

# Geological Structure and Lithological and Petrophysical Properties of Pliocene Deposits in the Northwestern Part of the South Caspian Depression

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## Abstract

**Relevance:** In connection with the study of the oil and gas potential of the deep-lying strata of the sedimentary cover of the South Caspian Basin (SCB) in Azerbaijan, a significant amount of geological exploration and geophysical work was carried out. Scientific criteria have been prepared that can serve as a basis for future geological studies. It was noted that the main deposits of oil and gas in the region are associated with the South Caspian and Kura depressions, which were subjected to intensive subsidence during the Meso-Cenozoic time. Despite the high prospects of the central part of the South Caucasus, its deep layers, the problems associated with the extraction of oil and gas from them have not yet been finally resolved.

**Object:** Local uplifts of individual structural elements of the SWC developed mainly with the activity of the same folding mechanisms, and the vast majority of them are injection structures. These include local uplifts of the entire axial anticlinal zone of the Absheron-Pribalkhan structural megasaddle, to which the Neft Dashlary uplift is confined. This anticline zone originates in the northwest from the Goshadash uplift and further through the structures of Pirallahi - Gyurgyan-deniz - Darwin kupesi - Khali - Neft Dashlari - Azeri, etc., extends to the east to the Cheleken-Sea uplift. Developing in the conditions of the Absheron-Pribalkhan non-classical (residual) subduction. A characteristic feature of the structures of this anticlinal zone is their formation by the mechanisms of longitudinal and transverse bends, with the former dominating.

**Methods:** As a result, most of them are linear and elongated brachyfolds complicated by mud volcanism. In the area of the Absheron archipelago, petrophysical studies were carried out in a number of areas. Their goal was to obtain detailed information about reservoir rocks, their lithological and petrophysical features, clarify hydrocarbon resources and, based on the results obtained, determine further directions for prospecting and exploration. For this purpose, the geological, geophysical and physical characteristics of the rocks were studied, which influenced the reservoir potential of the Meso-Cenozoic deposits containing oil, gas and gas condensate accumulations in the South Caucasus. Such work was also carried out at the Neft Dashlari field of the North Absheron archipelago.

**Result:** without sufficient knowledge of the reservoir characteristics of the stratum, it is impossible to estimate hydrocarbon deposits and production volumes, as well as to change the direction of the survey. In addition to the geoscience studies carried out in this area, lithologic-petrographic and reservoir characteristics have been investigated to determine the conformity changes along the area, carbon content, porosity, permeability, density, grain size and sound wave velocity of the above stratum. A table was compiled. Also in the table were given the minimum, maximum and average limits of the physical properties of rocks. The dependence of reservoir properties on the depth of occurrence and their dependence on other physical factors are considered.

**Keywords:** Petrophysics; Density; Propagation of ultrasonic waves; Porosity; Well; Rocks; Depth; Oil; Gas; Deposit; Criteria; Carbonate content; Deflection; Drilling; Geophysics; Oil and gas accumulations; Led reflecting the reservoir characteristics of the field

## Mini Review

Today, Azerbaijan has a voice in the oil industry as the main area of the world economy. Our Motherland once again confirms that it is an ancient land of oil, the center of the first offshore oil, an "oil academy". On September 20, 1994, the "contract of the century" was signed with the world's largest oil companies. This contract raises the economic strength and political

reputation of Azerbaijan more and more. Azerbaijan is one of the richest oil and gas provinces. The development of these reserves can play a big role in the development of the oil and gas industry in our country. Recently, in connection with the study of the oil and gas potential of deep layers in Azerbaijan, a significant amount of geological exploration and geophysical work has been carried out. Scientific criteria have been prepared that may be the basis for a future exploration study. It was noted that the main deposits of oil and gas are associated with the South Caspian and Kura depressions, which were subjected to intensive subsidence during the Meso-Cenozoic. Despite the high prospects of the central part of the deep layers, the problems associated with the extraction of hydrocarbons have not yet been fully resolved. In connection with the study of the oil and gas potential of the deep-lying strata of the sedimentary cover of the South Caspian Basin (SCB) in Azerbaijan, a significant amount of geological and geophysical work was carried out. Scientific criteria have been prepared that may be the basis for future prospecting and exploration. Despite the high prospects of the central part of the South Caucasus and its deep layers, the problems associated with the extraction of oil and gas from them have not yet been finally resolved.

Local uplifts of individual structural elements of the SCV developed mainly during the activity of the same folding mechanisms, and the vast majority of them belong to the injection structures. These include local uplifts of the anticlinal line Darwin kyupesi (the name of the structure), which have the same geological structure. To them, the Gyurgyan-Deniz structure, located on the anticline line Darwin-Kyupesi-South and Chilov Island, located in the anticline line Khali-Neft Dashlary. The structures that are located on these anticlinal lines have been correlatedly studied. Petrophysical studies were carried out in the area of the Absheron archipelago. Their goal was to obtain detailed information about reservoir rocks and their lithological and petrophysical features, clarify hydrocarbon resources and, based on the results obtained, outline the further direction of prospecting and exploration. For this purpose, the geological, geophysical and physical characteristics that influenced the reservoir potential of deposits containing oil, gas and gas condensate accumulations of the Meso-Cenozoic age in the South Caucasus were studied. The study of geological sections of local uplifts of the Fatmai-Zykh-Shah-Deniz anticline shows that in the northwest of this tectonic line, the thickness of the Pliocene-Anthropogenic deposits varies from 100 to 200m. in Shah Deniz - up to 6000m. Within the corresponding synclines, the thickness of the mentioned deposits reaches 3000m in the northwest, and in the Shah Deniz region it is about 10000m. In turn, the Neft Dashlari field of the North Absheron archipelago, being in the axial zone of the Absheron-Pribalkhan megasaddle, extends in the general Caucasian direction. It is complicated by two longitudinal and a large number of transverse ruptures [1-6]. In the section of the Productive Stratum (PS), multi-storey oil deposits were discovered. The Kalinskaya suite is represented by siltstones and clayey deposits with interlayers of fine-grained sands and sandstones. The sands are quartz, medium-fine-grained, and the clays are

