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A non-steady-state condition in sediments at the gas hydrate stability boundary off West Spitsbergen: Evidence for gas hydrate dissociation or just dynamic methane transport

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In 2008, a large area with several hundred methane plumes was discovered along the West Spitsbergen continental margin at water depths between 150 and 400 m (Westbrook et al. 2009). Many of the observed plumes were located at the boundary of gas hydrate stability (∼400 m water depth). It was speculated that the methane escape at this depth was correlated with gas hydrate destabilization caused by recent increases in water temperatures recorded in this region. In a later study, geochemical analyses of authigenic carbonates and modeling of heat flow data combined with seasonal changes in water temperature demonstrated that the methane seeps were active already prior to industrial warming but that the gas hydrate system nevertheless reacts very sensitive to even seasonal temperature changes (Berndt et al. 2014). Here, we report about a methane seep site at the gas hydrate stability boundary (394 m water depth) that features unusual geochemical profiles indicative for non-steady state conditions. Sediment was recovered with a gravity corer (core length 210 cm) and samples were analyzed to study porewater geochemistry, methane concentration, authigenic carbonates, and microbial activity. Porewater profiles revealed two zones of sulfate-methane transition at 50 and 200 cm sediment depth. The twin zones were confirmed by a double peaking in sulfide, total alkalinity, anaerobic oxidation of methane, and sulfate reduction. d18O values sharply increased from around -2.8 ‰ between 0 and 126 cm to -1.2 ‰ below 126 cm sediment depth. While U/Th isotope measurements of authigenic seep carbonates that were collected from different depths of the core illustrated that methane seepage must be occurring at this site since at least 3000 years, the biogeochemical profiles suggest that methane flux must have been altered recently. By applying a multi-phase reaction-transport model using known initial parameters from the study site (e.g. water depth, temperature profile, salinity, and sediment surface concentrations of CH4, SO4, DIC, and POC) were able to show that the observed twin sulfate-methane transition zones are an ephemeral phenomenon occurring during increase of methane production in the sediment, which can be introduced by, e.g., gas hydrate dissociation.

References

Berndt, C., T. Feseker, T. Treude, S. Krastel, V. Liebetrau, H. Niemann, V. J. Bertics, I. Dumke, K. Dunnbier, B. Ferre, C. Graves, F. Gross, K. Hissmann, V. Huhnerbach, S. Krause, K. Lieser, J. Schauer and L. Steinle (2014). "Temporal constraints on hydrate-controlled methane seepage off svalbard." Science 343: 284-287.

Westbrook, G. K., K. E. Thatcher, E. J. Rohling, A. M. Piotrowski, H. Pälike, A. H. Osborne, E. G. Nisbet, T. A. Minshull, M. Lanoiselle, R. H. James, V. Hühnerbach, D. Green, R. E. Fisher, A. J. Crocker, A. Chabert, C. Bolton, A. Beszczynska-Möller, C. Berndt and A. Aquilina (2009). "Escape of methane gas from the seabed along the West Spitsbergen continental margin." Geophys. Res. Let. 36: doi:10.1029/2009GL039191.