LİTHOFACİES MODEL AND OİL-GAS PROSPECTS OF MESO-CENOZOİC DEPOSİTS İN SHAMAKHİ-GOBUSTAN DEPRESSİON

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Abstract

Shamakhi-Gobustan oil-gas-bearing region is one of the most promising regions of Azerbaijan due to the hydrocarbon potential of Meso-Cenozoic deposits. Mesozoic, Paleogene-Miocene and Pliocene deposits are widespread in the area.

From north to south, the region divided into tectonic zones such as Northern Gobustan, Central Gobustan, Shamakhi, South-western Gobustan, South-eastern Gobustan and Alat.

In each tectonic element, regional anticlinal zones are separated, which are composed of stratigraphic sedimentary layers of a large range on the earth's surface.

Numerous core samples taken from the Meso-Cenozoic deposits in Shamakhi-Gobustan oil-gas-bearing region were analyzed and their reservoir properties were studied. The reservoir properties of the rocks were analyzed for separate zones and different stratigraphic units.

Carbonate content in the northern zone is relatively high, and the carbonation of the Cretaceous deposits varies in a wide range, from 24% to 93.4%. The average porosity of the rocks was more than 14%. However, these sediments are characterized by good reservoir properties, despite the low porosity in some areas. The highest porosity is typical for the Gizmeydan, Angikharan and Chikilchay areas. However, the areas of the northern zone are with low permeability. For this zone, there is an inverse relationship between carbonation and permeability.

In the northern zone, the carbonate content of Maykop deposits is less than that of the Cretaceous sediments and varies in a small interval, it is 17.5% only in the Garayazi area. In most cases, the porosity varies in the range of 20-26 5% in the studied areas, and with these values, the characteristics of the reservoir can be well characterized. Permeability was not very high, it is 20-70 $x10^{-15}$ m^2 only in Tuva area.

In the central zone, the deposits of the Upper Maykop and Chokrak horizons are characterized by low carbonate content and relatively high porosity and permeability.

Lower Pliocene deposits (PS) in South Gobustan are characterized by a high reservoir properties. Based on the lithofacies analysis of the Shamakhi-Gobustan depression, the increase of the reservoir properties from the North zone to the South direction was determined.

The prospect of oil and gas in Shamakhi-Gobustan oil-gas-bearing region is related to Meso-Cenozoic deposits. Industrially important oil accumulations were identified in the sandy reservoirs of the PS, upper Maykop and Chokrak horizons, which were uncovered during drilling in separate areas in the southeastern and southwestern tectonic zones of the area.

Presence of oil and gas are noted in the Upper Cretaceous fractured limestone and marls, which are widespread in the northern zone. The density of these rocks varies in the range of 1.94-2.55 g/cm^3 along the northern zone. The Upper Cretaceous deposits are buried under the Paleogene deposits in a south-southwest direction.

Oil-filled formations and dolomites in the form of breccias lying in separate intervals along the section of the middle and upper Miocene in central Gobustan are of special interest. It should be

noted that the natural reservoirs for collecting oil and gas cummulatives in the section of the Meso-Cenozoic deposits are the terrigenous and carbonate reservoirs.
The sandy-siltstone reservoirs of Maykop suite and Chokrak horizon are oil-gas-bearing in Hajivalli, Umbaki, Maraza, Donguzlug areas. A short-duration oil flow was obtained in the upper Cretaceous fractured-carbonate reservoirs in Gizmeydan and Hilmilli areas.

Keywords: carbonation, porosity, permeability, reservoir, Maykop, Cretaceous, fractured-carbonate, core

I. İntroduction

The Shamakhi-Gobustan oil-gas-bearing region is a regional geostructural element. İt is located in the southwestern limb of the Greater Caucasus close to the crest part.

The region is surrounded by the following geotectonic elements from north to south: the southern part of Govdag depression (Northern Gobustan), Shamakhi, Central Gobustan, South-western, South-eastern Gobustan and Alat tectonic zone [1,2].

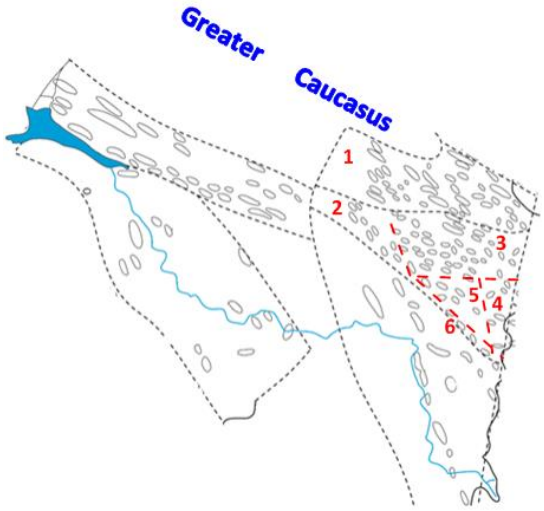

Figure 1: *Overview map of the tectonic zones of the Shamakhi-Gobustan oil-gas-bearing region*
Tectonic zones: 1- Northern Gobustan; 2- Shamakhi; 3 - Central Gobustan;
4 - South-eastern Gobustan; 5 - South-western Gobustan; 6 - Alat

In each geotectonic element, a number of regional anticlinal zones are separated, which are composed of a large range of stratigraphic sedimentary layers on the surface of the earth (from the lower Cretaceous in the north to the upper Pliocene in the south). The common characteristic of these zones is as follows. As a result of the ascent of the northern limbs and the descent of the southern limbs, the anticlines were bent to the south, the crests of the anticlines were complicated by longitudinal faults and mud volcanoes located on them. The dimensions of the folds depend on the lithological composition of the deposits that make them up. The widht of anticlines is 5-7 km made up by competent rocks and length is 13-15 km, while the anticlines made of soft rocks are 2 km widht and 10-5 km length [3].

