Reference

1. Erja Rautiainen, Ricardo Pimenta, Maria Ludvig, Carel Pouwels. Deactivation of ZSM-5 additives in laboratory for realistic testing // Catalysis Today. – 2009. – vol. 140 (3–4). – P. 179-186.
2. Ivanchina E.D., Ivashkina E.N., Nazarova G.Y., Stebeneva V.I., Shafran T.A., Kiseleva S.V., Khrapov D.V., Korotkova N.V., Esipenko R.V. Development of the Kinetic Model of Catalytic Cracking // Kataliz v promyshlennosti. – 2017. – 17(6). – C. 477-486.
3. Lipin P.V., Doronin V.P., Gulyaeva T.I. Conversion of higher n-alkanes under deep catalytic cracking conditions // Petroleum Chemistry. – 2010. – vol. 50(2). – P362–367.
4. Bartholomew C.H. Mechanisms of catalyst deactivation // Appl. Catal. A-gen. – 2001. – vol. 212 (1–2). – P.17–60.
5. Khadzhiev SN Cracking of petroleum fractions on zeolite-containing catalysts. - Moscow: Chemistry, 1982. - 280 p.
6. Etim U. J., Xu B., Bai P., Ullah Rooh, Subhan F., Yan Z. Role of nickel on vanadium poisoned FCC catalyst: A study of physiochemical properties // Journal of Energy Chemistry. – 2016. – Vol. 25. – P. 667–676.

THE ASSESSMENT OF CATAGENETIC SOURCE ROCK ZONING IN THE KYNDAL GRABEN OF THE BUREYA BASIN USING PALEOTECTONIC AND PALEOTEMPERATURE MODELING SOFTWARE (THE FAR EAST OF RUSSIA)

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Modeling of sedimentary basins makes it possible to trace the evolution of a sedimentary basin over time as it is filled by sediments which may ultimately form or contain hydrocarbons. Today, several computer programs for basin modeling are used, such as MatOil, Genex, Temis, PetroMod, GALO, etc.

In the Far East of Russia, computer modeling has been used in the study of the Sakhalin and Sea of Okhotsk sedimentary basins. The basins in the continental Far East are less thoroughly studied, and computer technologies are occasionally used to study the thermal history only one of the areas in the Pereyaslavsky Graben [2].

The main aim of the study is the oil-gas potential evaluation of Jurassic-Cretaceous deposits within Kindal Graben by tectonic and thermal history modeling of 1C, 1A and 1PR wells.

There are two stages of modeling. The first stage involves obtaining the basic geological, geophysical, and geochemical data on the basin structure and development, and also preparation of the initial parameters for the basin modeling. The input data set includes the following information: data on the current basin structure, absolute dates of geological boundaries, sedimentation washout/no sedimentation periods, climatic secular temperature variation on the Earth's surface, measured vitrinite reflectivity values. The second stage is the modeling process of subsidence history, rifting parameters, thermal history and HC generation in the basin.

The Bureya basin (BB) is the best-preserved part of the Bureya marginal trough in the boundary between the Bureya Massif and the Sikhote-Alin orogenic belt (Fig. 1) [4]. The sedimentary cover of the BB consists of the lower molasse composed of Upper Triassic–Jurassic marine sediments and the upper molasses composed of Middle Jurassic–Cretaceous continental coal-bearing deposits. In the central part of the BB, the continental coal-bearing deposits make up a large syncline structure such as the Kyndal graben–syncline, complicated in its center by the Kyndal graben (KG).

The sedimentary section of the KG consists of (bottom–up) the Talynzhan (tl), Urgal (ur), Chagdamyn (cg), Chemchuko (cm), Iorek (jr), and Kyndal (kn) suites; and Sandstone (ps) suite [1].

Having conducted the one-dimensional modeling the following conclusions are formulated. The BB bottom within the KG was subsided to a maximum depth 98 Ma ago, at the beginning of the Late Cretaceous. The greatest subsidence to the depth of 4089 m has been recorded for well 1C. The total subsidence reached 3338 m and 3437 m in wells 1A and 1PR, respectively.

