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3D seismic investigations of the Sevastopol mud volcano in correlation to gas/fluid migration pathways and gas hydrates occurrences in the Sorokin Trough (Black Sea)

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The Sorokin Trough forms a 150 km long and 50 km wide structural depression along the south eastern margin of the Crimean Peninsula at water depths of 800 - 2000 m. The trough, evolved in Oligocene time during the Crimean-Alpine folding, is considered to be a foredeep of the Crimean Mountains and belongs to a system of Oligocene-Miocene troughs located in the Eastern Black Sea Basin as e.g. the Kerch-Taman and Indolo-Kuban Trough. In the southeast, the Sorokin Trough is bordered by the buried Cretaceous-Eocene Shatsky Ridge and Tetyaev Rise. A compressional tectonic regime due to the northward movements of the Shatsky and Tetyaev Ridge affects the growth of diapiric structures and facilitates fluid and gas migration to the seafloor. This is expressed by a large number of mud volcanoes evolved above the diapirs and near-surface gas hydrates occurrences, which were sampled from several mud volcanoes.

In the frame of the MARGASCH Project (Meteor Cruise M52/1 in January 2002), a high-resolution multi-channel-seismic survey was carried out to study the evolution and formation of mud volcanoes correlated to gas/fluid migration and gas hydrates occurrences. The seismic survey was divided into two parts. Initially, 44 seismic lines were shot as overview profiles to image the general structures of the study area. The western overview profiles show a complex pattern of diapiric ridges and sedimentary basins. Mud volcanoes of varying morphology were observed next to amplitudes anomalies, indicating gas/fluids and gas hydrates. Based on these results, a 2.5 km x 7.5 km large box in the western Sorokin Trough was chosen for a three-dimensional

survey. Our 3D acquisition geometry consists of a series of 81 closely spaced 2D lines (line spacing=25 m) striking in the NNW-SSE direction. The goal of the 3D survey was to resolve the structural variability observed in the overview lines.

The 3D area is characterized by two sedimentary basins with well stratified bedding separated by an EEN-WWS trending diapiric structure consisting of two diapiric ridges. A deep fault system reaching up to the seafloor is developed between the diapiric ridges. In the central survey area the Sevastopol mud volcano is evolved on the seafloor above these faults. The mud volcano is characterized by a collapsed depression with two cone-shaped mounds inside. We suppose that the mud volcano is fed from the diapir by fluids arising along the faults towards the seafloor. Bright Spots in direct vicinity to the mud volcano indicate a close interaction of free gas/fluids, gas hydrates and the evolution of the mud volcano. Bright Spots are identified either on the diapiric top or at the updip terminations of strata with the north-western flank of the diapir at a relatively constant depth of 300-400 ms TWT beneath the seafloor. These high amplitudes are probably caused by underlain free gas in the sediments. Gas and fluids preferably migrate along weakness zones to the top of the diapir where they accumulate, if a seal exists. Due to the constant depth of the Bright Spots in the complete western area of the Sorokin Trough and sampled near-surface gas hydrates occurrences, we speculate that the Bright Spots represent the base of the gas hydrate stability zone (BGHSZ) and that gas hydrates, acting as seal for gas, are present above. Variations in depth of the Bright Spots could be explained by varying fluid flow. Micro faults above the diapiric top are considered to be potential pathways for gas and fluids migrating into the GHSZ and supplying the gas hydrates reservoir. We suggest that gas hydrates are formed locally where fluid flow occurs and expect gas hydrates occurrences above the diapiric top and in the surrounding of the mud volcano. Despite the sampled near-surface gas hydrates, bottom simulating reflectors were not observed in our seismic lines.