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Methane hydrates of the Russian Arctic seas: forecasts of distribution and resource assessment

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This paper summarizes results of the VNIOkeangeologia assessment of the undiscovered in-place gas hydrate (GH) resources for the Arctic seas within the limits of the 200 nautical mile Russian Federation Exclusive Economic Zone (RF EEZ).

The thickness and distribution of the gas hydrate stability zone (GHSZ) both for the cryogenic and filitrogenic GH within the study area was determined by use of various data obtained from Russian scientific reports and scientific publications. The base of the relic permafrost within Russian Arctic seas (0°C isotherm) occurs at the depths more than 260 m irrespectively from the water depth [1]. The calculated volume of the GHSZ related to the relic permafrost is $2.5 \cdot 10^{14} \text{ m}^3$. Routine method described in [2] was used in order to define pressure-temperature conditions for the filitrogenic GH. The calculations were based on distribution of measured bottom water temperatures, salinity and heat flow assuming the pure methane as a hydrate-forming gas. These data together with the available seismic and sediment gas chemistry datasets allowed revealing hydrate-prone areas for the filitrogenic GH. Some of these areas are characterized by the presence of high methane concentrations in the shallow sediment and evidences of hydrocarbon gases migration suggesting favorable conditions for methane generation. These data were incorporated for the resource assessment by using specific analogy factor varying from 1 (proved GH) to 0.5 (an absence of any GH indications). For the Russian Arctic seas (within the limits of RF EEZ) total area of GHSZ distribution is estimated as much as 1 843 845 square km. The GHSZ with thickness of 200-400 m (filitrogenic and cryogenic GH) is estimated to reach of 792 072 square km, whereas that of 0-200 m (filitrogenic GH) occupies an area of 37 471 square km.

The undiscovered in-place GH resources were calculated using analogy approach taking into account the analogy factor. While hydrate resources are well characterized at the European Arctic at the Nyegga site offshore mid-Norway [3] that have significant hydrate gas resources and the Arctic frontier basins offshore Russia are underexplored with little information about the GH, therefore, the analog method provides a way to understand the frontier basin by comparing the basin with the proven hydrate resources. The minimum, average and maximum values of total in-place GH resources for the Barents, Kara, Laptev, East Siberian and Chukchi seas are estimated as 0.83, 9.31, and 12.51 trillion cubic meters

of gas (TCM), respectively. It should be noted, that gas hydrate resources are assessed as in-place volumes and reported as the amount of natural gas that occur in the form of gas hydrate in the subsurface of the studied area, without regard to technical recoverability and individual accumulation size.

References:

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[3] Senger K. et al. (2010) *Energies* 3: 2001-2026

