Известия Саратовского университета. Новая серия. Серия: Науки о Земле. 2023. Т. 23, вып. 1. С. 31–38
Izvestiya of Saratov University. Earth Sciences, 2023, vol. 23, iss. 1, pp. 31–38
https://geo.sgu.ru https://doi.org/10.18500/1819-7663-2023-23-1-31-38, EDN: QNGTYP

Article

Lithofacies interpretation at the upper part of the Pokurskaya formation in the Cenomanian succession, the north of the West Siberian Basin

N. Mohammad[1,2]✉, **N. Hamada**[1,2]

[1]Kazan Federal University, 18 Kremlyovskaya St., Kazan 420008, Russia
[2]Damascus University, Al-baramka, Damascus, Syria

Mohammad Nosheen, nosheen.g.mohammad@gmail.com, https://orcid.org/0000-0002-3893-041X
Hamada Nadia, nadia.m.hamada@gmail.com, https://orcid.org/0000-0003-3269-6842

Abstract. The lithofacies of the Cenomanian succession within a gas field in the north of the West Siberian basin were studied using well log information especially spontaneous potential log to determine the lithostratigraphy, hydrodynamic characteristics, possible reservoir sands and depositional environment of the study area for opportunities that will support the exploration program. Geophysical well logs from six profile wells were used for this study. The lithostratigraphic model and sequence-stratigraphic frame were developed using spontaneous potential log curves to identify lithic units like sand, silt and mud. The depositional environments penetrated by the wells interpreted from log signatures gave four main types of lithofacies: Foreshore, Regressive Shoreface; Transgressive Shoreface; Discontinuous Currents were recognized from the stacking patterns of the spontaneous potential curves by modified electro facies classification. The stratigraphic column of the wells was subdivided into parasequences composing four sequences within the regional stratigraphic trend.
Keywords: Pokurskaya formation, Cenomanian age, spontaneous potential log, lithofacies, depositional environments, sequence stratigraphy

For citation: Mohammad N., Hamada N. Lithofacies interpretation at the upper part of the Pokurskaya formation in the Cenomanian succession, the north of the West Siberian Basin. *Izvestiya of Saratov University. Earth Sciences*, 2023, vol. 23, iss. 1, pp. 31–38 (in Russian). https://doi.org/10.18500/1819-7663-2023-23-1-31-38, EDN: QNGTYP

Научная статья
УДК 551.7.022

Литофациальная интерпретация сеноманских отложений на севере западно-сибирского нефтегазоносного бассейна

Н. Мохаммад[1,2]✉, **Н. Хамада**[1,2]

[1]Казанский (Приволжский) федеральный университет, Россия, 420008, г. Казань, ул. Кремлевская, д. 4/5
[2]Дамасский университет, Аль-Барамка, Дамаск, Сирия

Мохаммад Ношин, [1]магистрант, [2]ассистент преподавателя, nosheen.g.mohammad@gmail.com, https://orcid.org/0000-0002-3893-041X
Хамада Надия, [1]аспирант, [2]ассистент преподавателя, nadia.m.hamada@gmail.com, https://orcid.org/0000-0003-3269-6842

Аннотация. Литофации покурской свиты (ПС) (в составе сеноманских отложений) в пределах газового месторождения на севере Западно-Сибирского бассейна были изучены на основе данных электрокаротажа скважин. Данные кривых покурской свиты были использованы для интерпретации литологии, гидродинамических характеристик и условий осадконакопления на исследуемой территории. Анализировался материал шести профильных скважин. Были идентифицированы литоединицы по соотношению αПС и медианного размера зерен. По сигнатурам кривых ПС выделены фации устьевых баров и пляжей, фаций вдольбереговых баров (регрессивных и трансгрессивных) и прибрежных валов и фаций разрывных течений, согласно модифицированной классификации электрометрических фаций. На основе фациальной модели выделены парасеквенсы, составляющие четыре секвенса, соответствующие региональному стратиграфическому тренду и распределению резервуарных свойств.
Ключевые слова: покурская свита, сеноманские отложения, электрометрические модели фаций, обстановки осадконакопления, секвенс-стратиграфия

Для цитирования: *Мохаммад Н., Хамада Н.* Литофациальная интерпретация сеноманских отложений на севере западно-сибирского нефтегазоносного бассейна // Известия Саратовского университета. Новая серия. Серия: Науки о Земле. 2023. Т. 23, вып. 1. С. 31–38. https://doi.org/10.18500/1819-7663-2023-23-1-31-38, EDN: QNGTYP

Introduction

The Pokurskaya Formation (Fm.) is one of the main hydrocarbon reservoirs in the North West Siberian basin. The Pokurskaya Fm (the Aptian-Cenomanian) consists of sandstones, siltstones, and mudstones formed in shallow desalinated and continental sedimentary environments [1]. The formation is about 800 m thick depending on the regional setting. We are interested in the log lithofacies and sequences of the Cenomanian part of the Pokurskaya Fm about 200 m thick.

