First-Priority Directions and Targets of Geological Exploration Works for Oil and Gas in North Caucasus Region

Alexey I. Varlamov
VNIGNI
Moscow, Russia,
varlamov@vnigni.ru

Pavel N. Melnikov
VNIGNI
Moscow, Russia,
melnikov@vnigni.ru

Nikolay I. Nemtsov
VNIGNI
Moscow, Russia,
ninemtsov@vnigni.ru

Mikhail B. Skvortsov
VNIGNI
Moscow, Russia,
skvortsov@vnigni.ru

***Abstract*—Based on analysis of hydrocarbon resource potential, geological structure aspects and results of geological survey in the North-Caucasus oil-bearing province, first-priority directions and targets of geological exploration works are suggested in order to accelerate the preparation of discovered hydrocarbon reserves in the medium-term perspective. The key issue is speeding up the process of research drilling on prepared geological targets of Dagestan shelf of the Caspian, which has considerable resources of hydrocarbons.**

Keywords—resources, hydrocarbon, exploration, shelf of the Caspian Sea.

I. INTRODUCTION

The North Caucasus region covers the territory of the North Caucasus oil and gas province, including all the subjects of the North Caucasus and part of the Southern Federal Districts.

The North Caucasus region is the oldest oil and gas producing region of Russia and has recently been characterized by the following main negative trends:

- production decline and reserves growth of hydrocarbon;
- nonrecoverable production by hydrocarbon reserves increasing.

The unfavorable situation with the state of hydrocarbon reserves and their growth can be explained by the following factors:

- On the one hand, a significant exploration of the total initial resources (province average — 68%) and the development of initial explored reserves of the AB1C1 category (86 %);
- On the other hand, insufficient financing and exploration volumes, from both the business and the government. It is safe to say that the financing of geological exploration in the North Caucasus Federal District is 7 times less (on average since 2003) than in the Southern Federal District; accordingly, the volume of exploration is less: volume of deep well drilling is 10 times less, 2D seismic — 7 times less.
- Insufficient exploration drilling (maximum 1 prospecting and 1-2 exploration wells are drilled per year). In addition, the share of exploratory drilling decreases (to 6-37%), while in the Southern Federal District it is 48-85%, and in Russia — 45-62%.
- The main financing (92%) and the volume of exploration are implemented by the Vertically Integrated Oil Company «Rosneft»: drilling, seismic exploration and reserves growth — up to 100%. Most small companies are extremely passive.
- The minimum values for the majority of subjects of residual proven reserves of AB1C1 category and B2 and C2 estimated reserves (excluding the Stavropol and Krasnodar territories).
- Insufficient preparation of new exploration areas for companies on the province onshore, such as subsalt Jurassic of the Terek-Caspian and the West Kuban deflections, "shale" oil of Khadum, non-anticlinal traps, the foundation and its weathering crust.

II. RESULTS AND DISCUSSION

Taking into account the low value of explored and preliminary estimated reserves, the basis for the preparation of new proven hydrocarbon reserves in the most of the North Caucasus oil and gas province subjects may be mostly undiscovered resources.

The main volumes of undiscovered resources in the North Caucasus oil and gas province are predicted in the Caspian Sea, and onshore — within the Tersko-Caspian and the West Kuban deflections, where the discovery of large hydrocarbons accumulations is most likely in the near and medium term. In

other regions of the onshore province territory, it is expected to discover mainly small reserves deposits; at the same time, there is a resource potential of greater or lesser degree in almost every district and in each province's oil and gas play.

Most of the undiscovered hydrocarbon resources of the North Caucasus oil and gas province are concentrated on the Caspian shelf. According to the latest "Quantitative assessment of hydrocarbon resources ..." (2009), overall estimate of the recoverable resources of the C3 + D category of all onshore hydrocarbons of the North Caucasus oil and gas province is 1,165 million tons of oil equivalent (OE). As of 01.01.2017, the undiscovered C3 + D resources of the Caspian Sea's shelf exceed those of the entire oil and gas province onshore more than 3 times (with a much smaller shelf area). Only the prepared resources D0 of the total hydrocarbon content of the Caspian shelf make up more than 1.3 billion tons of OE.

The nearest reserve for the preparation of new discovered and preliminary estimated hydrocarbon reserves are prepared D0 and localized Dl resources ready for drilling and identified sites, respectively.

Over the past 10-15 years, as a result of exploration work carried out by companies, a significant number of traps of various types and ages have been identified and prepared for drilling on the Caspian shelf within the available drilling depth. The presence of numerous lithologic heterogeneities and pinchouts of the Mesozoic-Cainozoic sediments, which can be connected with varied lithological and lithologic and stratigraphic traps and hydrocarbon deposits with resources much larger than in the onshore fields, was established in cross-section (Fig. 1) [1, 2, 3].

