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Research Article

SOME PREREQUISITES FOR THE PROSPECTS OF OIL AND GAS CAPABILITY OF PALEOZOIC SEDIMENTS OF THE SYRDARYA DEPRESSION

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ABSTRACT
In recent years, there has been a tendency towards a targeted study of Paleozoic stratigraphic rock complexes in all oil and gas bearing regions of Uzbekistan, as well as within the Syrdarya depression, which is potentially oil and gas bearing. The obtained materials on Paleozoic formations within territories covered by a platform cover are of great interest, especially in connection with the discovery of numerous signs of oil and gas in them. The Upper Paleozoic deposits of the Syrdarya sedimentary basin are characterized by favorable conditions for the formation and preservation of hydrocarbon accumulations. The southeastern half of the Syrdarya depression is of much greater interest for oil and gas exploration.

Keywords: *Syrdarya Depression, Mesozoic, Cenozoic, Lower, Middle, Upper Structural Level, Paleozoic, Pre-Jurassic Complex, Oil Deposits, Bitumen*

INTRODUCTON

The growing needs of the national economy of the Republic of Uzbekistan for hydrocarbon raw materials and the high degree of realization of the projected resources of the sedimentary cover (Meso-Cenozoic) of oil and gas-bearing regions necessitated the accelerated study of new promising lithological and stratigraphic complexes and regions previously considered unpromising.

Ideas about the structure of Paleozoic deposits have been presented in the works of various scientists and researchers, including A.A. Abdulin, S.B. Abulgazin, A.A. Abidov, P.K. Asimov, A.A Alpaev, T.L Babajanov, A.A Bakirov, V.A Bykadorov, Yu.A Volozha, V.P Gavrilov, F.A Gilyazov, N.G Davydova, A Ch Iskakova, V Ya Zhaimina, G Zh Zholtaev, N X Zhamankulov, K A Kleschev, N A Krylova, N Ya Kunina, A B Li, V I Luk-Zilberman, M M Mailibaev, S D Mursalimov, D S Orujev, X X Paragulgov, V E Poleshchikov, L Ya Provodnikov, R B Sapozhnikov, O I Sergunov, S P Takirov, B B Talbirski, O A Fedorenko, GP Filipyev, BS Tsirelson, VS Shein, RS Shahabiev, VE Khain and others. Pre-Jurassic complex of rocks in this region has an extremely complex structural and tectonic structure, a diverse multi-tiered formation structure, as well as various capacities, degree of dislocation, etc. according to its geological structure and development history. In the most complete sections, they are composed of formations from the Cambrian to the Permian ages. But in some areas, there are no upper horizons, and strata of Carboniferous, Devonian, Silurian and even Cambrian rocks are exposed. Paleozoic deposits are composed of igneous and sedimentary formations - clay, sandy-siltstone, carbonate, etc. In the section, there are typical marine sediments that, according to general geological concepts, can be oil and gas-forming.

However, despite the fact that signs of bitumen and oil have been found in rocks of the Paleozoic period in natural conditions, the question of the prospects of oil and gas potential of this region remains open.

MATERIALS AND METHODS

In the Paleozoic deposits of the Middle Syrdarya massif, bitumen manifestations were found in various parts: in the upper reaches of the Pritashkent trough (Brichmulla, Chatkal, Chavaty areas), in the Turkestan and Nurata mountains (Gulibulak, Nuratau, Zainak, Aktau, Tamerlane Gate, Kenogaz, Shineak, Hishkat).

