INFLUENCE OF GEODYNAMIC PROCESSES ON RESERVOIR PROPERTIES OF GEOLOGICAL ENVIRONMENT (ON THE EXAMPLE OF THE ROMASHKINO FIELD)

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Abstract. A significant contribution to the structure of the hydrocarbon deposits can be made by fracturing, which is in the active state under the external stresses relative to the Earth (the lunar-solar gravitational action, the total rotational field of the Earth's stresses, etc.). On the example of comparing the results of system-geodynamic interpretation with reservoir properties of the Bobrikovian, Timanian and Pashian horizons of the Romashkino field using mathematical-statistical analysis, it has been shown that geodynamic activity significantly affects the reservoir properties. Improvement of reservoir productivity is noted in the areas of mutual overlap of geodynamically active zones of dislocations of various orders and strike, which is recommended to be taken into account both in exploration and development of hydrocarbon fields. Consideration of the geodynamic situation, carried out using the results of system-geodynamic interpretation, will allow the most rational use of various methods of oil extraction at operation sites.

The results of system-geodynamic zoning should be used in solving a wide range of oil and gas exploration and operational problems, where the development of fractured zones is important. They can be used both for the search and exploitation of hydrocarbon deposits in conventional carbonate and terrigenous reservoirs, and in non-conventional reservoirs, where the main reservoir properties are determined by fractures.

Keywords: geodynamic activity, reservoir properties, system-geodynamic interpretation, fractures
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Introduction

The geodynamic factor in the study of oil and gas fields is still practically ignored. A significant contribution to the structure of the hydrocarbon deposits can be made by fracturing, which is in the active state under the external stresses relative to the Earth (the lunar-solar gravitational action, the total rotational field of the Earth's stresses, etc.). All structures of this kind form a multi-rank, regularly developed system of geodynamically active zones of dislocations (DAZD) (Dragunov, 2011).

The activation of the DAZD system is connected, first of all, with the discharge of internal stresses caused by the uneven rotation of the Earth. Within the DAZD of various ranks, all existing tectonic dislocations are involved in constant movements. In this paper, it is shown that geodynamic activity affects the processes of oil formation and oil accumulation at the regional scale, while on the local scale it has a complicating effect on hydrocarbon traps. Proceeding from this, the question of the degree of DAZD influence of different ranks and strike on the porosity, oil saturation, phase and relative permeability of productive horizons within hydrocarbon deposits can be considered.

Initially, remote system-geodynamic studies were carried out at the Russian State University of the oil and gas named after I.M. Gubkin (Gridin, Gak, 1994) and have been further developed in the works of A.A. Dragunov, R.S. Shaikhutdinov and others (Dragunov, 2011; Dragunov et al., 2003; Dragunov, 2008).

Results of the research

Mapping of DAZD within the North Romashkino range was performed within the framework of remote system-geodynamic studies of the South Tatar arch. Reconstruction of the DAZD frame was performed using scaled-up space scanner images based on the following geo-indicators: input and output loop of rivers, active meandering, sharp turns of channel flows, and development of sandy beaches downstream of intersections with DAZD rivers (Dragunov, 2011) (Figure 1).

On the example of the North Romashkino range, a comparison was made between the reservoir properties

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of productive horizons within the DAZD and within the blocks with relatively stable geodynamic characteristics. The values of the porosity and oil saturation coefficients, as well as the phase and relative permeabilities, determined from the core of 3260 wells, were compared: 1523 wells along the Bobrikovian horizon, 1393 wells along the Timanian horizon, 1450 wells along the Pashian horizon. For comparison, samples were used for wells located within the DAZD of different rank and strike, and also in wells outside the DAZD (so-called control group). The comparison was performed using the variance analysis (Figure 2; Table 1).

The main results of the work are as follows (Figure 3).

• Within the DAZD, not complicated by the overlapping of several DAZDs of different ranks and strikes, the relative permeability is higher, and porosity, oil saturation and phase permeability are lower than in the control group.