The Kyndal graben–syncline was formed under thermal flow of 49–51 mW/m2 at the bottom. In the extension period, the thermal flow gradually increased to 51–52 mW/m2. In our model, the high sedimentation velocity obtained for the Kyndal suite caused a corresponding decrease in the thermal flow values during the deposition. After completion of the riftogenesis stage, the thermal flow gradually declined to 48–49 mW/m2.

In accordance with the vertical zoning of katagenesis and the location of oil and gas deposits based on the Ro diagrams, the oil-and-gas formation zones were identified as follows: ($0.1 < Ro < 0.55$) is a zone of intensive formation of HC gases; ($0.55 < Ro < 1.3$; 50–150°C) is a major oil-formation zone; ($Ro > 1.3$; 150–200°C) is a zone of intensive formation of wet condensate gas and, deeper, of dry HC gas. According to the proposed classification, the HC maturation history obtained in the three simulated wells is as follows (Fig. 2). In the period of 165–150Ma ago, the time of the Talynzhan deposition and the subsequent break in the subsidence, the regional heating was insufficient to generate hydrocarbons. In the following period of deposition of the Urgal–Chemchuko suites 150–118 Ma ago, the thickness of the sedimentary cover in the most subsided zones reached 2.5 km. Talynzhan suite was heated to 100–120°C, while the vitrinite reflectance values exceeded the level of 0.55%; in other words, all of the rocks achieved the main oil-formation phase (MOF). The Urgal, Chagdamyn, Chemchuko and partially Iorek suites entered the oil window 116–98 Ma ago, in the period of deposition of the Iorek–Kyndal suites. Approximately 95 Ma ago, the Ro parameter exceeded 1.3% at the bottom of the Talynzhan suite and the sedimentary deposits of the formation moved to the lower phase of gas generation.

Currently, the major part of the Talynzhan suite; the Urgal, Chagdamyn, and Chemchuko suites; and the Iorek suite bottom are still at MOF; the tops of the Iorek and Kyndal suites are in the upper phase of gas formation, while the Talynzhan

suite bottom is in the lower phase of gas formation. Thus, the Kyndal suite can generate gas, the Chemchuko–Urgal suites still have oil-formation conditions, while the Talynzhan and Iorek suites can generate oil and gas.

