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OIL ORIGIN AND AGE

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Abstract. The question of oil age is discussed on the basis of the biosphere concept of oil and gas formation. It considers oil and gas deposits as underground carbon traps circulating through the Earth's surface in the three main cycles of the circulation. A theoretical model has been developed that makes it possible to explain from these positions the phenomenon of replenishment of oil and gas deposits in the process of field development. The model provides a balance between carbon flows on the ascending and descending branches of its circulation through the Earth's surface. In this model, the ascending flow of carbon is represented by the products of subsoil degassing (CH_4, CO_2) and extracted by the person from the depths of oil, gas and coal. A descending flow is an organic matter and carbonates that are submerged in the subsoil in the processes of sedimentation and subduction of lithospheric plates, as well as atmospheric CO_2, entering the Earth's surface with meteoric waters in the process of their climatic circulation.

Since the fields are filled with hydrocarbons formed in cycles of carbon with widely differing circulation times, instead of the term 'age of oil', it is suggested to use the terms 'trap formation time' and 'hydrocarbon life time in the trap'.

This approach to the question of oil age in the biosphere concept leads to a number of conclusions, from which it follows that: 1) the 'old' petroleum of biogenic genesis is extracted at the initial stage of the development of deposits, whereas in the depletion stage the 'young' hydrocarbons of abiogenic synthesis prevail; 2) the age of industrial accumulations of oil on our planet is hardly older than the Pleistocene, while gaseous, liquid and bituminous fractions of oil have different lifetimes in traps.

Keywords: oil age, oil and gas formation, biosphere cycle of carbon, balance problems of carbon circulation

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This article continues to acquaint readers with the modern scientific revolution in oil and gas geology (Barenbaum, 2014, 2015). To replace recently competed organic and mineral theories of oil and gas formation, new ideas have come today (Sokolov, Guseva, 1993), according to which "oil and gas are renewable natural resources, and their development must be formed on a scientifically based balance of hydrocarbon generation and extraction possibilities in the process of field exploitation". Thus, the problem solution of oil and gas origin was transferred to the field of knowledge that goes beyond oil and gas geology.

These new views on the origin of oil and gas received an appropriate theoretical justification in the biosphere concept of oil and gas formation (Barenbaum, 2014), which linked the formation of these HC with the carbon and water cycle through the earth's surface involving the biosphere.

This work has a dual purpose: first, to clarify a number of provisions of the biosphere concept that implements a new approach to solving the problem of the origin of oil and gas, and, secondly, on the basis of this concept, consider the age of oil and its fields.

The issue of oil origin and age was actively discussed the last time at the turn of this century in connection with the establishment of hydrocarbons inflow into deposits (Muslimov et al., 1991; Sokolov, Guseva, 1993; Ashirov et al., 2000; also the discovery in the oils of nuclide ^{14}C of natural (Peter et al., 1991), and artificial (Kalmytkov et al., 1999) formation.

Isotope ^{14}C has a half-life of 5730 years and usually (Ferronsky et al., 1984) enters the groundwater with atmospheric air, where it is formed by the action of cosmic neutrons by reaction $^{14}N(n,p)^{14}C$. In the first work, the ^{14}C isotope was found in the oil of the Guaymes offshore field in the Gulf of California. And in the second work, the presence of ^{14}C and another radioactive nuclide – tritium ^3H with a half-life of 12.43 years – is established in oil fields where underground nuclear explosions were previously conducted. The halo of the spread of these radioactive nuclides in oil and water reaches 7 km from the site of the explosion, which cannot be explained by the direct contamination of oil and water with the products of explosion and indicates the transfer of ^{14}C and ^3H isotopes over long distances by groundwater.

It is not possible to satisfactorily explain from geological point of view the reason for the replenishment of hydrocarbons of exploited fields, as well as the presence of short-lived isotopes of carbon and hydrogen in oil. So the problem of the age of oil and its fields cannot be considered solved.

The problem of oil age

First of all, it is necessary to determine what to regard as the age of oil, and what should be understood under the time of formation of its fields. The answers to both questions obviously depend on how the oil itself appears in the interior. These views, however, differ in supporters of organic and mineral theories of oil and gas formation. According to the first, oil and gas originate from organic matter (OM) of dead organisms buried with sediments. According to the second, sources of oil and gas are hydrocarbon fluids and gases coming from the depths of the Earth.

