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HYDRO-GEOSYNERGETIC BIOGENIC-MANTLE HYPOTHESIS OF HYDROCARBON ORIGIN AND ITS INVOLVEMENT INTO DIRECT PROSPECTING TECHNOLOGY JUSTIFICATION

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In accordance with circuit of substance in nature, hydrogeosynergetic biogenic-mantle hypothesis of hydrocarbon origin was elaborated and consequently, direct prospecting structural-thermal-atmo-hydro-geochemical technology (STAHGT) was constructed. For the first time, considered technology was applied and implemented in the process of prospecting works both at ground-level oil-and-gas bearing facilities of Ukraine (Dnieper–Donets depression) and at off-shore facilities of Black Sea (the north-western and north-eastern shelf) via use of specifically developed hardware systems. Taking into account location of existing fields in the catchment of Sula River, comprehensive hydrological studies were conducted. The quantitative characteristics of biogenic methane within the catchment areas and underflow deposits were defined. The contents of biota, methane, as well as the thickness of the underlying sediments within the riverbed have been determined. As a result, zones of enhanced permeability were allocated. Within these zones infiltration afflux of water-dissolved substrates are formed. It was determined that hydrocarbons and their projections, located in degassing pipes of deposits in the valley of Sula River, are of mantle origin. The proposed unified approach enables to substantiate the search criteria of petroleum potential in areas where there are neither deflection zones nor thick sedimentary cover, but there are favorable conditions for hydrocarbons accumulation in crystalline rocks. Based on a unified technology STAHGT, recommendations for further studies to substantiate new petroleum-bearing areas and facilities are provided. For the first time, the sources of replenishment of oil and gas deposits in operation were substantiated.

Keywords: hydro-geosynergetic biogenic-mantle hypothesis, hydrocarbons, hydrocarbon migration, tectonics.

Introduction. Generation, migration and accumulation of hydrocarbons (HC) are the fundamental problems of petroleum geology. There are a number of problems that have not yet been resolved, and in the XXI century, in spite of the long and often seemingly successful attempts to solve them in the present state of the methodology and practice of hydrocarbon prospecting practically throughout XIX–XX centuries. For centuries, the two points of view on the nature of the origin of oil are known. The first one is the biogenic theory. According to it, oil was formed from the remains of plants or animals. The second theory, abiogenic, was developed in detail by D. Mendeleyev, who suggested that oil in the nature can be synthesized from inorganic compounds. Although most geologists still adhere to the biogenic theory, echoes of this debate do not subside to the present day. The price of the truth is too high in this case. If the proponents of biogenic theory are right, the fear that oil reserves occurred a long time ago, may soon come to an end is also true. If the truth is on the side of their opponents, it is likely that these fears are unfounded.

Previous study. In his assumptions D. I. Mendeleev [18] refered to experiments on the obtaining of hydrogen and unsaturated hydrocarbons by exposure of sulfuric acid on iron that contained a sufficient amount of carbon.

At the meeting of the Russian Chemical Society on October 15, 1876, D. Mendeleyev presented a detailed report. He outlined his oil formation hypothesis. Scientist believed that during orogenic processes along the cracks-fractures that cut the crust, the water permeates deep into the bowels. Permeating in the subsoil, it finally meets the iron carbides, and under the influence of ambient temperature and pressure reacts with it, resulting in the formation of iron oxides and hydrocarbons, such as ethane. The obtained substances are raised on the same faults into the upper layers of the earth's crust and saturate porous rocks. This way form the hydrocarbons.

Whence come from the oil fields from small to giant? Where the primary material is formed – methane in amounts corresponding to the size (volume) of deposits? The first and almost successful attempt to explain it has been undertaken by proponents of biogenic theory of oil formation.

Recently there has been a trend towards convergence of the two conflicting sides of abiogenic and biogenic hypotheses. The unifying element has become an idea of V. Vernadsky about global geochemical cycling of matter on our planet. The idea of circulation makes it possible to combine the best aspects of two existing hypotheses. Thus, the biogenic hypothesis explains the role of converting mechanism of organic matter in oil and gas on the descending branch of the cycle, and abiogenic – on the ascending one. In this combination the two given concepts can be considered a mutually supportive system of representations that reflect the two main mechanisms of formation of hydrocarbons in the process of global geochemical cycle.

Throughout the studies the theory has always lagged behind the practice, resulting in the current deplorable state of efficient prospecting and, consequently, the searching was unprovided by effective scientifically based theory of oil formation and methods of forecasting of oil and gas objects, which has led to a steady decrease in the results of search works.

Currently, when due to protracted dispute between the two schools, academic petroleum geosciences practically are not being recognized as such and western technologies are being actively implemented, the majority of geological specialists of petroleum industry reveal itself the illusion of the possibility of substitution of geological methods, new science-based search technologies by total computerization in the form of accounting software complexes, a three-dimensional seismic exploration, high tech drilling.

The oil and gas deposits search success, as it was in the 20–30 % range in the "low-technology" past, remains the

same in "high-tech" today, but the costs of exploration works have increased tenfold.

Giving due to technical progress, it should be stated that such a solution for a complex search problem based on an extremely low coefficiency of verifiability of results, requires development and introduction of new methods on a substantial level of a science-based solution to the problem of direct search forecasting of oil and gas bearing targets.

Is there any way out of this situation? Are there solutions that provide an opportunity to change the situation fundamentally with regard to the success of search and exploration of hydrocarbon deposits? Yes, there are. And these solutions have intellectual character that is multiple times more effective than existing technical methods, on the basis of the modern theory of naftidogenesis – petroleum accumulation which, taking into consideration exogenous-endogenous processes, should become a unifying biogenic-abiogenic paradigm in petroleum geology in the XXI century [21].

In the late 50s of the last century, the founder of inorganic direction in Ukraine academician V. B. Porfiriev joined the similar views of prominent scientists N. A. Kudryavtsev and P. N. Kropotkin and founded inorganic direction of petroleum geology in Ukraine [13, 14, 19].

The main idea of this direction can be stated as follow: oil and gas are formed at very high temperatures and pressures below the crust of the available there hydrogen and carbon monoxide by the Fischer – Tropsch reaction process. Geochemical data (abnormally high concentrations of zirconium, titanium, barium, vanadium, uranium and other signs of the incoherent association, the isotopic composition of carbon catalysts, sulfur, hydrogen, helium) indicate the connection of the mafic pelitomorphic polymineral substance with the introduction of the anomalous mantle fluids.

In addition, at the same period of time, E. B. Chekalyuk [26] has fully proved the stability of petroleum hydrocarbons in thermodynamic processes in abnormal conditions of the mantle.

Thus, the essence of the abiogenic theory concept is that from deep levels in conjunction with other gaseous substances resulting from injections in the form of structural migration of hydrocarbon mantle fluids occurs their introduction into a fractured reservoir in the form of inversion overflows. The formation of the latter can be seen in the broad development of condensation water rims.

Such tectonic-geodynamic zones, as mentioned earlier, appear in connection with mantle plumes, and as a result of the interaction with the impulse disturbances squeeze out salt-fluids in the form of diapirs.

The above seemingly fundamental arguments of mantle hypothesis have encountered irresistible thermodynamic and geochemical contradictions, according to supporters and founders of the opposing biogenic hypothesis (I. M. Gubkin, N. B. Vassoevich, B. A. Sokolov, Bazhenov's family [6, 20]).

