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ABSTRACT

of the dissertation for the degree of Doctor of Philosophy

**CONDITIONS OF CONCENTRATION OF MAYCOPIAN
DEPOSITS IN WESTERN AND EASTERN AZERBAIJAN
AND CHARACTERISTICS OF CARBOHYDROGEN
RESERVOIRS (IN THE EXAMPLE OF MIDDLE KUR
AND SHAMAKHI-GOBUSTAN SITS)**

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GENERAL CHARACTERIZATION OF WORK

Relevance and state knowledge of the topic: The development of the oil and gas industry plays a special role in increasing the economic power of Azerbaijan. At present, high-quality Azerbaijani oil is exported to the world markets, and as a result, investment flow to the country is ensured. This, in turn, makes it possible to increase the pace of search and exploration in promising oil and gas fields and to discover new fields. The oil and gas prospects of the onshore territory of Azerbaijan are attributed to the thick rock layer, good oil and gas producing formations and reservoirs, as well as Maykop sediments with hydrocarbon potential. The lithology, stratigraphy, microfauna and other geological issues of the sedimentary zone of these sediments have been studied by many prominent researchers for many years. Among these researchers, V.H.Abikh, I.M.Gubkin, B.E.Khain, V.V.Bogachev, C.M.Khalilov, D.A.Agalarovan, H.A.Ahmadov, A.A.Alizaden, S.H.Salayev, Sh.F.Mehdiyev, I.S.Quliyev, A.A.Feyzullayev, M.B.Kheyirov, T.N.Kangerli, V.Sh.Qurbanov, H-M.A.Aliyev, E.H-M.Aliyeva, D.A.Huseynov, F.S.Jafarov, E.Sh.Shikhalibeyli, M.N.Mammadov, E.M.Shekinski, S.A.Azizbayov, A.A.Alizade, R.I.Rustamov, S.A.M.Suleymanov, Sh.S.Kocharli, A.B.Mammadov, Kh.M.Yusifov, A.M.Salmanov, B.I.Maharramov, R.R.Rahmanov, B.A.Bagirov, M.A.Bakirov, A.G.Ahmadov, C.A.Tahirov, Y.N.Ganbarov, A.A.Babayeva, Klosterman and others can be shown.

Maykop sediments are considered to be one of the most important layers in terms of oil and gas after the Productive Layer in Azerbaijan. These sediments play a key role in the geological structure of deep-lying and widespread structures in the foothill regions of the Greater and Lesser Caucasus, especially in the Middle Kura depression and Shamakhi-Gobustan regions, in some cases with natural outcrops. In addition to actual materials, published scientific works and information from geological reports, as well as the results of field research were widely used in the research work, and comparative analyzes were made with reference to the scientific studies of some research scientists. Based on these data, Maykop sediments are distributed almost mainly in terrigenous clayey facies. However, sand, sandstone and siltstone layers of small

thickness are separated in separate intervals of the section. The conducted studies show that there are favorable paleogeographical conditions for oil and gas production in these depressions. Therefore, it is appropriate to increase attention to this field and expand geological research in this direction. Stratigraphy, lithology, history of geological development, petrography of Maykop sediments in Ganja and Muradkhanli oil and gas region and Kura-Gabirriinterfluvial areas covering the western flank of the South Caspian basin (Shamakhi-Gobustan depression) and the southwestern and northeastern wings of the Yevlakh-Aghjabedi depression, and the study of lithofacies, as well as the establishment of lithostratigraphic cross-sections, the extensive study of collection properties will allow for the correct direction of exploration work in the future. For this purpose, the collective conditions of Maykop sediments and the distribution of lithofacies were analyzed, and the characteristics of hydrocarbon reservoirs were determined.

Object and subject of the research:

The object of the research is the Middle Kura and Shamakhi-Gobustan depressions, and the subject is the discovery of the fluid accumulation feature of the Maykop sediments of Azerbaijan and their ranking by depth and area according to the collecting quality.

Purpose and objectives of the research:

- Analysis of the lithofacies characteristics of Maykop rocks in the territory of West and

East Azerbaijan and, based on this, determination of the regularity of their lithofacies changes in the field and section;

- Studying the properties of the reservoir based on the natural outcrop and core data of

Maykop-age rocks and identifying the intervals with good filtration capacity;

- Collector of Maykop sediments in the Middle Kura and Shamakhi-Gobustan depressions comparison of characteristics;

- The influence of facies conditions and mineralogical composition on the quality of reservoirs.

- Zoning of research regions according to the collection quality of Maykop rocks.

Research methods:

The solutions to the issues raised were studied with the Geco Hazard Permeameter and Helium Porosimeter analytical PVT laboratory complex of rock samples taken from the core and surface sections.

The basic provisions given to the defense:

- The lithofacies of the Maykop basin in the Middle Kura and Shamakhi-Gobustan depressions heterogeneity.

- Changes in the quality of collectors by section and area of Maykop rocks in the research regions, ranking of sections and regionalization of the collection by quality.

- Influence of facies-mineralogical factors on the reservoir quality of Maykop rocks in Middle Kura and Shamakhi-Gobustan depressions.

The scientific novelty of the research:

- For the first time, the Maykop sediments of the Middle Kura and Shamakhi-Gobustan basins comparative lithofascial characteristics are given;

- Filtration-capacity of Maykop sediments of the Middle Kura basin for the first, the time features were studied in detail and the regularity of their local and regional distribution was shown (Lesser Caucasus, Yevlakh-Agjabadi, Jeyranchol basin and Chatma anticlinorium);

- Facial and fluid accumulation properties of Maykop rocks and in the the Middle Kura effect of mineralogical factors were determined;

- In terms of the collecting quality the Maykop cross section of each region perspective intervals have been identified;

- From natural outcrops of Maykop sediments in the Shamakhi-Gobustan basin and filtration-capacity characteristics of rock samples taken from wells and significant differences were identified;

- Collectivity of Maykop rocks in the Middle Kura basin ranked by quality.

