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Lateral migration of hydrocarbons in terms of oil content of the terrigenous Devonian section in the Kama region

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Латеральная миграция углеводородов в аспекте нефтеносности разреза терригенного девона в Прикамском регионе

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migration, accumulation, geological risks, reservoir, trap, terrigenous Devonian, hydrocarbons, deposit, oil and gas source rocks, Kama-Kinel depression system, deep fault, generation, field, oil-bearing criteria.

In the Kama region, the problem of reducing potential traps of a structural type and reducing the role of traditional search objects can be solved by means of the oil potential of poorly or insufficiently studied objects. The latter within the Udmurt Kama region include deposits of the terrigenous Devonian. In view of the widespread use of the hydrocarbon migration factor in assessing the success rate of exploration work, the study of regional migration processes does not lose its relevance. The territorial confinement of a significant proportion of deposits in the terrigenous Devonian to the axial and inner side sections of the depressions of the Kama-Kinel system was shown; geothermal prerequisites for oil formation and a possible mechanism for the primary migration of hydrocarbons within the zones of development of oil and gas source strata of the Domanik formation were highlighted. One of the key roles for the start of the secondary lateral migration of micro-oil is assigned to gas emanations within the development paths of long-lived deep faults, followed by gas lateral transport of oil in the direction of uplift. An assumption was made about the early Permian and post-Permian time of the beginning of accumulation and re-formation of deposits for the territory of the Cis-Urals and adjacent areas, respectively. On the basis of statistical data, trends in changes in some parameters of deposits at a distance from the zones of supposed generation were traced: the degree of traps filling, oil saturation of reservoirs, density and content of oil heavy components, the main properties of associated gas. In accordance with the regional structural plan of the terrigenous Devonian, the proposed zonal directions of hydrocarbon migration were identified. Intra-reservoir migration was expected at an average distance of up to 30–40 km from the generation areas. Taking into account the data obtained and the peculiarities of the regional development of reservoirs and seals, the territory of the Udmurt Republic was ranked according to the degree of prospects for the Devonian terrigenous complex, taking into account the migration factor.

Ключевые слова:
миграция, аккумуляция, геологические риски, коллектор, ловушка, терригенный девон, углеводороды, залежь, нефтегазоматеринские породы, Камско-Кинельская система впадин, глубинный разлом, генерация, месторождение, критерии нефтеносности.

В Прикамском регионе проблема сокращения потенциальных ловушек структурного типа и снижения роли традиционных объектов поиска может быть решена посредством потенциала нефтеносности слабо- или недостаточно изученных объектов. К последним в пределах Удмуртского Прикамья отнесены отложения терригенного девона. Ввиду широкого использования фактора миграции углеводородов при оценке коэффициента успешности поисковых работ изучение региональных миграционных процессов не теряет своей актуальности. Показана территориальная приуроченность значительной доли залежей в терригенном девоне к осевым и внутренним бортовым участкам впадин Камско-Кинельской системы, освещены геотермические предпосылки нефтеобразования и возможный механизм первичной миграции углеводородов в пределах зон развития нефтегазоматеринских толщ доманиковой формации. Одна из ключевых ролей для начала вторичной латеральной миграции микронефти отводится газовым эманациям в пределах трасс развития долгоживущих глубинных разломов с последующим газовым латеральным переносом нефти в направлении восстания пластов. Сделано предположение о раннепермском и послепермском времени начала аккумуляции и переформирования залежей для территории Предуралья и смежных областей соответственно. На основе статистических данных прослежены тренды изменения некоторых параметров залежей при удаленности от зон предполагаемой генерации: степень заполнения ловушек, нефтенасыщенность коллекторов, плотность и содержание тяжелых компонентов нефтей, основные свойства попутного газа. В соответствии с региональным структурным планом терригенного девона выделены предполагаемые зональные направления миграции углеводородов. Внутрирезервуарная миграция предполагается на среднее расстояние до 30–40 км от областей генерации. С учетом полученных данных и особенностям регионального развития коллекторов и покрышек проведено ранжирование территории Удмуртской Республики по степени перспектив девонского терригенного комплекса с учетом миграционного фактора.

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Introduction

One of the pressing current problems for the old oil and gas producing regions of the Ural-Volga region, and in particular the Kama region, is the increasing rate of standard oil reserves depletion. Traditional search objects associated with structural traps of the Middle and Lower Carbon within the lateral parts of the Kama-Kinel system depressions (KKSD) are gradually losing their relevance. This is primarily due to a significant reduction in the stock of structures with low geological risks of exploration failure.

Under these conditions geological exploration work in the region is increasingly associated with two main directions. The trend of the first is focused on assessing the oil-bearing potential of new objects for the Volga-Ural oil and gas province (OGP): bituminous domanikoid deposits, non-anticlinal traps of depression zones of the KKSD, pseudo-rifogenic low-amplitude structures, pre-Paleozoic sedimentary, crystalline basement, weathering crusts, etc. The focus of the second one is on identifying the oil potential of poorly or insufficiently studied exploration targets. From our point of view, within the Udmurt Kama region to the last one they are included deposits of the terrigenous Devonian, which section was discovered only in 19 % of the wells of the prospecting and exploration drilling general fund, and certain territories were practically not involved in prospecting work.

Methods and materials

The main goal of the study was an attempt to assess the influence of the regional secondary migration of hydrocarbons (HC) process on the oil content of the Devonian terrigenous complex (DTC). The work objectives included summarizing the accumulated information on the oil-bearing capacity of the DTC in the Kama region and the northern Cis-Urals, searching for dependencies of changes in the parameters of the identified deposits in terms of regional migration, identifying additional search criteria and ranking the territory of the Udmurt Republic (UR) according to the degree of oil-bearing prospects. The materials used included data of more than 270 fields [1–8] (Fig. 1). It should be noted that within the framework of this topic, the term “accumulation site” (according to A.A. Bakirov et al. [9]) is more appropriate but is not used, since it does not emphasize the industrial significance of the deposits [10].

