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LITHOLOGICAL AND PETROPHYSICAL CHARACTERISTICS OF JURASSIC DEPOSITS IN THE BARSAKELMES TROUGH (USTYURT, UZBEKISTAN)



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Abstract. *Data on the petrophysical characteristics of the Jurassic deposits of the Barsakelmes depression of the Ustyurt region, the features of their geological structure and possible oil and gas potential are presented. The analysis of the main geological factors is aimed at laboratory studies of the core material of the exploration well No. 1-p in the Razlomnaya area, with the aim of obtaining a holistic petrophysical picture of the open cut of the well for further optimal exploration and increasing its efficiency.*

Keywords: *Ustyurt, Barsakelmes, Jurassic, oil and gas content, residual water saturation coefficient, specific electrical resistance (RES), porosity parameter (Rp), longitudinal ultrasonic wave propagation velocity (Vp), interval time (ΔT), saturation parameter (Pn).*

ЛИТОЛОГО-ПЕТРОФИЗИЧЕСКАЯ ХАРАКТЕРИСТИКА ЮРСКИХ ОТЛОЖЕНИЙ В ЛОЖБИНЕ БАРСАКЕЛМЕС (УСТЮРТ, УЗБЕКИСТАН)

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Аннотация. *Приведены данные по петрофизическим характеристикам юрских отложений площади Разломная Барсакельмесского прогиба Устюртского региона, особенности геологического строения и возможная нефтегазоносность. Анализ основных геологических факторов направлены на лабораторное изучение кернового материала поисковой скважины № 1-п площади Разломная, с целью получения целостной петрофизической картины вскрытого разреза скважины для дальнейшего оптимального проведения поисковых работ и повышения её эффективности.*

Ключевые слова: *Устюрт, Барсакельмесский прогиб, юра, нефтегазоносность, коэффициент остаточной водонасыщенности, удельное электрическое сопротивление (УЭС), параметр по -*

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ристости (Pп), скорость распространения продольных ультразвуковых волн (Vp), интервальное время (ΔT), параметр насыщения (Pн).

BORSAKALMAS BOTIG‘IDAGI YURA YOTQIZIQLARINING LITOLOGIK VA PETROFIZIK XUSUSIYATLARI (USTIYURT, O‘ZBEKISTON)

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Annotatsiya. *Ustyurt mintaqasi Borsakelmas egilmasining Uzilma maydoni yura yotqiziqlarining petrofizik xususiyatlari, geologik tuzilishining o‘ziga xos xususiyatlari va mumkin bo‘lgan neft-gazliligi bo‘yicha ma’lumotlar keltirilgan. Asosiy geologik omillar tahlili Qidiruv ishlarini yanada optimal olib borish va uning samaradorligini oshirish uchun ochilgan quduq kesimining yaxlit petrofizik manzarasini olish maqsadida Razlomnaya maydonidagi 1-p-sonli qidiruv qudug‘ining kern materialini laboratoriya sharoitida o‘rganishga qaratilgan.*

Kalit so‘zlar: *Ustyurt, Borsakelmas egilmasi, yura, qoldiq suvga to‘yinganlik koeffitsiyenti, solishtirma elektr qarshiligi, g‘ovaklik parametri (Pp), bo‘ylama to‘lqinlarining tarqalish tezligi (Vp), interval vaqti (ΔT), to‘yinish parametri (Pn).*

Introduction. The territory of Northern Ustyurt, which has a complex geological structure, has long attracted the attention of researchers. At the same time, its advantageous economic and geographical location, due to its proximity to existing gas pipelines, requires a more thorough scientific approach to generalizing all the accumulated geological and geophysical material. It should also be noted that the studied area is very fragmentally illuminated by deep drilling, in contrast to the well-studied Sudoch deflection and Kuanysh-Koskalinsky shaft. In this regard, the results of intensive drilling, which has resumed in recent years, make a significant contribution to solving the problems of oil and gas prospects [1,3].

No deep drilling has been carried out on Razlomnaya Square to date, and the nearest structures where deep wells have been drilled are Central and Eastern Kharoy, Baiterek, and Saritekiz. The main purpose of drilling was to search for hydrocarbon fluid deposits in the Lower Jurassic sediments and their preliminary geological and economic assessment. According to the actual data, exploratory well №1-P Razlomnaya at a depth of 3595 m revealed contact between Jurassic and Permo-Triassic sediments and, having reached its actual bottom at around 3700 m, did not exit them.