Shamakhi-Gobustan oil-gas-bearing region is one of the most promising regions of Azerbaijan due to the hydrocarbon potential of Meso-Cenozoic deposits. Paleogene-Miocene deposits, which are widespread in the area, as well as Mesozoic and Pliocene deposits, are one of the main areas of exploration for discovering new oil and gas reserves [4].

The region has a complex geological structure and is relatively poorly studied. There are 79 local uplifts in this oil-gas-bearing region. In total, 5 oil and gas fields with a small reserves were discovered and put into operation in the Shamakhi-Gobustan oil-gas-bearing region, and oil and

gas have been produced from these fields for a long time. These are East Hajiveli, Umbaki, Duvanni and Dashgil fields [5,6].

Only one structure- the Shikhigaya structure- was prepared for deep exploration drilling using the seismic exploration method.

Oil and gas occurrences and flows from Meso-Cenozoic deposits are optained. They are related with natural surface outcrops, as well as with fractured carbonate, sandy-siltstone reservoirs of drilled wells in the Shamakhi-Gobustan oil-gas-bearing region [7].

II. Metodology

The collected materials about of Meso-Cenozoic deposits show that these deposits are suffer of facies changes through the section vertically and areally along the horizontal in the Shamakhi-Gobustan oil-gas-bearing region. This is provide a basis for determining the distribution zones of reservoir rocks.

Reservoir properties of numerous core samples taken from Meso-Cenozoic deposits found in the research area were studied.

The oil-gas shows related to the Paleocene reservoirs in the separate uplifts of North Gobustan, formed from Mesozoic deposits, are mainly attributed to its southern part. Here, numerous thin (0.4-1.2 m) calcareous sandstone interlayers are found in the section of the Danian stage of Paleocene series (Ilkhidag suite).

Sand layers up to 10 m thick can be found in the section of the Sumgait suite (Paleocene) in the Garajuzlu and Nabur uplifts of the northern zone [8]. They are fine-grained and dense. Oil seeps are observed related with these sandstone layers in the Tuva area. The thickness of the sandy-clayey layer sometimes reaches 25 m, which is important as an oil object. The thickness of the Sumgait suite increases from the crest part of the folds towards its limbs and periclinals. An increase in the thickness of the sandstone layers is observed in this direction. This fact is also confirmed by the section of numerous structural wells drilled here. In the southern part of the northern zone, the thickness of medium- and coarse-grained sand and sandstone layers reaches 1.5-2 m in the section of the middle Govundag stage of the Eocene series. There is a sandy-clayey layer in the section of 25-30 m thick, which oil shows are found.

The lower and middle Eocene is 150-200 m thick in Central Gobustan and consists of irregular alternation of marly clays, marls, argillite and tuffaceous sandstones. The top of the Upper Eocene is 200 m thick in Cheyildag and is mainly composed of clays, while in Arzani-Kilij it consists of crushed clays [9,10].

In the southern part of the central zone of Gobustan, in the section of the Upper Eocene, intensive oil shows were noted in thin sandy layers (Boyanata, Baygustu, Boztepe).

All areas of Shamakhi-Gobustan are represented by clayey lithofacies of Lower Maykop.

The analysis of the prospecting-exploration works conducted in the South-West Gobustan area of Shamakhi-Gobustan depression shows that the oil and gas shows mentioned along the section are mainly observed in the Upper Maykop, Chokrak and Sarmatian reservoirs. As a result of drilling, intensive oil and gas flows were recorded in East Hajivalli and Gilij areas. Oil and gas deposits from the sandy-siltstone reservoirs of Upper Maykop and Chokrak were discovered in the Umbakı field. In South Gobustan, alongside the section of the Upper Maykop, numerous layers of sand and sandstone are found and their thickness increases toward south and southwest. In the Umbakı field, the horizon III of Maykop series is better studied by drilling and has more oil-gas-bearing [11].

III. Discussion and results

Analyzes of rock samples taken in Shamakhi-Gobustan oil-gas-bearing region were conducted to study the changes in reservoir properties of reservoirs of different ages.

In the Upper Cretaceous marl, sandy limestone rock samples in the Chikilchay area located in the northern zone, the carbonate content is 73-80%, the porosity is 14-26%, and the porosity is very low (2.5-3.0%) in the 2 samples with high carbonate content. The density of rocks is 2.3-2.44 g/cm^3.

In the Upper Cretaceous argillaceous marl samples in Eastern Agburun, carbonate content is 24-27%, porosity is 6.2-9.9%, permeability is 0.07x10^{-15} m^2, in Goradil area, marl samples of the same age have carbonate content of 60.5%, porosity is 6.3%, permeability 0.001x10^{-15} m^2, carbonate content in sandy-limestone samples is 57.6%, porosity is 8.1, permeability is 0.001x10^{-15} m^2, carbonate content in calcareous siltstone samples is 35%, porosity is 5.3%, permeability is 0.001x10^{-15} m^2, in the samples of limestone siltstone taken from Qizmeydan area, carbonate content varies from 27.3 to 93.4%, porosity from 2.9 to 17.8%, permeability from 0.001 to 1.5x10^{-15} m^2.

