MASS-DEPENDENT FRACTIONATION OF TUNGSTEN ISOTOPES IN IIIAB IRON METEORITES AND MAIN-GROUP PALLASITES.
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Introduction: Iron meteorites and stony-iron meteorites are fragments of differentiated asteroids, of which the cosmological data can provide key information regarding the formation of the metallic core of differentiated asteroids and the terrestrial planets. It has been reported that stable isotopes of siderophile elements (e.g., Fe, Ni, Cu, Zn, Ge, Mo and Ru) in various types of meteorites show isotopic variations either due to mass-dependent fractionation or nucleosynthetic effects [e.g. 1-5]. Isotopic fractionations of W are also recognized in some ordinary chondrites and iron meteorites, most of which the data fall on the theoretical mass fractionation line [6] except for [7]. In the previous investigation [6], the numbers of sample analyzed were restricted, and therefore, no detailed discussions on the isotopic variation of W among the chemical groups were made. In this study, we have measured the series of W isotopic data for IIIAB iron meteorites in order to evaluate the level of variations in W stable isotopes within a single chemical group. Moreover, it is widely accepted that the features of the IIIAB irons could be strongly related with that for the main group pallasites (PMG), and these meteorite groups are considered to be originating from the same parent body, based on the chemical composition and the oxygen isotope signature [8]. To investigate this, W isotope data for PMG were also analyzed. Here we report preliminary results on W stable isotopic measurements for IIIAB irons and PMG.

Techniques: *Sample preparation and chemical separation.* Three IIIAB irons (Henbury, Boxhole and Verkhnyi Saltov) and two PMG (Brahin and Esquel) were cut into small pieces with a diamond-saw. Pallasites samples were digested in 3 M HCl and the visible-olivine inclusions were carefully separated by hand picking. All IIIAB irons and metallic phase of PMG were digested in reverse aqua regia. Tungsten was separated using two steps anion-exchange chromatography, based on the technique described in [9]. The purified W fraction was then evaporated to dryness in the mixtures of HNO_3 and H_2O_2 for several times to remove Os. Finally, the W was re-dissolved in a high purity alkaline solution of 0.05 wt.% TMAH (Tetramethyl ammonium hydroxide) which was dedicated for subsequent W isotopic analyses.

Mass spectrometry. All isotope measurements were carried out by Thermo Scientific Neptune MC-ICPMS at Institute for Research on Earth Evolution, JAMSTEC. The sample solution was introduced into the ICP through nebulization using a PFA nebulizer. Seven Faraday cup collectors were used to measure the following isotopes: ^{182}W (L3), ^{183}W (L2), ^{184}W+^{184}Os (L1), ^{185}Re (Center), ^{186}W+^{186}Os (H1), ^{187}Re+^{187}Os (H2), and ^{189}Os (H3). Isobaric interferences from Os on ^{184}W, ^{186}W, and ^{187}Re were monitored. Combination of the standard-sample bracketing technique and the external correction technique using Re were applied to correct for the instrumental mass bias effect [10]. For this purpose, a Re standard (NIST SRM 3143) was added to the running standard of W and the sample solutions. Measured W ratios were correct for the instrumental mass fractionation by normalizing the measured ^{185}Re/^{187}Re ratio to be 0.59738 [11] using the exponential law. The standard-sample bracketing was repeated several times for each sample. Samples and standard solutions were conditioned to be 200ppb for W and 80 ppb for Re. Measured intensities were typically in the range of 3-4 V on ^{186}W and ^{187}Re.

Results: The W isotope data for three IIIAB irons and metallic phases of two PMG samples were analyzed in this study, of which the data are shown in Fig. 1. All the W isotope data were expressed as epsilon-notations defined by following equation.

$$\varepsilon^{m}W = [(^{m}W/^{183}W)_{sample}/(^{m}W/^{183}W)_{NIST3163} - 1] \times 10^4$$

The resulting ε^{186}W data for Henbury obtained here are consistent with that reported in [6]. The resulting ε^{186}W value in IIIAB irons varied from -0.3 to +0.7. The W isotope data for Verkhnyi Saltov showed slightly heavy to those of the other IIIAB irons, which agreed well with those for ordinary chondrites. The ε^{184}W and ε^{186}W values of two PMG samples are identical to each other within analytical uncertainties. PMG samples have W isotope compositions apparently heavier than IIIAB irons and ordinary chondrites. All the measurements in this study plot on the theoretical mass-dependent fractionation line.

