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#### On necessity of studying facies variability in mature oil fields

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Abstract. Facies variability is a key geological factor characterizing reservoir porosity and permeability heterogeneity, directly affecting the efficiency of oil and gas field development. This paper examines an integrated effect of facies variability on the geological structure of deposits, design and implementation of field development systems, including reservoir production potential and variations in sweep efficiency and displacement efficiency. The author emphasizes the importance of developing and refining a geological concept with regard to historical sedimentation processes and the spatial distribution of deposits (their impact on facies permeability anisotropy) as a reliable basis for field production data analysis. This includes sedimentological analysis, petrophysical modeling, as well as core data and well-logging data analyses.

Special attention is given to methods of facies prediction, their interaction and distribution based on the integrated core data analysis and digital tools as applied to an area in a mature field. These methods improve accuracy of geological modeling and analyze the effect of facies variability on hydrocarbon recovery efficiency. The analytical methods described in this paper rely primarily on the validity of conceptual understanding of subsurface geology and its effect on crude oil production within various facies zones.

Preliminary analysis of reservoir potential productivity within various facies zones has been performed, as well as assumptions on their heterogeneity in terms of fluid flowing within the identified geological bodies have been made. The study underscores the need to integrate sedimentological, petrophysical, and dynamic data to optimize development strategies for structurally complex reservoirs.

*Key words: lithofacies variability, geological model, core analysis, field development, well grid, lateral heterogeneity, well placement* 

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## Assessing the impact of the rate of introduction into development of a small-sized oil deposit in terrigenous sediments of the Berket-Klyuchevskoye oil field on the technical and economic indicators

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Abstract. Many years of experience in the development of many oil fields shows that the involvement of reserves of new production facilities by transferring production wells from one facility to another can have low profitability. However, under certain geological conditions, the use of equipment for simultaneous-separate exploitation (SSE) allows for the efficient introduction of reserves of new deposits into development. SSE allows for the involvement of reserves concentrated in the lower and upper horizons into development simultaneously, without waiting for the depletion of the lower layers. The start time of commissioning and the duration of exploitation of oil deposits primarily depend on the size of reserves. This article examines the impact of the dynamics of geological and technical measures (GTM) on the rate of commissioning of the Tula horizon of the Lower Carboniferous oil deposit of the Kzyl-Koch uplift of the Berket-Klyuchevskoye oil field in the Republic of Tatarstan using the WEM. Several options for further development of oil deposits in the deposits of the Bobrikov and Tulsk horizons were considered using geological and hydrodynamic modeling, and a technical and economic assessment of the proposed geological and technical measures was carried out.

*Key words:* field, oil deposit, permeability, porosity, geological structure, simultaneousseparate exploitation, well, oil properties, oil recovery factor, economic efficiency

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## The influence of Afoninskaya strata's geological features for the Orenburg region reservoirs development parameters

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Abstract. Prospects for increasing oil production in the Orenburg region are primarily associated with the involvement of the deep-lying Afoninskaya formation carbonate reservoir in the development. The design oil recovery factor for the fields reaches 0.492. Theirs reservoir development is currently carried out at a low rate, which is largely due to geological features, as well as the use of traditional development treatment that have proven themselves well on terrigenous reservoirs. Due to the geological features of the Afoninskaya formation and the presence of secondary dolomites in it, traditional development treatment to them does not give high results. Therefore, further progress in the oil reservoir development represented by deep-lying carbonate formations is of strategic importance for the Orenburg region fields.

*Key words:* carbonate deposits, injection well, hydrodynamic simulation, limestone, dolomite, depletion drive, producer well; acid fracturing of formation

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#### Residual oil saturation and peculiar aspects of its determination

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Abstract. Residual oil saturation factor is particularly important for estimation of oil reserves and creation of project documentation for oil fields development. The paper considers the main differences between the terms "residual oil" and "residual oil saturation". Russian and foreign literature review is performed to investigate the challenges associated with determination of residual oil saturation using various methods: laboratory core studies, well logging techniques, analogy methods. Of these, only laboratory studies present a direct method for determination of residual oil saturation, which, according to expert opinion, is the most reliable, but not free of disadvantages. The results of studies aimed at determination of residual oil saturation versus rock properties are also discussed.

