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FACTORS PROVING THE OIL AND GAS POTENTIAL OF TERRIGENOUS RESERVOIRS AT GREAT DEPTHS IN THE BAKU ARCHIPELAGO

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Muhammad Kashif Nawab
Master Student and Research Scholar
at Faculty of Geological Engineering and Exploration,
Azerbaijan State Oil and Industry University
Adalat Hasanov
Dr.
Head of Labs,
Faculty of Geological Engineering and Exploration,
Azerbaijan State Oil and Industry University
City, country: Baku Azerbaijan

ABSTRACT

Baku archipelago is well-known for high oil and gas production even at the great depth due to high sedimentation rate and low compaction during the formation of basin. This paper represent the Garnulomtric analysis of core samples, in which grain size fractions are determined along with porosity of the cores. Four types of rock groups (clayey-aleuritic sand, clayey-sandy aleurolites, sandy-clayey aleurolites and clayey sandy loams) were taken into account. In first group (clayey-aleuritic sand) the dominant grain size fraction is 0.175 mm which lead to increase in porosity, in second group the dominant fractions are 0.055 mm and 0.175 which tend to increase in porosity. In clayey-sandy aleurolites fractions like 0.055 mm and 0.25 mm have negative effect on porosity. Moreover, in clayey-sandy loam deposits, the coarser grains have positive impact on porosity compared to fine grains. On the basis of results obtained, the central part of Baku Archipelago is very promising for oil and gas potential especially the anticlinal zone of Gamamdag, Deniz, Sabail and Nakhchivan.Furthermore, accidents and complications in the drilling process may occur due to incorrect predictions of reservoir and hydrostatic pressure during the exploration process, that’s why, it is highly advisable to take into account this anomalous phenomena when choosing the location of wells.

Key words: Granulometric analysis, Aleurites, Grain-size Fractions, Porosity.

INTRODUCTION:

As is known, within the Baku Archipelago, the main productive interval is the Productive Series (PS), which is represented by terrigenous sediments with high filtration-capacitive properties (FCP). At the same time, deeper intervals corresponding to the Lower Pliocene are also considered very promising, since it has been proven that in these oil-and-gas-bearing sediments at depths above 4.5 km, compression of the pore space often occurs not only smoothly, but also, some time, in extremely manner [2, 3]. This is explained by the fact that, unlike of clay containing sediments, sandy-aleuritic reservoirs of PS are more sensitive to post-sedimentation processes in the variable transgressive-regressive conditions of the basins [4]. However, at depths of 4.5 km and more, in addition to dense rocks, there are weakly cemented sands and sandstones. It should be noted that with increasing depth of homogeneous rocks, their average density also increases.

Clay formations play an important role in the preservation of reservoir properties of granular reservoirs. It is known that in PS reservoirs the more common secondary clay minerals are montmorillonites (smectites) and kaolinites. The presence of montmorillonites in rocks has a negative effect, and the presence of kaolinites has a positive effect on reservoir properties of sediments.

Monomikty, coarse-grained quartz sandstones in the form of separated grains are well preserve reservoir properties at great depths. Such sediments were deposited by Paleo-Volga from the Russian Platform, where the amount of quartz in the light fractions is 80% (Umud area, well №1, V horizon and Nakhchivan area, №1, “fasila” suite). This fact shows that the rocks of the Absheronfacies are still at the stage of mesocathogenesis, so they can still their filtration-capacitive properties at a depth of 8-10 km. This is confirmed by data from the waste of mud volcanoes. According to A.L. Putkaridze [1], the composition of sandy fragments taken from mud volcano breccia on Sangi-Mugan, Dashly, Umud and other areas contains well-sorted grains of quartz with the disten-staurolite-sillimonite as the main mineral-forming. The above gives reason to highly assess the prospects for petroleum potential of the PS (VII horizon, “fasila” suite, PKS and PK) in the northeast part of the Baku Archipelago (Dashly, Sabail and Nakhchivan areas) [5].

METHODS AND MATERIALS:

To study the Analytical generalization of core material and to clarify the patterns of compaction of the pore space of productive reservoirs at great depths the exploration and exploitation of study area were carried out [6, 7]. The statistical representation of actual material mainly due to granulometric analysis of core sample is shown (Table 1).