The presence in oils of biomarkers (hemofossils) of various inherited biological molecular structures, often in high concentrations and genetically informative ratios, is impossible to explain by either biogenic synthesis or process of "washout from their host rocks of mantle oil at its jet migration" [6].

In the process of presentation of the two existing paradigms, unlike the abiogenic hypothesis, sedimentary-migration theory has a total prevailing significance that is almost completely diverting and crowding all other options, including abiogenous modifications.

Its proponents interpret naftidogenesis and gas accumulations as a result of katagenesis of organic matter in sedimentary rocks due to the gradual increase of temperature and pressure in the conditions of the infiltration complexes of hydrological and hydrogeological, structural and geochemical processes in the areas of geological and structural deflections and slopes of sea areas.

According to proponents of the biogenic hypothesis, the geological basis for this theory is composed of three elements: a layer of source rocks; reservoir layer, i.e. porous rock, capable to accumulate oil and gas, or both; sealed layer, i.e. low permeable rock for oil and gas and other fluids.

Arguments of academician N. B. Vassoevich [6], a supporter of an organic origin of hydrocarbon, about micro-oil and its primary migration in the sedimentary cover were fundamentally substantiated, but were not unequivocally accepted due to lack of conclusive evidence that mature oil forms in the source rocks.

In the early 90s of XX century academician A. A. Trofimuk, a proponent of organic theory of the hydrocarbons origin, suggested that oil nonetheless migrates, considering the fact that the nearby source rocks around most oil and gas deposits are practically absent [22].

However, this geological fact of secondariness of oil deposits is used by proponents of inorganic theory for the rightness of their constructions. Therefore, in the oil fields there is probably some other oil, i.e. it has an inorganic origin.

This approach of non-primary placement of hydrocarbon deposits has become a stimulus for A. A. Trofimuk [22] to search for a new version of the theory of organic origin of oil. "If the main concept – the oil is produced in one place and is accumulated in the other one" became a slogan and the logical basis for the development of ideas about the deep mantle genesis of oil, then eventually it led to urgency overdue revision of the organic concept in order to eliminate contradictions.

During the same 90s, academician A. E. Lukin [15–17] put forward and substantiated the geosynergistic concept of natural oil generating systems, which allows substantiating the different age multiphase nature of naftides and unity of formation mechanisms of different types of hydrocarbon deposits of oil generating systems. One of the most important challenges of establishing of the proposed concept is the conditions and forms of deposits localization.

There are reasons to suppose that this version would be unifying for the two existing paradigms that inhibit the processes of creating a highly efficient direct search technology of oil and gas deposits.

Materials and Methods. In the light of the two existing biogenic and abiogenic paradigms hydro-geosynergetic biogenic-mantle hypothesis of hydrocarbon formation is proposed to consider. The given hypothesis has been, for the last 20 years of our research, well consistent with the tectonic-geodynamic regularities of formation of oil and gas basins on the basis of hydrological and hydrogeological processes that reflect the biogenic hypothesis of accumulation and transformation of biogenic sediments in the form of primary hydro-gas-methane substrates, acting in conjunction with abiogenic tectonic processes of mantle plumes in the zones of critical pressures, high temperatures, and under the influence of catalyzation processes in the form of an entire range of elements of mantle origin involved eventually in the processes of HC fields formation by inversion (in the stretching zones that form degassing pathways).

The hypothesis proposed by us provides the answer to the question of why a major amount (almost 100 %) of oil and gas deposits are placed mainly in geological structures associated with the deflections and the river basin, synclines, rifts, grabens, and on the shelf and slope of sea areas, where there are generators of methane accumulation by bio-components of sedimentary rocks of river systems and hydrological processes of formation of river valleys and deltas, canyons, forming the primary products of oil and gas potential – biological substrates, constantly replenishes in the processes of water-gas injection along the infiltration channels.

Its practical confirmation and implementation of structural and thermo-atmo-hydrological and geochemical studies (STAHGT) eliminate the need to give preference to one or the other paradigm, since the hydro-geosynergetic biogenic-mantle hypothesis of hydrocarbon formation envisages the oil generating system of naftidogenesis and the unity of complex of oil and gas formation mechanisms, as well as their deposits, on the basis of a single cycle and all its components from the simple, at first glance, to complex biogenic geodynamic, geothermal and hydro-chemical processes occurring in the range from the surface to mantle plumes. This approach confirms the ideas of two prominent scientists D. I. Mendeleyev and V. I. Vernadsky.

Formation of oil and gas fields requires not only hydrocarbon (methane) components, but also certain structural-geological, geothermal and hydrological conditions for their accumulation and migration in the ongoing infiltration and inversion processes. One of the most convincing elements of the hydro-geosynergetic biogenic-mantle hypothesis of hydrocarbon formation is the formation factor of oil fields from small to the giant ones in the cycle of substance (water, methane), because in the process of replenishment of hydrocarbon substances it requires corresponding quantities of renewable organic not only molecular hydrogen, but also carbon which lacks in crystalline rocks sequences in such amounts.

Therefore, the assertion about the rise of hydrocarbons from the depths of the Earth, even in conditions of mantle plumes without receiving them from the outside in the form of permanent migration of the main carbon forming component – CH_4 does not look convincing.

V. B. Porfiriev believed that the best objects that validate the reliability of any theory of the origin of oil are the supergiant fields – hundreds of kilometers long, and with reserves of more than 100–150 billion tones of oil, such as deposits located within the Mackenzie Valley, Athabasca in Canada [19].

He was convinced that these deposits could not be formed from organic matter fossils diffused in the clayey material; that the so-called "oil gas maternal" sedimentary rocks – it's just logical fiction, and that the source for the formation of all the giant and supergiant deposits must have been the Earth's upper mantle.

In the 90s of the last century, Canadian geologists and geochemists, convinced proponents of the biological nature of the oil, S. Moshir and D. Uepplz thoroughly investigated this problem for the Athabasca, Cold Lake, Peace River and Uobaska when their total reserves were determined by more than 210–220 billion tons of oil (subsequently been refined – to 400 billion tons of oil).

In the process of these investigations of the Western Canada (Alberta) Mackenzie River basin all the rocks with fossil organic matter were studied. The concentration of methane in all rocks of river valleys was determined, and using the generally accepted quantitative geochemical model of biogenic-katagenic formation of oil, it was calculated that all these rocks can only give 7 % of the oil reserves, which are located in the bowels of Athabaska, Uobaska, Peace River and Cold Lake.

It would appear that researches conducted by Canadian school of the biogenic theory proponents, have put to an end the possibility of giant deposit formation, and hence the possibility of involvement of biogenic substrates in the formation of deposits.

What processes were not considered by Canadian researchers in their received 7 % possibility of biogenic participants of the giant Athabasca deposits? They did not take into account one of the most important elements of migration, defined by V. I. Vernadsky as a "global geochemical cycling."

The law of biogenic migration of the natural cycle by V. I. Vernadsky states that "Migration of chemical elements in the earth's surface and in the biosphere is generally carried out either with the direct participation of living matter (biogenic migration), or it takes place in an environment which geochemical features (O_2, CO_2, H_2, etc.) are caused by the living substance that currently inhabits the biosphere and also that took place on Earth during the entire geological history "[7, 8].