In the structure-mapping wells drilled in the Goradil area, gas and oil shows from the Upper Cretaceous deposits were observed. The Lower Cretaceous sandy carbonate reservoirs are considered to be more promising in this area. In separate wells (4, 5, 7) in the Garayazi area, active oil, gas, and water shows were recorded from the Upper Cretaceous deposits [12]. The oil and gas prospects of the area are mainly related to the Lower Cretaceous deposits. During the testing of structural-exploration well number of 36 in the Qizmeydan area, 3.5 t/day of light oil flow was obtained from sandstone and sandy limestone deposits of Upper Cretaceous series. Oil flow also was obtained from wells number of 15, 20, 29, 34 during the drilling process [13].

In Yunusdag area clayey limestone rock samples, carbonate content varies from 53.6 to 77.6%, porosity from 2.8 to 3.2%, permeability from 0.001x10^{-15} m^2 (Fig.2). Weak gas-water shows were observed here in individual wells from Upper Cretaceous (Campanian, Maastrichtian) deposits. The main oil-gas object in the Yunusdag anticline is considered to be the Lower Cretaceous granular carbonate reservoirs.

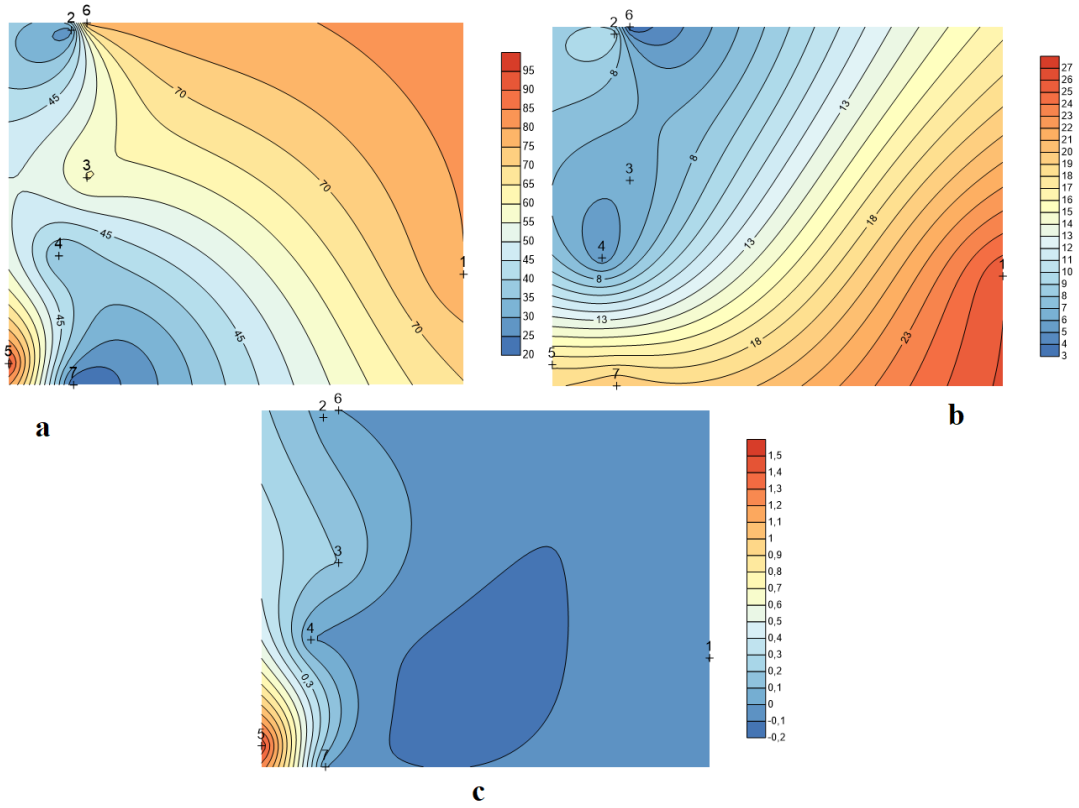

Figure 2: *Carbonate content (a), porosity (b), permeability (c) maps of Upper Cretaceous deposits in the northern zone of the Shamakhi-Gobustan depression*
Areas: 1 - Chigilchay; 2 - Shargi Agburun; 3 - Goradil; 4 - Garayazi; 5 - Gizmeydan; 6 - Yunusdag; 7 - Angikharan

In the Goradil area, located in the northern zone, the carbonate content of Eocene age silty limestone samples is 65.4%, porosity is 7.6%, permeability is 0.001x10^{-15} m^2, Calcareous siltstone

samples of Miocene are characterized by the carbonate content of 37.4%, porosity is 15.3%, permeability is 0.001x10^{-15} m^2 , carbonate content in argillite samples of Maykop is 13.5%, porosity is 13.8%, permeability is 0.001x10^{-15} m^2, porosity is 20% in Maykop age clay samples in Agburun area, permeability is 0.001x10^{-15} m^2, porosity in Paleocene age clay samples in Yunusdag area is 13-28% , Eocene age limestone, marl samples have a porosity of 14%.