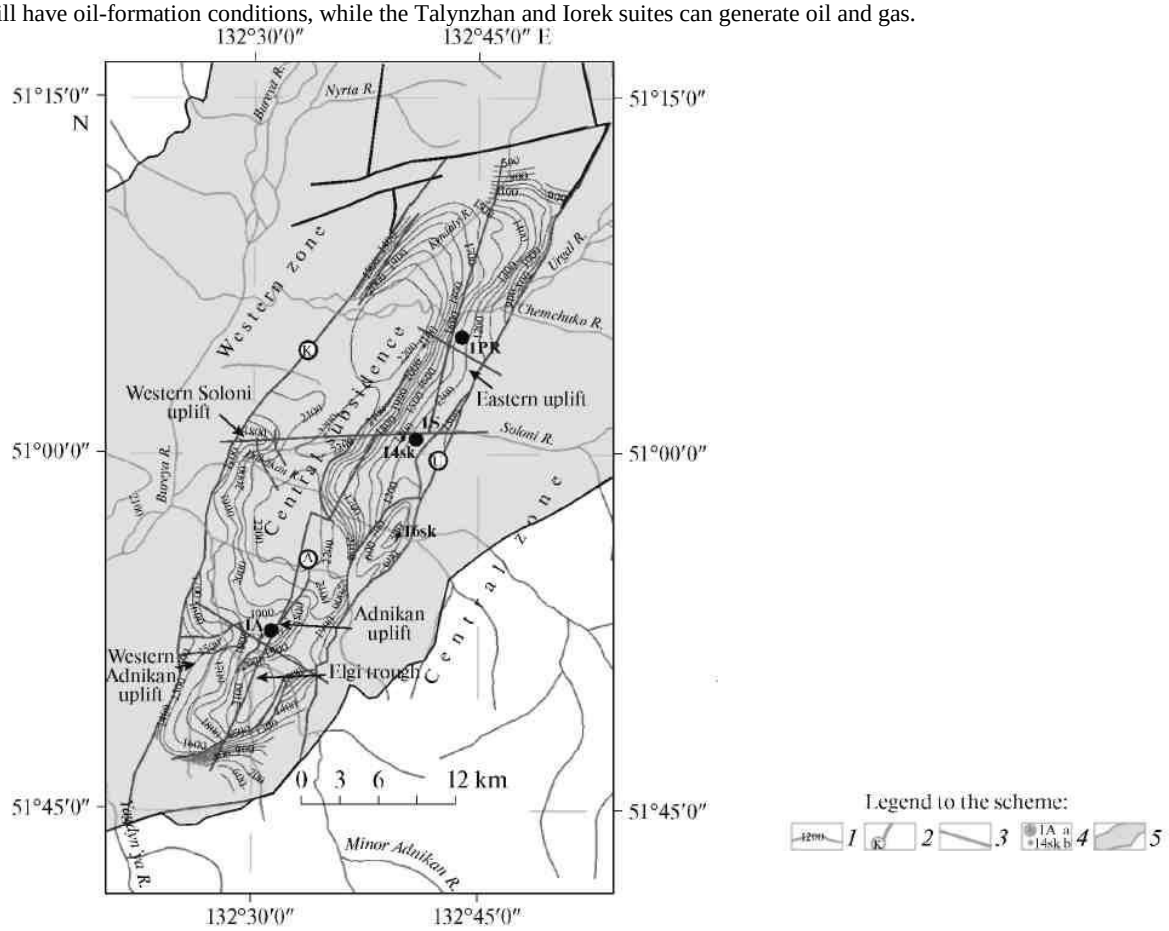

Fig. 1. Kyndal Graben: (1) structural contours of the Iorek suite foot; (2) faults and their letter symbols: (K) Kyndal, (U) Urgal, (A) Adnikan; (3) lines of seismic-geological sections; (4) wells; (5) Kyndal graben–syncline contours.

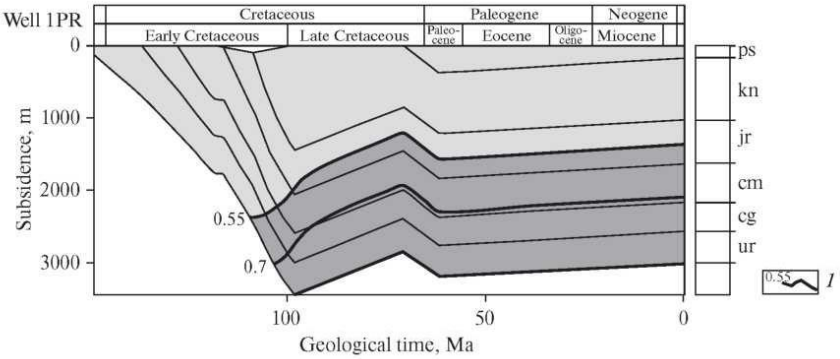

Fig. 2. Katagenetic maturity of the rocks in the Kyndal Graben sedimentary cover according to the 1D modeling results. (1) Curve of vitrinite reflectance variations, Ro.

References

1. Bureinskij osadochnyj bassejn: geologo-geofizicheskaya xarakteristika, geodinamika, toplivno-e'nergeticheskie resursy / Otv. red. G.L. Kirillova. Vladivostok: Dal'-nauka, 2012. 360 s. (Seriya «Osadochnye bassejny Vostoka Rossii» / Gl. red. A.I. Xanchuk; T. 4.
2. Gulenok E.Ju., Isaev V.I., Kosygin V.Ju., Lobova G.A., Starostenko V.I. Ocenka neftegazonosnosti osadochnykh bassejnov Dal'nego Vostoka i Zapadnojj Sibiri po dannym gravimetrii i geotermii // Tikhookean. geologija. 2011. T. 30, №4. S. 3-18.
3. Hantschel T., Kauerauf A.I. Fundamentals of Basin and Petroleum Systems Modeling. Springer Science & Business Media, 2009, 476 p.

4. Zabrodin V.Ju. Zona sochlenenija Bureinskogo massiva s Sikhoteh-Alinskojj skladchatojj sistemojj // Bjull. MOIP. Otd. geol. 2010. № 1. S. 1-22.

