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The use of acoustic seafloor backscatter measurements for quantitative and qualitative characterization of methane seep areas

L. Naudts (1), J. Greinert (1,2), Y. Artemov (3), M. De Batist (1)

(1) Renard Centre of Marine Geology (RCMG), Gent University, Krijgslaan 281 s8, B-9000 Gent, Belgium (Lieven.Naudts@UGent.be), (2) Leibniz-Institut für Meereswissenschaften, Wischhofstrasse 1-3, 24148 Kiel, Germany, (3) O. Kovalevsky Institute of Biology of the Southern Seas NAS of Ukraine, Pr. Nakhimov 2, 99011 Sevastopol, Ukraine

During the 2003 and 2004 cruises of the EC project CRIMEA almost 3000 active methane seeps were detected with an adapted scientific split-beam echosounder in the Dnepr paleo-delta area in the NW Black Sea (Naudts et al., in press). The seeps are widely, but not randomly, distributed over the transition zone between the continental shelf and slope, in water depths of 66 to 825 m. The highest concentration of seeps occurs on the shelf, in water depths of 80 to 95 m. Here, the location of the seeps is controlled by the underlying geology (filled channels) and seepage is characterised by the presence of pockmarks and high acoustic seafloor backscatter, visible on both multibeam and side-scan sonar data.

Since seep detection during the CRIMEA cruises was performed independently but simultaneously with the multibeam and side-scan sonar recordings, these datasets possess a great potential for quantitative and qualitative analyses of acoustic seafloor backscatter in relation to the seep locations. Our analyses are further sustained by visual observations, high-resolution 5 kHz seismic data and sediment samples from gravity and multi-coring.

For this study we selected an area of 37 km2 on the shelf. Within this area the normalized multibeam backscatter values ranges from -28.32 dB to 20.42 dB. After eliminating high-backscatter values caused by high topographic gradients, all seep positions within this area correspond to backscatter values of more than -2.89 dB and have a standard normal distribution. Furthermore, no seeps occur at locations characterised

by the highest backscatter values. Within the area, 99.3 % of the seeps correspond to backscatter values ranging between -1.39 and 4.60 dB.

These data indicate that actively bubbling seeps do not necessarily correspond to the highest backscatter values as would be expected; they rather surround the high-backscatter areas. This is also clear from visual observations in which bubbles are seen to emanate at the perimeter of white Beggiatoa mats. Since Beggiatoa mats are commonly associated with the precipitation of authigenic carbonates formed via AOM, these carbonates are very likely to be the cause of the higher backscatter values. Sediment samples and visual observation also indicated that areas corresponding to higher backscatter values are characterised by more shell material in the first 5-10 cm of the seabed.

Also pockmarks are characterised by typical backscatter patterns. Better evolved, deeper, pockmarks are characterised by higher backscatter values and the seep activity is lower than at shallow pockmarks, which are often active bubbling. This could be explained by some sort of self-sealing of these seeps, as postulated by Hovland (2002).

All these observations at the seafloor are clearly a result of the underlying geology where fluid migration is focussed to the sides of filled paleo-channels. The seismic data show the presence of a distinct "gas front" that locally domes up to the seafloor. These areas of gas front updoming on the shelf are characterised by seeps, higher backscatter values, Beggiatoa mats and pockmarks.

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Hovland, M., 2002. On the self-sealing nature of marine seeps. Cont. Shelf Res. 22, 2387-2394.