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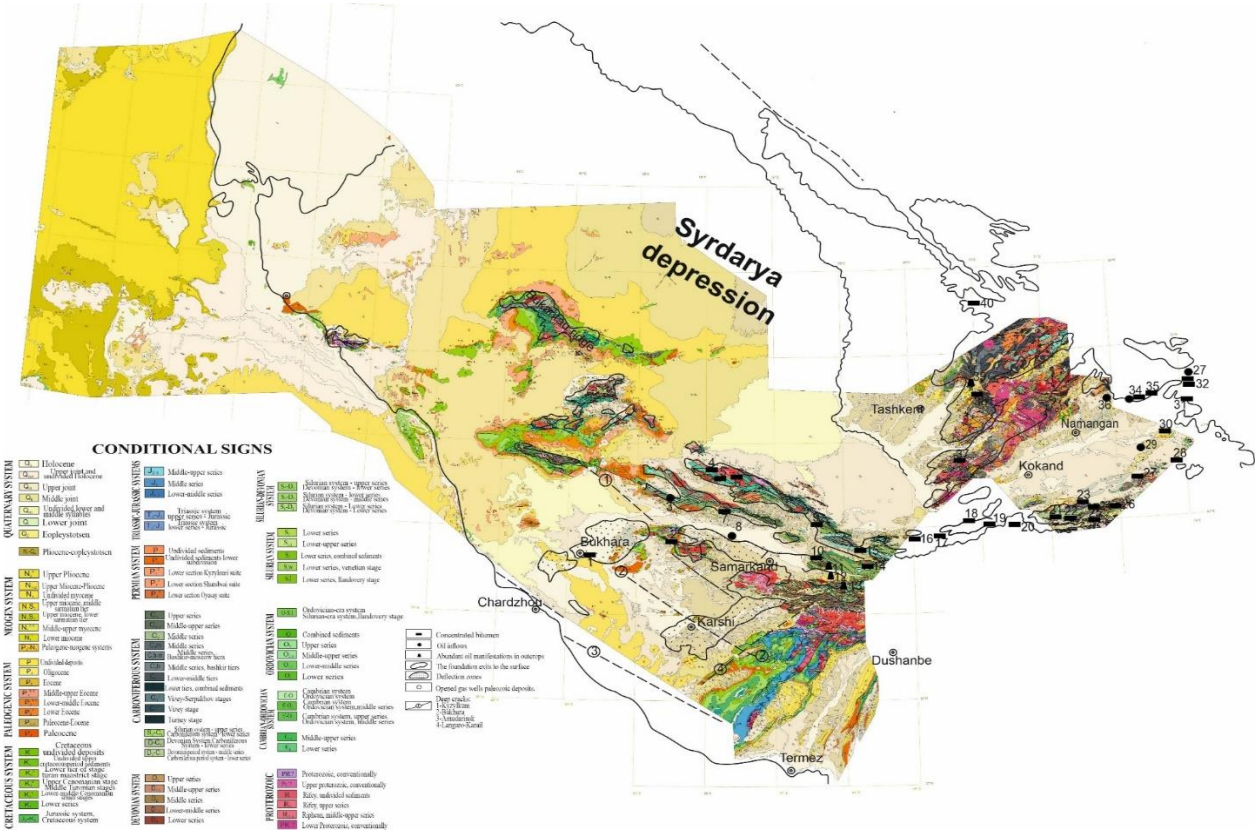

Figure 1: The distribution scheme of surface oil deposits in upper devonian-lower carboniferous sediments. Compiled by: Bigaraev A.B. 2004. The numbers on the scheme: 1. Suhaity; 2. Karnab; 3. Aktepe; 4. Gulibulak; 5. Nuratau; 6. Zainak; 7. Aktau. 8. Zeravshan; 9. Temerlan Gate; 10. Shineak; 11. Amansara; 12. Iora; 13. Kstut. 14. Hishkat; 15. Kenogaz; 16. Uratyube; 17. Sulukta; 18. Shchodymir; 19. Madygen; 20. Botkent; 21. Sarykamysh; 22. Kantrantau; 23. Kan; 24. Tamosha; 25. Shchakhimardan; 26. Chauvai; 27. Aravan; 28. Aldyyar; 29. Yuzhny Alamyshyk; 30. Kamlyrravat; 31. Urumbash; 32. Zinvan; 33. Kuraves; 34. Alash; 35. Mailisu; 36. Mailisai; 37. Chalata; 38. Chatkal; 39. Brichmulla; 40. Kornilovka.