The theoretical and practical significance of the research.

The theoretical significance of the research is the study of the collectivity conditions of Maykop sediments and the factors affecting the collection. The practical importance of the research –allows to determine the distribution map of the lithofacies and reservoir pa-

rameters of the depressions, sections and areas with the best reservoir characteristics are monitored, and it helps to determine the optimal conditions for the effective design of wells of various purposes (exploration, exploitation, etc.) and the parameters of oil and gas field exploration and development

Approbation and implementation:

12 scientific works on the subject of the dissertation work, including 8 articles, theses on 4 international conference materials were published: the main results and provisions of the dissertation work were published on republican and international scientific platforms, including at the X International Scientific Conference on the theme "Complex approach to the detection of hydrocarbon resources" (Baku 2012), "Assessment of the hydrocarbon potential of the South Caspian and similar depressions by geophysical studies" at the X International Geophysics Conference (Baku, 2017), "Lithology and reservoir properties of the Maykopian rocks the Middle Kura basin of Azerbaijan" AHI EVRAN "International Conference on Scientific Research" (Kırşehir, Turkey 2021) and Sh. It was presented at the XII Republican Scientific Conference (Baku, 2021) on the topic "Generation, migration and accumulation of hydrocarbons" dedicated to Mehdiyev's memory.

The name of the organization where the dissertation was performed:

Implemented at SOCAR's Oil and Gas Research Project Institute.

Structure and volume of the research:

The dissertation consists of an introduction, six chapters, a conclusion, and 147 titles of references and abbreviations. The text consists of 69 pictures and 9 tables, totaling 201 pages. The total number of characters is 206529, including introduction - 8790, chapter I - 81232, chapter II - 27112, chapter III - 27722, chapter IV - 22376, chapter V - 23254, chapter VI - 10936 and conclusions - 4107.

Personal contribution:

The basis of the dissertation work is the research conducted by the author. Lithofacies maps of the Maykop basin of Middle Kura (Yevlakh-Aghjabedi and between Kura and Gabirri rivers) and Shama-khi-Gobustan depressions were compiled. The author has comprehen-

sively analyzed a large amount of data on Maykop sediments, and compiled distribution maps of the seepage-capacity characteristics of Maykop rocks in the Middle Kura and Shamakhi-Gobustan depressions by area and section. Histograms showing changes in mineralogical and granulometric composition of rocks were constructed. The difference in collector characteristics was explained by the conditions of collection of Maykop sediments, the sources of rocks, the change of lithofacies and the influence of mineralogy.

He directly participated in the collection of rock samples and data interpretation of Maykop sediments in field conditions in Yevlakh-Aghjabedi, Kura-Gabirri and Shamakhi-Gobustan oil and gas regions, and compiled lithostratigraphic sections based on field studies and core data. The collection of Maykop rocks in the Middle Kura basin is regionalized according to quality.

Appreciation:

The author expresses his gratitude to the scientists who contributed to the study of the geology and geological development of the research regions, as well as the scientists whose scientific results were used as a reference in the dissertation. For his constant attention, patience, help and valuable advice, as well as for the opportunity to work together, his scientific supervisor, corresponding member of ANAS, g-m.e.d. He expresses his gratitude to E.H. Aliyeva. He also expresses his deep gratitude to the management of the "Oil and Gas Research Project" Institute of SOCAR, the Department of Geophysics and all the employees of the "Stratigraphy and Petrophysics" laboratory for the opportunity and help created for the completion of the dissertation work.

SUMMARY OF THE WORK

The introduction part reflects the relevance, purpose, research issues and their solutions, the main provisions defended, scientific innovations and practical significance of the dissertation.

The first chapter of the dissertation presents the history, stratigraphy, and tectonic structure of the geological-geophysical study of the Middle Kura and Shamakhi-Gobustan depressions are presented. In different years, geological-geophysical and exploration works

were carried out in Shamakhi-Gobustan oil and gas region. Exploration wells drilled in 1951-1953 in the Cheyildagh field, which is distinguished by intensive surface oil manifestations, in the southern wing of the rise of the same name, opened oil deposits related to the upper Maykop and Chokrak sand and sandstone horizons. In 1947-1953, exploratory wells were drilled in the Umbakı area, and as a result, it was confirmed that the upper Maykop and Chokrak sediments contain industrially important oil¹. The discovery of an industrially important oil field from the Oligocene-Miocene sediments in this area led to the expansion of search and exploration works in other areas. In the Upper Maykop section of well No. 29 dug in the Cheyildagh area, 6 sandy horizons were identified as collectors. Weak gas separations were observed in the I, II, III and V horizons.. In the wells No. 8, 11, 16, 17, 21, 25, 26, 27, 31, 97 and 99 drilled in the Gicekiakhtarma area for Maykop sediments, numerous sand interlayers saturated with oil with a thickness of 10 cm were found in the section of Maykop sediments.²

In Upper Maykop, the northern part of the Shamakhi-Gobustan depression has a clayey, and the southern part has a clayey-sandy lithofacies.

The Yevlakh-Aghjabedi depression is divided into 3 tectonic zones in the Paleogene basin: the northeastern, southwestern border and the central depression zone that separates them.³ It stretches to the Arazriver. Based on surface rock samples and data from wells dug in these areas, the Maykop formation was found. In many areas of Ganja region, the Maykop stratum is exposed. Gazanbulag II, Gazanbulag I, and Naftalan horizons are mostly oil in these sediments. These horizons consist of an alternation of calcareous clays,

¹ Ахмедов Г.А. Геология и нефтегазоносность Кобустана / Г.А.Ахмедов. – Баку: Азнефтеиздат, –1957. –258 с.