*Keywords*: displacement efficiency, residual oil, residual oil saturation, core studies, recoverable oil reserves

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## Changes of physical and chemical oil properties during development of an oil reservoir in the Volga-Ural province

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**Abstract.** The paper describes one of oil reservoirs in the Volga-Ural province. Development of this area started in 1951. The primary production targets are productive Kynovian (D0) and Pashian (D1) sediments of the Lower Frasnian substage of the Upper Devonian. Maximum oil production of as high as 3.3 million tons was reached in 1961. Implementation of waterflooding and enhanced oil recovery (EOR) methods allowed for maintaining of the production rate at 2.5 million tons per year.

The paper highlights the results of comparative analysis of changes in the main parameters of oil and gas of the Kynovian-Pashian sediments at different stages of development (initial - 1950-1970, intermediate - 1970-1990, late - 1990 - till present). It has been seen that such parameters as bubble point pressure, gas-oil ratio, and formation volume factor decrease, while density, viscosity, and compressibility factor of reservoir oil increase. Increase in the content of paraffins, resins and asphaltenes has been observed. Such changes are indicative of the final field development stage. Maintaining oil production requires selection of the most efficient EOR methods taking into account the changes in physical and chemical oil properties.

*Key words*: field, oil, physical and chemical properties, compositional analysis, density, viscosity, enhanced oil recovery

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# Effect of compartmentalization on the oil recovery of highly depleted terrigenous formations of Tatarstan

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**Abstract.** One of the relevant matters is the investigation of the relationship between oil recovery factor (ORF) and well spacing (WS) under various heterogeneity values of productive formations for mature fields. The results of these investigations can be used for the planning of additional well drillings, which would help to reach low production streaks barely covered by the displacement processes.

In this paper the authors analyzed 40 field assets related to Tulskian-Bobrikovskian and Kynovian-Pashian sediments, the depletion degree of which is more than 70%, to study the effect of heterogeneity on the relationship between well spacing and oil recovery. Investigated fields were divided into two groups based on initial oil mobility.

Coefficients *A* and *B* of the relationship  $ORF = A * e^{(-B*WS^{1.5})}$  were determined for facilities groups in different ranges of compartmentalization and net sand. It was noted that the relationship between ORF and well spacing can be observed more clearly and with greater approximation accuracy when categorizing field facilities by compartmentalization.

Following the analysis of parameters of 24 field facilities from the second group, a linear relationship with compartmentalization of the form y = -0.0317x + 0.7868 was determined for coefficient A, and for coefficient B – a logarithmic relationship of the form  $y = 0.9584\ln(x) + 0.0871$  (compartmentalization range is 1.4–6.5).

Relationship between ORF and well spacing was additionally analysed for two groups, with subdivision based on entropy associated with compartmentalization. Subgroups of field assets are nonoverlapping. Predominant relationship trends have sharper decline compared to assessment by compartmentalization. However, relationships acquired by subdivision based on compartmentalization have more reliable coefficients of determination.

It was concluded that heterogeneity of productive formation has a significant effect on the relationship between oil recovery and well spacing.

*Key words:* well spacing, heterogeneity, compartmentalization, net sand, the effect of compartmentalization on the oil recovery

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# Analysis of man-made impact parameters in wells with column circulation

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Abstract. Acid treatment of wells is an effective method of increasing well productivity. However, increasing the pressure to values exceeding the compressive or tensile strength of rocks leads to both rock deformation and destruction of the annular cement stone and the creation of cracks. The acid composition, penetrating into cracks and actively interacting with the annular cement stone, destroys it. The consequence of this process is the occurrence of behindthe-casing circulation with an inflow from overlying or underlying watered interlayers. The occurrence of ZKZ during well development and operation directly affects the increase in water cut of production and a decrease in the recovery of reserves in the target formation. Identification of complicating factors affecting the occurrence of behind-the-casing circulation is an urgent task of increasing the efficiency of acid treatments. The paper analyzes and summarizes the experience of implementing well acid treatment technologies with the identification of complicating factors affecting the occurrence of behind-the-casing circulation. Geological and technological parameters influencing the occurrence of behind-the-casing circulation to the wells of the production fund after acid treatments have been identified. It is recommended to conduct additional studies and scientific and technical work to prevent behind-the-casing circulation in wells during acid treatments at production facilities.