Returning to the results of studies of Canadian proponents of the biogenic hypothesis, as will be shown below, we can conclude that even 1 % of the biogenic-gas dissolved fluids during existing circulation of matter would be sufficient for the accumulation of giant oil and gas fields in the timescaled geological section corresponding to the size of the catchment area of river Mackenzie.

Canadian researchers have not yet considered one more important natural circumstance. All the processes of formation, accumulation of hydrocarbons are not in a static position, but in the process of constant natural replenishment in the form of hydrological and hydrogeological processes of accumulation of biota and their oxidation products. In addition, virtually all of the listed fields in the delta of Mackenzie are located in high latitudes – in the area of permafrost that is creating reliable screens which seal degassing processes and ultimately acting as additional hydrocarbon accumulator.

Using the entire arsenal of the evidence base for biogenic and abiogenic theories, all the deposits from small to giant are formed the same way in any case. However, each case makes it necessary to explain the capacity of the formation of hydrocarbons, particularly their quantitative characteristics that form the basis of oil and gas accumulations. And the corresponding amounts of hydrocarbon accumulation can be explained by the presence of huge volumes of biota – organic methane, which ultimately can produce complex hydrocarbons – components of crustal and subcrustal processes of the hydrocarbon fields' formation of different volumes.

In this sense, in the light the ongoing processes it is necessary once again to recall the statement of V. I. Vernadsky about the processes of gas breathing of the Earth and its role in the cycle of a huge complex of biogenic-inorganic substrate components, which are based on stimulants of processes – hydrogen and oxygen – source of life on the planet.

Under the fine metaphor for "breath" is meant a mode of functioning of the Earth in space. "Inhalation" – the Earth absorbs gas, primarily cosmic ether, which has the properties of a gas; transforms it into energy in the bowels, and then occurs "exhalation" – the Earth resets surpluses of products of geochemical processes of circulation elements in the form of water-gas mantle fluids and substrates – the catalysts, that are causing formation of hydrocarbons in super-high pressures and temperatures conditions. There is a constant energy exchange between the Earth layers and the constant transformation of matter into energy, and inversely – peculiar circulation of energy and matter.

As pointed out by academician V. I. Vernadsky, the nature and its processes are not in a static condition, but in the process of circulation of substance, i.e. in constant replenishment, within the framework of which Mendeleyev and V. I. Vernadsky assigned the leading role to the water-soluble biogenic-methane substrates at the stage of "inhalation". "Respiratory tract" in this case is the stretch zone, and at the stage of "exhalation" – compression-decompression processes in the areas of mantle plumes

and inversion flows. And the essence of "the earth breathing", according to V. I. Vernadsky, is as follows: for exhalation it is necessary to inhale.

The prefiguration of the proposed model, according to V. I. Vernadsky's doctrine about the breath of the planet and the origin of hydrocarbons, became the human body, consuming organic foods and water and inhaling oxygen, ultimately emits CO_2 and produce methane compounds. As we can see, organic products in both cases are required.

Turning from specific examples to the global issues of the origin of petroleum hydrocarbons in accordance with hypotheses of D. I. Mendeleyev and of V. I. Vernadsky, in the process of circulation is required a constant source of oil forming material – water, organic residues and thermo-geochemical processes, forming methane.

According to the calculations of many researchers, the amount of it remains sufficient to keep [maintain] the cycle of oil formation and replenishment processes, which currently explains the generation of hydrocarbon deposits.

The geodynamic zones in the form of gas-hydrodynamic water substrates on "inhalation" stage appear as the main ways of migration of biogenic methane. There occur processes of naftidogenesis and hydrocarbons accumulation as a result of katagenesis of methane organic matter due to an increase of temperatures (the hypothesis by Chekalyuk E. B.) and pressures under certain physical and chemical processes and involvement of a significant amount of active mineral catalysts. With the accumulation of products of katagenesis under the influence of tectonic processes occurs a logical process of "exhalation" from bowels of the earth along the inversion zones (along the contours of degassing pathways), the products of which are petroleum hydrocarbons, water-dissolved fluids – a base for many minerals, mud volcanoes, salt diapirs. This confirms the unity of genius thoughts of the distinguished scientists of V. I. Vernadsky and D. I. Mendeleev about the global circulation of the substance as a unified hydrocarbon-forming and accumulating, geochemical and geodynamic driving force of this process.

Below we consider the complex process of formation of hydrocarbons on the local hydrological level, where the river basin was adopted as a taxonomic unit.

Throughout the studying of the origin, migration and accumulation of oil, petroleum capacity was considered from the standpoint of the hydrogeological conditions of oil and gas bearing provinces, artesian basins, the piedmont depressions and troughs.

Therefore, hydrogeological studies, being very important in the searching for oil and gas fields, provide a reliable argumentation in favor of oil and gas potential of major oil- and gas-bearing territories, provinces and aulacogens.

Below, for the first time, we consider the problem of formation of hydrocarbon fields located in the river basins, on the local hydrological level.

Hydrological problems of formation of river flow in the light of the oil and gas potential issues include hydro-gas-geochemical composition of the groundwater, riverbeds processes, suspended sediments, sedimentary strata, the conditions of the accumulation of biogenic materials in the riverine areas and in the catchment area, geomorphic configuration of the valleys and ancient valleys, and a number of interrelated processes (Fig. 1).

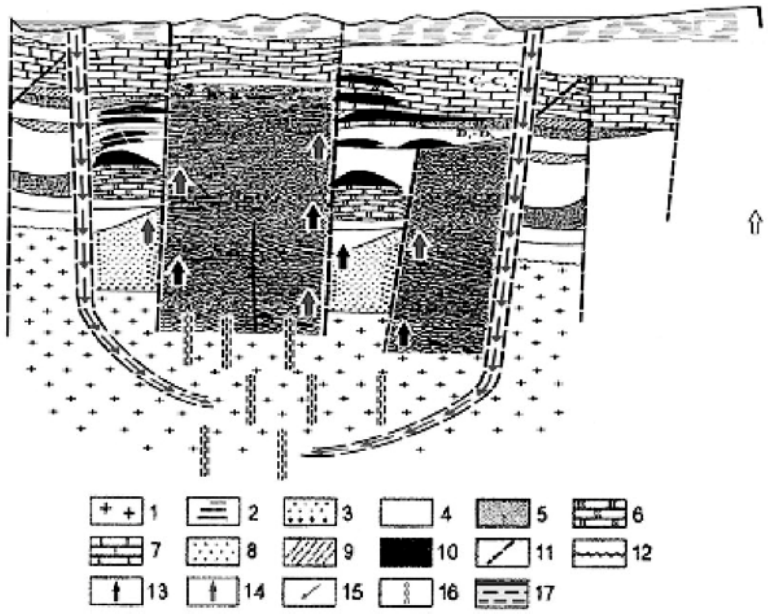

Fig. 1. Model of hydro-geo-synergetic biogenic-mantle formation of HC:
1 – crystalline rocks of the Precambrian basement; 2 – swamps; 3 – sand and coarse clastic molassoids;
4 – carbonate-clastic sediments; 5 – dark-colored siliceous-carbonate-clay sediments; 6 – riftogenic-carbonate massifs;
7 – shelf carbonates; 8 – accumulative sand bodies; 9 – paleo-channels; 10 – oil fields; 11 – faults; 12 – disagreements surface;
13 – oil; 14 – "dry" gas; 15 – water-dissolved methane; 16 – fracturing; 17 – riverbed

According to our research in the sphere of searching water-replete areas for laying the intake of water of infiltration and filtration types and composing sediment rocks, and in the sphere of formation of the gas composition in the zones of absorption of groundwater and gas composing elements, of fundamental importance in the formation of hydrocarbons are the following three gases: nitrogen N_2, carbon dioxide CO_2, methane CH_4, which in the form of micro concentrations are the search criteria in river waters at search for hydrocarbons. Normally in insignificant quantities in the river waters occur helium, hydrogen, radon, appearing as marking gases of hydrocarbon deposits formation in the sedimentary cover and basement.