Tectonically, the territory of the Caspian shelf is a continuation of the onshore tectonic structures — the Tersko-Caspian foredeep (TKFD), the Nogai stage, the Prikumsky uplift zone and Karpinsky range.

Within blocks 2 and 4 (Izberbash and Sulak), which are a continuation of the Tersko-Caspian foredeep, the resources of the prepared sites are estimated to be about 500 million tons of OE, and the prospective D1 resources are more than 900 million tons of OE. The following traps are prepared for drilling on the Block 2 territory: connected with a large sandbody in Chokrak stage, tectonically screened in Cretaceous and Jurassic sediments, non-anticlinal lithological and stratigraphic traps in the Miocene and Pliocene (Fig. 2) [3].

A sandbody object in Chokrak sediments is the largest and most promising for oil and gas (Fig. 2, 3). The object is a structure of north-north-west bearing, the arch of which (structural contour 3100 m) is located in the south-west. The greatest thicknesses (up to 140 m) is observed in the northern most submerged part. The overall dimensions of the object are 31 x 10 km. The sandbody is characterized by the following features in time sections (Fig. 3): 1) the presence of intraformational morphologically expressed positive structure on the object top; 2) increased capacity (over 100 ms) of Chokrak deposits inside the object; 3) lateral change in the nature of the wave record: chaotic inside the object, outside — parallel-layered; 4) the presence of the amplitude anomaly in the structure top and the intensity of reflections decrease in the structure bottom; 5) overburden onlap. On these criteria, based on the paleo facial conditions of Chokrak deposits formation here, as well as by analogy with the seismic wave pattern on the Frig oil field (North Sea, Norway), the Chokrak sand body is assigned to the submarine cone. Characteristic features of the object are the chaotic pattern of lineup and a visible reduction of signals power within it and parameter increments in the neighborhood of reflecting interface N1-2ch2-1 (roof)). The first testifies to a significant sanding of sediments in the thickness of the object, the second — its possible oil saturation.

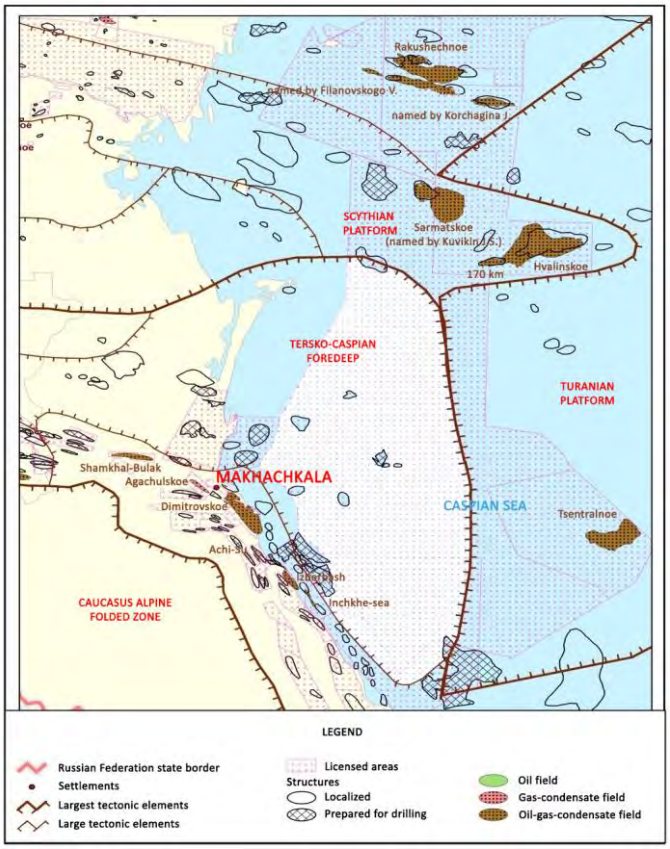

Fig. 1. Promising oil and gas exploration sites on the Russian shelf of the Caspian Sea

The presence of sandy composition of rocks in the body of the object and a clay cap above it is confirmed by comparing the interval of the temporary seismic section corresponding to the Karagan-Chokrak deposits (reflecting interface N1-2kg - N1-2ch1-3) with the well log data Izberbash-248. At the same time, the coincidence of field geophysical and stratigraphic benchmarks, as well as rock lithology with seismic data, has been noted.

According to the detailed analysis of the characteristics of lineup in the body of an object in its northern part, low-intensity near-horizontal reflections are distinguished, for which a forecast of oil-water contact is possible here.