² Yusifov, X.M. Şamaxı–Qobustan neftli–qazlı rayonunda Paleogen–Miosen çöküntülərinin qeyri–antiklinal tələləri və onların neft–qazlılıq perspektivliyi // – Bakı: Azərbaycan Neft Təsərrüfatı, –2015. № 7–8, –s. 9–20.

³ Yusifov, X.M. Azərbaycanın neftli–qazlı hövzələri / X.M.Yusifov, B.S.Aslanov / –Bakı: Mars Print, –2018. –324 s.

consisting mainly of clay sediments, various-grained, usually calcareous sandstones, and sometimes clayey conglomerate-breccias with foraminiferal rock fragments passing into river stone. In the Muradkhanli area, located on the northeastern side of the Yevlakh-Aghjabedi depression, the Maykop formation consists of thin (up to 1 m) sandstone and clay layers with siltstone hills. Its thickness increases from 400 m at the fold arch to 800-1000 m at the dip of the southwestern flank. Well No. 27 dug here produced oil with a daily output of 4 tons from the lens-shaped sandy formation.

The Maykop sediments of the Kura-Gabirri interriver region were opened with numerous full-thickness structural-research wells. In general, the thickness of these sediments gradually increases from south to north throughout the region and is divided into lower and upper subgroups. Maykop sediments are ubiquitously distributed in clayey facies, consisting of terrigenous sediments. Only in the foothills of the Lesser Caucasus, as well as in the areas close to the internal elevations, coarse-grained rocks - sandstone, gravelite and conglomerate beds are present. In the Kura-Gabirri oil and gas region, the thickness of Maykop sediments increases towards the north and reaches 2000 m in the shelf zone.⁴

In the second chapter, the lithology and accumulation conditions of Maykop sediments in the Shamakhi-Gobustan depression were studied based on the data on wells and natural outlets. The intense tectonic movements that took place in the Paleogene-Miocene period in the Shamakhi-Gobustan NKR caused the uneven distribution of these sediments in the area, the area was subjected to lithofacies changes, the thickness of the reservoirs in the section and lithophysical properties changed, the formation of tectonic faults, and at the same time it affected the oil and gas production. According to the excavation materials, six horizons were opened in the Umbaki field, and one in the Shaitanud field. Clay lithofacies are observed in the Upper Maykop formation in the Shikhzayirli and Tekla areas located

⁴ Рахманов, Р.Р. Перспективы нефтегазоносности мезокайнозойских отложений междуречья Куры и Габбыры / Р.Р.Рахманов, М.Б. Хейров, – Баку: Нурлан, –2001. – 200 с.

in the north of the study area.

In North Gobustan, both layers of Maykop are characterized by clay rocks, and in South Gobustan, the upper half-group is characterized by alternating clay, siltstone, sand and sandstone, and the lower group is characterized by clay rocks.

According to the information received from the exploration wells, 6 sandy horizons are separated in the section of the Upper Maykop peninsula, and these horizons correspond to the Ia, II, III, IV, V, VI oil-gas collector horizons in the Umbaki oil field. Those collector-horizons are separated from each other by thick clay layers. The lithological-petrographic characteristics of the samples taken from the sections of Maykop sediments in separate areas of the Shamakhi-Gobustan NKR were investigated.

It is possible to follow the variation of the amount of quartz mineral in the sediments of Upper Maykop by region. Towards the north of the region, the quantity of quartz decreases, while feldspars and carbonate rock fragments increase. The average amount of quartz in the sandy and silty rocks of Upper Maykop in the southwest of the region - Hajiveli and Umbaki is 60-80%, and it decreases to central Gobustan (Girgishlaq and Donguzlug) is 40%, and only 35% in the Shaytanud section. Quartz grains are mainly found in sharp and semi-rounded form. The cement is clayey and carbonated. More than 80% of the pore space is filled with cement material.^{5,6}

Such mineralogical composition indicates that the source of nutrition of the area may be the crystalline metamorphic rocks of the foundation of the Russian platform. It can be legitimately assumed that the sandy horizons of Upper Maykop were enriched with quartz mineral due to the intense washing of Kullullu sandstones that sur-

⁵ Əliyeva, E.H., Səfərli, K.H. Şamaxı-Qobustan NQR-da Maykopçöküntülərinin litofasiyası və kollektor xüsusiyyətləri // –Bakı: Azərbaycan Neft Təsərrüfatı, – 2018. № 11, – s. 3–9.

⁶ Алиева, Э.Г., Коллекторские свойства 3-х мерная модель резервуаров чокрак-майкопских отложений месторождения Умбаки Шамахи-Гобустанского района Южно-Каспийского бассейна / Э.Г.Алиева, К.Г.Сафарли, Ф.Б.Аслан-заде [и др.] // Азербайджанское Нефтяное Хозяйство, – Баку: – 2016. № 2, –с.6–13.

faced in some parts of Northern Gobustan at certain stages of the Maykop period.⁷

In this zone, the size of the grains of sedimentary materials varies analogously. If there are rock grains of size 0.4-0.2 mm in Umbaki and Cheyildagh areas in the southwestern part, rock grains of this size decrease in Central and Northern Gobustan and fine-grained rocks of size 0.02-0.01 mm are observed.

The number and thickness of horizons is expected to increase here. From what has been said, it can be concluded that the presence of sandy-siltstone horizons in the Upper Maykop section in southwestern Gobustan and their alternation with clayey horizons can be favorable conditions for maintaining industrially important oil and gas deposits in these horizons. Sandy horizons (VI, V, IV, III, II, I) are separated in the Upper Maykop section in the mentioned areas.

