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SECTION 12. Geology. Anthropology. Archaeology.

DISTRIBUTION REGULARITIES OF OIL SHALE IN AZERBAIJAN

Abstract: *The paper is devoted to a detailed study of oil shale that is considered a new alternative energy resource for Azerbaijan. More than 60 surface manifestations of oil shale, related to sediments between Cretaceous period and Miocene epoch in the territories (Shamakhi-Gobustan, Absheron, Pre-Caspian-Guba, Ismayilli and etc.) of the Republic are investigated. The analysis of oil shale objects in Azerbaijan shows that greater manifestations are mainly developed in Gobustan and Absheron regions, during the Middle Eocene - Upper Miocene. The main practical features of Azerbaijan oil shale relates with its distribution regularities along the areas. Connected with different geological age, oil shale manifestations (Kichik Siyaki, Boyuk Siyaki, Islamdag, Baygushgaya, Uchtepe etc.) have found development within the same area (mainly in Gobustan) and closely spaced from each other. Such regularities create favorable conditions in joint development of these manifestations for future exploitation. To be away from the tracts of forest and the housing unit, is extra superiority of Azerbaijan oil shale from an economic and environmental point of view.*

Key words: *Azerbaijan, distribution regularity, geochemistry, organic matter, oil shale, shale gas.*

Language: *English*

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Introduction and Background

The rich hydrocarbon potential of Azerbaijan has a great influence in the status of country. Integrated studies are expanded for further enrichment of hydrocarbons reserves of Republic. To explore new oil and gas fields in deeper sediments of onshore and offshore territories becomes very relevant. However, the energy potential of the country should not depend only on oil and gas resources, and together with them the Republic is rich in non-traditional, alternative sources of energy, such as natural bitumen, oil shale and gas hydrates [16, p. 31].

Currently, a number of countries are widely used of oil shale to produce shale gas (US, Canada, China and etc.), cement (Estonia China, Germany), agricultural fertilizers (Estonia, Switzerland), burn at power plants (Estonia, China, Germany, etc.), obtain medical (France, Russia, China) [13, p. 45] and chemical products (China, Estonia, Russia) and etc.

Researches on oil shale of Azerbaijan have been carried out at the beginning of the last century [3, p. 5-8; 7, p. 40-42; 8, 28 p.; 9, 48 p.; 10, 52 p.; 11, 37 p.; 12, p. 189-208]. More detailed studies have been carrying out since 2000 by scientists of Institute of Geology and Geophysics of the Azerbaijan National Academy of Sciences. Employees of Department "Mud Volcanism" of the Institute have been studying geological, geochemical properties and probably reserves of oil shale [2, p. 32-35; 6, p. 7-11].

Distribution regularities of oil shale in Azerbaijan

The most widespread areas of oil shale in the Republic are observed in Shamakhi-Gobustan, Absheron, Pre-Caspian-Guba and Vandam-Lahij and etc. regions (figure - 1). There are more than 60 surface manifestations of oil shale in these regions, distributed in a wide stratigraphic range (from the Cretaceous to Miocene).

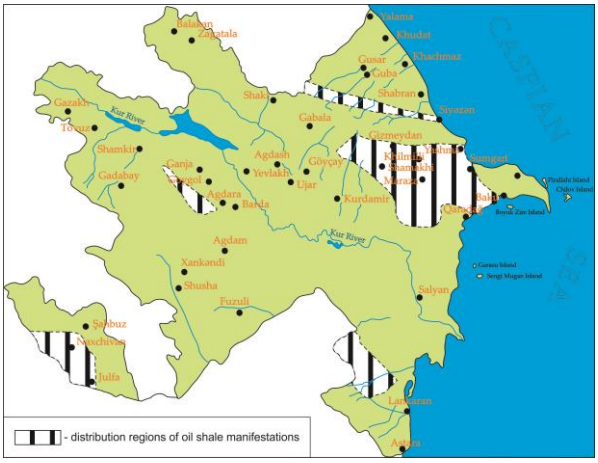


Figure 1 - Schematic map of oil shale distribution regions in Azerbaijan.

Shamakhi-Gobustan region

The region is located in the south-eastern part of the Greater Caucasus and has a very complex geological and tectonic structure. There are about 120 mud volcanoes, more than 30 manifestations of oil shale, as well as some oil and gas fields in the region. The known oil shale manifestations are developed mainly in the Central Gobustan and Shamakhi tectonic zone.

The geological structure of the region consists of Mesozoic-Cenozoic sediments. In generally, related to Goradil-Masazir Fault Zone and Gujur-Gyzyldash Thrust, three blocks: north allochthonous, central para-autochthonous and southern autochthonous are separated in Gobustan (figure - 2).