It follows from the analysis of the seismic section that Chokrak sandbody is complicated by intraformational fault. The quality of the cap can be judged by the symptom of stability along the lateral notation corresponding to the clay units directly above the top of the object — the reflecting interface N1-2ch2-1. The presented feature of the object is indicative of its high potential.

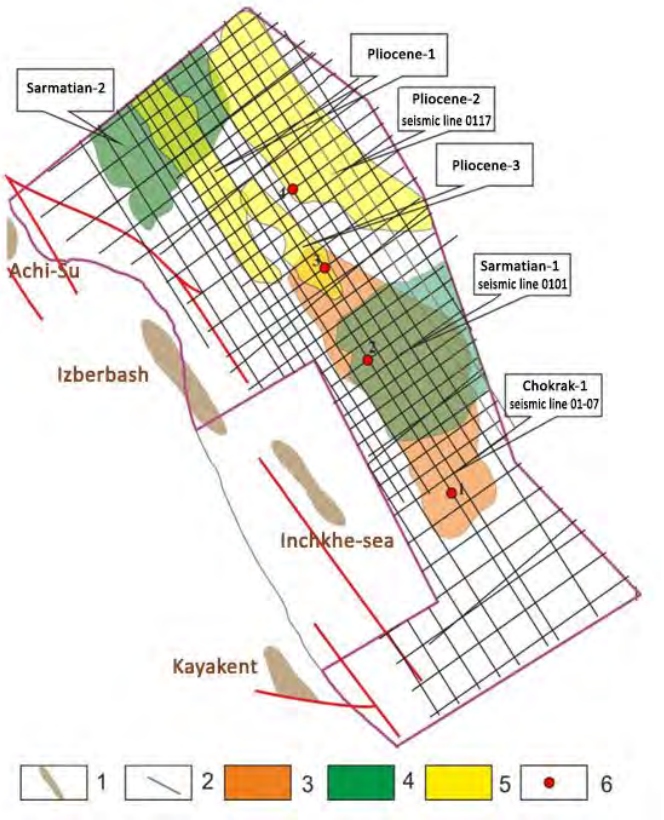

Fig. 2. Shelf of Caspian Sea. Block № 2. facilities prepared for exploratory drilling (according to "Geothermneftegaz"): 1 — oil fields; 2 — seismic profiles; trap outline in sediments: 3 — chokrak stage, 4 — Sarmatian stage, 5 — pliocene; 6 — project exploration wells

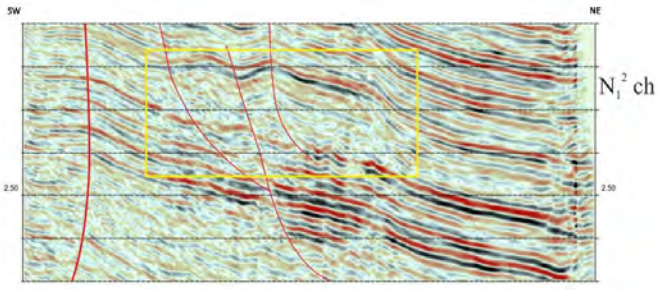

Fig. 3. Shelf of Caspian Sea. Block № 2. Traps related to the largest sand body in chokrak deposits. Seismic profile 0107 (according to "Geothermneftegaz")

Objects provisionally titled "Sarmat-1" and "Sarmat-2" are assigned to the Sarmatian deposits (Fig. 2, 4). Objects are distinguished by seismofacial appearance, corresponding to the cut. In the seismic sections, the cut is distinguished by the violation of the regularity of reflections that are traced below the reflecting interface N1-2S. Both objects can be referred to paleochannels. In spite of their significant thickness (200–300 m), the upper preroofed part with thicknesses of the order of 10–30 m (on the periphery) to 50–90 m (at the center of the objects) can be taken as potentially productive.

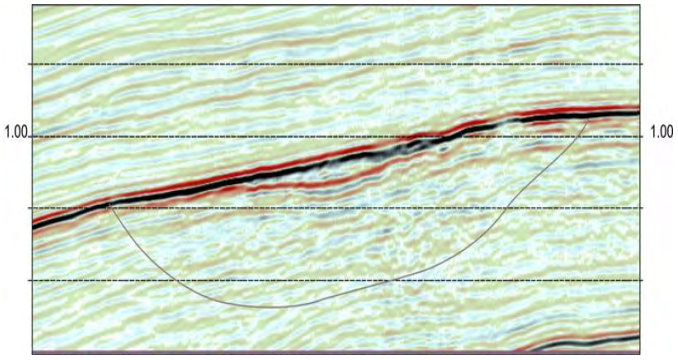

Fig. 4. Shelf of Caspian Sea. Block № 2. Isolation of lithologic and stratigraphic traps in the thickness of the paleo down-cutting filling of Sarmatian deposits. Seismic profile 0101 (according to "Geothermneftegaz")

