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Abnormally high acoustic sea-floor backscatter patterns in active methane venting areas, Dnepr paleo-delta, northwestern Black Sea

L. Naudts (1), J. Greinert (1,2), Y. Artemov (3), S.E. Beaubien (4), C. Borowski (5), M. De Batist (1)

(1) Renard Centre of Marine Geology (RCMG), Universiteit Gent, Krijgslaan 281 s8, B-9000 Gent, Belgium, (Lieven.Naudts@UGent.be), (2) Leibniz-Institut für Meereswissenschaften, Wischhofstrasse 1-3, 24148 Kiel, Germany, (3) A.O. Kovalevsky Institute of Biology of the Southern Seas NAS of Ukraine, Pr. Nakhimov 2, 99011 Sevastopol, Ukraine, (4) Department of Earth Sciences, Rome University La Sapienza, Piazalle Aldo Moro 5, I-00185 Roma, Italy, (5) Max-Planck-Institut für Marine Mikrobiologie, Celsiusstrasse 1, D-28359 Bremen, Germany

During the 58^{th} and 60^{th} cruise of R.V. Vodyanitskiy, conducted in the framework of the EU-funded CRIMEA project, almost 3000 active bubble-releasing seeps were detected with an adapted split-beam echosounder within the 1540 km^2 of the studied Dnepr paleo-delta area. The distribution of these active seeps is not random, but is controlled by morphology, by underlying stratigraphy and sediment properties, and by the presence of gas hydrates acting as a seal and preventing upward migrating gas to be released as bubbles in the water column (Naudts et al., 2006).

Here we present the relation between acoustic sea-floor backscatter and the distribution of more than 600 active methane seeps detected within a small area on the continental shelf. This study is further sustained by visual sea-floor observations, high-resolution seismic data, pore-water data and grain-size analysis.

The backscatter data indicate that seeps are generally not located within high-backscatter areas, but rather surround them. Most seeps are located within shallow pockmarks which are characterized by medium-backscatter values, whereas deeper pockmarks have high-backscatter values with much lower seep densities. The seismic data show the presence of a distinct gas front (free gas); shallow gas fronts correspond to high- and medium-backscatter areas, which are associated with gas seeps, whereas deep gas fronts correspond to low-backscatter areas without seeps. The presence of shallow gas is also confirmed by the pore-water data, showing higher amounts of dissolved-methane concentrations for areas with medium- to high-backscatter values. Visual observations showed that the high-backscatter areas correspond to white *Beggiatoa* mats. These thiotrophic bacterial mats are indicators for the anaerobic oxidation of methane (AOM) which results in the formation of methane-derived carbonates (MDAC's). AOM was also confirmed by the pore-water data. No clear correlation with grain-size distribution could be established.

Based on the integration of all datasets, we conclude that the observed high-backscatter anomalies are a result of methane-derived authigenic carbonates (MDAC's). The carbonate formation appears to lead to a gradual (self)-sealing of the seeps (Hovland, 2002), followed by a relocation of the bubble-releasing holes. Furthermore, the degree of MDAC-formation is directly linked to the backscatter intensity and seep activity which makes it possible to use the backscatter strength as a proxy for the seep activity and distribution.

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