The text of this article is available in Russian and English languages at: https://geors.ru/archive/article/822/

A NEW LOOK AT GEOLOGICAL STRUCTURE OF PASHIAN HORIZON (D_3PS) OF AZNAKAEVSKAYA AREA, ROMASHKINSKOYE OIL FIELD

Z.A. Loshheva[1], M.Sh. Magdeev[1], S.G. Agafonov[1], M.V. Fedotov[1], O.V. Magdeeva[2]
[1]Tatneft PJSC, Almetyevsk, Russia
[2]Scientific and Production Centre «Neftegazovye tehnologii», Bugulma, Russia

Abstract. This paper considers construction of a geological model for the Pashian Horizon (D_3ps) of Aznakaevskaya Area, Romashkinskoye Oil Field. Facies analysis is proposed for determination of spatial arrangement of the facies that contain reservoir beds. Development strategy designed and implemented based on the existing geological model does not ensure desired economic and production performance. The new model designed using facies analysis and up-to-date IT tools (IrapRMS ROXAR software package) with account of tectonic factor enables changing the philosophy and the approach to searching for remaining reserves in poorly swept or by-passed zones. During the Pashian, coastal-marine and offshore facies accumulated within the field: wave-cut zone – basal layer; lagoon zone – lagoon clays; intertidal zone – bar layer and tidal channel (replaces bar sediments); behind-bank zone – behind-bank clays, and alluvial fan facies that overly the behind-bank clays. Fluvial palaeovalleys were also present and contained compound fluvial channel and wave-cut facies. Throughout the geological history, multiple tectonic movements occurred and influenced the architecture of the deposited facies. At the first stage, well logging data were used to analyze each well and describe the standard cross section with the following facies from bottom to top: basal layer, lagoon clays, bar layer, behind-bank clays. Four cross section types were singled out taking into account secondary facies with regular-sporadic development. In the course of the research, core data on reservoir quality were analyzed to confirm separation into compound and intertidal facies. Porosity distribution histograms were also generated based on well logging findings. The authors of this work believe that the new geological model and the subsequent reservoir simulation model will allow to work out a successful production enhancement strategy to recover the remaining oil reserves localized in poorly swept or by-passed zones.

Keywords: modeling, geological model, well logging, basal-bar layer, behind-bank clays, channel deposits, horizon

DOI: http://doi.org/10.18599/grs.19.1.4

For citation: Loshheva Z.A., Magdeev M.Sh., Agafonov S.G., Fedotov M.V., Magdeeva O.V. A New Look at Geological Structure of Pashian Horizon (D_3ps) of Aznakaevskaya Area, Romashkinskoye Oil Field. *Georesursy = Georesources*. 2017. V. 19. No. 1. Pp. 21-26. DOI: http://doi.org/10.18599/grs.19.1.4

Aznakaevsky area is an integral part of the Romashkino oil field, which is designated as an independent development object in its structure. It is located in the eastern edge of the field. From the north and east beyond its border, an outer oil-pool outline has been adopted. In the north-west it borders with Chishminsky and Tashlyarsky, in the west – with Alkeyevsky and Kholmovsky, in the south – with Karamalinsky areas.

The development of the Pashian object of the Aznakaevsky area of the Romashkino oil field began in 1958. To date, oil production from the Pashian object is characterized by a sharp drop and water cut of the production close to the critical. The developers have to solve the task of stopping the drop in the volume of production (or reducing its gradient) and reducing the percentage of water cut to maintain profitability of development and achieve the established oil recovery factor.

To solve the task, it was decided to carry out complex geological and hydrodynamic modeling using modern technologies (IrapRMS ROXAR software).

The currently applied geological and engineering operations to increase production and reduce water cut, are developed on the basis of the existing geological model of Aznakaevsky area; they do not have a positive effect on the dynamics of oil production.

The material on geology and development of industrial objects accumulated during the operation allowed to conceptually change the existing geological model on the basis of facies analysis for the distribution of reservoir layers in the sediments of the Pashian horizon, both in the section and in the area. For this purpose, the sequence of facies was considered as it moved away from the shoreline. The change of facies was observed under conditions of a stable transgression of the sea during the Early Pashian time, then under the conditions of a rather transient regression, which caused the erosion of part of Pashian deposits, and the newly started transgression in the Late Pashian time.

In facies modeling, only the energy condition was taken into account. The rate of sediments supply, their mineralogical composition, climate and the organic world were not taken into account.