In the third chapter, the lithology and accumulation conditions of the Maykop sediments of the Middle Kura basin were studied based on the data on wells and natural outlets. Ganja, which covers the southwestern slope of the Yevlakh-Aghjabedi depression and the lithofacies of the Muradkhanli oil and gas region, which is the northeastern wing, were also examined.

In the northeastern part of the Yevlakh-Aghjabedi depression (Muradkhanli, Jafarli, Zardab, Amirarch), Maykop sediments consist mainly of clays. Only in the lower and partly upper parts of the Maykop formation of the Muradkhanli uplift, thin (up to 1 m) thin-bedded sandstone and siltstone layers are found.⁸

Maykop sediments in the southwestern part of the basin sometimes overlie Foraminiferal sediments with basal conglomerates. The Maykop Formation, consisting mainly of sandy-clay sediments, consists of coarse-grained terrigenous sediments lithologically with conglomerate layers in river valleys.

⁷ Алиева, Э.Г., Мустафаев, К. Петрографические и емкостно-фильтрационные особенности миоценовых отложений западного борта Южно-Каспийского бассейна // – Баку: ANAS Transactions, Earth Sciences, –2021. № 1, –с. 3-15.

⁸ Hüseynov, B.B. Azərbaycanın quru ərazisində neft-qaz-geoloji rayonlaşdırması / B.B.Hüseynov, Ə.M.Salmanov, B.İ.Məhərrəmov – Bakı: Mars Print, –2019. – 308 s.

The frequent change of the lithological composition and the diversity of the distribution areas of the existing sandy horizons of Maykop sediments on the southwestern side of the Yevlakh-Aghjabedi depression and the river valleys in the region played a big role in the distribution of these sediments.

From the well sections of the research area in the foothill zone of the Lesser Caucasus (Ganja NQR), it can be seen that the lithological composition of the lower part of the Maykop formation changes several times. Very coarse sediments - gravel and boulder conglomerates are recorded in these intervals. Among them, mainly clayey and well-cemented pomegranate-grained sandstone and sand layers are recorded. The thickness of these layers varies from several centimeters to meters. Lower Maykop sediments are characterized by layers of sand, sandstone and siltstone. At the same time, there is an alternation of fine-grained sand layers with grainy sand layers and clay layers.

From the south-west to the north-east direction of the region, an increase in the thickness of the sediments of the Maykop formation and a decrease in the amount of clastic rocks are observed. In a large part of the territory, the section of the Maykop formation is characterized by the alternation of clays, siltstones, sandstones, conglomerates and marls. The total thickness of this group, covering the Oligocene and lower Miocene, is up to 2200 meters, and consists of two parts: the lower and upper Maykop subgroup. Lower Maykop sediments in Ganja oil and gas region mainly have clay lithofacies. In the center of the region (Gazanbulag, Ajidara, Karachinar, Incechay) and in the southern part (Aghdam, Gullujah), these sediments are characterized by thick greenish-gray clay rocks with siltstone, sandstone and conglomerate layers, while in the eastern direction (Naftalan, Tartar) they are coarse and medium-grained sandstones and siltstones pass into layered clay deposits. Sandstone and siltstone type layers are generally of small thickness. They are most widespread in the intersections of the horizons bearing the names of I and II Gazanbulag, II, III, IV, V, VI Naftalan and II, III Tarter in the Delimammadli, Gazanbulag, Naftalan, Tartar, Gödekboz areas. In the southwestern direction, the amount and thickness of sandstone and

coarse-grained rocks increases and reaches a greater thickness in the Tartarchay and Gargarachay valleys. It can be assumed that the ancient river delta passed through here.

In the southern direction (Beylagan, Agjabedi) coarse-grained rocks disappear. Here, the Lower Maykop is characterized by gray, dark-gray calcareous clay and poorly cemented clayey siltstones and tuffs.

The nature of the lithofacies in individual zones depends on the granulometric sorting of the material. Thus, the amount of sand and siltstone rocks is more than 65% in Karachinar, Aghjakend, Meshali areas. However, in the Lower Maykop sediments in Ajidara, Gazanbulag, Delimadli, Naftalan, Borsunlu, Zeyva, Incachay and Tartar areas, these rocks are reduced or replaced only by siltstone fraction. In the south-eastern direction of the region (Gullujah), the amount of siltstone fraction does not exceed 55%, its amount drops to zero in the intersections of Beylagan, Khudafarin-Bahmanli areas. The thickness distribution of the lower Maykop is not stable. So, while the thickness is 300-400 m in the northern foothills (Meshali) of the Ganja NKR, it increases to 2500 m in the center (Naftalan), and decreases to 170 m in the south (Beylagan). Coarse-grained rocks: conglomerates and breccias are also found in the Lower Maykop sediments. In Zeyva, Karachynar, Ajidara areas, the upper part of Lower Maykop comes out to the ground with certain thicknesses and can be followed for a certain distance. The thickness of the conglomerates in the cross section of the Mesali area is 25.6 m.

These rocks are gray or brown-gray in color and weakly cemented. The debris mainly consists of sedimentary (87%), volcanic (10.1%) and metamorphic (2.9%) rocks. The thickness of rubble rocks reaches 17 m.

Clay sedimentation is found in the intersections of Ajidara, Gazanbulag, and Delmammadli areas. These rocks had weak sedimentation.

The granulometric and mineralogical composition of the sandy rocks of the Lower Maykop sediments of Delimammadli area was studied. Tuffaceous sandstones are more coarse-grained and they are medium in size, but polymict sandstones are dominated by fine-grained rocks.

