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LITHOFACIES, CHANGES IN MINERAL COMPOSITION AND RESERVOIR PROPERTIES OF THE MAYKOPIAN SEDIMENTS IN THE YEVLAKH-AGHJABEDI DEPRESSION

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ABSTRACT

Yevlakh-Aghjabadi depression is a well explored oil province located in the Middle Kura basin between Greater and Lesser Caucasus.The study investigates the lithofacial, mineralogical, and collector properties of the Maykopian sedimentary series within the Yevlakh-Aghjabadi depression, focusing on the Oligocene to Early Miocene epoch. Maykop deposits are widely distributed in the foothill regions of the Lesser Caucasus, both at the surface as natural outcrops and in the geological structure of deeper formations. In this article, in addition to core samples, the results of fieldworks have also been widely discussed. The conducted research indicates favorable paleogeographic conditions for oil and gas presence in these depressions. The sedimentary sequence, up to 2200 meters thick, is divided into Lower and Upper Maykopian subgroups, showing fluctuating thickness distribution. The primary source of clastic materials for the Maykopian suit is the Lesser Caucasus Mountain range. The lithological composition consists of clay, sandstones, and conglomerates, influenced by paleogeographic changes and paleochannels. Collector properties vary, with Lower Maykopian sediments exhibiting better characteristics, especially in the south-western part of the basin. The mineralogical composition dominated by fine-grained feldspars, impacts reservoir quality. Maykopian suits in the oil and gas regions of Ganja and Muradkhanli, which encompass the southern-western and northern-eastern flanks of the Yevlakh-Aghjabedibasin, as well as conducting extensive research on reservoir properties, will enable the proper direction of future exploration activities. For this purpose, the overall condition of the Maykopian suits and the distribution of lithofacies have been analyzed, and the characteristics of hydrocarbon reservoirs have been determined.

KEYWORDS:
Lithology;
Lithofacies;
Maykopian;
Sandy and clayey sediments;
Argillaceous sandstones;
Porosity;
Permeability.

e-mail: kamala.seferli@mail.ru
https://doi.org/10.53404/Sci.Petro.20240100051

Date submitted: 18.02.2024 ***Date accepted: 13.06.2024***

In the Oligocene to Early Miocene (Maykopian) epoch, the intensity of seafloor burial in the Yevlakh-Aghjabedi and Lesser Caucasus foothills increased further. [1]

During the deposition of the Maykopian sedimentary series, significant paleotectonic and paleogeographic changes occurred in the studied area.

The Maykopian sedimentary series is widely distributed in the study area, and in some areas it outcrops on the surface. For example, in the central part of the Ganja region, such as the areas of Injachay, Ajidere, Karachinar, Zeyva, and others, these sediments occur naturally on the surface [2]. However, on the southwestern side of the region, the natural exposure of the Maykopian sediments is scarce, and in some cases they either emerge on the surface or lie below the Aghjagil level. Moving from the southwest to the northeast of the region, an increase in the thickness of the Maykopian sedimentary series and a decrease in clastic deposits are observed. The Maykopian sedimentary section is characterized in much of the area by the alternation of clays, siltstones, sandstones and conglomerates.

The total thickness of this sequence, which includes the Oligocene and Lower Miocene, is up to 2200 meters and consists of two parts: the Lower and Upper Maykopiansubsuites.

The distribution of the thickness of the Lower Maykopiansubsuite is not stable. For example, in the northern foothills of the Ganja oil and gas region (Mesheli), the thickness is 300-400 meters, while in the center (Naftalan) it increases to 1800 meters and then decreases to about 170 meters in the south (Beylagan). The direction and intensity of the source of the clastic material for the Maykopiansubsuite in the Yevlakh-Aghjabedi Depression have not remained constant, but have changed continuously over time and space [3] (fig. 1).

On the northeastern border of the Yevlakh-Aghjabedi depression, the Maykopian sediments con-

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sist mainly of thin siltstone layers, which are mainly composed of clay layers, probably derived from the weakly eroded Qarajali-Saatli uplift zone [4, 5].

In the western part of this depression, sandy and silty layers are second only to clay in the lithological composition of the Maykopian sediments. Their thickness varies from a few millimeters to tens of meters. Sandy and silty layers are developed in the cross sections of Dalmammadli, Qazanbulagh, Naftalan, Ajidere, Tartar and Godokboz areas and are characterized by the alternation of coarse sand-clay layers. However, the quantity and thickness of these layers decrease in the sections of Gulluja and Agdam areas and disappear in the direction of Aqdere, Xudaferin-Bahmanli. Heterogeneity is also observed in the mineralogical composition of the deposits. According to the mineralogical composition of the sediments, it can be concluded that the Lesser Caucasus magmatic rocks, which are the main source of these formations, have been weathered and transported to this area through paleochannels [6-9].