*Key words:* column circulation, bottom-hole zone treatment, acid composition, pressure, flow rate

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## **Evaluation of the Efficiency of Pilot Testing of Aquathermolysis Catalysts for the Development of the Strelovskoye Field**

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Abstract. The paper analyzed the effectiveness of using catalysts of in-situ aquathermolysis together with coolant injection for the development of the Strelovskoye field. The essence of the technology lies in the injection of a special catalytic composition into the reservoir, as a result of its interaction with reservoir oil, hydrocarbons are converted, which leads to a decrease in the content of tar and asphaltenes, and, as a consequence, to a decrease in viscosity. Application of catalysts of in-situ aquathermolysis allows to increase the coverage of the formation during treatment by the heat carrier due to the reduction of molecular weight of resins and asphaltenes, which significantly reduces the viscosity of the produced oil and realizes the transformation of heavy components of oil in the formation. After viscometric tests, it was found that the dynamic viscosity of the oil after the pilot field test (PFT) at a temperature of 10 ° C decreased more than 10 times compared to the original oil. According to the results of analysis of group chemical composition, the content of asphaltenes decreased in most samples by 1.5 times compared to the original oil. There is also a decrease in the solidification temperature in all samples, the largest decrease was recorded in the sample with the date of sampling from 15.12.2022 and is 4°C. This can be explained by a decrease in the vapor content of asphaltenes. This can be explained by a decrease in the content of paraffins in the presence of a catalyst. The obtained data indicate that the initial oil in the course of thermocatalytic action undergoes significant changes due to the chemical reactions of cracking, leading to the destruction of large molecules with the formation of lighter compounds.

*Key words:* high-viscosity oil, catalyst; aquathermolysis; viscosity; paraffins; resins; asphaltenes; pour point; molecular weight; pilot field tests

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#### Use of a water-repellent filling agent in polymer-dispersed systems

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**Abstract.** An increasing trend in the oil production decline rate observed over the last few years poses risks of failure to meet production targets and to achieve planned oil recovery efficiency in many hydrocarbon fields. Under current conditions, use of physical-and-chemical EOR methods, particularly, flow diverting agents, is of utmost importance. Domestic experience shows that the most efficient among such EOR methods are conformance control in injection wells and flow diverting technologies using various disperse systems.

The paper studies the applicability of a water-repellent filling agent in disperse systems. The authors present the advantages of using this agent compared to the currently applied industrial fillers, such as mud powder and wood flour.

*Key words:* sedimentary and aggregate stability, high-dispersive filling agent, polyacrylamide, mud powder, system stability, residual resistance coefficient, oil displacement

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## Digital method for evaluation of

dispersive properties of chemicals

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Abstract. The paper considers one of the most urgent problems for petroleum industry - buildup of asphaltene-resin-paraffin deposits, which have adverse impact on oil production performance. Particularly, they cause decrease in oil production rates, disrupt transportation of hydrocarbons and accelerate equipment wear, ultimately resulting in higher operating costs and reduced profitability of oil production. The paper presents a detailed analysis of currently available methods for prevention of such deposits, including application of dispersants that help disperse and remove the deposits from the oil flow. Applicable standards for evaluation of dispersants efficiency are considered to allow for identification of their advantages and shortcomings. The paper also reveals the disadvantages of traditional evaluation practices, which often do not provide accurate and reliable data about the dispersive properties of chemicals, thus making the selection of the optimal solution for specific conditions a challenging task. Based on laboratory results, a new method for digitization of test data is proposed to enable more accurate qualitative and quantitative determination of the dispersive properties of chemicals while using lower volume of chemicals and formation water. This innovation not only simplifies the evaluation process, but also reduces the cost of experiments. The present research is aimed at optimization of oil production processes, improvement of the quality of chemicals performance evaluation and ultimately enhancement of the overall efficiency of oil production wells. The research findings can be useful both for oil production engineers and for scientists engaged in the development of new technologies in this field.

*Key words:* asphaltene-resin-paraffin deposits, dispersion, method, degree of contamination

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#### Water shutoff techniques for fractured reservoirs

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**Abstract.** Water-producing fractured reservoirs are one of the sources of gas, oil and water kicks due to their high permeability and insufficient range of pressure thresholds. Fractures can reach an aquifer or an overlying gas cap, thus making a path for gas or water to producing wells. They can cause well-killing fluid losses during well workover operations. Moreover, micro- and macrofractures can expand, deepen and break under high flowing pressures, forming an extensive fracture network which results in caving, bridge-over, and lost circulation. Waterflooding of carbonate fractured or cavernous fractured reservoirs can be accompanied with rapid break-through of the injected water into producing wells.

To shutoff fractured reservoirs in case of gas, oil and water kicks, various methods are used:

- injection of plugging materials, for example, clay-polymer slurries, viscoelastic polymer systems, liquid glass, oil, and oil products;

- injection of water-swelling polymers.

The study is aimed at development of methods to mitigate risks of gas, oil and water kicks in water-producing fractured reservoirs.

