf-^{182}W isotope system may prove useful **[1,2]**. ^{182}Hf, predominantly an r-process nuclide, decays to ^{182}W with a half-life of 9 Ma (λ=7.7x10^{-8} a^{-1}). Major fractionation between Hf and W is expected to occur during core segregation as Hf is retained quantitatively in the silicate mantle. The W distribution coefficients between metallic core and silicate mantle are not well constrained and depend on the fraction of silicate melt present and the relative abundance of oxidized W, but are probably greater than about three **[3]**. Combined, the long- and short-lived chronometers can be used to define the core formation, crystallization and cooling histories of individual asteroidal cores, and consequently provide information about the size of each parent body.

Experimental Methods: Iron meteorite samples were dissolved in HNO_3-HF. Tungsten was purified using AG1-X8 anion exchange resin in 0.5M HCl-1M HF and collected in 9M HCl-1M HF. Purified W was loaded with LiOH onto outgassed Re filaments. Approximately 10 μg each of La and Gd were added as electron emitters. Tungsten was measured as WO_3^- in static mode on a *Sector 54* solid source mass spectrometer, and was mass fractionation-corrected using ^{183}W/^{184}W=0.46712 **[4]**. Static measurements of SRM-3163 yield ^{182}W/^{184}W = 0.864635±17 (2σ_M, n=16). Dynamic multicollector measurements of the same standard yield ^{182}W/^{184}W = 0.864611±10 (2σ_M, n=20), indicating that our static and dynamic numbers are nearly equivalent.

Results and Discussion: Tungsten isotopic compositions are given in the Table and in Figure 1. Our results confirm the ^{182}W deficit exists in iron meteorites relative to W from a terrestrial standard. This observation was previously interpreted as evidence for the earlier segregation of the cores of the parent bodies of iron meteorites compared to Earth **[1,2]**. Our results show that all the IVA and IVB W isotopic compositions are nearly identical within analytical uncertainties, with an ε_W (part in 10,000 deviation from the terrestrial standard) averaging -4.2. The similarity in W isotopic compositions between the two iron meteorite groups occurs despite the contrasting characteristics of the IVA and IVB parent bodies. Samples from group IVA chosen for study encompass nearly the entire range in Ir contents in this group and therefore reflect most of the fractional crystallization sequence in the core. Complex Re-Os isotopic systematics and disparate cooling rates in the IVA irons suggest that their parent body may have been broken up, then reassembled **[5]**. The homogeneity of the W isotopic data suggests that during breakup and reassembly of the parent body, there was little exchange of W between core and mantle.

The IVB iron meteorites analyzed include the full range of Ir contents of the group, and are part of a sample set that give a Re-Os isochron age of 4527±29 Ma **[6].** Compositions of the IVB iron meteorites suggests derivation from a parent body that accreted from a high-temperature condensate **[7]**. Such a parent probably had minimal silicate mantle, which would have provided scant reservoir for radiogenic W growth after core segregation. The similarity of the W isotopic composition in the IVA and IVB groups suggests that core segregation in their parent bodies occurred within a narrow interval. In addition, the low ^{182}W/^{184}W ratios suggest core segregation occurred early, soon after nucleosysthesis. Because of uncertainty in the initial abundance of ^{182}Hf in the solar nebula, it is not presently possible to constrain more precisely the absolute time between nucleosysthesis and core segregation. A small excess of ^{107}Ag in samples from groups IVA and IVB indicates that Pd-Ag fractionation occurred (probably during condensation or sulfide removal) within a few million years of nucleosysthesis **[8]**. Further, in both of these groups there is no indication of changing W isotopic composition (within the resolution of our data) during the crystallization sequence, implying that minimal late segregation of metal with radiogenic W occurred as the cores of the IVB and IVA parent bodies crystallized.

Our sample set for the IIAB group encompasses the full crystallization sequence of the IIA irons (from Negrillos to Lombard) and the least evolved portion of the IIB crystallization sequence (from Old Woman to Navajo). Group IIA iron meteorites yield a Re-Os isochron age of 4537±8Ma [6], indicating crystallization of the IIA group within an interval of 16 m.y. Group IIB irons yield a younger and less precise Re-Os isochron age of 4467±79 Ma which may suggest late crystallization of the IIB irons **[9]**. Figure 1 shows small, but discernible differences in W isotopic composition between some of the IIAB samples. Negrillos is the least evolved IIA iron analyzed and has the lowest W isotopic compositon (ε_W=-6.4) of any iron we have measured. This may indicate that segregation of the IIAB parent body core occurred slightly earlier than the IVA and IVB cores. Pd-Ag isotopic results on Tocopilla (IIA) and Derrick Peak (IIB) suggest that condensation of material from which much of the parent body was formed occurred early **[6]**. More radiogenic W isotopic values for later-crystallizing IIAB irons may have resulted from assimilation of late segregated (and more radiogenic) metal into the core.

