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GENESIS AND ORGANIC GEOCHEMICAL CHARACTERISTICS OF OIL SHALE IN EASTERN AZERBAIJAN

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A b s t r a c t
The paper presents a study on genesis and organic geochemical characteristics of oil shales, occurred in different tectonic zones of Eastern Azerbaijan. Lithostratigraphic properties of oil shale containing sediments, evolutionary dynamics and structural types of organic matter were studied. In terms of paleogeography, it was defined that the formation of oil shales in examined regions, are associated with an almost identical sedimentation conditions (in shallow freshwater and silty pools - lagoons). The organic matter of the oil shales is mainly consist of phytoplankton (algae) and zooplanktons (fish larvae etc.). Connected with orogenic phases, the formation of oil shale, coal and oil in southeastern slope of the Greater Caucasus links their similar genetic properties. Thermal analysis of oil shale revealed that when organic matter loses the most part of its weight at a higher temperature (≥400 °C) corresponds to aliphatic, but at lower temperatures (≥200 °C) aromatic structures. Pyrolysis of oil shale samples showed that in the initial stage (500-550 °C), excluding the amount of gas, bitumen and pyrolytic water were increased. Increasing the temperature up to 800-850 °C leads to the conversion of higher molecular hydrocarbons into lower, and formation of gases and coke residues. The gradual increase in temperature ends with carbonization of kerogen. An abrupt change in the yielding of bitumen is mainly observed at a temperature of 400 °C. Thermal analysis and pyrolysis of oil shale samples, taken from different studied regions allow making conclusion that some of their kerogens is fully matured.

Keywords:
Oil shale;
Genesis;
Organic matter;
Kerogen;
Tthermal analysis;
Pyrolysis.

1. Introduction and Background

Oil shales in Eastern Azerbaijan are insignificantly related to Cretaceous but the major known outcrops are found in the Paleogene-Miocene deposits. The total number of outcrops is more than 60 in the republic. The most often oil shales are recorded in Shamakhi-Gobustan region, where more than 50% of outcrops are located. In addition, the outcrops have been also found in Absheron, Ismayilli and Guba-regions [1, 2] (fig.1).

Initial studies of oil shales in Azerbaijan were carried out in the last century by Azerbaijani and Russian scientists. Until end of the XX century these sediments were investigated at various aspects in studies of several researchers. The studies were devoted of the short geological and geochemical descriptions of the oil shales cropping out on the surface [3-10].

Since 2000, the studies on the oil shale were continued at the Institute of Geology and Geophysics. Specialists of Department of «Mud volcanism» have been conducting researches on geology, geochemistry, probable resources and industrial application of oil shales on the basis of the researches, that have been carried out in other countries [11-26].

In this study, stratigraphy and genesis of oil shales in Azerbaijan were investigated. In addition, a big part of the paper is devoted to the types and changes of organic matter in the oil shales during different stages of lithogenesis.

2. Distributional areas of oil shale in Azerbaijan

Shamakhi-Gobustan region occupies a vast area of the southeastern margin of the Greater Caucasus and is characterized by complex tectonic structure. The geological structure of the region is mainly consisting of the Mesozoic and Cenozoic sediments. There are more than 30 oil shale outcrops, and oil -

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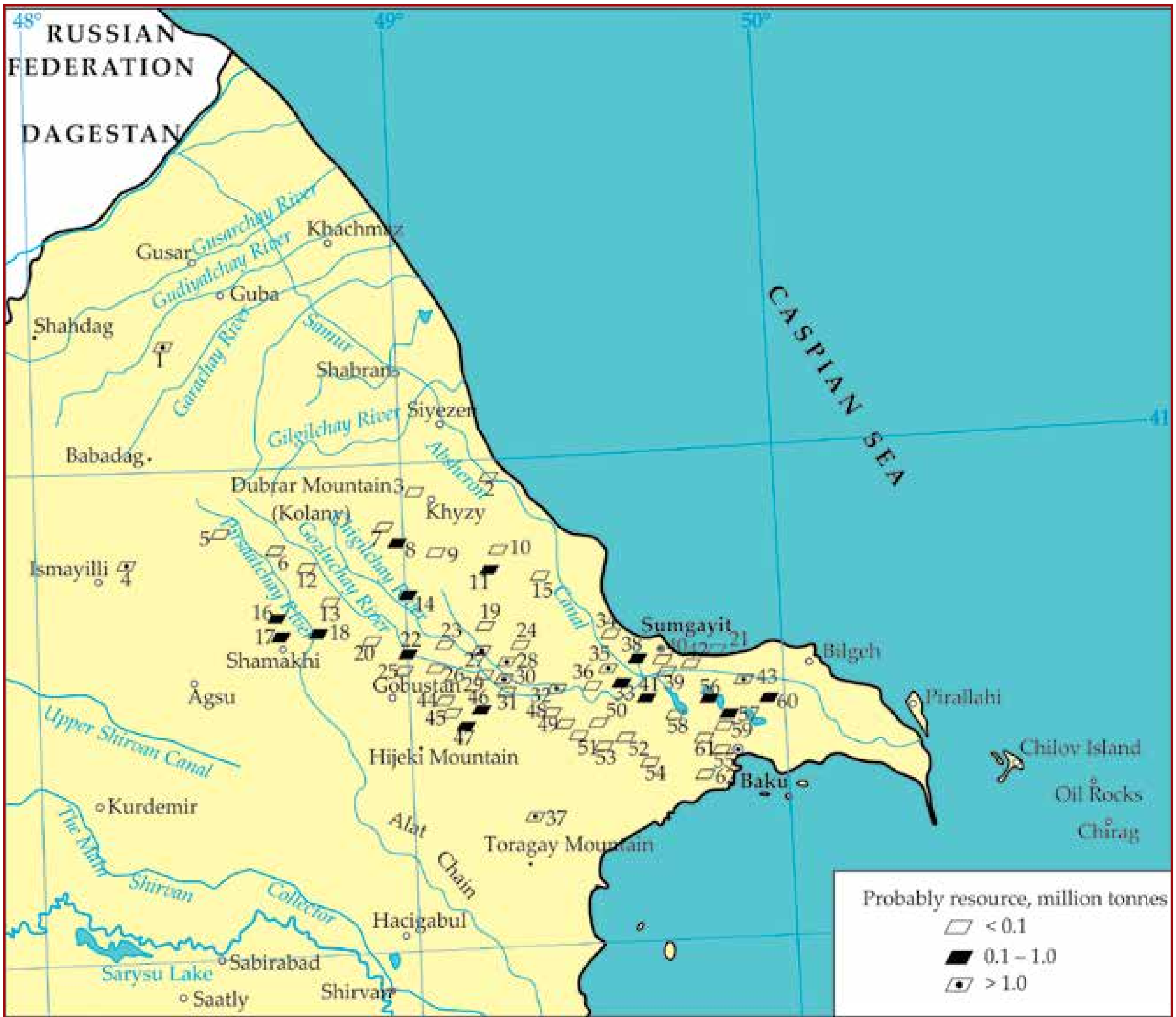