R. C. Selley was the first (1978) [2] who considered the shapes of well-log curves as the fundamental tool for understanding depositional facies, since log shape is directly linked to the grain size of rock successions. Following works, e.g. (V. S. Muromtsev [3], D. J. Cant [4], J. J. Chow et al. [5], N. A. Siddiqui et al. [6]) defined various spontaneous potential (SP) and gamma-ray (GR) log curve shapes used to interpret the depositional environments as important tool of facies interpretation in the subsurface. The facies alteration and geometry reflect sequence stratigraphic composition of strata.

Sequence stratigraphy deals with the correlation of coeval strata and facies units that typically vary through a basin and are bounded by surfaces of low diachroneity. We should note that facies studies leading to paleoenvironment analysis are far more crucial for sequence stratigraphy than for lithostratigraphy and understanding the vertical and lateral connection between facies in a time framework allows to connect the same timelines in multiple lithologies [7].

The object of our research is the lithofacies and sequence stratigraphy analysis of Pokurskaya Fm depending on the characteristics of SP logs data to carry out lithofacies and sequence stratigraphic interpretation of well logs in order to establish the environment of deposition, maximum flooding surfaces, and boundaries of sequences from the obtainable well logs.

The use of SP log data as lithological characteristics for purposes of lithostratigraphy, hydrodynamic levels, grain sizes, clastic sediments differences is the basis for creating facies geometry plot and a sequence stratigraphic frame [8, 9].

1. Regional Settings

Within Western Siberia, the Pokurskaya Fm is distributed over a large area in the northern, central and eastern parts (Fig. 1) in the Omsk-Urengoi structural facies zone (Tazovsko-Urengoisky and Omsk-Laryaksky subareas) from the Kara Sea in the north to the city of Omsk in the south [10]; in some places, the formation is also distinguished in the southern regions of the West Siberian plate and on the eastern slope of the Middle Urals.

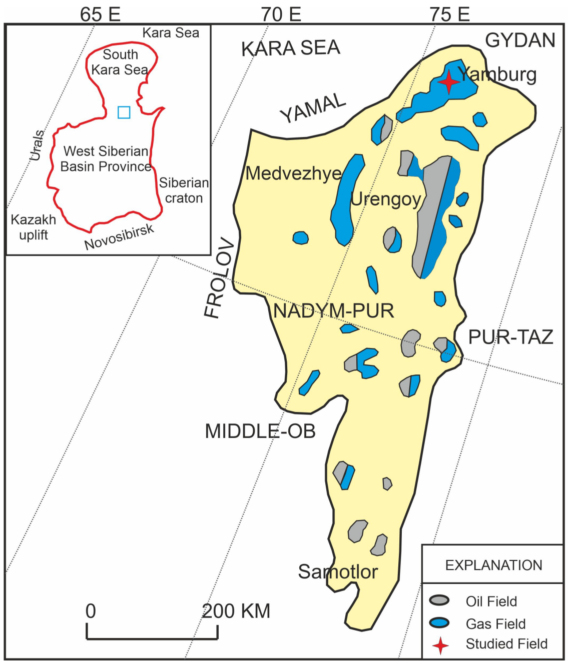


Fig. 1. Map of the petroleum regions with oil and gas fields of West Siberian Basin on the Nadym-Pur Oil- and Gas-Producing region where study area and its petroleum region boundary are located (Frolov, Middle Ob: in the central part of the West Siberian basin, Pur-Taz: in the northeastern part of the West Siberian basin, Yamal: in the northwestern part of West Siberia south of the Kara Sea, Gydan: in the northeastern onshore part of the West Siberian basin) (Modified from [11]) (color online)

The layers of the Pokurskaya Fm lie with a gradual transition to the Kiyalinskaya formation. In the southeast direction they are facilely replaced by rocks, the lower Simonovka subformation and further, from the side of the Chulym-Yenisei depression, the Kia formation. In the Kulundinsko-Barabinsky area, south of the Pokurskaya, the Lenkovskaya formation is widespread. According to the research [9] the clastic rocks of the Meso-zoic-Cenozoic sedimentary cover and the Paleozoic basement rocks represent the geological section of the studied field.

1.1. Paleogeography and Facies of Cretaceous (Cenomanian) in West Siberia

Regression was recorded on the Late Albian continued into the Cenomanian, led to shallowing of the sea [12]. The topographical relief on the platform margins was further dissected with tectonic rejuvenation. The Cenomanian climate was moderately warm and wet [13].