Results and their discussing

Relevance of the topic. In the practice of planning geological procpecting work (GPW) the question connected with the process of hydrocarbon migration most often arises at the stage of assessing the likelihood of geological exploration success. This probability is calculated as the product of several independent geological factors (probabilities) that determine the success or risk in further exploration. The number of the last ones can exceed ten, but several main ones are usually used: the presence of a HC generation source, the existence of a reservoir, a seal, a closed trap, hydrocarbon migration paths, filling the hydrocarbon trap, the influence of post-accumulation processes [11–19]. Moreover, each factor may include several subfactors, for example, the possibility of filling a hydrocarbon trap may be the result of a general assessing presence, maturity, time of realizing the potential of oil and gas source rocks (OGSR) and the presence of hydrocarbon migration routes. In general, Russian large companies use four- or five-factor analysis, which methodology was developed based on the papers [18, 19].

An assessing the presence of secondary HC migration in one form or another (vertical, lateral, remigration, etc.) is present in any forecast option and can significantly affect the final success of the project, the assessment of its resource base and, accordingly, economic efficiency. Thus, with equal values of all other parameters but with minimum and maximum values of the migration probability, the difference in the final success rates can reach a fivefold value. In this regard, despite the centuries-long history of researching the migration aspect of HC accumulation, the study of the regional migration characteristics does not lose its relevance.

OGSR and primary HC migration. Nowadays, most researchers take the leading role in the processes of HC generation in the Volga-Ural oil and gas province, it is allocated to the deposits in the Domanik formation of the depression and slope KKSD zones, and in particular, to a greater extent, the Domanik (Semiluki) horizon OGSR [20–23]. In this case, it is most significant that the oil from the supergiant Romashkinskoye field, according to isotope-geochemical data, is associated with Upper Frasnian domanikoids of the submerged depressions parts, in particular those adjacent to the Tatar Crest [23].

First of all, attention is drawn to the fact that a significant proportion of fields with the productivity of the DTC section are confined to the axial (27, or 10 % of all fields) and internal lateral (134, or 49 %) sections in the KKS depressions of the Kama region (Fig. 1). According to V.M. Provorov (2007), this system of depressions is the result of extensing the earth’s crust at the beginning of the Hercynian tectogenesis. At the same time, the thinning of the earth’s crust in the KKSD zone, tectonic movements along large regional faults and, importantly, an increase in the temperature regime significantly intensified the processes of transforming dispersed organic matter into hydrocarbons [24]. A certain dependence of the increase in reservoir temperature DTC is outlined for fields within the depression KKSD elements at the present time (Fig. 2, *a*). In addition, there is an increase in the average geothermal gradient in the terrigenous Devonian section as it approaches the development area of the indicated depressions (from 1.7 to 1.9–2.1 0C/100 m).

The territorial location or proximity of the traps to the indicated Late Frasnian-Tournaisian intraformational depressions is probably expressed in the completeing oil filling of the last ones. As analysis of data on 220 Upper Frasnian deposits within the Kama region has shown, over two-thirds of all productive traps are located at a distance of up to 30...40 km from the KKSD depression zones and are filled with oil by more than 70 % (Fig. 2, *b*). The last aspect, according to the authors, along with the factor of continuous destruction of deposits, is largely determined by the lateral HC migration.

While considering the process of primary HC migration from oil source rocks of the KKS, one of the controversial issues remains the mechanism of evacuatiing micro-oil into the underlying sediments of the terrigenous Devonian [25]. It is generally accepted that a reliable regional fluid barrier for oil from Devonian reservoirs is the clayey-carbonate Timan-Sargayev formation which provides screening for most fields in the region. Due to increased pressure in the zone of their generation or penetration of oil and gas-water-saturated fluids into underlying reservoirs in areas of uplift of layers during their lateral movement existing options for downward HC migration seem difficult to achieve.

In our opinion, violations in the continuity of the specified fluid seal and the possible the primary HC migration implementation due to the OGSR of the Domanik horizon in the region are based on two factors. The first is associated with relatively long-lived faults of a normal fault nature in the zones of juncting first-order tectonic elements. The second is with a zone of developing post-sedimentary (possibly synsedimentary) micrograbens (graben-like troughs) (Fig. 3). The oils fom some of these near-fault deposits, for example the Arkhangelsk field, are characterized by an increased content of isoprenes, which is one of the signs of proximity to generation zones [26].

