SOCAR Proceedings

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journal home page: http://proceedings.socar.az

EVOLUTION OF OIL AND GAS PROSPECTING IN THE BUKHARA-KHIVA REGION

A. N. Bogdanov*, O. A. Qarshiyev, M. A. Gaffarov, P. V. Khmirov, S. A. Rabbimkulov

Institute of Geology and Exploration of Oil and Gas Deposits, Tashkent, Uzbekistan

A B S T R A C T

The article briefly presents the history of discovery of hydrocarbon deposits within the Republic of Uzbekistan. Analysis on a continuous basis of the dynamics of discovery of deposits and raw hydrocarbon base is important in determining the directions of geological exploration. Allocation of the most promising regions for oil and gas prospecting allows to rationally place the volume of geological exploration works to achieve maximum efficiency. The research was based on a comprehensive analysis of materials on changes in the hydrocarbon base of the country, the dynamics of field discoveries for the period 1953-2023. Currently, the Bukhara-Khiva region occupies a dominant position in the country not only in terms of the number of fields and reserves, but also in terms of annual and accumulated oil and gas production. One of the main reasons for this is the presence on the territory of the region of 4 fields unique in terms of hydrocarbon reserves. The article notes that the depletion of 4 unique fields in the region is quite high, but these fields today still make a significant contribution to the total production of hydrocarbons. The scientific novelty of this study lies in relevant to date information, updated statistics on the impact of fields with large and unique reserves on the raw material base of the region. The conclusion is made about the determining importance of the size of hydrocarbon reserves of the fields in the structure not only of the region, but also of the republic as a whole.

Keywords: field; deposit; hydrocarbons; oil; gas; reserves.

Date submitted: 24.06.2024 **Date accepted:** 17.10.2024

Introduction

The foundation for the development of the economy, as well as extractive and processing industries of any country in the world is the geological exploration industry, which substantiates the prospects of territories and the deployment of geological exploration works on them, determines the directions, types and volumes of prospecting and exploration works, performs these works, creates and expands the mineral resource base of the country, creates a basis for stabilization and increase of mineral production [1, 2]. Revenues received from the oil and gas industry, which provides extraction, transportation, processing and sale of finished products constitute a significant part of the republic's budget [3-5]. That is why the geological exploration industry is referred to the strategically important sectors of the economy of the Republic of Uzbekistan, and geological exploration for oil and gas is not an exception.

Fossil energy production is currently increasing in all regions of the world except Europe and South America. The decline in production in some cases is due to depletion of reserves, in other cases it is economic in nature. Hydrocarbon resource base of any country is the basis for the development of oil and gas production and oil and gas processing industries [6-8]. The Republic of Uzbekistan in this regard is not an exception. The oil and gas industry occupies one of the leading positions in the economy of Uzbekistan (up to 96% of fuel and energy resources of the country), as it serves as a foundation for stabilization of the current state and further development of the country's industry and social sphere, provides national security and energy independence [9].

Analysis of the current state of the hydrocarbon base of the republic was carried out in different years by a large number of researchers. Previously conducted studies had a generalized form and were conducted in the framework of studies aimed at maintaining state statistical reporting on the movement of hydrocarbon reserves and resources (State Balances of Mineral Resources of the Republic of Uzbekistan) and in scientific and production reports aimed at determining the geological and economic efficiency of geological exploration for oil and gas.

The results presented in this article are detailed and cover the entire history of oil and gas exploration in the Bukhara-Khiva region (1953-2023), the dynamics of discovery of hydrocarbon deposits with the ranking of fields by the size of reserves and a conclusion is made about the significant impact on the raw material base and HC production of unique and large oil and gas fields.

The article attempts to reveal the history of oil and gas prospecting in the Bukhara-Khiva region for the entire peri-

**E-mail:* bogdalex7@yandex.ru

http://dx.doi.org/10.5510/OGP20240401012

od of geological exploration for oil and gas, to perform a comprehensive analysis of the achieved results on the annual changes in the raw material base of the republic and to make scientific conclusions on the prospects of increasing the hydrocarbon base of the republic and its production.

Analyzing the evolution of the search for oil and gas deposits

The first mentions of oil outlets on the surface of the earth on the territory of the Kokand Khanate were known before our era. It is no coincidence that it was in the Fergana region of Uzbekistan in the late XIX century that the oil industry was first born with oil production from two wells, the number of which soon exceeded 200 units. In 1885, the first oil field Chimion was organized in the Turkestan region. And in 1906, near Fergana, the first in Central Asia Vannovsky oil refinery was put into operation [10].

The Shursuv (1927), Andijan (1935), Palvantash (1943), South Alamyshik (1945), Sharikhan-Khodjaabad (1947) and Chongara-Galcha (1949) fields discovered in the following years and their commissioning allowed to gradually increase oil production, bringing this figure to 0.5 million tons per year in 1934. All this volume of oil production in Uzbekistan fell on the Fergana region.

The discovery in 1934 of the first in the Surkhandarya region of the field Haudag, allowed to refer the region in the category of oil-bearing, and identified in the following years fields Uchkyzyl (1935), Kokaiti (1939), Lyalmikar (1943) and their commissioning allowed the republic not only to increase annual oil production to 0.8-1.0 million tons, but also to position the region as oil and gas bearing (Lyalmikar).

