Prediction of sediment gas production from sediment properties

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Introduction: Turnover of sediment organic matter under reducing conditions leads to the formation of methane, carbon dioxide and others gases. Disposal and beneficial use of sediments are affected by the evolution of gas by reduction in sediment density, viscosity and shear strength and thereby increased susceptibility of subaquatic constructions or backfills towards erosion. On land, depletion in organic matter causes mass loss and possibly undesired subsidence. Further, methane is a potent contributor to global warming. Release of methane from subaquatic or land-based disposal sites enhances anthropogenic greenhouse gas emissions, poses a threat to human safety and, in the case of landfills, requires collection and treatment of the landfill gas.

Magnitude and rate of gas generation are a function of the content and degradability of sediment organic matter and are therefore subject to spatial and temporal variation on different scales (see Zander et al., this issue). Current investigations (project BIOMUD, www. MUDNET.eu) aim at quantifying differently degradable organic carbon pools in sediments of the Port of Hamburg and linking these pools to sediment properties that are more easily analytically determined. Investigations are based on earlier findings, presented here, on the degradability of fine-grained sediments disposed of in a mono-landfill for dredged material.

Methods: Gas generation on 11 samples of landfilled contaminated fine-grained sediment (aged 2 to 14 years) was assessed with long-term anaerobic incubation of sediments. Density fractionation was carried out using the LUDOX® HS-40 colloidal silica suspension [1, 2]. Analyses of TOC and TN were carried out according to DIN ISO 10694.

Results: Total (i.e. cumulative) gas production varied between 2 and 12 m^3 Mg_{dw}^{-1} and accounted for a share of 3 to 11% of the organic carbon present at the beginning of the incubation experiment (Fig. 2). Gas production could be correlated strongly (r=0.88) to the TN present in the bulk sediment and even better to sediment present in the heavy fraction (r=0.93; data not shown). Between 80% and >98% of bulk TOC (Fig. 2) and between 90% and > 99% of bulk TN were found in the heavy fraction.

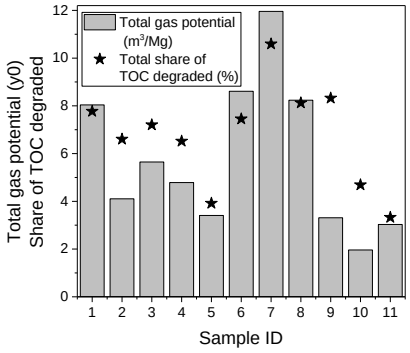

Fig. 1: Gas production and share of degraded TOC.

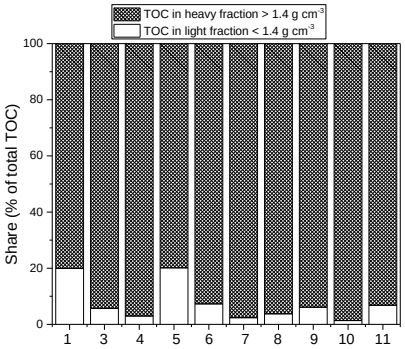

Fig. 2: Distribution of TOC over the light and the heavy density fraction.

Discussion: With increasing sediment age and/or treatment (dewatering, ripening) the degradable organic matter pool is shifted from the light fraction to the heavy fraction, characterized physical protection in organo-mineral complexes, whereas in fresh sediments, this pool is to a much larger extent associated with the light fraction. In both cases, gas production could be predicted from bulk TN, but with higher certainty from TN in the heavy fraction for older sediments (this study) and in the light fraction for younger sediments [2].

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References: [1] Van den Pol-van Dasselaar et al. (1999) *Soil Biol Biochem* **31**:877-886. [2] Gebert et al. (2006) *J Soils Sediments* **6**:75-83.