Fig.1. Location map (1:1000000) of oil shale fields in Azerbaijan [2]
Oil shale outcrops: 1 – Guba; 2 – Zarat; 3 – Bakhyshly; 4 – Diyally; 5 – Heyberi; 6 – Qyzmeydan; 7 – Altyaghaj; 8 – Kemishdagh; 9 – Embizler; 10 – Charqyshlaq; 11 – Kurkechidagh; 12 – Talyshnuru; 13 – Khilmilli; 14 – Aghdere; 15 – Yashma; 16 – Engekheran; 17 – Shamakhi; 18 – Erebshalbashy; 19 – Shabandagh; 20 – Jeyirli; 21 – Goredil; 22 – Qaraja; 23 – Tuva; 24 - Qibledagh; 25 – Ahudagh; 26 – Sheibler; 27 – Kichik Siyeki; 28 – Boyuk Siyeki; 29 – Qarayokhush; 30 – Jengidagh; 31 – Jengichay; 32 – Kecheller; 33 – Pirekeshkul; 34 – Aghburun; 35 – Islamdagh; 36 – Mayash; 37 – Goytepe; 38 – Orjandagh; 39 – Saray; 40 – Jorat; 41 - Guzdek; 42 – Kecheldagh; 43 – Fatmayi; 44 – Bayqushlu; 45 – Alaqyshlaq; 46 – Qaryqyshlaq; 47 – Bayqushqaya; 48 – Sungur; 49 – Bayanata; 50 – Sarıdagh; 51 – Qırdagh; 52 – Shorbulaq; 53 – Kosmalı; 54 – Uchtepe; 55 – Qaraheybet; 56 – Masazyr; 57 – Bineqedi; 58 – Xyrdalan; 59 – Zigilpiri; 60 – Qyrmeki; 61 – Shabandagh; 62 – Ateshgah.

gas fields in the region [23].

A few oil shale outcrops (Qyzmeydan, Zarat, Heyberi, Kurkechidagh and etc.) were discovered in Northern Gobustan. They are related to Cretaceous sediments which have no commercial value.

Numerous outcrops like Jengichay, Kecheller, Boyuk Siyeki and others were recorded in Central and South Gobustan, where the Paleogene-Miocene sediments are widely occurring. These outcrops are confined to the Middle Eocene, Maikopian (Oligocene-Lower Miocene), Konkian and Meotian successions (Middel-Upper Miocene) (fig.2) [24].

There have been recorded more than 15 oil shale outcrops in Absheron. The outcrops are mainly associated with the Upper Maikopian, Konkian and Meotianian sediments. Upper Meotian oil shales have been revealed in Binegedi, Fatmayi, Saray, Ateshgah and other anticlines. Oil shales tied to the Maikopian sediments have been found in the west part of Absheron. In the border with Shamakhi-Gobustan region, there are only two (Goytepe and Uchtepe) oil shale outcrops, which are related to the Middle Eocene (Koun) sediments.

In studied sections oil shale beds of different thickness are alternating with other rocks. Sometimes, the signs of bitumen traces are recorded in these sections. For example, such a feature was revealed in the Konkian-Karaganian (Middle Miocene) sediments in Zigilpiri outcrop.

