Investigations on Gas Hydrate Occurrences in the Western Black Sea with the Sputnik Controlled Source Electromagnetic System

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In early 2014, a marine controlled source electromagnetic (CSEM) experiment was conducted over gas hydrate targets in the Danube Delta off the coasts of Bulgaria and Romania. The cruise (MSM35 on R/V Maria S. MERIAN, part of the German SUGAR Project) was aimed to study submarine gas hydrates as a source of methane and possible sink for CO2 sequestration. Within European waters the Black Sea is one of the most prospective hydrocarbon areas with thick sedimentary basins. The existence of an extended gas hydrate stability zone and the observation of multiple bottom simulating reflectors (BSR) in the western part indicate a huge gas hydrate potential in sandy sediments. Low pore-water salinities between 1 and 4 ppt have been observed in borehole data at depths below ~30 mbsf, and are attributed to sea level low stands in the past. Experiments were carried out in two working areas in water depths of 1400m and 600m, respectively, which are at a distance of about 60km. In both working areas temperature and pressure conditions in combination with results from seismic investigations indicated potential occurrences of gas hydrates. In workarea 1, 12 receiver (RX) stations were positioned along two parallel, NE -SW striking profiles consisting of six stations each and with spacing between stations of about 300 m and a separation of the two profiles of about 500 m. Transmissions with the Sputnik transmitter (TX) system, which has two perpendicular horizontal TX polarizations, were then conducted at 81 different locations along three profiles with lengths between 2.5-3km each. A similar experiment with 11 RXs and 49 TXs was carried out in workarea 2.

The acquired data were first processed to yield transient rotational invariants for each RX-TX pair, which were then inverted in terms of 1D common-mid point (CMP) inversions. Results of workarea 1 suggest that there are two resistive layers starting at a depth of 70m and ~200m, respectively, which is well consistent with the seismic data. Since low pore-water salinities are not sufficient to explain the obsereved high resistivities, high saturations of gas or gas hydrates are the likely cause. Similar results with two resistive layers and possibly a third resistive layer at greater depth were found in the interpretation of data from workarea 2.