Growth of the Earth's core

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Hafnium-tungsten chronometry provides evidence that some magmatic iron meteorite parent bodies formed relatively small cores within a million years of the start of the solar system. Similar timescales can be inferred from martian meteorites and ureilites. There is some evidence that the degree of siderophile element depletion, possibly reflecting relative core size, increased over the first 10^7 years on Mars and the angrite parent body. How the Earth's core started is less clear and some assume more efficient core growth under reducing conditions. The Si isotopic compositions of mantle-derived silicate rocks from the Earth and Moon are heavy relative to those from Mars and Vesta which in turn are identical to those of chondrites. A likely explanation for this is Si isotopic fractionation during high pressure and high temperature metal segregation. On this basis Si is one of the light elements in the Earth's core. There is a hint of an analogous effect for oxygen. However, the heterogeneity within the circumstellar disk renders this interpretation less certain. Similarly, slightly heavy Fe in the bulk silicate Earth may reflect high pressure core formation in the presence of perovskite. The Moon does not have a high pressure core yet lunar basalts display O, Si and Fe isotopic compositions similar to those found on Earth. This can be reconciled with giant impact simulations provided there was efficient mixing between the silicate Earth and the protolunar disk as recently proposed (Pahlevan and Stevenson 2005). This being the case the Moon represents an important new archive for the composition of the early silicate Earth and demonstrates that Si and possibly O were already light elements in the core before the Giant Impact.

Reference

Pahlevan K. and Stevenson D.J. (2005) The oxygen isotope similarity between the Earth and Moon – source region or formation process? *LPSC* **XXXVI**, 2382.

Molecular and isotopic study of acidic metabolites in the deep biosphere employing petroleum reservoirs as natural bioreactors

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Being systems that support a biologically active environment, petroleum reservoirs can be used as naturally occuring analogues to bioreactors in view of studying the anaerobic cata- and metabolism of an extremophile deep-subsurface biosphere. Although living cells have been identified in deep sub-seafloor sediments (Schippers *et al*., 2004), cell organic matter is not preserved well in the aqueous environment. The hydrophobic oil matrix of petroleum reservoirs, in contrast, can act as an accumulator of *in-situ* produced metabolites and cell-wall lipids.

This presentation will examine the molecular distribution and stable carbon isotopic variation between carboxylic acids and their non-carboxylated hydrocarbon counterparts in oils that were biologically degraded to various extents and recovered from different non-communicating compartments of a reservoir. Oils were fractionated into compound classes and further analysed by gas chromatography (GC) and mass spectrometry (MS), as well as isotope ratio monitoring (irm)GC-MS.

The lack of microbial petroleum degradation in reservoirs that were ever heated >80ºC suggests that microbes have been present in the sediments since their deposition and possibly survive by the release of volatile organic acids from dispersed sedimentary organic matter (Wellsbury *et al*., 1997). Significant migration and recolonization of microbes in the subsurface does not appear to take place. The escape into the deep could be an ancestral evolutionary survival strategy that allows microbes to maintain their viability for extremely long periods, to the expense of pushing the physicochemical limits of life. Understanding the evolution of earth's early biosphere is therefore closely related to understanding the biochemical adaptation of life to extreme environments, which can only be studied in present-day analogues, one of which are deep anaerobic petroleum reservoirs. This study focusses on the structural and isotopic analysis of carboxylic acids as indicators of deep biosphere processes.

References

Schippers, A., Neretin, L., Kallmeyer, J., Ferdelman, T., Cragg, B., Parkes, J., and Jørgensen, B. (2005) *Nature* **433**, 861-864.

Wellsbury, P., Goodman, K., Barth, T., Cragg, B., Barnes, S., and Parkes, J. (1997) *Nature* **388**, 573-576.