Table 1:

Garnulometric Analysis of core samples

Allocation depth of the samples, m	Fractions, mm %				Name of rocks	Porosity, %
	0,25	0,175	0,055	0,01		
3029,5	0,1	51	27	21	clayey-aleuritic sand	22,1
2570,5	1,2	57,8	27	14	clayey-aleuritic sand	29,3
2215,5	10,7	55,7	22,4	11,2	clayey-aleuritic sand	28
2226	0,5	24,1	55,9	19,5	clayey-aleuritic sand	24,2
2052,5	0,6	26,2	53,7	19,5	clayey-sandy aleurolites	22,2
2057,5	0,1	44,3	45,6	10	clayey sandy loam	27,6
1778,5	0,5	18,7	55,5	25,3	sandy-clayey aleurolites	25,2
1781,5	1,6	54,3	30,7	13,4	clayey-aleuritic sand	29,6
1791,5	0,5	20,7	49,5	29,3	Sandy hlidolit	27,6
1794,5	3	63	23,5	10,5	clayey-aleuritic sand	30
1804,5	0,6	61,6	29,2	8,6	Silty sand	29,4
1807,5	0,7	16,7	53,8	28,8	Sandy-clayly siltstone	23,7
2334	0,2	22,1	59,5	18,2	clayey-sandy aleurolites	26,6
2344,5	0,3	51,6	34,8	13,3	clayey-aleuritic sand	23,9
2362	3,5	46,3	33,9	16,3	clayey sandy loam	25,8
2372,5	1,2	58	27,6	13,2	clayey-aleuritic sand	26
2376	1,6	50,7	33,7	14	clayey-aleuritic sand	25,9
2383	0,6	39,7	41	18,7	clayey sandy loam	25,8
2389,5	0,3	31,6	51,4	16,7	clayey-sandy aleurolites	25,1
2358	6,3	63,8	17,3	12,6	clayey-aleuritic sand	27,1
2379,5	1,4	55,6	22,4	20,6	clayey-aleuritic sand	23,9
2402,5	0,2	7,2	70,4	22,2	sandy-clayey aleurolites	18
2405,5	0,3	24,6	51,2	23	clayey-sandy aleurolites	19
2376	1,9	58,1	23,6	16,4	clayey-aleuritic sand	25,8
2396,5	3,5	51,9	20,9	23,7	clayey-aleuritic sand	22,5
2107	0,2	40,8	40,7	18,3	clayey sandy loam	24,8
2113	0,6	34,2	52,2	13	clayey-sandy aleurolites	26
2273	0,3	25,1	61,9	12,7	clayey-sandy aleurolites	20,7
2591,5	0,5	36,5	46	17	clayey sandy loam	21,8
2594,5	2,3	52	22,8	22,9	clayey-aleuritic sand	22,6
2597,5	0,1	12,1	67,4	20,4	sandy-clayey aleurolites	20,4
2647,5	0,8	64,8	23,5	10,9	clayey-aleuritic sand	23,9
2601	0,2	33,1	48,6	18,1	clayey sandy loam	22,9
2631	0,1	40,7	45,2	14	clayey sandy loam	22,1
2636,5	1,2	67,6	22,3	8,9	Silty sand	24,7
2650,5	4,2	60,7	20,3	14,8	clayey-aleuritic sand	24
2600,5	0,1	39,7	43,3	16,9	clayey sandy loam	24,4
1887,5	0,8	36,3	33,3	29,6	Hilidolit	27,6
1957	0,2	45,9	38,2	15,7	clayey sandy loam	24,3
1957	0,5	28,2	50,5	20,8	clayey-sandy aleurolites	22,9
2248,5	0,5	20,7	62,4	16,4	clayey-sandy aleurolites	25,5
2260,5	8,2	48,2	23,6	20	clayey-aleuritic sand	22,9
2263,5	5,5	62	21,6	10,9	clayey-aleuritic sand	25,5
2248,5	0,4	6,7	72,5	20,8	Clayey siltstone	18,3
2055	0,2	29,6	53,3	16,9	clayey-sandy aleurolites	27,5
2354,5	2,7	27,5	15,2	9,6	Silty sand	24,2
2366,5	3	71,5	17	8,5	Silty sand	25,6
2369,5	1,2	46,3	37,6	14,9	clayey sandy loam	24,8
2372,5	0,3	43,2	43,5	13	clayey sandy loam	27,1
2375,5	1,1	51	38,6	9,3	Silty sand	26,2
2381,5	1,8	58,8	28,6	10,8	Silty sand	25,9
2393,5	0,1	29,1	55,6	15,2	clayey-sandy aleurolites	23,7
2351,5	0,5	59	32,9	7,6	Silty sand	27,4
2349	0,2	15,7	42,2	41,9	Sandy loam	24,1

