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Influence of the oil field development on the hydrogeological conditions of the Pripyat trough

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The influence of the oil field development on the hydrogeological conditions on the intersalt and subsalt complexes of the Pripyat trough is grounded by analyzing data on reservoir pressure, water chemical composition, geothermal and heliometric research.

Our research is referred to the intersalt sediments in the northern zone of the Pripyat oil and gas-bearing province that is situated in the southeast part of Belarus. The Pripyat trough is a large depression rift structure of sublatitude extension. Its maximum length is 280 km; its average width is 150 km.

The Pripyat trough consists of Upper-Archaean and Proterozoic basement and thick (up to 6.5 km) sedimentary cover. The particular feature of the sedimentary cover is two regional salt-bearing layers. With regard to these layers the sedimentary cover is subdivided to subsalt-terrigenous, subsalt carbonate, lower salt, intersalt, upper salt and oversalt complexes.

The genetic correspondence of the earth's crust and the upper mantle deep structure with the development and the structure of the Pripyat sedimentary cover is determined. From the north and south the Pripyat trough is bounded by the vertical listric deep faults that plateau in the mantle. In the south the trough is limited by one edge listric fault. In the northern part there are three faults. This part with three faults is singled out into particular northern zone where the oil fields are intensively developed and the aquifers are highly exploited. Sublatitude fault system is intersected by submeridional faults of restricted extension. The trough is divided by faults of different extension and depth on the second-order sublatitude blocks. The submeridional faults complicated the tectonics of the trough and determined the development of the second-order and other structures.

Generally the subsalt sediments have the broken-block tectonics, the intersalt sediments have a plicated –broken tectonics and uppersalt and oversalt sediments have the plicated tectonics.

The most representative data on influence of oil field development on hydrogeological conditions are obtained in the intersalt oil-gas-water-bearing complex.

The intersalt sediments are carbonate in the northern zone of the Pripyat trough, clay-carbonate in the central zone and terrigeneous in the southern zone. The reservoirs are pore-cavern-fractured in the northern and central zones and pored in the southern zone. The intersalt complex does not cover the trough by continuous layer. Within the domes of swells the intersalt sediment thickness decreases or breaks and within the depressions it increases up to 800-1000 m.

Two thick waterproof layers confine the hydrodynamic intersalt complex. Water mineralization is 300—390 g/l. In the Northeast the porosity is 5-10 %. In the South it is 20-30 %. The permeability is some milliDarcy. It increases in the south up to some Darcy. The intersalt sediments are divided into some separate pools of sublatitude extend. High sediments isolation in fact eliminates modern water movement in the intersalt complex. The processes of pore water expression and their movement to the weakened tectonic zones of breaking played important role. The reduced water heads of the intersalt complex in the uplifted areas are 200 m in the west, and 700 m in the east. In the northern zone there are many areas of anomalous high pressure that are usually observed in local structures in the southern dropped limbs of regional faults. There are also zones with anomalous low pressure.

Almost all of 65 proven hydrocarbon fields (185 pools) are in the intersalt and subsalt complexes in the northern zone of the Pripyat trough. Hydrocarbon fields are located at the depth from 1640 to 4500 m. The initial formation pressure varies from 18 to 90 megaPascal. The temperature is 50-110 ºC. Petroleum is light, sweet, gummy and paraffinaceous.

After the development of the intersalt pool of Ostashkovichi oil field the hydrodynamic balance in adjoining areas was broken [1, 2]. The oil fields developed with the help of edge injection to maintain the reservoir pressure. The pressure in the pool and out of the pool changed according to the production rate and injection and influenced on the whole hydrodynamic zone. For example, in Sosnovskoe oil field the pressure began to change synchronously to the pressure in the developed pool of Ostashkovichi oil field (the distance between two oil fields is about 10 km). Hence there is a clear hydrodynamic interrelation between aquifers of these two areas. The development of intersalt pool of Ostashkovichi oil field influenced on the hydrodynamic conditions of intersalt pool of Sosnovskoe oil field.

The present day distribution of reservoir pressure in the intersalt pools of the Pripyat trough represents the brines dynamics under the imbalanced conditions caused by oil fields development. The extent of broken initial in-situ regime is represented by spread in pressure values at the same depth. For example, pressure in Pozhikharka (10 km from the developed oil field) is 29-30.4 megaPascal that is 5-7 megaPascal less than the pressure before the development. The spread in pressure values of developed and more distant areas at the same depth usually does not exceed 1-2 megaPascal [2].

During 1988-1996 the monitoring in 3 observation wells (Borovikovcka area) was carried. Piezometric level in these wells changed on 42-210 m. The only possible reason can be the development of Ostashkovichi and then Dubrovskoe oil fields that are 4-11 km away from the observation wells. The level changed in accordance with the production rate and water injection.

So, the fulfilled research testifies that different intersalt pools are interrelated hydrodynamically.

Another argument is the data on chemical composition of produced with oil water. The synchronism of reservoir water chemical composition change during oil field development proofs the hydrodynamic interrelation of oil fields and neighboring areas. The reservoir water chemical composition of oil fields and on neighboring areas changed considerably under the great volume of water injection of different chemical composition.

The hydrodynamic changes in aquifers under oil field development is ascertained in subsalt complex by research of filtration channel tracing. The research was carried in the subsalt pool of Vishanskoe oil field. The indicator (marked water) was injected. Water samples were taken from producing wells in a certain period of time. Then the presence and the concentration of the indicator were tested. And at last the direction and velocity of filtration water was calculated. This research revealed the hydrodynamic and hydrochemical influence of injection wells of Vishanskoe oil field on the producing wells of the Marmovichi pool (are situated 10 km from one another).

In the northern zone of the Pripyat trough the thermometric research in wells and heliometric research in water-supply wells and draw-wells were fulfilled [3, 4]. Increased temperature and high temperature gradients in some wells situated within the tectonic-breaking zones were measured. The further from the tectonic-breaking zones the wells were situated, the less values of the parameters in question were measured. In aquifers used for water-supply the anomaly high values of dissolved helium were revealed. The given data helped to draw the conclusion that the subsalt and intersalt hydrogeologic complexes are connected in spite of the stagnant regime, tectonic faults and waterproof layers. There is a certain connection with oversalt hydrodynamic complex too. This

interrelation is not constant and changes within the course of time under the impulse tectonic movement caused by local and coming seismic events (earthquakes), fluxing of salt-bearing layers, reservoir pressure decreasing under the oil field development, injection of great values of produced water in aquifers for their burial and so on.

The results of this research can be used during exploration of new oil field. During the well tests we can get water with modified chemical composition. Using the traditional interpretation of water chemical composition for petroleum survey, new areas can be considered as lacking in prospects. The study of change of reservoir water in regard to the injected water helps to correct the hydrogeochemical criterions for petroleum exploration on the neighboring areas and to quantify the interrelation of developed oil fields with aquifers. The results should be taken into consideration while planning new offtakes for water-supply, oil- and gasholder, sewage disposal.

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