

Core formation and volatile element addition to the Earth

B.J. WOOD¹ AND M. REHKÄMPER²

¹Dept of Earth Sciences, University of Oxford, South Parks Road, Oxford, OX1 3AN; U.K.

²Dept of Earth Science & Engineering, Imperial College, London SW7 3AZ; U.K.

It is well known that the Pb isotopic composition of the silicate Earth indicates a fractionation of U from Pb at ~100 M.yr after the origin of the solar system. This fractionation has recently been ascribed to entry of Pb into the core (e.g.[1]) on an Earth with low U/Pb, and to late addition of Pb and other moderately volatile elements to an Earth which initially had very high U/Pb [2]. Use of extinct radioactive systems, combined with an understanding of volatile element partitioning into the core can elucidate the relative timings of core formation and volatile addition [3]. We have determined the metal-silicate partitioning of moderately volatile elements Ag, Pb, Tl, Mn and Cr in order to use the extinct systems ¹⁰⁷Pd-¹⁰⁷Ag, ²⁰⁵Pb-²⁰⁵Tl and ⁵³Mn-⁵³Cr in conjunction with ¹⁸²Hf-¹⁸²W and ^{238,235}U-^{206,207}Pb to investigate core formation and volatile element addition to the growing Earth.

Tl, which is chalcophile but only weakly siderophile at low pressure is found to become as siderophile as Pb at pressures >20 GPa. This means that, given the high pressures of core formation indicated by refractory siderophile element (Ni, Co, Mo etc) abundances in the mantle, the ²⁰⁵Pb-²⁰⁵Tl system is consistent with core formation being the principal reason for the low Pb and Tl abundances (relative to lithophile elements of similar volatility) in silicate Earth. Ag is moderately siderophile at all pressures while Mn and Cr are similar to one another in having weak siderophile character. When considered together the 3 short-lived systems are consistent with addition of moderately volatile elements during the principal period of core formation with timescale constrained by the ¹⁸²Hf-¹⁸²W system. ⁵³Mn-⁵³Cr and ¹⁰⁷Pd-¹⁰⁷Ag indicate that accreted materials became more volatile rich as accretion progressed with major addition of volatiles during the last 30-60% of accretion.

[1] Wood, B.J. & Halliday, A.N., (2010) *Nature* **465**, 767-771.
[2] Albarède, F., (2009) *Nature* **461**, 1227-1233. [3] Schönbacher, M., Carlson, R.W., Horan, M.F., Mock, T.D., & Hauri, E.H., (2010) *Science* **328**, 884-887.

Controls on early biomineralisation: Oxygen and competition

R.A. WOOD^{1*}, A.R. PRAVE², K-H. HOFFMANN³, S.W. POULTON⁴, J.W. LYNE¹, M.O. CLARKSON¹ AND S. KASEMANN⁵

¹School of Geos., Univ. of Edinburgh, EH9 JW, UK

(*correspondence: Rachel.Wood@ed.ac.uk)

²Dept. of Earth Sci, Univ. of St Andrews, KY16 9AL, UK

³Geol. Survey of Namibia, Windhoek

⁴School of Civil Eng. and Geosciences, Newcastle Univ, NE1 7RU, UK

⁵Dept. of Geosciences, University of Bremen, 28334 Bremen, Germany.

Animals require oxygen, and so the first appearance of metazoans during the Ediacaran (580-543 Ma) has been linked to the widespread development of oxygenated oceanic conditions [1, 2, 3]. However, the nature of ocean redox chemistry through this period is complex, with deeper water anoxia persisting in certain areas [4]. In addition, few studies have directly documented the nature of ocean chemistry at locations that coincide with palaeontological evidence for major biological innovation [3]. Thus, the precise environmental context for early animal evolution, particularly the rise of biomineralisation, remains unclear. Here, we present a high resolution reconstruction of carbon isotope and ocean redox dynamics, as recorded in sedimentary rocks deposited from ~553-549 million years ago in the Zaris Sub-Basin of the Nama Group, Namibia. The succession spans deep distal to shallow proximal carbonate settings, and coincides with the first appearance of skeletal metazoans. Iron-sulphur systematics demonstrate that oxic conditions developed only intermittently in the shallowest waters where the first skeletal metazoans are preserved, while deeper waters remained consistently anoxic and iron-rich (ferruginous). Thus, late Ediacaran surface-water oxygenation was unstable, inferring that the first skeletal metazoans developed in short-lived habitats. The opportunistic ecologies and characteristically simple biomineralisation styles of Ediacaran taxa are likely to be a direct consequence of these dynamic redox conditions.

[1] Knoll et al. (1999) *Science*, 284, 2129-2137 [2] Fike *et al.* (2006) *Nature*, **444**, 744-747 [3] Canfield *et al.* (2007) *Science*, **315**, 95-99 [4] Canfield *et al.* (2008) *Science*, **321**, 949-952.