In the western Siberian basin, the following paleogeographic conditions have been recognized [1]: Shallow Sea, less than 25 m deep; Often flooding coastal plain by the sea; Lowland depositional plain; Erosional-depositional plain; elevated erosional plain; Low mountains.

During this regression the gradual shallowing in the basin limited the marine deposition area to

1,290,000 km^2. The shallow sea areas with a depth of 25–100 m were again disappeared and a series of intermittent coastal plains along the paleo-Urals was created. The south and southeast boundary of the basin consists of a small strip (up to 50 km wide) of the erosion plain. A waterway in the Gulf of Ob in the center of the basin linked the shallow epicontinental sea with the open sea. The accumulation of the sand and silts on the Uvat and Marre-Sale Formations occupied a freshwater marine basin of less than 25 m, while sands dominated coastal environments [1]. Marine and continental lagoon facies represented sedimentary environments of a coastal plain that had regularly transgressed the sea and occupied an area of 1,130,000 km^2 during the Cenomanian age (Pokurskaya and Dolgan Fm) [1].

1.2. Stratigraphy of the Pokurskaya Fm

The stratigraphy and sedimentary history of the Pokurskaya Fm were studied by many scientists as A. M. Brekhuntsov, A. A. Bulynnikov, I. Gutman, T. I. Gurov, V. I. Ermakov, Yu. N. Karagodin, A. E. Kontorovich, A. A. Nezhdanov, N. N. Nemchenko, I. I. Nesterov, M. V. Poroskun, F. Z. Khafizov, V. I. Shpilman and many others.

The Pokurskaya Fm relates to the Aptian, the Albian and the Cenomanian stages of the Lower and the Upper Cretaceous Series. The age of the formation is determined using spore-pollen complexes. The Cenomanian aged rocks are dominated by gymnosperm pollen [9].

The studied Cenomanian stage consists of interbedded sandstones, siltstones, and mudstones (clays). Sandstones: from light gray to gray, fine-medium-grained, micaceous, weakly cemented, clayey to varying degrees, rare carbonate interlayers; Siltstones: gray and light gray, unequal-grained, micaceous, clayey with interlayers of thin black clays, less often carbonate; Mudstones: gray and dark gray, silty, dense, with thin lenses of sandy-silty material; interlayers of carbonaceous clays with thin layers of brown coal (lignites) are noted. The Pokurskaya Fm is about 800 m thick while the studied part of the Pokurskaya Fm is 200 m. This part relates to the upper part of the Cenomanian stage (28% of the whole Cenomanian thickness).

2. Materials and Methods

The SP and resistivity log data from six profile wells were used for this study. For the data analysis, the following methods have been adopted.

2.1. Lithology Identification

Without any artificially applied current the SP log tests the spontaneous potential difference between the surface and the borehole. The spontaneous potential is produced by electro-chemical effects at the contacts between permeable beds and shale/and across the transition zone between mud filtrate and formation water within the permeable beds. One of the uses for SP log is the indication of the shaliness of a formation as well as a grain size.

The αSP well log signatures by (V. S. Muromtsev [3], V. V. Lapkovksy et al. [14]) were used to identify lithostratigraphic units and facies. The αSP values are calculated using the normalizing SP values to the maximum between the sand line and the clay line [3]. By αSP vs Md grain size plot sandstones with median grain size from 0.1 to 0.4 mm are concentrated in the upper right corner of the graph. In the interval $\alpha SP = 0.6–0.8$ there will be fine-grained sands, and in the interval, $\alpha SP = 0.8–1.0$ sands are coarse and medium-grained, non-clay. The scatter of points horizontally in the interval $\alpha SP = 0.8–1.0$ is explained by the absence of clay content in coarse-grained sands, as a result of which the SP curve practically ceases to respond to an increase in the grain size in them. The siltstones and mudstones are characterized by the interval $\alpha SP = 0.4–0.6$ and $\alpha SP = 0.0–0.4$ respectively (Fig. 2).

2.2. Well Log Facies Identification

The type of SP log signatures is a fundamental means of interpreting lithofacies and deposition environments. The work was focused on well logs for wells 2020, 3140, 3160, 6040, 6080 and 7222 were placed side by side and correlated to determine stratigraphic units that are equivalent in time, age or stratigraphic position.

The αSP well log signatures facies classification for shallow marine environments (Fig. 3) was used in the study. As well as depositional sequence was determined by the cycle of sea level changed. And in vertical succession, depositional sequences were identified in the well logs.

The electrometric properties of sand bodies generated under marine conditions, in particular, will be fundamentally different from those of bodies formed under continental settings in most situations (Fig. 3). Where in each condition the αSP curves differ by many specifications, the width ranges of the anomaly from units to tens generally, the position of the maximum value αSP varies depending on the facies from the lower to the upper part with the maximum hydrodynamic activity of the sedimentation between 0.6–1 [15].

