S^0 formation mechanisms in the Proterozoic ocean – potential signatures in the rock record

JULIE COSMIDIS[1], CHRISTINE NIMS[1], BRANDI KAMERMANS[1], JENNIFER MACALADY[1], ALEXIS TEMPLETON[2]

[1]Department of Geosciences, The Pennsylvania State University, University Park, PA, USA
jxc1158@psu.edu

[2]Department of Geological Sciences, University of Colorado, Boulder, CO, USA

During much of the Proterozoic, large portions of the oceanic margins might have experienced ferro-euxinic conditions, where both dissolved sulfide and ferrous iron were available. Local microoxic conditions close to the redox interface might have enabled sulfur-oxidizing microorganisms to thrive, producing elemental sulfur (S^0) [1]. Chemical oxidation of sulfide to S^0, catalysed by iron, could also have been an important reaction at the redox interface. S^0 is highly biologically reactive and thermodynamically unstable under diagenetic conditions, and evidence of S^0 can be found in the Precambrian rock record. However, isotopic evidence for sulfur-based metabolisms such as S^0 disproportionation exist as early as the Archean. Putative fossilized sulfur bacteria have furthermore been described in Proterozoic cherts [2].

We performed laboratory experiments where S^0 was formed in the absence of any microbial activity by reacting sulfide with dissolved organics in the presence of ferrous iron in an oxygen gradient. The S^0 particles have micrometric sizes, filamentous and spherical shapes, and are encapsulated within an envelope of organic carbon. Without precluding the possibility for microbial S^0 formation, this demonstrates that S^0 could have formed through a non-biological process close to the Proterozoic oceanic redox interface in the presence of dissolved organic matter.

Most interestingly, the S^0-carbon microstructures possess both morphologies and chemical compositions reminiscent of S^0-biomineralizing bacteria. We performed silicification experiments on these microstructures as well as on actual sulfur bacteria (*Thiothrix*), in order to investigate the specific signatures that both biogenic and abiogenic processes for S^0 formation might leave in Proterozoic cherts. This study might lead us to reconsider our interpretation of the Precambrian microfossil record, and deepen our understanding of the sulfur biogeochemical cycle during that eon.

[1] Koeksoy et al. (2017), *Goldschmidt Abstracts*, 2069. [2] Schopf at al. (2015), *PNAS* **112**, 2087–2092.