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Toxic effects of butyl elastomers on aerobic methane oxidation

Helge Niemann (1), Lea I. Steinle (1,2), Jan H. Blees (1), Stefan Krause (2), Ingeborg Bussmann (3), Moritz F. Lehmann (1), and Tina Treude (2)

(1) University of Basel, Dept. of Environmental Sciences, Basel, Switzerland (helge.niemann@unibas.ch, +41 61 2670479), (2) GEOMAR Helmholtz Centre for Ocean Research Kiel, Department of Marine Biogeochemistry, Kiel, Germany, (3) Alfred Wegenener Institute, Meeresstation Helgoland, Helgoland, Germany

Large quantities of the potent greenhouse gas methane are liberated into the water column of marine and lacustrine environments where it may be consumed by aerobic methane oxidising bacteria before reaching the atmosphere.The reliable quantification of aerobic methane oxidation (MOx) rates is consequently of paramount importance for estimating methane budgets and to understand the controls on water column methane cycling. A widely used set of methods for measuring MOx rates is based on the incubation of water samples during which the consumption of methane is monitored, for instance with radio-tracer assays. Typically, incubation vessels are sealed with butyl rubber stoppers because these elastomers are essentially impermeable for gases at the relevant time scales. We tested the effect of different stopper materials (unmodified- and halogenated butyl rubber) on MOx activity in environmental samples and in cultures of methane oxidising bacteria. MOx rates in samples sealed with unmodified butyl rubber were > 75% lower compared to parallel incubations with halogenated butyl rubber seals, suggesting inhibiting/toxic effects associated with the use of unmodified butyl elastomers. To further explore the cause of these effects, we analysed aqueous extracts of the different stoppers. Halogenated butyl rubber stoppers appeared to bleed off comparably little amounts of organics. In stark contrast, extracts of unmodified butyl rubber were contaminated with various organic compounds including potential bactericides such as benzyltoluenes, phenylalkanes and benzuothiazoles. We also found tetramethylthiourea, a scavenger of active oxygen species, which may inhibit the MOx pathway.