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# Subsurface and morphologic setting of 2778 methane seeps in the Dnepr paleo-delta, northwestern Black Sea

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The Dnepr paleo-delta area in the NW Black Sea is characterized by an abundant presence of methane seeps, which were observed for the first time by Polikarpov et al. in 1989. During the CRIMEA expedition of May-June 2003 and 2004 detailed multibeam, seismic and hydroacoustic water-column investigations were carried out in the area to study the relation between the spatial distribution of the methane seeps, sea-floor morphology and subsurface structures.

During the two expeditions, 2778 new methane seeps were detected on echosounding records in an area of 1540 km$^2$. All seeps are located in the transition zone between the continental shelf and slope, in water depths of 66 to 825 m. The integration of the hydroacoustic and geophysical datasets clearly indicates that methane seeps are not randomly distributed in this area, but are concentrated in specific locations.

The depth limit for the majority of the detected seeps (725 m water depth) coincides more or less with the stability boundary of pure methane hydrates. This suggests that, where gas hydrates are stable, they play the role of buffer for the upward migration of methane gas and thus prevent seepage of methane bubbles into the water column.

Higher up on the margin, gas seeps are widespread, but careful mapping and integration of the datasets illustrates that seeps occur preferentially in association with particular morphologic and subsurface features. On the shelf the highest concentration of seeps can be found in combination with elongated depressions. On the continental slope seeps are concentrated on crests of sedimentary ridges, in the vicinity of canyons (bottom, flanks and margins) or in relation with submarine landslides. The seismic data show the presence of a distinct “gas front” within the sea-floor sediments, which is characterised by acoustic blanking and enhanced reflections. The depth of this gas front is variable and locally it domes up to the sea floor. These areas of gas front updoming coincide with areas where seeps were detected in the water column. A regional map of the subsurface depth of the gas front emphasises this “gas front – seep” relationship.

The integration of all data sets allows us to suggest that the spatial distribution of methane seeps in our study area is controlled by several factors (stratigraphic/ sedimentary/ structural). The presence of seeps at the crest lines of the sediment ridges can be a result of relief inversion. Coarse-grained sediments deposited on canyon floors can act as a focused conduit for seepage. As a result of the seepage, sediments are carbonate-cemented and stand out as ridges after a period of erosion. Seeps associated with submarine landslides can be due to upward migration of fluids along faults, resulting in a reduction of slope stability or can be the result of steepened pore-pressure gradients adjacent to scarps due to the sudden erosion associated with slumping.