

Biogeosciences Discuss., referee comment RC1
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Comment on bg-2021-253

Anonymous Referee #1

Referee comment on "Aqueous system-level processes and prokaryote assemblages in the ferruginous and sulfate-rich bottom waters of a post-mining lake" by Daniel A. Petrash et al., *Biogeosciences Discuss.*, <https://doi.org/10.5194/bg-2021-253-RC1>, 2021

In this paper, Petrash et al. used aqueous chemistry profiles, analysis of stable isotopes of S, C and O, microbial community analyses, and sediment characterizations to develop a model for processes occurring in suboxic portion of a pit lake resulting from coal mining activities. This is an interesting system in that it has overlapping S, N, Fe, and C cycles all in the anoxic portion of the water column. This is unusual, b/c in many systems at least one of these is a functionally absent, a minor component, or undergoes minimal redox transformations because of the dominance of (an)other component(s). The paper is mostly observational, but I think that's fine, because the authors have developed a nice model for the processes occurring that's shown in Figure 8. The paper presents a lot of results. I almost wish the authors could tie everything together a little more succinctly. I think Figure 8 gives a nice summary of the processes involved. Maybe a little more time in the discussion focused on this model and a little less on the "paleo" implications would help the reader synthesize all of the observations into the process model.

Below, I provide some specific comments and suggestions that I hope can help improve the manuscript:

Ln. 11. Do the authors mean "reductive Fe(III) dissolution"?

Ln. 16. "sustained" how?

Ln. 17-18. What is the electron acceptor for sulfide oxidation? And if sulfide is oxidized all the way to sulfate, at which point does the sulfur disproportionation happen?

Ln. 104. Change to "DNA extraction and MiSeq"

Ln. 105. Do you mean ICM-MS? Does mass spec work for specific ions? I don't think this is an adequate description of the analytical methods. I'm also a little bit leery of putting the entire description of nucleic acid-based microbial community analysis in the supplement.

Ln. 106. Change to "measurement of dissolved"

Figure 2. Can the authors make the axes the same on panels above and below the redoxcline? My first impression was that there was no difference between any of the organic acids, but there are actually rather dramatic differences.

Ln. 150. VFAs were a minor fraction of the total DOC. What is likely the rest? How labile might it be, and how does that inform the biogeochemical model?

Ln. 167-168. Wouldn't sulfate reduction induce increase in pH? You're producing carbonate alkalinity and reducing a strong acid (sulfate) to a weak acid (sulfide).

Ln. 221. Please be consistent in including the charge for nitrate

Ln. 223. Please change "sequenced" to "detected"

Ln. 232. By "abundance peak" do you mean maximal relative abundance?

Ln. 210-256. Did the authors try to quantify nitrite? If there are nitrogen transformations occurring in this system I would expect it to be important, and perhaps the ultimate oxidant for Fe²⁺ in reactions 1 and 2.

Ln . 282. Are the authors referring to Fe(II) oxidation by Mn(III/IV)? Please clarify.

Ln. 293. Please change "[Fe]" to "Fe concentration"; also here and throughout, please check tense agreement.

Ln. 301. I don't know about this. Attributing metabolism when you only have 91% similarity is tough.

Ln. 329. Please remove "significantly"

Ln. 336 and throughout this section. Why does diversity matter. Wouldn't relative abundance be more informative with respect to S transformations? There could be a whole lot of diversity of sulfate reducers, but they're only a minor fraction of the community. A later use of the term "diversity" leads me to believe the authors are referring to diversity of S metabolisms (e.g. oxidation, disproportionation, reduction of different redox states, etc.), but I'm not sure. Please revisit the use of this term and clarify.

Ln. 372-374. If there's evidence of S metabolizing organisms and some aqueous chemical evidence of S transformations, why no change in $\delta^{34}\text{S}$ -sulfate?

Reactions 4-6. Is Mn-dependent S disproportionation from the Bottcher et al. 2001 paper? What about the siderite-dependent disproportionation? I am unsure how this reaction might occur.

Ln. 520, 534, 559. Why are these minerals italicized?