In addition to the seismic-facial appearance, according to which, within the objects, the presence of sandy units is predicted, the potential of the objects are due to local "bright spot" anomalies type in the neighborhood the reflecting interface N1-3S overlapping the objects. Contours of the most promising oil-saturated areas of objects can be distinguished by the signal power level ≥50 c.u. with a sufficient degree of reliability. Taking into account the isopachyte ≥50 m, Sarmat-1 object ("central") is characterized by dimensions of 10.5 x 9.3 km, and Sarmat-2 object (north-western) isopachyte ≥10 m is 8.5 x 5.5 km. Clay units of overlying pliocene sediments serve as a cap for traps predicted in the upper parts of objects.

"Pliocene - 1, 2, 3" (P1, P2, P3) objects are located in the pliocene-Quaternary seismic sequence. A characteristic feature of the considered part of the seismic complex is the clinoform appearance constituting it axes of coherent reflections, the presence of anomalies of signals amplitudes of signals of "bright spot" within the reflecting interface overlapping the selected objects (Fig. 2, 5). Object sizes: 14.5 x 2, 16,6 x 5,5, 8,5 x 2,0 km. Each of the objects is accompanied by a local increase in signal power (≥10–15 c.u.). The thickness of the objects is up to 35 m. The contours of the objects are determined by isopachyte 10 m. The areas of the greatest hydrocarbon potential are identified by a combination of thicknesses and power level of signals.

In the north-west of the Caspian shelf, on the continuation of the Prikumsky zone of uplifts and the Manych trough, more than 10 potentially productive oil and gas objects of anticlinal and non-anticlinal types were found in the Jurassic-Cretaceous and partially in the Triassic sediment complexes; the area of the structures is up to 244 sq. km, the amplitudes are up to 175 m.

The hydrocarbon resources of the prepared Severo-Tyulenye uplift (block 5) are about 80 million tons of OE (Fig. 7).

Oil and gas content in the layers of the Middle and Upper Jurassic, Lower Cretaceous and Lower Triassic is predicted in

the limits by analogy with the identified fields on the shelf and on land (Khvalynskiy, Sarmatian and others) (Fig. 7). The object on the surface of the Middle Jurassic is a structural trap with an area of 244 sq. km and an amplitude of 140 m.

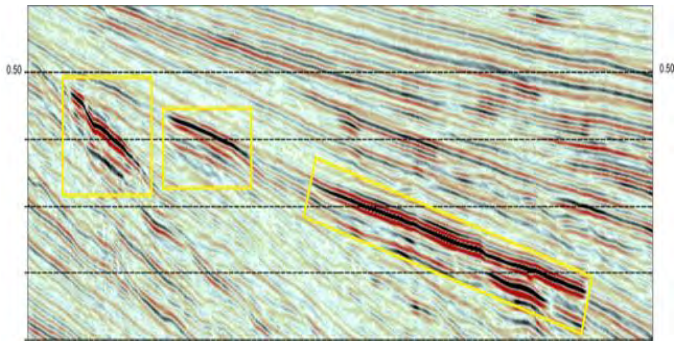

Fig. 5. Shelf of Caspian Sea. Block № 2. Isolation of lithologic-stratigraphic traps in Pliocene sediments. Seismic profile 0117 (according to "Geothermneftegaz")

The structural-stratigraphic traps in the Miocene and lithological trap connected with clinoforms in the Pliocene are also predicted in the north-western part of the Caspian shelf (Fig. 8).

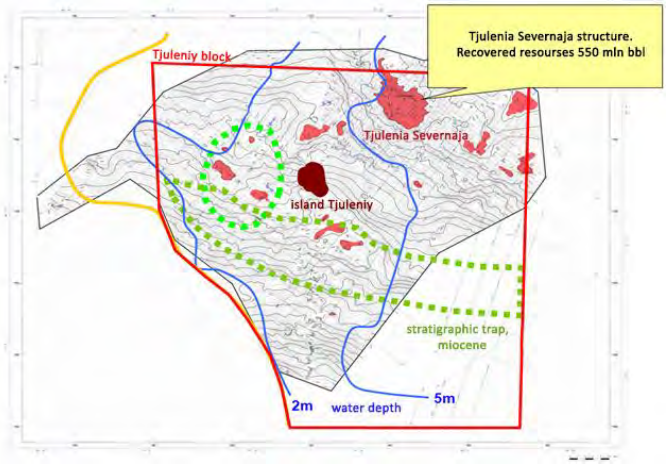

Fig. 6. Caspian shelf. Block № 5. Scheme of hydrocarbon leads in the Jurassic-Cretaceous complex (according to " Megatron" company)