Throughout the last century, the disputes between "organicians" and "non-organicians" about the genesis of HC did not stop. Depending on who won these disputes, the ideas of oil age changed.

So, since the 1930s, during the period of formation and dominance of organic theory, the age of oil and gas was associated with the age of oil source rocks. It was believed that the formation of hydrocarbons and the formation of reservoirs rocks that surround them is a single geological process, during which catagenetic transformation of OM occurs.

However, by the present time, a large number of facts have been accumulated by the proponents of the inorganic theory, which prove that hydrocarbons can form in abiogenic synthesis reactions (joumal. deepoil.ru). Emerged hydrocarbons rise to the surface, where, filling traps in reservoir rocks, create oil and gas deposits. Therefore, the age of hydrocarbons and the age of reservoir rocks in which hydrocarbon deposits are located may not coincide.

As a result, the age of oil, and as its top estimate, is the time of formation of rocks that contain hydrocarbon deposits. However, this approach to determining the age of oil is not correct. The fact is that the formation of rocks, appearance of traps in them and filling of traps with hydrocarbons are different processes that usually do not occur simultaneously.

In this paper, the age of oil is decided on the basis of the biosphere concept, which involves participation biosphere processes in the formation of oil and gas. Along with biogenic and mineral mechanisms of the HC genesis, the biosphere concept takes into account influence of carbon and water cycles on the oil and gas formation through the earth's surface, which depends on modern human activity.

Biosphere concept

Unlike biogenic and mineral theories, operating with the concepts of "organic" and "inorganic" carbon, the biosphere concept proceeds from the premise that such carbon of both forms does not exist in nature, but there is carbon of the biosphere that, when geochemically circulating through the earth's surface (Fig. 1), is

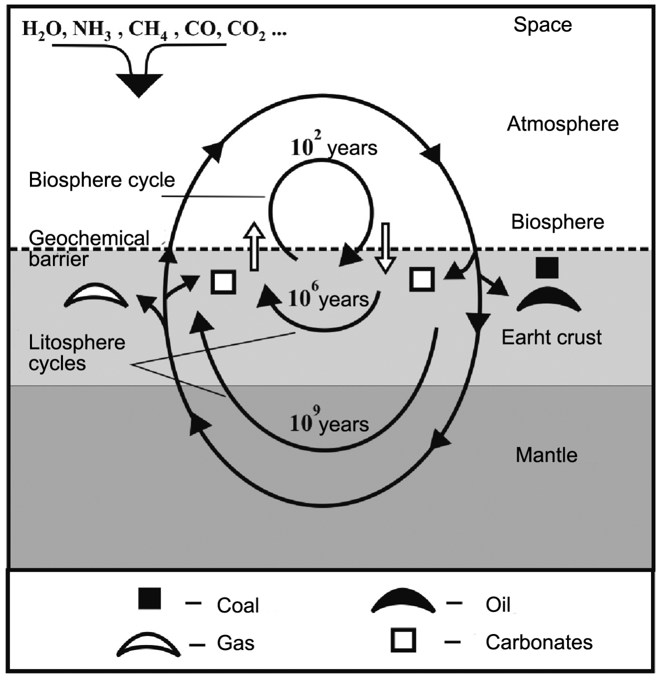

Fig. 1. Scheme of the geochemical circulation of carbon on Earth

repeatedly involved in oxidation-reduction processes. Entering into the composition of living organisms, then mineral aggregates, carbon changes its chemical form and isotopic composition. The diagram shows three main cycles of the carbon circulation of the biosphere through the earth's surface: two lithospheric cycles – "slow" and "fast", and biospheric.

The slowest cycle with the characteristic time $\tau_3 \sim 10^8$-10^9 years is caused by the deep immersion of carbon-bearing rocks in the mantle during the subduction of lithospheric plates. The second one is due to the transformation of OM of sedimentary rocks, as well as the carbon of carbonate sediments into hydrocarbons in the earth's crust for a characteristic time $\tau_2 \sim 10^6$ years. And the third – the fastest biosphere cycle with $\tau \sim 10$-100 years, corresponds to the carbon cycle in the biosphere, including its underground part. This cycle is mainly connected with the transfer of water-dissolved CO_2 under the earth's surface by meteoric waters at their regional circulation.