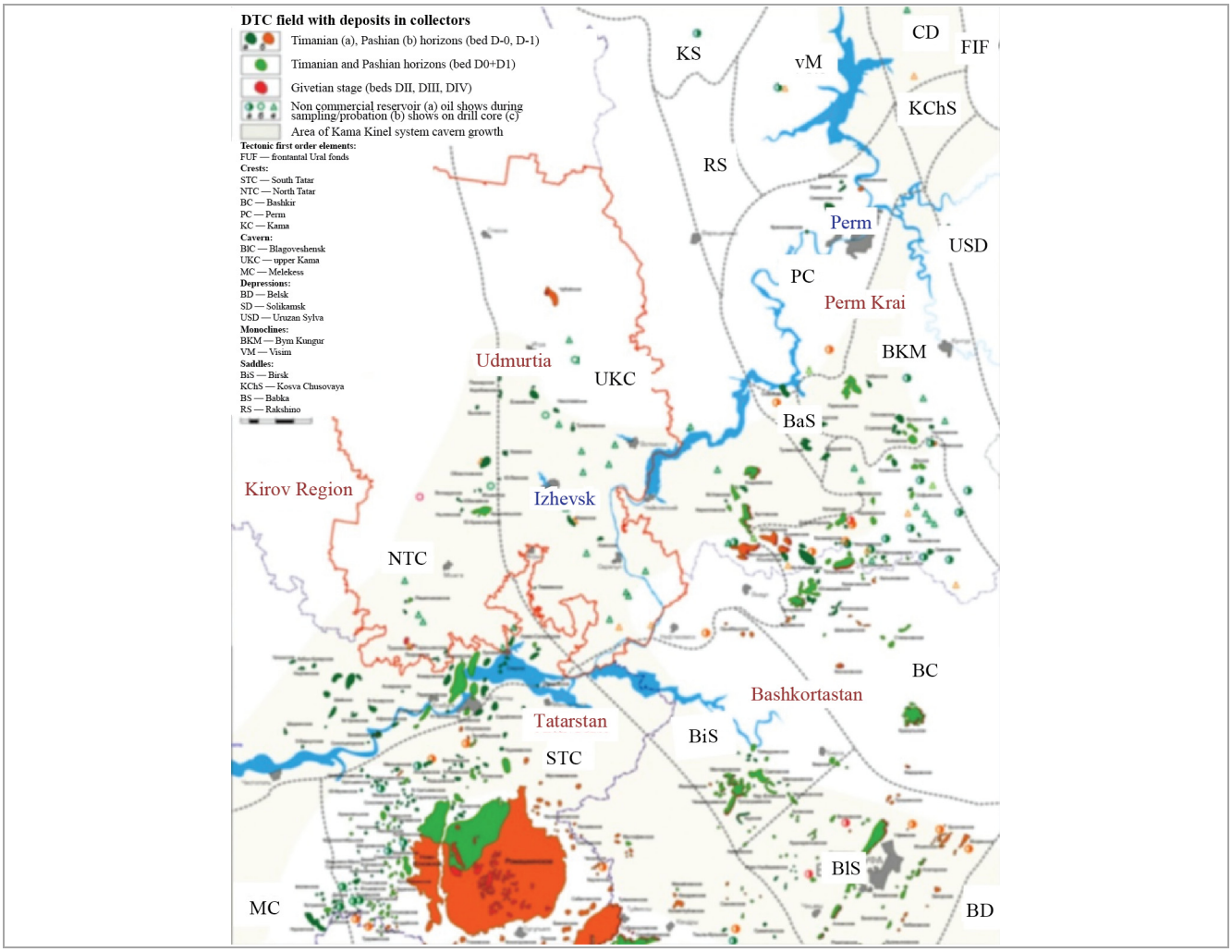

Fig. 1. Regional diagram of the locating oil fields in the DTC cross section

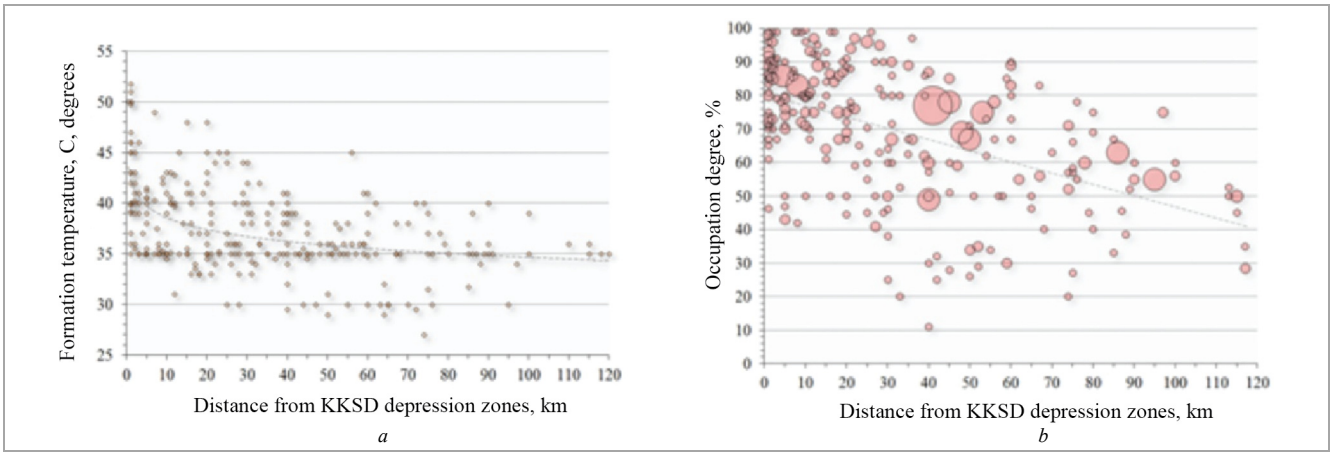

Fig. 2. Formation temperature (*a*) and degree of filling the Timan-Pashiya traps (*b*) in relation to the distance to the axial KKSD zones (the circles diameter is the degree of deposits size by size of recoverable DTK reserves: very small, small, medium, large and unique)

Secondary lateral HC migration. The issue and importance of lateral HC migration in the accumulation process of oil and gas accumulations in the Ural-Volga region, and in particular the Kama region, have been addressed in various studies throughout the history of oil and gas exploration. Thus, an analyzing the features of the oil fields location in Tatarstan clearly shows that the oil is migratory there and all its fields are located on the path of regional fluid migration [4]. In general, the intrareservoir HC movement as one of the factors in the deposits formation is recognized by most researchers (at least local). However, the form, time and distance of hydrocarbon migration continue to be the subject for debate.

It is known that the KKS branches outline the peripheries of large paleoarches along regional deep faults [5, 27]. For the considered territory the main disjuncts are the Main Udmurt and Prikamsky deep faults. Both faults are characterized by the nature of their manifestation as supra-order [28], with the Main Udmurt fault being one of the highest amplitude faults, and the Prikamsky fault being the