The granulometric and mineralogical compositions of the Lower Maikopian sandstones of the Dalimamedli area are given below as an example (fig. 2). The tuffa-

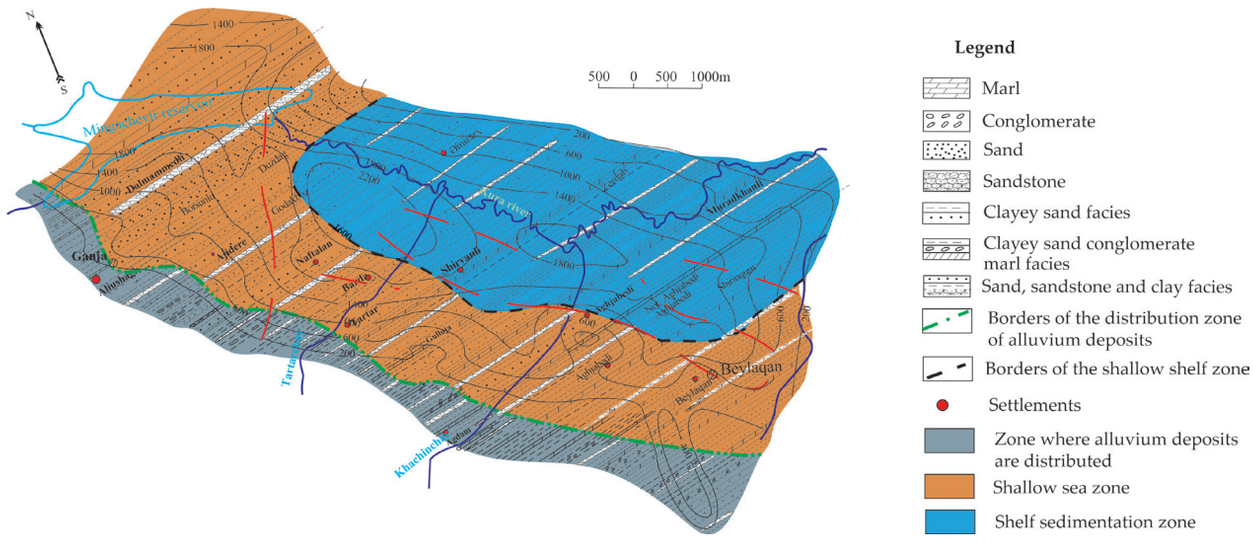

Fig. 1. Lithofacies and thickness map of the Maykopian sediments in the Yevlakh-Aghjabedi depression (The thickness of the Maykopian formation according to A. Suleymanov)