But this is all about oil production. In view of the fact that within the Fergana and Surkhandarya regions the overwhelming number of fields refers to oil, less often to oil and gas by types of fluids, the annual production of free gas in Uzbekistan at that time was carried out in insignificant volumes (200-400 million m^3).

A turning point can be considered 1953, when the industrial gas content of the Bukhara-Khiva region (BKhR) was proved by the discovery of two fields - Setalantepe and Tashkuduk. 1956 for the republic is marked by the discovery of the first in the Soviet Union unique in hydrocarbon reserves Gazli field [10, 11]. In 1962, the Gazli field was put into operation, which directly affected the increase of free gas production in the republic up to 9.2 billion m^3 in 1964 (of which 91.3% came from the Gazli field), but also confirmed the high prospects of oil and gas content of the subsoil of Uzbekistan. Since then, the Bukhara-Khiva region has taken a leading position among other oil and gas bearing regions of the country in terms of hydrocarbon resource base and annual oil and gas production. This situation also contributed to the construction of the Central Asia-Center and Bukhara-Urals trunk gas pipelines [10, 11].

Despite the fact that in subsequent years new oil and gas bearing regions were identified: South-West Gissar (in 1962 with the discovery of the Adamtash gas condensate field) and Ustyurt (in 1963 with the discovery of the Shakhpakhty gas field), to date the Bukhara-Khiva region remains the leading one both in terms of the number of discovered fields and hydrocarbon reserves and production volumes.

The five currently known oil and gas bearing regions of Uzbekistan (Ustyurt, Bukhara-Khiva, South-West Gissar, Surkhandarya and Fergana) differ from each other in geological structure, stratigraphic range of productivity, number of identified deposits and discovered fields, depth of occurrence of oil and gas deposits [10].

Currently, 28 fields have been identified in the Ustyurt region, 211 fields in the Bukhara-Khiva region, 19 fields in the South-West Gissar region, 14 fields in the Surkhandarya region, and 33 fields in the Fergana region. In total, 305 fields of hydrocarbon raw materials were discovered in the Republic of Uzbekistan as of 01.01.2024 [12].

Results of geological exploration works

According to the size of hydrocarbon reserves, oil and gas fields of the Republic of Uzbekistan are divided into unique (>300 million tons of fuel equivalent (t.u.t.)), large (30-300 million t.u.t.), medium (10-30 million t.u.t.) and small (<10 million t.u.t.). The world experience of hydrocarbon development testifies to the prevailing share of large and unique fields in the total production volume. In total, about 43000 oil fields and 27000 gas fields have been identified in the world. Of these, more than 120 fields are categorized as unique in terms of HC reserves, where about 37% of the initial HC reserves of industrial categories are concentrated. The efforts of the world oil and gas industry specialists have been devoted to the issues of search and further development of unique hydrocarbon fields, which are primarily related to economic feasibility. Currently, the role of unique and large oil and gas fields is gradually decreasing, but continues to be significant, which is reflected in the Republic of Uzbekistan [13]. The reserves concentrated in 4 unique fields of the republic, to date, reach 36.2%, in 27 large fields - 43.8%, in 33 medium - 8.8%, and the remaining reserves (11.2%) are concentrated in 241 small fields (fig. 1) [14]. The above data show that the role of large and unique deposits in terms of reserves can hardly be overestimated. A similar situation is observed in the production indicators for the entire period of exploitation, where their share reaches 89.7% of the republic's indicators [11].

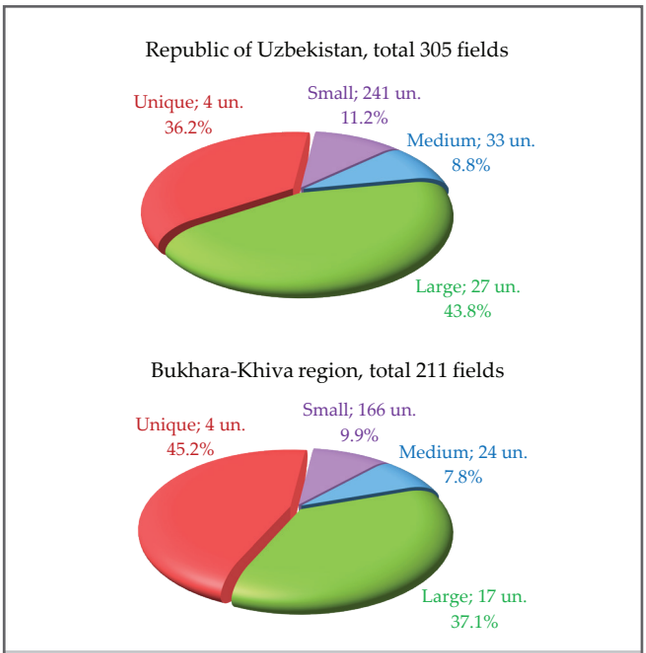

Fig. 1. Hydrocarbon deposits of the Republic of Uzbekistan and Bukhara-Khiva region by size of initial reserves

The analysis of exploration in many oil and gas bearing regions of the world shows that since the beginning of oil and gas prospecting, the index of prospecting efficiency has been changing naturally [15]. According to this indicator, in general, four main periods can be distinguished. For the Bukhara-Khiva region this regularity is also traceable [14, 16].