2381,5	1,6	63,9	22	12,5	clayey-aleuritic sand	28,8
2351,5	0,4	8,3	61	30,7	sandy-clayey aleurolites	23
2349	0,2	14,9	48,3	36,6	Sandy loam	17,3
2315	0,5	62	24,2	11,3	clayey-aleuritic sand	25,8
2791	0,2	17,7	55	27,1	Sandy-clayey aleurite	21,2
3034	1	51	27	21	clayey-aleuritic sand	22,1
1669	0,2	37,7	28,8	32,4	Hilidilit	17
1745	1	33,5	49,8	24,7	Clayey sandy loam	20,3
1865	0	27	58	15	clayey-sandy aleurolites	26
1875,5	1	37	49	13	clayey sandy loam	22
1897,5	4	55	25	16	clayey-aleuritic sand	28
1865	0,4	9,8	55	35,2	sandy-clayey aleurolites	25,8
2100	0,3	14,2	59,8	25,7	sandy-clayey aleurolites	25,4
2094	0,3	58,6	31,2	9,9	clayey-aleuritic sand	26,3
2124,5	0,5	27,7	55	16,8	clayey-sandy aleurolites	26,1
2129	0,6	30	53	16,4	clayey-sandy aleurolites	26,8
2208	1,1	54,8	29,3	14,8	clayey-aleuritic sand	26,3
2094	0,1	19,2	49,2	34,5	Sandy loam	15,7
2132,5	0,5	30,5	42,4	26,6	Hilidolit	22,7
1143	0,8	54,1	38	7,1	Silty sand	28,8
1128,5	1	25,1	50,3	23,6	Clayey sandy loam	31,3
1161,5	0	10,2	75,5	14,3	clayey-aleuritic sand	28,8
1165	0,6	60,2	32,8	6,4	Silty sand	27,6
1199,5	1,2	54,5	28,7	15,6	clayey-aleuritic sand	25,3
1201	0,7	39,7	46,7	12,9	clayey sandy loam	25,3
1530,5	2,4	71,6	19,7	6,3	Sand	29,1
1530,5	2,7	72,6	18,9	5,8	Sand	30
1632,5	0,6	41,2	49,7	8,5	Sandy loam	19,7
1572,5	0,2	38,2	43,2	18,4	clayey sandy loam	22,6
1667	6,2	58,6	21,6	13,6	clayey-aleuritic sand	28,7
2855,5	0,2	48,5	32,1	19,2	clayey-aleuritic sand	22,2
2855,5	0,3	69,5	17,2	13	clayey-aleuritic sand	23,6

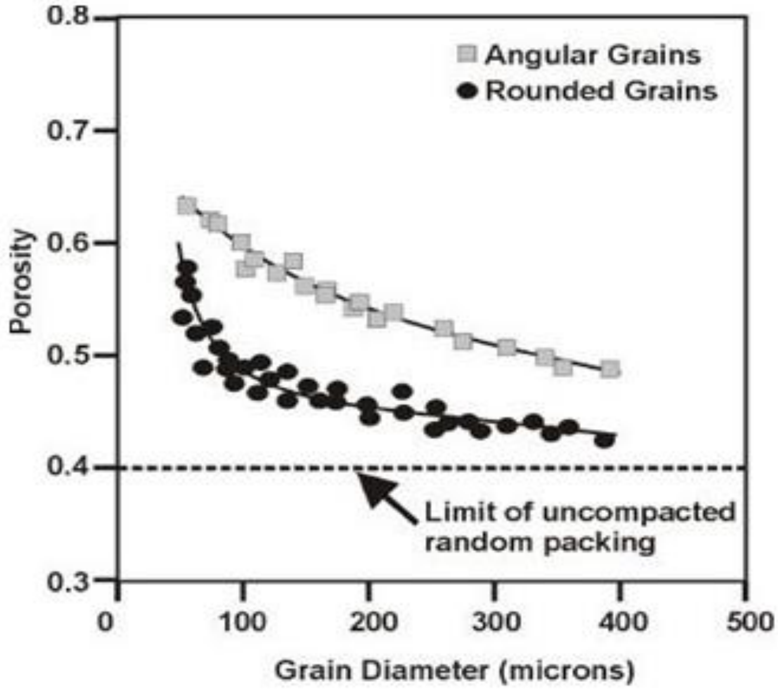
The importance of granulometric analysis is determined by the fact that in terrigenous reservoirs the initial (pre-diagenic) porosity depends on three main microstructural parameters:

- grain size
- grain packaging,
- The shape and distribution of grains of different sizes in the matrix volume.

The influence of grain size on inter-granular porosity with random packing of spherical grains depends on the stability of the acting internal friction and adhesion forces between individual grains. These forces are proportional to the specific surface of the grains, which is assumed to be equal to the total surface area of the grains per unit of solid volume (matrix) and inversely proportional to the size of the grains. This pattern indicates that when all other factors are equal, the contribution of coarse grains at lower porosity is less than the contribution of fine grains [8]. This general rule is illustrated in Figure 1; from which it follows that the increase in porosity for sedimentary rock consisting of a specific grain size becomes significant only when the grain sizes are below 0.1 mm (100 microns). In particular, for some young sediments, the porosity can reach values of up to 0.8 (80%).

When the grain size increases by 0.1 mm, the friction forces decrease, and the porosity decreases until a condition is achieved that is a random package without friction forces, which occurs at a porosity of 0.399 mm and does not depend on the grain size more.

As noticed in real rocks, due to secondary processes (compaction, geochemical and diagenetic processes, etc.), the initial porosity is rarely encountered, so it is necessary to take into account the conditions that directly determine the pore size, their distribution and the degree of coherence [9].



(For rounded -● and angular-□)
Figure 1: Porosity dependence on grain size Adopted from Paul Glover, 2016

RESULTS AND DISCUSSIONS:

To identify and account for the influence of dominant fractions in different reservoirs, core samples were divided by name of rocks into 4 groups: clayey-aleuritic sand, clayey-sandy aleurolitic, sandy-clayey aleurolitic and clayey sandy loams. The distribution of fractions according to the selected groups of rocks is shown in Fig. 2.

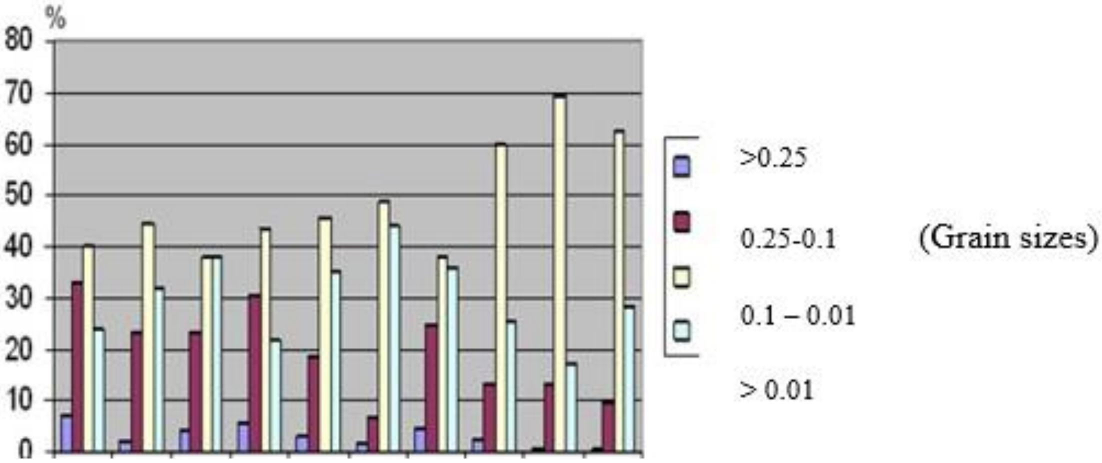


Figure 2: Variations of the fractional composition of terrigenous reservoirs of some oil and gas deposits in Azerbaijan

Fig. 3 reveals that in the composition of the first group of rocks (clayey-aleuritic sands) a fraction with a grain size of 0.175 mm dominates. The other two fractions, with a grain size of 0.055 and 0.01 mm, occupy approximately the same volume, and finally, the fraction of coarse grains (0.25 mm) is an insignificant part of the volume and may not be taken into account.