Inhomogeneity is also noted in the mineralogical composition of the rocks. Thus, tuffaceous sandstones are characterized by quartz, and then by feldspar. The sediments contain a certain amount of terrigenous fragments and carbonate rocks.

In polymict sandstones, feldspar plays the main role among the light fraction minerals, followed by clastic rocks. The mineral content of these rocks is very low in quartz. Apparently, such a difference in the mineralogical composition of these 2 types of sandstones is related to the volcanoclastic diversity that composes them in tuffaceous sandstones rich in quartz mineral.

Lower Maykop sediments of Gullujeh area are characterized by clayey facies. The terrigenous-clastic material is poorly sorted, sharp-edged and semi-rounded. 90% of the mineralogical composition is effusive, clay-carbonate and siliceous with rock fragments. The amount of feldspars is 10-25%. The rocks contain little quartz mineral. The cement material is mainly iron-chlorite, chlorite-clay and siliceous-clay.

The lithological composition of Lower Maykop sediments in the Naftalan area consists of sandstone siltstone and tuff. The thickness of sandstone and tuff varies from 10 cm to 4 m. The thickness of the tuffs does not exceed 0.5 m. Sedimentary rocks in the IV, III horizons are represented by clayey-sandy, fine-grained sandstone and siltstone. The amount of sand fraction in the Naftalan II horizon is 41%, siltstone 30%, clay fraction 29%. The average amount of carbonation in the rocks is 5.6%. In the Naphthalan I horizon, the content of the sandy fraction decreases to 36%, but the carbonate content increases to 8.0%.

The mineralogical composition of the rock remains constant throughout the field and section. Siliceous, effusive, clay and carbonate rocks (80-90%), quartz (0.1-5%), feldspar (10-40%) prevail. A slight increase in the amount of quartz (2.0-3.0%) is noted in the central part of the Naftalan area.

The sediments of the Maykop formation deposited under such conditions often undergo lithofacies changes.

The Maykop sediments of the Kur-Gabirri interriver oil-gas region appear in the form of narrow strips and separate spots in the

Armudlu, Alacık and Chobandag areas of the Chatma anticlinorium, and the thickness reaches 80-85 m. It consists of thin brown, gray and brown clays.

Maykop sediments were opened in full thickness in a series of structural exploration wells. In general, when comparing well sections, the thickness of Maykop sediments in the region increases from south to north, and this increase occurs due to the formation of new horizons both above and below the section.

The thickness of Maykop formation reaches 800-1000 m in Tovuz-Gazakh, Girakhkasaman, Mammadtepe, Girzan-Khuluf areas. The fully exposed thicknesses of Maykop sediments in the Chatma anticlinoria are 1450-1860 m in the Palantöken area, 1640 m in Molladag, 1760-1970 m in Demirtepe-Udabno and 1660 m in Armudlu. The maximum thickness of Maykop is 2862 m, opened in well No. 1 in the Saccdag field.

800-1900 m in the Cheyranchol depression, 1360 m in Keyrükkeylan, 1600 m in Gurzündag. It is 890 m in Mammadtep, and 780 m in Gazakh-Mammadtep. Lithofacologically, it consists mainly of clays and is characterized as an alternation of sand, sandstone, siltstone, tuffaceous sandstone with aragat (Upper Maykop) and sand, volcanic ash aragat (Lower Maykop) clay layers.

A large part of the region originated in the shelf conditions of the Maykop Basin and is lithologically overlain by the Maykop sediments, which consist of layers of sandy aragonite clay. They are spread in the southern part of the northwestern part of the shallow-coastal zone district. Coarse-grained rocks are more often observed in the section of this zone.

The direction and intensity of the source of detrital materials for the Maykop formation of the Yevlakh-Aghjabedi depression was not constant, but constantly changed in time and space. Frequent changes in the lithological composition of Maykop formation sediments on the southwestern side of the Yevlakh-Aghjabedi depression and the diversity of the distribution areas of the sandy horizons present here indicate that paleorivers play a major role in the distribution of these sandy horizons.

In the fourth chapter of the dissertation, the field and cross-

sectional distribution characteristics of the collector characteristics of Maykop sediments in the Shamakhi-Gobustan basin are reflected.

The collector parameters of a number of areas surrounding this depression have been studied. The study of rock samples taken from natural outcrops of Maykop rocks and drilled wells shows that they have granular-type collectors (sand, sandstone, siltstone) with high collector properties for oil and gas storage.

As can be seen from these data, the amount of coarse-grained fractions in Maykop sediments decreases in the areas of North and Central Gobustan. The maximum amount of sand fraction grains (>0.25 mm in size) is within 60-10% in the Umbakı deposit in the southern and southwestern part of the region, in Hajiveli, Cheyildagh, Ilkhichi and Arzani-Glic areas. In the areas of Central Gobustan (Nardaranakhtarma, Gichekiakhtarma) this indicator decreases and varies between 50-6%. The amount of sandy fraction is low in Shaytanud area, located in the north of the study area.

The indicators of seepage-capacity characteristics in the study area had a complex picture. Total porosity has the maximum value in Umbakı, Hajiveli, Cheyildagh and Arzani-Glic areas. However, the effective porosity and permeability of the Upper Maykop sediments are recorded in 4 areas in the western part of South Gobustan. In other areas, the value of effective porosity does not reach the boundary value of the rock-collector. Thus, for a number of areas of South Gobustan, the reservoir properties of the Upper Maykop formation can be assessed as good and sufficient. Maykop sediments of Central and Northern Gobustan have poor seepage-capacity properties.