In the Zarafshan depression, most of the bitumen fields are associated with the Zirabulak-Ziaetdin mountains, where deposits such as Karaiz, Maizak, Sukaity, Chodyr and Kermena are located.
Oil occurrences on Karaizskaya Square are concentrated in three intervals: the uppermost interval is represented by bituminous albite sandstones (XI horizon), which are found in the center of the structure. Bitumen is evenly distributed throughout the entire rock in this interval, forming a cementing mass. Bitumen has also been found in the cores of wells drilled in the southern foothills of the Zirabulak-Ziaetdin Mountains and in the Azkamara, Akrabat, and Khazar structures, which are located north of Karaiz, in the same geological layers.

The presence of bitumen deposits in clay (Azkamar, Nizhny Turon, Senon) and anhydrite (Akjar, Shurchi, etc.) suggests that tires have lost their protective properties in the periphery of the Amudarya syncline. At the same time, light or "normal" oil can convert into heavy and viscous oil, and then to malts and asphalt under near-surface conditions during movement through the reservoir under the influence of oxygen-rich and microbial infiltration water.

Based on the presence of bitumen in the cores of drilled wells and monoliths from Western Uzbekistan pits, seven bitumen fields have been identified: Maizak, Kermene, Sukaity I, Sukaity II, Chadyr, Zapadnoye, and Karaiz.

The oil occurrence in the Upper Silurian-Devonian deposits was first studied by geologists D.P. Lashkevich, L.T. Lupina, and N.D. Vinogradov at four more locations - Amandara, Maikota, Iora, and Uchkol - located on the northern side of the Panjakent depression (the southern slope of the Turkestan ridge). Oil-bearing rocks here are thin-bedded dolomitized limestones, dolomites, and sandstones dating back to the Upper Silurian and Lower Devonian periods. (Akhmedova, 2021**)**

These limestones have low porosity of 5.5% but relatively good permeability of 42 millidars. Liquid oil and its solidified products are found in irregularly spaced cavities and voids in the limestones and sandstones. Cavities are typically 1-2 centimeters in diameter, and an oil-bearing unit of dolomitized limestone and sandstone 10-20 meters thick is continuously traced along a stretch on the left bank of Iorysai River at a distance of 400-500 meters.

RESULTS AND DISCUSSION

The results of geochemical studies on the core material of Paleozoic rocks in the Kazakh part of the basin showed that the concentrations of residual organic matter and bitumens in these rocks were as follows: for rocks from the lower-middle Carboniferous period, 0.70% for residual organic matter and 0.0008% for bitumens (well 1-P); for rocks of the Serpukhov age, 0.53% for residual organic matter and 0.02-0.03% for bitumens (well 2-P); and for Famennian rocks, up to 0.69% for residual organic matter and up to 0.0012% for bitumen (well 3-P and 2-P). It was also found that higher concentrations of these substances were characteristic of interbeds of dark gray clastic rocks and polygenic carbonate rocks.

In addition, microscopic analysis of carbonate rocks revealed the presence of bitumens in individual sections of sample 2-P, along cracks and in a scattered form. This was observed during visual inspection of the cores (Table 1).

Table 1: Luminescent-bituminological studies of core samples from parametric wells of the Syrdarya sedimentary basin

Rock	Geological age	Content Corg, %	Bitumen type	Bitumen content		Insoluble residue%
				CB chloroform bitumen	ABB alcohol-benzene bitumen	
1	2	3	4	5	6	7
Sandstone	J_{1-2}	0.03	OB-oily bitumen	0.0012	0.0006	96
Gravelite	J_{2-3}		ORB resinous bitumen	0.0012	-	
Sandstone	-”-		ORB-oily resinous bitumen	0.0012	0.0155	
Limestone	C_1t_1	0.22	OB, LB-light bitumen, ORB	0.0063	0.0014	8.3
Siltstone	C_{1-2}	0.67	OB	0.0005	0.0003	92
Argillite	-”-	0.70	OB	0.0007	0.0004	85.1
Sandstone		0.70	OB	0.0005	0.0002	87