In addition, in the coastal zone of the Caspian Sea, to the east of the Izberbash and Dimitrovskiy fields and running from the Makhachkala to Belidji, about 20 prospective structures were found located in the same structural-facial zone with the Inche-Sea oil field and which can be identified both petroleum (Chokrak (horizon) and oil-gas condensate fields (Jura-Cretaceum-Paleogene) (Fig. 1). The advantage of these structures is their location near the coast (5–7 km) in the shallow part (up to 5 m) of the water area, which will allow revealing potentially oil and gas bearing reservoirs by controlled directional wells from land. More detailed analysis of these objects is recommended in order to identify if they are ready for licensing. In order to estimate resources more reliably, it is possible to recommend geological exploration at the expense of the federal budget to conduct regional-zonal seismic survey — a longitudinal seismic profile with a length of 150 long km, connecting the allocated uplifts with individual cuts

According to seismic data, traps connected with faulted carbonate buildups are distinguished in deposits of the Upper Cretaceous. Objects are characterized by hummocky configuration of lineup; cover thickness — more than 5.0 km, sizes about 14 x 6 km.

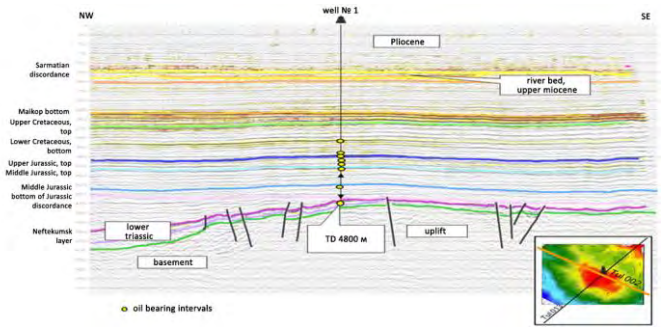

Fig. 7. Caspian shelf. Block № 5. Structural trap Tulenya Severnaya. Seismic cross section lateral — Tul 002 (according to " Megatron" company)

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The result of the works within the shelf blocks were identified numerous potentially productive oil and gas traps in a wide stratigraphic range. However, no company has started exploratory drilling due to various types of risks for medium and small companies yet: financial (high drilling costs compared to onshore), technical (lack of drilling platforms in the region for offshore drilling) and political (situation in the region). In the further continuation of geological exploration works on the Caspian shelf, in our opinion, government intervention is needed in order to give companies some preferences or to take the prospective drilling initiative with companies at one of the promising areas on certain agreements. The cost of a well can vary in the range of 0.9–1.2 billion rubles, which is 3 times less than the cost of time-consuming and expensive parametric well drilling such as 1-Chumpalovskaya (Kabardino-Balkaria Republic). The probability of discovering large hydrocarbon deposits on shelf is high enough without sulphuretted hydrogen.

The main unexplored hydrocarbon resources (44 %) are concentrated in the Terek-Caspian trough on the Onshore territory of the North Caucasus oil-bearing province in which, in addition to the traditional Jura-Neogene complex, subsalt Upper Jurassic carbonate strata should be considered as one of the primary objects of study (Fig. 9).

The high oil and gas potential of the Jurassic subsalt complex is based on the large thicknesses (up to 500-700 m) of carbonate rocks, industrial oil and gas potential of both Upper Jurassic and the overlying Meso-Cenozoic sediments and the presence of reefogenic facies, reef traps, reliable saliferous seal, large subsalt positive structures and faults (as hydrocarbon conductors and as a factor of reservoirs

hyperpermeability). This area of focus is now mainly at the regional stage of study and its development is complicated and deceleratted by the following factors — large stratum depths (5000-7000 m); lack of reliable sedimentation model of the subsalt complex; presence of aggressive components such as hydrogen sulphide (6% and more) and carbon dioxides (6.5% or more) in formation fluids; difficult well drilling conditions due to the high development of Upper Jurassic salt deposits and intensive salt brine occurence and abnormally high formation pressure. These factors, as well as the absence of parametric wells in the internal most promising downfold zones affect the low efficiency of seismic survey.

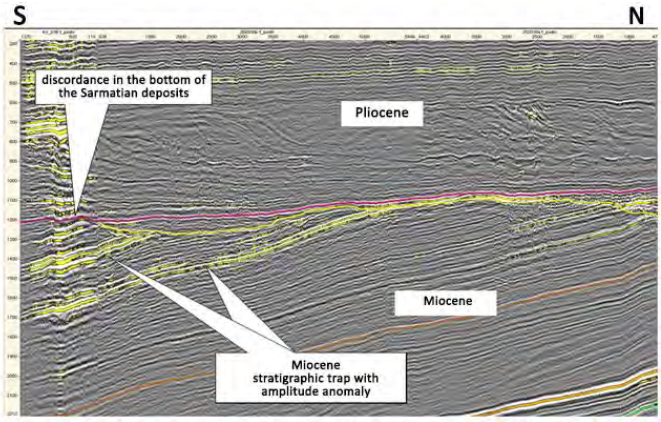

Fig. 8. Caspian Sea Shelf. Block № 5. Structural and stratigraphic traps in the Miocene and lithological traps in the Pliocene. Profile 202038 (according to “Megatron” company).