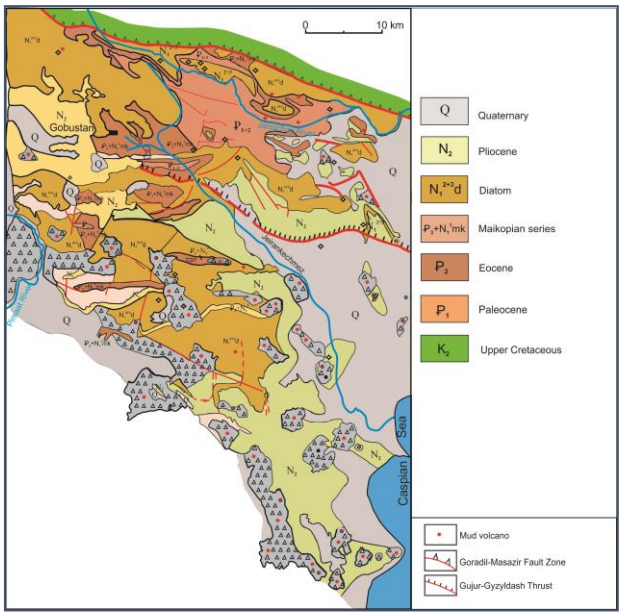


Figure 2 - Geological map of Gobustan [4, p. 130].

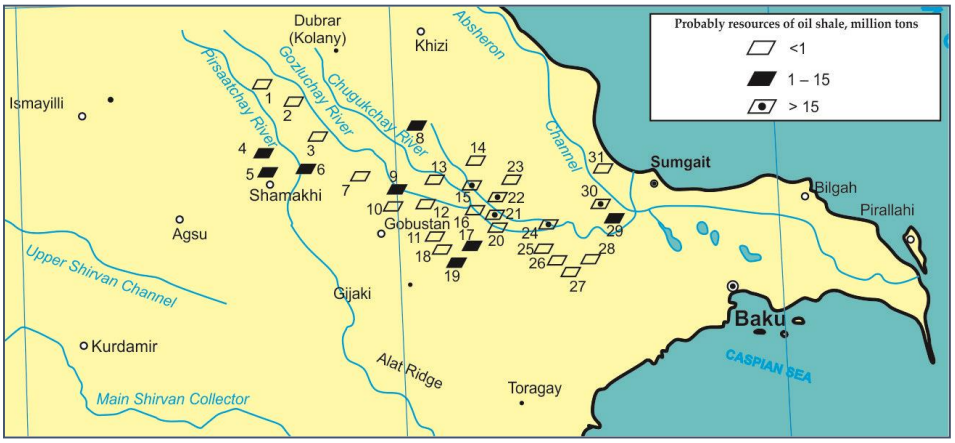
Oil shale of the Northern Gobustan belonging to the Cretaceous deposits, have no commercial value [2, p. 33].

Many of oil shale manifestations are observed in areas of the Central Gobustan associated with Paleogene-Miocene sediments. The Central Gobustan covers areas, relating to para-autochthonous tectonic block (Bayanata), which indicates favorable paleogeographic and paleotectonic conditions of the zone for the formation of oil shale. Paleogene-Miocene sediments are involved in the geological structure of Bayanata block, have thickness of 2.5-4.5 km. In contrast to these structural and facies complexes, deposits of the same age, observed in north of Geradil-Masazir fault zone (north allochthonous) are located under the

Cretaceous sediments (consisting of flyshoids). It is assumed that the sediments of Paleogene-Miocene age in Bayanata block have been compressed between the carbonate complexes (Upper Cretaceous age) of allochthonous and the sediments (Cenozoic age) of autochthonous, increasing up to 11 km. In such a complex tectonic environment, there were favorable facies and paleogeographic (accumulation of organic matters in silt sediments, existence of shallow, broad bays and continental lagoons) conditions for the accumulation of organic compounds, which forming oil shale. The sediments accumulated with short geochronological breaks and at subsequent stages, a result of dynamic metamorphism these exposed to the process of oil shale formation.

According to the spatio-temporal distribution, the development of oil shale in the Central Gobustan are associated with complex tectonic structure of the region and accumulation of organic compounds with breaks, started from the Middle Eocene, continued in the Maikopian and Konk, ended in the Meotian during the process of lithogenesis.

In general, the number of oil shale manifestations in Gobustan and their probably resources are reduced in the direction from the center to the south-east [1, p. 26] (figure - 3).