This sedimentary process can be interpreted by sandy sediments, which are formed by the dispersion of detrital particles from land along coasts and the introduction of waves from deeper sections of the seafloor. Since the activity waves extend over a large region of the shore, sand bodies grow along a substantial portion of the sea coast at the same time.

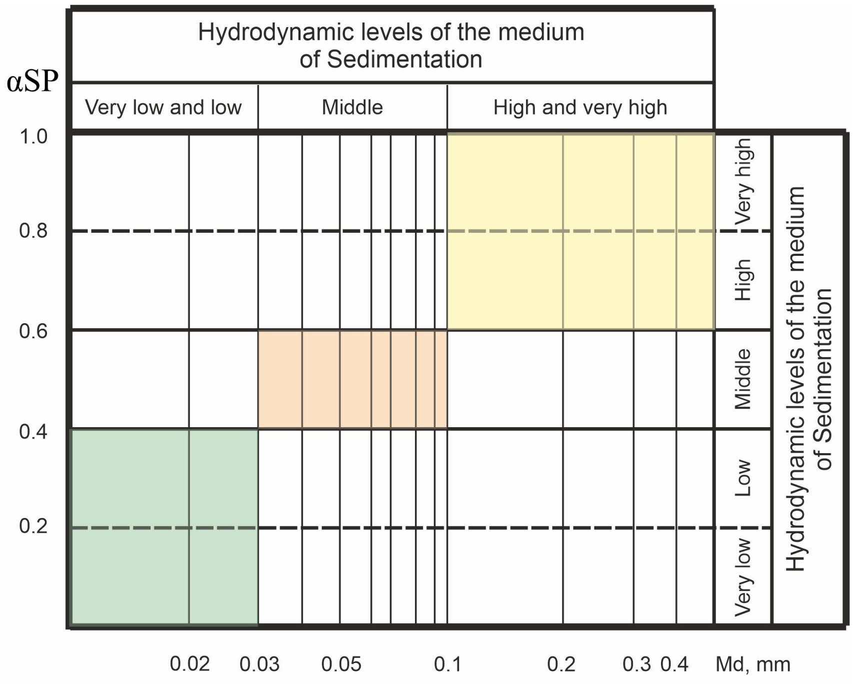


Fig. 2. Hydrodynamic conditions of clastic bodies – traps of HC (Modified from V. S. Muromtsev [3])

3. Results and Discussion

The SP log data from six profile's wells were taken as lithic and facies characteristics.

3.1. Identified Lithology

To determine the genesis of sediments from logging data, it is necessary to know how sedimentation conditions change over time for sediments of each facies. In this case, facies are considered from the standpoint of identifying the mechanism of formation of their constituent sediments, which is based on the sedimentological factor of changes in the paleohydrodynamics of the environment.

There are at least three hydrodynamic levels (modes) (Fig. 3): high, medium, low [3]. Each of these levels is characterized by a number of initial features reflecting the dynamic activity of the sedimentation environment. At least two large bedsets are revealed. Each of them begins with sandstones (high hydrodynamic level) of more or less thickness.

3.2. Heterogeneities Estimate

The heterogeneities can be estimated as: K1 – the proportion of beds number with grain Md size > 0.03 mm (Fig. 2); and K2 – the proportion of beds thickness with grain Md size > 0.03 mm in the lower and upper bedsets (Fig. 4).

The comparison of bedsets by K1 and K2 values shows the increasing of (high + medium) hydrodynamic level's material participation in the upper bedset, so we can propose Sediment Supply Factor's influence growth during accumulation of this bedset (Fig. 4). The received model points to wider spreading of sedimentary environments with higher hydrodynamic activity to the Cenomanian's end within the studied area. When comparing the lower and upper bedset (Fig. 4), the number of layers and thickness are greater in the upper bedset. Therefore, the upper bedset is characterized by higher reservoir properties in comparison with the lower bedset.

3.3. Identified SP Facies and Depositional Environments

Each facies have its own unique combinations of paleohydrodynamic sedimentation modes. The change in paleohydrodynamic levels in a sequence characteristic of a given facies is called the sedimentological model of the facies. These models make it possible to reconstruct the paleohydrodynamic environment and determine the genesis of sediments from the electric logging sections of the wells.