It can be noted that V, IV, III oil horizons in the Umbak area have relatively good seepage-capacity characteristics. Most of the samples (53%) have porosity in the range of 17-22%. The average value of total porosity is up to 19% (41 units). Upper Maykop rocks can be attributed to medium and low capacity reservoirs due to effective porosity. The price of conductivity varies between $1-450 \cdot 10^{-15} \text{m}^2$. Most of the rocks (48%) have permeability in the range of $50-100 \cdot 10^{-15} \text{m}^2$. In fact, the amount of impermeable rocks is up to 10% of the total volume of studied samples (58 samples). In general, the

average value of permeability for Upper Maykop is $70 \cdot 10^{-15} \text{m}^2$ (43 samples). Relative improvement of reservoir properties and quartz content is noted in III and IV sandy horizons.

The changes in the parameters of the reservoir rocks were considered in the region in plan and cross-sections, and the regional distribution of total, effective porosity and permeability for the Upper Maykop sediments according to natural outlets was investigated. According to the study of rock samples taken from natural outcrops, total porosity distribution in the sandy and siltstone rocks of the Maykop formation is relatively high in the areas of Central and South-Western Gobustan. The porosity of Maykop rocks in the Nardaranakhtarma and Gicekakhtarma areas is 20-15%. The porosity of the area increases from north to southwest. The total porosity of Maykop rocks in Umbakı, Arzani-Glic structures is 20-23%. This shows that the capacity of sandy rocks of Maykop formation is good. The effective porosity also increases towards the southwest of the region. Thus, while the effective porosity is 4.5% in Shaytanud, which is located in the center of the region, this indicator is recorded as 12% in the area of East Hajiveli in the southwest direction.

Similarly, the value of conductivity also varies. While the permeability in Nardaranakhtarma and Gicekiakhtarma areas is $40-45 \cdot 10^{-15} \text{m}^2$, it varies between $160-170 \cdot 10^{-15} \text{m}^2$ in Hajiveli and Ceyildagh areas.

According to Kern's data, higher porosity $>25\%$ is recorded in central Gobustan - Shaitanud, Gicekiakhtarma, Kaftaran areas. In South Gobustan, the value of total porosity is also very good - it has a value of $>20\%$. In general, according to the core data, the total porosity of the Maykop sediments decreases significantly in the north direction and is $< 5\%$ in the Qizmeydani structure. According to the core data taken from the wells, the permeability of Maykop rocks in South Gobustan is weak, while the rocks in Central and North Gobustan are non-permeable.

Thus, the core studies showed that the sandy rocks of the Upper Maykop sediments in the Umbak, Ceyildagh, Hajiveli areas of South Gobustan have better collector properties. In areas located in

central Gobustan, seepage is poor against the background of good overall porosity in Maykop sediments. This can be explained by the distribution of carbonation in the sandy rocks of Maykop sediments. The Upper Maykop rocks of South Gobustan are characterized by lower carbonation and basal type of cement. In other areas of the study region, the amount of carbonate cement exceeds $>15\%$, and in some areas it is $>26\%$.

It should be noted that the collector characteristics of Maykop rocks according to their indicators, the data obtained from kern and natural outputs are slightly different. Against the background of good overall porosity, the permeability of the core in the Central Gobustan-Nardaranakhtarma and Suleymanakhtarma structures is equal to 0. However, in the samples taken from the exits, this indicator is characterized by a weak filtering feature. Thus, as a result of the weathering process, cracking occurred in the Maykop sediments taken from the natural outlets, and the indicators of the seepage properties of the sandy rocks of the Maykop layers slightly increased.

In the fifth chapter, the collector features of the Maykop sediments of the Middle Cura sediments are discussed. Fluid accumulation of Maykop sediments in the Yevlakh-Aghjabedi depression was caused by the inhomogeneity of the paleogeographic environment in the early and late Oligocene. In connection with the wide development of the cone of mountain rivers of the Lesser Caucasus, the accumulation of coarse-grained potential rock reservoirs on the slopes of this mountain system is within the boundaries of the Pre-Caucasus depression.

In the area of Ganja region (Ajidara and Zeyve areas), the studies conducted on the collector characteristics and lithological composition of the coarse-grained particles of the sediments of the Maykop formation show that the sediments of these sections are non-homogeneous, and along the section, the decrease of sandy rocks and the deterioration of the collector characteristics are observed.

The sediments of the lower part of the Maykop transect are better compared to the Upper Maykop rocks due to their fluid accumulation characteristics.

According to the core samples, the carbonation of terrigenous

rocks of Lower Maykop sediments in the Yevlakh-Aghjabedi basin has a higher value in the southwestern and northeastern parts of the basin and is 23.5% in the Muradkhanli area, and 21.8, 22.5% in Delimammadli and Gazanbulag, respectively. The amount of CaCO_3 in rocks is relatively low in Amirarch (5.2), Shikxbagi (7.1) and Gödekboz (7.7) areas. The highest carbonation is 20-21% in Muradkhanli-Bozgobu in the northeast and Delimammadli and Gazanbulag in the southwest.

The general porosity of Lower Maykop sediments in the study area has a good capacity characteristic (25-20%) in the southwestern parts of the basin (Güllüce, Delmammadli areas). According to the core data taken from the wells, the porosity is 27.4% in the East Agjabadi field and 20% and 15% in the Gödekboz and Amirarch fields, and 15.5% in Shixbagi area.

The value of porosity deteriorates in the northeast and northwest direction. According to core data taken from the wells, the porosity is 6.3% in the Duzdag area and 9.1% in the Muradkhanli area.⁹

The permeability of the lower Maykop sediments increases similarly from the northeastern to the southwestern part of the basin. In general, Maykop rocks have poor leaching properties. It is possible that due to the processes taking place in these sediments, it affected the degree of cementation of the rocks and caused a change in the amount of cement, which also affected the permeability.