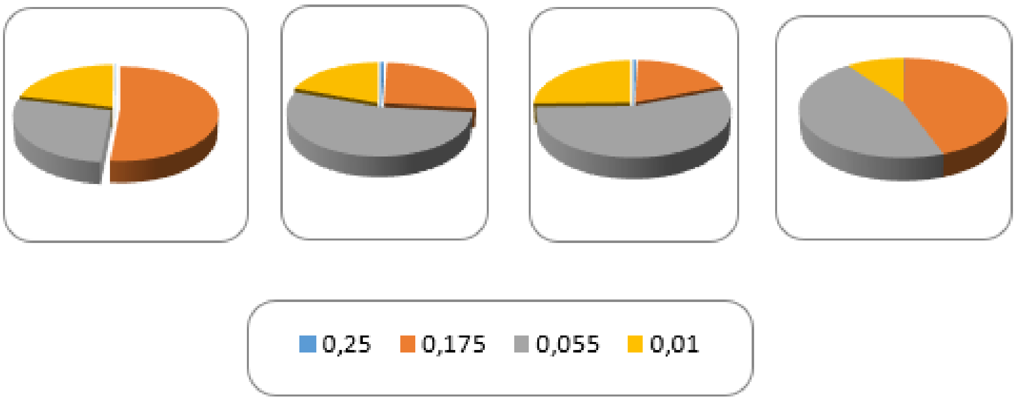


Figure 3: Distribution of fractions in rock groups (from left to right): clayey-aleuritic sand, clayey-sandy aleurolites, sandy-clayey aleurolites and clayey sandy loam

Fig. 4 shows the results of assessments of the effect on the porosity of the dominant fraction (0.175 mm) and the fraction with a grain size of 0.055 mm for the rocks of the first group. As follows from these data, an increase in the content of the dominant fraction in clayey- aleuritic sands leads to an increase in porosity, while an increase in the content of the fraction with a grain size of 0.055 mm reduces the porosity of this group of rocks.

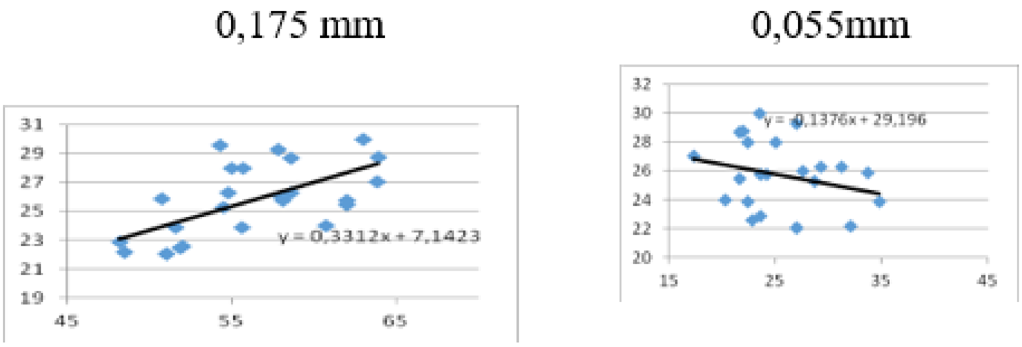


Figure 4: Dependence of porosity on the fraction content (0.175 mm and 0.055 mm) in clayey-aleuritic sands

For the remaining 3 rock groups, the dominant fraction is a fraction with a grain size of 0.055 mm, with a different ratio of fractions of 0.175 and 0.01 mm. Here, just as in the first group of rocks, the fraction of coarse grains (0.25 mm) is an insignificant part of the volume and may not be taken into account.

In particular, for rocks of the clayey-sandy aleurolite group, the effect on the porosity of the dominant fraction (0.055 mm) and fractions with a grain size of 0.175 mm is shown in Fig. 5. As follows from these data, an increase in the content of both the dominant fraction and the fraction of 0.175 mm in clayey-sandy aleurolites leads to an increase in porosity.