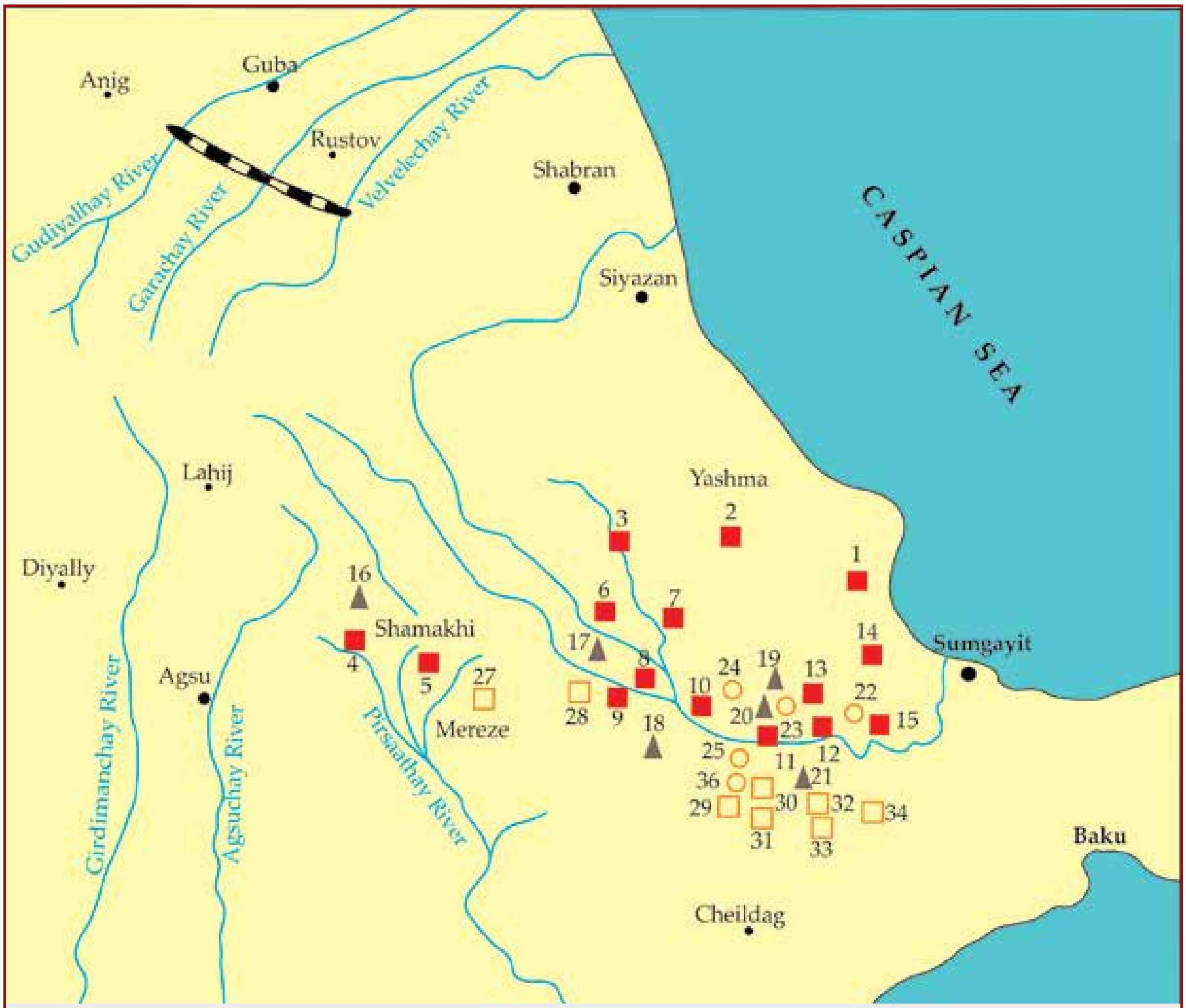


Fig.2. Location map of oil shale outcrops (linked to the Middle Eocene-Meotian sediments) in Shamakhi-Gobustan region

■ Eosene (Koun): 1 – Yashma (Meotian); 2 – Charqyshlaq; 3 – Embizler; 4 – Shamakhi (Upper Maykopian); 5 – Erebshalbashy (Upper Maykopian); 6 – Aghdere (Upper Maykopian); 7 – Shabandagh; 8 – Tuva; 9 – Qarajuzlu (Upper Maykopian); 10 – Kichik Siyeki (Upper Maykopian, Konk); 11 – Jengichay; 12 – Kecheller; 13 – Ashaghykend; 14 – Aghburun; 15 – Pirekeshkul;
▲ Upper Maykopian: 16 – Engekheran; 17 – Goredil; 18 – Sheibler; 19 – Qibledagh; 20 – Jengidagh; 21 – Bayanata (Meotian);
○ Konk: 22 – Islamdagh (Meotian); 23 – Mayash (Meotian); 24 – Boyuk Siyeki (Meotian); 25 – Sungur (Meotian); 26 – Bayqushqaya (Meotian);
□ Meotian: 27 – Jeyirli; 28 – Ahudagh; 29 – Bayqushlu; 30 – Alaqyshlaq; 31 – Qaryqıshlaq; 32 – Sarydash; 33 – Qyrdagh; 34 – Kusmelidagh

Below we submit a lithological description of this succession:

	True thickness, *m*
Gray and brown gray finely «laminated» oil shale, oil smell	0. 63
Dark gray «laminated» shales	0.15
Gray and dark gray oil shales	0.42
Low sandy gray shales	2.31
Gray, brown gray, sometimes dark gray and thick «laminated» oil shale, oil films along bedding planes	1.31
Gray, dark gray and dense «laminated» shales	5.9
Gray, dark gray and sometimes brown gray oil shale, oil smell	2.35
Gray, dark gray and sometimes brown gray shales	0.42
Gray and dense shales	0.63
Gray, dark gray, brown gray oil shale with oil films	2.52
Thick «laminated» and dense gray shales	8
Gray and brown gray, and sometimes dark gray oil shale, oil smell	1.36

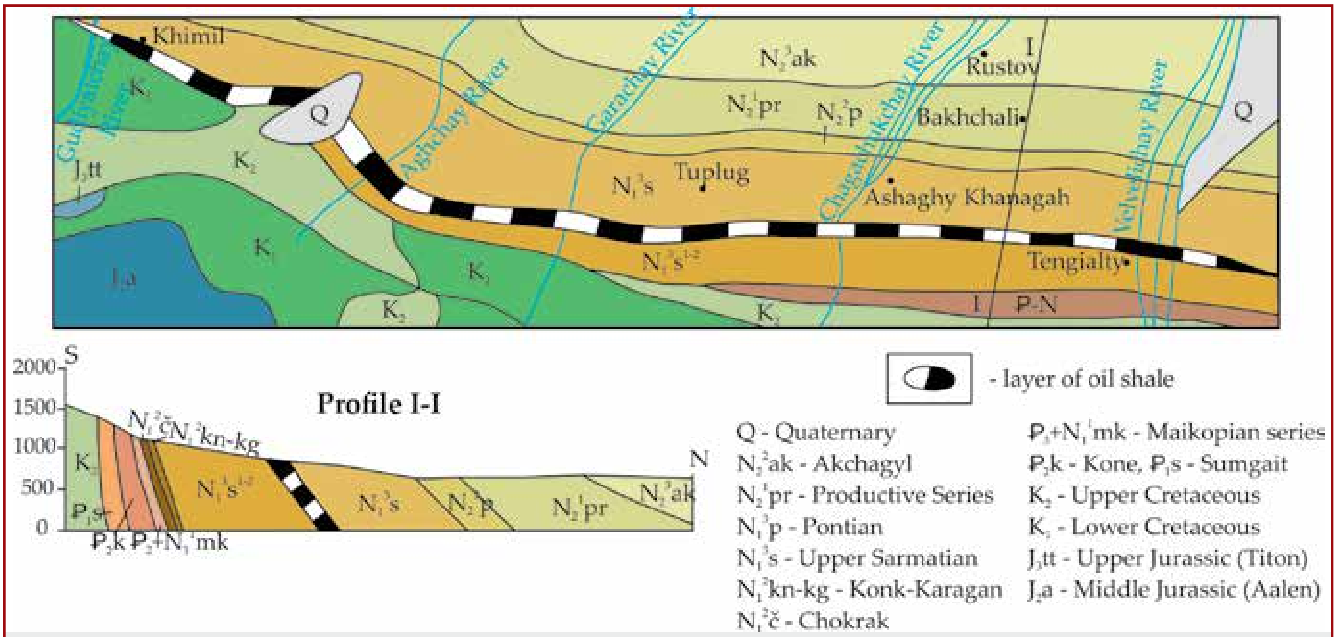


Fig.3. Geological map (1:100000) and profile across oil shale fields in Guba area

The oil shale outcrops of the Maikopian Series (Oligocene-Lower Miocene) were observed only in the north-western part of Pre-Caspian-Guba region, but they do not draw attention to their economic efficiency.

Oil shale outcrops of the Konkian sediments having thickness 8 - 15 m have been developed on the Chandagar River banks. The Meotian sediments were recorded in the southeast of Shuraabad field. Two oil shale beds have been described in the section of the Meotian in the Yashma area.