Well №1-P - Razlomnaya uncovered a complete section of the Neogene-Quaternary sedimentary complex of rocks, sediments of the Paleogene, Cretaceous, Jurassic systems and the Permo-Triassic complex [7-9].

Fig. 1. Overview of the work area.

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Discussion. According to GRW data, the roof of Permian-Triassic sediments is beaten off at around 3595 m and at the bottom of the 3700 m well, the uncovered thickness of the described sediments is 105 m. This rock complex, uncovered by exploratory well №1-P Razlomnaya, was studied from core material in the depth range of 3595-3700 m. The total core removal was 4.8m, which is 4.6% of the exposed capacity of the Permo-Triassic formations. The Permo-Triassic system is mostly represented by interlayers of fine-to-medium-grained sandstones of 80%, the total thickness of which, according to the available core volume, is 3.03m (63%). Sandy siltstones and silty mudstones are sparsely distributed. The color of the rocks is mainly brown, brownish-green, pink, and is often spotted or striped. It is necessary to note the strong carbonation of rocks and frequent inclusions of mica leaves. The reservoir properties of Permian-Triassic rocks are characterized by very low indices, where the total porosity reaches no more than 6%, and the permeability is less than 1x10^{-3}mkm^2. [1,6-7]

The Jurassic system. Lower section (J_1). The lithological composition of the rocks of the Lower Jurassic in the №1-P Razlomnaya exploration well is mainly represented by sand formations (64.3% of the total number of interlayers of the Lower Jurassic section) of light gray, gray, and dark gray colors, less often with a bluish tinge. In terms of grain size, sandstones are fine-to-medium-grained, more often coarse-to-medium-grained, gravelly. The thickness of individual interlayers reaches 1.8-2.0 m in places. The total thickness of the sandstones in the available core material is 21.15 m, which is 7.0% of the total capacity of the Lower Jurassic section.

The filtration and capacitance parameters of the Lower Jurassic rocks are quite stable throughout the section: permeability varies from 0 to 0.65•10-3mkm^2, occasionally up to 23.13•10-3mkm^2, total porosity averages 10.6%. In the Lower Jurassic section, wells are limited due to the low permeability of the reservoir rock. In total, there are up to 3 collector layers in the ranges of 3459.37-3457.37m, 3327.75-3326.55m, 3312.61-3311.83m with a maximum capacity of up to 2.0m. Moreover, among them, pebble-gravellite sandstones have the highest filtration and capacitance values.

According to logging data, the upper contact of the Lower Jurassic complex is located at 3294m, the lower contact is 3595m. The total thickness of the straton is 301 m, core material sampled evenly throughout the Lower Jurassic section characterizes 8.4% of its total capacity [7].

Middle department. Aalen stage (J_2al). According to GRW and core data, the Aalen stage in the well is recaptured in the range of 3108-3294 m. The total capacity of the tier was 186m. The lithological composition of the rocks is mainly represented by sandy-gravel formations of whitish-gray, light gray color, and only in the upper part in the int.3289.41-3292.4 m there are interlayers of dark gray, black mudstones. Sandstones account for 30% of the total number of isolated interlayers of the Aalen stage, their total thickness is 8.01m, and 35.9% of the total thickness of the characterized core of the Aalen rocks. The thickness of the individual layers is not more than 2.95 m [7-9].

The largest part among the lithotypes of rocks are gravelly-sandy, sandy-gravelly, rarely pebble-gravel formations, which account for 61% in terms of the number of interlayers, and 51.3% (11.45m) in total thickness. The thickness of the individual interlayers reaches 1.45 m. Psephitic fragments are medium-rolled, often have a subangular shape, the average size of which is 3-5 mm. In the above range, siltstone-sand mudstones are intensely fragmented, thinly layered, and the thickness of the interlayers is not more than 1.6 m. The total thickness is only 12.8% of the total core removal from this straton.

In terms of filtration and capacitance parameters, alena deposits are characterized by relatively high values: permeability varies unevenly from 0-45.1•10^{-3}mkm^2, total porosity in sandy rocks varies from 4.17 to 14.39%. Medium-coarse-grained, gravelly sandstones and pebble gravelites with a total number of up to 8 interlayers have the highest reservoir properties. The total capacity of the reservoirs in this part of the well section is 10.95 m, with a single thickness of the interlayers reaching up to 2.95m.

Bayous stage (J_2bj). According to the characteristic changes in logging curves, the Bayous layer in the well is reflected in the range of 2935-3108 m. The power of the described straton is 173m. According to the types of rocks, there is a predominance of sandy interlayers, accounting for 69.8% of the total number of interlayers. Siltstone formations are much less common and characterize

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only 23.3% of the core material of the Bajocian sediments, the rest consists of thinly layered sandy-siltstone-clay formations. The color of the rocks is black, dark gray, gray, light gray.