The presence of methane in the sediments of the river systems, deltas of sea areas, a hundred or more times higher than amount of complex hydrocarbon in river and

marine waters, indicates not only its involvement in the deposits formation, but also its participation in the processes of replenishment in the geological section, as well as during its development.

One of the most important stipulations of oil and gas formation within the framework of the unified hydro-geosynergetic biogenic-mantle hypothesis of hydrocarbon formation is the compressibility of the gas-saturated river waters of infiltration in their depth migration on the fractured zones in conditions of increasing of geothermal and geodynamic processes. At high values of gas saturation, the compressibility of groundwater as described above may exceed 10 times or more the compressibility of water.

The saturation of groundwater by organic methane can take place at high pressure and is very important for determining conditions for the accumulation and mode of oil-bearing formations, as well as the geodynamic processes in the areas of growth stocks of salt, clay diapirs, mud volcanoes, etc.

The different classifications of hydrocarbon of processes of migration are known. Vertical and lateral, primary and secondary types of migration are distinguished. The primary migration means the movement of water-dissolved gases from the underlying sediments of the river valleys, predominantly from low permeable rocks into adjacent reservoirs. The secondary migration means the movement of oil and gas to reservoir layers with the subsequent formation of deposits.

The problem of the primary migration (emigration) of hydrocarbon from the underlying riverbed biogenic sediments of rivers, predominantly argillaceous strata, is the most difficult in one the general problem of the genesis and accumulation of hydrocarbons. The reality of the aquatic form of hydrocarbon migration becomes particularly clear if one considers that the deep underground water are unavoidable products of lithogenesis and processes of infiltration of river surface water, the overall process of the water cycle.

One of the most important aspects of formation of hydrocarbons deposits is, as it was shown previously, the water solubility of hydrocarbon gases [11].

A wide range of changes in the solubility of natural gas, depending on the mineralization, temperature and pressure, have been clarified experimentally. The solubility of methane in fresh water varies from 0,05 m^3/m^3 at a pressure of 1 MPa and a temperature of zero to 50,3 m^3/m^3at a pressure of 188,8 MPa and 280 °C and up to 135,2 m^3/m^3 at a temperature of 354 C and the same pressure. Mineralization significantly reduces the solubility of hydrocarbon gases at 250 °C, a pressure of 107,8 MPa and mineralization of 280 g/l methane solubility decreases to 6,5 m^3/m^3.

The actual gas saturation of underground water within oil and gas basins varies extensively. Gas saturation of underground water to a depth of 3–4 km is well investigated, where it usually amounts to 1–5 m^3/m^3, rarely more. With the depth increase temperature and pressure and, consequently, increases gas capacity of fresh underground water.

A particularly high gas saturation characterized by underground water with low mineralization. With pressure increases hydrocarbon gas solubility in underground waters is unique, the water becomes elastic. Underground waters with low mineralization are characterized by especially high gas saturation. With increase in pressure the water becomes elastic; hydrocarbons gas solubility in underground waters is unique.

Data on high gas saturation of fresh water of deep zones within oil and gas basins were also obtained by foreign researchers. Data on high gas saturation of fresh water of deep zones of oil and gas basins were also obtained by foreign researchers. Thus, the gas saturation of water in the borehole 1 at the area Edna-Delkabr drilled on the coast of the Gulf of Mexico (USA) at a depth of 3800 m, accounted for 9.3 m^3/m^3. In the course of investigation of the deep-water sample of water from the oil-bearing layer in the Gulf Coast a gas saturation of 27 m^3/m^3 have been ascertained. Finally, from a well drilled to a depth of 6000 m, near Baton Rouge in Louisiana (USA) the influx of low-mineralized water with a gas saturation of 92,8 $m^3/m^3$was received.

A significant increase in the solubility of hydrocarbons in underground waters with increasing pressure is quite substantially in order to explain processes of migration and accumulation of hydrocarbons, since the main factor of the primary migration are the pore solutions of biogenic-saturated dissolved gases of underlying sediment of riverbeds in the areas of infiltration. This is especially important to explain the oil and gas fields of hydrogeology, as well as their genesis and forecast performance. This, in its turn, is particularly important in order to explain the hydrogeology of oil and gas fields, as well as its genesis and expected features.

For the formation of oil and gas fields of fundamental importance is an underground hydro-gas-component of river flow in areas of infiltration and absorption along fault zones of increased permeability (FZIP) in the form of seepage flows in the areas of absorption through a porous medium along communicating pores and cracks; conventionally is accepted that the seepage flow penetrates through the entire thickness of the rocks from the Earth's surface and lower in zones of fracturing into the crystalline rocks.

In addition, in the course of development of search technology, one of the most important factors in the technological search cycle is the data of studying the temperature difference between surface water and groundwater. This could be used to track the seepage paths through the bottom sediments; conversely, data on geotectonic conditions and hydrogeology of the area in some cases serve as search criteria and provides an understanding of the causes of the geothermal features of formation of hydrocarbons, as well as finding out of features of permeable riverbed sites (absorption and unloading zones). Ultimately, these data serve as forecasting-search characteristics of the existing and new hydrocarbons deposits and underground potable water.

A significant role in these processes is played by the pore waters, which are capable of receiving and dissolving huge amounts of gaseous hydrocarbons and thereby provide its transit from the sedimentary rocks underlying the riverbeds [23].

The solubility of hydrocarbons in water decreases almost simultaneously with a growth of salinity. But associated water is low mineralized, and its mineralization the smaller, the stronger the connection between "water – methane – rocks". Therefore, in the process of lithogenesis mineralization of pore water progressively decreases, and its capacity to accumulate and expand the hydrocarbons increases.

With increasing temperature increases the solubility of hydrocarbons. But the role of temperature appears not only in increasing the solubility hydrocarbons, but also in decreasing of adsorption capacity of rocks. It has been established that at 374 °C, the mutual solubility of hydrocarbons and water becomes practically unlimited: a homogeneous water-gas-oil solution forms – fluids are in or near the supercritical condition. A substantial increase in hydrocarbon solubility with increasing pressure and decreasing of polarity of water makes the real an assumption that the condition of mutual solubility in the system "pore water – hydrocarbons" occurs at a lower temperature and therefore, at relatively shallow depths. All this allows highly evaluate the role of water migration of liquid and gaseous hydrocarbons in a wide range of existing deposits and the depths, from the surface to the crystalline rocks.