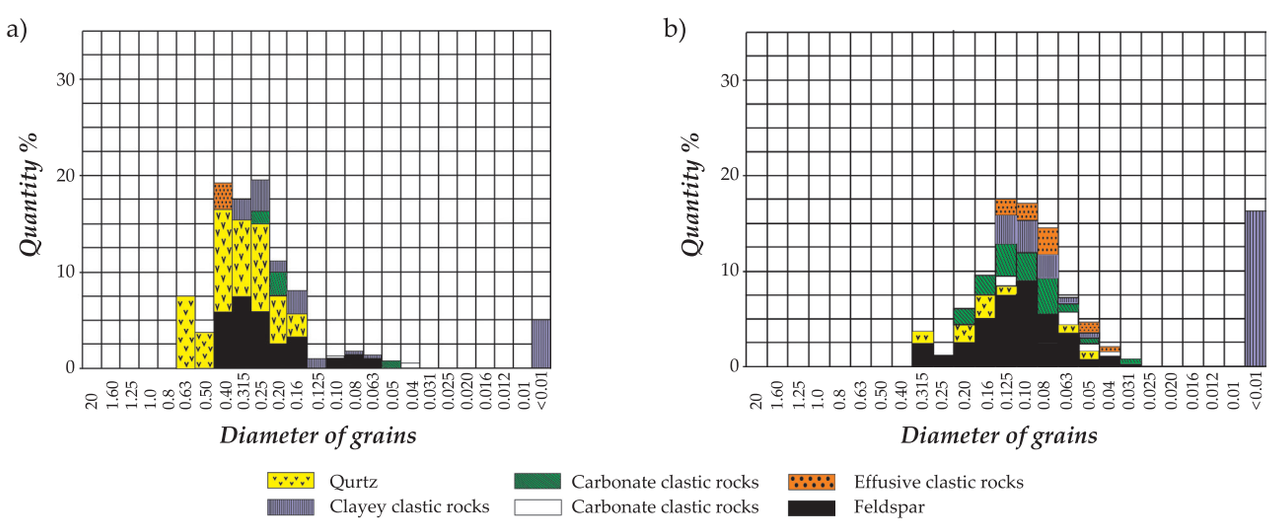

Fig. 2. Granulometric and mineralogical compositions of the sediments of the Maykopian Formation in the Delimammadli area: a) tuffaceous, b) polymictic sandstones

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Oil and gas fields exploration, geology and geophysics

ceous sandstones are coarser grained and dominated by medium grains, while the polymictic sandstones are dominated by very fine grains. There are also differences in mineralogy. In tuffaceous sandstones, quartz is the most abundant mineral, followed by feldspars. Fragments of terrigenous and carbonate rocks are of lesser importance.

In polymictic sandstones the main role in the lighter fraction belongs to feldspars, in the second place are fragments of sedimentary rocks. The share of quartz in the mineralogical composition is very small. Obviously, such a difference in the mineralogical composition of the two types of sandstones is due to the presence of quartz-rich tuff composition in their volcaniclastic variety.

The distribution of the Maykopian deposits and the circumstances of their formation along the Yevlakh-Aghjabedi basin allow to determine the lithofacies of the area. As a result of the research, the spreading zone of the coarse-grained sediments is traced with a narrow strip along the foothills of the Lesser Caucasus, which consists of alternating thick layers of conglomerates, argillaceous sandstones and sandy clay layers. These sediments indicate the conical alluvial supply of mountain streams to the coastal part of the Maykopian Basin. Outside the distribution area of the conglomerate layer, towards the north, a distribution zone of clayey-sandy sediments is observed, covering the shallow-water facies of the basin. In the central part of the Yevlakh-Aghjabedi basin, it is covered by a shelf sedimentation zone dominated by clayey deposits (fig. 1).

The frequent changes in the lithological composition of the sediments of the Maykopian Formation on the southwestern margin of the Yevlakh-Aghjabedi Basin and the diversity in the distribution areas of the sandy horizons here indicate the significant role of paleochannels in the distribution of these sandy horizons.

For the Yevlakh-Aghjabedi depression zone, the main source of Maykopian sediments is the Lesser Caucasus mountain range. As a result of sedimentary accumulation, the presence of conglomeratic and coarse-grained terrigenous formations and lenses in the southwestern part of the Lesser Caucasus foothills zone, namely in the valleys of the Ganjachay, Kurekchay, Tartarchay and Qarqarchay rivers, indicates that these sediments were formed in the basins of ancient rivers of the same name.

The lithology and facies-mineralogical factors have shown their influence on the collector properties of the Maykopian sediments in the Yevlakh-Aghjabedidepression [10].

As a result of significant development of alluvial fans of mountain streams in the Lesser Caucasus, potential rock collectors have accumulated on the slopes of this mountain system, within the limits of the Lesser Caucasus foothills zone. On the basis of lithological and collector characteristics, Maykopian sediments were divided into lower and upper subsuites. As shown in the graph of the distribution of porosity and permeability of the Maykopian sedimentary series, the Lower Maykopian sediments are characterized by relatively better filtration-retention properties in comparison with the Upper Maykopian series [11-13]. Based on the data of the collector properties of the Zeyva and Acidere areas on full-scale sections (representing all subdivisions of the Maykopian sediments), it can be said that the improvement of the reservoir properties is clearly visible in the lower part (Lower Maykopian) of the section (fig. 3).

The formations of the lower part of the Maykopian section are better in terms of their fluid accumulation properties compared to the Upper Maykopian deposits; therefore, based on core samples, the accumulation properties of the terrigenous reservoirs of the Lower Maykopian deposits in the Yevlakh-Aghjabedi depression have been analyzed.