The highest carbonation is in the northwestern and eastern part of the area. The highest porosity is recorded in the southwestern and central parts of the basin. The rock permeability is impermeable in the central part of the basin and is $<1 \cdot 10^{-15} \text{m}^2$. Permeability varies in a wide range ($0-927,5 \cdot 10^{-15} \text{m}^2$) in Maykop rock samples in Giraqkasaman area, located in the western part of the basin. The average price is $147,4 \cdot 10^{-15} \text{m}^2$. Here, the rocks had very poor and medium permeability. Toward the east of the basin, the sedimentation properties of the rocks deteriorate and become impermeable.

According to the obtained results, the Maykop rocks in the areas of

⁹ Səfərli K.H. Yevlax–Ağcabədi çökəkliyində Maykop çöküntülərinin litofasiya və kollektorluq xüsusiyyətləri // – Bakı: Azərbaycanca Geofizika Yenilikləri, –2021. № 1–2, –s.51–54

the north-eastern part of the Kura-Gabirri inter-river NQR, where the northward uplifts are developed, are characterized by bad and very bad collector properties. In general, it can be said that the filtration capacity of Maykop sediments in the Kura-Gabirri inter-river oil-gas region is relatively good in the southwestern and central parts of the basin.

The sixth chapter of the dissertation is a comparison of the collector properties of Maykop rocks and the regionalization of the research areas according to the qualities of the collectors (Middle Kur and Shamakhi-Gobustan depressions).

In the northern and southern parts of the Lesser Transcaucasian depression (Ganja monocline), the lithological composition of the Lower Maykop rocks has fundamentally changed, and clay rocks are dominant in the section. The amount and thickness of the sand layers in the section decreases sharply and completely disappears in the central part of the Yevlakh-Aghjabedi depression.

In the Shamakhi-Gobustan region, the Lower Maykop section is characterized by the alternation of a fairly thick clay layer and fine-grained sandstone layer, not exceeding a few centimeters in thickness.

There is a certain difference between the Middle Kura and Shamakhi-Gobustan depressions due to the lithological type and granulometric composition of the Upper Maykop sediments. A sharp change in the lithological composition of Maykop sediments is recorded in the Shamakhi-Gobustan region. Thus, sand rocks are widespread in a number of areas of southwestern Gobustan (Hajiveli, Umbakı, Nardaranakhtarma, Gicekiakhtarma, etc.). At the same time, in the cross-section of the southeastern, central and northern parts of Gobustan, sandy-siltstone rocks decrease and clayey rocks dominate.

There is a clear difference between the mineralogical composition of Maykop rocks in both studied depressions. Thus, in the rock samples of some areas of southwestern Gobustan, monomict sandstones with a quartz content of 95% (Hajiveli area) are common. In some rock samples from other areas, quartz dominates with 75% of light fraction minerals. The remaining part belongs to feldspar. Finally, in the southern part of Gobustan, polymict sandy-siltstone rocks with light fractional

quartz minerals with an absolute abundance are dominant.

Polymict sandstones are mainly present in the small pre-Caucasian depression. These rocks are dominated by feldspars. In the 2nd place, it is not significant amount, with rock fragments and quartz mineral. It is impossible to say anything about the mineralogical composition of the sandy-siltstone rocks in the eastern part of the Kura-Gabirri interriver region due to the poor distribution and even their absence.

Sedimentary rocks can be collected from both mountain systems in the Kura-Gabirri interfluvial region, but the Lesser Caucasus is the predominant source of rocks.

The explanation of such a high content of quartz mineral in Upper Maykop sandstones in Shamakhi-Gobustan NQR can be due to local sources of quartz-rich material, more precisely, quartz-rich Kullulu sandstones of Tebashir, distributed in North Gobustan.

The difference between the lithological and mineralogy composition of the Maykop sediments in different areas of the research region had its effect on the collector properties of the rocks. The best seepage-capacity feature is the Upper Maykop sediments, which are characterized by monomict quartz sandstones in a number of areas of South Gobustan (Hajiveli, Umbakı). Oligomict and polymict sandstones dominated by quartz mineral are somewhat inferior to them in terms of fluid generation properties. In general, the collectors of Maykop sediments of Southern Gobustan have good and sufficient filtration capacity. In Northern Gobustan, Upper Maykop sediments are dominated by clayey rocks, so their seepage-holding capacity is sharply low.

Lower Maykop sediments of the Shamakhi-Gobustan depression also have insufficient filtration capacity.

Lower Maykop rocks have better collector properties due to the presence of more sandy layers in the Maykop section of the Middle Kura depression. If we compare the 2 depressions where the research work was carried out, then Maykop rocks of the Middle Kura depression lag behind South-Gobustan in terms of its filtration capacity. It seems that the deterioration of the collector properties can be explained by the fact that the sand layers are finer-grained and the amount

of clay layers is high, and the feldspars are dominant in the composition of the rocks during the diagenesis stage.

Thus, research objects in Middle Kura and Shamakhi-Qobustan depressions have different stratigraphic ranges and are spread over a limited area. In the Shamakhi-Gobustan depression, this object is the quartz sandstones of southern Gobustan. In the small pre-Caucasus depression - in the central part of this depression it is Lower Maykop sediments with feldspar sandstones. The object of search in the Kura-Gabirri interriver region is the Maykop rocks, which are outside the uplift zone, mainly in the southwestern part of the region.

Based on the conducted analysis, the research area can be divided into the following regions according to the reservoir quality (Figure 1).

