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Interactive comment on "Methane emission and consumption at a North Sea gas seep (Tommeliten area)" *by* H. Niemann et al.

Anonymous Referee #1

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Review of " Methane emission and consumption at a North Sea gas seep (Tommeliten area) submitted by Niemann et al. to Biogeosciences.

General comments

Niemann and co-authors present a diverse dataset describing the biogeochemical processes involved in the consumption of methane in the shallow sediments of a North Sea gas seep. The approach is multidisciplinary and includes determination of relevant pore water geochemical profiles, identification of microbial communities (biomarkers and molecular phylogeny), identification of carbon sources and rate measurements. Both unlithified sediments and methane-derived carbonates are investigated. An attempt is made to explain the lateral variability of biogeochemical processes in terms of the shallow subsurface structure of the Delta diapir as deduced from an echsounder profile and the lithologies of the analysed cores. The material in their paper is relevant

to the topics covered in Biogeosciences. No new concepts are presented that improve our understanding of cold seep biogeochemical processes. In fact, biogeochemical processes at the studied seep share the geochemical and microbial characters of other seeps worldwide. However, the knowledge of cold seep biogeochemistry and its variability in the world oceans is still limited and Niemann and co-authors fill in the gap of shallow marine environments. As such, this contribution should be considered for publication in Biogeosciences.

Specific comments

1)Sulfate concentrations do not decrease to zero at the sulfate-methane interface in the three cold seep cores considered. This observation is interpreted as a sampling artefact. If this is the case, then a considerable error in the ex situ sulfate reduction and AOM rate measurements could have been introduced because rates of organic matter-based and methane-based sulfate reduction are very likely dependent on the sulfate concentration. At other seep sites, however, non-zero sulfate concentrations below the SMI are interpreted as due to convective circulation of bottom waters into the sediment. Convection at cold seeps can be driven by salinity and/or temperature contrasts (Henry et al., 1996), entrainment in a gas flow (Haeckel et al., 2004) and emptying of subsurface gas reservoirs (Tryon et al.1999). The origin of the non-zero sulfate concentrations below the SMI at the North Sea sites should be discussed further, as well as the consequences of possible sample contamination on rate measurements should be addressed.

2)In the abstract (line 11) and in page 1215, line 26, the authors conclude that:

“ From these observations it can be concluded that the seeps of the Tommeliten area contribute to atmospheric methane, especially during deep mixing situations in the North Sea ”.

This phrase implies that the observations presented in the article show that increased ocean-atmosphere methane fluxes occur in periods of deep mixing. It is better to state

BGD

2, S523–S526, 2005

that the “ contribution of seepage from the Tommeliten area is likely to be enhanced by deep mixing of North Sea waters ”.

3)In the first part of the introduction the authors state that:

“ the contribution of this process [cold seepage] to the global methane budget and the carbon cycle are not well constrained ”, and that:

“ The main challenge in constraining methane emission from the ocean is the need for quantitative estimates of the abundance and activity of cold seeps of ocean margins ”.

The authors underline here the outstanding problem of quantifying the role of methane seepage to the global CH4 budget. However, their paper does not add knowledge in this field. As it is correctly explained at the end of the introduction, the authors aim is to “ study microbial processes related to methane seepage in shelf sediments ”. The beginning of the introduction should be focussed on the knowledge gap concerning the nature of cold seep biogeochemical processes in shallow seas. The question that the authors address in the paper has to be given more relevance in the introduction. Introductive material on the current ignorance on the role of cold seeps in the global methane budget should be cut considerably.

4)A reference to figure 1 is needed in the introduction when the Tommeliten area is introduced. An inset in figure 1 should be added to show where the Tommeliten area is in the North Sea.

5) At the beginning of section 2.2 the length of the vibrocorer should be specified. This gives the reader an idea of the type of samples he should expected in the rest of the paper.

6)The differences in the ratio of in vitro potential AOM and SR rates between the different sites (section 3.4) should be further discussed. What is the origin of the rather large variability (i.e. 1:1 ratio in core 1904 and 0.3:1 ratio in core 1866)?

7)Page 1215, lines 10 to 21, finishing with “ .....Hovland et al., 1993). ”: This is in-

BGD

2, S523–S526, 2005

troductory material and should go in the Intorduction section of the paper, where the Tommeliten seepage area is introduced.

8)Page 1218, line 13, the MDACs exposed at the surface of the sediment may also have been formed at the surface of the sediment. They are not necessarily formed in the subsurface and subsequently exposed due to erosion.

9)Do the authors have an idea why the archaeal lipids in MDACs are isotopically lighter than those in the sediment (figure 7)?

Technical corrections

Section 2.6, title: The title should read: " Ex situ AOM and SR rate measurements ".

Section 2.6, equation 1: The rate of AOM appears on the left side of the equation as " AOM ". It should be clear that this is a rate. A name analogue to SRR should be introduced for the rate of AOM and should be used in the rest of the paper.

Section 3.1, title: a better title could be " Water column and sea-floor observations ".

Page 1210, line 11: I think the reference to lithology (1) should be changed to (2).

Figure 1: The camera track on my pdf printout is barely visible. The minute indicator " ' " is used in the latitudes and longitudes but degrees are divided in hundredths of a degree.

Figure 4: The number of the core is missing in the legend.

References Henry et al., 1996, Journal of Geophysical Research, 101(B9), 20297-20323. Haekel et al., 2004, Geochimica et Cosmochimica Acta, 68(21), 4335-4345. Tryon et al., 1999, Geology, 27(12), 1075-1078.

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