The sediment deposition of the shallow marine delineated for the wells were inferred from the study. As a result there are four main types of lithofacies: Foreshore (IV-7), Regressive Shoreface (V-9); Transgressive Shoreface (V-10); Discontinuous Currents (VI-(12–13) (Fig. 5) where recognized by facies classification (Fig. 3). According to V. S. Muromtsev [3] these facies have the following environmental features:

The Foreshore lithofacies (IV-7): are represented by estuarine bars. They are formed when river waters flow into the sea basin. Bars can be oval, isometric, fan-shaped, or crescent-shaped. The length of the sandy body can reach tens of kilometers. The energy levels of the water environ-

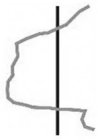
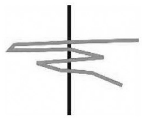
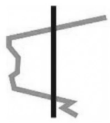
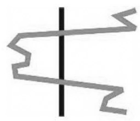
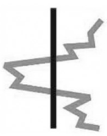
Environment of sedimentation	Index of the facies group	Group of facies	Index facies	Electrometric model	The name according to V. S. Muromtsev (1984)	Curve deviation sign αSP	The width of anomaly αSP (m)	Position of the maximum value αSP	Maximum dynamic activity of the sedimentation	Reducing the value αSP
Costal - Marine	IV	Foreshore	7		Estuary Bars	–	Units and tens	In the middle part	0.8–0.6 (High)	⇧⇩
			8		Beach	–	Units	In the upper part	1.0–0.8 (Very high)	⬇
	V	Shoreface	9		Shoreface (regressive)	–	Units and tens	In the upper part	1.0–0.8 (Very high)	⬇
			10		Shoreface (transgressive)	–	Units and tens	In the lower part	1.0–0.8 (Very high)	⬆
			11		Barrier island	–	Tens and the first hundred	In the upper and middle part	1.0–0.8 (Very high)	⬇
	VI	Discontinuous currents	12		Gullies of discontinuous currents	–	Units and tens	Weakley expressed in the lower part	0.8-0.6 (High)	⇧
			13		Head parts of discontinuous currents	–	Units and tens	In the middle part	0.8-0.6 (High)	⇧⇩

Fig. 3. The classification system of marine sedimentation conditions depending on αSP log, showing the electrometric properties of sand bodies generated under coastal-marine conditions, including: Foreshore; Shoreface and Discontinuous currents facies. The electrometric model represents an anomaly of the PS curve, which has located in the zone of negative deviations. The greatest deviation of the αPS reaches to 0.8–1.0. Black arrows indicate to the very high hydrodynamic activity (Modified from V. S. Muromtsev [3])

ment in which the sediments were created fluctuate from low at the start to high in the middle, and then back to low towards the conclusion of the bar's creation. The least quantity of clay particles is found in the middle of the bar and rises towards the bottom and top. The mouth bars are characterized by an abundance of charred plant detritus, plant scraps, and stem fragments. The deposits of these facies are 40–60% composed of well-sorted fine-grained cross-bedded sands. Depending on the river system, the cross-sectional width varies within substantial bounds, ranging from units to tens of kilometers.

The Regressive Shoreface lithofacies (V-9): are formed under conditions of a regressing sea basin. The ridge of the bar moves after the retreating sea, and the zone of relatively coarse-grained sediments formed at high hydrodynamic levels moves towards the sea. The regressive bar's sedimentological model shows an increase in sedimentation activity.

