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**EXPEDITIOUS MODELLING OF DEPOSITS OF OIL WITH USE OF  
MATHEMATICAL METHODS OF THE CLUSTERING OF FACIAL  
DEPOSITS**

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**Abstract.** In the work, the technique of expeditious modeling of deposits of oil with use of facies and facial heterogeneity is described during creation of geological and hydrodynamic model. Expeditious diagnosing of facial deposits is based on a mathematical method of a clustering by an algorithm k-means. In the work merits and demerits of this method and a way of his calculation for differentiation and the subsequent grouping of wells with various data are specified. An object of a research is terrigenous layer of the large-scale deposit of Western Siberia of Lower Cretaceous age. In the facial relation layer was created in a transitional situation of sedimentation and includes deposits of both sea, and transitional genesis. The research was conducted on 900 wells of layer collector, according to geophysical researches curves PS,  $\alpha_p$ s, with control under the curve of GR log.

By results of the cluster analysis several groups, excellent in the form of curve geophysical surveyshave been allocated. Comparison of the allocated groups given logging received as a result of a clustering with standard forms of curves according to V.S. Myromtsev facial deposits of the beach, a gully of explosive currents, alongshore gullies, the top part of shoreface, transgressive shaft of shoreface, the lower part of a shoreface, underwater shaft of a shoreface of the beach, alongshore bars have been allocated. The obtained data have been correlated to their vulgar distribution and the received distribution doesn't contradict features of sedimentation of this region.

Expeditious diagnosing of facial deposits by means of the cluster analysis allows to estimate more competently the provision of a collector of geological model and to predict petrophysical properties and features of layer, to exclude subjective mistakes of the expert and to lower assessment time during the work with a large number of data.

**Keywords:** *clustering, method, layer collector, model, algorithm, facies.*

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## ON IMPROVEMENT OF WATERFLOODING TECHNOLOGY TO ENHANCE RECOVERY FROM COMPLEX MATURE RESERVOIRS

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**Abstract:** The paper presents analytic data on the effectiveness of different waterflooding techniques to enhance production at different stages of a reservoir life. It was found that at the initial production stage the most efficient is regular waterflooding characterized by “piston-like” method of oil displacement. With time however, the effectiveness of regular waterflooding decreases, because the residual oil reserves are found, mainly, in low-permeable and tight portions of depleted reservoirs. To improve waterflooding efficiency in depleted reservoirs, cyclic injection, or cyclic waterflooding is used. This pulsed injection helps to release oil from the formation minerals. In practice, any strict criteria as to when cyclic injection shall start are lacking. Apart from the water oil ratio, the authors suggest using coefficients of flushing and water consumption as the said criteria [1].

Having analyzed benefits and shortcomings of non-cyclic and cyclic waterflooding techniques the authors conclude that a so called “combined” waterflooding technique might be an efficient mechanism to control the intrinsic drawbacks of both techniques and to improve oil recovery factor.

**Key words:** *regular waterflooding, cyclic waterflooding, piston-like displacement, release of oil, contour waterflooding, water-oil ratio, coefficient of flushing, coefficient of water consumption, combined waterflooding*

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## **AUTOMATIC CONTROL OF WELL DRILLING USING DOWNHOLE DRILLING MOTOR**

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**Abstract.** Conventional well drilling technology involves maintaining continuous weight on drill bit, or rather hook load, which has been adopted from turbo-drilling and rotary drilling techniques.

This paper reviews some aspects of downhole drilling motor (DDM) response to abrupt changes in torque, and suggests an improved drilling technique to maintain stable drill-bit torque. This paper also presents field test results for the proposed drilling technique and the recent engineering solutions for automatic control of well drilling process using downhole drilling motors.

**Key words:** *downhole drilling motor, automatic control of well drilling, simulator*

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## ESTIMATION OF PORE AND FRACTURING PRESSURES FOR FRACTURE DESIGN

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**Abstract.** The paper considers the methods used to estimate the overburden load, pore and fracturing pressures.

Range of applicability of the Doronkin equation for pore pressure prediction has been defined. The paper also reveals the implications associated with application of well logging software. To make the utmost use thereof in geomechanical analysis reliable tools for curve integration and extrapolation to the Earth's surface are required. The importance of precise datum setting for depth domain is also highlighted. Applicability of Stoneley wave in pressure estimates is considered.

**Key words:** *pore pressure, well logs, depth integration of density, extrapolation of density curves, Stoneley wave*

УДК 665.61.033.5

**VANADIUM AND NICKEL IN ASPHALTENES AND RESINS OF  
HEAVY OILS IN VOLGA-URAL PETROLEUM PROVINCE**

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**Abstract.** Asphaltenes and resins found in heavy oils produced from the Carboniferous and Permian reservoirs in the Volga-Ural petroleum province have been analyzed for content of vanadium and nickel. It was found that heavy oils produced from the Carboniferous reservoirs are characterized by higher content of vanadium, from 0.041 to 0.165 weight %, while in the Permian heavy oils the content of vanadium varies from 0.009 to 0.047 weight %. Increase of vanadium and nickel content in heavy oils brings about increase of concentration of these metals in asphaltenes and resins. Peculiar aspects of interrelation “asphaltenes-vanadium” for heavy oils produced from different reservoirs have been identified. It was found that in each particular case the asphaltenes/vanadium ratio changes over different ranges.