The overall porosity of the study area for the Lower Maykopian deposits is significantly high in the

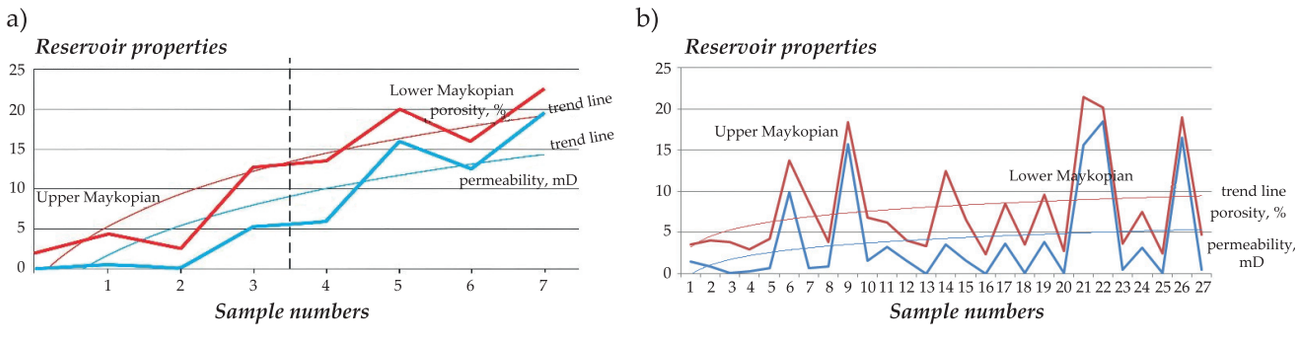

Fig. 3. Collector properties of reservoirs from natural outcrops of the Maykopian Formation (on the y-axis) a) Zeyva, b) Acider sections.

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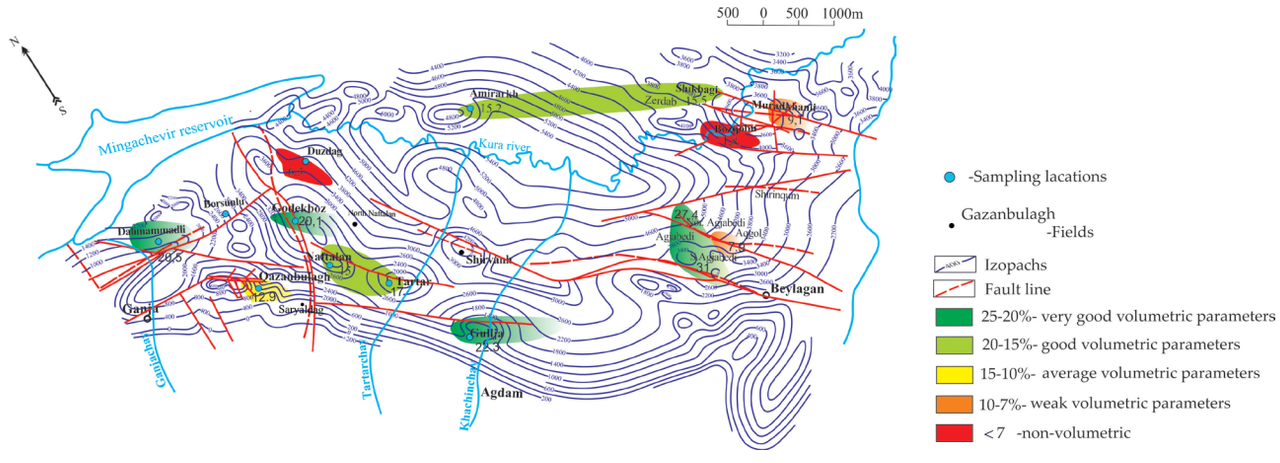

Fig. 4. Map of porosity variations of the Lower Maykopian stratigraphic sequence based on core samples in the Yevlakh-Aghjabadi depression, %(Maykopian basic structural map according to Maharramov et al.)

