A bioturbation-induced decrease in atmospheric oxygen across the Precambrian-Cambrian boundary

R.A. BOYLE[1], T.W. DAHL[1,2], A.W. DALE[3], G. SHIELDS-ZHOU[4], M. ZHU[5], M.D. BRASIER[6], D.E. CANFIELD[7] AND T.M. LENTON[1]

[1]Earth System Science Group, College of Life and Environmental Sciences, University of Exeter, UK.
[2]Natural History Museum of Denmark, University of Copenhagen, Denmark.
[3]Geomar Helmholtz Centre for Ocean Research, Kiel, Germany.
[4]Department of Earth Sciences, University College London, UK.
[5]Nanjing Institute of Geology and Palaeontology, Chinese Academy of Sciences, Nanjing, China.
[6]Department of Earth Sciences, University of Oxford, UK.
[7]Institute of Biology and Nordic Centre for Earth Evolution, University of Southern Denmark.

Bioturbation is the reworking of sediments by animal motility, and its emergence across the Precambrian-Cambrian boundary occurred against the backdrop of major changes in the biogeochemical cycles of oxygen, phosphorus and organic carbon. Bioturbation substantially increases sedimentary phosphate content, limiting the phosphate available for primary production and thus reducing the marine organic carbon burial flux, which is the source of atmospheric oxygen over geological timescales. We use simple modelling to show how an increase in marine organic phosphate burial associated with the onset of bioturbation caused a net decrease in atmospheric oxygen across the Precambrian-Cambrian boundary. The resulting de-oxygenation of the ocean restricted the spread of oxygen-demanding bioturbating animals, and established negative feedback loops that stabilised atmospheric oxygen at a lower level. Although more data are needed to quantitatively constrain model parameters, our results are supported by evidence for a resurgence of anoxic and sometimes euxinic conditions in the early Paleozoic.

[1] McIlroy, D. & Logan, G. (1999). Palais **14**. 58-72. [2] Och, L. & Shields-Zhou, G.A. (2012). Earth Science Reviews **110**. 26-57. [3] Papineau, D. (2010). Astrobiology **10** (2). 165-181. [4] Maloof, A.C., Porter, S.M., Moore, J.L., Dudas, F.L., Bowring, S.A. Higgins, J.A., Fike, D.A. & Eddy, M.P. (2012). GSA Bulletin **122**. 1731-1774. [5] Ingall, E.D., Bustin, R.M. & Van Capellen, P. (1993) Geochim. Cosmochim Act. **57**. 303-316. [6] Redfield, A.C. (1958) Am. Sci. **46**. 205-221. [7] Betts, J.N. & Holland, H.D. (1991) Paleogeog, Palaeoclimatol. Palaeoecol. **97**. 5-18. [8] Catling, D.C., Glein, C.R. Zahnle, K.J. & McKay, C.P. (2005) Astrobiology **5** (3). 415-437. [9] Schroder, S. & Grotzinger, J.P. (2013) J. Geol. Soc. Lond **164**. 175-187.

The rate of iron compounds precipitation from AMD waters in the Łęknica region (the Muskau Arch, western Poland)

P. BOŻĘCKI AND G .RZEPA

AGH - University of Science and Technology, Faculty of Geology, Geophysics and Environmental Protection, Departament of Mineralogy, Petrography and Geochemistry, Krakow, Poland (pbozecki@agh.edu.pl)

The Muskau Arch is a large horseshoe-shaped glaciotectonic belt formed mainly during the Mid Polish Glaciation. Lignite deposits containing pyrite were excavated there till the end of the 70-ties of the 20th century. Abandoned excavations are recently filled with water forming large so called "*anthropogenic lake district*" (with about 110 reservoirs). Oxidation of sulphide leads to the generation of abundant quantities of sulphuric acid. Therefore many of these lakes, especially at the Łęknica area, are of acidotrophic type characterized by low and very low pH values (usually < 4.0). This is associated with the formation of numerous ochreous precipitates as a consequence of iron oxidation and hydrolysis.

The aim of this study is to assess the precipitation rate of iron compounds from acid mine drainage waters. Experiment was conducted in over one year period, from July 2009 to September 2010, in eleven locations. For this purpose, unglazed ceramic plates (dimensions: 10x10 cm) were, after removing possible traces of iron, placed on the bottom of selected lakes. The plates were collected monthly and the amount of precipitated iron compounds was evaluated by the determination of Fe leachable in hydrochloric acid. Mineralogical analyses of the precipitates using X-ray diffractometry and SEM-EDS were carried out as well.

The amount of precipitated iron compounds turned out to be very variable, ranging from ca. 50 *[mg Fe*cm^{-2}]* per month to nearly 13 000 *[mg Fe*cm^{-2}]* per month. The average value for all monitored locations was approximately 1100 *[mg Fe*cm^{-2}]* per month.

.X-ray diffractometry indicate that the only mineral phase formed was schwertmannite – poorly crystalline iron oxyhydroxysulfate.. Images obtained with use of scanning electron microscope reveal the presence of numerous bacteria structures, confirming that the precipitation of schwertmannite was microbially-mediated.

This work was supported by AGH-UST (Faculty of Geology, Geophysics and Environmental Protection statutory grant).

DOI:10.1180/minmag.2013.077.5.2
www.minersoc.org