The results of the study show that the higher vanadium content in resins the lower the asphaltenes/resins ratio. The results obtained make it possible to forecast distribution of vanadium and nickel in petrochemical products produced from heavy oils with various original characteristics.

**Key words:** *heavy oil, asphaltenes, resins, vanadium, nickel*

УДК 553.98.048

**PRIORITY-RANKING OF PROSPECTS BASED ON ESTIMATE OF  
RESOURCES USING MONTE-CARLO PROBABILISTIC METHOD**

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**Abstract.** This paper discusses application of the Monte-Carlo probabilistic method to estimate recoverable resources of the Vostochno-Dolinnoye prospect (Bugulma-Tumutuk exploration zone), the Kimovskoye prospect (Cheremshan-Bastrykskaya exploration zone), and the Zapadno-Saklovskoye prospect (Tlyanche-Tamak exploration zone).

The amount of the potential resources is estimated as three figures, P90, P50 and P10, where P90 is the lowest estimate (low-risk estimate), P50 is the mean figure representing the optimal amount of resources with 50% probability, and P10 is the highest estimate (high-risk estimate).

Using P90, P50 and P10 estimates the three prospects have been priority-ranked for the purpose of deep exploratory drilling. Monte-Carlo and volumetric estimates of recoverable oil resources were compared and analyzed.

**Key words:** *Monte-Carlo probabilistic estimate, Monte-Carlo method, volumetric method of reserves estimation, resources, oil, priority-ranking*

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## TYPES OF GEOLOGICAL CROSS-SECTIONS OF SHESHMINSKIAN FORMATION ON TATARSTAN TERRITORY

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**Abstract.** In Tatarstan, commercial reserves of heavy oil have been found in the Sheshminskian formation dated to the Ufimian age, and, as such, the Sheshminskian formation has been the object of numerous studies. This paper aims to detail geological cross-sections of heavy oil deposits and to define types of geological cross-sections of the Sheshminskian formation.

Different methods of typification of cross-sections and their applicability to the Sheshminskian formation have been considered. The decision was made in favor of the method involving analysis of well logging data, modeled reservoir properties, and laboratory-based core analyses. The method made it possible to identify four types and four sub-types of the geological cross-section of heavy oil deposits in the Sheshminskian formation.

The data obtained can be used for successful planning of reservoir management programs and for evaluation of hydrocarbon potential of the territory under study.

**Key words:** *heavy oil, geological cross-section typification, Sheshminskian formation, sand unit*



УДК 551.7.022

**APPLICATION OF LITHOLOGIC-AND-FACIES ANALYSIS IN  
GEOLOGICAL MODELING OF SIRENEVSKOYE FIELD  
BOBRIKOVSKIAN FORMATION**

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**Abstract.** The authors focus on importance of the conceptual geologic model of the Sirenevskoye field Bobrikovskian formation for evaluation of reserves and building of a reservoir model. To model the sedimentation environment of the Bobrikovskian formation, the lithologic-and-facies analysis was used. Lithologic-and-facies analyses have been widely used in petroleum geology both at the initial exploration stage, and at the stage of commercial production of reserves. This method allows to formalize the properties of the geologic space and to visualize consequential changes of geological bodies. The studies performed made it possible to issue recommendations regarding follow-up exploration in the Republic of Tatarstan, and to define sweet spots.

**Key words:** *sandstone reservoir, electric facies analysis, depositional model sedimentation environment*

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## EFFECT OF HORIZONTAL WELL PRODUCTION TESTING ON SAGD PERFORMANCE IN HEAVY OIL RESERVOIRS

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**Abstract.** This paper discusses production testing of SAGD horizontal well pairs drilled in heavy-oil reservoirs of Tatarstan fields. Effect of the initial oil viscosity and oil viscosity at close-to-steam temperature on cumulative oil production has been analyzed. Various steam injection volumes have been tested based on oil properties, and the best options have been selected for 14 heavy-oil reservoirs. Reservoir simulation was used to develop guidelines for selection of optimal steam volumes during well testing phase to provide high well performance.

**Key words:** *SAGD, well production testing, initial oil viscosity, heavy oil, reservoir simulation*

УДК 622.245.44

**DEVELOPMENT OF PACKER ELEMENTS FOR SLIMHOLE WELLS  
AS PART OF INFILL DRILLING PROJECT IMPLEMENTED BY  
TATNEFT COMPANY**

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**Abstract.** To improve the efficiency of infill drilling program implemented at a group of low-production oil fields two packer configurations for wells equipped with 114-mm and 102-mm casing have been designed:

- a) stainless steel polished bushing set downhole with production string and a nipple as part of tubing string which engages with the resilient seals,
- b) anchorless packers with self-sealing packing

Packer design objective was the creation of simple, cost effective and reliable devices that could replace expensive mechanical packers available on the market. New devices were successfully tested in 36 wells. Implementation of packer elements in slimhole wells has demonstrated their operability, simplicity and reliability, reduced number of trips, and lower cost compared to conventional packers.

**Key words:** *oil recovery factor, dual completion systems in slimhole wells, production string, packer element.*