All three cycles are interconnected and occur in such a way that above the earth's surface, which plays the role of a geochemical barrier, carbon in the biosphere circulates mainly in the form of CO_2. Under the surface, a significant portion of the carbon in the form of CO_2 and OM is converted to hydrocarbon oil and gas. Due to poor solubility in water, oil and gas form their own accumulations in geological structures-traps of the earth's crust.

Thus, according to the biosphere concept, industrial oil and gas deposits are nothing more than large, long enough existing reservoirs in the earth's crust – traps of mobile carbon reduced to HC, which circulates through the earth's surface.

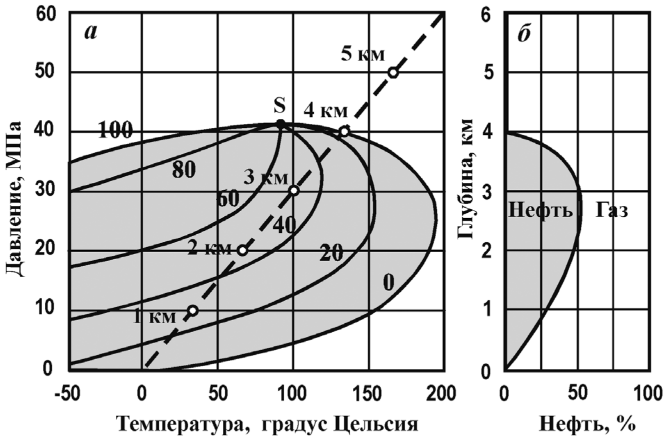

Fig. 2. Phase diagram of a typical HC mixture with isotherms (a) and oil saturation curve (b) corresponding to this diagram: inclined dotted line – depth scale; S – critical point of the mixture (Barenbaum, Batalin, 2001).

Since there are no ideal traps, and the insulating properties of the traps for different fractions of oil vary greatly, it is not possible to clearly define the concept of "age of oil". Instead, the biosphere concept introduces the notions of "mean lifetime" of HC in deposits (traps) and "the time of formation (age) of the trap". It is understood that the gaseous, liquid and bituminous fractions of oil essentially differ in the lifetime in traps, and the ratio of liquid and gaseous hydrocarbons to other conditions is determined by the temperature and pressure in the deposits (Fig. 2).

This figure theoretically explains the shape of the "oil window" reflecting the distribution in oil and gas basins of the world in the depths of oil and gas fields (Sokolov, Ablya, 1999).

Problematic issues of oil and gas formation

For a long time, the central issue in the problem of oil and gas origin was the choice between the organic and mineral theory of hydrocarbon formation, which play the role of independent scientific paradigms in oil and gas geology (Barenbaum, 2014).

The biosphere concept, however, showed that the dispute between "organicians" and "non-organicians" is actually being conducted on the question of which of the two lithospheric carbon cycles (Fig. 1) plays a major role in the processes of oil and gas formation: organicians claim that a cycle with τ_2~10^6 years, while inorganicians insist that the cycle with τ_3~10^8-10^9 years. Both disputing parties did not take into account at all participation of the most rapid biospheric cycle of the circulation from τ-10-100 years in the formation of hydrocarbon oil and gas.

This circumstance gave rise to a number of serious balance problems. One of them is the famous paradox of G.I. Voitov (1986). Generalizing the measurement data, G.I. Voitov found that the flow of carbon (oxidized + reduced) through the surface on the ascending branch of the circulation (Fig. 1) multiply exceeds its flow on the descending branch. And if carbon falls below the surface with sediments, consisting of -1/3 of OM and -2/3 of carbonates, CH_4 and CO_2 degrade into the atmosphere from the interior.

Another problem is established by climatologists (Kondratiev, Krapivin, 2004). With the modern production of oil, gas and coal, which is 7x10^{15} g per year, approximately 30% of CO_2 produced during the combustion of these fuels cannot be removed from the atmosphere due to the known mechanisms of its dissolution in the waters of the World Ocean and plant photosynthesis even under the most optimistic assumptions.

Consideration of the biosphere cycle easily eliminates these imbalances. At the same time, the solution of three balance issues of the carbon cycle in the biosphere, named by the author as problems of "source", "flow" and "exchange", comes to the fore in the problem of oil and gas origin.