The porosity of rocks of the Bajocian stage is characterized by average indicators. There are up to 5 reservoir rock layers with a total thickness of 4.65m, which are mainly represented by light gray sandstones of various grains and only in a single case by sandy gravelite. The total porosity of these reservoirs is 11.7-17.74%, the permeability is more often less than 2•10^{-3}mkm^2, however, in some layers it reaches 4.5•10^{-3}mkm^2, rarely 15.69• 10^{-3}mkm^2.

Bat stage (J_2bt). According to logging data, the Bat tier is located in the range of 2595-2935m. The depth of the tier is 340m, of which 23.65m is characterized by core material.

Lithologically, the most developed sandstones are mixed-grained, mostly medium-fine-grained. They account for 57.8% in terms of the number of interlayers, siltstones (23%) are found in a relatively smaller proportion, and mudstones make up only 19.2%. The breeds have light gray, gray, dark gray, rarely black colors with a constant presence of brownish-beige shades. The thickness of the sand layers reaches up to 3.4 m in places, and averages 0.9 m. The total thickness of the sandstones is 13.55m.

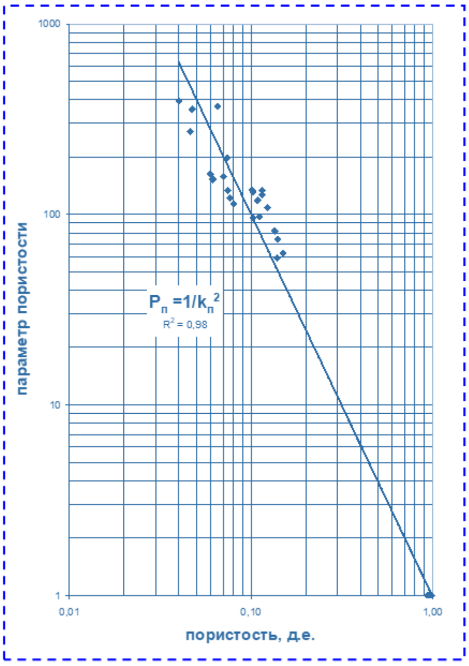

Fig.2. Dependence of Rp=f (kp) porosity parameter on porosity coefficient of Lower-Middle Jurassic rocks.

According to reservoir parameters, the bath rocks are not of interest due to their impermeability, the filtration capacity does not exceed 0.43•10^{-3}mkm^2, and only in some samples a fracture permeability of up to 4.25•10-^{3}mkm^2 is observed. The open porosity in the samples varies from 1.29-1373%, with an average of 9.3%.

Petrophysical characteristics of rocks. A number of petrophysical parameters were determined from 30 rock samples taken from well №1-P in Razlomnaya Square: the coefficient of residual water saturation, the electrical resistivity (RES) of 100% water-saturated samples (rp), the porosity parameter (Rp), the propagation velocity of longitudinal ultrasonic waves (Vp), the interval time (DT), the specific electrical resistance of partially saturated samples (rvn), saturation parameter (Ph) [2, 4-5,10].

Results. The residual water saturation of the studied sand-siltstone samples, measured by the method of cetrifugation, varies from 38.8 to 93.2%. In general, there is a tendency to decrease the residual water saturation with an increase in the open porosity coefficient. However, high values of kov (90-85%) persist even in samples with a porosity coefficient of Kp =8.0-10.0%. More than 1/3 of the samples have a residual water saturation of less than 70%. A possible reason for this may be the very complex structure of the sandstone pore space.

The electrical resistivity of rocks completely saturated with 10% aqueous NaCl solution varies from 4.73 to 31.6 ohms•m. Low-porosity sandstones and siltstones (kp=1-5%) are characterized by high values of rp - 28.5-31.6 ohms•m. The porosity parameter of the samples varies between 59-395.An empirical relationship has been established between the porosity parameter (Rp) and the porosity coefficient (Kp) for sand-siltstone rocks taken from well No. 1-p of the Razlomnaya area (Fig. 2), which has the form: Rp=1/kp2 (correlation coefficient r=0.98). The power-law index m, which characterizes the structure of the pore space of a rock, is 2.0. This value of m is typical for well-cemented terrigenous rocks with intergranular porosity. A similar relationship exists for sandy-siltstone rocks of the SLE. No. 1-pl Gel has the form Rp =1/kp 1.92 [2, 4-5].

