A chondritic and nonchondritic Earth: What would the dynamicists say?

AMARA L. GRAPS[1,2] AND ALESSANDRO MORBIDELLI[3]

[1]INAF Istituto di Fisica dello Spazio Interplanetario, Rome, Italy (amara.graps@ifsi-roma.inaf.it)
[2]Planetary Science Institute, Tucson, Arizona, USA.
[3]Observatoire de la Côte d'Azur, BP 4229, F-06304 Nice cedex 4, France.

The question of the origin of water on Earth is as pure as SMOW: it can be reduced to endogenic or an exogenic sources, however the reduction problem is anything but simple. This complex question must probed via theoretical, physical, isotopic, and geochemical arguments, each of which require highly specialized skills. Many of the physical arguments can be numerically probed via n-body simulations that build terrestrial planets from smaller bodies in the inner solar system during its formation period, while many of the isotopic and geochemical arguments can be explored via sample collections and remote measurements of terrestrial and extraterrestrial materials. To properly address the question of the origin of water on Earth requires that each of these approaches use the other approach as a constraint.

For example, upon building their planets, the dynamicists will negate or affirm their simulated planets with constraints including (D/H) ratios, water abundances, noble gas isotopic ratios and abundances, and nitrogen, oxygen, and HSE isotopic compositions. And, upon collecting their samples, the geochemists will negate or affirm the samples' origins using physical models of solar nebula gas temperatures, time for core formation, dates of chondrules and zirons and mixes of solar elements to construct a body with plausible elemental compositions. However, their tasks are not finished, until a synthesis of the two approaches is attempted.

In this work I will present the second approach from the geochemical angle with a first synthesis between the two approaches. While a chondritic Earth is often assumed by geochemists, the implications for a nonchondritic Earth are: 1) no depleted mantle reservoirs, 2) no geochemical paradoxes, 3) the Earth's mantle is entirely degassed, 4) an explanation of the early appearance of a depleted mantle, and 5) a solution of the heat-^{4}He paradox [1]. Which type of Earth better meets the dynamical constraints?

References

[1] O'Neill, H. "What can the variations in chemical composition among the Earth and other terrestrial planetary bodies tell us about how terrestrial planets form?" (2007), EGU2007-A-11605.

2.7-2.6 Ga Archaean ecology determined by microbial activities: A view from C and S isotopes

N.V. GRASSINEAU AND E.G. NISBET

Dept. of Geology, Royal Holloway University of London, Egham TW20 0EX, UK (nathalie@gl.rhul.ac.uk)

The well-preserved Belingwe Greenstone Belt (2.7-2.6Ga) in Southern Zimbabwe was deposited in a sub-continental basin upon a basement gneiss. The isotopic study from drill-cores was based on clastic sedimentary units of two formations: Manjeri Fm. (2.7Ga) and Cheshire Fm. (2.6Ga). The most interesting sections of the Manjeri Fm. are two carbon- and sulphur-rich black shale layers, Shavi and Jimmy Members, with reduced carbon contents up to 20wt%. The very wide δ^{34}S range of 40‰ obtained on pyrite separates (from –23.7 to +16.7‰) and the similarly wide δ^{13}C range for reduced carbon of nearly 32‰ (from –38.4 to –7.0‰) indicate primary bacterial matter. Such variations are in favour of biological fractionation that indicate various co-existing metabolic pathways: an oxygenic photosynthesis signature and anoxygenic processes. There is also strong evidence for sulphate-reducting activity and even for S-oxidizers in various sections of the core. Some results associated with δ^{13}C measured in carbonate clumps suggest the existence of a methane seep environment, emphazing that complex microbial communities existed at 2.7Ga, based on well represented C and S biological cycles.

The Jimmy Member has been sampled from three different cores. The isotopic results suggest variations in the biological activities between the three localities. There is evidence of changing processes in the microbial mats, which allows an overview of the ecology of the Belingwe basin at this specific period. In fact, these changes are caused by changing biotopes in the environment, most likely due to the subsidence of the basin shifting sedimentation for shallow water to a deeper setting.

In the Cheshire black shales, δ^{13}C with values between –44 and –32‰ suggest that methanogenic and even methanotrophic processes were present in the basin too. In addition to this study, δ^{13}C for carbonate and reduced carbon have been measured on different stromatolitic sequences (Abell *et al*., 1985) from the two formations. The isotopic fractionations obtained are in favour of the Rubisco I signature indicating cyanobacterial activity.

All these information allow the re-constitution of the ecosystems that were present between 2.7 and 2.6Ga in the Belingwe basin. Multiple biological activities and various ecologies were needed to colonize the entire planet and to allow the evolution of the Archaean life.

References

Abell P.I., McClory J., Martin A. and Nisbet E.G., (1985), *Precambrian Research*, **27**, 357-383.