Their solutions are obtained (Barenbaum, 2010), relying on the teachings of V.I. Vernadsky of the biosphere (Vernadsky, 2001). According to this teaching, first, the carbon of the biosphere is of cosmic origin and enters the Earth from the Galaxy. And, secondly, the living matter of the biosphere actively participates in geological and climatic processes occurring on the surface of the Earth, exerting geochemical influence on them.

The essence of the problems of the "source", "flow" and "exchange" is set forth in the work (Barenbaum, 2014). Below are their solutions in the biosphere concept.

The "source" problem is the answer to the questions, where the mobile carbon is taken from in the biosphere, and how, following the views of V.I. Vernadsky, living matter geochemically affects geological processes.

We associate this problem with the incidence of galactic comets on Earth and the utilization of their matter in the biosphere (Barenbaum, 2010). The falls of such comets are of the nature of "showers", which cycle through time T = 20-35 million years. During a single shower of ~2-4 million years, ~10^4-10^7 comets can fall to Earth, which can bring up to ~10^{22} g of water, an order of magnitude less carbon and two orders of magnitude less than other chemical elements. Cometary carbon entering the surface with the participation of living matter is redistributed in three cycles in accordance with the time t of their circulation, thus ensuring the stable functioning of the entire geochemical system.

The problem of "outflow" is an explanation of the mechanism by which CO_2 from the atmosphere enters the rocks of the earth's crust. It is established that this mechanism on the continents is the transfer of water-soluble CO_2 under the earth's surface by meteoric waters of the regional climatic cycle, where CO_2 participates in the formation of hydrocarbon oil and gas (Barenbaum, 2015a). An important role is also played by the geological cycle of seawater in the earth's crust (Barenbaum, 2010). Underground waters not only carry mobile carbon in the upper zone of the earth's crust, but also are the main donor of hydrogen in the reactions of hydrocarbon oil and gas formation.

The problem of "exchange" is the identification of a chemical mechanism that transforms water-dispersed CO_2 and dispersed OM in the rocks of the earth's crust into oil and gas hydrocarbons. It is confirmed that this mechanism is the polycondensation synthesis of HC on the surface of a water-saturated mineral rock matrix mechanically activated by seismic and micro-tectonic processes. The possibility of this synthesis of hydrocarbons was justified theoretically and proved in the experiments of V.I. Molchanov (1992) and independently N.V. Chersky and V.P. Tsarevym (1984). Carbon donors in the synthesis are water-soluble CO_2 and OM, and water is a hydrogen donor.

According to (Zakirov et al., 2013) the reaction for the synthesis of n-alkanes (C_nH_{2n+2}) from CO_2, and H_2O can be represented by the phenomenological formula:

$$nCO_2 + (n + \mu + 1)H_2O + æFe = CnH_{2n+2} + \mu H_2 + æ(FeO) + ½\,(3n + \mu + 1 - æ)O_2,$$

where n is the number of carbon atoms in the HC molecule, μ and æ are the stoichiometric coefficients; "Fe" sign denotes not only iron but also other metals that act as reaction catalysts and oxygen absorbent.

Experiments at room temperature and atmospheric pressure showed that when the O_2 is completely removed, this reaction proceeds at a high rate, decomposing a large amount of H_2O (Barenbaum, Klimov, 2015).

Model of the carbon circulation

The above solutions to the problems of "source", "outflow" and "exchange" were used in the development of the theoretical model that provided the carbon balance in the scheme (Fig. 1) during the circulation through the earth's surface. This model is represented by a system of three first-order differential equations, each of which characterizes its cycle of carbon circulation (Barenbaum, 2010):

$$\begin{aligned}
\frac{dn_1}{dt} + \frac{n_1}{\tau_1} &= \alpha_{12}n_2 + \alpha_{13}n_3 + Q(t) \\
\frac{dn_2}{dt} + \frac{n_2}{\tau_2} &= \alpha_{21}n_1 + \alpha_{23}n_3 \\
\frac{dn_3}{dt} + \frac{n_3}{\tau_3} &= \alpha_{31}n_1 + \alpha_{32}n_2
\end{aligned} \qquad (1)$$

Where n_1, n_2, n_3 and τ_1, τ_2, τ_3 – the mass of carbon and its lifetime in each of the three cycles, respectively; Q(t) is the function of carbon input to the surface; α_{ij} – constants of carbon exchange between cycles.