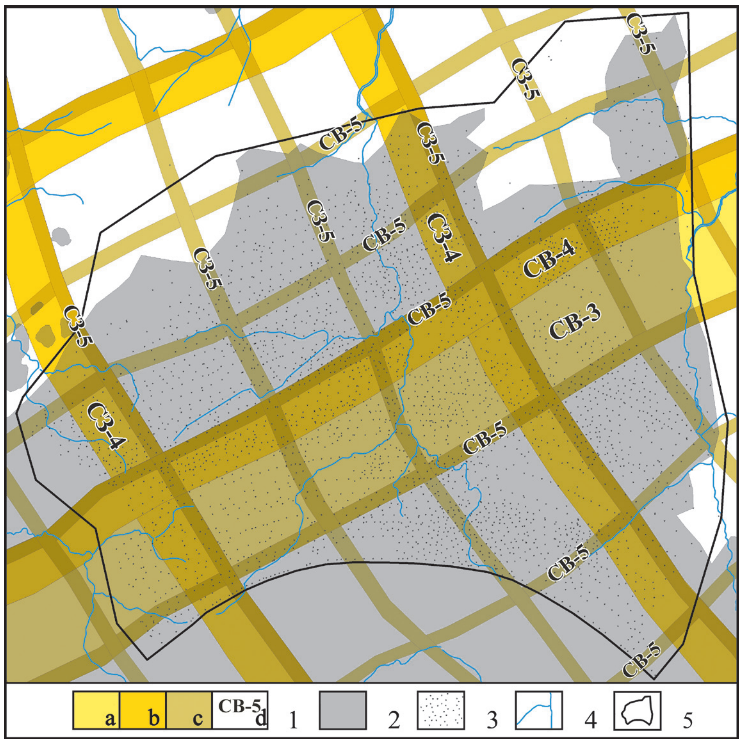

Figure 1. Results Map system-geodynamic interpretation of the North Romashkino range. Scale 1: 350,000. 1 – geodynamically active zone: a – of the 3d rank, b – of the 4th rank, c – of the 5th rank, d – its name; 2 – oil field; 3 – wells; 4 – river bed; 5 – border of the North Romashkino range

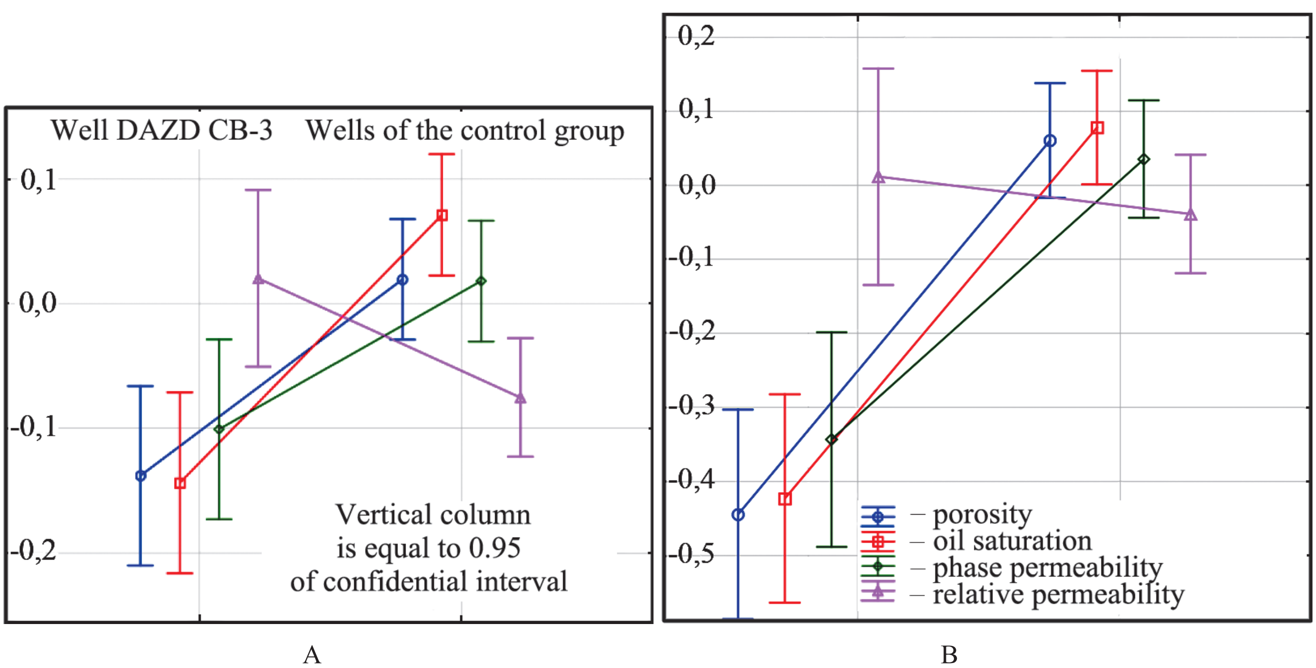

Figure 2. Diagrams of reservoir properties within the DAZD of 3d rank and North-East strike: A – 3 horizons, B – Bobrikovian horizon