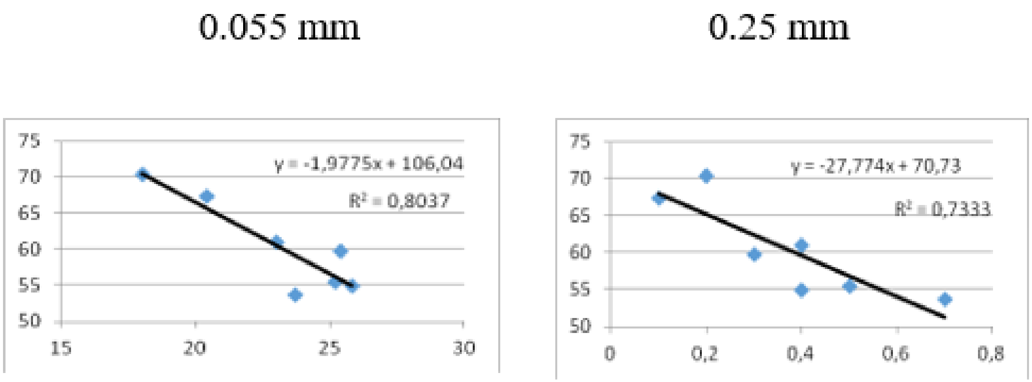


Figure 5: Dependence of porosity on the fraction content (0.055 and 0.175 mm) in clayey-sandy aleurolites

In contrast to the group of clayey-sandy aleurolites, in the group of sandy-clayey aleurolites, the effect on the porosity of the dominant fraction (0.055 mm) and the coarser fraction (0.25 mm) are negative tendency (Fig. 6).

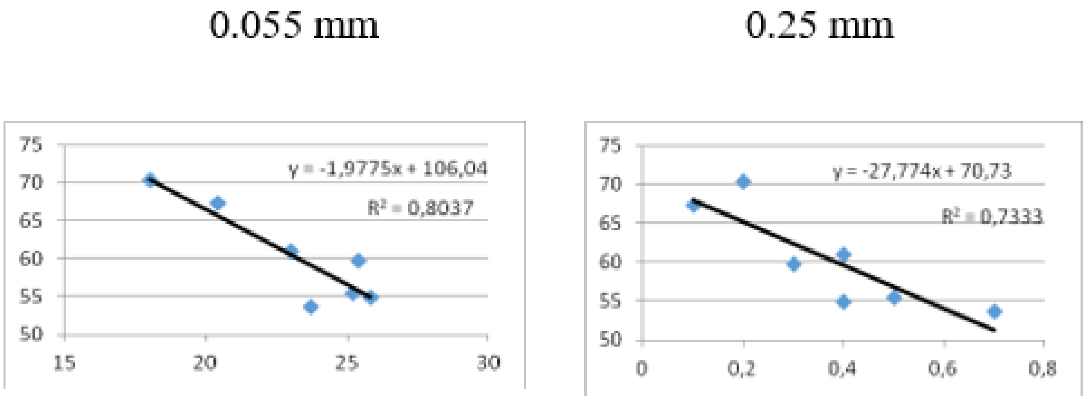


Figure 6: Dependence of porosity on the fraction content (0.055 and 0.25 mm) in sandy-clayey aleurolites

Finally, in the latter group, in clayey sandy loam deposits, the influence on the porosity of the dominant (fine, 0.055 mm) and subordinate fractions (coarser, 0.175 mm) also, like in the group of clayey-aleuritic sands, has the opposite tendency. In particular, an increase the content of the fine (dominant - 0.055 mm) fraction in clayey sandy loam leads to a decrease of porosity, while an increase the content of the coarser fraction (0.175 mm) increases the porosity of the clayey sandy loams (Fig. 7).