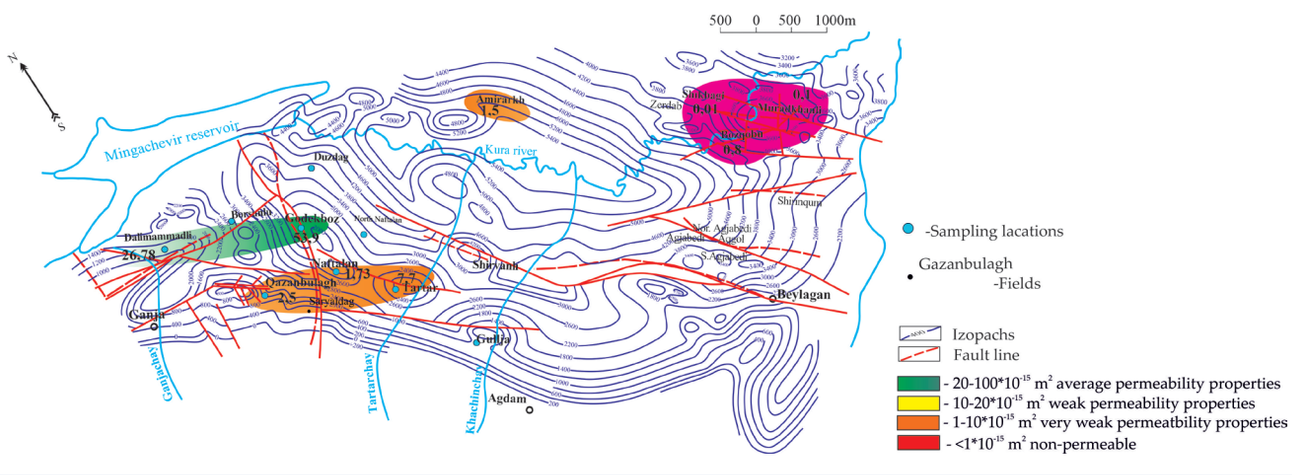

Fig. 5. Map of permeability variations of the Lower Maykopian sedimentary sequence based on core samples in the Yevlakh-Aghjabedi depression, 10^{-15} m² (Maykopian basic structural map according to Maharramov et al.)

Gulluja and Delmemmedli areas (25-20%) and shows good volume characteristics. According to drill core data, the porosity in the Eastern Aghjabedi area is 27.4%, while in the Godekboz and Amirarkh areas it is 20% and 15%, respectively, and in the Shikhbagi area it is 15.5% (fig. 4).

Porosity decreases in the northeast and northwest directions. According to the core data obtained from wells, the porosity in the Duzdag area is 6.3% and in the Muradkhanli area it is 9.1%.

This trend is also reflected in the permeability of the reservoirs.

The average permeability in the Lower Maykopian formation is not high. Across the section in the southwestern part of the region, the permeability is high, reaching 53.8×10^{-15} m² in the Godekboz area, while in Delmemmedli it is 26.78×10^{-15} m². In the northeastern part, however, permeability is lower, with values less than 1×10^{-15} m² in the Muradkhanli and Shikhbagi areas (fig. 5).

Similarly, the permeability of the Lower Maykopian formations is generally higher in the southwestern part of the basin. In general, the Maykopian formations have weak filtration properties. It is possible that geological processes occurring in these reservoirs have influenced the degree of cementation, thereby affecting both the amount and composition of cement, which in turn affects permeability.

In terms of lithological composition, the proportion of aleurite (0.1-0.01 mm) and clay (<0.01 mm) fractions varies across the basin, ranging from 14% to 58% and 42% to 65%, respectively. The amount of

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sand (0.1-0.25 mm) fraction is noted in the Naftalan and Qazanbulaq areas. However, in other areas, the amount of sandy fractions is not so high.

Thus, by analyzing the lithofacial and mineralogical composition as well as the collector characteristics of samples taken from natural outcrops and cores of Maykopian formations, we can come to the following conclusions:

1. The lithologic composition of the Maykopian sediments in the Yevlakh-Aghjabedi depression is highly variable. Thick alluvial sediments alternating with conglomerate and argillaceous sandstone and argillaceous rocks are recorded in the Lower Maykopian section of the areas near the Lesser Caucasus. From the south to the north, the Maykopian rocks of the region are characterized by clayey-sandy and sandstone-argillaceous clayey rocks. The central part of the depression is characterized by clayey rocks.
2. In the mineralogical composition of the Maykopian reservoirs in the Middle Kura Depression, fine-grained feldspars dominate.
3. In the Yevlakh-Aghjabedi Depression, Lower Maykopian sediments have better collector characteristics.
4. The collector quality of the Lower Maykopian sediments in the Lesser Caucasus foothills of the Yevlakh-Aghjabedi Depression (Gazanbulagh, Ajidera, Naftalan, etc.) was sufficient, towards the north of the depression it was poor and very poor, in the central part of the sedimentation the sediments are almost impermeable (porosity less than 5%).
5. The quality of the reservoirs was significantly influenced by the facies conditions of the sedimentation basin and the mineralogical composition of the Maykopian sediments.

The analytical data demonstrate the moderately good reservoir properties of the Lower Maykopian sediments.

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