NICKEL ISOTOPE ANOMALIES IN IRON METEORITES

M. Bizzarro[1], D. Ulfbeck[1], J.A. Boyd[1] and H. Haack[1]. [1]Centre for Star and Planet Formation, Natural History of Denmark, University of Copenhagen, Copenhagen, Denmark, DK-1350.

The presence of isotope anomalies of nucleosynthetic origin in meteorites and their components provide insights into the nature of the various stars that contributed matter to the nascent solar system. With five isotopes (^{58}Ni, ^{60}Ni, ^{61}Ni, ^{62}Ni and ^{64}Ni) synthesized by various nucleosynthetic processes, nickel is an interesting element to study. It is a moderately refractory, siderophile element, and is a major component of both iron and silicate meteorites. Thus, Ni isotopes can trace potential genetic relationships between iron and silicate meteorite groups.

However, Ni isotopic measurements present a significant analytical challenge given the small abundance of three of the Ni isotopes, ^{61}Ni, ^{62}Ni and ^{64}Ni, with relative abundances of 1.1%, 3.6% and 0.9%, respectively. Moreover, the magnitude of the ^{60}Ni and ^{62}Ni anomalies found to date is relatively small (<30 ppm [1, 2]) and different groups have reported contrasting results for the same types of meteorites. Some have argued for the presence of ^{60}Ni and ^{62}Ni variations [1, 2], while others have suggested that there are no resolvable mass-independent variability in ^{60}Ni and ^{62}Ni [3, 4]. This debate can be carried further through high-precision measurements of the ^{64}Ni nuclide, given that the magnitude of the anomalies is predicted to be approximately three times larger based on Ni measurements of CAIs [5]. However, a potential limitation of the accuracy of the ^{64}Ni data is the presence of a significant isobaric interference from ^{64}Zn.

In light of these caveats, we have developed analytical procedures allowing for the measurements of Ni isotopes with improved accuracy and precision by high-resolution plasma source mass spectrometry. Our approach enables the measurement of ε^{60}Ni, ε^{62}Ni and ε^{64}Ni with an external reproducibility and accuracy of 2.5, 5 and 10 ppm, respectively. Using these techniques, we have analyzed the Ni isotope composition of 11 iron meteorites from the IAB, IC, IIAB, IIIAB, IVA and IVB classes as well as four ungrouped irons (Santiago Paspaquiero, Cowra, De Hoek and Guffey). Apart from IABs, which have a terrestrial Ni isotope composition, all irons show resolvable anomalies in ^{60}Ni, ^{62}Ni and ^{64}Ni. Our results are consistent with those reported by [1], but not with [2], [3] or [4]. In ε^{62}Ni-ε^{64}Ni space, all samples define a single correlation line of slope 2.8±0.3 that intercepts the terrestrial value. IVBs show the most extreme enrichments in ε^{64}Ni (~23 ppm) whereas ICs record the lowest ε^{64}Ni values (~ –50 ppm). Apart from De Hoek, which is characterized by enrichment in ε^{62}Ni and ε^{64}N slightly greater than the IVBs, all other ungrouped irons fall within the existing classes of irons. The variability observed in ε^{60}Ni-ε^{64}Ni space requires the existence of at least three nucleosynthetic components. This is consistent with the suggestion that some of the ^{60}Ni observed in solar system objects results from the heterogeneous distribution of a carrier of fossil ^{60}Ni associated with the high ^{62}Ni and ^{64}Ni composition [1]. Our data also supports the existence of a ^{60}Fe-rich carrier, which may have been heterogeneously distributed amongst solar system solids, asteroids and planets.

References: [1] Regelous, M. *et al.* (2008) EPSL, 212: 330-338 [2] Bizzarro, M. *et al.* (2007) Science, 316:1178-1181. [3] Chen, J. *et al.* (2009) GCA, 73: 1461-1471. [4] Dauphas, N. *et al.* (2008) ApJ, 686: 560-569. [5] Birck, J.-L. and Lugmair, G. (1988) EPSL 90: 131-143.