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Water column methane oxidation in the vicinity of benthic methane seeps in the North Sea and Gulf of Mexico.

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Methane is a potent atmospheric greenhouse gas that has important biological and abiotic sources and is intimately involved in the global carbon cycle. Significant quantities of methane are released from the seafloor and move upward into the water column of continental shelf and slope environments. This upward transfer of CH_4 represents a potentially important source of organic matter to support pelagic production in the overlying water column. The biota of the water column, by consuming CH_4 and incorporating it into biomass, effectively act as a filter to prevent or at least inhibit the movement of CH_4 into the atmosphere, where it contributes strongly to the atmospheric greenhouse effect.

We quantified water column methane concentrations and methane oxidation rates in the vicinity of methane seeps in North Sea and in the Gulf of Mexico (offshore of Louisiana, USA). Benthic methane seeps were located using CHIRP sonar. A CTD rosette was then carefully lowered through the water column to obtain water samples directly in the water column plume. Similar profiles were obtained in control sites, where no water column plumes were evident. In the Gulf of Mexico, profiles were obtained over depths of about 500 m. In the North Sea, profiles ranged in depth from 50 to 150 m. The water column at all the sampled sites was thermally stratified.

In areas of active seepage, methane concentrations were high ($\geq$ 400 nM) in bottom waters and surface ($\sim$10 m) waters were often supersaturated with methane. At control sites without seepage, methane concentrations were low throughout the water column. Bottom waters were well oxygenated (oxygen concentrations exceeded 150 μM) at

all the sites studied, though oxygen concentrations were lower in bottom waters than in surface waters. Methane oxidation rates were highest in bottom waters, mirroring methane concentration profiles. Methane oxidation rates were generally higher in the Gulf of Mexico than in the North Sea. Though high rates of methane oxidation were present in the waters overlying benthic methane seeps, supersaturation of methane in surface waters suggests that some fraction of seep-derived methane escapes to the atmosphere.