The electrical resistivity of partially saturated

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rocks, depending on the degree of saturation, increases from 1.1 to 5.8 times than that of fully saturated rocks. Based on the data of the electrical resistivity of partially saturated rocks and the water saturation coefficient, the relationship between the saturation parameter and the coefficient of residual water saturation is constructed (Fig.3), which in numerical terms has the form: Ph=1.1/cov1.87 (correlation coefficient r=0.77). The power exponent of n is 1.87. This value of the n index is typical for hydrophilic terrigenous reservoirs with intergranular porosity with a complex structure of the pore space.

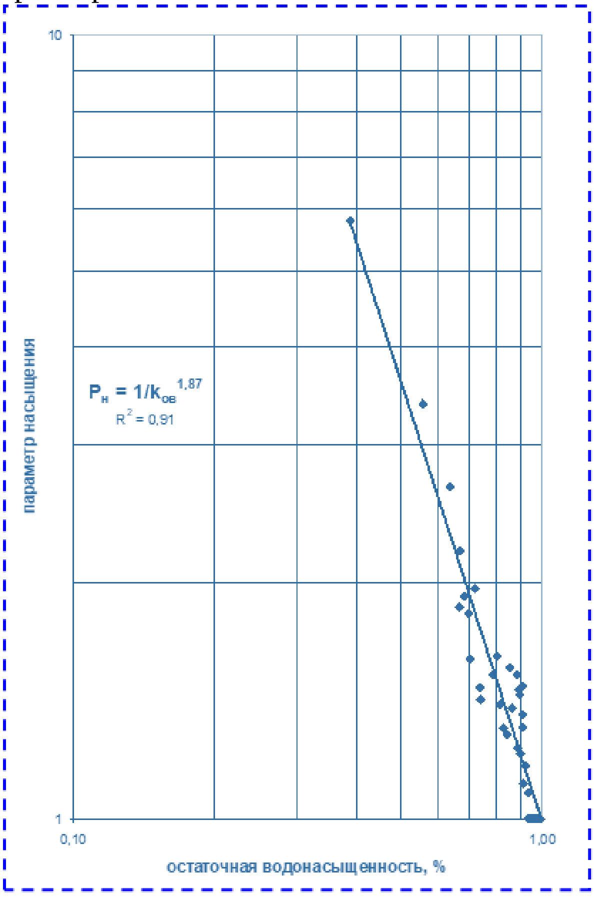

Fig.3. Dependence of Ph=f(kov) saturation parameter on the coefficient of residual water saturation.

The propagation velocities of elastic longitudinal waves in air-dry samples (this petrophysical parameter was determined on 50 samples) vary from 2370 to 4590 m/s. The interval time in the dry samples varies from 218-421 microseconds. Saturation of samples with a reservoir analog increases the overall elasticity of the rock, which causes an increase in the velocity of longitudinal waves. The propagation velocity in water-saturated samples varies from 2650 to 4710 m/s. For sandy-siltstone rocks with such porosity limits, the velocity Vp corresponds to increased values. This complements our assumptions about the complex nature of the structure of the pore space of the rocks studied and the predominant role of micropores in the total volume of the void space. The interval time in water-saturated samples varies from 212-378 microseconds. An empirical relationship has been established between the interval time (DT) and the coefficient of open porosity (kp) for sandy-silty rocks (Fig.4).

The linear regression equation has the form DT=8.4kp+199 with a correlation coefficient of 0.65. As can be seen from the graph, the interval time in the rock skeleton at kp = 0 is 199 microseconds. This value is close to the maximum values of the interval time for sandy-silty rocks (for single-component quartz sandstone - 189 microseconds). Based on this value, using a Schlumberger palette, the values of the interval time in the skeleton of samples with different porosities were calculated.

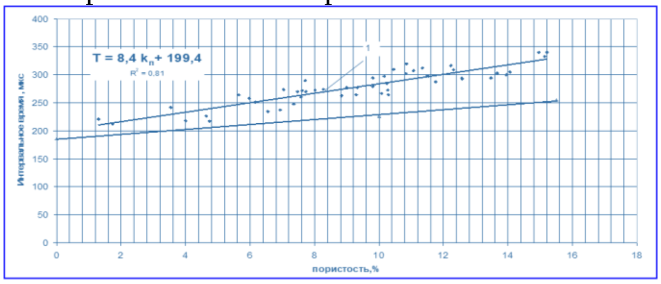

Fig.4. Dependence of T=f(kp) of the interval time on the coefficient of open porosity for sandy-silty rocks of the Lower-Middle Jurassic age.