Carbonate content in siltstone limestones of Maykop agedeposits in Garayazi area is 17%, porosity is 12.7%, permeability is 0.001x10^{-15} m^2, carbonate (8.5-9.0%) in samples of Maykop-age limestone, marl, siltstone, clayey limestone in Gizmeydan area it varies in a small interval (1.7-3.5%).

In the Tuva area of Northern Gobustan (Fig.3), there are numerous oil and gas shows related to Upper Cretaceous deposits, some of which are related to faults. During drilling process of structure-mapping wells number of 2 and 5, oil and gas shows were obtained from deposits of the Paleocene and Danian stages. The drilling process of exploration well number of 1, gas shows was observed at a depth of 113 (Danian)-2219 m (Santonian) [14]. During the passing of the deposits of the Campanian stage in the exploratory well number of 2, gas shows was determined. Despite this, the prospect of industrially important oil and gas deposits is considered to be granular reservoirs of the Lower Cretaceous series. Study results of rock samples taken from well number of 1 show that Paleocene sandstones are light oil-saturated. Their porosity is 15.5-22%, effective porosity is 1.0-2.5%, and permeability is 20-70x10^{-15} m^2.

Oil and gas shows are noted along the section of fractured limestone and marls of Upper Cretaceous buried under Paleogene sediments toward south-southwest in the northern tectonic zone. Based on the analysis of rock samples, it should be noted that these deposits lithologically have favorable reservoir properties.

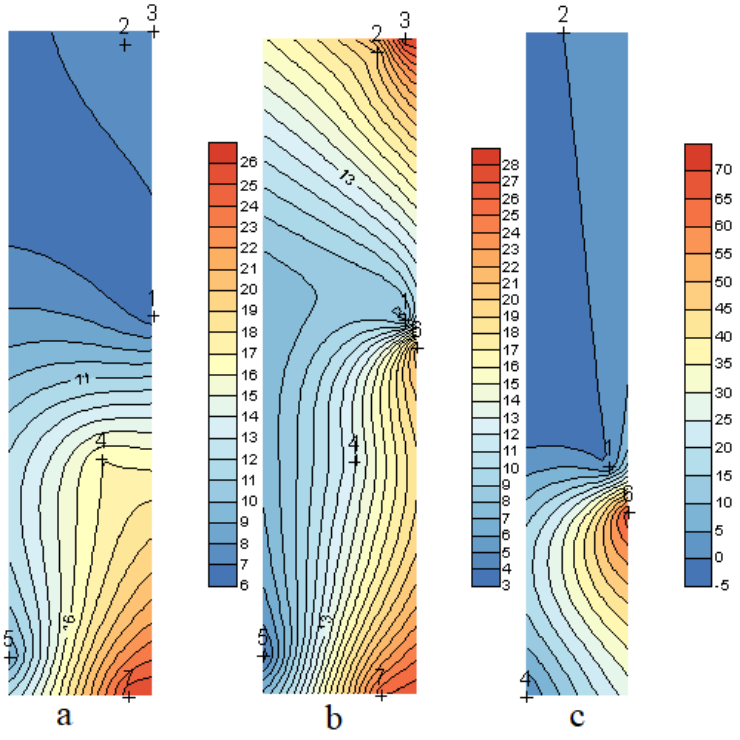

Figure 3: *Carbonate content (a), porosity (b), permeability (c) maps of Paleogene-Miocene deposits in the northern zone of the Shamakhi-Gobustan depression*
Areas: 1- Goradil ; 2-Shargi Agburun; 3- Yunusdag; 4-Garayazi; 5-Gizmeydan; 6-Tuva; 7-Angikharan

Sandy and sandstone layers of Middle Eocene series alongside the south part of the northern zone, represented by reservoir properties with porosity of 17-24%, effective porosity of 2.5-3.5% and permeability of 35-70.0x10^{-15} m^2.

The average carbonate content of the Lower Maykop deposits in the Cheyildag area is 8.0%, the total porosity is 20.5%, the effective porosity is 3.4%, and the permeability is 72.0x10^{-15} m^2. These indicators are 6.9%, 15.6% and 22.0x10^{-15} m^2 in the Umbaki area, respectively (Fig.4).

In the Maraza area located in the central zone of Gobustan, carbonate content of siltstone limestone, marl deposits of Upper Cretaceous is 23.2-65.3%, porosity is 3.9-17.6%, permeability is 0.001x10^{-15} m^2, the carbonate content of sandy limestones of Paleocene is 68-76.4 %, porosity 12.6%, permeability 0.3-0.6x10^{-15} m^2, carbonate content of clayey marls of Maykop series is 2.5-28%, porosity is 7.5-24.4%, and permeability is 0.001x10^{-15} m^2, limestone, silty limestone, and sandy limestones of Upper Miocene represented by carbonate content of 45.4-93.4%, porosity is 14.3-21.3%, permeability is 0.2-10.1x10^{-15} m^2. Here, the Upper Miocene deposits are characterized with high porosity and permeability.

The lithofacies characteristics of the Upper Eocene sediments show that these sediments in the Bayguştu area have a higher sand content. This suggests that the collector characteristic is higher in that area.