The first (initial) period is reconnaissance in nature and is characterized by a small number of discovered oil and gas fields. During this period, regional studies are conducted to study the geological structure of the region, to determine and substantiate the prospects of oil and gas bearing capacity of the territory, to identify stratigraphic complexes potential for the presence of oil and gas deposits, and their detailing, identification and preparation of objects, drilling wells to search for hydrocarbon deposits. The efficiency of this period is not high due to a large number of «empty» traps, the number of which reached 15 units [16].

The greatest efficiency of geological exploration was in the second period, when a significant number of fields with significant hydrocarbon reserves were discovered. This is due, first of all, to the fact that the results of geological and geophysical studies reveal, first of all, large structures that have the potential to contain significant hydrocarbon reserves. Naturally, these objects become the first priority in the search for oil and gas deposits, since with relatively small volumes of deep drilling, in the case of discovery of hydrocarbon deposits, there is a high probability of finding significant hydrocarbon reserves [16].

In the third period, against the background of decreasing growth of oil and gas reserves, there is a decrease in the volumes of their production, which begins to acquire a steady character, which was not necessarily related to the volumes of deep drilling and density of well placement, but more likely to the high development of large fields and lack of new large discoveries. The efficiency of hydrocarbon reserves growth at one large field is incomparably higher than at a dozen of small fields with hydrocarbon reserves. Finding a way out of this situation by directly increasing the volume of deep drilling is not always expedient for a number of reasons, which are mainly based on the economic factor. Also in this period there is a gradual involvement of deep-lying horizons in prospecting, associated with the growth of the study of overlying sediments, which affected the number of discovered fields [16].

The final (fourth) period is characterized by a further decline in production, which is inherently associated with a smaller increase in oil and gas reserves, as a result of the manifestation of mainly two factors: geological and scientific and technical [16].

The geological factor is characterized by a significant reduction to a minimum of the probability of detection of new deposits and fields, especially unique and large HC reserves, caused by a significant increase in the study of territories and stratigraphic complexes. The increment of hydrocarbon reserves due to the discovery of small hydrocarbon deposits in the aggregate is insignificant and cannot affect a significant increase in hydrocarbon reserves. Nevertheless, the fourth period, in terms of time, is very long and is characterized by the discovery of mainly small hydrocarbon deposits [16].

According to many researchers (Krylov N. A., Kontorovich A. E., etc.), oil and gas reserves of large fields usually do not exceed 50% in well explored oil and gas bearing basins of the world, and in small fields - 40-45% [16].

On the example of the Bukhara-Khiva region, where the share of reserves of large fields is 37.1%, and of small fields - does not exceed 10%, we can talk about the feasibility of exploration for many years (fig. 1) [16].

The scientific and technical factor in the search for and exploration of hydrocarbon deposits can be represented by a number of reasons. Among them are changes in views on the processes of formation and distribution of oil and gas deposits, as well as limitations in the necessary equipment and modern technology for exploration at great depths or in complex geologic structures. Often, problems with research and development funding are at the heart of the technical factor. Lack of funds can seriously affect each stage of work [12, 17].

Discussion of exploration results

A comprehensive analysis of the results of geological exploration for hydrocarbons in the Bukhara-Khiva region shows that the first period covers the time period from 1950 to 1955, at the time of the first discoveries (Setalantepe and Tashkuduk), belonging to the category of small, with total HC reserves of industrial categories as of 01.01.1956 in the amount of 7.3 million tons of oil equivalent (0.2% of the initial reserves of industrial categories of BKhR as of 01.01.2024).

The time interval from 1956 to 1990 belongs to the second period and is characterized by discovery of 76 hydrocarbon fields, including all 4 fields of the Bukhara-Khiva region unique in hydrocarbon reserves, 14 large, 13 medium and 45 small, with total hydrocarbon reserves in the Bukhara-Khiva region as a whole as of 01.01.1991 in the amount of 3334.1 million tons of oil equivalent (72.9% of the initial reserves of industrial categories of BKhR as of 01.01.2024).

The third period started from 1991 and continues up to the present time. During this period 133 oil and gas fields have been discovered in the BKhR, including 3 large HC reserves, 9 medium-sized and 121 small ones, with total HC reserves in the region as of 01.01.2024 in the amount of 1274.1 mln. t.c.e. (27.6% of the initial reserves of industrial categories of the BKhR as of 01.01.2024).

A comprehensive analysis of the results of geological exploration work in the BKhR indicates the dominant position of the second period relative to other time periods, and allows us to attribute it to the third stage of work [16].

The Bukhara-Khiva region, with a total area of prospective lands of 53.8 thousand square kilometers, currently occupies a dominant position (80.0% of the total hydrocarbon reserves of industrial categories of the republic; 89.2% of the total accumulated production of the republic and 76.7% of the annual production of the republic). The region covers the territory of Bukhara, Kashkadarya, Samarkand and Navoi [10].

In orographic terms, the territory of the region represents desert (Kyzylkum), semi-desert (Karshi, Karnabchul steppes) and foothill lands, bounded in the south and north-west by the state border of the Republic of Uzbekistan, in the north by the Central Kyzylkum uplifts, in the north-east by the spurs of the Turkestan and Zarafshan ranges and in the south-east by the south-western spurs of the Hissar range [10].

The Bukhara-Khiva region is the northeastern side of the Amu Darya syneclise and is characterized by a two-storey structure: the lower storey is represented by the basement (consolidated Paleozoic subcap complex) and the upper storey by the cover composed of sedimentary formations.