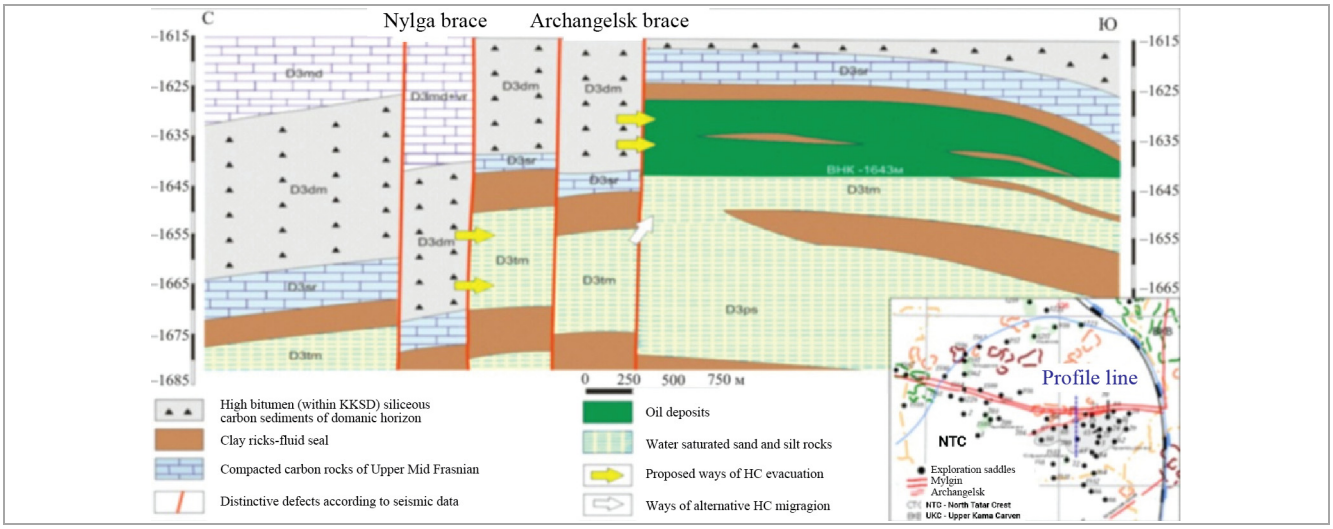

Fig. 3. Schematic diagram of the primary HC migration using the example of the Arkhangelsk field

main one in the Kama strike-slip fault system. In the sedimentary cover such faults are usually presented in the DTC, often in the carbonate Devonian, as a series of low- and medium-amplitude (10–40, sometimes up to 70–80 m) secondary faults or are reflected as zones of increased tectonic fracturing. It is also important that partial tectonic activation of deep faults along the KKSD is currently observed, and local epicenters of modern microearthquakes can be traced along their routes [29, 30]. Within the framework of the considered topic, the confinement of the OGSR depressions of the KKS to the routes of deep long-lived faults is interesting from the position of a possible triggering mechanism for secondary lateraloil migration.

According to the authors, the process of hydrocarbon migration in the considered region could possibly occur according to the mechanism proposed by V.I. Ivannikov [31, 32], namely through its pulsation flotation with a gas microemulsion in a microdroplet state. In general, the essence of this approach is as follows.

As is known, deep faults serve as the main migration routes not only for ore solutions but also for large volumes of endogenous gases, primarily methane and carbon dioxide (the cold branch of deep degassing). Juvenile dissolved gases enter through diffusion from deep faults in the earth's crust into porous and permeable layers and gradually saturate the volume of the collector near the gas supply fault and push aside the water filling it and the micro-oil dispersed in it. When supersaturation is reached (for these PVT conditions), an abnormally high formation pressure arises in the near-fault part of the collector, the gas pack enters the floating mode and its lateral movement occurs under the influence of buoyancy forces. In this case, the collection and flotation migration (transport by gas bubbles) of the dispersed oil phase and the saturation of traps along the path of regional formations uplift occur. In this case formation water is the host medium. The escape of the gas pack along the lateral side of the formation leads to the appearance of an abnormally low pressure in the near-fault zone of the collector for that period of time until conditions for a new supersaturation with the gas phase arise in it [31–33].

Regarding the question connected with the time of forming the deposits in the Kama region, it should be noted that, probably, the processes of HC generation, accumulation and reformation in DTC traps began at the end of the Paleozoic. At the same time, the HC migration was largely due to regional reorganizing structural plans. For the Cis-Urals territory this may be connected with the beginning of the forming large depressions of the Cis-Urals trough in the Early Permian era which led to a general trend of lateral migration in a westerly direction [34]. For the western regions, in our opinion, the migration and redistribution of hydrocarbon accumulations are associated with the post-Permian uplift of the South Tatar and a significant part of the North Tatar crests (UTC, NTC). By this time, the OGSR of the Domanik formation in the KKS depressions were somehow in the oil “window” zone [35], while the generation of oil hydrocarbons began in the Kazan and Tatar times [36].

The scale of vertical tectonic restructuring can be judged by the degree of denudating Permian deposits within the Udmurt Republic (UR). Thus, in the north-west of the Verkhnekamsk depression, where Triassic deposits are exposed, the uneroded section of Permian system sediments has a thickness of about 1000 m, in the southern parts of the indicated depression and the slope of the NTC - about 600 and 400 m, respectively. The uplifting the southern block of the Tatar massif against the background of the consistently elevated position of the adjacent part of the northern block, as well as the subsequent phases of Late Alpine tectogenesis, determined the general southwestern direction of the uplifting the territory. At the same time, the current regional slope of the DTC surface in the direction from the Verkhnekamsk Depression (UKD) to the tops of the Tatar paleoarch ranges from 1 to 3–4 m/km. Thus, taking into account the HC generation in the KKSD zones, it is possible to trace possible trends in lateral migration and the general direction of the HC redistribution in traps for each of the considered territory zones (Fig. 4).

Regional changes in the hypsometry of the DTC surface, along with areas of hydrocarbon generation, correlate well with the main zones of DTC deposits or their absence. In particular, migration processes obviously had a wide development within the southern regions of the NTC and the northern side of the Bashkir arched uplift. The subradial nature of the HC transport to the top of the NTC became the reason for the forming he largest oil-bearing region in the Volga-Urals in terms of reserves.

It is to be noteworthy the almost complete absence of industrial deposits in the northern half of the UKC, where, in conditions of remoteness from the OGSR zones, low gradients of differences in DTC elevations are recorded. In this area, a number of amplitude (up to 30–40 m) traps were searched which have a good potential for the accumulation and preservation of hydrocarbon accumulations but in the section of the terrigenous Devonian they turned out to be “empty” (Kezskaya, Karsovaiskaya, Zolotarevskaya and other uplifts). The only field in this zone, the Chuboyskoye one (see Fig. 1)