Oil shales in the Guba area are dated by the Upper Sarmatian. There is section consists of oil shale beds, ranging in thickness from 27 to 255 m and alternating with shale beds, which hardly can be differentiated from oil shales. The greatest practical interest is assosiated with the oil shale bed of the Upper Sarmatian, which occurs 29 km to the NW-SE from Gudiyalchay River toward Velvelechay River [12] (fig.3). Several individual outcrops of oil shales have been found near the Gilgilchay River and as well as to the north-west of Gudiyalchay River, between the watershed Gusarchay-Tahirjalchay and village Anig.

Thick oil shales were recorded in the area between rivers Velvelechay and Garachay. There are three localities, known by the most favorable properties for practical use. 11 oil shale beds have been recorded in the section trending for 4.7 km in the first locality. The second section is located between rivers Kamalchay and Chagachukchay and there are 14 oil shale beds in a section matching for 3 km. The third oil shales containing section consists of 16 oil shale beds occurring within the area of 1.5 km and located on the right bank of Garachay River [12].

The Diyally outcrop is located 7 km east of Ismailly city. Tectonically, the area relates to the Vandam Lahij zone. There were discovered two troughs (moulds), composed of Sarmatian sediments and occurring for a distance of 1.5 km. The thickness of oil shales is 300-370 m, in the north they are covered by the thrust of Kemchi suite limestone (Cretaceous) (fig.4).

3. Genesis and organic geochemistry of oil shales

Oil shales in the upper horizons of Miocene occur in Gobustan, Absheron and Guba and were comparatively studied. In the example of all three mentioned regions, some lithostratigraphic characteristics of oil shale are described in table 1.

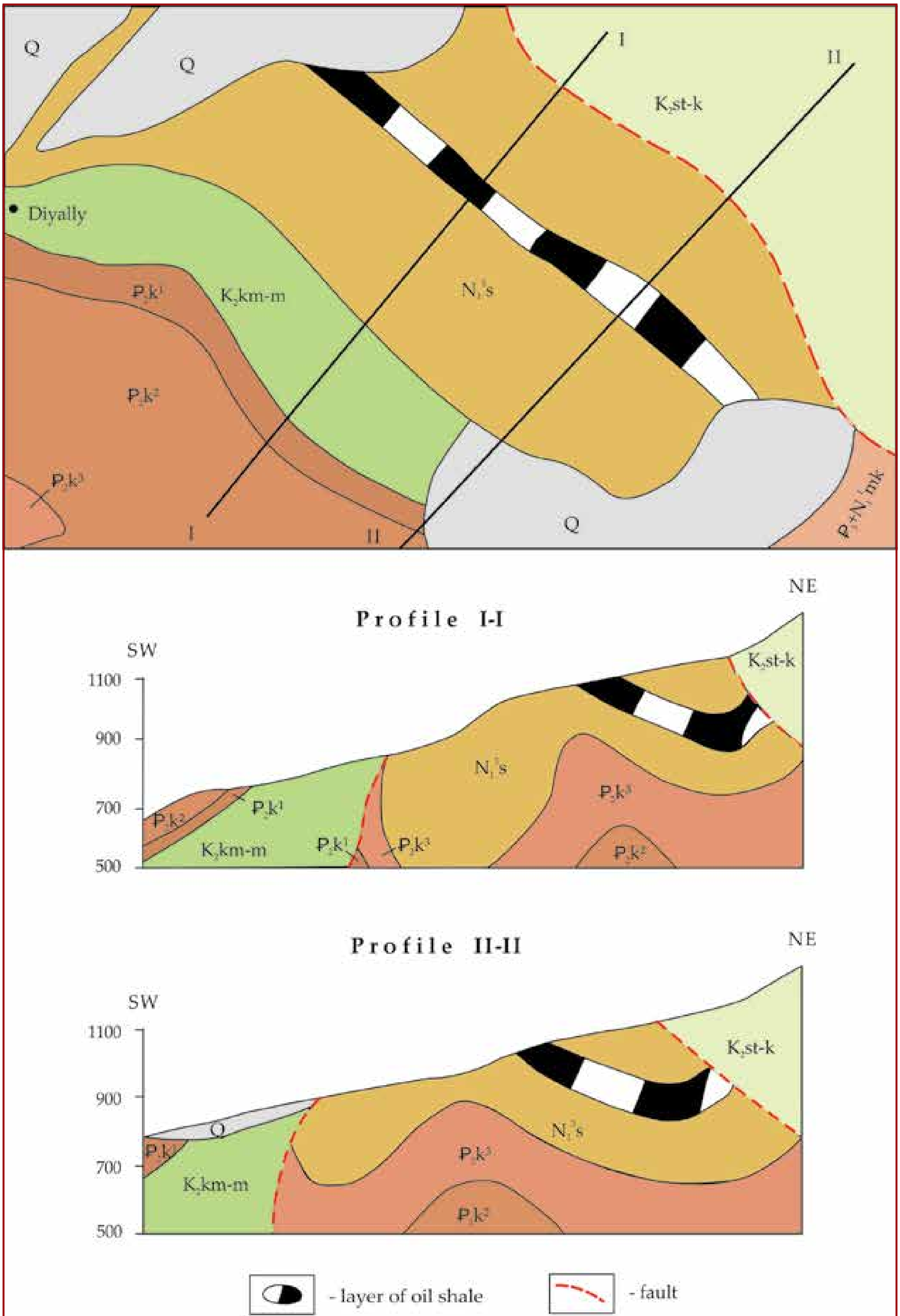
In all of these areas, the accumulation of sediments may almost related to the certain environment – shallow freshwater and silty pools (lagoons), which are particularly characteristic for the first and third sections. In the first section the ash bed was also recorded.

Taking into account that the coal debris is presented in the oil shales we tried to reconstruct the history of oil shale accumulation by analyzing the coal formation, which is refer to the folding phases in the south-eastern end of the Greater Caucasus (fig.5).

The black oil shales with the thickness of 4 m are related to the Upper Cretaceous (Cenomanian) sediments in the section of the North Gobustan (Kemishdagh). There in the section were also recovered fish larvaes and algae [26]. The most likely accumulation of these rocks is connected to the Austrian orogenic phase.

The «laminated» dark brown oil shales in the section located in the vicinity of village Heyberi of Shamakhi region composed of marl and dated as Coniacian-Campanian [27] the most probable are linked to the Sub-hercian orogenic phase.

