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Seasonal impact of lugworms (Arenicola marina) on biogeochemical processes and carbon isotope geochemistry of intertidal surface sediments: Results from an in-situ experiment

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Organic matter (OM) is mineralized in marine intertidal sediments by microbial activity using oxygen, sulfate, and metal oxides as major electron acceptors. The oxidation produces carbon dioxide that is a strong green-house gas and may be liberated from the sediments into the overlying water and the atmosphere. OM mineralization in the intertidal zone may be influenced by the activity of bottom dwelling organisms, as the lugworm Arenicola marina, causing bioturbation and bioirrigation of sediments. The isotopic composition of dissolved inorganic carbon (DIC) is a useful tracer for biogeochemical transformation of different carbon sources and was used in this study to identify the key reactions in the carbon-sulfur cycle of intertidal surface sediments. Variations in biogeochemical processes (e.g., sulfate reduction rates, pore water accumulation of metabolites and nutrients) and the carbon isotopic composition of DIC were measured in an intertidal area of Königshafen (Sylt island, North Sea) at lugworm-inhabited control sites and 'exclusion' sites that were free from lugworm activity due to the in-situ introduction of a 1mm mesh net at 10 cm depth on areas of 400 m^2 (Volkenborn & Reise, 2007). Pore waters from experimental plots were sampled in the top 10cmbsf (exclusion sites) and 20cmbsf (control sites) using pore water lances. Water and sediment samples were analyzed for a number of

(bio)geochemical parameters such as grain sizes distribution, temperature, TOC, TIC, DIC, microbial sulfate reduction rates, salinity, pH, sulfate, sulfide, pyrite, AVS, reactive Fe* and Mn*, and the carbon isotopic composition of DIC. Analytical methods include radio tracer incubation, ion chromatography, spectrophotometry, ion-selective electrodes, extraction and titration methods, and C-irmMS. In the surface sediment, OM was mainly oxidized by oxygen and sulfate reduction (de Beer et al., 2005; Al-Raei, in prep.). Highest sulfate reduction rates were found in the top 10 cm and during summer time. No effects of lugworm presence/absence on SRR was detected. Correspondingly, the accumulation of DIC and the light carbon isotope signatures in DIC were found during summer months (down to -5.5 per mil vs. V-PDB). Due to the reduced exchange of pore waters with bottom waters, DIC at the exclusion sites was isotopically enriched in C-12 compared to the control sites. Acknowledgements: The research is supported by Max-Planck Society, Leibniz IO Warnemünde, Sylt Wadden Sea Station, and partly by Deutsche Forschungsgemeinschaft (JO 307/4-2).