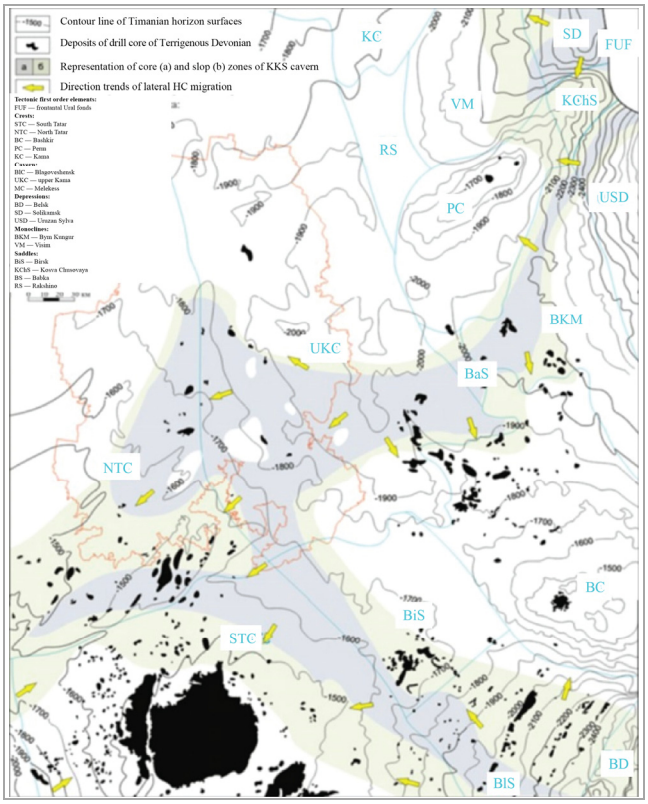

Fig. 4. Structural map of the DTK surface in Prikamsky region and Cis-Urals

with deposits in the DTC formations, has high-viscosity oil, which properties are characteristic of the pre-Paleozoic deposits in the region [24, 37] (Sharkanskoye, Tylovaiskoye fields), i.e. vertically migrated from Upper Vendian or Riphean sediments. In our opinion, secondary migration in the DTC UKC was of a local nature, when oils of the first generation phase moved (before the regional subsidence of the territory) and was limited in the north by a strip of land no more than two tens of kilometers from the OGSR. The last one is indicated by oil shows in cores from wells of the Zura, Novoglazov and Nozhov uplifts.

Regarding the distance of lateral HC migration, there are different opinions among researchers of this issue, from only its local and zonal manifestation (within generation centers or several tens of kilometers) to regional (100...200 km) and even ultra-long-range development of migration processes (up to 1000 km) [38–46]. Many works note the best prerequisites and conditions for regional lateral migration in platform areas, however, ultra-long distances of hydrocarbon movement are rarely considered at present.

For the territory of the Volga-Ural OGP a number of scientists (A.L. Kozlov, V.P. Savchenko, Yu.A. Pritula, V.A. Lobov, M.I. Zaidelson, etc.) also assume intra-reservoir lateral migration from the Caspian depression and the Cis-Ural trough, reaching many hundreds of kilometers. However, most researchers are inclined to believe that the formation of oil deposits in this region occurred due to the HC migration to elevated zones from adjacent depression zones (A.A. Bakirov, S.P. Maksimov, S.Ya. Weinbaum, etc.) [47]. In particular, in relation to the Kama region, lateral migration distances are allowed from a few tens to 60...80 km, in some publications it is more than 100 kilometers [26, 48–51, etc.].

In this regard, the authors made an attempt on a statistical basis to trace general trends in changes over the area of the average parameters of collectors' oil saturation, oil properties and associated gases.

It has long been established that the gas content of oil and the collectors' oil saturation in the Devonian section of the Volga-Urals increase with depth. For the Prikamsky region, an increase in the content of dissolved gas is also observed, however, within the main top of the NTC including its southeastern side (Bavlinskaya group of fields), an irregular increase in associated gas is noted at a relatively shallow depth of the formations (Fig. 5, *a*).

For the parameter of oil saturating DTC collectors, a certain pattern of its decrease up the section in the depressions and a further increase in the crests are established (Fig. 5, *b*). The last aspect, perhaps, indicates a local manifestation of intra-reservoir migration, redistribution or replenishment of hydrocarbon deposits in the direction of uplifting DTC layers. It is important that a systematic regional decrease in the values of these parameters is recorded in the northwestern direction of the region (Fig. 6). For the western part of the NTC, this is partly explained by the erosion of DTC section part, as well as a sharp reduction in effective thicknesses. For the UKC territory, this is probably due to the limitation or absence of lateral migration routes for hydrocarbons here.

The oil density of DTC deposits is characterized by relatively increased values in areas that geographically coincide with the internal and onboard KKSD sections and from their distance there is a tendency for it to become lighter (Fig. 7, *a*). While assessing the migration HC abilities, it is usually believed that asphaltenes are less migratory in relation to oil resins. Despite the fact that the obtained values of the relations between resins and asphaltenes of Devonian oil in the region have unsystematic variations (as indicated in paper [51]), a decrease in their total content in oil with distance from the KKSD zones obviously also indicates the sorption separation of oil in traps during its lateral mass transfer (Fig. 7, *b*).

As it is known, during intra-reservoir migration the oil adsorption and loss of high-molecular asphalt-resin components is accompanied by a decrease in the content of heavy fraction microelements in it. For the Kama region data on the regional decrease in absolute concentrations in DTC oil, the most indicative in this regard, of vanadium and partly nickel, using the example of the area of the Tatar Arch, are given in paper [52].

With regard to changes in the compositional analyses of dissolved gas over the area, attention should be paid to the fact that within the northwestern territory in the DTC section there is a significant increase in the nitrogen content in the gas which proportionally reduces the volume of methane. Thus, if for the fields of the Cis-Urals and lower Kama region dissolved gas contains on average about 40 % methane (nitrogen 10–15 %), then in the north-west of the territory its volume decreases to 10–20 %, while the amount of nitrogen dissolved in oil can reach 50–80 % (Arkhangelskoye, Ilyinskoye, Yeseneiskoye and other fields). Therefore, with regard to the study of migration processes in the considered region, the indicator of the methane amount in associated gas is probably poorly informative.

The content of methane gaseous homologues in oil gas also does not have a specific area dependence. However, with the total attraction of pentane and higher components there is a trend of increasing fat content of associated gas with distance from the zones of expected hydrocarbon generation (Fig. 8, *a*). Along with this an overall increase in the values of the dissolved gas specific gravity is recorded (Fig. 8, *b*). It is possible, as noted in paper [51], with the lateral migration of gas-oil systems, all conditions arise for selective degassing of oil leading to the redistribution of gas components in accordance with their solubility in liquid hydrocarbons. During these processes, in the direction of lateral migration, gases become heavier and the degree of oil gas saturation decreases.