The constants α_{ij} are related to each other and to τ_i system of relationships, which in model (1) provides a balance between carbon flows in the descending and ascending branch of the circulation through the earth's surface.

Despite the simplified nature, model (1) makes it possible to understand and explain the specificity of the carbon circulation in the Precambrian and the Phanerozoic, and also leads to the conclusion that the circulation of matter in the biosphere is a self-organizing geochemical system currently in stable dynamic equilibrium (Barenbaum, 2010).

Equilibrium is ensured by the fact that the system removes excess carbon from the biospheric cycle and fixes them in certain "reservoirs". Such reservoirs of mobile carbon on the surface of the Earth are primarily the World Ocean, living matter, atmosphere and soil-ooze, and below the surface are decompact rocks of the earth's crust, including hydrocarbon traps.

The condition for stable equilibrium of the entire geochemical system is the fulfillment of the requirement: $n_i/\tau_I = C = const$, where ni и ti are the amount of carbon and its lifetime in the i-reservoir, and C is the rate of carbon circulation in the biosphere. The value of $C = (2.7\pm0.1)\cdot10^{17}$ g/year in the biospheric concept is determined by the rate of circulation of the waters of the World Ocean through the mid-oceanic ridges (Barenbaum, 2010).

The data (Fig. 3) indicate that the carbon circulation system in the biosphere is now in a state close to equilibrium. In this state, any disturbance of equilibrium

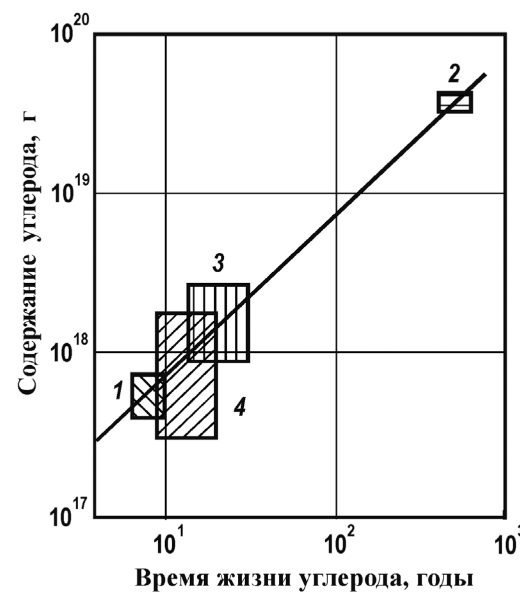

Fig. 3. Comparison of the content of mobile carbon and its lifetime in main reservoirs of the biosphere on the earth's surface: atmosphere (1), oceans (2), living matter (3), soil-ooze (4); Rectangles show the scatter of estimates from literature data; The inclined line corresponds to the rate of carbon circulation in terms of CO_2: $C = 2.7 \times 10^{17}$ g/year.

is sought by the system by redistributing carbon between its reservoirs. The characteristic time to return to equilibrium is 40 years on the continents, and in the oceans ~ 600 years (Fig. 3).

Human influence

The biosphere concept has made it possible to establish that currently intensive formation of hydrocarbons due to human activity occurs on our planet (Barenbaum, 2015). While extracting oil, gas and coal from the bowels and burning them on the surface, a man breaks the dynamic balance between carbon circulation that has developed on Earth for many millions of years. As a result, the large mass of carbon that participated earlier in the lithospheric cycles with characteristic times of $\sim 10^6$ and $\sim 10^9$ years is now involved in the fast ~ 40 year biosphere cycle.

First of all, this carbon in the form of CO_2 enters the atmosphere. In the postwar period, the amount of CO_2 in the atmosphere increased from 310 ppm (1950) to 387 ppm at the present time (Fig. 4), i.e. increased by 24% rel. This growth, according to climatologists, can cause climate warming on Earth.

However, the reservoirs for this new carbon on the surface are not enough. The geochemical system of the biosphere is forced to seek new traps for it, using the processes of oil and gas formation under the earth's surface. Two such processes can be identified (Barenbaum, 2015).

The main process, covering almost the entire globe, is the deposition of aquamarine gas hydrates on the continental shelf of the oceans and seas. Gas hydrates are "chemical" traps of mobile carbon of the biosphere (Barenbaum, 2010), in which CH_4 and CO_2 enter the structure of H_2O molecules, with traps very effective. One cubic meter of gas hydrates can contain 150-160 m^3 of gas. According to some estimates, $\sim 10^{20}$ g of hydrocarbons are concentrated in gas hydrates, which is ~100 times higher than in conventional oil and gas fields (Yakutseni et al., 2009).

