

Interactive comment on “Fracture-controlled fluid transport supports microbial methaneoxidizing communities at the Vestnesa Ridge” by Haoyi Yao et al.

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Authors reply to Referee #1:

We thank the anonymous reviewer’s positive comment and suggestion. Below we reply to the comment and suggestions one by one.

Referee’s comment (RC): 1. The authors have used multicorer and push-coring techniques to retrieve the sediment samples. The fractured core (893 MC) in particular was retrieved by the multicorer. While it remains uncertain as to how faithfully a 40 cm core retrieved by this process can preserve small-scale fracture networks and present

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them for analysis, the authors too seem to have appreciated the possibility that high internal gas pressure released at the time of the exposure of the core to atmospheric pressure (which is far low than its in situ pressure) may have expanded the fracture. The most remarkable fact, also according to the authors, is that despite the above issues, methane significantly increases in concentration as we go up the fracture from the bottom (Fig. 4). My concern is that the text offers no clear explanation regarding why methane concentration is higher near the sediment surface than at the bottom.

Authors's reply (AR): We thank the reviewer for suggesting to clarify the concentration differences in the fractured core. We will edit the text accordingly offering the explanation that the methane concentration is higher near the sediment surface than at the bottom. Indeed, the fact that the methane concentration at the top sections of the core were higher is a very remarkable fact and we will highlight this further in the revised version of the manuscript. Obviously, the pressure change during core retrieval will have led to bubble formation. However, although outgassing effects may have led to a smearing of the methane concentration profile, the pressure change will have affected both the top and bottom of the core equally (both of which contained CH₄ concentrations above saturation level at atmospheric pressure). We thus argue that already in situ, methane concentrations were higher at the top of the core, possibly because we didn't fully capture the fracture but only the upper part at the sediment surface (as the reviewer rightly points out). Indeed, our X-ray analysis suggest the prevalence of the fracture in the upper 30 cm of the sediment. We will better explain this in the revised version of the MS.

RC: Whilst a robust explanation of this is absolutely necessary, I would additionally recommend that the lipid biomarker study be complemented with metagenomic and/or metatranscriptomic analyses to reveal the microbial communities more objectively.

AR: Thanks for the reviewer's recommendation for adding the metagenomic or metatranscriptomic analyses. While the reviewer is right that such analyses would further add to the ID and functioning of the microbial community, we have to admit that this is

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beyond the author's PhD project, so that we would like to refrain from running further analyses.

RC-2. For smoother reading and comprehension of the present manuscript, the authors should coin such identifiers (or names) for individual sediment cores that harness both the core numbers as well as the coring-site names.

AR: We thank the referee's suggestion and will change the text accordingly.

RC-3. In the Methods section, the procedure for measuring methane concentration (the central parameter of this study) must be described and not entrusted entirely on cross referencing.

AR: We will update the method section with a brief description of the method for methane measurement.

RC-4. The labels of Figure 2 and 4 lack resolution.

AR: We will change the resolution of the labels in Figure 2 and 4.

RC-5. Page 1 Line 22: I think the readers will find it easier to navigate the data if you say here "In a separate un-fractured core, recovered from the same pockmark approximately 80 m away from the fractured core, we observed".

AR: We will change the description here for a clear navigation of the geographic position of these cores.

RC-6. Page 1 Line 34: "Increased sediment permeability due to fractures may facilitate gas and fluid transport." – I think one should also consider seepage of sulfate, nitrate, etc. from the water into the sediment. Next sentence: no need to start with "Indeed".

AR: Thanks for the reviewer's comment, we have discussed a little on the water column solutes such as sulfate are drawn into the sediment, but we will make this more clear in the revised version.

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RC-7. Page 2 Line 4: Words like “tremendously” are subjective and judgmental so should be avoided.

AR: We will change the wording accordingly.

RC-8. Page 2 Line 5: Instead of obscure words such as “consume methane”, or “benefit from sulfide” one should use specific terms as “oxidize”.