In order to evaluate the possible time significance of the W isotopic differences in the IIAB irons, the data are shown in Fig. 2 relative to a hypothetical calculated growth curve for ^{182}W in a parent body with a W/Hf ratio identical to carbonaceous chondrites (Allende and Murchison **[2]**, curve

calculated using their eq.1). This curve therefore represents the maximum possible rate of growth of ^{182}W in a parent body. At a given time, any radiogenic W assimilated into an earlier-formed core (that contains less-radiogenic W) will produce a mixture that is less radiogenic than the curve indicates for that time. In this way, minimum differences in the times of Hf/W fractionation between iron meteorites in a can then be determined from this curve. For example, taking into account the analytical errors, the difference in ^{182}W/^{184}W ratios in Negrillos and Lombard, the first and last of the IIA irons to crystallize, reflects at least 3 Ma growth of ^{182}W. If time reflects differences in crystallization age, then it is well within the uncertainty in the IIA Re-Os isochron. Tungsten in Negrillos and Navajo records at least 8 Ma growth of ^{182}W. These results are qualitatively consistent with the younger Re-Os isochron age obtained for the IIB iron meteorites **[9]**.

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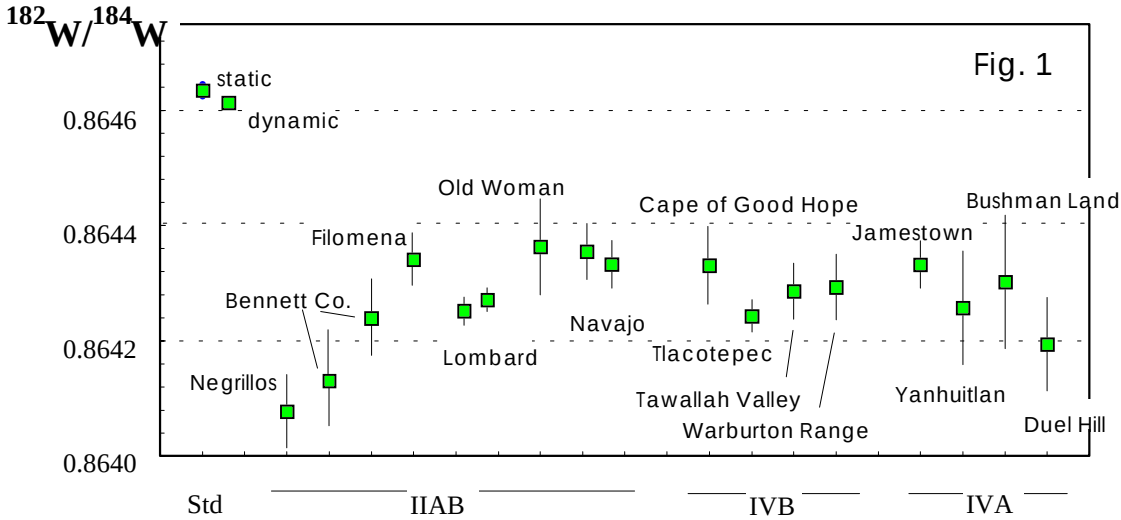
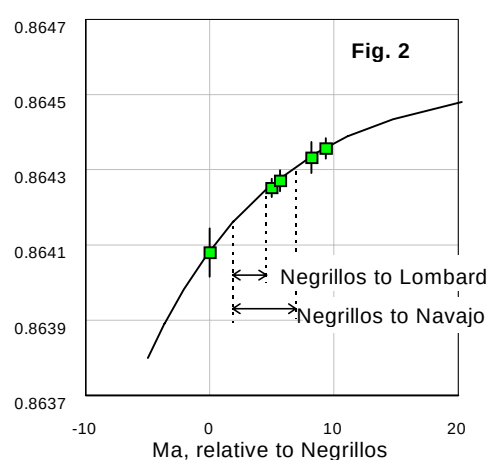
Table.	Ir, ppm [10]	^{182}W/^{184}W		ε_W
Group IIAB				
Negrillos	59 ± 5.90	0.864077	±64	-6.4
Bennett Co.	41 ± 4.10	0.864131	±92	-5.8
Bennett Co.	41 ± 4.10	0.864239	±71	-4.6
Filomena	3.4 ± 0.10	0.864341	±48	-3.4
Lombard	2.3 ± 0.23	0.864252	±24	-4.4
Lombard	2.3 ± 0.23	0.864271	±28	-4.2
Old Woman	0.8 ± 0.08	0.864363	±83	-3.1
Navajo	.49 ± 0.05	0.864333	±41	-3.5
Navajo	.49 ± 0.05	0.864357	±27	-3.2
Group IVB				
Cape of Good Hope	28.6 ± 2.0	0.864331	±67	-3.5
Tlacotepec	26.3 ± 1.8	0.864244	±28	-4.5
Tawallah Valley	16.0 ± 1.6	0.864286	±48	-4.0
Warburton Range	13.0 ± 1.3	0.864250	±57	-4.5
Group IVA				
Jamestown	3.5 ± 0.35	0.864332	±41	-3.5
Yanhuitlan	2.7 ± 0.27	0.864209	±99	-4.4
Bushman Land	.98 ± 0.10	0.864302	±116	-3.8
Duel Hill (1854)	.34 ± 0.04	0.864194	±81	-5.1