Connectivity between Petrophysical Parameters and Hydrodynamic Activity in Achikulak Oil Field

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Abstract. Researches on structure of detrital part of sedimentary rock, particularly granulometric composition of rocks give not only information about restoration of their condition of deposition, duration, direction and transfer ranges, but also for some reconstructions of demolition’s areas, in particular to fixe concern about structure of rocks in areas of sedimentation, and sometimes partially on the climate. Therefore, considering connectivity of petrophysical parameters specially porosity and permeability of rocks with hydrodynamic activity of layer of lower Cretaceous deposits in order to describe formation of reservoir rocks, condition of sedimentation, formation recoveries, sequences of changes and fluid traps bring us to lead subsequently these types of work in one of the Achikulak oil fields and determine future movements, settlements and sand body of the reservoir. The change of lithological structure of rocks by section, maybe define conditions of sedimentation on Achikulak deposits field, it is known that the initial signs that are stable over time are studied in the lithofacial analysis.

1. Introduction
Granulometric compositions of rocks in evaluating condition of their formations and recoveries of paleodynamic condition of sedimentation are extremely important in order to separate areas of reservoir and fluid traps distributions. Moreover, give evaluation of reservoir properties of rocks and geological section, what are the most necessary conditions to define possible oil and gas bearing capacity in this or other territories. According to lithofacies analysis, we can find on time sustainable first signs. These include granulometric parameters, characteristics of contact, capacity of textural features of rocks. These parameters are located in the close dependence from dynamic environment of sedimentation and change by section and by space in Achikulak Field. Study of these first signs give possibilities to establish the sequence of change of paleodynamic level of sedimentation into avoid space. In this area, where prevailed high paleodynamical level of sedimentation, rough detrital material was concentrated and formed the sand body of the reservoir.

2. Materials and methods
Oil field Achikulak is located on the territory of neftekumsk district of Stavropol territory, 25 km from Neftekumsk and 75 km from Budennovsk railway station These studies has been done in one of the oil and gas field in North Caucasus Region particularly in Achikulak field southern Russia. Materials used in this paper has been conducted with an oil and gas company located in the: Rosneft,
with relevant petroleum engineers. In addition technical specifications used to gather these data are seismic researches in Lower Cretaceous deposits K1 Achikulak field. The initial signs that characterized Lower Cretaceous deposits are stable over time in lithofacial studies. To analyze the data we used statistical procedures such as histograms and dependence graphs and mathematical such as linear, exponential and logarithmic equation to describe and interpreted results.

3. Results
Results of granulometric researches compositions and detailed calculations of petrophysical parameters of these lower Cretaceous deposits of layer K1I in Achikulak Field respectively

3.1. Evaluation of median parameters distribution
According to the construction of histogram of the median diameter, all observed particles, with are divided into classes, its values in every class and acquired data presented graphically as curve step. The height of each of steps displays value of particles of every class, width, there is a measure for chosen interval (values) classes. Abscissa of every step displays boundaries of sizes of elements, belonging to every class (figure 1).

![Figure 1. Histogram of distribution of median diameter of particles by size, by data of sedimentary analysis.](image)

3.2. Level of sortings
Reconstructions affected particularities of levels of formations of petroliferous reservoirs of independent fields [1, 2] and based on earlier conducted results of researches. Average size of particles is the most important among granulometric parameters, which fixe position of empiric distribution of composition in dimension’s scale and characterize hydrodynamic level of sedimentary environment. Structure of rocks can be found as granulometric degree of heterogeneity of detrital grains or their sortings. In Achikulak field of lower Cretaceous deposits, layer K1I, noticeable level of detrital sorting can be defined as following: rocks content detrital, strongly differ by size and avoid space between filled sortings (figure 2.). Badly sorted (83.64%), average sorted (7.27%) and good sorted (9.01%). Level of sorting of detrital was defined by cumulative curve, with formula \( S_p = Q_p/Q_1 \).
3.3. Level of activity

In areas with increased hydrodynamic activity respectively accumulated more coarse-grained sand deposits. Consequently, in first sight was fixed, these or certain environmental conditions, in which occurred accumulation of settlement and its changes. First signs maybe unified in groups so that every group can become a relevant distinct level of hydrodynamic activity in that environment of sedimentation (figure 3). In the change of lithological structure of rocks by section, maybe define condition of sedimentation. By defining the genesis of deposits and by locating models of areal position of facies for these conditions of sedimentation, it is possible to predict general position of facies in limit of these of other conditions of sedimentation.

S. A Muromtsev [1] has developed sedimentological models of changes of paleohydrodynamic regime in time. Facies in this case are considered with detection position mechanism of formation combining its settlements, because of sedimentological factor change of paleohydrodynamic environment. Was allocated five hydrodynamic levels (regimes): very high, high, average, low and very low. Every of them is characterized by a number of initial feature, showing dynamic activity of environment sedimentation.

Under the sedimentological model of facies are understood as change in a certain defined sequences of paleodynamic level of sedimentation during a period of its deposits. Sedimentological models of facies served as basis for determining electrometric models of facies, giving the possibility to define genesis of settlement and materialize reconstruction of paleodynamics environments on electrometrical sections of wells. That is why figure. 3 shows that, in Achikulak Field of lower cretaceous deposits layer $K_1p$ presents (1.79%) high, (39.29%) average and (58.93%) low.
For analysis of connectivity activity environments with porosity was built histogram of distribution of rocks porosity.