At the regional level, the main process of CO_2 utilization is replenishment of the reserves of oil and gas fields being developed. This phenomenon is now reliably established on the deposits of Tatarstan, Chechnya, Ukraine, Kazakhstan, Caspian region, Azerbaijan, Western Siberia, etc.

An important consequence of the biosphere concept, which directly relates to the "age of oil", is the conclusion that the composition of oil produced in the process of industrial development of deposits does not remain constant. At the time of discovery of the deposit and at the initial stage of its development, the "old" oil comes to the surface, formed in accordance with the organic theory in a cycle of carbon $\sim 10^6$ years. This oil can also include impurities of non-processed organics and chemofossils deposited in the host rocks in a cycle of $\sim 10^9$ years.

However, in the course of reservoir development, hydrocarbons of modern polycondensation synthesis begin to accumulate in the reservoirs. As a result, "young" light oil, formed in the 40-year biospheric cycle of carbon, begins to occupy an increasing share in production of wells.

The presence of the C^{14} isotope in this oil is beyond doubt. In work (Barenbaum et al., 2005) it is even suggested to use measurements of the C^{14} content in oil while controlling the development of fields.

It should also be borne in mind (Barenbaum, 2012) that the volumes of oil, gas and coal produced today in the world are so great that the geochemical system does not have time to utilize the CO_2 produced during their combustion during the biospheric cycle. As a result, not only does the content of CO_2 grow in the atmosphere, but also the rate, at which anthropogenic oil deposits are being filled, is increasing. We do not exclude the fact that the composition of oil produced

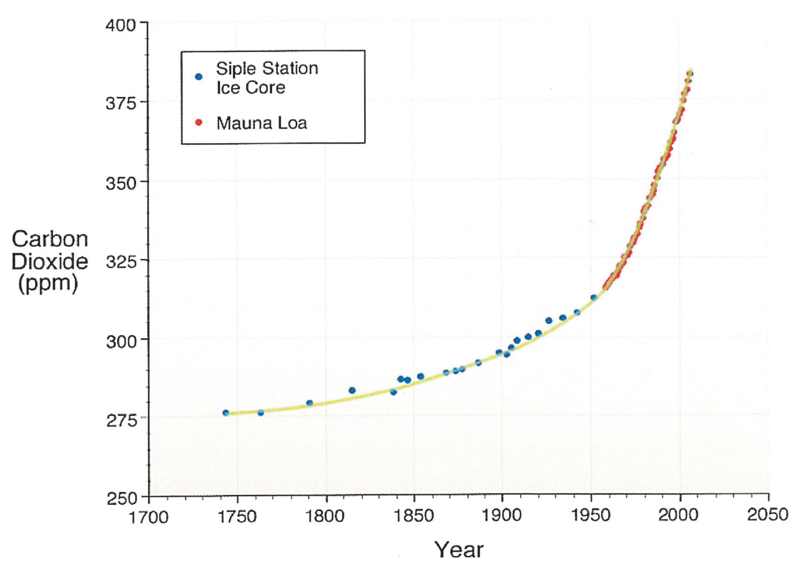

Fig. 4. Content of CO_2 in the atmosphere in the last 300 years

today and extracted more than half a century ago may have noticeable differences in the composition of hydrocarbons.

In this connection, we suggest that the persistence with which "organicians" and "inorganicians" defend different points of view on the origin of oil is probably due to the fact that the supporters of organic theory substantiate their conclusions on the basis of studying the composition and properties of the "old" oil, then as supporters of the mineral theory – "young" oil.

Since the scale of anthropogenic formation of hydrocarbons has significantly increased in recent years, it seems not accidental that the circle of supporters of inorganic origin of oil is today more widespread than ever.

Returning to the question of oil age, it can be stated that the biomarkers present in the oil composition, as well as the age of the reservoir rocks, do not allow to unequivocally diagnose the time of formation of the oil itself. Due to the heterogeneous composition of the oil, the polygenic mechanism of its hydrocarbon formation and the very different times of entry and life of hydrocarbons in the traps, the upper estimate of the age of oil, and only the "old" oil, can be the time of trap formation.