Limestone	C_1s-C_2b_1	0.0442	ORB, OB, LB, RB	0.004		2.97
Dolomite	-"-		ORB	0.0025		
Siltstone			OB, RB	0.0044	0.01	18.7
Argillite	-"-	0.23	LB, RB, ORB	0.0035	0.15	25.1
Limestone	D_3fm	0.68	OB, LB,	0.0015		24.2
Argillite	D_3fm	0.1	OB, ORB	0.003		48
Sandstone			ORB, OB	0.002		17.8
Argillite	-"-		OB	0.0021	0.0004	
Dolomite	-"-		LB,	0.0003	0.0006	
Breccia	-"-	-	LB,	0.0003	0.0006	-
Anhydrite	-"-	0.92	LB,	0.0003	0.0003	58.5
Siltstone	D_{2-3}	0.51	OB	0.0006	0.0012	89.5
Sandstone	-"-	0.118	OB	0.0002	0.0107	84.6
Breccia	-"-	0.57	OB, ORB	0.0006	0.0013	87.5
Argillite	-"-	0.29	ORB, LB, OB	0.0015	0.0018	85.05

The study of the chemical composition of bitumoids using gas-liquid chromatography techniques reveals that a significant amount of normal paraffinic hydrocarbons is found in the bitumoids extracted from these deposits. Isoprenoid octanes, such as phytane and pristane, are also present, and naphthenic aromatic hydrocarbons are noted. Additionally, several compounds characteristic of syngenetic bitumen have been identified. (Bigaraev, et al., 2002).
The unique chemical composition of these naphthenic compounds suggests that the observed bitumen deposits may be considered to be microneedles in the early stages of migration (Sergeeva, 2002).

The world's experience in oil and gas exploration has shown that the potential for oil and gas in any sedimentary basin is determined by three factors: source rocks, reservoir rocks, and cap rocks. If any of these factors are absent or of poor quality, it indicates that the region in question is not promising.
The high concentrations of organic substances found in mudstones that are more than 2,000 meters thick indicate that they should be classified as oil-bearing rocks. In addition, the high level of catagenetic transformation of the organic matter in these rocks makes it possible to consider them confidently as oil-producing rocks with most of their potential for oil generation realized. However, it should be noted that analogues to the 2-P and 3-P wells, which have comparable generation capacities, are generally more enriched in bitumen components despite having lower organic matter content compared to the 1-P well.

Discussion

The main theoretical prerequisites for the study of the geological structure and the oil and gas potential of Paleozoic formations are:
1. Rich bituminous content (CB up to 0.31%) has been established in Silurian rocks from outcrops. In Silurian rocks selected from outcrops near the content of Jizzakh organic matter turned out to be 0.33-5.5% on average 2.8%, so very high. Humic acids are almost absent. The yield of CB (A+C) is 0.06-0.2%, so significant.
2. In the area of the Pistalitau mountains, a 30-40m wide band of bituminous limestones has been established in the limestone of the Devonian. It is characteristic here that the pores and cracks of limestone are impregnated with bitumen, and their content in rocks increases 2.2 times from a depth of 50 meters.