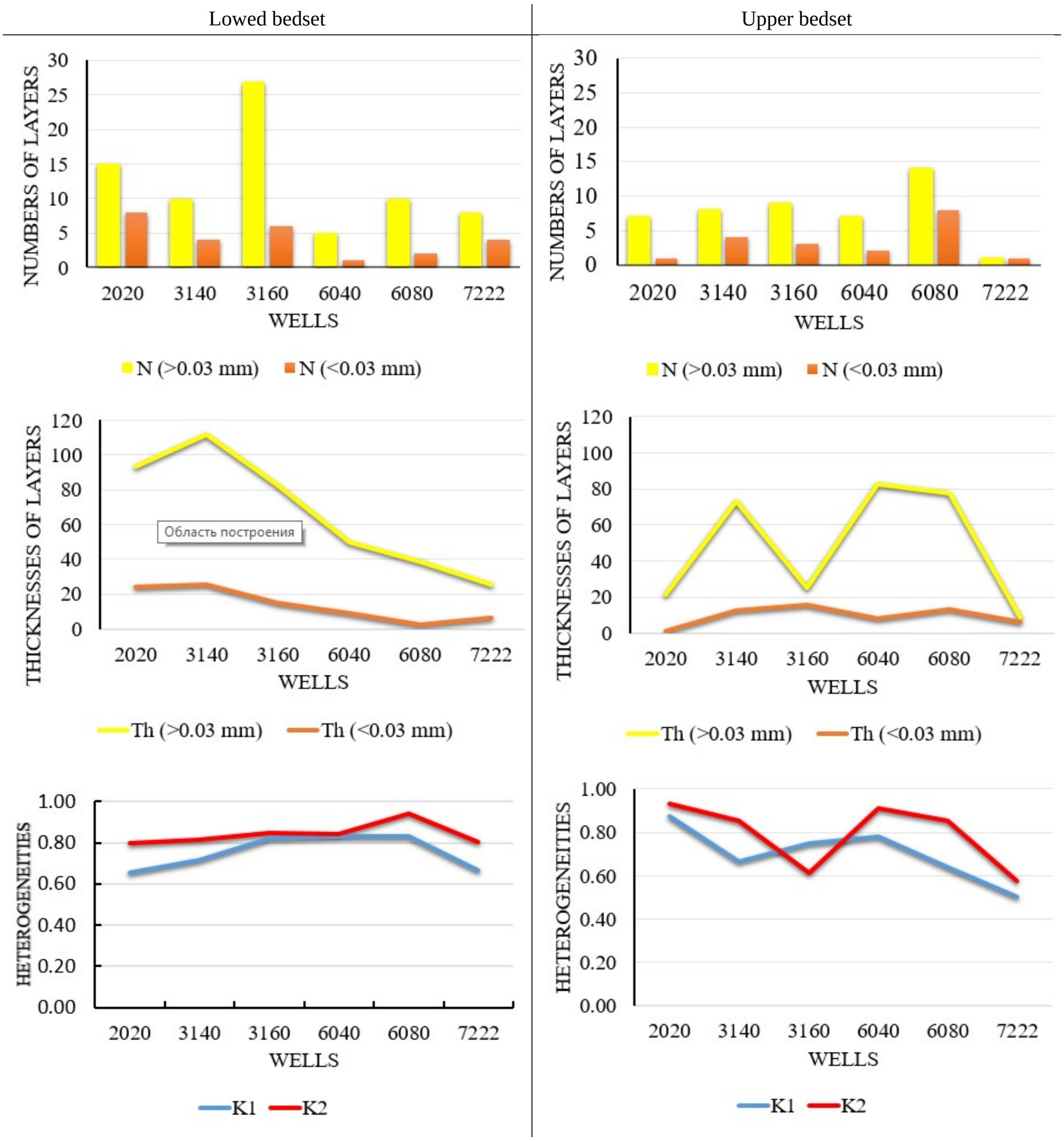


Fig. 4. Estimating heterogeneities for the upper and lower bedsets, Pokurskaya Fm. the lithostratigraphic heterogeneity of the sections was estimated by using the coefficients of the relative number and the thickness of layers with the size of clastic grains corresponding to low and medium-high paleohydrodynamic levels. The obtained estimate corresponds to the regional trend in the evolution of sedimentation. When comparing the top bedset to the lower bedset, the upper bedset has higher reservoir characteristics. Legend: K1 – the proportion of beds number with grain Md size > 0.03 mm (Fig. 2); and K2 – the proportion of beds thickness with grain Md size > 0.03 mm in the lower and upper bedsets; N: numbers of beds; Th: thickness of layers (color online)

The Transgressive Shoreface lithofacies (V-10): represent an elongated swell-like accumulation of debris separated from the coast by an alongshore ravine called a submerged shaft. A bar is a sand bank that protrudes from the ocean during low tide and is positioned some distance from the shore. Alluvium spits are formed, on the contrary, in the concave parts of the coast. The oblique is a narrow alluvial swell that protrudes above the sea level and is attached to the beach at one end. The barriers are created by intergrown spit shafts. When the waves travel at an angle to the shore, they can fully divide the lagoon from the sea and produce islands or barrows in addition to the designated sand formations, spits and barrows. The model of the formation of transgressive bars is characterized by the high hydrodynamics, as a result, relatively coarse-grained sediments accumulated.

The Discontinuous Currents lithofacies (VI): relate to barnyard lagoons as a result of seawater surge through a bar during storms or filling them with fresh water flowing from land (VI-12). Excess water tears apart the sandy body of the alongshore bar and rushes into the open sea. The cross-sections of the sand bodies are lenticular-concave symmetric; their breadth might extend to hundreds of meters. These facies' sediments stretch for tens of kilometers, producing linearly elongated bands that occasionally branch. In the open sea, due to the spreading of jets and a drop in the current velocity, the carried out silty-sandy material accumulates in the form of an underwater alluvial fan (VI-13). These sediments can occupy various regions depending on the duration of these currents' operation, the amount of material carried by them, the topography of the bottom, and the climatic and hydrodynamic conditions that existed in this portion of the water area.

The electrometric facies model is a segment of the SP curve that reflects the lithophysical properties of rocks due to the characteristic sequence of changes in the paleohydrodynamic levels of the sedimentation medium in time (Fig. 4, 5).

