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Evidences of fluid-saturation in near-surface sediments in northern Barents Sea shelf

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Arctic shelves represent ideal targets for research investigations since they feature numerous oil and gas provinces with high exploration potential. The Barents Sea is one of the largest prospective hydrocarbon basins in Russia, however, only few and scattered geological and geophysical surveys have been conducted.

The Barents Sea region largely developed under the influence of Quaternary glaciations, as highlighted by the characteristics of the uppermost sedimentary section and, more distinctively, in the near-surface deposits. During the last deglaciation dense subglacial accumulations were deposited almost ubiquitously. These units often serve as litho-geochemical barriers, preventing the migration of fluids from deep horizons to the surface. Therefore, standard surface geochemical surveys are difficult to be applied in such a complex geological setting.

This study presents new evidences of fluid saturation of near-surface sediments in the northern part of the Russian Barents Sea, especially from the poorly studied region between Novaya Zemlya and Franz Josef Land. Multibeam bathymetry, sub-bottom profiler data and high-frequency seismic data were collected during the international scientific «Training-through-Research» cruises TTR-19 and TTR-20 on the R/V «Akademik Nikolaj Strakhov» in 2020 and 2021.

Acquired data reveal that bottom sediments are characterized by extremely low methane content: background concentrations are 1-5 ppm, with highest measured values not exceeding 85 ppm. Methane homologues (C2-C5) are present in trace amounts. In this regard, we focused to additional potential indirect indicators of possible fluids migration. The acquired geophysical data allowed to identify areas where bedrock and tectonic faults reach the seafloor. Here amplitude anomalies were typically observed under the base of the glacial complex suggesting recent fluid migration. Bathymetry data allowed detecting fields of pockmarks, blow-out crater and «hill-hole pair» type structures. The formation of these structures is likely associated with focused fluid discharge. In addition, «flares» were also observed on the profiler data, suggesting ongoing fluid discharge in the water column.

Localities characterized by geophysical anomalies were sampled with gravity cores. Sediments

cored at these sites revealed lithological indicators of fluid discharge including: core swelling, the presence of degassing channels, uneven compaction of the sediment. Further, the presence of a large amount of hydrotroilite within the sediments and methane-oxidizing Pogonophora worms, typically present at methane-degassing sites, may reflect increased concentrations of organic carbon.

Compiling the fluid migration indicators collected during our multidisciplinary surveys, we created a schematic map of localities characterized by modern and palaeo fluid discharge in the northern part of the Barents Sea shelf. This scheme contains integrated probability of the connection of detected features with fluid saturation and, thus, allows us to predict the most prospected areas for fluid discharge investigations. This study highlights that combined geophysical and seafloor sampling techniques represent a valuable tool to detect hydrocarbon migration even in difficult geological settings.