Biogeosciences Discussions

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Reply on RC2

Claudio Argentino et al.

Author comment on "Sulfate reduction and anaerobic oxidation of methane in sediments of the South-Western Barents Sea" by Claudio Argentino et al., Biogeosciences Discuss., https://doi.org/10.5194/bg-2021-58-AC3, 2021

We thank the reviewer for the useful comments and constructive criticisms, and for providing a pdf file with detailed review. Regarding the lack of deep pore water data, please refer to our answer to Reviewer1 (AC2). At line 170 we described the hydrocarbon composition in gas sample from core 358-GC "dominated by methane, representing 99.8% of the total hydrocarbon gas fraction". We do not report ethane and propane concentrations as they are too low compared to analytical uncertainty. We are aware of the fact that d^2H is fundamental to classify the origin of gas (lines 246-247):" We could not measure the hydrogen isotopic composition for our gas sample, due to limited sample size, and the determination of the gas source was out of the aim of this study.". The good homogeneity in source rock and reservoir spatial distributions is at the base of the high prospectivity of the SW Barents Sea, leading to the discovery of major hydrocarbon fields e.g. Goliat, Snøhvit, Albatross. Deeper Triassic and Jurassic reservoirs generally show a thermogenic composition whereas shallower gas accumulations fit in the area of mixed microbial-thermogenic gas. This has been reported from all over the Hammerfest Basin (Rodrigues Duran et al., 2013) and also in well no. 7122-2-1 at the Caurus field which shows a dominant thermogenic signature in Jurassic sediments (avg $d^{13}C$ =-45‰; d^2H= -218‰) and a mixed composition in shallower Cretaceous accumulations (avg $d^{13}C$ =-55‰; d^2H= -188‰). High amplitude gas anomalies related to shallow gas pockets are common around the study area (Chand et al., 2009; Tasianas et al., 2018) for which a mixed thermogenic-microbial origin has been proposed. Therefore, the origin of gas causing the bright seismic spot in the study area remains unknown, but it is conceivable to hypothesize that the gas accumulated in the subsurface has a mixed microbial-thermogenic origin.

This study aims to emphasize the need of region-specific investigations of SMTZ dynamics and associated SO_4 and CH_4 fluxes, for monitoring the effects of contemporary and future climate change on SMTZ depth and predict the expansion of methane seepage areas at continental margins. There is growing awareness in the scientific community regarding the potential increase in methane emissions from shallow continental shelves and coastal environments due to ocean warming and eutrophication (Wallenius et al., 2021). The figure at the end of the manuscript is not in scale (horizontal) and is a simplified scenario for shallow shelves. It is likely if we consider the occurrence of shallow SMTZs located at few tens of cm to few meters below the seafloor (Egger et al., 2018), and the fact the accelerating high-latitude warming trend may cause a shoaling of the SMTZ due to increasing rates of methanogenesis (Borges et al., 2019; Egger et al., 2016; Humborg et

al., 2019).

Best regards,

Claudio Argentino

On behalf of the authors

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