

The anatomy of the Great Oxidation Event

SIMON W. POULTON¹, ANDREY BEKKER²,
JAMES FARQUHAR³, AUBREY L. ZERKLE¹,
DAVID T. JOHNSTON⁴ AND DONALD E. CANFIELD⁵

¹School of Civil Engineering and Geosciences, Newcastle University, UK (s.w.poulton@ncl.ac.uk)

²Department of Geological Sciences, University of Manitoba, Canada

³Department of Geology, University of Maryland, USA

⁴Department of Earth and Planetary Sciences, Harvard University, USA

⁵Nordic Center for Earth Evolution, University of Southern Denmark

The Palaeoproterozoic was characterised by three major glaciations that coincided with the transition from a dominantly anoxic to a well-oxygenated atmosphere (the Great Oxidation Event; GOE). This transition has been dated at 2.32 Gyr ago, based on a loss of S isotope mass-independent fractionations (MIF) in sediments from the Transvaal Supergroup, South Africa [1]. These South African sediments are considered to correlate with the second of three widescale glaciations recorded in the Huronian Supergroup, Canada [2].

To provide more insight into links between the detailed dynamics of the GOE and Paleoproterozoic glaciations and ocean chemistry, we have performed a multi-proxy reconstruction of Earth surface oxygenation across the second Huronian glaciation. We combine a variety of sensitive indicators of oxygenation, including the role that sulphate exerts on ocean redox state, Mo concentrations, and multiple S isotopes. We find clear evidence for euxinic depositional conditions during deposition of the Bruce glacial diamictite. Coupled with enrichments in Mo, this implies significant pervasive atmospheric oxygenation that was glacially-driven. However, persistence of mass-independent S isotope fractionations suggests that this was at a low level. The MIF signal is possibly transiently lost in the lower part of the overlying Espanola Formation, implying that oxygenation may have been close to the upper threshold for MIF generation. However, a clear S isotope MIF signal is present throughout the upper succession, despite enrichments in Mo, suggesting that atmospheric oxygen levels fluctuated around a low level between the second and third glaciations.

[1] Guo, Q. *et al.* (2009) *Geology* **37**, 399–402. [2] Bekker, A. *et al.* (2005) *Precamb. Res* **137**, 167–206.

High precision analysis of all REEs in chondrites and Earth

A. POURMAND^{1,2*}, N. DAUPHAS¹ AND T.J. IRELAND¹

¹Origins Lab., Dept. of Geophys. Sci., Univ. of Chicago, Chicago, IL 60637, USA

²RSMAS - Division of Marine Geology and Geophys., Univ. of Miami, Miami, FL 33149, USA

(*correspondence: apourmand@rsmas.miami.edu)

Advances in rare earth element (REE) analyses have succeeded in increasing the precision of measurements, while concurrently decreasing preparation time (e.g. [1, 2]). Here, we present high precision data for the REEs, Sc and Y that were collected following an innovative technique that we developed for the separation and purification of these elements. This technique applies a low-blank flux fusion procedure to ensure the complete digestion of a sample, followed by column chromatography to separate the REEs, Sc and Y from matrix elements, prior to analysis on a Neptune multi-collector ICP-MS [1, 3]. The REE patterns in all geostandards are in excellent agreement with compilations of literature values, albeit at a higher precision.

Rare-earth element, Sc and Y data were obtained for 10 carbonaceous chondrites, 16 enstatite chondrites and 15 ordinary chondrites. Previously, U, Th and Hf concentration, as well as Hf isotopic data were gathered for these meteorites [4]. In general, REE patterns for carbonaceous chondrites are relatively flat, although some CV3 samples (e.g. Allende) show a group-2 CAI pattern. Other chondrite groups show evidence for REE re-distribution during metamorphism, consistent with Dauphas and Pourmand [4].

A critical goal of this study was to re-evaluate CI-chondrite abundances, and if necessary, suggest a revised composition for normalizing purposes. We analyzed three CI-chondrites (Orgueil, n=5; Ivuna, n=2; Alais, n=1) and based on these 8 measurements, we propose a revised CI-composition for the REEs [3].

In addition to chondrites, we analyzed several terrestrial samples. When normalized to our revised CI composition, terrestrial rocks show smooth REE patterns except possibly for a small anomaly at Tm (also reported by [5]). This REE is seldom reported in literature, as it is mono-isotopic and often used as an internal standard. Further work is currently in progress to assess whether this effect is real.

[1] Pourmand & Dauphas (2010) *Talanta* **81**, 741–753. [2] Baker *et al.* (2002) *GCA* **66**, 3635–3646. [3] Pourmand *et al.* (2011) submitted. [4] Dauphas & Pourmand (2011) *Nature*, in press. [5] Bendel *et al.* (2011) *Lunar & Planetary Science Conference 2011*, abstract #1711.