In this regard, the magnitude of gas generation should be emphasized. High hydrocarbon gases enrichment of underground water of petroleum basins provides an opportunity to evaluate the role of gaseous solutions as the main mechanism of hydrocarbon migration and formation of deposits in an integrated hydro-geosynergetic biogenic-

mantle cycle. The volumes of gaseous solutions depend on the water availability of the river systems, landscape and vegetation conditions, as well as the catchment area of the river systems.

In accounting for all forms of hydrocarbon migration from the perspective of abiogenic branch, the evacuation of oil and gas from the underlying strata into the overlying through pathways of degassing is represented as follows. The growth of geodynamic processes leads to a hydraulic fracturing of rocks.

Most of the researchers conclude that the fractures serve not only as the main migration routes of water-dissolved hydrocarbons, but also exist in the form of inversion channel forming oil and gas deposits along the pathways of degassing. In recent years, a large amount of accumulated factual material provides an opportunity to consider that it is due to the formation of intense fracturing of various origins in rocks additional cavities form, and significantly increase the filtration properties of sequences, communication takes place between the generation and reservoir layers [12, 24].

For the first time, by us at a substantiation of the new concept of hydro-geosynergetic biogenic-mantle origin of hydrocarbons into search technology have been included hydrological studies of surface and groundwater flow, reflecting the biogenic-sedimentation branch, on the basis of gas-chemical and water balance calculations. In the process of field investigations, the samples of bottom sediments of valleys and river basin have been selected and examined on the methane-producing organic material. The concentration of methane in the river water, as well as in the bottom sediments and adjacent coastal valleys, were determined. The peculiarities of emplacement and the transformation of channel processes in conjunction with structural and tectonic graben-forming processes were studied. In addition, for mapping areas of discharge or absorption of the underground component of the river flow, aerospace methods of mapping of geodynamic units are applied, included in the complex of studying of hydrocarbons deposits formation and substantiation of search criteria. Conducted investigations (emanation and helium gas surveys) provide an opportunity to identify areas of different fluid conductivity, confined to foci of decompression of formative geo-structural zone. Such ways of linear zones of vertical and horizontal stresses form hydrodynamic conditions in which hydro-fluid-methane migration occurs, providing processes of fluid flows.

Based on the water-gas-emanation surveys (for Rn, He, H, CO_2), for the first time by us were investigated and substantiated dependence of the structural and tectonic characteristics of oil and gas objects in river basins, their location and volume on zones of infiltration. The same study we have carried out in the sea areas of Ukraine when developing search techniques STAHGT, as well as at mapping of submarine sources and hydrocarbon deposits.

The analysis of the locations of oil and gas deposits and hydrogeological basins in the world hydrocarbon production regions, closing cross-sections of deltas of Amazon, Ganges, Gulf of Mexico, the Danube et al., and also rivers of hydrological basins Canada, Bolivia, the Persian Gulf, Vietnam, Western Siberia, Perm Urals, Volga Kamskaya, Pechora, Kura, Terek, Kuban, Lena, Amudarya, DDD rivers, Carpathian depression, etc., provides an opportunity to prove and introduce into a new search technology for hydrocarbon accumulations one of the most important search criteria – hydrological-structural and geochemical elements reflecting the nature of emplacement of river systems (riverbeds) and located in their basins generators hydro-biogenic methane-forming processes under the influence of mantle catalyst, extremely high temperatures and pressures that produce complex hydrocarbons and causing it to migrate through the pathways of degassing in the cycle of matter in nature.

This is the path selected by us, eventually provides an opportunity to answer the questions about the origin, formation and placement of hydrocarbon deposits in the light of the cycle of water and methane substrates, and on this basis to develop a new method of direct search STAHGT (Fig. 2).

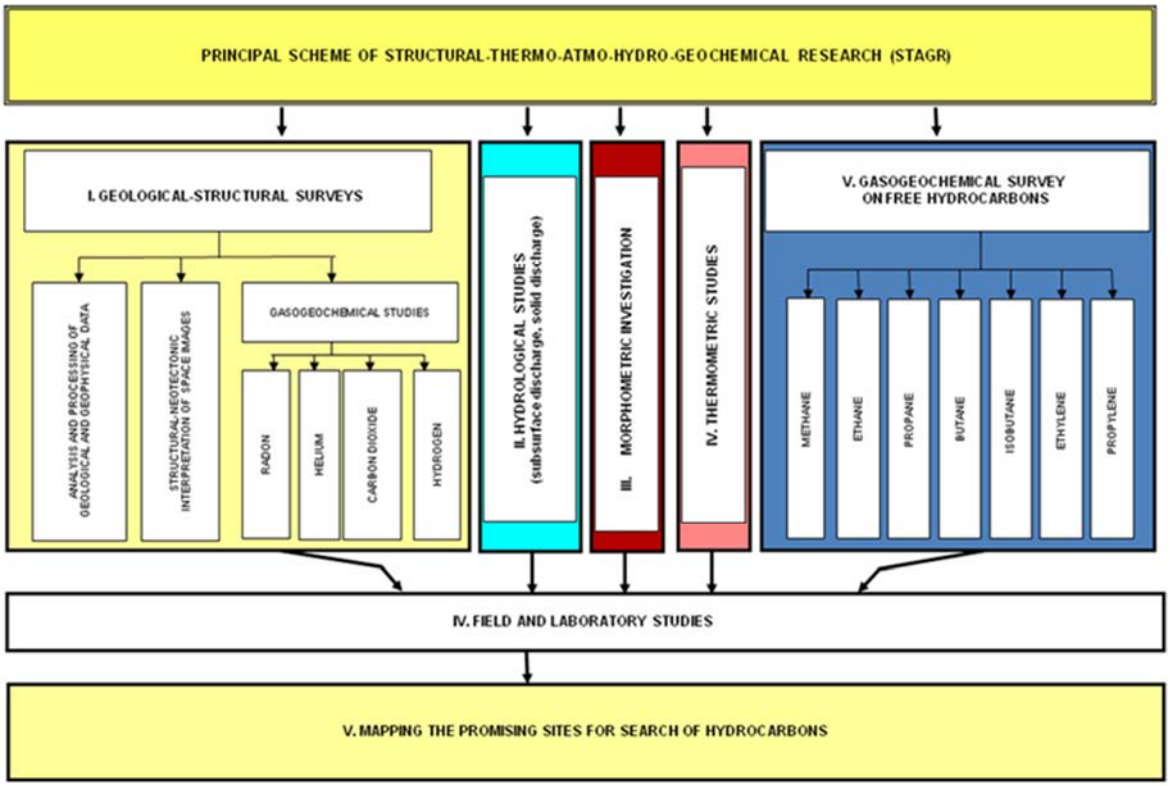

Fig. 2. Principled schedule of direct searches for hydrocarbons according to the structural and thermo-atmo-hydrological and geochemical technology

The study of hydrological, structural and geological features on the territory of river basins under consideration in accordance with hydrological unit of search technology provides a reliable basis for calculation of volumes of accumulation of biota and products of hydro-gas-substrates (water – methane), providing an opportunity to allocate the primary contours of expected and promising areas for hydrocarbons.

And already in the 70s of the last century at the Institute of Geological Sciences of Ukraine, a successful attempt to unify the whole complex of geological-structural, of geodynamic, atmogeochemical, geothermic and hydrological studies into one search technology on groundwater in the sedimentary cover and crystalline rocks was undertaken by the author, and since the year 2000, a positive experience has been received. On this basis, the new concept of direct search for hydrocarbons was developed [1–4].

