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Interactive comment on “Biogeochemistry of a low-activity cold seep in the Larsen B area, western Weddell Sea, Antarctica” by H. Niemann et al.

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Authors response to the comments posted by two anonymous reviewers for the manuscript “Biogeochemistry of a low-activity cold seep in the Larsen B area, western Weddell Sea, Antarctica”

We would hereby like to thank the two anonymous reviewers for their helpful comments and criticism. In the following, all reviewers comments are listed followed by our response.

Reviewer I Specific Comments:

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1. Did you analyze replicates for methane, ethane, sulfate, or sulfide (Fig. 3, 4, and 5)? If so, please add error bars to the graphs. If not, it is difficult to determine the accuracy of your results and subsequent conclusions. How can you definitively say that a single replicate is representative of the true geochemistry at each of the sites?

We did not measure replicates for light hydrocarbons and pore water solutes. It is indeed true that replicated measurements are preferable, but this would involve extended station time for additional coring. Unfortunately, our station time at Larsen B was, as a result of bad ice conditions, very limited. The applied set of methods (analytical and sample recovery) is widely used in ocean sciences and has been proven useful with respect to accuracy and reproducibility. Never the less, for the light hydrocarbons and sulphide a certain error cannot be excluded due to degassing and auto-oxidation. However, this is rather unlikely here as concentrations of volatiles were very low at Larsen B. We have specified in the text that concentrations were measured ex-situ and indicated if replicate measurements were preformed (which we performed for AOM and SR measurements). We therefore think that further specifications in the text are not necessary.

2. Please show the data for the reference core (702-6). If the whole paper is trying to show that the trough is a methane seep then the reader needs to see the data for the background site. I recommend adding the background data to the graphs of data for the other cores.

We will add a separate graph for hydrocarbons and pore water solutes of the reference station in the revised version.

3. Is a “scattered aggregation” and a “dense bed”, as indicated in figure 1, considered the same thing as a “clam bed” or “clam patch” as mentioned on pg. 5749, l. 5-20? If these are considered the same thing in terms of the geochemistry then why give them different symbols in figure 1? Also, I would consider an area with a dense patch of clams to have different geochemistry than a scattered, low-density patch. If this is the

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point of defining the different macrofaunal observations, please revise the section to make it clearer.

The terms “scattered aggregation” and “dense bed” are based on videographic observations; i.e. low and high density of clam shells, respectively. We were only able to recover one video guided MUC from a rather scattered aggregation (core 709-3) but did not succeed to recover samples from the dense beds. Core 706-4 was launched at a position where we documented dense beds during ROV dives. However, the beds were approximately 1 m across. As gravity cores are not video guided and were not equipped with a positioning system, we cannot estimate if such a bed was sampled during gravity coring or if the core hit the seafloor in the vicinity of such beds. Thus, we cannot compare the geochemistry of scattered aggregations versus dense beds. We will specify what types of clam beds were sampled in the revised version of the manuscript.

4. The latitude and longitudes presented in Table 1 are redundant with figure 1. Please remove these columns. It may also help to add a column with the analyses run on each core.

This is a good suggestion and will be included in the revised version of the manuscript.

5. Why are no rates or sulfate and sulfide concentrations presented for cores 711-4 and 711-5? For core 711-4 the hydrocarbon concentrations are similar to those of core 706-4 and the same for 709-3 and 711-5. This would make an interesting comparison.

Pore water solutes as well as rate measurements could not be determined from the cores 711-4 and 711-5 (limitation of station time). Indeed, the geochemical signatures of core 711-4 and 706-4 are more similar than 706-4 and 711-5. This indicates a decrease in methane flux and thus seep activity with distance to the clam shell patches. We will discuss this further in the revised version of the manuscript. Cores 711-5 and 709-3, on the other hand, are very different as the sediment layers where methane starts accumulating in core 711-4 is below -40 cm bsf, which was not sampled with the

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MUC (core 709-3). We will therefore restrain from comparing these cores. However, the main goal of the manuscript is to show that there is a very low seep activity in the trough of the Cranes and Evans glaciers (in comparison to the reference station), whereas comment 5 of Reviewer I would rather lead to a discussion about geochemical variability within the seep area. Clearly, the limited data set available does not allow such detailed estimates.

Technical Corrections: Pg. 5742, l. 7: please put a space between 'synthetic' and 'clam' Ok

Pg. 5742, l. 23: please put a space between 'animals' and "(“ Ok

Pg. 5743, l. 15: please put a space between 'collapse' and "of" Ok

Pg.5744, l. 20: The name of the database is spelled wrong, please change to PAN-GAEA. Ok

Pg. 5745, l. 13: do you have a reference for the methods used to determine methane/ethane concentrations?