Conclusion. Thus, according to petrophysical studies, the Jurassic section as a whole continues to have a tendency to decrease residual water saturation with an increase in the coefficient of open porosity. However, high values of kov (90-85%) persist even in samples with a porosity coefficient of Kp =8.0-10.0%. More than 1/3 of the samples have a residual water saturation of less than 70%. A possible reason for this may be the very complex structure of the sandstone pore space. The electrical resistivity of rocks completely saturated with 10% aqueous NaCl solution varies from 4.73 to 31.6 ohms•m. Low-porosity sandstones and siltstones (kp=1-5%) are characterized by high values of rp -

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28.5-31.6 ohms•m. The porosity parameter of the samples varies between 59-395.The value m=2.0 obtained by plotting the dependence of the porosity parameter (Rp) and the porosity coefficient (Kp) for sandy-siltstone rocks is typical for well-cemented terrigenous rocks with intergranular porosity.

Based on the data obtained (power-law index n=1.87), the dependence of the saturation parameter and the coefficient of residual water saturation leads to a conclusion about the complex structure of the intergranular pore space and the hydrophilicity of terrigenous reservoirs.

It should be noted that saturation of samples with an analog of reservoir water increases the overall elasticity of the rock, which causes an increase in the velocity of longitudinal waves, which complements the assumptions about the complex nature of the structure of the pore space of the rocks studied and the predominant role of micropores in the total volume of the void space.

REFERENCES

1. Абдуллаев Г.С., Хайитов Н.Ш., Шарафутдинова Л.П., Джалилов Г.Г. Особенности строения нижнепермских отложений, вскрытых на площади Сатбай скважиной 1 (Южный Устюрт) // Нефтегазовая геология. Теория и практика. – 2017. - Т.12. - №4. - http://www.ngtp.ru/rub/2/37_2017.pdf
2. Авчян Г.М., Матвеенко А.А., Стефанкевич З.Б. Петрофизика осадочных пород в глубинных условиях // М.: Недра, 1979. — 224 с.
3. Акрамходжаев А.М., Юлдашев Ж.Ю. и др. Опорные и параметрические скважины Устюрта. – Т.: «Фан». - 1981. – 127 с.
4. Алеева А.О., Исаев В.И. Сравнительная петрофизическая характеристика разрезов Герасимовского и Крапивинского месторождений (в связи с нефтегазоносностью доюрских отложений) // Известия ТПУ. 2019. №9.
5. Белохин В.С., Иванов М.К., Калмыков Г.А., Корост Д.В., Хамидуллин Р.А. Петрофизические методы исследования кернового материала. Книга 1 и 2.
6. Каршиев, О. А., Джалилов, Г. Г., Ахмедова, Д. А. (2024). Особенности геологического строения и перспективы нефтегазоносности южной части Сырдарьинской впадины. Sanoatda raqamli texnologiyalar, 2(4), с. 137-149. https://doi.org/10.70769/3030-3214.SRT.2.4.2024.54
7. Шарафутдинова Л.П., Джалилов Г.Г., Хайитов Н.Ш. Основные результаты бурения поисковой скважины №1 на площади Джел (Западный Шахпахты, Устюртской регион, Узбекистан) // Нефтепромысловое дело. - Москва. - 2010.– №12 – С.30-33.
8. Шарафутдинова Л.П., Ахмеджанова Л.С., Джалилов Г.Г. Литолого-стратиграфическая характеристика и условия образования юрских отложений по керну скважины 1 площади Джел (Устюрт, Узбекистан) // Геология и минеральные ресурсы. - Ташкент – 2010. - №3. - С. 3-11.
9. Шарафутдинова Л.П., Джалилов Г.Г. Особенности строения юрской тер-ригенной толщи Шахпахтинской ступени (Южно-Мангышлакско-Устюртская впадина) и связанных с ней песчаных тел-коллекторов (на примере месторождения Джел). // Геология, геофизика и разработка нефтяных и газовых месторождений. - Москва – 2014. - №8. - С. 35-44.
10. Шоймуротов Т.Х., Джалилов Г.Г., Хакимзянов И.Н., Юсупов Ш.К. Условия формирования и закономерности размещения битумопроявления в южном Узбекистане // Нефтяная провинция.-2024.-№4(40).-С.1-17.- DOI https://doi.org/10.25689/NP.2024.4.63-75. - EDN ZTCECP.