How well do we know the initial Nd isotopic state of the Earth?

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As is evident from the extensive studies of CAIs and pre-solar grains in meteorites, the material in the Solar System is a mixture of debris from widely different nucleosynthetic sources. The differences in isotopic composition of bulk meteorite samples may therefore reflect variations in the mixing ratio of various components in different "planetary" materials. It would then follow that models of planetary evolution that are based on small shifts in isotopic ratios due to radioactive decay (Boyet and Carlson, 2005) are strongly dependent on the initial isotopic state and a "bulk solar" value that cannot be properly assumed. A key issue to understand the evolution of early Earth has been whether the available samples of meteorites accurately reflect the Nd isotopic composition of bulk Earth (Andreasen and Sharma, 2006; Ranen and Jacobsen, 2006). We have addressed this question using high precision Sr, Ba, Nd, and Sm isotopes in large samples of chondrites and a eucrite (Andreasen and Sharma, 2006; 2007).

High-precision barium isotopic compositions of large samples of St. Severin (LL6) and Juvinas (eucrite) are identical to the terrestrial values. In contrast, Murchison and Allende (carbonaceous chondrites) reveal excesses in ^{135}Ba and ^{137}Ba of around +39 and +22 parts per million, respectively; no anomalies are resolvable in ^{130,132,138}Ba. High precision Sr isotopic compositions of all meteorites are identical within error. The data are consistent with carbonaceous chondrites having an excess in r-process ^{135,137}Ba with respect to Earth, Eucrite Parent Body, and ordinary chondrites. The carbonaceous chondrites, however, display no variation in the r- and s-process Sm and Nd isotopes suggesting that the r-process sources of Ba and the lanthanides were decoupled. The homogeneity of Ba and Sm isotopes in the Earth, Eucrite Parent Body and ordinary chondrites indicates that the Solar Nebula that fed planetesimals between ~1 to ~2.4 AU was well mixed with respect to these elements. It was heterogeneous beyond ~2.7 AU where carbonaceous chondrite parent bodies formed. These observations also indicate that the best estimate of the Nd isotopic composition of the Earth is obtained from ordinary chondrites and not from carbonaceous chondrites, as is normally assumed. Since the terrestrial upper mantle shows a ^{142}Nd anomaly of +18±8 parts per million with respect to the ordinary chondrites, this is further evidence that the upper mantle retains a memory of early Earth differentiation and sequestration of a reservoir with an average Sm/Nd ratio lower than that of chondrites.

References

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Remediation of heavy metals with species and green vegetables

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The common spices and green vegetables (i.e. Amaranth, Anise, Coriander, Methi and spinach) grown in the contaminated soil of the pyrite belt area, Mandala, central India has been studied for remediation of heavy metals (HMs) i.e. As, Cr, Mn, Fe, Ni, Cu, Zn, Hg, Pb. These plant have remarkable accumulation capacity for these elements. The total mean soil contents of metals i.e. As, Cr, Mn, Fe, Ni, Cu, Zn, Hg and Pb were found to be 53.0, 1380, 1832, 8900, 667, 743, 153, 4.8 and 387 mg kg^{-1}, respectively. The total mean contents of HMs i.e. As, Cr, Mn, Fe, Ni, Cu, Zn, Hg and Pb in these plants were 0.48-2.81, 107–5869, 76–1700, 716-53381, 56–8837, 19.9-165, 59–196, 0.9–11.2, 4.6–54 mg kg-1 of DW respectively. The species: Anise, Coriander and Spinach were found to be hyperaccumulator for Cr (> 0.1); Cr (>0.5), Fe (> 5%), Ni (> 0.8%) and Cr (>0.4%), Ni (>0.2%). A sequential extraction procedure was used to fractionate heavy metals in highly contaminated soils into the conceptual metal pools: exchangeable; carbonate bound; bound organically; bound in Fe-Mn oxides; and residual. The leachable and total contents of metals in soil, total metal contents in six plant species and their correlations are discussed. Among five plant leaf tested, Anise, Coriander and Spinach showed the extremely high accumulation tendency towards the heavy metals (i.e. Cr, Fe, Ni), may be due to micellization with essential oils, and sequestrilization with dibasic acids i.e. oxalic, succinic, etc. The species: Anise, Coriander and Spinach accumulated Cr; Cr, Fe and Ni; Cr and Ni at extremely high levels and considered as hyperaccumulator. These spices provide new plant resource for exploring the mechanism of metal hyper accumulation to use in the phytoremediation of the heavy metal contaminated soils.