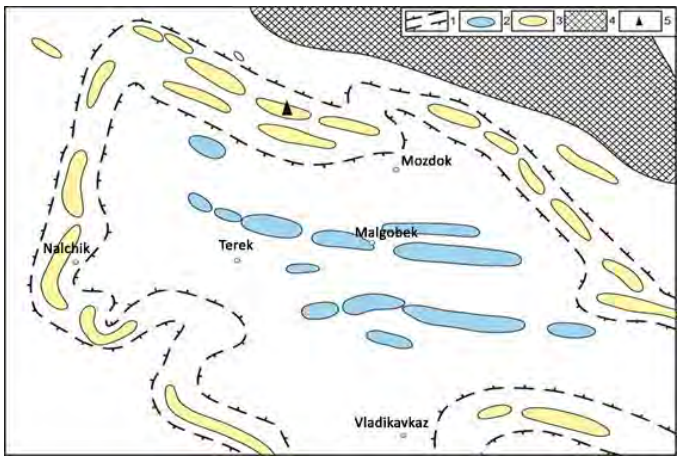

Fig. 9. Scheme of the proposed development zones of the Upper Jurassic reef structures in the Terek-Caspian trough (by Samoylovich V.L., 2004 r.): 1 — estimated zone of barrier-type reef traps distribution; 2 — prognosticated interbasin reefal traps; 3 — reefal buildup in the shelf zone and of barrier type; 4 — the area of subsalt Jurassic deposits absence; 5 — drilling parametric 1-Chumpalovskaya well

Hydrocarbon potential of the Jurassic carbonate deposits is established on the south side (Datykh gas field) and in the southeast part of TKFD (Shamkhal-Bulak and Makhachkala-Tarki gas fields, the Republic of Dagestan).

In 2016, at the expense of the federal budget, the construction of a parametric 1-Chumpalovskaya well was started on the northern side of the trough to clarify the oil and gas potential of the subsalt Upper Jurassic carbonate and the middle Jurassic terrigenous strata (projected depth — 6250 m, target horizon — middle Jurassic); its current depth in the Lower Cretaceous — 4720 m. FGBU "VNIGNI" initially did not agree with the selected location of the parametric well, since, in our opinion, barrier reef traps with small hydrocarbon reserves can be distributed on the border of TKFD. While in the central parts of TKFD high-capacity Jurassic reef traps of intrabasin type with medium and large hydrocarbon reserves can be expected. The amplitudes of the intrabasin reef traps, by analogy with other basins (Peri-Caspian depression, Umetovsko-Linevskaya depression and others) can amount to hundreds of meters, the amplitudes of barrier traps mostly amount to tens of meters. Even today, large and high-amplitude (up to 500 m) subsalt uplifts supposedly connected with the Upper Jurassic reefal buildup are outlined according to seismic data in the depression zone of the TKFD (Fig. 9). As such, it is recommended to drill a parametric well in the central part of the TKFD with the maximum completion of subsalt deposits with a depth of 6500-7000 m, regardless of the drilling results of the 1-Chumpalovskaya well. In order to improve the mapping technique of deep subsalt horizons, when choosing the location of parametric drilling, additional zonal-regional seismic profiles may need to be carried out using 2D CDP method. One of the most reasonable and promising oil and gas locations for a new parametric well for subsalt Jurassic is in the junction zone of the Sunzhenskaya anticlinal zone with the southern border of the Alkhanchurtskaya syncline, as was suggested earlier, before establishing the location drilling 1-Chumpalovskaya well.

In 2016, as a result of processing and interpreting 2D seismic surveys (materials of OAO Stavropolneftegeofizika and the Gubkin Russian State University of Oil and Gas), 15 objects with D0 resources of 54 million tons of oil, 29 objects with Dл resources of 103 million tons of oil and 11 billion cub. m of gas; average resources per object make up 3-4 mln. tons of HC, which is typical for intrashelf reefal traps. In addition, stratigraphic traps connected with the stratigraphic truncation of Jurassic deposits of different age are mapped on the northern border of the Terek-Caspian trough. It should be noted that seismic studies were only partially concerned for the inner part of the Tersko-Caspian trough, where spreading of large hydrocarbon deposits connected with reefal traps of the intrabasin type is possible. Unfortunately, in the basin part of the trough it has not yet been possible to achieve a sufficiently reliable mapping of subsalt objects due to difficult subsurface conditions — cover overthrust and salt tectonics, great depths, Maykopsky thick clay mass, etc.