The volume of the basement includes the crystalline basement formed during the Precambrian, Cambrian, Ordovician and Silurian, and the folded basement formed during the Devonian, Carboniferous and Lower Permian. The basement is completed by an intermediate structural stage formed during the continental break after the uplift of the region as a result of crustal destruction, separating the consolidated basement and sedimentary cover. The section of the intermediate structural stage is composed of Permo-Triassic sediments, the formation of which is associated with denudation processes and their redeposition in depressed areas of the Paleozoic relief [18].

On the territory of the Bukhara-Khiva region hydrocarbon deposits are represented mainly by gas accumulations. Oil-bearing deposits are not so numerous, are of subordinate importance and lie mainly in the form of sub-gas deposits and oil rims of small thickness.

Industrial productivity of the Bukhara-Khiva region according to the results of geological exploration for oil and gas has been established in the section of the Jurassic carbonate formation and terrigenous formations of Cretaceous and Jurassic age [11, 16]. Initial commercial reserves and cumulative production in these formations are distributed as follows: Cretaceous terrigenous deposits account for 16.1% and 20.5%, Jurassic terrigenous deposits - 1.2% and 0.6%, and Jurassic carbonate deposits - 82.7% and 78.9%, respectively (fig. 2) [11].

This situation is typical not only for oil and gas bearing regions of Uzbekistan, as currently a significant part of hydrocarbons in the world are produced from carbonate reservoirs. Carbonate Jurassic is a gas-bearing complex of the world scale, containing up to 75% of hydrocarbon reserves of industrial categories of Uzbekistan (more than 4 trillion m^3) and more than 90% of proven reserves of the Amudarya province (about 35 trillion m^3 with maximum concentration in unique and large fields Galkynysh, Yashlar, Shurtan, Urtabulak, Zevardy, etc.). The maximum concentration of liquid hydrocarbons within the BKhR is distinguished by the oil and gas condensate field Kokdumalak with initial geological reserves of liquid hydrocarbons in the amount of over 142 million tons [18]. In spite of a sufficiently high study of carbonate reservoirs, reliable assessment of hydrocarbon reserves and planning of development of carbonate reservoirs are associated with a high level of risk.

Due to the fact that hydrocarbon deposits of the first fields of the Bukhara-Khiva region were located mainly in terrigenous sediments of Cretaceous age, the bulk of hydrocarbon reserves were confined to these sediments and, accordingly, almost all production was carried out from them. This state of affairs remained in the 1970s, when, along with the discovery of new fields with oil and gas deposits in Jurassic carbonate sediments, the high potential of these sediments for the presence of large hydrocarbon deposits was confirmed.

The point is that until the late 1960s there was an opinion about the structural type of all traps within the Bukhara-Khiva region. This opinion was changed due to the discovery of significant thicknesses of carbonate formation associated with reef massifs in Dengizkul, Urtabulak, Zevardy, South Pamuk, Alan and other wells. The results of the exploration works made it possible to delineate the barrier-reef system and a number of single reef massifs in the section of the carbonate formation of the Middle-Upper Jurassic age of the

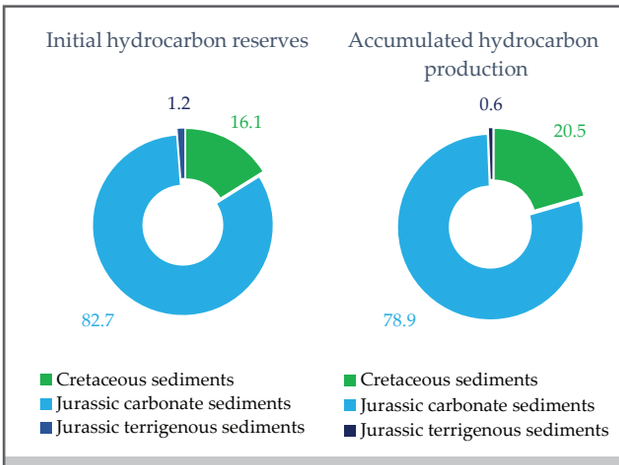

Fig. 2. Bukhara-Khiva region. State of initial reserves and accumulated production of hydrocarbons as of 01.01.2024

Bukhara-Khiva region. Wide development of high-capacity granular reservoirs in the volume of reef traps allows generating substantial HC reserves in their volume [11, 16].

This fact served as a basis for reorientation of the main volumes of geological exploration to the sediments of riffogenic genesis, and subsequent discovery of new fields with large HC reserves in their volume, to significantly increase the volumes of their production [19]. As a result, by the mid-60s, the number of deposits in carbonate sediments increased to 48 units, to 58 units in Cretaceous sediments and to 9 units in terrigenous sediments of Jurassic age. The total number of deposits amounted to 115 units (fig. 3) [11].