These levels set the stacking pattern of parasequences. Parasequences are bounded by marine flooding surfaces [8]. Surfaces of flood reflect abrupt changes in the level of water during transgression, as well as facies are also changing abruptly, from shallow to deep, across the flood surface. The maximum flooding surfaces (MFS) observed from the stratigraphy analysis indicate majorly to high mudstone content as a lithic unit and higher values of αSP respectively (e.g. [9]).

Parasequences compose four sequences: Sq1, Sq2, Sq3, Sq4 with different number of surfaces and stacking elements (Fig. 5). Average thicknesses of Sq1, Sq2, Sq3 and Sq4 are 34, 32, 30 and 61 m respectively. The Cenomanian duration is ~6.6 Ma. Therefore, relatively section thickness (~200 m) and duration (~2 Ma) we can estimate cycles as 0.3–0.5 Ma (4rd order) that is properly sequence size [7]. Parasequences generally reflect short periods of progradation or retrogradation that are superimposed on or mark regressive or transgressive trends. The studied logged section is the example of the stacking of parasequences as a result in 3rd order progradation with a significant component of aggradation (Fig. 5) in accordance with a stratigraphic trend in the Cenomanian by [1], where the normal regressive (seaward) shoreline trajectory of successive parasequences is predictable [8].

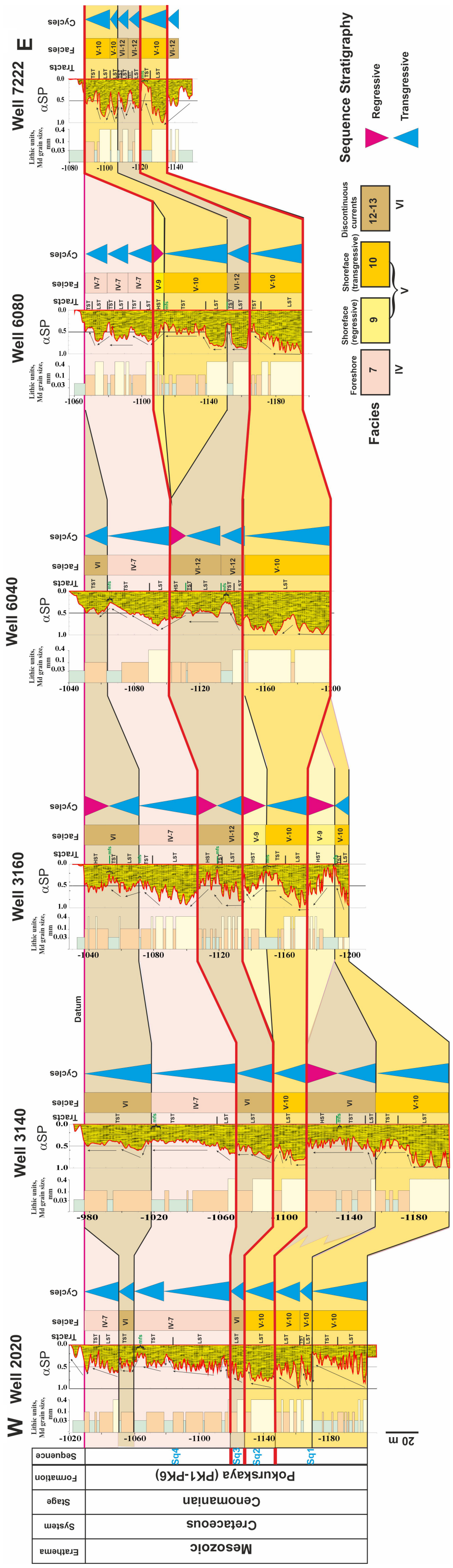


Fig. 5. Lithofacies and sequence elements of the Pokurskaya Fm across the field (Fig. 2)(LST-lowstand system tract, TST-transgressive system tract, HST- highstand system tract). Legends: Facies by the classification from Fig. 4: IV-7 – Foreshore; V-9 – Shoreface (regressive); V-10 – Shoreface (transgressive); VI-12 and VI-13 – Discontinuous currents. Thick red line refers to the sequence boundary (color online)

Conclusion

The lithofacies and environment of deposition of the field have been described where SP (spontaneous polarization) log data from six wells were taken to reconstruct lithic characteristics, hydrodynamic levels, grain sizes, clastic sediments differences.

Two lithostratigraphic bedsets were distinguished and estimated by beds numbers and thicknesses heterogeneities. The Upper bedset consists of clastic sediments of higher hydrodynamic levels and reservoir properties.

Four major types of electrometric lithofacies (Foreshore, Regressive Shoreface, Transgressive Shoreface, and Discontinuous Currents) were recognized by examining the log curves. The αSP changes and the stacking patterns of the logs were used to characterize and interpret the depositional environments.

Four sequences were identified in the cross-section; the results were based on well log shapes and lithofacies model. Electrometric lithofacies by αSP values and log shapes subdivide strata into parasequences composing progradational-aggaradational stratigraphic trend.