In Azerbaijan, oil shale outcrops are mainly tied to the middle Koun (Middle Eocene) and these were accumulated during the Laramide orogenic phase (end of the Cretaceous and beginning of the



Q - Quaternary, N_1^3s - Upper Sarmatian,
$P_3+N_1^1$mk - Maikopian serie, P_2k - Kone,
K_2km-m - Campanian, Maastrichtian,
K_2st-k - Santonian, Coniacian.

Fig.4. Geological map and profiles (1:20000) across Diyally oil shale field

Table 1

Lithostratigraphic description of oil shale in the upper horizons of the Miocene in Gobustan, Absheron and Guba regions

Birgut horizon (M.S.Shatski, V.V.Veber), Gobustan	Upper pack of shales (I.M.Gubkin), Absheron	Northeastern slope of the Greater Caucasus, Guba (I.F.Pustovalov)
Ash-brown or light gray oil shale with abundant diatomic flora and fish remains. Sometimes dark colorized bituminous rocks, dolomite, marl and white volcanic ash are presented. Thickness 325-500 m.	Olive-brown and light gray «laminated» shales, and siliceous marls. In the bottom of suite, sometimes strongly bituminous rocks are recorded. Thickness 300-500 m.	Alternation of dark gray shales and sands. In the bottom of suite were recorded dark bituminous shales with numerous fish remains, and limestones, sandy shales, which rich with fauna. The apparent thickness of the shale bed is approximately 20 m. Total thickness up to 100 m.

Cenozoic).

The oil shales of the Makopian Series is associated with accumulation that took place after the Pyrenean orogenic phase.

Oil shales of the Miocene sediments may accumulate after the Attic orogenic phase.

The formation of brown coals in Vandam zone is most likely connected to freshwater environment, which probably existed during the East Caucasian orogenic phase. This phase corresponds to the time of accumulation of the Lower Pliocene Productive Series in the South Caspian basin.

Regarding the genesis of brown coal, oil shales and oil, it is assumed that accumulation of coal occur on the banks of the highly vegetated pools; oil shales - simple flora and fauna (algae, plankton, fish larvae and etc.); oil - organic matter in subsided areas in the marine basins. Thus a conclusion on the transformation of coal, oil shales and oil into each other can be present in such a form

coal ↔ oil shale ↔ oil

In addition to oil shales, there were traced bituminous limestone and marls in the same sections of Gobustan, Diyally and Guba. Chemical analyzes show that increased percentage of carbonates leads to the growth of pitch amount, and decrease of carbonates' amount - to increased bitumens. Such a combination between carbonate and bitumen can probably be explained by the high content of algaes (Lithotamnium) constituting oil shales.

Depositional environment of oil shales is interpreted as sedimentation during sea level high stand. Additionally, bitumen traces in the oil shale section (see section Zigilpiri) can be explained in two ways: occurrence of the source rocks in the section or the possible due to generation potential of the oil shales itselves.

To clarify the type and distribution of organic matter in the oil shales the laboratory experiments were carried out. The OM type and composition in oil shales depend on the processes taking place at the end of diagenesis and OM specific features. The results of thermal analysis may be

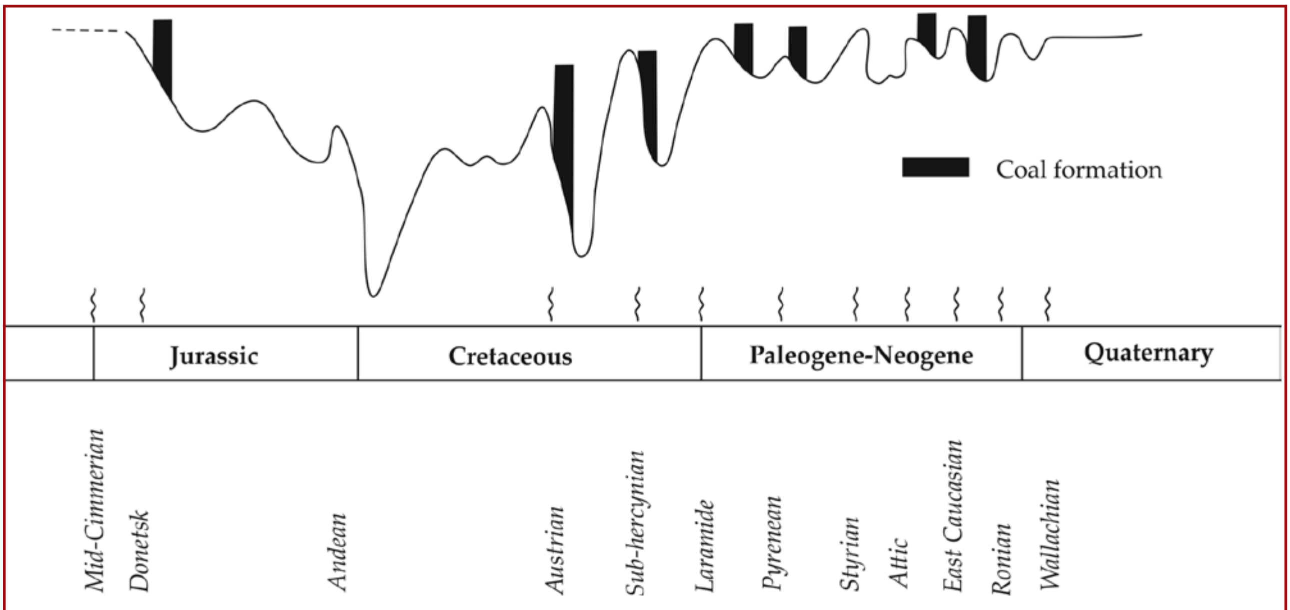


Fig.5. Coal formation corresponding to the folding phases in the south-eastern end of Greater Caucasus [19]

Table 2

Geochemical patterns of oil shales of Guba and Ismayilli regions

Sample No.	Area	Organic matter, %	Kerogen, %
61	Guba, Velvelechay	23.84	20.12
3	Guba, Velvelechay	22.38	20.87
130	Guba, Shabranchay	24.63	23.57
139	Guba, Shabranchay	32.22	31.21
140	Guba, Shabranchay	18.33	17.04
150	Guba, Shabranchay	17.50	17.11
160	Guba, Shabranchay	23.43	22.66
170	Guba, Shabranchay	23.13	22.51
87	Diyally	18.33	20.24
89	Diyally	21.17	14.46
90	Diyally	21.13	16.22
96	Diyally	22.33	18.31
99	Diyally	19.32	15.53
103	Diyally	26.32	22.79
105	Diyally	27.88	25.63
106	Diyally	27.17	25.12

used as a model to explain the natural processes occurring during the diagenesis and catagenesis. In this purpose, geochemical characteristics of oil shales in Guba and Ismayilli regions were studied. The amount of organic matter in samples ranges between 17.50 and 32.22%. The major part of organic matter is concentrated (14.46-31.21%) in the kerogen part (tabl.2).