In various zones of the Tersko-Caspian trough potentially productive (primarily for oil) sub-thrust downdip deposits blocks (from the Jurassic-Cretaceous to the Neogene) remain virtually unexplored. This is particularly so with the deposits of the Tersko-Sunzhensky anticlinorium and anticlinal zones of the South Dagestan (Inchkhe-sea and others).

High potential for hydrocarbon accumulations discovery is located within the flank of the West Kuban foredeep. The buried zone of the Upper Jurassic reefal buildup (Khadyzhenskaya Cordillera), extending along the Akhtyrsky deep fault, which separates the shallow-water sediments zone

of the Jurassic-Cretaceous complex from the deep-water paleotrog of the North-West Caucasus was established by drilling and seismic survey on the southern side of the West-Kuban foredeep. The oil and gas content of the carbonate complex of the Upper Jurassic (Victory Square, Shirvansky, Samursky, South Khadyzhensky) is established within this zone. To the west, the carbonate thickness dives and is poorly studied. Identification of potentially productive areas in the Upper Jurassic carbonate complex (zone length is 180 km, width — 15-20 km) is possible along the western part of the Akhtyrsky fault.

Promising Krupskaya Upper Jurassic reefogenic structure with the D0 resources of 86 billion m^3 of OE is discovered on the northern side of the trough. Potentially productive sediments were penetrayed by the 1-Krupskaya well at a depth of 5681 m with 17-meter exposed thickness. This interval is characterized by a sharp increase in penetration rate and intense gas show. But due to an emergency, the well was suspended. It is necessary to continue well drilling. A number of promising reef traps, exploring of which will depend on the results of 1 Krupskaya well, are also identified in this area. It is necessary to conduct prospecting seismic work on the rest of the promising territory of the West Kuban foredeep.

The distribution zone of the Upper Jurassic bioherm structures is also allocated by drilling and seismic survey in the East Kuban Basin. The Koshekhablsky hydrocarbon deposit is confined to one of them, in other deposits (Konstantinovskaya, Schedokskaya, East-Khlebodarovskaya, West-Chapayevskaya fields) signs of oil and gas occurence are established. More than 20 objects of reef type (South Koshekhablsky and others) were identified by seismic survey; total resources are estimated at 90 million tons of OE.

Shale rocks of the Khadum suite represent an independent direction of geological exploration in the North Caucasus oil and gas industry, by analogy with non-traditional shale oil-bearing formations of other basins (Domanik of the Volga-Ural and Timano-Pechora, Bazhenites of the West Siberian basins and others). The oil and gas content of the Khadum suite has been established at a number of fields in the Stavropol arch and its slopes (Zhuravsky, Vorobyevsky), the East-Stavropol depression and the Prikumsky uplift system. Unconventional deposits are identified in the Khadum suite and are connected with local decompression zones of clay-carbonate rocks. 73 potentially productive objects with recoverable oil resources of 280 million tons are allocated.

For the purpose of prospecting and exploration of the shale formation of the Khadum and Batalpashinsky suites, it is recommended to actively conduct exploration works on the already existing wells in the already discovered fields by returning from the lower or upper layers, or drilling the missing interval, drilling the second or lateral wellbore. These works can also be recommended to identify missed deposits in the fields. In order to intensify inflows in wells, by analogy with other shale unconventional reservoirs (Domanik, Bazhen), it is necessary to carry out hydraulic fracturing in horizontal wells.

The weathering crust and metamorphosed rocks of the pre-Mesozoic foundation represent an independent direction of geological exploration in the North Caucasus oil and gas province, similar to the West Siberian oil and gas province and other regions where hydrocarbon deposits are found, both in the weathering crust and in the Paleozoic foundation. The oil and gas content of the weathering crust of the Paleozoic foundation in the North Caucasus oil and gas province was established at the Yubileyny oil (Prikumsky uplift zone) and gas condensate Rashevatsky and Karmalinovsky (western slope of the Stavropol arch) fields. Petroleum deposit at the Yubileiny field is confined to Paleozoic fractured reservoirs of quartzous hornstone in contact with oil-saturated cavernous-porous lower dolomites of the Lower Triassic which make up a single reservoir with the deposit. Producing wells operate with oil output of 100-125 m^3/day. The discovered hydrocarbon accumulations in these fields are confined, as a rule, to the contact areas of fractured basement rocks or weathering crust with reservoirs in the Meso-Cenozoic depositional sequences with the presence of a structural factor. Besides, oil and gas inflows from the basement and its weathering crust were obtained on the southern slope of the Voronezh anteclise, the Rostov ledge and other structural and tectonic units of the North Caucasus oil and gas province (Pervomaisky, Tarasovsky, Mazhurovsky, Khlopovsky, Ternovsky, Azovsky, Armavirsky, Kunakovsky, Kushchevsky, Fedorovsky, Miussky, Novo-Bataysky, Platovsky, Ekaterininsky, Golovatovsky, Priazovsky and other areas). Reservoirs here are fractured metamorphic and crystalline Paleozoic, as well as crystalline Precambrian rocks. So, on the Rostov basement high, when testing the well 255 at the Azov field, a gas influx with flow rate of 10 thousand cub. m per day on 8-mm choke was obtained from Precambrian.