Discussion: The resulting stable W isotopes signatures for IIIAB irons and the PMG indicate that these samples have presumably experienced mass-dependent isotope fractionation from a common, isotopically homogeneous reservoir because they plot on the same theoretical mass-dependent fractionation line. This is consistent with previously investigated data [6]. The variation of the resulting W stable isotope ratios found in the IIIAB irons suggests that the W isotopes could be fractionated through planetary scale processes such as metal-silicate segregation or fractional crystallization stages, possibly achieved on the their parent body. To test this, we investigated the possible relationship between ε^{186}W values and some siderophile element contents. In this study, Ir was chosen for further discussions, because precise and reliable Ir abundance data are comprehensively reported for various meteoritic metals [e.g., 12-15]. Fig. 2 illustrates the resulting ε^{186}W values plotted against the Ir concentrations in our IIIAB irons and PMG. Although analytical uncertainties are relatively large, it appears that ε^{186}W values negatively correlate with Ir concentrations. It should be noted that the wide variation of Ir abundances in iron meteorites can be explained by the results of fractional crystallization of molten metal, since Ir is preferentially distributed into the solid phase through the crystallization of liquid metal [16, 17]. Fig. 2 suggests the possibility that W stable isotopes in IIIAB irons fractionate during fractional crystallization of solid metal in the liquid metal. To further evaluate the potential relationship between W stable isotopic variations and elemental concentrations, more W stable isotope data on IIIAB irons and PMG as well as other iron and stony-iron meteorites are required with high precisions.

References: [1] Zhu X. K. et al. (2001) *Nature, 412,* 311–313. [2] Luck J. M. et al. (2005) *GCA, 69,* 5351-5363. [3] Moynier F. et al. (2007) *GCA, 71,* 4365-4379. [4] Luais B. (2007) *EPSL, 262,* 21-36. [5] Dauphas N. (2004) *EPSL, 226,* 465-475. [6] Irisawa K. (2007) *Ph.D. Thesis, Tokyo Instit. Tech.* [7] Qin L. (2008) *Astrophys. J., 674,* 1234-1241. [8] Haack H. & McCoy T. J. (1996), Treatise on Geochem., *1,* ch. 1.12, 325-345. [9] Quitté G. et al. (2002) *Geostand. Newslet., 26,* 149-160. [10] Irisawa K. & Hirata T. (2006) *JAAS, 21,* 1387-1395. [11] Gramlich J. W. et al. (1973) *J. Res. Natl. Bur. Stand., 77A,* 691-698. [12] Wasson J. T. et al. (1998) *GCA, 62,* 715-724. [13] Wasson J. T. (1999) *GCA, 63,* 2875-2889. [14] Wasson J. T. & Choi B. G. (2003) *GCA, 67,* 3079-3096. [15] Russell S. S. et al. (2005) *Meteoritics & Planet. Sci., 40,* A201-A263. [16] Willis J. & Goldstein J. I. (1982) *LPSC XIII, JGR, 87,* A435-A445. [17] Jones J. H. & Drake M. J. (1986) *Nature, 332,* 221-228.

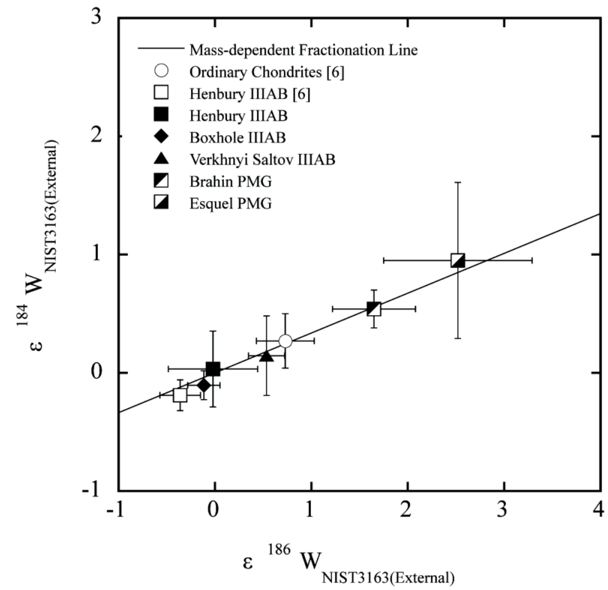

Fig. 1. The resulting W isotope data plotted on ^{184}W/^{183}W and ^{186}W/^{183}W three isotopes diagram.

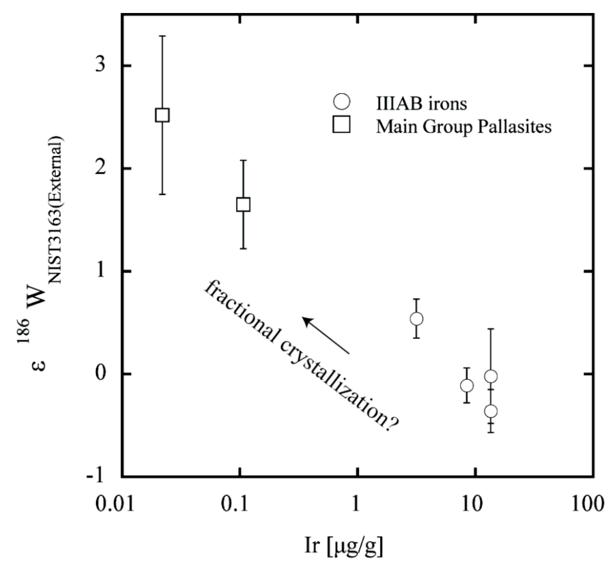

Fig. 2. Correlation of the resulting ε^{186}W with the Ir abundance reported by [12-15].