Sobolev Institute of Geology and Mineralogy SB RAS (IGM SB RAS)
Trofimuk Institute of Petroleum Geology and Geophysics SB RAS (IPGG SB RAS)
Novosibirsk State University (NSU)

8th INTERNATIONAL SIBERIAN EARLY CAREER GEOSCIENTISTS CONFERENCE

13-24 June 2016

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HYDROGEOCHEMICAL FEATURES OF THE NORTHEASTERN PART OF THE BOL'SHAYA KHETA MEGASYNECLISE

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Administratively, the study area is located in the Krasnoyarsk region of the Russian Federation, and in terms of tectonic zoning is confined to the northeastern part of the Bol'shaya Kheta megasyneclise, which is a large negative structure isolated in the West Siberian geosyneclise.

The section of the sedimentary cover is represented by the Triassic, Jurassic, Cretaceous and Quaternary sedimentary rocks. According to the conducted hydrogeological stratification, two hydrogeological stages, differing in their hydrodynamic and hydrogeochemical characteristics, have been distinguished. The upper stage, characterized mainly by a free water cycle, is represented by Quaternary and Upper Cretaceous sediments of up to 550 m in thickness. All deposits are aquifer, and hydrodynamically the complex represents a single water-saturated stratum. Nevertheless, the study area is characterized by continuous permafrost rocks, which exclude the most part of the upper stage section from the free water exchange.

Below clayey rocks of the Upper Cretaceous Dorozhkovskaya Formation occur, which are considered as a regional Turonian seal (up to 150 m thick) separating the permeable horizons of the upper and lower hydrogeological stages.

Within the lower hydrogeological stage (from bottom to top), undifferentiated Triassic-Paleozoic, Lower-Middle Jurassic, Upper Jurassic, Neocomian and Aptian-Albian-Cenomanian hydrogeological complexes have been distinguished.

The main object of research is the Neocomian and Aptian-Albian-Cenomanian complexes. The greatest amount of information is obtained on the Neocomian oil-and-gas prospective hydrogeological complex. The Lower-Middle Jurassic, Upper Jurassic and Aptian-Albian-Cenomanian complexes are much less studied.

The results of geochemical analysis of 353 groundwater samples, including 245 samples from the Neocomian complex and 37 samples from the Neocomian - Aptian-Albian-Cenomanian complex, provided factual information (Table 1).

Ground waters from fresh to brackish are common within their limits. Waters of chloride sodium type (by classification of Shchukarev S.A.) are dominating. Within the Aptian-Albian-Cenomanian aquifer complex, ground waters with salinity from 2.4 to 17.0 g/L are developed. Total content of sodium and potassium varies from 0.8-5.9 g/L, chlorine content - 1.3-10.3 g/L, hydrogen-ion – 0.03-1.40 g/L. Sulfate content of water is no more than 53.1 g/L. Bromine content in waters is 4.8-76.5 mg/L, iodine – 1.8-13.1 mg/L, and boron – 1.2-60.0 mg/L.

The total salinity of the Neocomian complex varies within the range 0.7-23.5 g/L. The total content of sodium and potassium ranges within 0.2-6.0 g/L, chlorine content – 0.2-13.3 g/L, sodium ion - from trace amounts to 1.3 mg/L and to 4 g/L. The sulfate ion is present in theamount of no more than 1.2 g /L. The water contains iodine – 0.6-95.2 mg/L, bromine – 0.5-126.4 mg/L, and boron – 0.1-100.0 mg/L. Water-dissolved gas contains methane – 81.2-98%, heavy hydrocarbons to hexane inclusive – 0.1-3.4%, nitrogen – 0.7-17%. Carbon dioxide accounts for 3%.