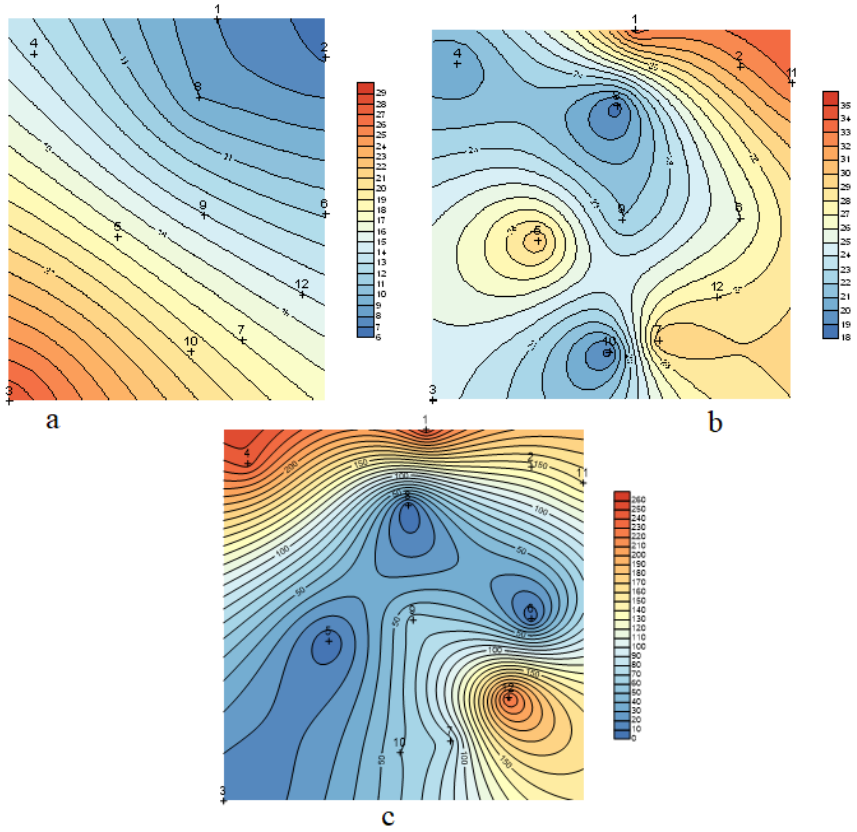

Figure 4: *Carbonate content (a), porosity (b), permeability (c) maps of Upper Maykop deposits in the central zone of the Shamakhi-Gobustan depression*

Areas: 1- Cheyildag ; 2-Umbaki; 3- Maraza; 4-Baygushtu; 5-Shaytanud; 6-Hajiveli; 7-Sundu; 8-Nardaran-Suleyman; 9-Nardaran-Akhtarma; 10-Gijakiakhtarma; 11-Arzani-Gilij; 12-Ilkhichi

The sandy layers forming the horizon are characterized by high collecting properties. The total porosity of the rocks is 20% on average, the effective porosity is 6% on average, and the permeability is 245x10-3 μm2.

The porosity of Upper Cretaceous sediments in the Angikharan area is 6-20%, the porosity of Paleocene sediments is 8-10%, the porosity of Eocene sediments is 10-26%, and the porosity of Miocene sediments varies from 6-10%. The density of the rocks of the mentioned stratigraphic units varies in the range of 2-2.6 g/cm3. In the Angikharan field, natural oil output is noted in the valleys intersecting with the southeastern pericline of the fold, and the oil-gas prospect is related to Upper Cretaceous carbonate and Lower Cretaceous terrigenous reservoirs, which increase in thickness from north to south, in the direction of regional subsidence of Mesozoic sediments.

The porosity of the rocks of Upper Maykop in Shaytanud area is 20-30%, permeability is 1.5x10^{-15} m^2, density is 2.1-2.18 g/cm^3. Here, the same name mud volcano is located. Around of Shaytabud mud volcano there are numerous mud gryphons and mud salsas. Gas, water, and water with an oil films are released from them. The Upper Maykop series represents with alternation of sand, sandstones and clays that along the section gas shows are observed. Thick sandy-clay bands saturated with oil were uncovered in the Maykop section. Slight oil and gas shows were noted along sandy-clay bands of Upper Maykop uncovered at different depths by structure-mapping wells [7,15]. The prospect in the lowered southern limb of the Shaytanud area is related to the Maykop suite. The Upper Cretaceous carbonate reservoirs are considered promising also.

In Hajiveli area, porosity of deposits is 21-26%, permeability is 1.5x10^{-15} m^2, density is 1.92-2.08 g/cm^3. Here, oil and gas shows were observed in the structure-mapping wells drilled into Upper Matkop and Chokrak horizons (middle Miocene) [16]. Oil and gas prospects are related with sandy deposits of Oligocene, Lower-Middle Miocene and carbonate reservoirs of Upper Cretaceous (Fig.5).