Based on the presented data it can be assumed that the distance of lateral HC migration in the DTC of the region

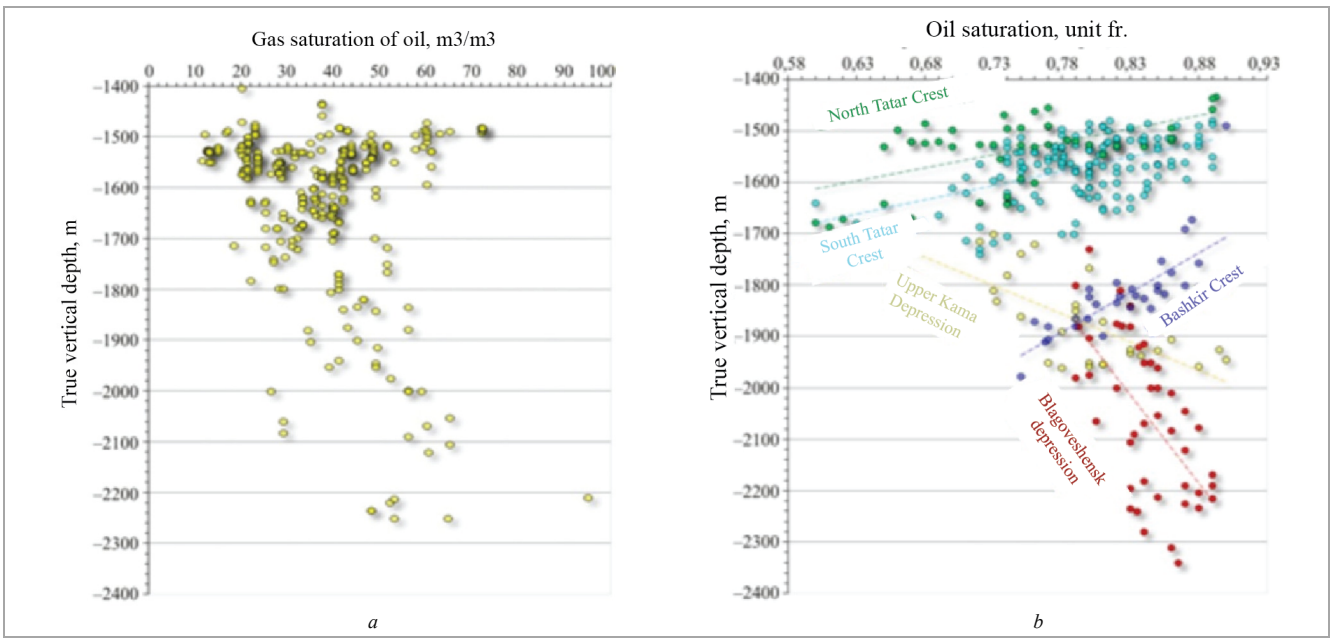

Fig. 5. Change in average values of oil gas content (*a*) and oil saturation of rocks (*b*) with burial depth

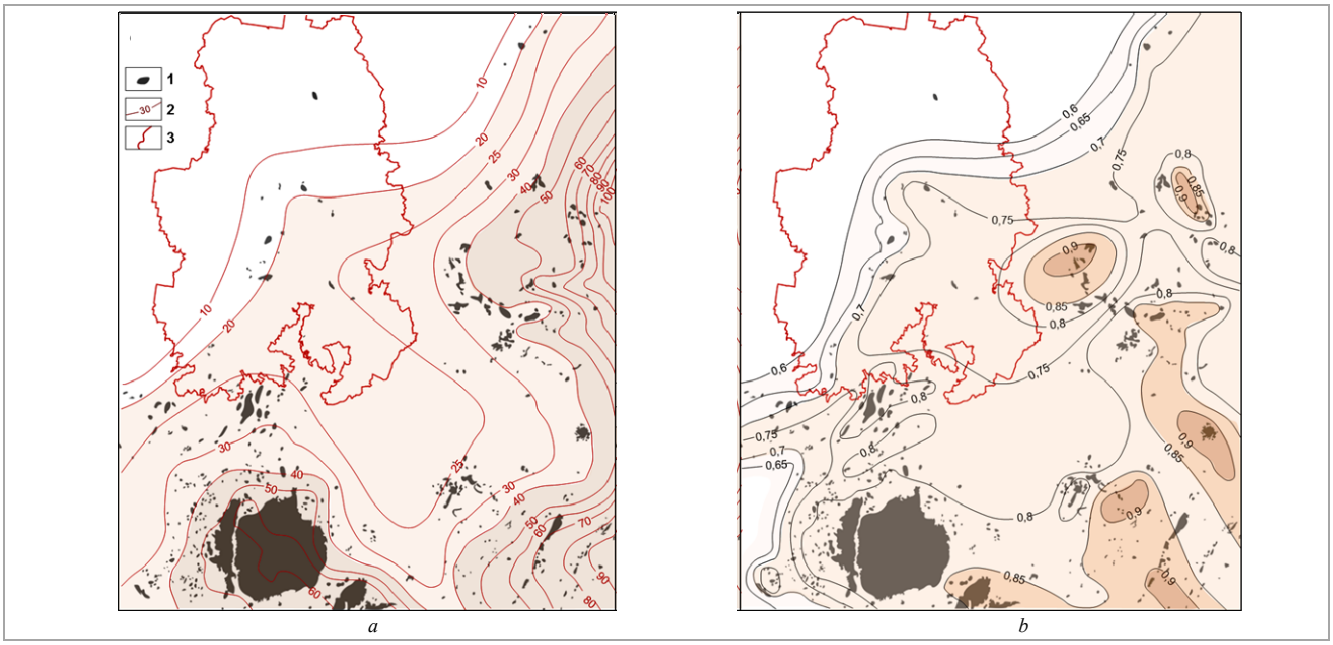

Fig. 6. Scheme of changes in gas saturation of oil (*a*) and oil saturation of collectors (*b*) by area:
1 – oil field; 2 – lines of equal values; 3 – administrative boundary of the UR