During the Pashian, coastal-marine and shelf facies accumulated within the field, as they moved away from the shoreline: wave-cut zone – basal layer; lagoon zone – lagoon clays; intertidal zone – bar layer and tidal channel (replaces bar sediments in a narrow band); behind-bank zone – behind-bank clays, and alluvial fan facies that overly the behind-bank clays. (Sellie, 1989). In addition, river paleovalleys were present, which are filled with mixed river and wave-cut facies.

In a section from below upwards the sequence of facies repeats lateral. In the first case, facies are considered as they move away from the shore and, as a result, increase in depth, and in the second case, during the transgression the coastline itself moves northwest, and with an increase in depth, a similar facies change occurs. In the case of well location in the development zone of the river paleovalley, the channel bed is located beneath the basal layer, and in the development zone of alluvial fan, the siltstones of these fans are traced within the behind-bank clays. From literature (Mukharsky et al., 1975, Adbulin, Aminov, 1979; Itenberg, 1978; Muromtsev, 1984) it is known that within the Pashian horizon there is a erosion that divides it into upper and lower subhorizons. Since the basal layer of Pashian horizon overlaps the eroded sediments of Mullian horizon and a clear sequence, defined as a cycle, is traced within Pashian erosion, a similar cycle will be repeated in the same sequence.

The formed sequence of sediments during the geological history was overlaid with different ages of tectonic movements, which made some changes to the modern shape of the section opened by wells. Authors of the work traced dislocations of various geneses on the territory of the field using the analysis of curvature attributes for the structural surface of bottom of the "upper limestone" benchmark. The chronological position of the border allows identifying only the post-Pashian faults. During this time, two stages of tectonic activation occurred in the territory, connected with the formation of the Pre-Ural fore deep in the Kungurian time and the Caspian depression in the Jurassic time. The first one formed dislocations of the submeridional direction, and the second one – sublatitudinal (Fig. 1).

All disjunctive dislocations are divided into two types: interblock dislocations, with an amplitude of vertical displacement of more than 5 meters and intra-block dislocations, with an amplitude of vertical displacement of less than 5 meters. Interblock dislocations were formed by horizontal tensile stresses and generated pairs with a depression of the inter-fault zone, and intra-block dislocations – by the type of faults or dynamic pairs that flanked the interblock zones. At the first stage only interblock faults are loaded into the geological model.

First, the sections of the Pashian horizon in all wells of Aznakaevsky area were analyzed to isolate and estimate the total thickness of the standard facies set in each cycle. The analysis was based on well logging data, mainly radioactive logging data (gamma-ray logging, neutron gamma-ray logging). As additional information, the data of electrical methods were used.

The following facies were assigned to the standard set of facies in the sequence from the bottom up: the basal layer, lagoon clays, bar layer and behind-bank clays. In addition to these, there are paleochannels, tidal channels, alluvial fans and well intersection of fault zones in the form of clay in the form of cracks, repetition of the section, mylonitization and cataclasis. Additions to the standard section of the above changes, in various combinations, necessitated the typification of sections.

As a result, four main types of section were identified (Fig. 2-5). Such typing allowed us, in our opinion, the most correct way to track the distribution of the various facies along the area and in the section.

To confirm the separation of mixed channel and wave-surfacing facies, the results of core studies for changes in reservoir properties are analyzed.

In the sediments related to the wave-cut and tidal facies, 621 core samples were selected from 36 wells, over which the average open porosity K_p = 19.8% was determined (according to logging data K_p = 19.2%). The permeability coefficient K_{pr} = 785 * 10'3 μm^2 was determined or 510 core samples (Fig. 6).

In the mixed facies of paleochannels, 520 core samples were selected from 24 wells for 25 intervals. The average value of open porosity by core is 21.3%, according to logging data K_p = 20.7%. The average value of permeability by core is 985.5*10 ~ 3 μm^2 for 467 samples (Fig. 7).

The analysis of core material on the reservoir properties confirmed the validity of the facies separation in the section (Table 1).

As a result of histograms construction of distribution of Kp in the basal-bar and channel sediments determined by well logging, the differences in the reservoir properties between these facies are clearly shown. So the number of values of K_p in channel sediments with maximum values is greater than in basal-bar deposits (Fig. 8).

Based on the work carried out using the IrapRMS ROXAR software, a geological model of the Pashian horizon (D_3ps) of the Aznakaevsky area was created (Fig. 9).

According to this model, the concept of the studied object's structure has changed significantly. Instead of the previously proposed layered section with plicative nature of seams, it is a collection of different facies, regularly distributed both over the area and along a section complicated by interblock faults of submeridional and sublatitudinal strike (Fig. 10).