3. In the Chashkat outcrops, Silurian rocks (limestones, marls, shales and sandstones) were studied; the sandstones and cavernous limestones resembled oil-saturated rocks in appearance. Bituminological analyses conducted by A.K. Karimov and H.N. Avazmatov confirmed their oil saturation (limestones 0.54%, marls – 0.35%, shales 0.66%, sandstones 0.30%).
4. S.R. Ramazanov gave a geochemical characteristic of the dispersed organic matter of the Paleozoic rocks of wells No. 1P-Aidar, No. 2P-Timur, No. 3P- middle Syrdarya. The content of C_{org} in the argillites of well No. 1P-Aidar is 0.48-0.83%, in sandstone 0.03%. The concentration of bitumoids is low (0.003-0.18%). The bitumoid coefficient fluctuates from 0.56 to 2.08%. In well No. 2P-Timur, mainly carbonate rocks were studied, the concentration of C_{org} in which fluctuates widely from 0.06 to 0.86%. In well No. 3P middle Syrdarya, the C_{org} content in the studied rocks fluctuates from 0.01 to 0.36% and does not depend on the lithological type of rocks.
5. In the Syrdarya depression, high-nitrogen gases have been found in Cretaceous and Jurassic deposits, and it is quite possible that in Paleozoic rocks the gases will have a hydrocarbon composition.
6. According to one of the geodynamic concepts, three main regimes must be passed for the formation of oil and gas-bearing regions: subduction, riftogenic and depression. The subduction regime is characterized by the "closure" of the ocean and the emergence of a continental structure in its place. During its evolution, the territory of investment blocks under consideration experienced at least three stages of subduction accretion: at the end of the Proterozoic, in the Ordovician - Early Silurian, in the Devonian - Middle Carboniferous. At the same time, the model of subduction oil and gas formation assumes the immersion of sedimentary rocks containing organic matter and buried gas hydrate accumulations under the accretionary prism.
7. Within the Baltakol swell of the middle Syrdarya depression, well No. 7-G Kekpenkaldi was drilled, in which horizons were tested in Paleozoic deposits (interval 2104-2195 m), in the middle part of the Neocomian (interval 1964-1975 m) and in the middle-upper Albian (interval 1802-1837 m).
Fresh water inflows were obtained from the upper horizon of the section, as in well No. 6G, and a different fluid characteristic was established in the lower horizons - a very weak inflow of salt water with signs of dissolved combustible gas was obtained from Paleozoic deposits; a somewhat more intense inflow of water with combustible gas was obtained from Neocomian deposits. In well No. 8-G Aidar (located 140 km to the east of the object under consideration), two horizons were tested in the intervals of 1674-1665 and 1750-1769 m. Both intervals yielded an inflow of salt water with a flow rate of 0.76 to 2.96 l/sec with signs of non-combustible gas. Gas analysis showed the presence of 1.2% helium in it. In the section of well No. 1P Aidar, increased gas readings were noted according to gas logging.
The features of the composition of the soluble part of organic matter of the Upper Paleozoic CPC formations indicate their active participation in the processes of hydrocarbon generation. The component composition of bitumoids of the Upper Paleozoic complex of the Syrdarya sedimentary basin indicates the presence of hydrocarbons of normal and isoprenoid structure in their composition, the molecular weight distribution of which is typical for hydrocarbons of the naphthenic series. Terrigenous-carbonate formations of the Lower Tournaisian substage of the Lower Carboniferous and the Famennian stage of the Upper Devonian are slightly enriched in organic matter. It is possible that these sediment complexes have also fully realized their generation potential. The Visean section of the section, which has high oil and gas potential in neighboring areas, is almost not opened in the inner regions of this basin and is practically not studied.
At the same time, the results of geochemical studies of organic matter of the Upper Paleozoic Syrdarya sedimentary basin and the establishment of intensive oil shows in their analogues of the North Torgay and industrial gas accumulations of the Shu-Sarysu basins indicate the prospects for oil and gas potential of the studied region. The results of the analysis of drilling and seismic exploration materials show a great similarity between the salt dome structures of the Arys and Bayrkum troughs and their analogues of the Shu-Sarysu and eastern Caspian basins (Gubkin 1975; Dalyan et al., 2005). In this regard, the oil and gas potential of the southeast of the Syrdarya sedimentary basin should also be associated with two Upper Paleozoic rock complexes: supra-salt and sub-salt. Supra-salt deposits may contain ring, semi-ring and other

types of hydrocarbon deposits screened by a salt stock, while sub-salt deposits, similar to the fields in the east of the Caspian basin (Kenkiyak, Karatobe, Zhanazhol) and the Shu-Sarysu gas fields (Amangeldy, Pridorozhnoye, etc.) (Bigaraev, *et al.,* 2002), will be associated mainly with various types of massive and sheet domed deposits. However, when determining the significance and priority of involvement in oil exploration, preference should also be given to the Upper Paleozoic sub-salt, especially the zone of the predicted barrier reef. Its possible hydrocarbon accumulations will be covered by salt-bearing strata of the Lower-Middle Carboniferous, both of diapiric nature and of sheet-like occurrence. Fluid-sealing seals of such types are characterized by a higher degree of reliability of screening compared to the conditions of adjoining the salt stock.

The southeastern half of the Syrdarya sedimentary basin has not yet entered the stage of its development. In this regard, large-scale studies should be planned here: a) to analyze a set of geophysical data; b) to drill wells to confirm the development of zones of supposed salt domes within the Arys-Bayrkum troughs; c) to detail the identified salt domes using CDPM seismic exploration; d) to expand the areas of geophysical work of varying detail in order to delineate new gravity anomalies-structures analogous to salt domes. (Paragulgov, *et al.,* 2007).