Some thermal analyses of samples were carried out in order to explain decomposition mechanism of kerogen and determine type of organic matter.

Samples results, of the samples, collected from Shabranchay and Velvelechay areas in Guba region show that the organic matter loses its most part at the temperature of 200 °C (chart 1). But in sample №139 this process occurred at the temperature of 500 °C. The smooth gradual changes (loss of 6.78-6.49% of OM total amount) are recorded at temperatures of 200-400 °C.

Depending on the temperature, the weight loss process occurred gradually in the samples collected from Diyally in Ismayilli (chart 2). For example, the process starts at the temperature of 200 °C (5.14%) in the sample №89. A little difference is observed at the temperatures between 300 and 500 °C (5.19 - 5.18%). The same trend was recorded in samples №87 and 90. In general, the transformation and weight loss of organic matter start at the temperatures of 300-400 °C in samples collected from the Diyally area.

These results give a way to explain the process of hydrocarbon formation in oil shale. Initially the organic matter exposes to insignificant changes. Increasing the temperature leads to decomposition of the weak heteroatomic compounds that exist between nuclei. The process goes on with releasing of soluble high molecular heteroatomic components

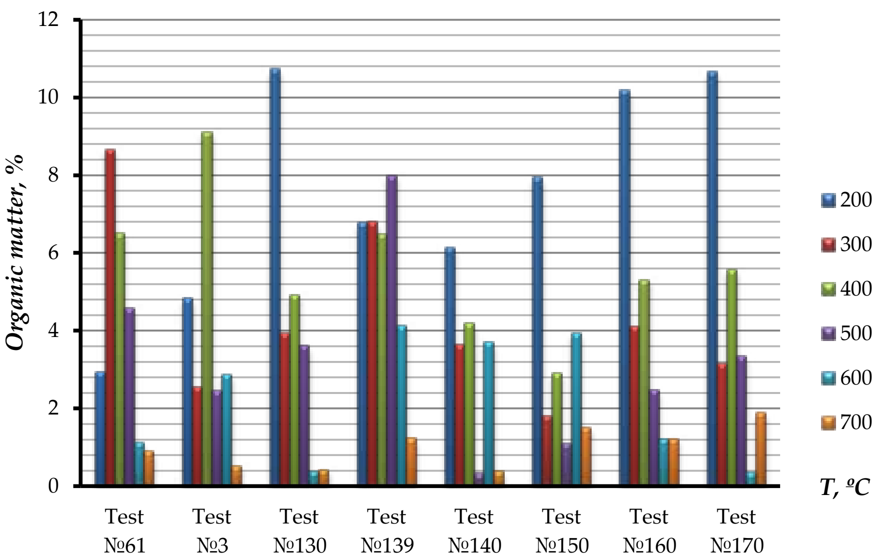


Chart 1. Results of thermal analysis of oil shales collected from Shabranchay and Velvelechay areas in Guba region

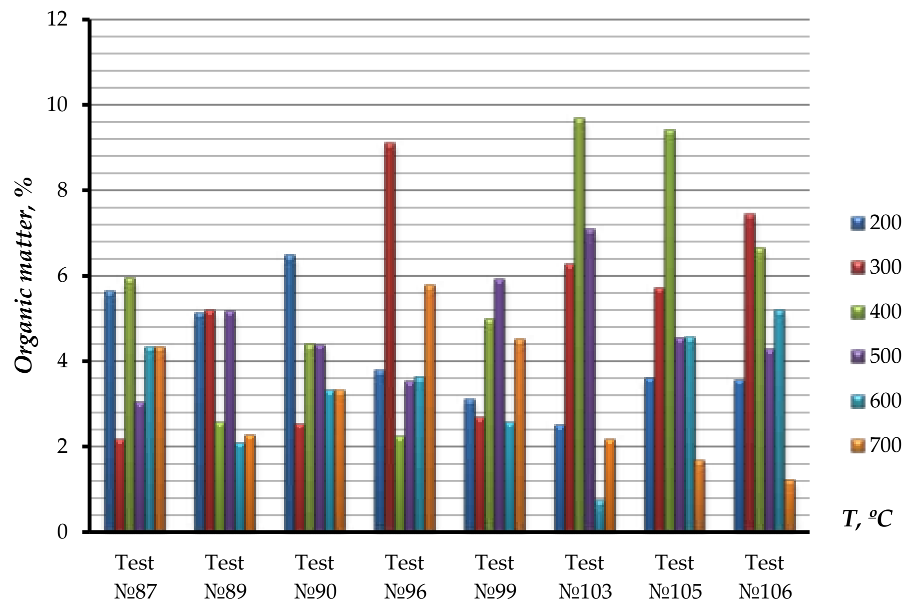


Chart 2. Results of thermal analysis of oil shale of Diyally area

the polyaromatic compounds and O_2-containing functional groups predominate in organic material. The long-chain alkanes and fatty acids play a minor role in their composition, but ketone and carboxylic groups vice versa. Depending on the temperature, the decomposition process goes quickly in the compounds which are composed of heteroatomic organic matter. As organic matter of aliphatic structure is more resistant to temperature to get less amount of heteroatomic compounds in its composition the additional temperature is required [35]. Thus, the weight loss of the organic matter occurs at high temperatures in aliphatic type

and formation of bitumen, asphaltene and as well as loss of light components (CH_4, H_2O, CO_2 and C_2H_6) in kerogen. In addition, a high degree of aromatization also occurs (H/C ratio). At the end the kerogen turns into high molecular heteroatomic compounds and after that generates relatively small molecules. In the maturated structure of kerogen, the aromatic plastic sheets form a subparallel series and they become more regulated.

According to some authors, depending on the temperature of OM in coal and oil shales the time of OM catalytic transformation can be accelerated [23, 28-35].

As a result of catalytic transformation of carbonate and mud rocks the organic matter having condensed aromatic or aliphatic structure is formed. Abundance of H_2 and deficit O_2 in the organic matter of aliphatic structure is characteristic because lack of polyaromatic compounds and heteroatom bonds.