Prediction, search and exploration of oil and gas deposits in carbonate sediments, primarily of reef genesis, are determined by the specifics of lithological and facial composition and physical properties of reservoir and cover rocks, paleogeographic situation of their accumulation and conditions of realization of oil and gas-maternal potential [20, 21]. The carbonate complex of the Jurassic age of the Bukhara-Khiva region is composed mainly of limestones, with which organo-

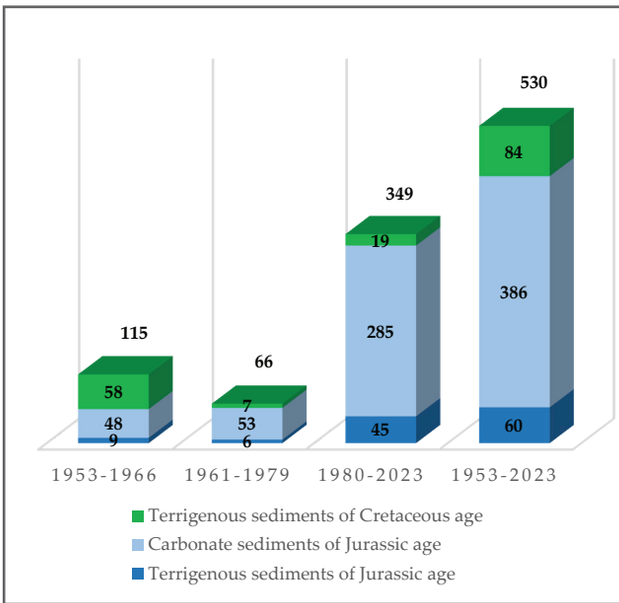

Fig. 3. Bukhara-Khiva region. Distribution of hydrocarbon deposits by stratigraphic complexes

genic structures are genetically related, the total thickness of which can reach 450 meters. By type, reefs in the area under consideration are subdivided into barrier reef systems, solitary reefs and shelf bioherms, biostromes.

At this stage, in Cretaceous terrigenous sediments, the unique Gazli field was discovered, the initial reserves of which amounted to 579.1 million tons of hydrocarbons or 81.4% of the total initial hydrocarbon reserves of the entire Bukhara-Khiva region and 60.8% of the initial hydrocarbon reserves of the Republic of Uzbekistan. As we see, the share in the hydrocarbon base of the country of the only at that time unique field Gazli, oil and gas deposits in which were confined in full to terrigenous sediments of Cretaceous age, was predominant.

This, in turn, was reflected in the production figures. The discovery of such a field as Ghazli had a huge impact on the increase in annual oil and gas production, which by the early 1960s reached 77.7% (or 8.7 million tons of oil equivalent) of the total production in the region (11.2 million tons of oil equivalent). This trend continued in subsequent years, and by the end of the 1960s, the share of HC production at the Gazli field reached 81.8% (29.6 mln. t.c.e.) of the 36.2% mln. t.c.e. production in the region as a whole [11].

By 1967, by stratigraphic section, HC reserves, annual (1966) and cumulative production were distributed, respectively, as follows: 84.7%, 73.4% and 87.9% - were in Cretaceous sediments; 14.4%, 26.6% and 12.1% - in carbonate sediments of Jurassic age and, finally, 0.9% of the initial reserves of hydrocarbons of commercial categories were in terrigenous sediments of Jurassic age, from which no extraction was carried out. Based on this, we can state the fact that the Cretaceous sediments were, at that time, the main stratigraphic complex for HC reserves and production (fig. 4) [11].

With reorientation of the main volumes of geological exploration to Jurassic carbonate sediments, the number of discovered HC deposits in these sediments naturally began to grow, and in the period 1961-1979 a total of 66 deposits were discovered, of which 7 - in Cretaceous sediments, 53 - in Jurassic carbonate sediments, 6 - in Jurassic terrigenous sediments (fig. 3).

By the 1980s, the number of identified deposits within the Bukhara-Khiva region reached 181 units, of which 65 were located in Cretaceous, 101 - in Jurassic carbonate and 15 - in Jurassic terrigenous sediments [11, 16].

At the same time, the period under consideration was marked by the discovery of 3 more fields categorized as unique in terms of reserves: Dengizkul-Khauzak-Shady-Northern Dengizkul-Khojasayat (1966), Zevardy (1968) and Shurtan (1974). As a result, HC reserves concentrated in the volume of this group of fields reached 67.5% of the total reserves of the region, annual production (1980) - 63%, and cumulative production -74.4% [11].

Also, the state of initial HC reserves in the region was greatly influenced by the stock of large fields, the share of which reached 26.6%. Share indicators of annual (29.6%) and accumulated production (20.1%) relative to the total indicators for the region look comparable.

The total initial reserves of unique and large deposits in the Bukhara-Khiva region amount to 94.1%, annual production - 92.6%, and cumulative production - 94.5%, which indicates their overwhelming importance in the resource base of the region. At the same time, medium and small hydrocarbon fields play a much less important role in the formation of the resource base, which account for the remaining percent.

As a result, the share of initial hydrocarbon reserves of Jurassic carbonate deposits reached 69.1%, while the share of Cretaceous terrigenous deposits decreased to 30.6% and the share of Jurassic terrigenous deposits was insignificant and amounted to only 0.3%. At the same time, the indicators of annual and cumulative production remained practically unchanged due to the fact that the discovered unique fields were at the initial stage of development. Thus, the indicators of annual hydrocarbon production were 45.6% (vs. 53.8% for Cretaceous sediments, the remaining 0.6% were Jurassic terrigenous sediments), and cumulative production - 13.2% (vs. 86.5% for Cretaceous sediments, the remaining 0.3% were Jurassic terrigenous sediments) (fig. 5).