Oil shale manifestations: 1 - Gizmeydan; 2 - Talishnuru; 3 - Khilmilli; 4 - Angakharan; 5 - Shamakhi; 6 - Arabshalbashi; 7 - Jeirli; 8 - Agdara; 9 - Garaja; 10 - Ahudag; 11 - Baygushlu; 12 - Shaiblar; 13 - Tuva; 14 - Shahandag; 15 - Kichik Siyaki; 16 - Garayokhush; 17 - Garigishlag; 18 - Alagishlag; 19 - Baygushgaya; 20 - Jangichay; 21 - Jangidag; 22 - Boyuk Siyaki; 23 - Gibladag; 24 - Kechallar; 25 - Sungur; 26 - Bayanata; 27 - Girdag; 28 - Saridag; 29 - Pirekeshkyul; 30 - Islamdag; 31 - Agburun.

Figure 3 - Map of probable resources of oil shale in Shamakhi-Gobustan region (scale 1:1,000,000).

Absheron region

The geological structure of Absheron consists of clastic-carbonate rocks of the Upper Cretaceous and Cenozoic. There are more than 15 surface manifestations of oil shale in the region, relate mainly to the sediments of the Upper Maikopian, Konk and Meotian. The exceptions are related to two manifestations (Goytapa and Uchtepe), the age of Eocene, are located on the border with Shamakhi-Gobustan region.

Conditional border between clay and sandy-clay facies of the Upper Maikopian, traced in the direction of the north wing of Shorbulag folds over of mountains Garaheybat and Bozdag-Qobu, and further to the southeast to Puta Cape. Clay facies of the Upper Maikopian developed in the northern, north-western parts of the Absheron Peninsula and linked to the nature of folding - diapirism occurrence, composing the crest of folds. The most representative section is Riki horizon, situated in the northern slope of Mountain Uchtepe-Shorchala, with thickness of 112 m, composed layers of dark, chocolate-brown clay and black oil shale. The last traced in sections of Mountains Goytepe, Orjandag and Fatmai.

Thus, a broad band of oil shale in the section of Riki horizon coincides with the deepest part of the Upper Maikopian Basin and extends from Willage Gorjevan through Shamakhi region to River Sumgaitchay.

Oil shale of Konk horizon developed within the Shorbulag and Garaeybat areas in the Western Absheron, has a thickness of 30 m. Whitish foliated oil shale is traced in Uchtepe-Ilkhidag syncline and 2 km noth-west of station Guzdek along the south-eastern end of Geytepe folds. Here, 120 m thickness of Konk-Karagan sediments are observed as a pack of gray, brown-gray foliated oil shale, with a thickness of 18.7 m. Within the southern pericline of Kechaldag- Zigilpiri fold, has been found Karagan-Konk sediments with frequent interlayers of oil

shale, traces for several kilometers: in a section, near the Mountain Zigilpiri with a thickness of 26 m, allocated 7 layers of gray, dark gray oil shale. In addition, they are also recorded to south of the village Masazir and north of the mud volcano Kechaldag, in the western part of the Lake Shirinnour in a distance of 1.5 km. Further to east from station Binagadi, oil shale have been found in Karagan-Konk sediments, have a tickness of 125-130 m [5, p. 69].

In the north-western and northern parts of Absheron Peninsula, oil shale is observed in sections of the north-eastern wing of Fatmai, Orjandag and Saray folds. Total thickness of Konk sediments in the area is 20-25 m. In Absheron Peninsula, oil shale is traced in section of Meotian, spreads throughout the area and characterizes by different thicknesses.

In the southern part of West Absheron, oil shale is observed in Shorbulaga area, Kosmalidag synclines and Uchtepe, as well as and in a considerable part of the hill Damlamaja down to the town Garaeybat. The others distributions of oil shale are traced in the areas of Ateshgah, Khirdalan, Shabandag, Binagadi and to the north of the mud volcano Keyreki, near Kerpyukshor syncline [15, p. 21] with 1.5 km lenghth and 4.5 m thickness to the west of station Masazir and district Guzdek. In the northern part of Absheron, oil shale found along the right bank of Sumgaitchay River, in the northern Geytepe Mountain, western and eastern periclines of Jorat folds, north-east wing of Orjandag (thickness of 22 m, length of 650 m), Saray (thickness of 6 m, length more than 1 km) and Fatmai folds. The thickness of Meotian in these areas ranges from 72 to 130 m.

