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Controls on methane accumulation and methane fluxes in gassy sediments, Baltic Sea.

Bo Barker Jørgensen (1), Sabine Flury (1), Laura Lapham (1), Henrik Fossing (2), Hans Røy (1), Jørn Bo Jensen (3), and Andrew W. Dale (4)

(1) Center for Geomicrobiology, Department of Biological Sciences, Aarhus University, Ny Munkegade 116, 8000 Aarhus C, Denmark (bo.barker@biology.au.dk; +4589423314), (2) National Environmental Research Institute, Aarhus University, Vejlsøvej 25, 8600 Silkeborg, Denmark, (3) Department of Marine Geology and Glaciology, GEUS, Øster Voldgade 10, 1350 København K, Denmark, (4) IFM-GEOMAR, Wischhofstrasse 1-3, 24148 Kiel, Germany

The accumulation of methane in marine shelf sediments is regulated by a few key parameters, including the burial rate and reactivity of organic matter, the depth of sulfate penetration, and the thickness of the methanogenic sediment deposit. In organic-rich shallow-water sediments methane may exceed the ambient hydrostatic pressure and develop free gas bubbles. The BALTIC GAS project under the EU BONUS Program aims to understand how climate change and long-term eutrophication may affect the accumulation of shallow gas and the emission of methane from the seabed. Studies are made in the Baltic Sea where Holocene mud with high organic content has been deposited over the past 6-8000 years on top of organic-poor late-glacial till and post-glacial clay. The question addressed here is whether gas bubbles exert a positive feed-back on the overall methane formation, thereby enhancing the methane flux once methane accumulation exceeds the threshold of free gas formation.

A detailed study was made in Aarhus Bay situated on the Baltic Sea - North Sea transition. The Holocene mud layer varies here in thickness and gassy sediments are widespread. Thirteen gravity cores were taken along a 600-m long seismic transect going from outside to inside a gassy area. The geochemical zonation could thereby be coordinated with the geological formations and the occurrence of gas. Furthermore, the depth distribution of organic matter mineralization by sulfate reduction was analyzed experimentally by radiotracer incubations. Extrapolation of these mineralization rates into the deep methanogenic zone explained why the methane flux reacts in a non-linear manner to the depth of the Holocene mud layer and is particularly sensitive to the occurrence of free gas. The results provide some general information on the regulation of methane formation in marine sediments.