The analysis of stratigraphic confinement shows that HC deposits in the newly discovered unique fields (3 units) were fully located in the section of carbonate sediments of the Middle-Upper Jurassic age, which greatly changed the distribution of HC reserves over the stratigraphic range.

With the growing study of the territory and discovery of new oil and gas fields, the picture of the current state of the hydrocarbon base of the Republic became clearer. During the period 1980-2023, 349 deposits were discovered, of which 19 - in Cretaceous sediments, 285 - in Jurassic carbonate sediments, 45 - in Jurassic terrigenous sediments (fig. 3). As of

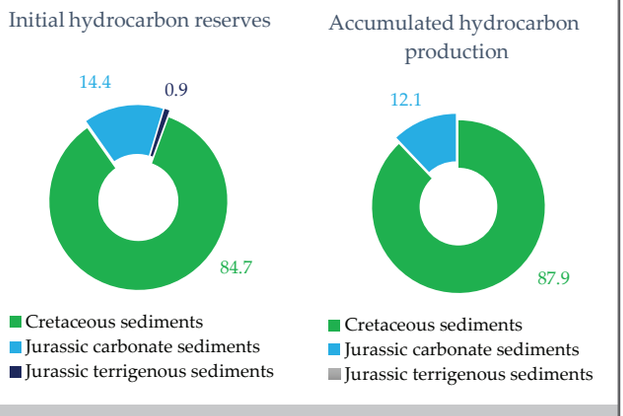

Fig. 4. Bukhara-Khiva region. State of initial reserves and accumulated production of hydrocarbons as of 01.01.1967

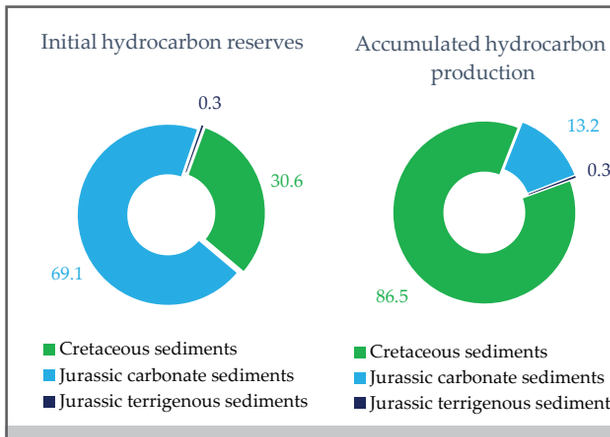

Fig. 5. Bukhara-Khiva region. State of initial reserves and accumulated production of hydrocarbons as of 01.01.1980

today, 211 oil and gas fields have been discovered within the BKhR, where 530 deposits are concentrated. By stratigraphic complexes, they are distributed as follows: 84 deposits are located in Cretaceous sediments, 386 deposits - in Jurassic carbonate sediments and 60 - in terrigenous sediments of Jurassic age (fig. 3). The change in the identification of hydrocarbon deposits by years was reflected in the dynamics of production by stratigraphic complexes (fig. 6). Among the deposits by types of fluids gas, gas condensate, oil, oil-gas and oil-gas-condensate are distinguished. In the Bukhara-Khiva region there are 468 deposits containing gas accumulations in free form, deposits containing condensate - 404 units, deposits containing oil - 132 units. That is, as we can see, deposits containing free gas prevail.

At the current stage (as of 01.01.2024), the development of the unique fields of the Bukhara-Khiva region is quite high and amounts to: 62.1% for the Dengizkul-Khauzak-Shady-Northern Dengizkul-Khojasayat field, 83.7% for the Shurtan field, 85% for the Gazli field and 90.1% for the Zevardy field. Despite this, the annual production of this group of fields, even today, reaches 34.8% of the annual hydrocarbon production of the Bukhara-Khiva region and 27.5% of the hydrocarbon production of the Republic of Uzbekistan, that is, these fields remain the base fields for the oil and gas production industry of the Republic of Uzbekistan [11, 22].

In the future, the depletion of unique hydrocarbon reserves will steadily grow and strive for complete depletion, as well as in the more distant future of large fields, so one of the promising directions of stabilization and increase in hydrocarbon production is the introduction of advanced innovative technologies to increase the recovery rate of oil, gas and condensate. The prospective directions of development of the oil and gas sector of the republic are similar in many respects and directly depend on the prospective directions of strategic development of hydrocarbon production technologies in the world [23].

In addition, a similar situation is observed in the group of large HC fields, the share of initial reserves of which is 37.1%, annual production (2023) - 44.8%, and cumulative production - 35.7% of the total for the region.

The share of unique and large HC fields in the structure of initial reserves of the Bukhara-Khiva region is 82.3%, in the structure of annual production - 79.5% and in the structure of cumulative production - 91.9% (fig. 7).

