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Methane Gas Accumulation and Degradation in Aarhus Bay Sediments (Denmark) - a Case Study

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Microbial formation of methane gas is a common phenomenon in northern European ocean margin sediments. Only a fraction of this methane is released into the water column, while large amounts remain in the sediments and build up vast shallow gas accumulations in the Holocene mud. The retention of this gas in the Holocene is controlled by microbial anaerobic oxidation of methane which occurs in a narrow interface layer of sulfate and methane mixing termed the sulfate-methane-transition zone (SMTZ). The effectiveness of this methane barrier is well recognized, but the controlling factors for this process are only poorly understood.

Aarhus Bay, a shallow semi-enclosed basin in eastern Jutland (Denmark) with extended Holocene sediment coverage, was chosen by the EU sponsored project METROL for a case study on the factors controlling the spatial distribution of shallow gas, the associated vertical distribution of the SMTZ, and the related patterns of the relevant fluxes of sulfate and methane.

A high resolution seismic survey revealed that the depth of the upper front of free gas bubbles in the sediment varies between several meters to less than 1 m below the sediment surface. Pore water analyses indicate that the upper boundary of pore-water diluted CH_4 is located considerably above the zone of free gas bubble formation, but that the depth of the SMTZ correlates with the upper boundary of free gas. Based on our pore water analyses, we conclude that the rates of sulfate reduction and anaerobic methane oxidation increase the closer the SMTZ, and thus the CH_4 saturation zone,

reach towards the sediment surface.