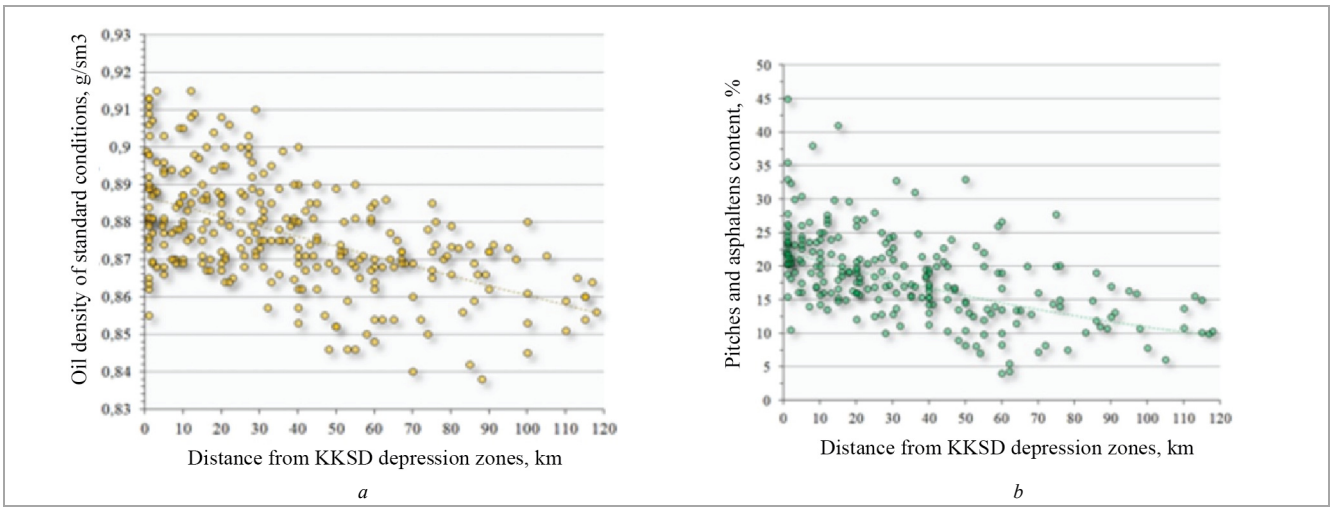

Fig. 7. Change in density (*a*) and content of resins and asphaltenes (*b*) in oil depending on the distance of the KKSD

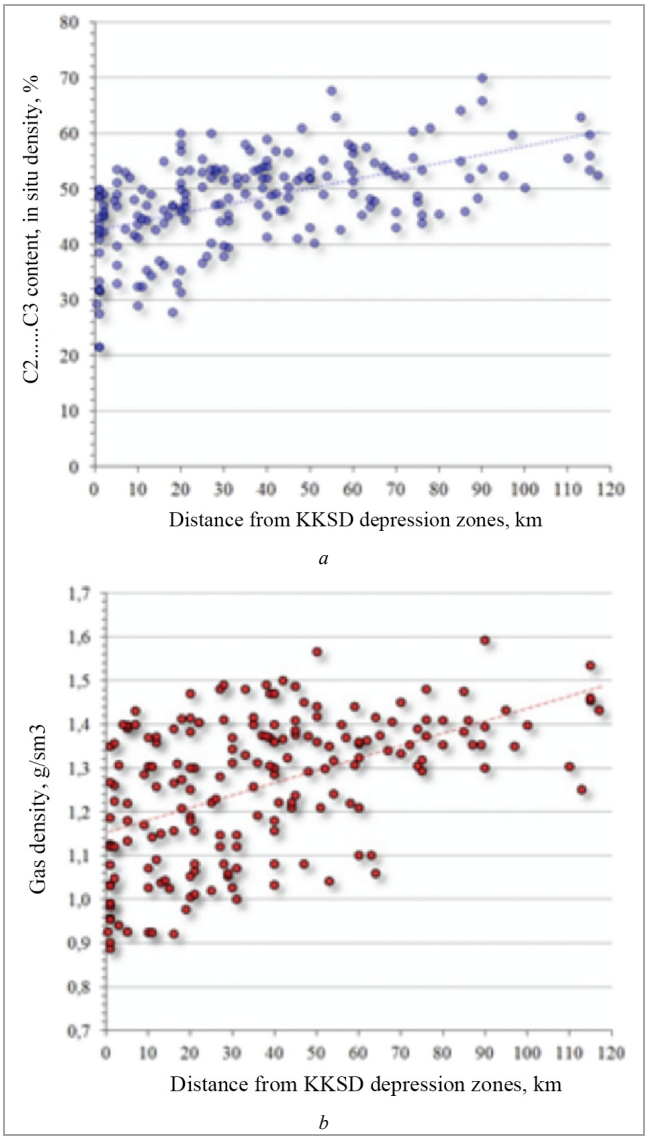

Fig. 8. Change in the sum content of methane homologues (*a*) and the density of dissolved gas (*b*) depending on the distance of the KKSD

probably reached about 100 kilometers within large arched uplifts but the optimal (average) distance did not exceed 30–40 km from the zones of their generation of the Kama system OGSR depressions.

We would like to note that all areal changes in these parameters relate directly to traps with proven oil-bearing capacity which can be considered as a definite or intermediate result of migration processes. As it is known, one of the main critical arguments of lateral migration is the absence of traces (trails) of residual oil saturation in the rocks adjacent to the oil fields, i.e. on hydrocarbon transit routes.

