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Active methane seepage in the North Sea: Gullfaks and Tommeliten

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The North Sea hosts many subsurface hydrocarbon reservoirs and may hence represent a source of methane to the ocean and atmosphere. However, today, only few active seep areas were found during our studies within the projects METROL and EXOCET, as well as previous studies of methane leakage in the North Sea.

Two of the most active seep areas are found at Gullfaks (61°15'N, 2°15'E) and Tommeliten (56°29'N, 3°00'E) in the northern and central North Sea, respectively. Both seeps were explored with geophysical, molecular and geochemical tools, to identify the pathways of methane in these systems. At both sides AOM related microorganisms were detected via 16S-RNA based clone libraries and CARD-FISH with a dominance of sulfate oxidizers (Beggiatoa), ANME 2a and 2c and SRB related sulfate reducers. The biomarker signals were in agreement with the detected organisms and are typical for cold seep and hydrate-bearing sediments. The seeps of Gullfaks are located within a huge gas and oil field at the edge of the North Sea Plateau. In our seafloor observations Beggiatoa mats, indicating a high sulfide flux from the sediment to the surface, covered large areas of the sandy sea floor. These highly permeable sands allow a rapid advective transport of the seeping methane through the seafloor. In this area methane is the main primary electron donor as indicated by the very low organic carbon content of the sands.

At Tommeliten acoustically detected gas leakage into the water column appeared even stronger that at Gullfaks but Beggiatoa mats or highly active sediments are limited to small spots of < 50 cm in diameter at the seafloor. Poorly permeable, consolidated carbonate-rich clay prevents the dispersion of the methane in the ground. So gas

seepage is limited to a few cracks in the seafloor formed by gas pressure. Only little methane can be oxidized in these narrow zones and some escapes to the hydrosphere and atmosphere.