Why is evidence for microbial sulfate reduction so scarce in Earth's early geologic record?

JAMES FARQHAR[1]

[1]University of Maryland, College Park, Maryland, USA

Dissimlatory sulfate reduction (DSR) is an ancient microbial metabolism that is thought to have evolved by approx. 3500 million yrs ago (MA). This age is consistent with the location of sulfate reducers deeply in phylogenetic trees and with inferences made about the antiquity of enzymes that comprise the metabolism as well as geochemical evidence from S-isotopes (c.f., Sousa et al, 2013; Shen et al., 2001, 2009; Ueno et al., 2008).

S-isotopic signatures of sulfate reducers are not widespread in the interval between ~3500 MA and ~2450 MA, the time before the rise of oxygen. This may be because an overprint of mass independent fractionation obscures evidence of sulfate reduction. It may also be because of the metabolic response of sulfate reducers to Archean oceanic sulfate concentrations. It is commonly held that the combination of diminished isotope fractionations at low sulfate concentrations, when combined with transport of sulfate into marine sediments, limited expression of DSR fractionations in the Archean geological record (Habichet et al., 2002). This has also been recently demonstrated in a modern analog by Gomes and Hurtgen (2013). Recently, Canfield et al. (2013 Golsdchmidt) demonstrate that large isotopic fractionations can be produced at a very low (10's of μM) sulfate concentrations. Questions that arise from all of this is: How widespread was DSR in the Archean? And what was its role in the Archean oceans.

I will discuss how factors related to the environments inhabitted by sulfate reducers in the Archean may have conspired to generate a very different type of sulfur isotope record, one that masks traditionally accepted evidence for DSR, but also that evidence for sulfate reducers is ubiquitous in the late Archean, and that the role of these organisms was significant in the Archean oceans and sediments.

[1] Gomes and Hurtgen (2013) *Geology* **41** 663. [2] Habicht, et al. (2002) *Science*, **298,** 2372. [3] Sousa *et al*. (2013) *Roy. Soc. B*., **368**, 20130088. [4] Shen Y. A., *et al* (2001) *Nature*, **410**, 77. [5] Shen, *et al* (2009) *Earth and Planet Sci Lett*, **279**, 383. [6] Ueno *et al* (2008) *Geoch. Cosmochim Acta*, **72**, 5675.