AR: We will changed the wording here.

RC-9. Page 2 Line 13: What does “poorly constrained” mean here? In the context of the sentence, how can the significance of something be poorly constrained?

AR: Mini fractures are a mostly unknown phenomenon (while large-scale fractures and faults have been investigated more frequently), and it is in particular unclear how such pathways for fluid and gas migration will affect the development of methanotrophic communities. We will clarify in the revised MS that such fractures likely change the availability of electron donors and acceptors around the fracture and thus create microbial habitats around the fracture that may differ from sediments at the same sediment depth but away from the fracture

RC-10. Page 2 Line 14: “maintain their metabolism” is technically not a right phrase; better say, “. can then be used by sedimentary microbes as metabolic / bioenergetic substrates”.

AR: We will changed the wording to “. . .” can be used by microbes as substrates”.

RC-11. Page 2 Line 23: “thus” or “therefore” should come before “play”.

AR: We will change the wording.

RC-12. Page 2 Lines 27-28: “Using an interdisciplinary approach that combines geochemical and biogeochemical measurements, we investigate the” – There can be nothing like “biogeochemical measurements”; the whole thing is biogeochemical, so geochemical and biogeochemical are two redundant words; moreover lipid profile

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is a microbiological issue, and when combined with isotope ratios the issue becomes geomicrobiological. So this phrase should be written as, “..... geochemical and geomicrobiological methods”

AR: We will rephrase the wording as suggested.

RC-13. Page 2 Line 37: Must introduce the reader to what “pockmark structures” are; can’t pass on the onus of explaining this key concept to other citations.

AR: We will add a brief introduction to pockmark.

RC-14. Page 3 Line 4: ‘Enhanced reflections and “push-down” features’ – Please explain these terminologies so as to make the paper more comprehensible and attractive in its professed interdisciplinary context.

AR: Together with the introduction to ‘pockmarks’, we will clarify these terms.

RC-15. Page 3 Line 6: “High excess” – it’s a redundancy of words; just say “Excessive pore pressure”.

AR: Yes, we will change the wording here.

RC-16. Page 3 Line 31: “.X-ray analysis in our home laboratories” – I think the authors meant “in the on land laboratory (rather than in the on board or on ship laboratory)”; so it should be written that way. Otherwise it seems that the authors had installed the Geotek MSCL-XCT in their homes.

AR: We will change the text to “onshore laboratories”.

RC-17. Page 4 Line 36: “Nevertheless, methane analyses revealed a significant increase in methane concentration along the observed fracture (Fig. 4).” – When you just say “along the observed fracture” and don’t mention the trajectory (whether from top to the bottom or upward from the bottom) then the reader gets to construe the first. But actually from top to the bottom of 893 MC, methane is not increasing rather decreasing. So please mention the specific trajectory.

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AR: We will change the description of the methane concentration profile to be more comprehensive.

RC-18. Page 7 Lines 3-4: 5. “Assuming a uniform source methane value of XX for the Lomvi pockmark, site 008PC showed the highest $\Delta\delta^{13}\text{C}$ values (Fig. X).” – major oversight behind this incomplete statement – please rectify (what would be the value of XX?).

AR: We are sorry for this typo that was left from an internal review round. The XX refers to a $\delta^{13}\text{C}$ source methane value of -55 ‰ which we will correct here and in Figure 5.

RC-19. Table 1 should have a one-line description in relation what is listed in it; for instance, location of coring-stations, seafloor habitat information, analyses performed for individual sample-sites, etc. Incomplete / abbreviated expressions, such as “bac. mats & carb” for crucial habitat-related information, in Table 1, should be avoided. In Table 1 it is appearing that methane concentration and lipid biomarker analysis were not determined in the whole study although that was actually not the case; please amend.

AR: We will change the text here as well as in the caption of table 1 and will edit the table accordingly.

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