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Intense gas bubble emissions in the Kerch seep area – A newly discovered high-flux seep site in the Black Sea

M. Römer (1), H. Sahling (1), T. Pape (1), A. Bahr (2), T. Feseker (1), P. Wintersteller (1), and G. Bohrmann (1)

(1) MARUM - Center for Marine Environmental Sciences and Department of Geosciences, University of Bremen, Germany, (2) Institute of Geosciences, Goethe-University Frankfurt, Germany

More than 500 bubble-induced hydroacoustic anomalies (flares) were found in the water column above the seafloor in the study area comprising about 430 km2 at the Don-Kuban paleo-fan (Eastern Black Sea) by using ship mounted single beam and multibeam echosounders. Almost all flares originated from the seafloor above the gas hydrate stability zone (GHSZ), which in that region is located below ∼700 m water depth. This observation confirms the sealing mechanism of gas hydrate, which impedes migration of free gas through the GHSZ and subsequent bubble emission from the seafloor. However, an intense seep site, called the "Kerch seep area" was discovered as an exception at 890 m water depth well within the GHSZ.

In situ temperature measurements in shallow sediments indicate locally elevated temperatures probably caused by enhanced upward fluid flow. The base of the GHSZ in this region is generally situated at about 150 m below the seafloor. However, the local thermal anomalies result in a thinning of the gas hydrate occurrence zone to only a few meters below the seafloor and allow free gas to reach the seafloor.

At sites where gas migrated into near-surface deposits, shallow gas hydrate deposits evolved and up-doming of overlying sediments led to the formation of mounds rising several meters from the surrounding seafloor. Further gas bubbles ascending from greater depth are accumulated below the gas hydrate layer at the base of the mound structures and migrate horizontally to their rims. At the mound edges gas bubbles either might form fresh gas hydrates and increase the extent of the mound structures by pushing up overlying sediments or escape at several sites into the water column. Two mounds were mapped in ultra-high resolution during dives with the autonomous underwater vehicle 'AUV MARUM SEAL 5000'.

Several individual flares were detected in the Kerch seep area using hydroacoustic systems. Repeated surveys in that area conducted during three cruises within four years suggested that gas discharge varied spatially and temporally while the total number of flares remained rather constant. During seafloor inspections with MARUM′s remotely operated vehicle 'ROV QUEST 4000 m' gas bubble emission sites were investigated in detail. Gas bubbles collected during the ROV dives mainly consisted of methane predominantly of microbial origin. By analyzing the high-definition video material the gas flux from several bubble emission sites was calculated. In combination with the hydroacoustic results (flare distributions) it is estimated that about 2.2 – 87 × 106 mol CH4/yr are emitted from the seafloor at the Kerch seep area. Despite this high mass of methane injected into the hydrosphere, the peak of the highest flares at ∼350 m water depth as revealed by echosounder recording suggest that the ascending methane completely dissolves in the water column and does not pass the sea-atmosphere boundary.