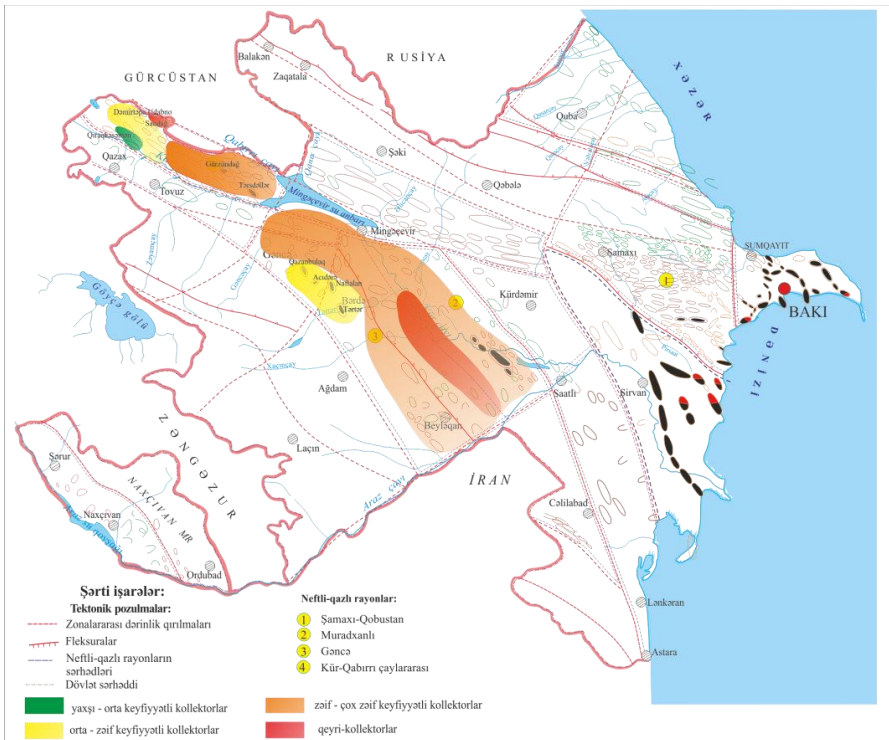


Figure 1. Lower Maykop sediment reservoir in Middle Kura according to quality

In the Yevlakh-Aghjabedi basin, several zones can be distinguished: the central part of the Small Transcaucasian basin - Lower Maykop sediments are characterized by reservoirs of sufficient quality. Lower Maykop age reservoirs are of poor to very poor quality in most of the basin. Finally, due to the clayey nature of the section in the central part of the depression and the deep burial of the Maykop sediments, (>4000 m) Lower Maykop sediments can be characterized as rocks with negative collector properties. Here, the filtration capacity of the Upper Maykop sediments lags behind the Lower Maykop, and their regionalization is not of interest. The eastern part of the Jeyranchol depression and the Chatma anticlinorium have very weak reservoir properties.

In the western part of the Kura-Gabirri interriver region, the reservoir properties of Maykop rocks change dramatically. In the north-western part of the region, the parameters given in the uplift zone have a negative value, and it is not possible to separate the rock-collectors here. In the south-western direction of the region, a gradual transition from collectors of sufficient quality to collectors with good filtration capacity is observed.

CONCLUSIONS

1. The lithological composition of Maykop sediments in the Yevlakh-Aghjabedi depression changes sharply. Thick alluvial sediments alternating with conglomerate and clayey-sandstone and clayey rocks are recorded in the Lower Maykop section of the areas near the Lesser Caucasus. From south to north, Maykop 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. Maykop sediments are characterized by sandy-siltstone rocks in the coastal zone of the Maykop basin in the Kura-Gabirri interriver region. In the eastern part of the district, sandy-siltstone rocks disappear from the Maykop section.
3. Upper Maykop rocks of the southwestern part of the Shamakhi-Gobustan depression, Lower Maykop sediments in the Middle Kura depression are characterized by coarse-grained clastic materials. In

a number of areas of the southwestern part of Shamakhi-Gobustan (Hajiveli, Umbaki, Ceyildagh, etc.). While sandy rocks develop in the upper Maykop layer, in the northern and central zone, sandy-siltstone rocks decrease in thickness and gradually disappear from the section, and clayey rocks dominate.

4. There is a difference in the mineralogical composition of Maykop rocks in the Middle Kura and Shamakhi-Gobustan depressions. Monomict quartz sandstones are common in southwestern Gobustan, and polymict sandstones are common in the southeast and north. The mineralogical composition of the Maykop rocks of the Middle Kura basin is dominated by light-fraction steppe spars.
5. In the Yevlakh-Aghjabedi depression, Lower Maykop sediments have better collector characteristics, and in Shamakhi-Gobustan region, Upper Maykop sediments.
6. According to the collector quality, the central part of the Lesser Transcaucasian zone (Gazanbulag, Ajidira, Naftalan, etc.) in the Yevlakh Aghjabedi depression was sufficient, and the collectors of Lower Maykop age sediments in other parts of the depression were of poor and very poor quality. In the central part of the sedimentation, the sediments are almost impermeable (porosity less than 5%).
7. In the south-eastern part of the Kur-Gabirri area, the collector characteristics of Maykop rocks are very weak, in the north-western part, in the uplift zone, these parameters are negative. In the southwest direction, a gradual transition from sufficient quality reservoirs to rocks with good filtration capacity is observed. In the central part of the Kura-Gabirri interriver region, Maykop rocks collected in shallow coastal conditions have a better filtration capacity (Alimardanli, Saloglu, Girakhkesamenli structures).
8. Comparative analysis of Maykop rocks of the Middle Kura and Shamakhi-Gobustan depressions shows that the Upper Maykop rocks of the southwestern part of the Shamakhi-Gobustan depression have better collector quality.
9. The quality of the reservoirs was significantly influenced by the facies conditions of the sedimentation basin and the mineralogical composition of Maykop rocks.

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[5-7, 9-12] works were performed independently. In the works [1-4, 8], the claimant participated in setting the issue, making calculations, and interpreting the results.

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