Fig. 1. Tectonic scheme of the Paleozoic structural level of the central regions of the Volga Federal District (Shargorodsky et al., 2003)

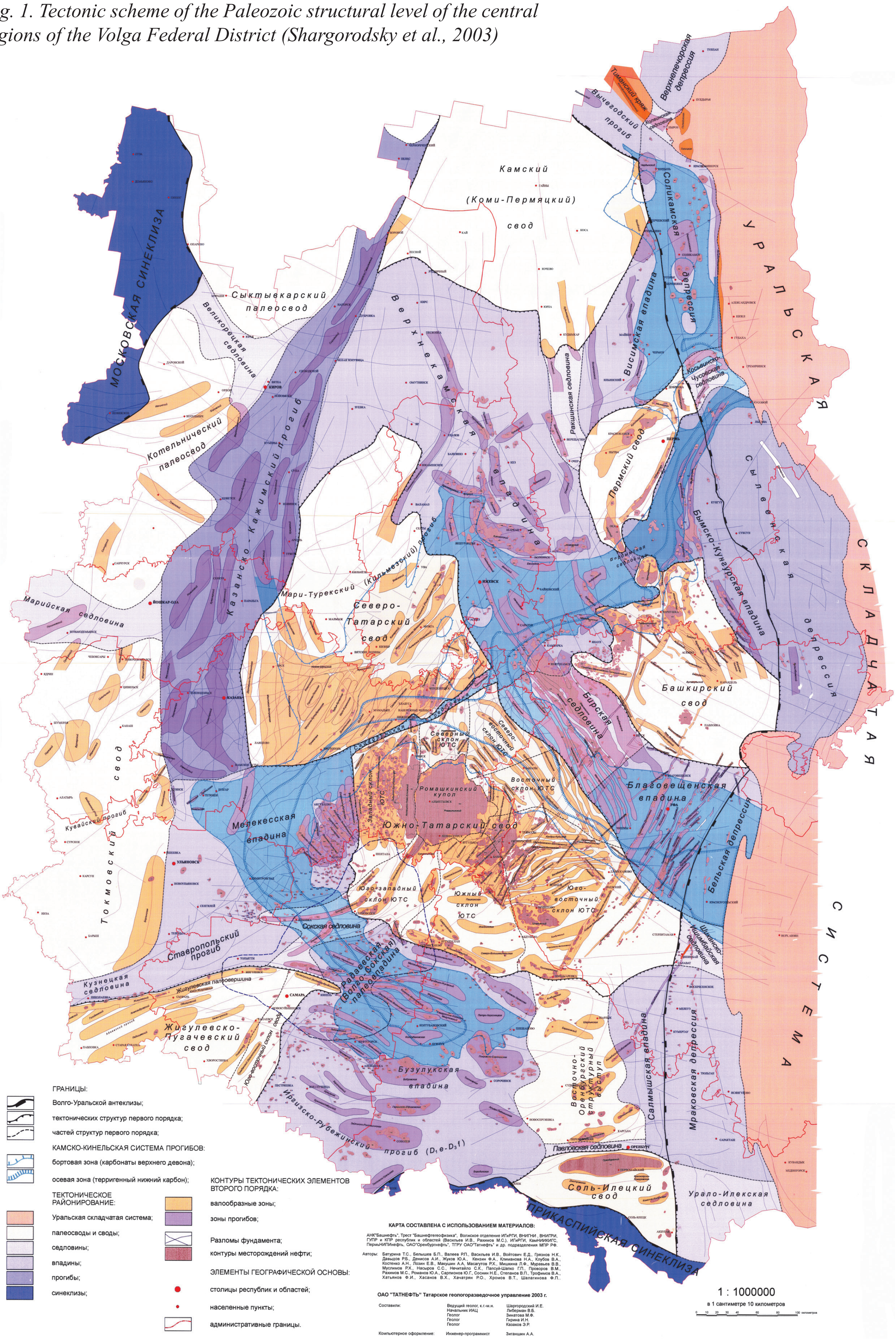


Fig. 2. The first type of the section (basal layer + bar)

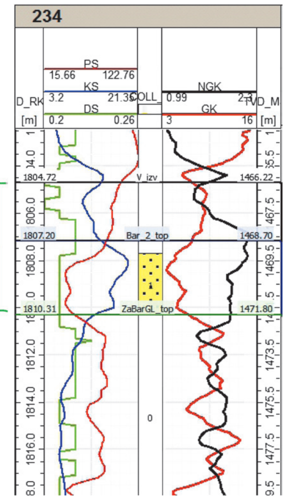


Fig. 3. The second type of the section (channel + basal layer + bar)