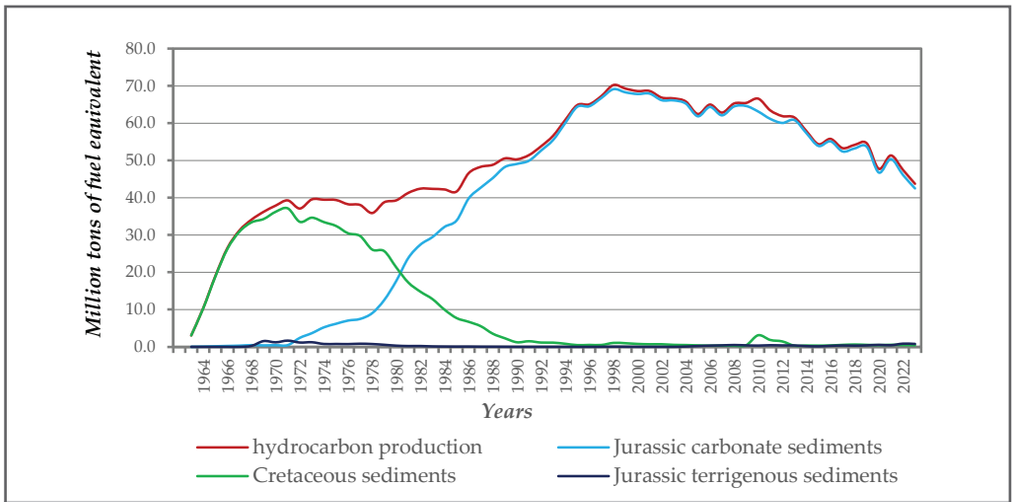

Fig. 6. Bukhara-Khiva region.
Dynamics of hydrocarbon production by stratigraphic complexes

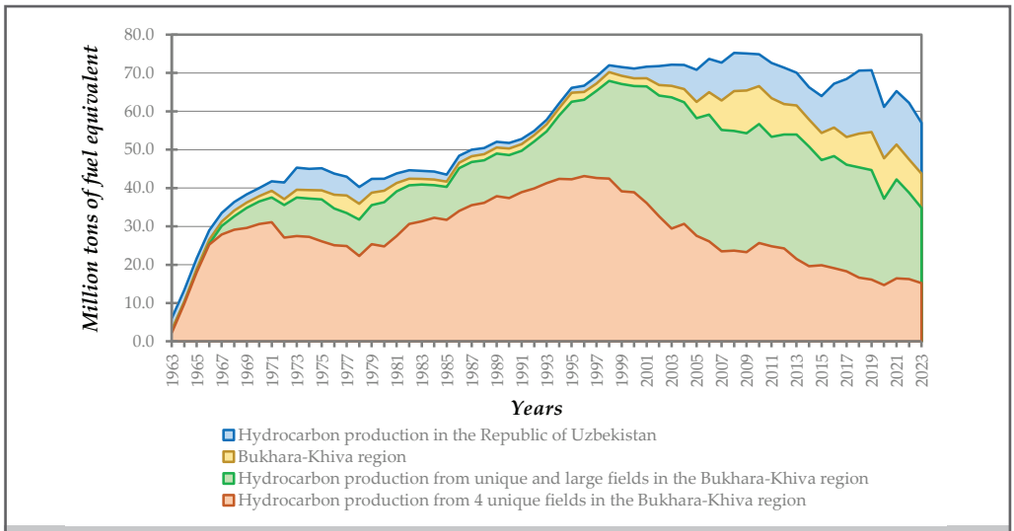

Fig. 7. Dynamics of hydrocarbon production for the period 1963-2023

In particular, the share of initial HC reserves in such fields is 80.0% of the total initial reserves of commercial categories of Uzbekistan. Annual production in 2023 in these fields amounted to 80.4% of the total annual production in the Republic, and the accumulated production for the entire period of operation reached 89.7%. Nevertheless, at present, the probability of identifying unique and large hydrocarbon reserves in the sedimentary cover section of the Bukhara-Khiva region (at relatively shallow depths) is low. There are few alternative proposals on strategic directions of prospecting and exploration of new oil and gas giants, among which the most priority is the development of great depths. For the Republic of Uzbekistan this issue is becoming more and more urgent every year [24].

Conclusion

1. The efficiency of the use of hydrocarbon resources in any region of the world directly depends on the pace of search and development of unique and large hydrocarbon deposits, oil and gas processing facilities, intensification of the construction of pipeline systems and the establishment of interstate export-import relations [25].
2. Unique and large hydrocarbon fields have had and continue to have a significant impact on the indicators of the raw material base of both the Bukhara-Khiva region and, in general, on the indicators of the Republic of Uzbekistan.
3. Most of the annual oil and gas production in the Bukhara-Khiva region in 2023 (more than 98%) falls on the Jurassic carbonate deposits, and the remaining 2% come from the Jurassic and Cretaceous terrigenous deposits.This situation is likely to continue in the coming years, since the current reserves, totaling the large and unique fields of the BKhR, account for 63.8% of the region's reserves and 42.6% of the republican reserves [11].
4. Gradually, the depletion of unique hydrocarbon deposits will be compensated by involving mainly large fields into development. However, on the example of Bukhara-Khiva region we can observe that it is not quite enough. In order to stabilize HC production, it is necessary to intensively bring into development also medium and small fields.
5. In order to increase the hydrocarbon base of the republic, it is necessary to multiply the volume of geological exploration works, not only within oil and gas bearing regions and stratigraphic complexes, but also in new promising areas and deep-immersed stratigraphic complexes.

References

1. Tamala, J. K., Maramag, E. I., Simeon, K. A., Ignacio, J. J. (2022). A bibliometric analysis of sustainable oil and gas production research using VOSviewer. *Cleaner Engineering and Technology*, 7, 100437.

2. Sohag, K., Sokhanvar, A., Belyaeva, Z., Mirnezami, S. R. (2022). Hydrocarbon prices shocks, fiscal stability and consolidation: Evidence from Russian Federation. *Resources Policy*, 76, 102635.