Pre-Caspian-Guba region

Related to Upper Cretaceous deposits, oil shale are mostly located in the north-east wing of Zarat syncline. The most studied section is in Atachay River, near the village of Bakhishli in Khizi region. The section consists of dark gray bituminous marl, black oil shale and the total thickness is 27 m. The bituminous oil shale also has been found in the section of the Lower Cretaceous (Albian), in the south-eastern pericline of Kemchi fold with the thickness of 3.5 m in Altiagaj area.

The Eocene sediments are presented in two facies in the area: bituminous marl in the north-west (from Samur River to the city of Shabran) and clay, clay shale in the south-east. The thickness of Middle Eocene in this layer is not more than 40-50 m. Here, there are basically no significant oil shale manifestations with much practical value. Also, minor interlayers of oil shale encountered in some sections of the wells (Siyazan, Saadan and Shuraabad) [3, p. 6].

The layers of Maikopian series (Oligocene-Upper Miocene) oil shale found in the north-west of Pre-Caspian-Guba region do not attract the attention of the economic prospect.

Oil shale of Konk sediments observes in the Chandagar coast with thickness of 8 to 15 m, but Meotian sediments only in the southeast of Shuraabad district. In the Yashma area, two layers of oil shale are separated in the section of Meotian.

Guba oil shale deposit

Guba oil shale deposit is located 25 km south of Guba city. Oil shale of deposit relates to Upper Sarmatian, ranges from 27 to 255 m and alternates with layers of clay shale, which hardly differ from oil shale. The greatest practical interest is assosiated with the segment of the Upper Sarmatian layer, length of 29 km, elongated in the NW-SE direction from Gudiyalchay River to Velvelichay River (figure - 4), although the individual manifestations of oil shale are found to Gilgilchay River. To the north-west of Gudiyalchay River, oil shale appears like an individual spots in the watershed Gusarchay-Tahirjalchay and village Aniq [6, p. 9]. In this direction, the overall thickness of the upper Sarmatian increases up to 1350 m and transgressive bedding of oil shale also traces in the Middle and Lower Sarmatian. Sheet black oil shale in the section has a monoclinal bedding.

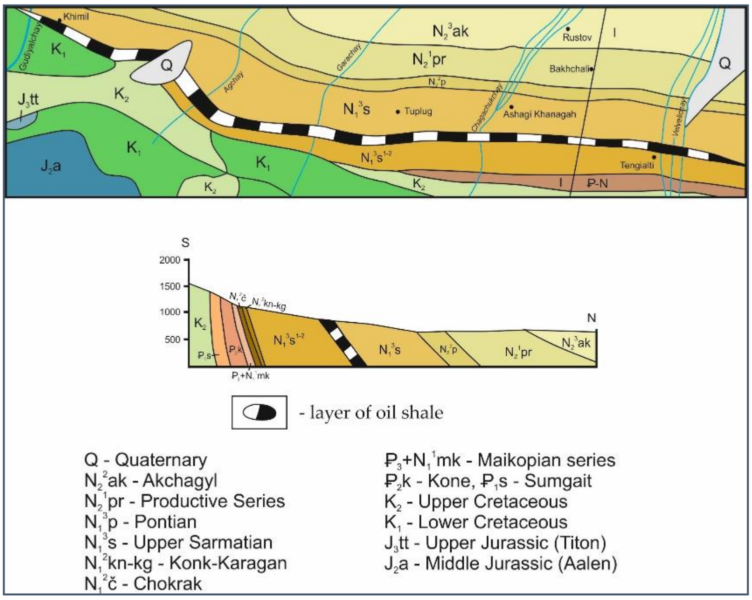


Figure 4 - Schematic geological map and profile of Guba oil shale deposit.

Larger manifestations of oil shale have been studied in the area between rivers Velvelichay and Garachay. There are three areas that contain oil shale with the most favorable properties for practical use. The first area, a length of 4.7 km, includes 11 layers of oil shale. The second area, situated between rivers Kamalchay and Chagachukchay, a length of 3 km, includes 14 layers. The third area, 1.5 km, located on the right bank of Garachay River contains 16 layers of oil shale (figure - 5).

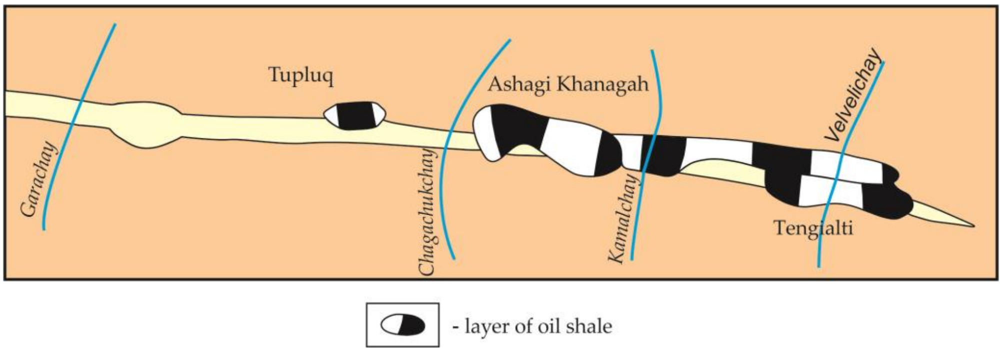


Figure 5 - Schematic map of oil shale containing areas, located between the rivers and Velvelichay and Garachay.