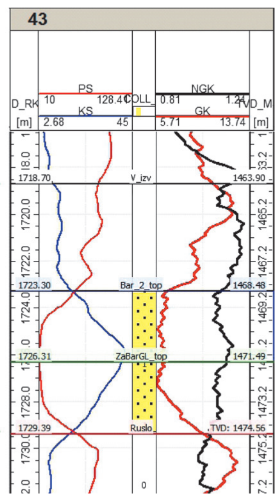
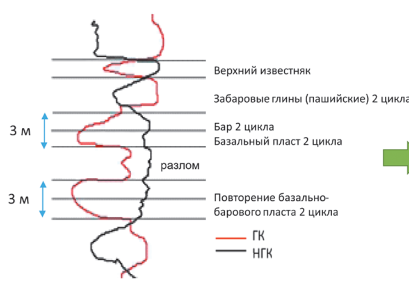


Fig. 4. The third type of the section (the first or second type is complicated by a fault)



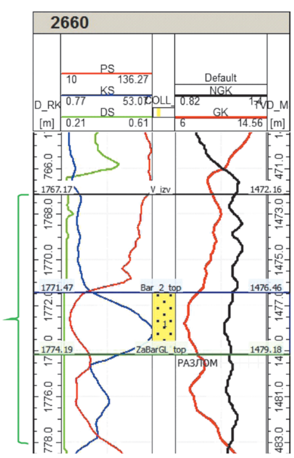
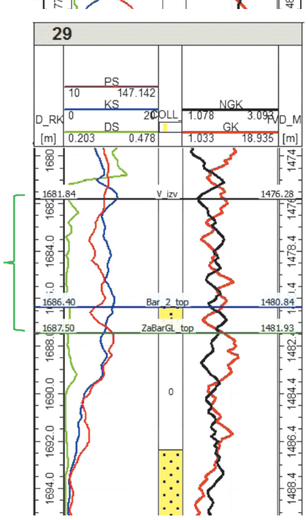


Fig. 5. The fourth type of the section (tidal channel)



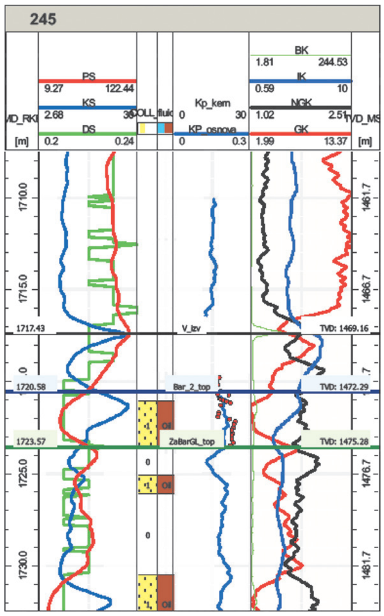


Fig. 6. Well logging board with core sampling intervals in the basal and bar reservoirs

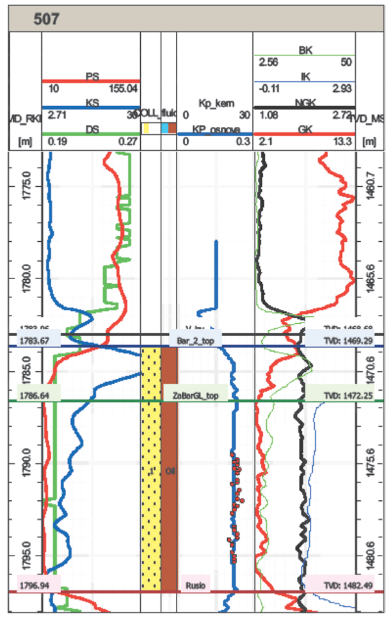


Fig. 7. Well logging board with core sampling intervals in the facies of paleochannel

Section types	K_p GIS, %	K_p core, %	Number of samp.K_p	K_{pr} core, $*10^{-3}micron^2$	Number of samp.K_{pr}
Basal+bar	19.2	19.8	621	785	510
Paleochannel	20.7	21.3	520	985.5	467

Table 1

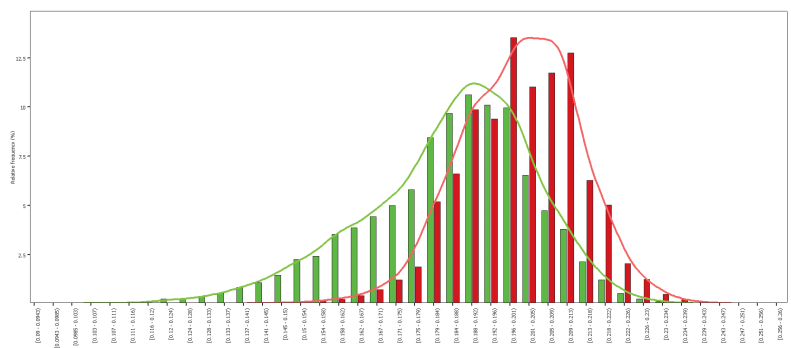


Fig. 8. Comparison of K_p determined by well logging in basal-bar and channel sediments

