independently eliminates the emergency situations occurrence during diagnostic work, and kinematics provides unlimited maneuvering in a complex pipeline manifold.

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GEOCHEMICAL FEATURES OF THE CHEMICAL COMPOSITION OF THE BOTTOM WATER OF THE LAPTEV SEA

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Evaluation of the exchange of chemical elements at the natural boundaries of the seas is the basis for understanding the cycle of substances on our planet.

In the system water - rock - gas - organic matter V.I. Vernadsky, attached decisive importance in the formation of the composition of water not to rocks, but to gases and organic matter (Falkowski et al., 2000; Reeburgh, 2007). In this regard, the work is devoted to the study of the chemical composition of near-bottom sea waters under conditions of methanogenesis.

The main point in identifying the features of methane manifestations in the seabed water is the comparison of the abundance of chemical elements in the seabed water at the anomalous (6492) and background (6491) stations in the Laptev Sea. Anomalous station - a station at which samples of the bottom sea and pore water were taken at the places where the bubbly gas emerged. The background station is located close to the anomalous one, the difference is that no methane gas unloading was observed at this sampling point.

The data used in the work was obtained in September-October 2019 during the 78th expedition on the research vessel "Akademik Mstislav Keldysh". Bottom seawater samples were taken with bathometers by sounding with the Rosette complex.

The bottom water temperature varies from -0.3 to 0.27 ° C. In terms of acid-base properties, the bottom sea water is slightly alkaline, the pH is 8.23 at the background station (6491), and 8.13 at the anomalous sampling point (6492) (Table 1). These values are characteristic of the redox conditions of the geochemical environment of ordinary seawater with pH values of about 8.2 and Eh = + 0.3 mV. (Garrels Christ)

The oxygen content is 11.9 mg / L at the background level and changes to 8.5 mg / L at the abnormal level. Alkalinity is 2.65 / 161.65 at a depth of 23.9 and pH 8.23 and 2.95 / 180 at a depth of 20.3 m and 2.71 / 165.3 at a depth of 20.4 m with a pH change of 8.13 and 8.07, respectively. The concentration of nitrates is 3.42 mol (212.2 mg / l), and the concentration of ammonium ion is 1.29 on the surface and 0.97 at a depth of 23.9 m at the background station and 1.01-1.25 mol / 18.2-22.5 mg / l at a depth of 20.3-20.4 m. The ratio of nitrates to ammonium is more than 9.4, the predominance of oxide forms of nitrogen indicates the oxidative nature of the geochemical environment. The phosphate content in the bottom water at the anomalous station is 0.225 mol / 94.97 mg / l.

Table 1

Chemical composition of the sea bottom water at the background and anomalous stations in the Laptev Sea

№ station	T	pH	M*	HCO_3^-	SO_4^{2-}	Cl^-	Ca^{2+}	Mg^{2+}	Na^+	K^+	Br^-	Si
units	°C	ед.pH	мг/л	мг/л	мг/л	мг/л	мг/л	мг/л	мг/л	мг/л	мг/л	мг/л
6491	-0,3	8,23	30100	162	2074	16821	280	1003	9634	163	63	1,09
6492	0,27	8,13	28100	158	1904	15586	250	946	8839	297	52	1,27
6492	0,27	8,07	27960	165	1720	15829	183	987	8954	226	52	1,02

The values of the total salinity in the studied waters are 30099.89 mg / l (background station) and increase to 28100 mg / l (anomalous station). At the same time, in the waters of the background station, the geochemical coefficient Cl / Br

corresponds to the values of sedimentation waters at the background station and slightly increased in the waters of the anomalous station.

In terms of chemical composition, the sea bottom water is sodium chloride at the background station (1) and at the anomalous (2).

$$M_{30,1}\frac{Cl\,91\ \ SO_4 8\ (HCO_3)1}{Na81\ Mg16\ Ca3\ \ K1}pH8{,}23\ \mathrm{T}(-0{,}3)^{\circ}\mathrm{C}$$

$$M_{28,1}\frac{Cl\,91\ \ SO_4 8\ (HCO_3)1}{Na81\ Mg16\ Ca3\ \ K1}pH8{,}13\ \mathrm{T}(0{,}27)^{\circ}\mathrm{C}$$

Sulfate ion concentrations vary significantly. In the near-bottom waters at the background station, the sulfate ion concentration is 2074 mg / l, and at station 6492, they have lower values of 1904 mg / l. At the same time, with respect to the chlorine content, other anions retain similar ratios both in the waters of the background and anomalous stations. The cationic group of elements has a similar tendency.

Concentrations of calcium, magnesium and sodium in the waters of the background and anomalous stations change insignificantly. Only the behavior of potassium differs sharply from the rest of the cations. The concentration of potassium in the bottom waters of the anomalous station is higher than in the background, 297 mg / l and 163 mg / l, respectively.

The chemical composition of the bottom seawater shows that the effect of methane unloading is observed on the example of pH. The pH values are influenced by the geochemical environment, which is directly related to the redox potential. At anomalous stations in places of bubbly gas manifestation (methanogenesis processes), the concentrations of chemical elements also exceed the concentrations of chemical elements in the bottom seawater by several times, but the nature of their distribution differs significantly in values, which can be traced from the composition of the concentration series of chemical elements. Due to the influx of sources of methanogenesis into the waters, the prevalence of chemical elements in the reducing conditions of the geochemical environment increases.

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ANALYSIS OF BARRIER FLOODING EFFICIENCY AT KIENGOPSKOYE FIELD

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The development of oil rims is getting more relevance every year. Many fields in Russia are complicated by the presence of a gas cap. Barrier flooding is mainly used in case of edge oil rims as presented in work [7]. Average effective oil rim thickness at Kiengopskoye field is 3 meters, but the gas cap is greater. Moreover, the distance between gas-oil contact and oil-water contact is 26 meters, and it contributes to the formation of aquatic and gas cones near production wells. According to the well tests, the average permeability is 0.138-0.149 mD. The average value of the dynamic viscosity of oil is 12.88 mPa s [1]. In case of two-phase flow of oil and gas, gas will move faster to the production well. But the more viscous the oil, the greater the role of this effect. The problem is explored in work [3].

The analysis of barrier flooding of at Kiengopskoye field. Initial formation pressure is 118 atm. According to the current information, reservoir pressure is estimated at 116 atm. As it is close to the initial value, barrier flooding is considered to be the most effective [6].

The process of barrier flooding started in 2013. As of 01.01.2019, there are 9 injection wells.

To systematize the analysis, the entire area was divided into several cells, including all the operating wells. The efficiency of each cell was evaluated separately. The analysis considered:

- technological parameters of injection and production wells;
- the dependence of the injection wells location;
- the period of the barrier formation after bringing the well into production.