Comparative stable Fe isotope systematics of terrestrial and meteoritic materials

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Thus far, variations in δ^{56}Fe values reported for chondrules from carbonaceous and ordinary chondrites (Zhu et al., 2001) and between bulk samples of HED meteorites, chondrites, Mars, Moon and Earth (Poitrasson et al., 2004) were interpreted by a number of different processes. These include Fe isotope fractionation through partial Fe evaporation and condensation, physical metal-silicate differentiation, and low-temperature aqueous alteration on the parent bodies. The aim of this study was to investigate (1) to what extent intra-planetary and inter-planetary processes may be responsible for the variability of Fe isotope signatures of planets and planetesimals and (2) whether trace element patterns of chondrules and CAIs that are related to condensation correlate with their Fe isotope variabilities.

A comprehensive set of new high-precision Fe isotope data (Schoenberg et al., 2005) of 15 bulk chondrites, 15 iron meteorites, 8 eucrites, 20 terrestrial rocks as well as chondrules and CAIs from carbonaceous and ordinary chondrites will be presented. Within student-t test limits the three chondrite groups remain indistinguishable from each other and have an average δ^{56}Fe value of –0.023±0.104‰ (2 S.D.) relative to the IRMM-014 Fe standard. However, student-t statistics also reveal that chondrites, eucrites (-0.002±0.024‰), iron meteorites (+0.035±0.078‰), and terrestrial silicate rocks (+0.085±0.080‰) analysed here have discernible, different Fe isotope compositions at a high level of confidence. The meteorite data suggest that preferentially heavier Fe isotopes were incorporated into metal cores during metal-silicate differentiation. Therefore, this process cannot be the cause for the slightly elevated δ^{56}Fe values of terrestrial silicate rocks compared to bulk chondrites. We reproduce the wide Fe isotope fractionation in CAI and also show that chondrules form different chondrites are variably fractionated in Fe. Trace element data for chondrules and CAI show that those with the most anomalous refractory element abundances tend to also be strongest fractionated in Fe.

References

Zhu, X.K. et al., (2001), Nature 412, 311-313.
Poitrasson, F. et al., (2004), EPSL 223, 253-266.
Schoenberg, R. et al., (2005) Int J Mass Spectrom (in press).