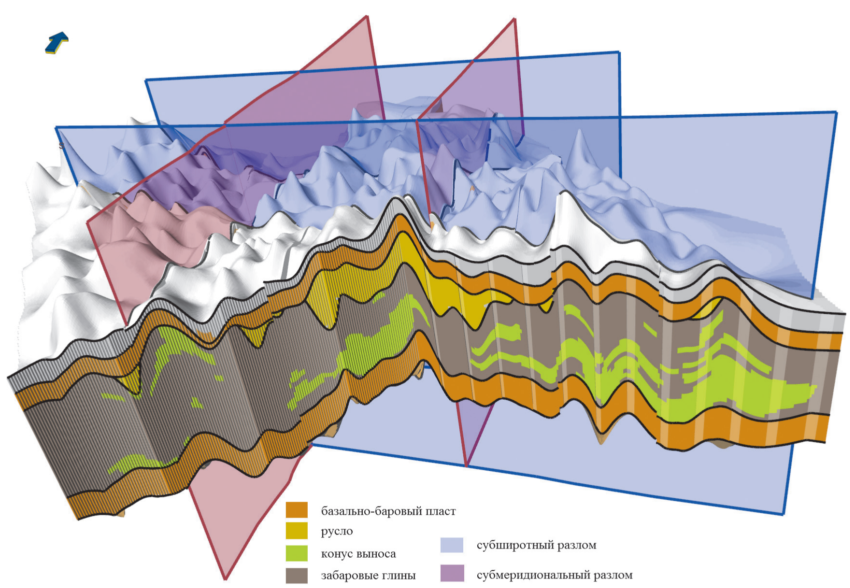


Fig. 9. Geological 3D model of the Pashian horizon (D3ps) of Aznakaevsky area

Fig. 10. Distribution map of channel sediments along the area with the imposition of submeridional and sublatitudinal faults

According to the authors of the performed work, the newly created geological model makes it possible to change the methodology and philosophy of allocating residual reserves, and in combination with hydrodynamic modeling to determine the permeability of disjunctive dislocations, directions of fluid flows and using simulators to develop successful geological and engineering operation for producing residual oil reserves concentrated in weakly drained and deadlock zones.

References

Abdullin N.G., Aminov L.Z. et al. Location pattern and generation conditions of oil and gas formations of Volgo-Uralsk region. Moscow: Nedra. 1979. Vol. 3. 168 p.

Itenberg S.S. Well Logging Interpretation. Moscow: Nedra. 1978. 389 p.

Muharskiy E.D., Knyazev S.V., Sukhanov N.I., Fattahov B.Z. Development of Kynovian and Pashian formations of the Romashkinskoye oil field in 1976-1990. Research report. TatNIPIneft, Bugulma. 1975.

Muromtsev V.S. Electrometric geology of sandbodies – lithological oil and gas traps. Moscow: Nedra. 1984.

Selli R.Ch. Ancient sedimentary environments. Moscow: Nedra. 1989. 296 p.

About the Authors

Zoya A. Loshcheva – Head of the Simulation Center, Engineering Center, Tatneft PJSC

Russia, 423458, Almetyevsk, Fakhretdina St., 43

Marat S. Magdeev – PhD in Engineering Sciences, Head of the Methodological and Petrophysical Support Division, Simulation Center, Engineering Center, Tatneft PJSC

Russia, 423458, Almetyevsk, Fakhretdina St., 43

Sergei G. Agafonov – Leading Engineer, Methodological and Petrophysical Support Division, Simulation Center, Engineering Center, Tatneft PJSC

Russia, 423458, Almetyevsk, Fakhretdina St., 43

Mikhail V. Fedotov – Engineer, Methodological and Petrophysical Support Division, Simulation Center, Engineering Center, Tatneft PJSC

Russia, 423458, Almetyevsk, Fakhretdina St., 43

e-mail: mv_fedotov@mail.ru

Olga V. Magdeeva – PhD in Engineering Sciences, Head of the Development Department, Scientific and Production Centre «Neftegazovye tehnologii»

Russia, 423236, Bugulma, M. Dzhalilya St., 32

Manuscript received 30 September 2016;
Accepted 29 November 2016; Published 30 March 2017