Analysis of the location of large oil and gas deposits in the hydrogeological basins of Western Siberia (180 fields) and Perm Ural (173 fields) provides an opportunity to draw some conclusions in order to develop recommendations for the search for new oil and gas deposits, associated with river beds.

The greatest number of discussed above hydrocarbon deposits located under the riverbeds or in immediate proximity to the riverbeds in the valleys formed by sedimentation-biogenic sediments of river systems.

Deposits of hydrocarbons within marine areas are located in river deltas-zones of groundwater discharge of river basins confined to fractured zones of traced canyons of ancient valleys of river systems formed in the sediments of the sedimentation zones in Cenozoic.

Methane-soluble substrates filling of fractured volumes of mantle origin inevitably leads to migration of surpluses of gas component in marine areas, introduced by water-gas stream, and to the incapability of its acceptance by limiting volumes of fractured zones of crystalline rocks. They wedge out with gas, pure methane fountains, mud volcanoes, saturating the upper layers of the sedimentary cover of bottom sediments, representing an inverted effect of bottom sediments of the river systems. Therefore erroneously it is interpreted by many researchers as gas hydrates. According to the results of our research, on its sorbing characteristics during degassing of marine bottom sediments and sediments of river systems they are practically identical, reaching in both the first and second cases up to 60–80 vol. %.

In areas of water-gas submarine sources pinchout along listric faults such phenomena sometimes cause the diapiric rise, mud volcanoes, etc.

According to the unifying hydro-geosynergetic biogenic-mantle hypothesis, in the zones of development of deep tracing faults, freshwater-gas-saturated substrates are getting inside the mantle stretching zone interpreted as mantle plumes, which are characterized by high temperatures and pressures, as well as by implication of the range of mantle fluid catalysts. As a result of this, complex hydrocarbons are formed. In conditions of geodynamic processes they are partially squeezed into the sedimentary cover along the pathways of degassing and accumulate in the stretching zones. They also partially accumulate in fractured areas of basement, forming hydrocarbons deposits in crystalline rocks.

Results and Conclusions. For the first time on the basis of a unifying hydro-geosynergetic biogenic-mantle hypothesis, a comprehensive hydrological studies within the framework of improvement of direct search technology STAHGT on the rivers of Ukraine were conducted by us: within Dnieper–Donets depression (DDD) – on rivers Sula, Vorskla, Psel, Orel, on the rivers of Carpathian piedmont trough, in the deltas of the river systems and their canyons. In addition, there were mapped on the of structural-tectonic basis river systems, canyons, more than 250 current and forecast deposits, considering development of graben-forming processes.

Analysis of placement of oil and gas deposits in the marine areas and in mapped river canyons (E. F. Shnyukov, V. I. Melnik) completely confirms geographical placement of hydrocarbon deposits and riverbeds processes in river deltas and canyons (the Danube, the Dnieper, Kuban etc.). A total of more than 300 current and predicted deposits in rivers of deflections zones and marine areas were analyzed.

Thus, the analysis of materials of aerospace survey, of topographic bases 1 : 100000 scale, structural-tectonic maps in areas of deposits placement, as well as data of katabatic characteristics of the surface river flows and, in particular, of underground flows provides reason to believe that almost all oil and gas bearing structures (in this case, of Ukraine – Carpathian piedmont basin and DDD) are located under the riverbeds or adjacent to them, in areas of absorption of river underground flow forming a water-gas-methane biogenic substrates due to income from areas of infiltration.

Almost all of the riverbeds, as mentioned above, are laid along the graben-shaped troughs and FZEP of river systems controlled by deflections, located in areas of high humidification and wetlands.

As shown by a comprehensive analysis of hydrological, hydro-geological, structural and tectonic studies, including materials concerning the fault-block tectonics and graben-shaped formations, there is reason to believe that practically all oil and gas bearing objects of river basins of DDD – Sula, Vorskla , Psel, Oril, and also of zones of Black Sea and Carpathian depressions with deltaic canyons in the form of continuing river systems, are located in the areas of absorption and discharge of superficial river water and in terms of placement are confined to its river valleys.

In addition, this configuration of deposits placement in the riverbeds and within its valleys is easily explained from the standpoint of paleogeographic features in the areas of depressions – graben, forming as a result of its transformation by structural processes.

An insignificant part of hydrocarbon deposits is located in the watershed areas – the probable ancient valleys, geodynamic zones of extension – the most permeable extension zones, favorable for both the emplacement of river basins of the lower orders and for FZEP.

For the first time, a comprehensive analysis of hydrocarbon deposits placement within the river basins of DDD on the structural-tectonic basis (Fig. 3) have been carried out, which provides every reason to assert about the interrelation of hydrocarbon deposits formation with the hydrological and geomorphic, sedimentation and biochemical processes occurring in the areas of development of geodynamic structural-tectonic processes, which serves as one of the main hydrological search criteria for hydrocarbon [5].