3.4. Correlation of permeability to porosity
The graph show dependence of permeability on porosity. So that when porosity content increases from 0.2% to 0.3%, permeability increases from 0.10 to 20. Critical coefficient of porosity reaches \( K = 0.205\% \) (figure. 4), when porosity value more \( K \) we obtain reservoir rocks and instead non-reservoir rocks. Higher is porosity value greater is the permeability value.

![Figure 4. Dependence graph of permeability to porosity.](image)

3.5. Porosity distribution
Analysis of histogram distribution shows that 98% of formations have porosity value more than 10%. Considering critical porosity values (20%) these deposits can be attributed to reservoir rocks (figure. 5).

![Figure 5. Histogram of porosity distribution.](image)

3.6. Correlation of porosity to clay fraction
The graph shows the dependence of porosity on the content of clay fractions, between these parameters there are correlations described by the following linear equation \( y = -0.0027 x + 0.3019 \), when the content of clay increases from 17% to 43%, the porosity decreases to 0.18. The correlation coefficient characterizes the relationship between these parameters \( R = 0.42 \); this correlation coefficient says that the porosity does not depend only on the clay content but also on other factors (figure 6).
Figure 6. Dependence graph porosity to clay fraction.

3.7. Correlation of porosity to activity level
Dependence of porosity on level of hydrodynamic activity shows that between parameters, we can observe respectively linear straight connectivity and exponential connectivity, described by equations with correlation coefficient respectively R1=0.07 and R2=0.08 (Figure. 7).

Figure 7. Dependence graph of porosity to level of activity.

In that way with increases of environmental activity porosity increases. This conclude good conditions for paleohydrodynamic accumulations. In the formation of average and low conditions, activity level in basis can form reservoir rocks with critical porosity more than 20%.

3.8. Permeability distribution
Was built histogram of distribution permeability of rocks (Figure. 8). Analysis shows that with permeability values was formed reservoir classes respectively (58.78%) very good permeable, (39.13%) good permeable and (2.71%) average permeable. These deposits can be attributed to reservoir rocks.
3.9. Correlation of permeability to clay fraction

The graph shows the dependence of permeability on the content of clay particles. Correlation relations described by equation $y = 113.7e^{-0.164x}$ shows that, when the clay content increases from 17% to 45%, the permeability decreases to 0.07. The correlation coefficient characterizes the relationship between these parameters $R = 0.72$; this correlation coefficient indicates that the permeability depends on the clay content. Critical coefficient reaches $K=32\%$. The greater the clay content the lower the permeability (Figure 9).

3.10. Correlations of permeability to hydrodynamic activity level

Was built dependence graph of permeability to hydrodynamic activity level. Analysis shows that between these parameters exist respectively linear straight connectivity and logarithmical connectivity describing equations, with correlation coefficient respectively $R1=0.09$ and $R2=0.08$. In that case with increased environmental activity, permeability increases (Figure 10).
3.11. Neugebauer and Muller and conditions of sedimentation

Was built dependence graph of asymmetry (%) to conditions of sedimentation by Neugebauer and Muller. It shows that (1.9%) beaches: sorted deposits, optimal asymmetry more than 1: (13.2%) shallow sea deposits: badly sorted and asymmetry less than 1 and (84.9%) deep-sea deposits.

![Dependence graph of asymmetry to sedimentation condition](image)

**Figure 11.** Dependence graph of asymmetry to sedimentation condition by Neugebauer and Muller.

According to generalization of Neugebauer and Muller, studied rocks were mostly formed by river sedimentation conditions sorting mainly. By ratio of sorting to asymmetry (by Bearlike) of studied rocks, refer to turbidity current.

Based on these generalizations, it was found from the values of sorting and asymmetry coefficients that in this area, mostly accumulated (15%) of shallow marine sediments, characterized by poor sorting and having an asymmetry of less than 1. There were practically no sand fractions on the far shelf.

(85%) of deep-sea sediments that characterize the continental slope and abyssal plain. On the continental slope, clay siltstone, on the abyssal plain siltstone clay; include more coarse-grained deposits of turbidities flows. The rock structure is also determined by the degree of granulometric homogeneity of detrital grains or their sorting [3, 4].

4. Conclusion

In areas where high paleohydrodynamic levels of the sedimentation medium prevailed, the coarsest debris material was concentrated, and reservoir bodies were formed. As is known, the initial signs that are stable over time are studied in the lithofacial analysis. These include grain size parameters, the nature of the contacts, power and textural characteristics of rocks. These parameters are closely dependent on the dynamics of the sedimentation medium and vary both by section and area. The study of these initial features allows us to establish the sequence of changes in the paleohydrodynamic levels of the sedimentation medium within the Achikulak field. In areas where high paleohydrodynamic levels of the sedimentation medium prevailed, the coarsest debris material was concentrated, and reservoir bodies were formed. The structure of rocks is also determined by the degree of granulometric homogeneity of detrital grains or their sorting.

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