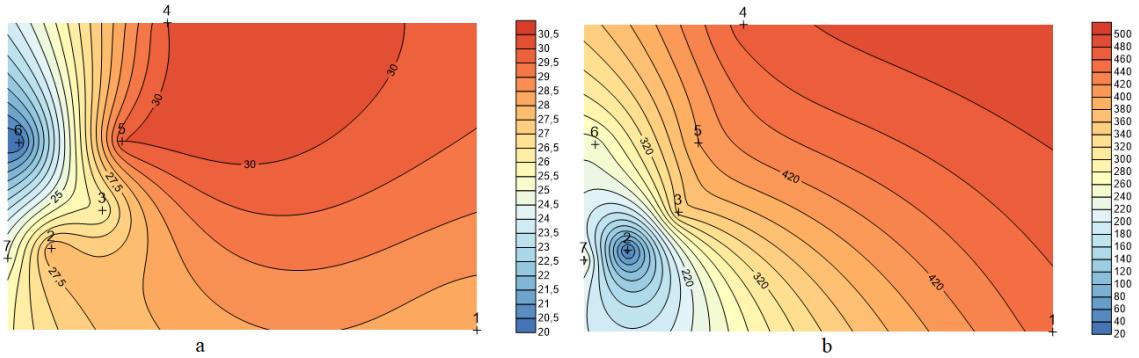

Figure 5: *Porosity (a), permeability (b) maps of Chokrak (Middle Miocene) deposits in the central zone of the Shamakhi-Gobustan depression*
Areas: 1-Cheyildag; 2-Sundu; 3-Ilkhichi; 4-Arzani-Gilij; 5-Shargi Hajiveli; 6-Nardaranakhtarma; 7-Gijaki.

The porosity is 18.0-30%, permeability varies in the range of 25-75x 10^{-15} m^2 in the Sundu area. In the structure-mapping wells in the Western Sundu area, oil flow related to the Upper Maykop, Chokrak, Karagan deposits was observed. In particular, a gas gush was obtained in well number of 10 from the sandy bands located in the upper part of the Chokrak horizon [7]. The oil and gas prospects of the area are related to the Maykop, Chokrak horizon, and the main object for the search of industrially important oil and gas deposits is the carbonate reservoirs of the Upper Cretaceous.

The argillites of Maykop series are represented by a carbonate content of 9%, porosity of 18.5%, permeability of 0.001x10^{-15} m^2 in the Nardaran-Süleyman area. In the process of drilling structure-mapping wells, intense oil and gas shows were noted from sandy reservoirs of the Upper Maykop, Chokrak horizon [9]. İn addition, Upper Cretaceous carbonate reservoirs are also considered the main object for the search of industrially important oil deposits.

Porosity of reservoirs in the Nardaran-Akhtarma area is 10.0-22%, permeability is 18-65x10^{-15}m^2, in the Gijakiakhtarma area porosity is 11.0-18.6%, permeability is 15-60x10^{-15} m^2, in Cheyildag porosity and permeability is 13.5-33.5% and 35-250x10^{-15} m^2, in Umbaki- is 11.5-31.8% and 10-145x10^{-15} m2, in Arzani-Gilij- is 12-33.0% and 30-150x10^{-15} m2, in Ilkhichi- is 9.7-28.0% and 25-235 x10^{-15} m^2, respectively.

Oil-gas shows in the Nardaranakhtarma area are related to the Nardaranakhtarma mud volcano, numerous mud gryphons, salsas, as well as the outcrops of sandy layers of the Upper Maykop at the crest and Chokrak horizon deposits along the south limb of the fold. Oil-gas shows

related to the deposits of the Maykop suite and Chokrak horizon were also observed during the drilling of exploration and structure-mapping wells [9].

The Gijakiakhtarma area is differ by the presence of various oil and gas shows. İn addition, information about oil and gas content of Maykop, Chokrak deposits was obtained through structure-mapping wells. Also, during the opening of the deposits of the Karagan (Middle Miocene) horizon, Pontian (Upper Miocene) and Aghjagil (Upper Pliocene) stages near the tectonic fault, slight oil and gas shows were noted [5]. The presence of 1.5-2 m thick sandy layers in the section of the Upper Maykop and Chokrak horizons allows to consider it as the main object for the search of oil and gas induvidual deposits. The main object of exploration is the carbonate reservoirs of Upper Cretaceous.

Chokrak horizon is represented by sandy-clay facies in South Gobustan. Sandy layers reach their maximum in Cheyildag, Umbaki, and East Hajivalli areas. An industrially important oil deposit has been uncovered in the horizon I of the Çokrak stage of Umbaki field. Along the section of Chokrak with high porosity reservoir rocks oil and gas shows were recorded in exploration wells number of 9, 12, 29, 32 in Cheyildagh area. The production of the wells varies between 2.5 t/day. The layers are traced to the Zahirdag area and an oil gush was obtained from the section of Chokrak at a depth of 529 m in the exploration well number of 9. Oil-bearing layers of Chokrak stage belong to the southern limb of the Cheyildag uplift in the Cheyildara area. 6 oil-filled sandy layers are noted along the section [8]. The porosity of the rocks here is 26-28%, permeability is 100-450 $x10^{-15}$ m^2.

There is a sandy sandstone layer 45-55 m thick, 100 m below the top of the Chokrak horizon in the Sundu area. A gas gush was noted in well number of 10 from this layer [6]. The porosity of the rocks is 24-28%, and the permeability is 24-27 $x10^{-15}$ m^2.

Natural oil-gas shows in Ilkhichi and Arzani-Gilij areas are related to mud gryphons, and mud salsas of mud volcanoes. İnrush of gas and oil were observed from the sandy layers of Chokrak. Also, intense oil-gas shows were observed during the passing of individual sandy layers of Maykop, Miocene, Productive series (Lower Pliocene). The gush of gas obtained from Sarmatian, Konk and Karagan sandy bands has a special interest [14]. Apart from these deposits, carbonate reservoirs of Upper Cretaceous are also considered promising. The porosity of the rocks of the Chokrak horizon is 22-26%-24-30%, and the permeability is 30-350-50-470 $x10^{-15}$ m^2.

