

High sea bed methane emission rates at Hikurangi margin (New Zealand) associated with extremely dense populations of ampharetid polychaetes

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Occurrence of gas hydrates and gas seepage from Hikurangi margin sediments has been inferred from BSR structures, methane derived carbonates, gas flares in the water column, and the presence of chemosynthetic bivalve mollusks. Apart from these geophysical indications and sporadic observations by fishermen and scientific dredge samples, detailed biogeochemical studies are missing. We determined the in situ sea bed methane emission and associated fluxes of oxygen, nitrate, sulfate and sulfide at 3 different locations along the Hikurangi margin in water depths ranging from 662 to 1104 m using GEOMAR lander technology. Highest sea bed methane emissions of up to 203 mmol m⁻² d⁻¹ were associated with extremely high abundances of ampharetid polychaetes (10320 ind. m⁻²), highly elevated total oxygen uptake rates (up to 98 mmol m⁻² d⁻¹) and steep pore water gradients of methane, oxygen, sulfate and sulfide. Although members of the family Ampharetidae have been also reported from other cold seep sites and whale falls, this is to the best of our knowledge the first record where these polychaetes constitute key organisms of a cold seep environment. The distribution of the ampharetids was restricted to spatially highly confined patches of darkened sediment at the fringe of extended carbonate concretions. Close to these sites expulsion of free gas from the sea bed has been observed. They live in tubes of organic material that penetrate about 3 cm deep into the sediment. Density and spatial arrangement of their tubes, that extend a few millimeters into the water column, likely affects the current regime of the bottom contact water and therewith physical sediment properties and in consequence the exchange of solutes across the sediment-water interface. Micro gradients of oxygen and sulfide indicate further solute transport along the tubes. Both mechanisms might largely affect methane carbon turnover and release from this particular environment.

Sequential oxidation of arsenite by both permanganate and the reaction byproduct

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Arsenic contamination of soil, surface- and groundwater is of serious concern over the world because of its toxicity and carcinogenicity. One of the most effective ways to remove As from water is to oxidize it to less mobile and less toxic As(V), which can be subsequently immobilized by sorption to various sorbents. This study investigates the effects of permanganate on the oxidation of As(III) at pH 4 and 8 at varying doses of As(III) (10 or 100 µM) and permanganate (1 – 170 µM) in 0.01 M NaNO₃. The solution pH was adjusted to the desired values using 10 mM of either monobasic or dibasic phosphate buffer with 10 mM HNO₃.

The oxidation of As(III) by permanganate at the stoichiometric ratio of As(III) to Mn(VII) (i.e., 3:2 for As(III) oxidation to As(V) with an assumption of Mn(VII) reduction to Mn(IV)-oxide) or at excessive Mn(VII) concentrations is instantaneous at both pH's. In addition, the ratio of oxidized As(III) to reduced Mn(VII) is ca. 2.1, indicating the reaction product is probably Mn(III)-oxide/oxyhydroxide. When As(III) dose exceeds Mn(VII) concentration at pH 8, the excess As(III) is further oxidized by the primary reaction product, which is thereby reduced to dissolved Mn(II). This subsequent heterogeneous reaction between the excess of As(III) and the manganese solid byproduct is slower than the primary reaction. These results indicate that permanganate may be an effective and efficient reagent for As(III) oxidation in water treatment processes.