The methods for gas chromatography and flame ionization detection as well for the head space technique will be cited in the revised version of the manuscript

Pg. 5745, l. 18: please put a space between "helium" and "at" Ok

Pg. 5747, l. 15: The name of the online program is capitalized incorrectly; please change to CHIMERA CHECK version 2.7.

We will changed the name to "Chimera Check (version 2.7)" This appears to be the correct spelling

Pg. 5749, l. 4: please put a space between "and" and "seep" Ok

Pg. 5749, l.16: please put a space between "patches" and "(up" Ok

Pg. 5750, l. 20: please put a space between "results" and "have" Ok

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Pg. 5752, l. 23: please put a space between “assemblage” and “in” Ok

Pg. 5753, l. 2: please remove the hyphen between AOM and associated to be consistent This will be written with a hyphen consistently throughout the text

Pg. 5754, l. 4: please change to *Desulfococcus* group (with *Desulfococcus* italicized and group in normal text) Ok

Pg. 5755, l. 6: please put a space between “populates” and “sulphidic” Ok

Pg. 5755, l. 16: please hyphenate sulphate-reducing bacteria Ok

Pg. 5764: Please add the accession numbers to Table 2. Ok

Pg. 5767: Please be consistent in the way the depth below surface is written in the text and legends. The legend of figure 3 has “8 cm bsf” whereas in other parts of the paper it is written as “- 8 cm bsf”, please make corrections as needed. Ok

Pg. 5768: please remove the text about the chloride concentrations from the figure legend. This is redundant to the text and does not relate to the figure. The sentence about chloride concentrations will be removed from the revised version of the manuscript.

Reviewer II

Part I. General Comments Because no current seep activity was detected, I would suggest rewording of the title of the paper writing, for example, “extinct cold seep” instead of “low-activity cold seep”.

We have been thinking about this option for the title ourselves. However, this would not do the Larsen B seep justice. An extinct seep would be a geo-structure without any seep activity like a fossil seep. Since we could detect seep activity, albeit a very low one, we would like to keep the title as it is.

Part II. Detailed Comments Line edits:

1. Please review manuscript thoroughly as several pages have words without spaces,

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it may simply be a formatting issue during submission (e.g. pg 5743 line 15). Ok

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2. Typo pg 5745 line 23 change tan to than. Ok

3. Pgs 5746-7 rate equations do not include isotopic discrimination corrections (_).

Isotopic discrimination factors (α ; 13C vs. 12C) for AOM, AOM-dependent SR and to a lesser degree for MOx are not well constrained. Almost nothing is known about the discrimination against 14C and 35S. Thus, discrimination factors were not included.

4. Pgs 5746-7 are rates corrected by porosity? For AMO rates it is not necessary if methane concentrations were measured for wet sediments, but for SRR rates it is absolutely necessary because SO₄ concentrations were measured in pore waters.

All rates were determined as turnover per volume of sediment and time. Thus, the calculation includes a porosity term (further details can be found in the papers about AOM and SR measurements that have been cited in the manuscript).

5. Pg 5747 lines 7 and 8 are worded poorly. It's not availability of oxygen or sulfate because oxygen and sulfate co-occur. The presence of oxygen dictates which process you observe be it aerobic or anaerobic, adding sulfate into this sentence makes it awkward.

In the revised manuscript, we will make it clearer that oxygen is the preferred electron acceptor for methane oxidation and that AOM is only present under anoxic conditions.

6. Pg 5747 is 30 g of sediment for DNA extraction a typo? Seems excessive, maybe 0.3 g?

We did not use a commercially available DNA extraction kit where indeed an amount of 0.5 g is usually used for extraction. Instead, we followed the approach of Zhou et al '96 (involving higher sediment volumes for extraction and freeze-thaw cycles) to increase the extraction yield and thus to have a better representation of the microbial community in the clone libraries.

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7. In section 3.4 relative proportions of groups of bacteria and archaea are described. It would be good for the reader if these were defined as a percentage of the clone library throughout, rather than qualitative statements (e.g. largest archaeal clone group).

We disagree with this as a percentage figure could easily be mistaken as the *in situ* abundance of microbial groups. For this type of data a FISH or Q-PCR approach would be needed (which we did not perform). The predominance (!) of one OTU often matches *in situ* abundance but not always. The term 'most abundant' etc. is used semantically in the text. Thus we would keep the wording as it is.

8. Pg. 5747 3.2 ' : : : and seep activity' , separate " : : : and seep activity". Ok

9. Pg 5754 line 1 'bacterial partner' should reference Pernthaler et al., 2008, as diverse bacterial partners to ANME are observed.

Good suggestion; the reference will be included in the revised version of the manuscript.

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