Oil-gas-bearing of the sand-sandstone layers of the Chokrak horizon in Eastern Hajivalli area has been confirmed. 5-7 t/day of heavy oil flow was obtained during the testing of sandy layers of the Chokrak horizon in 2 wells [9]. The porosity of the rocks is 25-30%, and the permeability is 100-400 $x10^{-15}$ m^2.

Fine-grained sands of Chokrak in the Nardaranakhtarma area are oil-gas-bearing. 2 oil-bearing layers are identified in the Chokrak stage along the northern limb. Layer I is located 115 m below the top of the horizon and is represented by fine- and medium-grained sands. Layer II is located 166 m below the top of the horizon. This is the main oil-bearing layer in the northeast limb and it is clearly traced. The porosity of the rocks is 13.8-20%, permeability is 25-250 $x10^{-15}$ m^2.

Oil leaks from the dolomites of the Çokrak horizon were noted in Gicaki area [10]. The porosity of the rocks is 21-25%, the permeability is 28-250 $x10^{-15}$ m^2.

Rock samples analyzes prevail taken from the Productive series (PS) in South Gobustan.

The porosity of the sandstones of the PS in Solakhay area is 11.4-26.5%, permeability is 90-664 $x10^{-15}$ m^2. In the southwestern limb of the structure, there are several small faults are found, which are associated with a large number of mud gryphons, mud salsas, which inrush of oil, gas, and water [7, 17, 18] (Fig.6). Intensive oil and gas shows were noted during the testing of almost all exploratory wells during the drilling process. There was an oil gush with production of 5-7 t/day in separate wells. 4 sandy horizons (I, II, III, IV) with a thickness of 900 m, three of which are oil-bearing, have been determined in the unopened part of the PS [9].

Carbonate content of sandy-clayey-limy deposits of PS in Dashgil area is 3.5-24.7%, porosity is 6-35.8%, permeability is 26-221 $x10^{-15}$ m^2.

There are numerous natural oil and gas shows in the Dashgil area relation to the activity mud gryphons of the Dashgil mud volcano. Oil and gas shows have also been recorded in numerous structure-mapping and exploratory wells related to the sandy-siltstone horizons of the PS. During the testing of the horizon VII of the PS in the southern limb of the fold, an industrial oil flow with an initial production of 75-100 t/day was obtained from well number of 15 [10].

The porosity of sandy deposits of PS in the Anart area is 20.2-30.6%, permeability is 32-326 $x10^{-15}$ m^2.

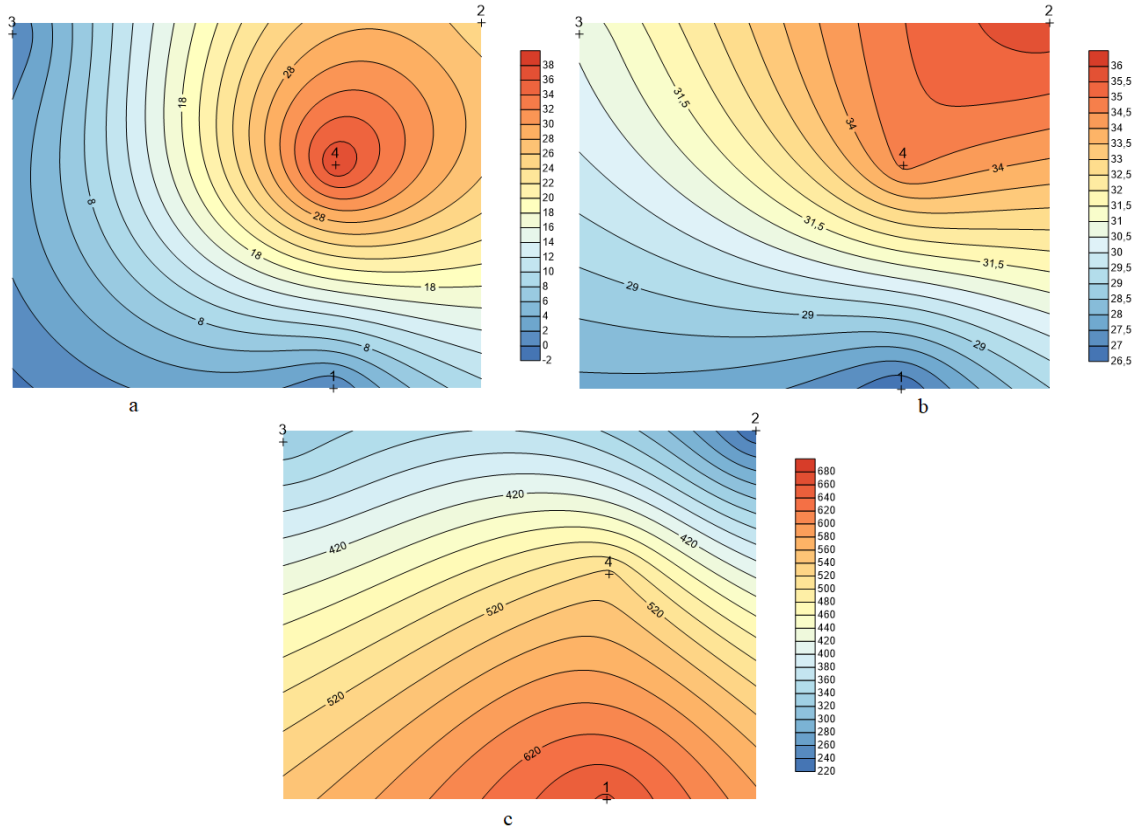

Figure 6: *Carbonate content (a), porosity (b), permeability (c) maps of PS (Lower Pliocene) deposits in the South Gobustan*
Areas: 1-Solakhay; 2-Dashgil; 3-Anart; 4-Duvvani.