	Dependent variable	SS Model	SS residual	df residual	p
	3-CB				
	POR	12,50569	2319,734	2351	0,000378
	NNAS	23,30947	2357,346	2351	0,000002
	PRONFAZ	7,13744	2326,915	2351	0,007295
A	PRONOTN	4,60700	2247,008	2351	0,028225
	031PL 3-CB				
	POR	36,87082	794,0621	814	0,000000
	NNAS	36,31501	784,8007	814	0,000000
	PRONFAZ	20,72185	834,0544	814	0,000008
B	PRONOTN	0,36554	848,0715	814	0,553792

Table 1. Confidence by DAZD of 3d rank and North-East strike: A – 3 horizons, B – Bobrikovian horizon

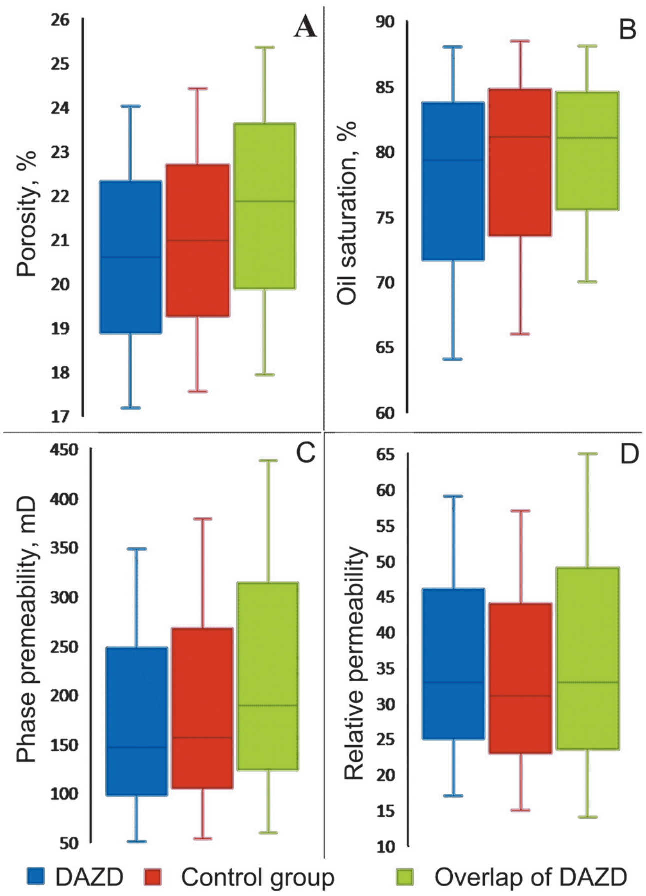

Figure 3. Percentages of the reservoir properties distributions over the 3 horizons: A – porosity, B – oil saturation, C – phase permeability, D – relative permeability.

• Within the zones of mutual overlapping of DAZD, porosity, oil saturation, the phase and relative permeability is higher than in the control group.

Based on the results of the dispersion analysis, the following conclusions can be drawn.

• The increased relative permeability noted within the DAZD facilitates the flow of anhydrous oil to the production wells and, ultimately, facilitates its more efficient extraction.

• The relatively less porosity within the DAZD, not complicated by the mutual imposition of several DAZDs of different ranks and strike, associated with the processes of gravitational compaction of rocks, causes a lower phase permeability, which increases the probability of formation of oil deposits within the DAZD and contributes to their better safety.

• The marginal parts of the DAZD and, mainly, the zones of mutual overlapping of DAZDs of different ranks and strike, are distinguished by improved reservoir properties.

Conclusion

Based on the results of the dispersion analysis of the reservoir properties conducted at the North Romashkino range, with a confidence greater than 95%, it is established that geodynamically active zones of dislocations have an impact on the reservoir properties.

Consideration of the geodynamic situation, carried out using the results of system-geodynamic interpretation, will allow the most rational use of various methods of oil extraction at operation sites.

The results of system-geodynamic zoning should be used in solving a wide range of oil and gas exploration and operational problems, where the development of fractured zones is important. They can be used both for the search and exploitation of hydrocarbon deposits in conventional carbonate and terrigenous reservoirs, and in non-conventional reservoirs, where the main reservoir properties are determined by fractures – in clay, siliceous, volcanogenic, metamorphic, magmatic and intrusive rocks, including the rocks of the crystalline basement.

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