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Comment on bg-2022-89

Rick Wilkin (Referee)

Referee comment on "Do bacterial viruses affect the framboid-like mineral formation?" by Paweł Działak et al., Biogeosciences Discuss., https://doi.org/10.5194/bg-2022-89-RC1, 2022

The title of the manuscript asks whether bacterial viruses could affect the formation of framboidal morphology. I was intrigued. After reading the manuscript, I am probably convinced that the answer is no. Compelling experimental data, analysis, and a coherent model of framboid formation does not come forward from this work. Suggestions are provided below to make better a connection between bacteriophage shape/size with framboid minerals, provide a more coherent explanation of pyrite formation in the environment, and link variable framboid sizes observed in natural systems (in space and time) to properties of bacterial viruses. The paper describes a novel idea, so it is perhaps publishable. I recommend major revision (minimum) to rejection. Consider being clear about the factors that fit and do not fit a biotic framboid origin. The paper would be more useful if this analysis was included.

- The Introduction is one long paragraph. It is unreadable as a coherent introduction. Consider breaking this text up.
- Line 31, framboids are present in sulphides and oxides.
- Line34, spelling on euxinic
- Line 35, the text here is not accurate. Pyrite framboids are markers of the redox transition between oxygen-containing and anaerobic/sulphidic waters. In fact, some pulse of an oxidant is needed for pyrite formation since its sulfur atoms are present in the -1-valence state and precursor minerals like FeS are in the -2-valence state.
- It is true that the Ohfuji paper looked at abiotic synthesis, but so did many other studies (Farrand et al. 1970; Berner 1969 Econ Geol v. 64; Graham and Ohmoto 1994 Geochim Cosmochim v. 58; Sweeney and Kaplan 1973 Econ Geol; Wilkin and Barnes 1996 Geochim. Cosmochim v. 60). These should be referenced, at a minimum, along with others. Seems to me that a very accurate and trustworthy evaluation of abiotic syntheses is required here as a point of comparison.
- Line 42, why Interestingly?
- Line 53, why should it be assumed? The Introduction is very fuzzy about the sizes and dimensions of bacterial viruses. The 50 to 200 nm size range makes to connection to

any dimension in framboids that is consistent across the environments of their formation. And the image shown in Figure 2 is not connective to framboid sizes or shapes. The whole set up seems to be a stretch.

- Framboids are quite notably present in hydrothermal deposits yet this fact is quite conveniently omitted. Hydrothermal occurrence should be noted as a fact that may be contrary to bacteriophage involvement.
- The experimental setup lacks any connection to natural settings and does not recognize the established understanding of pyrite formation. 1) describe redox and pH control; 2) describe aging. The use of the culture medium is an experimental requirement, perhaps. But it should be acknowledged that you are setting up the experiment to favor biology and not reproduce anything that happens in nature.
- I was left unsure why so much emphasis was placed on the zeta potential experiments & data. Provide some introduction as to why this is important.
- Results: the XRD data show that the experiments produced nothing that is realistic for natural settings. The traces of pyrite in the XRD patterns are not especially characteristic or convincing. Troilite is a high temperature phase; there should be no expectation for troilite identification. How were the samples collected for XRD studies? Please describe the controls that were in place to prevent oxidation.
- In the SEM studies, did you use backscatter detection? This would have revealed the high atomic Z particles more precisely.
- The images shown in Figure 6 look less like framboids then the kinds of precipitates that form in abiotic experiments. There is no improvement in morphological connection to framboid structures, in fact a step back, which leaves the reader unconvinced that this represents anything new. The weak similarity should be acknowledged.
- Line 270, microcrystals in framboids come in multiple shapes and sizes. The link to Ohfuji and Akai is a weak thread. Please acknowledge the full range of microcrystal sizes and shapes.
- Line 277, pyrite framboid size in nature depends on the environment of formation (it is not based on the study - not sure what this means). A coherent model would need to explain why viruses would produce different sized framboids in different environments.
- Line 284, again there are many abiotic framboid synthesis examples, all of them produce even more framboid-like morphology than what is described here (see references above in point 5; please consider adding these to the discussion for an objective analysis).