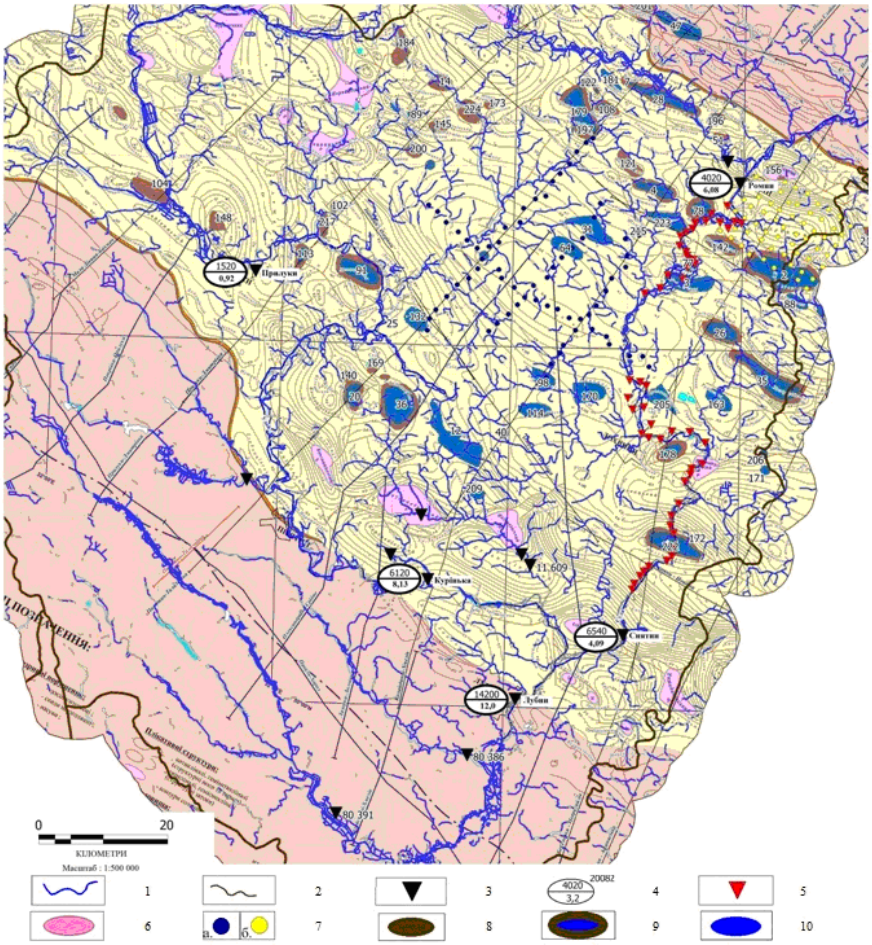

Fig. 3. Map of hydrocarbon deposits location on the structural-tectonic base with elements of with river network:
1 – riverbeds of rivers Sula, Uday; 2 – boundary of Sula River Basin; 3 – gauging stations; 4 – catchment area of gauging station, on the right – the number of gauging station, the numerator – the catchment area, km^2, the denominator – the water consumption, m^3; 5 – the sampling points of the bottom waters and sediments for soil vapor survey; 6 – the contours of salt stocks; 7 – the points of observation points STAHGT placement: a – on Sribnyanska depression, b – on Bobrykivska area; hydrocarbon deposits: 8 – oil deposits, 9 – oil and gas condensate deposits, 10 – gas and gas condensate deposits

Conducted investigations (including methodological issues) in the river Sula basin for substantiation of hydrological search criterion in the STAHGT within a framework of hydro-geosynergetic biogenic-mantle concepts include:

– Processing of the data of hydrological research for 80 years of field measurements expenditures of water in river basins of DDD;

– calculated characteristics of superficial and underground water discharge;

– carrying out hydrometric measurements with detailed elaboration in the areas of hydrocarbon deposits placement at the relevant riverbed area in order to determine locations of the infiltration and the size of underground river discharge absorption, and to study the chemical composition of the river water on hydrocarbon, as well as methane content of bottom sediments all over the riverbed, taking into account the placement of hydrocarbon deposits.

Carried out analysis of cartographic material, reflecting the value of the surface and underground discharge modules in oil and gas bearing areas (National Atlas of Ukraine, 2007), as well as maps of groundwater discharge modules (based on zoning of Ukraine on the conditions of underground waters formation – the author I. D. Bagriy) provides concept of the quantitative characteristics of river waters infiltration and of possible amounts of dissolved methane, participating in hydrocarbons formation in oil and gas bearing areas Carpathian trough, DDD, as well as in the Black Sea depression region.

In the process of working out of field methodical research, in accordance with the proposed direct search technology, we selected an experimental site on the river Sula, bounded by two gauging station in the upper alignment river Sula – Romny, with a catchment area of 4020 km^2, closing post is located on the river Sula – Snitin village with a catchment area of 6540 km^2. In the area of the channel process Yablunivs'ke, Skorobogativs'ke, Krasnozavods'ke, Selyuhovs'ke, Yarmolinets'ke hydrocarbon deposits are placed.

The results of a comprehensive analysis of river flow on the above site, covering an area of over 2000 km^2, according to data of hydrometric gauges for the entire period of observations (hydrological yearbooks), constituting more than 70 years, evidence of considerable losses of river discharge. The quantities of river water losses vary depending on the dryness of the year from 0,7 m^3/s in limiting drought years up to 5–8 m^3/s during the years with average normalized discharge of 50 % availability that in daily section is approximately 100 000 – 500 000 m^3/s and an annual losses are correspondingly constitute up to about 15 million m^3.

Waterlogged outwash plains forming biogenic sequences in the processes of seasonal, annual, secular cycle (in the geological section) of water, flood and geomorphic processes of river basins, form an substantial reserves of bionts over large catchment area of swamps adjacent to the riverbeds with high humus content, producing significant constantly

renewing biogenic methane-water substrates in the processes of oxidative reactions.

For the first time, comprehensive hydrological studies within the framework of hydro-geosynergetic biogenic-mantle concept were conducted, including hydrological measurements of river water with account of existing deposits location under the riverbed of a river Sula and in adjacent areas.

The researches on biota content and methane content, as well as on the capacity of the underlying riverbed sediments were conducted. Capacity of bottom sediments in many areas reached 3 meters or more.

Quantitative characteristics of biogenic methane in catchment areas and underflow sediments were determined, the content of which varied from 10 to 80 %, which in quantitative terms is an average of about 4 000 000 m^3 of methane per year, and in years with enhanced discharge characteristics this amount can reach more than 20 million m^3. During the research, specially designed by us vacuum decontaminators of deep samples were applied.

The results of the conducted researches (gas-emanation (Rn, Tn), gas-helium surveys) of river water and bottom sediments within the framework of search technology, provide an opportunity to identify zones increased permeability which form infiltration supplies of water-dissolved substrates, as well as mantle nature of the origin of hydrocarbons and their projections, located in the degassing pathways of deposits in the valley of river Sula.

Within the framework of the proposed unifying hypothesis of the origin of hydrocarbons are used the statutes of P. N. Kropotkin on the stage of "Earth's breathing cycle" (according to V. I. Vernadsky and D. I. Mendeleyev), conversion of biogenic methane-water substrate into complex hydrocarbons in the mantle-plume conditions and its inversion migration along zones of tectonic deformation (pathways of degassing), as was described above, i.e. by complex hydrocarbon branch of degassing (exhalation) of the Earth, which indicators are the mantle elements – helium, nitrogen, hydrogen and decay products (Rn, Tn). The above gas-emanation components are the marker elements of deep-mantle processes.

Similar processes of migration of hydrocarbon components we recorded during forecasting and exploratory researches of numerous structures located at a depth of 40–100 m on the western and eastern Black Sea shelf. Also, for the first time there were conducted researches on the continental slope in the area of Pallas and British structures, where the depth is suitably from 400 to 800 m.

The applying of instrumental complexes developed by us provide the purity of the experiment in the form of complete sealing and degassing of samples taken in rivers and in the sea areas and their pumping on the surface.

Thus, as shown by experience in applying STAHGT (Fig. 4), hydrocarbons deposits formation and its prognostic characteristics should be investigated systematically in the hydrological and geological time section, taking into account the influence of high-temperature conditions and hydrological-biogenic methane-producing processes in close relation to geodynamic deep mantle transformations of biogenic methane-water-dissolved substrates in association with the deep product of fluid-mantle degassing processes, catalysts and decay products (Rn, Tn).