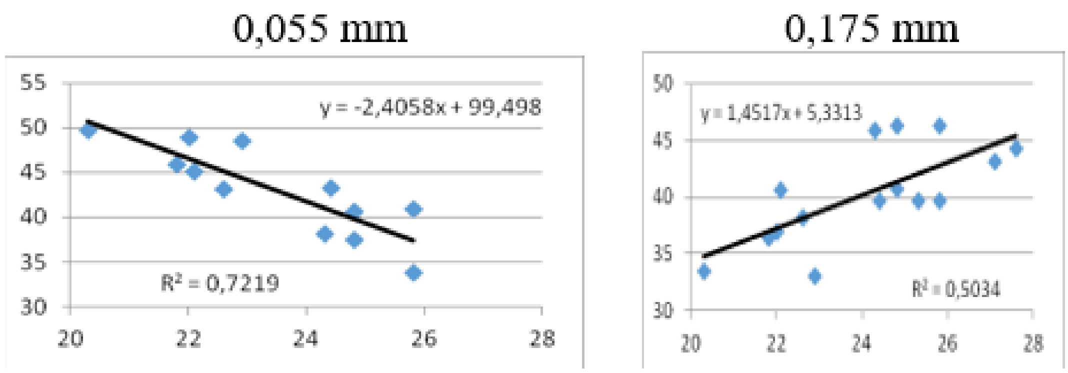


Figure 7: Dependence of porosity on the fraction content (0.055 and 0.175 mm) in clayey sandy loams

CONCLUSIONS AND RECOMMENDATIONS:

➢On the basis of results obtained it is concluded that the anticlinal zone of Gamamdag-deniz-Sabail-Nakhchivan, located in the central part of the Baku archipelago is highly promising.

➢There is an assumption that hydrocarbons are localized here (in the south-east) in deep synclinal troughs, migrated and accumulated in reservoirs from parent rocks located in the northeast part of these structures. Therefore, it is expected that the prospect of deep-seated sediments in this zone is associated with the VII horizon PS and the underlying sediments.

➢The prospect of recent exploration work on the areas of the Baku archipelago is also based on a more detailed assessment of temperatures and pressure in the oil and gas systems of the Productive Series. In addition, incorrect prediction of reservoir and hydrostatic pressures in the section of the Productive Series will led to accidents and complications in the drilling process. From this point of view, it is highly advisable to take into account the above anomalous phenomena when choosing the location of wells in the anticline zone of Gamamdag-deniz-Sabail-Nakhchivan.

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ОСОБЕННОСТИ СЕЗОННОГО РАЗВИТИЯ ПОЛЕЙ СЕРЕБРИСТЫХ ОБЛАКОВ СЕВЕРНОГО И ЮЖНОГО ПОЛУШАРИЙ ЗЕМЛИ

Солодовник[1] А.А.,
Байбусинова[2] А.К.
([1] кандидат физико-математических наук, доцент [2]магистрант,
Северо-Казахстанский государственный университет им. М. Козыбаева, Петропавловск)

АННОТАЦИЯ

На основании компьютерной обработки массивов изображений глобальных полей серебристых облаков северного и южного полушарий Земли изучены особенности сезонной и межсезонной изменчивости их общих характеристик. Основное внимание уделено временному ходу площади облачного поля. Обсуждаются детальные особенности сезонной эволюции полей серебристых облаков северного полушария. Показано резкое различие интегральных характеристик и характера эволюции и полей серебристых облаков северного и южного полушарий.

Ключевые слова: мезосфера, серебристые облака, спутниковый мониторинг, изображения облачности, компьютерная обработка, площадь облачного поля, аппроксимация, экстремумы, цикличность.

Введение

На основании детального анализа спутниковых изображений глобального поля серебристых облаков северного полушария (методика которого описана нами в предыдущей работе), полученных за более чем 10-летний период, нами выявлены некоторые важные особенности их сезонного развития [1]. Они касаются, прежде всего, характера изменения во времени общей площади облачного поля, кроме того, дат начала и окончания, а также длительности сезонов существования серебристых облаков в северном полушарии Земли.

Исходные данные и метод их обработки.

Изучение структуры глобальных полей серебристых облаков как северного, так и южного полушарий и изменения их общих параметров в продолжении сезонов их эволюции возможно благодаря свободному доступу, к ежесуточным картам облачности и их составным компонентам. По сути каждая из карт представляет суммарное суточное изображение облачного поля, которое в силу естественных причин не может быть получено одномоментно, даже с применением средств космической техники. Примеры спутниковых карт, изображающих вид глобального поля серебристых облаков северного (рис. 1 слева) и южного полушарий Земли (рис. 1 справа), показаны ниже на рисунках [2].