This research resulted in the improved efficiency and success rate of the operations as compared with plugging Portland cement. The efficiency is improved by more rapid mixing of two streams of water shutoff system components, as well as by simplifying the application technology due to the use of neonol with lower freezing point.

*Key words.* model tests, proppant, polyacrylamide, curable plugging material, clay-silicate solution, silicone compound, water shutoff barrier, pressure differential, clay mud

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## Mitigation of gas, oil and water inflow risks during well workover at later phase of oilfield development

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Abstract. Late phase of oilfield development is characterised by development of previously untapped formations and streaks, development of multizone targets using single well, dual completion, extensive formation pressure maintenance system, wells with production-induced anomaly high formation pressure, wide usage of bottom-hole treatment for well stimulation and water-zone isolation, production-induced alteration of near well-bore area properties due to geology (transition and commingle) and technical conditions of production casings, increase of well workover frequency. The need for well testing and geophysical studies for assessment of actual parameters before well workover also increases.

Moreover, later phase of development brings in hard-to-recover reserves, such as highly viscous and super viscous oil (SVO), extracted with thermal recovery methods (steam injection, downhole combustion), using SVO wells for shallow reservoirs with inclined wellheads and long horizontal sidetrack fitted with filters. Thus, creating additional risks of gas, oil and water inflow.

*Key words:* gas, oil and water inflow, bottom-hole condition prompt assessment method, well kill operation methods for wells with several penetrated formations, strength certificate determination

**For citation:** Ziyatdinov R.Z., Valovsky V.M. Snizhenie riskov gazovodonefteproyavleniyi pri remontah skvazhin na pozdntei stadia razrabotki neftyanih mestorozhdenii [Mitigation of gas, oil and water inflow risks during well workover at later phase of oilfield development]. Neftyanaya Provintsiya, No. 2(42), 2025. pp. 151-163. DOI https://doi.org/10.25689/NP.2025.2.151-163. EDN FUNPXP (in Russian)

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## Development of a selective waterproofing compound based on organosilicon polymers for deposits in the south of the Perm Krai

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**Abstract.** Currently, the main volume of oil and gas production in the Perm Krai is accounted for by fields that have been under development for more than fifty years. Most wells are characterized by a high water cut, as a result of which it becomes necessary to carry out special waterproofing works using selective compositions.

The article contains a detailed analysis of the causes of high water cut of wells in the south of the Perm Krai. The main well stimulations for the intensification of oil inflow are considered. The analysis of the experience of using previously developed water-shutoff compositions for the conditions of deposits of oil-producing enterprises of the Perm Krai has been carried out. Experimental studies on the development of a selective water-shutoff compound based on organosilicon polymers and its interaction with reservoir water of high mineralization are presented.

*Key words: increase of well flow rate, water-shutoff compounds, well stimulation, organosilicon polymers* 

**For citation:** M.E. Mironov, V.V. Derendyaev, S.E. Chernyshov Razrabotka vodoizolyaionnogo sostava selektivnogo dejstviya na osnove kremnijorganicheskih polimerov dlya mestorozhdenij yuga Permskogo kraya [Development of a selective waterproofing compound based on organosilicon polymers for deposits in the south of the Perm Krai]. Neftyanaya Provintsiya, No. 2(42), 2025. pp. 164-177. DOI https://doi.org/10.25689/NP.2025.2.164-177. EDN BGFZRO (in Russian)

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# The study of the effectiveness of using oleophobic particles for the preparation of water injected into the reservoir

#### (comparison of two methods)

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**Abstract.** The purpose of this work was to study the properties of oil-water emulsions and determine the effectiveness of using special oleophilic particles to prepare water injected into the reservoir and purify it from residual droplets of the hydrocarbon phase. The study analyzed the physico-chemical properties of models of oil-water (direct) emulsions, and also identified the main factors influencing their purification from residual oil. Filtration tests were also carried out for various oil temperature and viscosity conditions.

The result is dependencies that reflect the area of effective operation of the filter under specified conditions, which can be used to optimize the water treatment process to maintain reservoir pressure in production. As a result of the study, the following conclusions were obtained: water purification from residual hydrocarbons is a complex and urgent problem in the oil industry, and effective separation methods are necessary to ensure the efficient operation of oil refineries. The use of oleophilic particles has proven to be the most effective method of water purification, which can be used in practice to improve the efficiency of field water and oil treatment processes.