slightly sandy and slightly carbonate. The material composition and thickness of sandy horizons and clay interlayers separating them are unstable in area. The sandiness of the section from the base to the top of the formation and from the dome to the wings of the fold increases to 70%. The suite is divided into 4 oil and gas horizons. In addition, 4 more horizons are noted in the lower part of the horizon in a number of blocks. To determine the reserves of an operational facility by area, an analysis of the accumulated numerous geological, geophysical and field materials and the integrated use of their results is carried out. The accumulated field and geophysical data of each well are interpreted and the values of such parameters as effective thickness, porosity, oil saturation are determined. The technique used is implemented according to the program of the algorithm. The discovered maximum thickness of the PT in the wells is 2400m. But, in some parts of the field, deep exploration wells, at great depths, have opened some horizons of the PT. The density of clay rocks here is 2.20-2.48g/cm<sup>3</sup>, the porosity is 8.3-17% (in some cases it reaches up to 25%), the propagation of ultrasonic waves is 2150-2200m/sec. The density of the siltstones is 2.13-2.60g/cm<sup>3</sup>, the porosity varies between 15-28%, the propagation of ultrasonic waves varies between 1300-2200m/s. The density of sandstones ranges from 2.00 to 2.50g/cm<sup>3</sup>, the porosity varies between 7.2-22.0%. In all rocks, the propagation of ultrasonic waves, depending on the lithological composition, varies within 850-2800m/sec. The PT carbonate clays have undergone alteration; their physical properties are characterized by the following values: density 2.02-2.59g/cm<sup>3</sup>, porosity 8.5-30% and propagation of ultrasonic waves 2100-3500m/sec. It should be noted that the carbonate content and permeability of the PT deposits as a whole also underwent a significant change.

When studying the granulometric composition of the PS formations in the Neft Dashlary area, it was found that the grain diameter varies mainly from 0.1 to 0.01mm. This indicates that there are more silts in the section than deposits of a different composition. As you know, the Neft Dashlary field is multi-storey. In order to find out the reservoir properties of deposits that depend on depth, the limits of changes in physical parameters were correlated across the area. As a result, it was found that the lower and upper layers differ little, despite the difference in physical parameters. This indicates a decrease in porosity with depth and a relative increase in the density and propagation velocity of ultrasonic waves. The conducted studies make it possible to assume that changes in the physical characteristics of the object under study are associated with the lithological heterogeneity of the main complex, the diversity of rocks and tectonic conditions. A pattern of change in porosity and permeability coefficients has also been established [7-10]. Processing and interpretation of petrophysical and field geophysical materials made it possible to establish that some PS horizons in terms of oil and gas are more promising. By studying the lithological and petrographic properties of the deposits of the field, using geological and geophysical materials and the reservoir properties of core samples taken from wells in the area, it is possible to predict the oil and gas potential

of deep layers along with exploited ones. In order to study the geological structure of the Gyurgyan-deniz deposit and about Chilov, geological and geophysical materials were collected, on the basis of the study of which structural maps were built along the top of the productive layers and several transverse and longitudinal geological profiles. Deposits from modern (Quaternary) up to and including the diatom suite take part in the geological structure of the Chilov Island deposit. The latter (Karagan, Konk, Sarmatian, Meotis) is represented by frequent alternation of clays, marls and siltstones. Its stripped thickness is 290m. Pontian deposits are mainly composed of clays.

As a result of paleotectonic analysis, it was revealed that in the Absheron archipelago, at the beginning of the era of the productive stratum, the structures developed slowly, and at the end of development - intensively. Therefore, the wings of the structures are at different hypsometric levels. Also, under the action of compressive stresses, the southwestern flank was pushed over the northeastern one. The core of the structure is subject to erosion [11-14]. To determine the lithological-petrographic and reservoir properties, as well as the patterns of changes in area and with depth, carbonate content, porosity, permeability, density, granulometric composition and P-wave propagation velocity of samples taken from drilled exploration wells of the Oil field were studied in the above-mentioned area Dashlars. The minimum, maximum and average limits of the physical properties of the rocks were also determined. The dependence of the reservoir properties of rocks on the depth of occurrence and on other physical factors is considered. Accordingly, a petrophysical table was compiled reflecting the reservoir characteristics of the rocks.

## Conclusion

According to the results of the work carried out within the study area, the PT deposits are lithologically represented by sands, sandstones and alternation of silts with clay interlayers. In the southern and eastern parts of the region, the carbonate content of rocks undergoes some changes. In the central part of the region, the change in porosity and carbonate content occurs abruptly. It has been established that the change in petrophysical values in a wide range is associated with lithological heterogeneities, a variety of rock depths and tectonic conditions in the region. When studying the reservoir properties of the region, it was found that effective porosity is noted in deep layers, and this makes it possible to predict oil and gas reservoirs at the considered depths. But according to the graphs of petrophysical changes in the limits of the parameters under consideration, it is clear that due to some

lithophysical changes, the established pattern is violated. To predict the oil and gas content in the deeper layers of the structure, optimal geophysical methods were used. The use of the method of reservoir properties of rocks is considered expedient.

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