In organic matter of the aromatic structure

OM, but at low temperatures (200 °C) in OM of aromatic type.

The results of thermal analysis enable us to note some regularities and differences. Taking this into account, the samples collected from the areas Guba and Diyally were also analyzed by pyrolytic method in two stages (tabl.3).

Yield pyrolytic bitumen and pyrolytic water amount was increased at low temperatures, but the same tendency to the gas volume were recorded only when the temperature increases. The main structures of macromolecules in kerogen nearly were unchanged at the same temperature. The generation of gas at low and high temperatures was recorded clearly. Thus, the temperature increasing results with carbonization and decomposition of organic matter.

In the samples of Guba (tabl.3) and Diyalli (tabl.4) areas the bitumen formation is recorded at temperature up to 550 °C. It was observed that

Table 3

Geochemical patterns of oil shales of Guba and Ismayilli regions

Sample No.	Organig matter, %	Pyrolyzed organic matter, %	Low temperature (500-550 °C)			High temperature (800-850 °C)			Carbonized part, %
			Pyrolytic water, %	Bitumen, %	Gas, %	Pyrolytic water, %	Bitumen, %	Gas, %	
61	23.84	22.82	10.28	2.21	5.72	0.53	-	4.08	1.02
3	22.38	17.17	4.09	2.40	5.53	1.44	-	3.71	5.21
130	24.62	22.16	12.05	1.82	4.21	0.63	-	3.44	2.46
139	24.22	20.34	13.02	1.56	3.55	0.08	-	2.14	3.88
140	18.33	17.61	6.88	0.34	2.03	1.32	2.78	4.26	0.72
150	17.75	16.50	6.87	0.15	2.87	1.29	-	5.31	1.25
160	23.34	19.73	11.26	1.61	4.63	0.26	-	1.98	3.61
170	23.13	20.92	13.98	0.40	4.31	0.13	-	2.09	2.21

Table 4

Pyrolysis of oil shale samples of Diyally area

Sample No.	Organic matter, %	Pyrolyzed organic matter, %	Low temperature (500-550 °C)			High temperature (800-850 °C)			Carbonized part, %
			Pyrolytic water, %	Bitumen, %	Gas, %	Pyrolytic water, %	Bitumen, %	Gas, %	
87	21.17	22.49	3.23	10.89	5.05	-	-	3.32	-
89	20.19	18.80	1.16	6.73	4.52	-	-	6.39	1.39
90	21.13	18.93	1.62	8.12	3.94	-	-	5.25	2.20
96	22.33	26.61	3.49	11.66	4.97	-	-	6.49	-
99	19.32	21.59	2.11	8.46	4.01	-	-	7.01	-
103	26.32	26.01	1.03	12.30	5.04	-	-	7.73	0.31
105	27.88	24.13	0.17	10.20	3.04	-	-	10.72	3.75
106	27.17	25.29	2.78	11.52	4.48	-	-	6.51	1.88

in the higher temperature intervals only gas is produced. Along with the organic part inorganic matter was also exposed to decomposition process in the samples of Diyalli area. Amount of bitumen fractions are more (6.73-12.30%) than other products. According to the thermal analysis, organic matter loses its significant part at temperatures ranging from 300 to 400 °C. Thus, we can conclude that aliphatic compounds are more than aryl compounds in the sample samples of Diyalli. Therefore, they require more energy. Bitumens dominate among decomposition products.

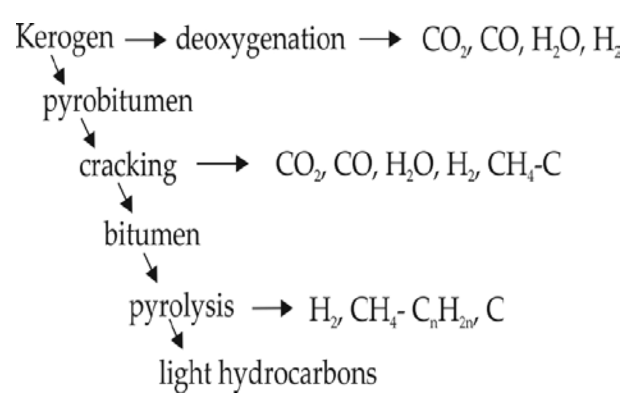
Amount of bitumen in Guba area samples varies in 0.40-2.40% limits. According to the thermal analysis of samples, the weight loss of the organic matter occurs at 200 °C in many tests. In contrast to the Diyalli area, the structure of organic matters is more appropriate to aromatic types in these samples.

The increasing the temperature (800-850 °C) leads to transformation of large molecules of kerogen into low molecular hydrocarbons, gases and coke residues. Summarizing the results, it can be concluded that increasing amount of gas corresponds to the temperature increase, but slowly decrease of bitumen. An abrupt change in the yielding of bitumen is mainly observed at a temperature of 400 °C

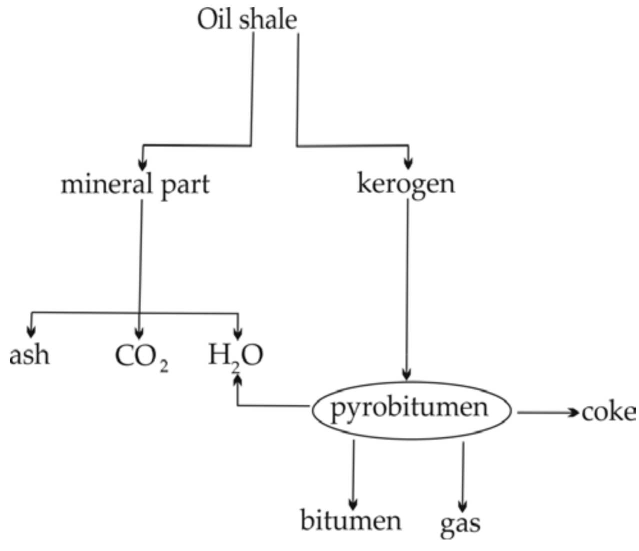
Since, gradual increase in the temperature results with carbonization of kerogen. The process is almost the same for all samples. Although the amount of products that are produced at low temperatures and rates of destructive decomposition vary but the final step is similar.

