IRON ISOTOPE COMPOSITIONS OF ACHONDRITIC METEORITES FROM DISTINCT PARENT BODIES.

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Introduction: In recent years, several investigations have focused on the iron isotope compositions of terrestrial and meteoritic samples to assess whether iron isotope fractionation can be used as a tracer for planetary accretion and differentiation processes [1-10]. In this study, we report the iron isotope compositions of several achondrites: Northwest Africa (NWA) 6962 and NWA 5297, two primitive ungrouped achondrites [11,12]; NWA 2976, a basaltic ungrouped achondrite [13]; and two angrites, including the quenched NWA 1670 [14] and the plutonic NWA 2999 [15]. The goal was to investigate a variety of achondrites that record different degrees of differentiation (ranging from incipient melting processes that produced the primitive achondrites to more extensive differentiation that resulted in the formation of the angrites) on distinct planetesimals in the early Solar System to gain new insights into the effects of planetesimal differentiation on iron isotope fractionation.

Method: A clean interior piece of each meteorite (~100-200 mg) was ultrasonicated in MilliQ water and dried, then crushed and homogenized to a powder in an agate mortar and pestle. A ~60 mg aliquot of each homogenized powder was digested in a 3:1 $HF:HNO_3$ mixture, followed by digestion in a Parr vessel. Iron was purified using standard anion exchange column chemistry procedures similar to those described previously [16]. Iron isotopes were measured on a Thermo Neptune MC-ICPMS in medium resolution mode and instrument mass bias was corrected using both Cu-doping and sample-standard bracketing (using IRMM-014 as the standard) [16]. The accuracy and precision of our analyses were assessed using repeated analyses of BIR and BCR-2 terrestrial rock standards and an Allende bulk sample during each analytical session.

Results: The Fe isotope compositions for the rock standards and samples analyzed here are presented:

Samples	$\delta^{56/54}$Fe	2SD	$\delta^{57/54}$Fe	2SD	N
BIR	0.08	0.05	0.12	0.10	16
BCR-2	0.11	0.04	0.17	0.07	15
Allende	0.03	0.07	0.05	0.08	10
NWA 6962	-0.06	0.05	-0.07	0.12	5
NWA 5297	-0.07	0.06	-0.14	0.15	5
NWA 2976	0.14	0.05	0.18	0.08	1
NWA 1670	0.14	0.11	0.22	0.11	2
NWA 2999	0.12	0.05	0.16	0.09	2

Discussion: The average Fe isotope compositions measured here for the terrestrial rock standards, BIR and BCR-2, and for the Allende chondrite agree with those reported previously for terrestrial basalts and bulk chondrites [2-4,7,10]. The compositions of the two primitive ungrouped achondrites, NWA 6962 and NWA 5297, are the same, within the errors, as those of chondrites [2,4,7]. This is not surprising given that these primitive achondrites have bulk compositions that are near chondritic even though they have igneous textures. The Fe isotope compositions of the two angrites, NWA 1670 and NWA 2999, and the ungrouped basaltic achondrite NWA 2976 are all similar to each other, within the errors, and similar to terrestrial basalts [4,10], but resolvably heavier than bulk chondrites and eucrites [1-4]. These basaltic achondrites were produced by partial melting of the mantle reservoirs on their parent bodies. Moreover, the angrites were formed under significantly more oxidizing conditions than the eucrites [17]. As suggested by a recent study [18], magma redox and structural controls may factor into iron isotope fractionation during differentiation, and may at least partly explained the Fe isotope compositions reported here for the three basaltic achondrites (particularly the angrites).

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