Diyally oil shale deposit

The deposit is located 7 km east of Ismailly city, 1.5 km the northeast of Diyally village, in strong cross wooded area, at an altitude of 800 m. Tectonically point view, the area relates to the complicated zone of Vandam Lahij where at the Upper Sarmatian time there were favorable geological and geochemical conditions for the formation of oil shale. The main structural element is tilted to the south anticlinal fold of the northwest with a torn stretch to fault the southern wing, with dips 50-55°. The core of the folds in the west is composed of Upper Cretaceous rocks, in the south-east of the Maikopian and Upper Sarmatian sediments. North of these folds at a distance of 1.5 km there are two troughs (moulds), relates to Sarmatian sediments, and which belonging to Diyally oil shale deposit. The thickness of oil shale layer varries 300-370 m, in the north is hidden under limestone thrust of Kemchi suite. At the base of the section of the Upper Sarmatian, lies pack of basal conglomerates, with a thickness of up to 70 m, under which a pack of layered clays with interbedded sandstone and oil shale . The last one confined to the upper half of the section, black and light brown (weathered) colors, 1.5 km long and contains 12 layers. [14, p. 148] (figure - 6).

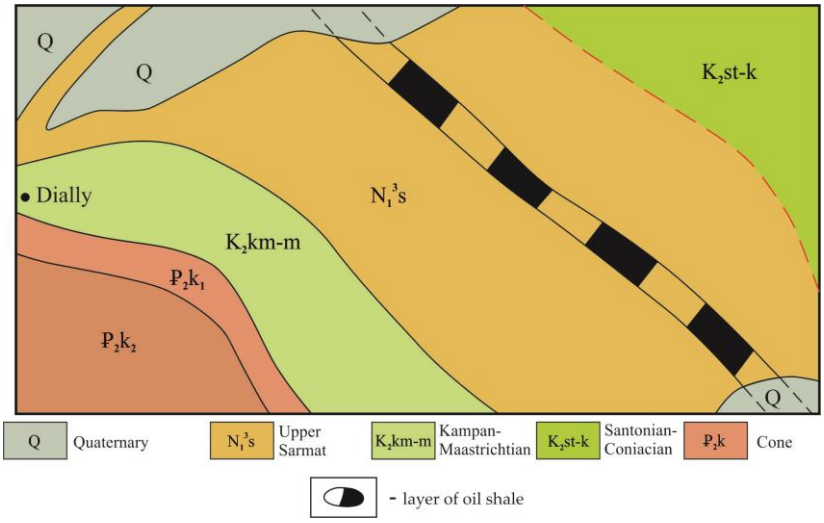


Figure 6 - Schematic geological map of Diyally oil shale deposit.

Conclusion

The analysis of oil shale objects in Azerbaijan shows that greater manifestations are developed in Gobustan and Absheron, during the Middle Eocene (Kone) and the Upper Miocene (Meotian). But Diyally oil shale deposits belong to Sarmatian age. Regarding the conditions of formation of oil shale (within the shale facies) in these areas, it should be noted that a relatively significant manifestation (sustained by length and thickness) observed in large synclines or trough: in the northern areas of Gobustan they trace in the cores of synclines (Charkishlak, Ambizlar, Shahandag, Agburun and etc.), in the southern areas, in the wings of synclinal folds (Boyuk Siyaki, Kichik Siyaki, Mayash, Jangidag, Islamdag and etc.) and in the front wings of anticlines (Buransiz-Bayanata, Jangichay and etc.).

The main practical features of Azerbaijan oil shale relates with its distribution regularities along the areas. Connected with different geological age, oil shale manifestations (Kichik Siyaki, Boyuk Siyaki, Islamdag, Baygushkaya, Uchtepe etc.) have found development within the same area (mainly in Gobustan) and closely spaced from each other. Such a regularities creates favourable conditions on joint development of these manifestation for their future exploitation. To be away from the tracts of forest and the housing unit, is extra superiority of Azerbaijan oil shale from an economic and environmental point of view.

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