During the thermal processing the kerogen composition change can be described as follows (Scheme 1):

In the same thermal condition, the process of kerogen decomposition takes place as shown below (Scheme 2):



Scheme 1. Kerogen composition change depending on thermal processing



Scheme 2. The stages of kerogen decomposition depending on thermal processing

Conclusion

Lithostratigraphic properties of oil shales from different regions make possible to conclude on their similar depositional environment. The accumulation of oil shales is associated with sedimentation, which takes place in shallow freshwater and silty pools – lagoons environment. The organic compounds of oil shales mainly consist of phytoplankton (algae) and zooplanktons (fish larvae etc.). Linked to orogenic phases, the formation of oil shales, coal and oil in southeastern slope of the Greater Caucasus is related to their similar genetic properties.

The decomposition of most part of the organic material occurs at high temperature (≥400 °C) in organic matter of aliphatic structure, and at low temperatures (≥200 °C) in aromatic type organic matter.

Results of pyrolysis of oil shale samples display that at the initial stage (500-550 °C), amount of bitumen and pyrolytic water increases. At the same stage amount of gases increases when the temperature rises too. Increasing the temperature up to 800-850 °C leads to the transformation of high molecular hydrocarbons into low ones, gases and coke residues. The gradual increase of the temperature results with carbonization of kerogen. An abrupt change in the yielding of bitumen is mainly observed at a temperature of 400 °C.

Thermal analysis and pyrolysis of oil shale samples taken from different studied regions allows making conclusion that some kerogens of the Diyalli area (in the samples no. 99, 103 and etc.) are fully matured.

In general, the transformation of oil shales may be starts with organic matter change in the diagenesis stage and destruction of long aliphatic C-C bonds in catagenesis stage; continuing separation of minerals and organic matter from each other in the composition of kerogen is completed with the hydrocarbon formation.

Ejected products of mud volcanoes, widely developed in Absheron and Shamakhi-Gobustan regions, are supplied from the depth of 6-8 km and more. These products are sole data, which contain information on geology of deep sediments of region that are not assessable with drilling. Sometimes oil shale and bitumen rocks are found among the volcanic products of Eocene-Miocene age [23, 24, 36-39]. Geochemical and geological studies of oil shales and bituminous rocks of volcanic ejectas bring to understanding of hydrocarbon generation potential of these sediments and their possible accumulation at certain stratigraphic levels. It also creates opportunity to explore shale gas accumulations in Azerbaijan.

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Генезис и органические геохимические характеристики горючих сланцев в Восточном Азербайджане

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Реферат

В статье расмотрены вопросы генезиса и геохимии органического вещества (ОВ) горючих сланцев различных тектонических зон Восточного Азербайджана. Изучены литостратиграфические свойства сланцесодержащих отложений, динамика эволюции и структурные типы ОВ, образование которых связывается с происходящими в почти одинаковых палеогеографических условиях (в неглубоких пресноводных бассейнах - лагунах) осадконакоплением. Содержание ОВ горючих сланцев в основном представлено фитопланктоном (водоросли) и зоопланктоном (личинки рыб и т.д.). Образование наряду с горючими сланцами проявлений угля и нефти в орогенных фазах юго-восточного склона Большого Кавказа, объясняется сходством их генетических свойств. По результатам термического анализа горючих сланцев, потеря ОВ большей части веса при более высокой температуре (≥400 °C) соответствует алифатическим, а при более низких температурах (≥200 °C) ароматическим структурам. По данным пиролиза горючих сланцев увеличивается на начальной стадии (500-550 °C), за исключением газа, количество битума и пиролитической воды. Повышение температуры до 800-850 °C приводит к превращению высокомолекулярных углеводородов в более низкомолекулярные; образуется газ и кокс. Постепенное повышение температуры приводит к карбонизации керогена. Резкое увеличение в выделении битума в основном наблюдается при температуре 400 °C. Термический анализ и пиролиз изученных образцов горючих сланцев, отобранных на разных площадях исследуемых областей, позволяют сделать вывод, что некоторые керогены достаточно созрели.

Ключевые слова: горючие сланцы; генезис; органическое вещество; кероген; термический анализ; пиролиз.

Şərqi Azərbaycanın yanar şistlərinin genezisi və üzvi geokimyəvi xüsusiyyətləri

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Xülasə

Məqalədə, Şərqi Azərbaycanın müxtəlif tektonik zonalarında intişar tapmış yanar şistlərin genezisi və üzvi geokimyəvi xüsusiyyətləri təhlil olunur. Yanar şist saxlayan çöküntülərin litostratiqrafik xarakteristikaları, həmçinin şistlərin tərkibində çoxluq təşkil edən üzvi maddənin təkamül dinamikası, sturktur tipi və s. araşdırılır. Onların əmələgəlməsi təqribən eyni palecoğrafi (dayaz və şirinsulu qapalı hövzələrdə (laqunalarda)) şəraitdə baş vermiş çöküntütoplanma ilə əlaqələndirilir. Şistlərin tərkibindəki üzvi maddələri, əsasən fitoplankton (yosunlar) və zooplanktonlar (balıq sürfələri və s.) təşkil etmişdir. Orogen fazalarla əlaqədar olaraq Böyük Qafqazın cənub-şəqr yamacında yanar şistlərlə bərabər, kömür təzahürlərinin və neftin əmələgəlməsi onların oxşar genetik səciyyələrə malik olması ilə izah olunur. Yanar şistlərin pilləli termiki təhlili daha yüksək temperaturda (≥400 °C) öz kütləsini azaldan üzvi maddələrin alifatik, aşağı temperaturda (≥200 °C) itirənlərin isə aromatik tipli struktura uyğunluğunu göstərir. Şist nümunələrinin priloz nəticələrinə görə, ilk mərhələdə (500-550 °C) neftəoxşar maddələrin (bitum), piroliz suyunun, həmçinin temperatur artdıqca qazların miqdarı artır. Temperaturun yüksəldilməsi (800-850 °C) nəticəsində iri molekullu kerogen kiçik molekullu karbohidrogenlərə, qazlara və koks qalığına çevrilir. Belə nəticəyə gəlmək olar ki, temperaturun artması ilə qazların miqdarı artır, neftəoxşar maddələrin miqdarı tədricən azalır. Böyük temperatur intervallarında kerogenin kömürləşməsi prosesi müşahidə olunur. 400 °C temperaturda isə kəskin sıçrayış (bitumun artımında) baş verir. Müxtəlif sahələrdən götürülmüş yanar şistli nümunələrin termiki analizi və pirolizinin nəticələrinə əsasən, Diyallı sahəsinin bəzi sınaqlarının kerogenlərini kifayət qədər yetişkən hesab etmək olar.

Açar sözlər: yanar şistlər; genezis; üzvi maddə; kerogen; termiki analiz; piroliz.