STUDY IN THE IMPACT OF DISPERSANT ON PARAFFIN CRYSTALLIZATION USING THE METHOD OF DYNAMIC SCATTERING

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During field development paraffins dissolved in oil can be released in the form of solid phase by changing pressure and temperature. Oil flow in the formation and bottom hole zone are negatively affected by phase transition of reservoir oil. When oil flows through pipeline, separated solid phase deposits on pipe and pump equipment walls.

The main phase state characteristic of reservoir oil (liquid-solid phase) is a paraffin saturation temperature of oil. Solid phase formation depends on paraffinic hydrocarbons content in oil [1]. Special additional agents (dispersants and inhibitors) are used to regulate phase transitions. During the initial stage of paraffin crystal formation the additive molecules are embedded in its structure and limit the growth process. The choice of an additional agent is specific for each particular case because of its possible inverse effect [6].

The effect of C-5A dispersant on the transition phase behavior of the model system during cooling process is considered in this paper. To solve this problem, the dynamic light scattering (DLS) method [5] based on the registration and evaluation of photons was used. According to the theory, the measurement of the correlation fluctuation function in the stray light intensity makes it possible to determine the characteristic correlation time and then calculate the particle radius using the diffusion coefficient. The operation of "Photocor Complex" device is based on The DLS method [2]. The algorithm of the photon correlation spectrometer functioning was considered in [4].

The purpose of the experiment was to determine the radii of the solid phase particles formed during isobaric cooling of the system. C-5A dispersant of different concentrations (0.03%, 0.06% and 0.08% by weight) was added to the paraffin-heptane model system (4%, 6%, 10% by weight).

According to the study [1], the paraffin saturation temperature increases with the growth of paraffins concentration in oil. This fact was confirmed in [3], it was also determined that the growth of the additional agent mass leads to the increase in the intensity for all paraffin concentrations.

The solid particles formation temperatures in the initial system without additional agent were 7.9 ° C and 9.3 ° C respectively (for paraffin concentrations of 4% and 6% by weight, respectively). Figure 1 illustrates the results of solid particles formation in the system (paraffin concentration of 10% by weight) at the temperature of 45.3 ° C. The particle sizes vary from 10 to 150 nm.

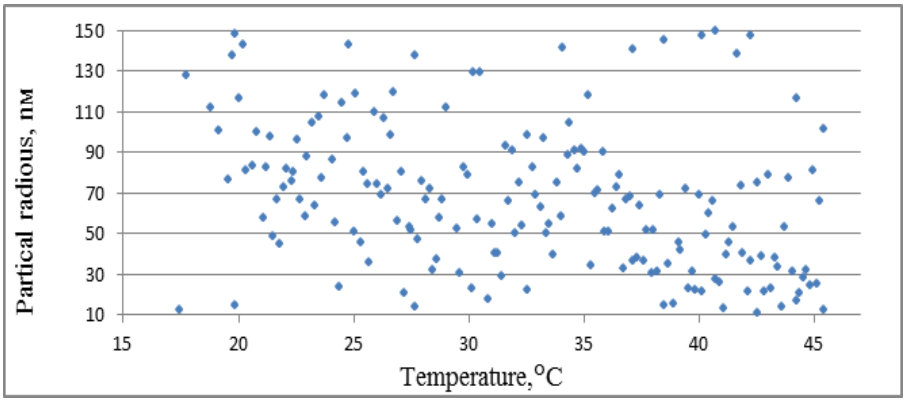

Fig.1 Particle size dependence on temperature (paraffin concentration of 10% by weight; without additional agent)

The action of the additional agent is illustrated by heptane with the paraffin concentration of 10% by weight. Adding the agent (0.03% by weight) to the initial system leads to the system reconfiguration and formation of various particles with radii from 10 to 65 nm (Fig. 2).

When the concentration of the additive increases to 0.06% by weight (Fig. 3), the range of the region of particles with small dimensions decreases from 10 to 45 nm.

When adding an additive 0.08% by weight to the system (Fig. 4), particle size stabilization is observed in the same range with a significant decrease in the number of coarse particles.