İn addition, along the section of the PS 9 single sandy horizons were separated, from which 50,000-75,000 m^3/day of industrial gas flow was obtained. During the testing of one of the sandy horizons, a gas gush was obtained from well number of 6 with a flow of 110,000 m^3/day [6]. This is suggests that the Anart field is promising as a gas facility. By outlining the open gas field in the intersection of the PS, conducting exploration work in the unopened part of the PS, it is possible to open an analogue of the V horizon of the PS in the Garadag gas and oil field.

Carbonate of Miocene clayey-siltstones in Duvanni field is 2.7-44.1%, permeability is 11.3-36$x10^{-15}m^2$, carbonation of sandy-clayey-siltstone sediments of PS is 5.2-38%, porosity is 7.0-34.64 %, permeability varies in the range of 11.7-526 $x10^{-15}$ m^2.

Industrially significant gas content of 2 sandy horizons was determined with the first exploratory well in the Duvanni field. The industrially important induvidual gas deposit related to the reservoirs of the horizon V covers the small northwestern part of the structure, and the large gas-condensate deposit related to the sandy-siltstone reservoirs of the horizon VII covers the southeastern half of the fold [6].

The prospecting for new oil and gas deposits in the Duvanni field may be related to the sandy-clayey sediments of the Maykop (Oligocene-Lower Miocene) suite, which was determined based on the analysis of eruption products of mud volcanoes.

As the Shamakhi-Gobustan depression is located in the area of the southwest limb of the Greater Caucasus, which is relatively close to the crest, the compressive stresses generated in this mountain folding system are intensely reflected here and have led to the development of thrusts, napps and mud volcanism in its structure. Due to the lithofacies composition of the rocks, this situation also affects the formation of derivative reservoir properties in them [11]. The northern tectonic zone of the Shamakhi-Gobustan depression is characterized by a wide spread of Cretaceous deposits (thickness 2000-2500 m), and mainly competent terrigenous-carbonate deposits were formed here. These rocks have a highly derived reservoir property.

Paleogene-Miocene-Pliocene deposits are widespread in the Central and South-West, South-East tectonic zones and have been relatively studied by drilling. It is noted that the number and thickness of the sandy-siltstone layers involved in their intersection increases from north to south-southeast.

It should be noted that the increase in the thickness of the deposits of Maykop, Chokrak and PS in the southern direction and the presence of sufficiently thick sandy reservoir horizons in their composition also played a role in the separation of South Gobustan as a highly prospective zone.

The prospect of oil-gas-bearing in Shamakhi-Gobustan region is related to Meso-Cenozoic deposits. Industrially important oil accumulations were identified in the sandy reservoirs of the PS, Upper Maykop and Chokrak horizons, which were uncovered during drilling in separate areas in the southeastern and southwestern tectonic zones of the area.

The oil and gas shows are noted in the Upper Cretaceous fractured limestone and marls, which are widespread in the Northern zone. The density of these rocks varies in the range of 1.94-2.55 g/cm^3 in the northern zone. The Upper Cretaceous sediments are buried under Paleogene sediments in the south-southwest direction [1].

Oil-filled layers and dolomites in the form of breccias lying in separate intervals at the section of the Middle and Upper Miocene in central Gobustan are of special interest. It should be noted that terrigenous and carbonate reservoirs are natural reservoirs for collecting oil and gas deposits in the Meso-Cenozoic deposits.

The sandy-siltstone reservoirs of Maykop suite and Chokrak horizon are oil-gas-bearing in Hajivalli, Umbaki, Maraza, Donguzlug areas. A short-duration oil flow was obtained in the upper Cretaceous fractured-carbonate reservoirs in Gizmeydan and Hilmilli areas.

IV. Conclusion

1. Due to incease the number and thickness of the sandy interlayers along the section of the Upper Cretaceous from the northern zone to the south, that is, in the direction of the regional dip, so they can be considered promising in the Central Gobustan zone in the Shamakhi-Gobustan depression.

2. In the northeastern part of South-Eastern Gobustan, the sediments of the Maykop suite and the Chokrak horizon have a high reservoir properties, and they are likely to contain industrially important oil and gas.

3. Based on the analysis of the reservoir properties of the rocks, it was determined that there are oil-gas sandy-siltstone reservoirs with high reservoir properties in the upper half-layer of the Maykop suite, the Chokrak horizon and the Sarmatian stage deposits in South-Western Gobustan.

4. The sandy horizons of the Upper Maykop series are considered most promising In the authochthones of the overthust that complicate the large folds in South-West Gobustan.

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