*Key words:* physical properties of oil, water-oil emulsion, oleophobic particles, oil reservoir, filtration and capacitive properties, methods of oil purification, enhanced oil recovery, microscopic studies, qualitative analysis, reservoir water

**For citation:** A.V. Dengaev, A.Yu. Gizzatov, D.I. Valeev, R.R. Khaziev Izucheniye effektivnosti primeneniya oleofobnykh chastits dlya podgotovki nagnetayemoy v plast vody (sravneniye dvukh metodov) [The study of the effectiveness of using oleophobic particles for the preparation of water injected into the reservoir (comparison of two methods)]. Neftyanaya Provintsiya, No. 2(42), 2025. pp. 178-190. DOI https://doi.org/10.25689/NP.2025.2.178-190. EDN ABUGPF (in Russian) DOI: https://doi.org/10.25689/NP.2025.2.191-199 EDN ZGAJWC УДК 628.16

#### **Application of sorption-filtration technology**

#### treatment of produced water for low-permeability reservoirs

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**Abstract.** During the development of hard-to-recover oil reserves the quality of water injected into oil reservoirs and promoting rims often does not correspond to the porosity and permeability of the developed reservoirs.

The purpose of research is to determine the possibility of obtaining water of the required quality for low-permeable reservoirs in the process of water treatment by sorption-filtration method.

The article shows the normative requirements and peculiarities of water preparation technology for injection into productive formations, presents the results of pilot tests in field conditions, and suggests ways to improve the quality of purification of produced water using granulated filtration materials.

The obtained results have important practical application and will allow to obtain water of high degree of purification from oil and mechanical impurities for its further use in the system of reservoir pressure maintenance, including for low-permeable reservoirs of traditional oil fields.

*Key words:* hard-to-recover reserves, low-permeable reservoirs, produced water, treatment, deep purification, filtration material, sorption-filtration unit

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## Study of the efficiency of displacement of drilling mud by cementing mud at various annular gaps

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**Abstract.** The main condition for ensuring the tightness of the annular space of wells is the complete displacement of the drilling mud by the cementing mud from the cementing interval. It is obvious that the success of cementing operations significantly depends on the geometric conditions of the wellbore, which can be complicated by large cavernosity, borehole curvature, channeling, borehole sludge contamination, formation of a filter cake on the wellbore walls, the presence of absorbing horizons and the geometry of the annular space itself. In this paper, the effect of the annular gap value on the completeness of drilling mud displacement by cement in a borehole is investigated. A test bench was created for the research and hydrocarbonbased drilling mud (OBM), water-based drilling mud (WBM) and cement slurry prepared from oil-well portland cement (I-G-SS-1) with a density of 1900 kg/m3 were used. The purpose of this study is to determine the effect of the degree of displacement and mixing of drilling mud with cement on the quality of the resulting cement stone.

Key words: Fastening quality, cement slurry, drilling mud, displacement, annular gaps

**For citation:** R.I. Shafigullin, F.F. Akhmadishin, A.R. Iskhakov., D.A Syrkin., D.N. Kamasheva Stend dlya issledovaniya vytesneniya burovogo rastvora tsementnym pri razlichnykh kol'tsevykh zazorakh [Study of the efficiency of displacement of drilling mud by cementing mud at various annular gaps]. Neftyanaya Provintsiya, No. 2(42), 2025. pp. 200-213. DOI https://doi.org/10.25689/NP.2025.2.200-213. EDN TDBSKE (in Russian)

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## Investigation of the effect of alkaline drilling mud filtrate on the stability of borehole walls

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**Abstract.** The article describes the stability of borehole walls from drilling mud filtrate with different pH, describes the theoretical aspects of the instability of borehole walls composed of clay rocks and, as a logical conclusion of the article, shows the practical value of the proposed technical solution to prevent the collapse of unstable clay rocks during the construction of oil wells.

*Key words: drilling of wells; instability of the borehole walls; drilling mud filtrate; the effect of the pH of the filtrate on the stability of the walls of the well* 

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## The role of the Kazan Geological School in the development of geophysical science in the USSR and Russia,

German Efimovich Kuznetsov

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**Abstract.** The role of the Kazan Geological School in the formation of the geophysical research centers of the USSR and the Russian Federation is noted.

The scientific and pedagogical activity of geophysicist G.E. Kuznetsov is given as an example. A significant contribution to the expansion and reproduction of the mineral resource base of oil-promising areas and regions is the results of studies of the deep structure of the subsurface, necessary for forecasting and searching for combustible and non-metallic minerals.

**Key words:** Kazan Geological School, scientific centers, minerals, oil, gas, non-metallic raw materials, mineral resource base, deep structure, geophysical methods, gravity exploration, magnetic exploration, forecast, prospecting, minerals

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