During diagenesis and catagenesis, significant changes in the chemical composition of buried waters, their mixing with thermodehydratational and elision waters occur in the "water-rock-gas-organic matter" system, so it is very difficult to establish their initial genesis. One can try to determine their origin only in the zones of hindered water exchange through indirect signs

(genetic coefficients). As indicators reflecting the groundwater genesis, there have been assumed genetic factors, rNa/rCl (r − mole fraction) and Cl/Br, proposed by V.A. Sulin, which characterize the quantitative relationships between various components of water.

Table 1 - The type groundwater composition of Bol'shaya kheta megasyneclise northeastern part

Hydrogeological complex	Total sample	Salinity	$Na^+ + K^+$	Cl^-	SO_4^{2-}	HCO_3^-	Ca^{2+}
		g/L			mg/L		
Triassic-Paleozoic	4	7.0-21.1 13.2	1.1-7.8 4.4	0.7-12.8 7.0	17.3-47.7 35.8	146.5-1311.9 471.3	4.8-352.7 208.8
Lower-Middle Jurassic	50	2.0-23.3 9.1	1.1-8.3 3.1	1.1-14.0 3.7	4.8-816.0 150.8	16.0-6102.0 1915.7	1.2-1147.4 135.4
Upper Jurassic	13	2.6-23.0 9.6	2.1-5.7 3.4	1.6-15.0 5.3	6.7-90.9 26.2	54.9-3321.8 758.9	4.0-2404.8 236.9
Neocomian	245	0.7-23.5 5.8	0.2-6.0 1.9	0.2-13.3 2.7	0.8-1186.4 90.1	1.3-3977.0 750.9	2.8-5290.6 192.3
Aptian-Albian-Cenomanian	37	2.4-17.0 10.8	0.8-5.9 3.8	1.3-10.3 6.1	6.2-53.1 10.7	31.1-1440.0 509.6	38.0-1468.0 286.4
Upper Cretaceous	4	0.2-3.6 2.3	0.02-1.2 0.8	0.02-1.8 1.1	12.4-42.0 23.0	79.3-549.1 258.3	23.8-106.2 51.3

The analysis of changes in total mineralization of different complexes showed that the main part of Bol'shaya Kheta megasyneclise is characterized by vertical hydrogeochemical zonality of the inversion type (Halmerpautinskaya, Suzunskaya and other areas). This type is manifested in decreasing of salinity and main macro- and microcomponents contents with the depth. There is a direct vertical zonality type in the individual areas (e.g. Lodochnaya, Gorchinskaya et al.).

The lateral hydrogeochemical zonality in the neocomian complex has a complicated distribution. Zones with the anomalous low miniralisation (less than 4 g\L) are tracing the Bol'shaya Kheta megasyneclise contours and were identified in Halmerpautinskaya, South-Soleninskaya and Winter areas. This anomaly can be connected with elision water cycle: the large depressions were the inner ground water recharge areas because of higher argillaceous sediments thickness.

The anomalous high mineralisation zones (more than 7 g\L) confined to positive and middle tectonic structures were identified in Vankorskaya, Lodochnaya, Gorchinskaya areas. These structures were inner ground water unloading zones. Similar trends are retraced in other complexes.

The analysis of changes in the basic genetic coefficients showed that in the studied area, the most widespread are ancient infiltrogenic waters or sedimentogene waters from desalinized basins which are characterized by the value of total salinity from 1.4 to 15 g/L, the values of Cl/Br ratio from 296 to 915, and rNa/rCl ratio from 0.88 to 3.56. They are observed in all the complexes in the Vankorskaya, Pelyatkinskaya, Suzunskaya and other areas. Metamorphosed sedimentogenic waters characterized by lower values of both coefficients and a higher salinity are much rarer. An example is the waters of the Aptian-Albian-Cenomanian complex in the Lodochnaya area and those of the Neocomian complex in the Khalmerpayutinskaya area.

Furthermore, in the border zones of hydrocarbon pools, condensatogenic waters were identified, which formation occurred simultaneously with the filling of traps. This is confirmed by the presence of zones of reduced salinity (1.6-8 g/L) and high values of gas saturation (from 2 to 115 m^3/m^3) of groundwaters.