

## ***Interactive comment on “Cryptic role of tetrathionate in the sulfur cycle: A study from Arabian Sea oxygen minimum zone sediments” by Subhrangshu Mandal et al.***

**Anonymous Referee #2**

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original comment: “Line 492 – The authors cite three papers to support a link between MnO<sub>2</sub> cycling and pyrite oxidation to tetrathionate and other dissolved species. I have no idea what the authors are referencing, which is troubling and forces me to recommend rejection. The Berner and Petsch paper from 1998 does not include the words manganese, thiosulfate, or tetrathionate. There is similarly no mention of MnO<sub>2</sub> in the Luther 1991 paper. And, although the Jørgensen and Bak paper discusses manganese, it is in the context of “manganese or iron oxides” which could similarly be used as electron acceptors, not anything about pyrite oxidation.

SM: WE ARE EXTREMELY SORRY for this "copy-paste" goof-up committed in the

C1

haste of submitting multiple manuscripts within the same time-window! The actual reference that should have been used is Schippers, A., and Jørgensen, B. B.: Oxidation of pyrite and iron sulfide by manganese dioxide in marine sediments, Geochim. Cosmochim. Acta., 65, 915-922, [https://doi.org/10.1016/S0016-7037\(00\)00589-5](https://doi.org/10.1016/S0016-7037(00)00589-5), 2001. (Please note that this was already included in the Reference list and cited in another context of Discussion). This paper should have also been cited in this particular context of tetrathionate production from pyrite, instead of the three irrelevant references that mistakenly got inserted. Please see Line numbers 4-8 of the Abstract itself of Schippers and Jørgensen, 2001, which clearly states that “FeS<sub>2</sub> and iron sulfide (FeS) were oxidized chemically at pH 8 by MnO<sub>2</sub> but not by nitrate or amorphic Fe(III) oxide. Elemental sulfur and sulfate were the only products of FeS oxidation, whereas FeS<sub>2</sub> was oxidized to a variety of sulfur compounds, mainly sulfate plus intermediates such as thiosulfate, trithionate, tetrathionate, and pentathionate. Thiosulfate was oxidized by MnO<sub>2</sub> to tetrathionate while other intermediates were oxidized to sulfate.”

Current Response: Thank you for clarifying the correct references here, your thinking is far clearer now. Although this reference does describe pyrite oxidation via MnO<sub>2</sub>, I am still unconvinced that it is relevant to the sediments in the current study. If one reads beyond the abstract of that paper, one also finds that “Below 7.5 cm, where the content of Mn did not exceed 0.2% (w/w), a dissolution of FeS<sub>2</sub> was not detectable.” One also finds that the abiotic incubations produced intermediately only for days to weeks and not longer, decreasing rapidly with depth. Manganese concentrations in the current paper (71-172 ppm) are orders of magnitude lower than the threshold for activity reported before, and there are no depth trends in either pyrite or MnO<sub>2</sub> discussed, or porewater metal ion data, that might support this mechanism as active. Purported Mn-driven oxidation also appears to increase, rather than decrease, with depth, in contrast with the prior report. I do not think pyrite is a source of dissolved S species in this system; stronger evidence is required.

Allied key comment: I would certainly not use this discussion to conclude that “Pyrites

C2

(via abiotic reaction with MnO<sub>2</sub>) and thiosulfate (via chemolithotrophic oxidation by members of the bacterial group designated as A in Fig. 4) are apparently the main sources of tetrathionate". This has not been demonstrated.

Our response: Chemolithotrophic conversion of thiosulfate to tetrathionate by members of the bacterial genera *Pseudomonas* and *Halomonas* (designated as A in Fig. 4) has been experimentally demonstrated - we have shown such isolates of both *Pseudomonas* and *Halomonas* which are capable of chemolithotrophically converting thiosulfate to tetrathionate in vitro. Furthermore, when metagenomic sequence data obtained for each of the 25 distinct sediment-samples of SSK42/5 and 6 were assembled and annotated individually, 23 out of the 25 contig-collections obtained were found to contain genes for tetrathionate formation (namely, genes encoding subunits of the thiosulfate dehydrogenases TsdA that converts thiosulfate to tetrathionate; see Denkmann et al., 2012; Pyne et al., 2018) [Table S3]. Whole metatranscriptome sequencing and analysis for the 275 cmbsf sediment-sample of SSK42/6 also revealed the gene-catalog obtained via annotation of the assembled contigs to encompass homologs of the thiosulfate dehydrogenase gene tsdA [Table S19]. These data clearly supported the potential in situ functionality (metabolically) of thiosulfate to tetrathionate converting bacteria.

Current Response: I do not dispute that thiosulfate-to-tetrathionate conversion was demonstrated and is quite intriguing; the piece of your claim that has not been demonstrated is related to pyrite. Without showing any depth trends, porewater metal ion data, or pyrite-specific (tracer) incubations, there is no data evidencing the involvement of pyrite.

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Interactive comment on Biogeosciences Discuss., <https://doi.org/10.5194/bg-2019-248>, 2019.

C3