For exploration areas within the KKSV of Udmurtia in the DTC section, such isolated examples were recorded in the traces of oxidized oil or bitumen “smudges”, the smell of oil on the core chip, residual oil saturation according to geochemical analysis of the sludge as well as an increase in background gas readings. The absence of widely developed residual saturation outside the fields is possibly due to the selectivity of lateral migration paths (non-frontal direction of least resistance), osmotic effects in the collector pores and the form of hydrocarbon transfer (flotation of micro-oil by gas) [32], gas dissolution and removal of residual oil from breeds [53]. In addition, it is probably impossible to exclude cases of HC signs absenc due to complete washing of the core with filtrating clay solution [54] with relatively high

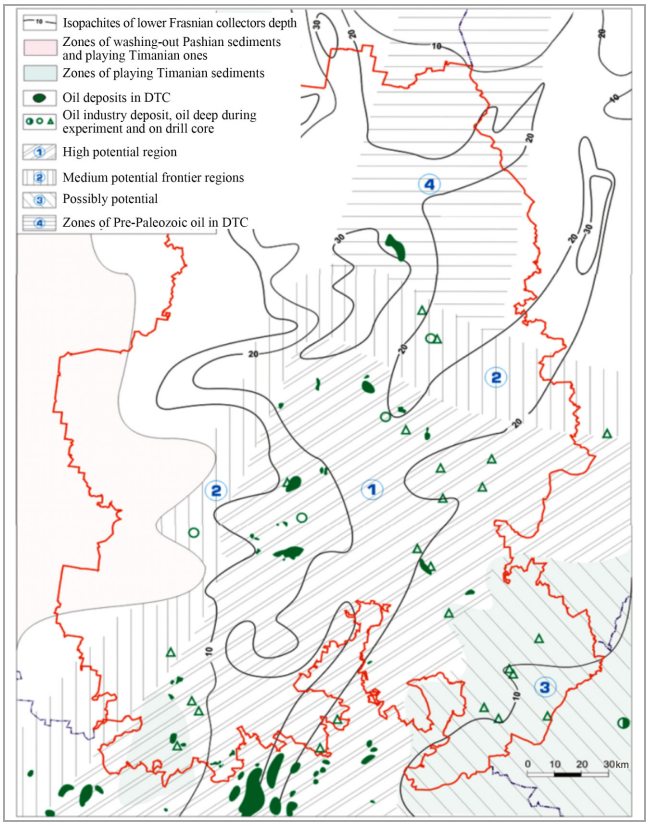

Fig. 9. Scheme of oil potential prospects for the DTC within the UR

filtration-capacitive properties of DTC collectors. In the last century these solutions were the main type of drilling fluid.

In general, the fundamental possibility of intra-reservoir migration is indicated, first of all, by the size of the largest oil-bearing fields. Thus, the Pashi deposits of the Romashkinskoye and Novo-Elkhovskoye fields have a diameter and longitudinal size of about 70...80 km, which already implies the need to move hydrocarbons in the collectors for at least the first tens of kilometers. Local secondary movement of oil is recorded during long-term development of large fields (raising watershed contacts, displacement while maintaining reservoir pressure, movement of tracer research agents, etc.).

Ranking of the UR territory according to the degree of prospects. In relation to the territory of Udmurtia, data on possible directions of lateral migration (see Fig. 4) were combined with maps described the total thickness of the Timan and Pashiy horizons collectors [26]. Taking into account the features of the developing the regional Emssian-Timan tergeneous complex seal [55] and the features of hydrocarbon migration, an assessment of the prospects for the DTC was carried out (Fig. 9). Within the republic, in terms of exploration potential, the following lands have been identified: highly promising (oil content has been proven), moderately promising (favorable for oil accumulation), possibly promising (very poorly studied) as well as a zone of probable deposits with high-viscosity oil that migrated into Devonian traps from the pre-Paleozoic section (zone hard-to-recover degassed Upper Proterozoic oil).

Exploration criteria for oil content. In order to more correctly substantiate prospecting and exploration work for the Devonian terrigenous object within the new areas of the UR, it is advisable to take into account the estimated parameters in a complex for each of the selected zones (table). At the same time, the proximity of a potential trap to the sources of generation and its location in relation to the hydrocarbon transit routes are key indicators for assessing the hydrocarbon migration factor.

A set of parameters for assessing the DTC oil potential

Estimation parameters	High potential		Medium potential	Possibly potential	Zone of Pre-Paleozoic oil in DTC
	East part (UKC)	West part (NTC)			
Number of fields	15, inclusing West perm Krai	20, including North Tatarstan	3 (Tatarstan)	2 (Bashkartastan)	1 (Udmurtia)
Distance from OGSR: 0..20 / 20..30 km (+ + + / + +) 30..40 / 40..50 km (+ / -) 50..60 / > 60 km (- - / - - -)	(+ + +)	(+ + +) / (+ +)	(+ +)	(+ +)	(-) / (- -) / (- - -)
Traps and directions of lateral migration in via / (+ / -) out of transit ways (- -)	(+)	(+)	(+)	(+)	(-) / (- -)
Trap amplitude and summary D_3fr_1 collectors thickness (hydrodynamic trap): $A_д$ more / $A_д$ less (+ / -)	Summary collectors thickness amounts to 15…25 m	Summary collectors potency amounts to from 10 to 20 m	Thickness from first meters (west part) to 15…30 m (north part)	Zone of claying Timanian collectors, thickness of Pashian from 5 to 15 m	Summary collectors potency From 20 to 40 m
Fault amplitude: more than 20 m (+ + +) 10..20 m (+ +) 5..10 m (+)	Characterized by low amplitude Fault tectonics (till 10 m)	In the zone of NTC and UKC joint there can be amplitude reduction till 30 m	Similarly to high potential zone according to the region	Fault tectonics in little and medium amplitude (till 20…30 m)	Amplitude reductions on zones of UKC and NTC joints
Misaligning organogenic buildups: no / 250 < m (+ + / +) 250..1000 m (-) > 1000 m (- -)	Significant for organogenic buildups in KKSD, on-board massives and и paleo shelf	Significant for Insular carbon massives in KKSD	Possible in Carbon massives and carbon paleo uplands	Possible for organogenic buildups in KKSD and Arlan Paleo upland	Hardly in evidence
Regional barriers for migration	For UR areas it is set apart because of no disjunctives with more than 40–50 m displacements				

Conclusion

Thus, the analysis of the geological and geochemical information accumulated to date on prospecting and exploration work in the Kama region shows the possibility of developing in the region the process of secondary lateral HC migration from the internal zones of developing the Domanik-type OGSR to the peripheral and adjacent areas. The scale of this movement probably averaged several tens of kilometers and was due to the tectonic restructuring the territory in the early and post-Permian periods. Taking into account data on the characteristics of hydrocarbon migration for each oil and gas complex contributes to a more correct assessment of geological risks within individual zones and local areas.

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