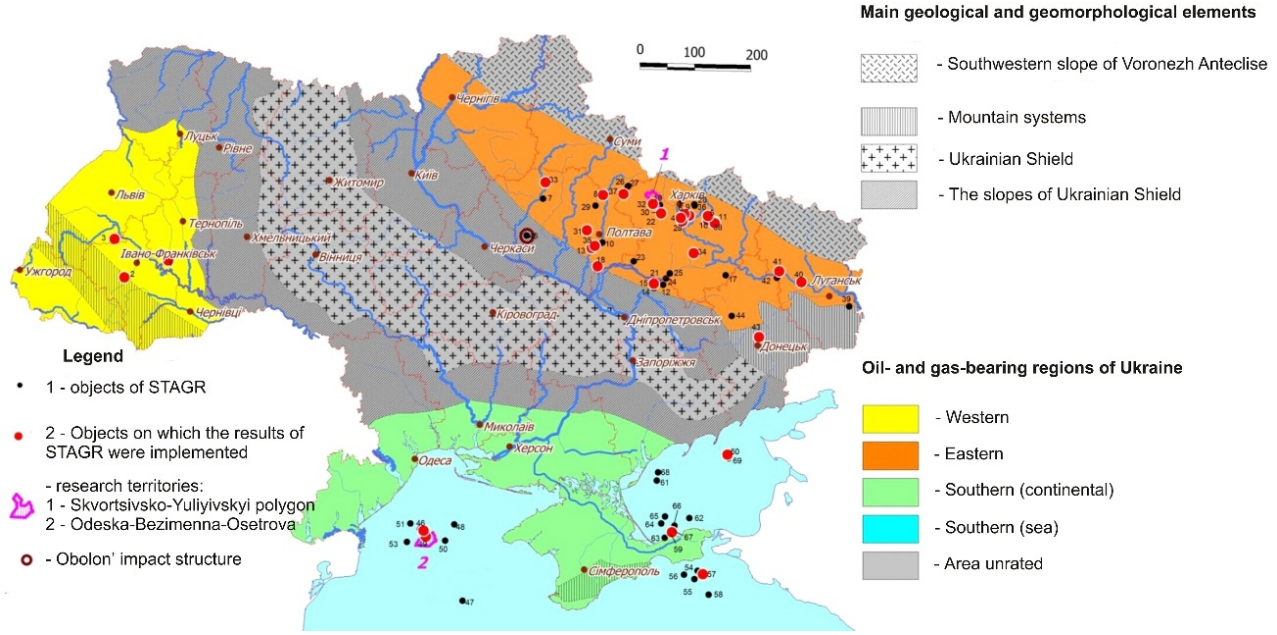

Fig. 4. The results of implementation of promising facilities and areas for petroleum exploration by STAHGT

When developing and implementing of the comprehensive direct search structural-thermo-atmo-hydrological and geochemical technology (STAHGT), created on the basis of hydro-geosynergetic biogenic-mantle concept, we were governed by the following rule (by V. I. Vernadsky): if the forming conditions in the hydrogeologic (stratigraphic) section are observed on the surface, they will certainly appear at a depth – in the crystalline basement.

In order to increase hydrocarbon potential of Ukraine, carrying out the complex of researches in the framework of hydrogeosynergetic biogenic-mantle hypothesis of hydrocarbons formation is provided, for substantiation of new oil and gas bearing areas and objects in the zones of development of mapped structures located within meandering sites of river systems of oil- and gas bearing regions on the basis of a unified search technology STAHGT.

The proposed unified approach provide an opportunity to substantiate the search criteria of petroleum capacity in areas where there are neither depressions zones nor sufficiently thick sedimentary cover, but favorable conditions for hydrocarbons accumulation occur (in zones of

development of river systems, swampy-outwash areas) in crystalline rocks as a result of sufficient generation of biogenic methane-producing sediments and structural-geodynamic, geothermal processes.

These studies should be conducted in the north-western part of the Carpathian trough covering the territory of the upper tributaries of the river Pripyat, Kovel ledge, as well as in the south of Ukraine in the Black Sea depression and in the shelf zone of river deltas – canyons, areas of accumulation of sedimentary-stratigraphic complex.

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ГІДРОГЕОСИНЕРГЕТИЧНА БІОГЕННО-МАНТІЙНА ГІПОТЕЗА УТВОРЕННЯ ВУГЛЕВОДНІВ ТА ЇЇ РОЛЬ ПРИ ОБГРУНТУВАННІ ПРЯМОПОШУКОВОЇ ТЕХНОЛОГІЇ

На основі кругообігу речовини в природі розроблено гідрогеосинергетичну біогенно-мантійну гіпотезу утворення вуглеводнів і, як результат, створено прямопошукову структурно-термо-атмо-гідролого-геохімічну технологію (СТАГГТ). Дана технологія вперше була застосована й успішно впроваджена в процесі прогнозно-пошукових робіт на нафтогазоносних об'єктах України на суші (Дніпровсько-Донецька западина) і в Чорному морі (північно-західний і північно-східний шельфи) з використанням спеціально розроблених апаратурних комплексів. Проведено комплексні гідрологічні дослідження з урахуванням розміщення діючих родовищ у межах басейну р. Сула. Визначено вміст біоти, метаноносність, а також потужності підстеляючих відкладів у межах русла і прируслових ділянок. Визначено кількісні характеристики біогенного метану водозбірних площ і підруслових відкладів. У результаті виділено зони підвищеної проникності, що формують інфільтраційні надходження розчинених у воді субстратів. Визначено мантійну природу походження ВВ та їхніх проекцій, розташованих у трубах дегазації родовищ в долині р. Сула. Запропонований уніфікований підхід дозволяє обґрунтувати пошукові критерії нафтогазоносності в районах, де відсутні зони прогинів і потужний осадовий чохол, але існують сприятливі умови для накопичення ВВ в кристалічних породах. Наведено рекомендації щодо виконання досліджень з обґрунтування нових нафтогазоносних територій та об'єктів на основі уніфікованої технології СТАГГТ. Уперше обґрунтовано джерела відновлення вуглеводневих родовищ, що перебувають в експлуатації.

Ключові слова: гідрогеосинергетична біогенно-мантійна гіпотеза, вуглеводні, міграція вуглеводнів, тектоніка.

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ГИДРОГЕОСИНЕРГЕТИЧЕСКАЯ БИОГЕННО-МАНТИЙНАЯ ГИПОТЕЗА ОБРАЗОВАНИЯ УГЛЕВОДОРОДОВ И ЕЕ РОЛЬ ПРИ ОБОСНОВАНИИ ПРЯМОПОИСКОВОЙ ТЕХНОЛОГИИ

На основании круговорота вещества в природе разработана гидрогеосинергетическая биогенно-мантийная гипотеза образования углеводородов и, как результат, создана прямопоисковая структурно-термо-атмо-гидролого-геохимическая технология (СТАГГТ). Рассматриваемая технология впервые была применена и успешно внедрена в процессе прогнозно-поисковых работ на нефтегазоносных объектах Украины на суше (Днепровско-Донецкая впадина) и в Черном море (северо-западный и северо-восточный шельфы) с использованием специально разработанных аппаратурных комплексов. Проведены комплексные гидрологические исследования с учетом размещения действующих месторождений в пределах бассейна р. Сула. Определены содержание биоты, метаноносность, а также мощности подстилающих отложений в пределах русла и прируслових участков. Определены количественные характеристики биогенного метана водосборных площадей и подрусловых отложений. В результате выделены зоны повышенной проницаемости, формирующие инфильтрационные поступления водорастворенных субстратов. Определена мантийная природа происхождения УВ и их проекций, расположенных в трубах дегазации месторождений в долине р. Сула. Предложенный унифицированный подход позволяет обосновать поисковые критерии нефтегазоносности в районах, где отсутствуют зоны прогибов и мощный осадочный чехол, но существуют благоприятные условия для накопления ОВ в кристаллических породах. Приведены рекомендации по выполнению исследований для обоснования новых нефтегазоносных территорий и объектов на основе унифицированной технологии СТАГГТ. Впервые обоснованы источники восстановления углеводородных месторождений, находящихся в эксплуатации.

Ключевые слова: гидрогеосинергетическая биогенно-мантийная гипотеза, углеводороды, миграция углеводородов, тектоника.