References

1. Kontorovich A. E., Ershov S. V., Kazanenkov V. A., Karogodin Y. N., Kontorovich V. A., Lebedeva N. K., Nikitenko B. L., Popova N. I., Shurygin B. N. Cretaceous paleogeography of the West Siberian sedimentary basin. *Russian Geology and Geophysics*, 2014, vol. 55, no. 5–6, pp. 582–609. https://doi.org/10.1016/j.rgg.2014.05.005

2. Selley R. C. *Concepts and methods of subsurface analysis*. AAPG Continuing Education Course Notes Series. Tulsa, Oklahoma, American Association of Petroleum Geologists, 1979, vol. 9, 82 p. https://doi.org/10.1306/CE9397

3. Muromtzev V. S. *Electrometric geology of sand bodies-lithological traps of oil and gas*. Leningrad, Nedra Publ., 1984. 260 p. (in Russian).

4. Walker R. G., James N. P. *Facies models: Response to sea level change*. Stittsville, Ontario, Geological Association of Canada, Love Printing Service Ltd., 1992. 407 p.

5. Chow J. J., Ming-Ching Li., Fuh S. C. Geophysical well log study on the paleoenvironment of the hydrocarbon producing zones in the Erchungchi Formation, Hsinyin, SW Taiwan. *TAO : Terrestrial, Atmospheric and Oceanic Sciences*, 2005, vol. 16, no. 3, pp. 531–543. https://doi.org/10.3319/TAO.2005.16.3.531(T)

6. Siddiqui N. A., EL-Ghali M. A., bin Abd Rahman A. H., Mijinyawa A., Ben-Awuah J. Depositional environment of shallow-marine sandstones from outcrop gamma-ray logs, Belait Formation, Meragang Beach, Brunei Darussalam. *Research Journal of Environmental and Earth Sciences*, 2013, vol. 5, no. 6, pp. 305–324. https://doi.org/10.19026/rjees.5.5705

7. Catuneanu O. Principles of Sequence Stratigraphy. *Geological Magazine*, 2007, vol. 144, iss. 6, pp. 1031–1032. https://doi.org/10.1017/S0016756807003627

8. Van Wagoner J. C., Mitchum R. M., Campion K. M., Rahmanian V. D. *Siliciclastic sequence stratigraphy in well logs, cores, and outcrops : Concepts for high-resolution correlation of time and facies*. AAPG Methods in Exploration Series. Tulsa, Oklahoma, American Association of Petroleum Geologists, 1990, vol. 7. 55 p. https://doi.org/10.1306/Mth7510

9. Zunde D. A. Methods for constructing a sequence-stratigraphic model of the Pokurskaya suite. *Oilfield Engineering*, 2015, no. 5, pp. 54–59 (in Russian).

10. Alexandrova G. N., Kosmynin V. A., Postnikov A. V. Stratigraphy and sedimentation conditions of Cretaceous deposits in the southern part of the Varyogan mega-shaft (Western Siberia). Stratigraphy. *Geological Correlation*, 2010, vol. 18, no. 4, pp. 65–91 (in Russian).

11. Ulmishek G. F. *Petroleum Geology and Resources of the West Siberian Basin, Russia*. Reston, Virginia, US Department of the Interior, US Geological Survey, 2003. 49 p. https://doi.org/10.3133/b2201G

12. Kontorovich A. E., Nesterov I. I., Salmanov F. K., Surkov V. S., Trofimuk A. A., Erv'ye Yu. G. *Petroleum Geology of West Siberia*. Moscow, Nedra Publ., 1975. 679 p. (in Russian).

13. Lapkovsky V. V., Istomin A. V., Kontorovich V. A., Berdov V. A. Correlation of well logs as a multidimensional optimization problem. *Russian Geology and Geophysics*, 2015, vol. 56, no. 3, pp. 487–492. https://doi.org/10.1016/j.rgg.2015.02.009

14. Yasamanov N. A. *Mesozoic and Cenozoic Climates and Landscapes of West and Central Siberia (Paleogeographic Factors of Bauxite Accumulation)*. Moscow, Nedra Publ., 1976. 142 p. (in Russian).

15. Potapova E. A. Implementation of a sequence-stratigraphic approach to clarify the correlation of clinoform formations of the BU group on the southeastern slope of the Srednemessoyakhsky swell. *Geology, Geophysics and Development of Oil and Gas Fields*, 2015, no. 7, pp. 22–29 (in Russian).

Поступила в редакцию 24.07.2022; одобрена после рецензирования 10.10.2022; принята к публикации 16.12.2022
The article was submitted 24.07.2022; approved after reviewing 10.10.2022; accepted for publication 16.12.2022