The above indicates that the southeastern half of the Syrdarya sedimentary basin has higher oil and gas potential than its northwestern half. It is this part that is characterized by all favorable geological prerequisites for oil and gas potential. These are: a) the presence of oil source strata; b) good hydrodynamic and hydrochemical conditions; c) the presence of reservoirs with satisfactory filtration and capacity properties in the sediments; d) the establishment of ideal seals - salt-bearing strata - in the Lower-Middle Carboniferous deposits.

In the section of the Upper Paleozoic quasi-platform complex of the studied sedimentary basin, strata of regional and zonal caprocks and reservoirs have been established, which are favorable for the formation of hydrocarbon accumulations. In order to differentiate the Upper Paleozoic quasi-platform complex of this sedimentary basin into reservoir and caprock horizons, we will consider the capacitive-filtration properties of each of the above-mentioned strata separately (Table 2).

The values of the latter were established based on the results of laboratory studies of core samples, as well as sampling and testing of possibly productive horizons. The results of testing and testing of individual reservoir horizons of the Upper Devonian-Lower Carboniferous age indicate that they have satisfactory capacity-filtration properties. Analysis of the above shows that in the thickness of the deposits of the Upper Paleozoic complex of the Syrdarya sedimentary basin, reservoirs and seals of both regional and local nature are distinguished. (Karshiev, *et al.,* 2024).

The regional seal developed within the entire northwestern half of the Syrdarya sedimentary basin is a thick stratum of Serpukhovian-Bashkirian argillites, penetrated by well 1-P, where its partial thickness is 1200 m. However, according to seismic exploration results, its thickness may be more than 2000 m. The role of an ideal regional (or zonal) seal will be played by halogen (salt-bearing) deposits of the lower-middle Carboniferous, established within the Arys and Bayrkum troughs of the southeastern half of the studied basin.

RESULTS

Table 2: physical studies of core samples from parametric wells of the Syrdarya sedimentary basin.

Rock	Geological age	Porosity, %		Volumetric weight of the rock, g/cm^3	Specific gravity of rock, g/cm^3
		unbar	full		
Sandstone	J_{l-2}	16.9		2.23	
Limestone	C_1t_1	-	-	2.755	-
Siltstone	C_{1-2}	1.3	1.27	2.62	2.65
Argillite		-	-	2.685	-
Sandstone		3.12	-	2.6	-

Limestone	C_1s-C_2b_1	-	-	2.49	-
Siltstone		0.8	-	0.7	-
Limestone	D_3fm	1.49	-	1.32	-
Argillite	D_3fm	0.74	-	2.03	-
Sandstone		0.51	-	2.13	-

The local seals are represented by layers of monolithic weakly fractured limestones, layers of sulfates and sulfated carbonate rocks. In addition, argillite layers are considered as local fluid seals. It is possible that sulfate and terrigenous lithological differences established in the sections of parametric wells 2-11 and 3-11 represent regional screening horizons, but the limited number of wells does not allow us to trace the nature of their areal development.

CONCLUSION

The above factual data on oil and bitumen manifestations, the assessment of oil and gas potential based on geochemical, hydrogeological, lithological-facies, structural and other criteria, allow us to give a very definite positive answer to the question of the existence of oil-producing layers in the Paleozoic deposits.
Consequently, the Upper Paleozoic deposits of the Syrdarya sedimentary basin are characterized by favorable conditions for the formation and preservation of hydrocarbon accumulations. The southeastern half of the Syrdarya sedimentary basin is of much greater interest for oil and gas exploration.
It is quite obvious that this complex and important issue can be finally resolved only with further deepening of comprehensive studies. For the most complete study of the Paleozoic lithological-stratigraphic complex of rocks, clarification of the material composition, stratigraphic division, study of the commercial parameters of reservoirs, generation capabilities, study of the velocity characteristics of the section, stratification of the reflecting boundaries of the Mesozoic and Paleozoic deposits, i.e. obtaining the necessary data, it is necessary to conduct targeted geological exploration work, including parametric drilling.

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