3. Dorian, J. P. (2006). Central Asia: A major emerging energy player in the 21st century. *Energy Policy*, 34(5), 544-555.

4. Badeeb, R. A., Szulczyk, K. R., Lean, H. H. (2021). Asymmetries in the effect of oil rent shocks on economic growth: A sectoral analysis from the perspective of the oil curse. *Resources Policy*, 74, 102326.

5. Elhuni, R. M., Ahmad, M. M. (2017). Key performance indicators for sustainable production evaluation in oil and gas sector. *Procedia Manufacturing*, 11, 718-724.

6. Filimonova, I. V., Eder, L. V., Provornaya, I. V., Cherepanova, D. M. (2020). The influence of the oil and gas industry on the economy of producing countries. *St Petersburg University Journal of Economic Studies*, 36(4), 693-718.

7. Rasoulinezhad, E., Sung, J., Talipova, A., Taghizadeh-Hesary, F. (2022). Analyzing energy trade policy in Central Asia using the intercountry trade force approach. *Economic Analysis and Policy*, 73, 441-454.

8. Wang, Z., Fan, Z., Chen, X., et al. (2023). Global oil and gas development in 2022: Situation, trends and enlightenment. *Petroleum Exploration and Development*, 50(5), 1167-1186.

9. Karanfil, F., Omgba, L. D. (2023). The energy transition and export diversification in oil-dependent countries: The role of structural factors. *Ecological Economics*, 204(B), 107681.

10. Abdullaev, G. S., Bogdanov, A. N., Eidelnant, N. K., et al. (2022). Oil and gas fields of the Bukhara-Khiva region. *Tashkent: Fan - Ziyosi*.

11. Bogdanov, A. N., Karshiev, O. A., Khmirov, P. V. (2023). The role of the Bukhara-Khiva region in the state of the hydrocarbon potential of the Republic of Uzbekistan. *ANAS Transaction. Earth Sciences*, Special Issue, 168-172.

12. Abdullaev, G. S., Bogdanov, A. N., Eidelnant, N. K. (2019). Current state and prospects for the development of geological exploration for oil and gas in the Bukhara-Khiva region of the Republic of Uzbekistan. *Oil and Gas Geology. Theory and Practice*, 14(2), 1-51.

13. Kontorovich, A. E., Eder, L. V., Filimonova, I. V., Mishenin, M. V. (2016). The role of unique and large fields in the Russian oil industry: retrospective, current state, forecast. *Energy Policy*, 2, 34-43.

14. Bogdanov, A. N., Khmirov, P. V. (2024). Results of geological exploration for oil and gas and development of hydrocarbon resource base of Bukhara-Khiva region. *Journal of Oil and Gas Geology*, 1, 45-57.

15. Zhang, G., Qu, H., Chen, G., et al. (2019). Giant discoveries of oil and gas fields in global deepwaters in the past 40 years and the prospect of exploration. *Journal of Natural Gas Geoscience*, 4(1), 1-28.

16. Abdullaev, G. S., Bogdanov, A. N. (2013). Problematic issues of domestic geological exploration for oil and gas. *Uzbek Journal of Oil and Gas*, 4, 10-16.

17. Salam, A.-R. (2023). A review of modern approaches of digitalization in oil and gas industry. *Upstream Oil and Gas Technology*, 11, 100098.

18. Melikhov, V. N., Abdullaev, G. S., Bogdanov, A. N. (2022). Traditional and new structural-tectonic and oil-gas geological models of the South Turan Plate in the context of the Caspian International Geological Project. *Oil and Gas Geology. Theory and practice*, 17(4), 1-68.

19. Hayitov, O. G., Salizhanova, G. K., Mutalova, M. A., et al. (2021). Oil and gas potential in the territory of the South-Eastern part of the Bukhara-Khiva region. *Revista Geintec-Gestao Inovacao E Tecnologias*, 11(4), 4699-4708.

20. Lei, T., Hong, L., Yuzhe, T., et al. (2020). Characteristics and mechanism of upper permian reef reservoirs in the Eastern Longgang Area, Northeastern Sichuan Basin, China. *Petroleum*, 6(2), 130-137.

21. Sun, L., Fang, C., Sa, L., et al. (2015). Innovation and prospect of geophysical technology in the exploration of deep oil and gas. *Petroleum Exploration and Development*, 42(4), 454-465.

22. Rybyakov, A. N., Skorobogatov, V. A., Khabibullin, D. Ya. (2023). The largest, gigantic and unique hydrocarbon deposits of Siberia and the Russian Far East. How many are still open and where? *News of Gas Science*, 1(53), 278-293.

23. Sokolov, N. A., Larin, S. N. (2018). Prospects for the development of the oil and gas sector of the Russian economy in the context of the implementation of import substitution programs. *Bulletin of Science and Practice*, 4(1), 191-206.

24. Volozh, Yu. A., Abukova, L. A., Rybalchenko, V. V., Merkulov, O. I. (2022). Formation of oil and gas fields in deep-seated hydrocarbon systems: towards a universal exploration concept. *Geotectonics*, 5, 27–49.

25. Okeke, A. (2021). Towards sustainability in the global oil and gas industry: Identifying where the emphasis lies. *Environmental and Sustainability Indicators*, 12, 100145.