In the Ukrainian part of the southern slope of the Voronezh anteclise, hydrocarbon deposits are discovered in sediments of the Precambrian basement in Korobchinsky, Chernetchinsky, Khukhrinsky, Nyryzhnyansky, Gashinovsky, Yuzhno-Evgenyevsky fields. Hydrocarbon deposits are confined both to the weathering crust and in the granitoid basement itself, in the zones of its decompression. Oil free-flowing from 4 to 259 cub. m per day, gas — 8-800 thousand m^3/day, condensate — 1.2-71.5 m^3/day were obtained by testing wells.

So far there is no reliable method for prediction and identification of hydrocarbon traps in the basement. One of the main exploration criterion for the presence of hydrocarbon traps in the basement is, in our opinion, the presence of oil and gas structure in the sedimentary cover, fracture connecting the basement and the trap in the cover, fracturing zones and/or basement deconsolidation according to geophysical data. Thereupon, in zones of relatively shallow bedding of the basement, it is recommended to drill promising structures with basement penetration. In addition to the above mentioned priority areas of geological exploration of oil and gas province onshore, it is also necessary to maintain and develop traditional, long-established geological exploration directions in each of the following oil and gas areas: Tersko-Caspian — Upper Cretaceous, Miocene; West Kuban — Neogene, Paleogene; West Ciscaucasian — Jurassic, Lower Cretaceous, Paleogene; East Ciscaucasian — Lower Triassic, Cretaceous, Jurassic; Central Ciscaucasian — lower Cretaceous, Paleogene, Miocene.

In spite of a high degree of exploration (up to 70%) of individual oil and gas areas of the North Caucasus oil and gas province, connected with traditional areas of oil and gas extraction, there are still directions of geological exploration and territories that are in the initial stage of exploration maturity. These areas, as a rule, are confined to the unallocated subsoil reserve fund, and within licensed areas this is related mainly to deep-sunk petroleum plays. The areas of geological exploration that are poorly studied by regional surveys, where it is possible to identify large and medium-sized hydrocarbon deposits, include the subsalt Jurassic complex of the central regions of the Tersko-Caspian trough, the Meso-Cenozoic complex of the Sulak depression (especially in the area of the Caspian Sea), the Cretaceous complex of the northern and central parts of the West Kuban foredeep, non-anticlinal traps, the Meso-Cenozoic zone of the Manychsky deflections and the Paleozoic basement and its weathering crust. These directions of geological exploration, in our opinion, should be high-priority for regional geological exploration in the North Caucasus oil and gas province and their realization can have a significant impact on the growth dynamics of the regional resource base in the mid-term.

III. CONCLUSION

- In spite of the high extent of exploration and development of the total initial hydrocarbon resources of the North Caucasus oil and gas province, the potential for its oil and gas content are still high.
- The most promising direction for geological exploration works in order to increase the explored reserves of hydrocarbons in the North Caucasus is the shelf of the Caspian Sea, where there is a significant potential of resources (about 1 billion tons) comparable to the total undiscovered resources D0 + Dl + D1 + D2 of the entire onshore territory of the province (1.3 billion tons). To realize this potential, the interest in required and significant amounts of financing for geological exploration works from both companies and the government is needed in order to create a favorable investment climate and public-private partnership.
- Poorly studied sediments of the subsalt Jurassic of the Terek-Caspian and Cretaceous of the West Kuban troughs, shale deposits of the Khadum and the Batalpashi horizons, the pre-Jurassic basement and its weathering crust are priority directions of onshore geological exploration of the North Caucasus oil and gas province along with traditionally developed.
- The new “Quantitative assessment of hydrocarbon resources ...” requires a significant resources clarification of petroleum plays, primarily: a) in the Caspian Sea — the whole cross-section; b) Tersko-Caspian and West-Kuban troughs — the subsalt Jurassic; c) shale formations of the Khadum and the Batalpashinsky horizons; d) the pre-Jurassic basement and its weathering crust.

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