Let us consider the question of traps in more detail.

Classification of traps in the biosphere concept

Without claiming for the completeness and accuracy of this definition, geological structures capable of accumulating and retaining in quantities of industrial interest liquid and gaseous hydrocarbons participating in the biospheric cycle of carbon are called "traps".

In accordance with this definition, the traps can be divided into man-made (artificial) and natural. We refer to the man-made underground gas storages (UGS); underground "burial grounds" intended for injection and burial of CO_2, as well as developed deposits of bitumen and shale. Bitumens and shales are included in this group because from the beginning of development of their deposits should be considered as full-fledged traps of liquid and gaseous hydrocarbons that participate in the biosphere cycle of the carbon circulation.

For man-made traps it makes sense to talk about the length of their service. Examples of such traps are shale gas and oil deposits. Production wells on them in the first 1-2 years dramatically reduce productivity. In order to maintain production of hydrocarbons has to constantly drill new wells and arrange hydraulic fracturing of the layers. The period of profitable exploitation of fields, as a rule, is short-lived, and after ~ 10 years of operation they have to be closed.

Natural HC traps can be chemical and geological. An example of chemical traps can serve as accumulations on the shelf and deep-water slope of continents of aquamarine methanohydrates, in which, in the form of CH_4, today it is two orders of magnitude greater than hydrocarbons than in conventional deposits of oil and gas. Accumulations of methanohydrates, however, are unstable and distributed in oceanic sediments extremely unevenly. According to our estimates (Barenbaum, 2010), the time of formation of large accumulations of aquamarine methanohydrates takes ~ 10^3-10^4 years, and the lifetime in the hydrates of CH_4 molecules is ~ 10 years.

We attribute the conventional oil and gas deposits to the geological traps. There are classifications of geological traps, based on either their search characteristics, or the conditions of formation, or a combination of both. The geological age of the traps in these classifications is not taken into account. Nevertheless, it is obvious that in the Phanerozoic, the formation of traps can have a clear link to the geochronological (stratigraphic) scale.

Age of HC geological traps

Today, few doubt that HC traps of industrial importance arise as a result of sufficiently powerful geological processes (tectonic and/or sedimentary). There is no doubt that such processes occur cyclically in the history of the Earth, sharply increasing in the periods of the orogenic phases of Stille.

At present, it is firmly established that the culmination of the Stille phases, as well as the longer tectonic cycles of Bertrand and Russell, are the result of the Earth's bombardment by galactic comets (Barenbaum et al., 2004). Due to the specifics of the interaction with the planets, galactic comets cause the heating of the asthenosphere rocks, which leads to a significant uplift of the earth's surface (Barenbaum, 2016).

This effect will be illustrated by the actual data for the last cometary bombardment that took place at the Neogene quaternary boundary between 5 and 0.7 million years ago (Barenbaum, 2010). On Earth, it caused a strong rise in the surface of all continents, called the phenomenon of "the latest uplift of the earth's crust".

It is known that in this Pliocene-Pleistocene time, surface elevation was experienced by: Central and North-Eastern Asia, most of Africa, the western parts of the North and South Americas, Greenland, the Urals, the Scandinavian Mountains, the Siberian platform, the mountains of the Alpine belt, Tibet, the Guiana and Brazilian shields, etc. The height of the uplifts varied greatly. On the most part of the Pacific coast it amounted to the first hundreds of meters, on the Siberian platform 200-1000 m, in South Africa 300-400 m in the west and 900-1200 m in the east. The Antarctic continent is intensively uplifting. The fastest growth was in the highlands. So, the Arabian platform increased the altitude by ~ 2 km, the Alps climbed ~ 3 km, and the Himalayas rose by ~ 6 km. Under the majority of mountains, a significant rise in the asthenosphere is noted, accompanied in a number of places by intense magma outflows (Artyushkov, 2012).

Similar processes occurred on our planet and in the era of previous cometary bombings (Barenbaum, 2016).

Therefore, it can be assumed that if there were HC traps filled with oil and gas earlier in the continental crust, then as a result of neotectonic processes in the Pliocene and Pleistocene, these deposits are very unlikely to survive today. On the other hand, the very processes of the "newest uplifts" could have formed in the last million years a large number of new large hydrocarbon traps that exist and are functioning at the present time.

An example is the Romashkino oil field, located in the South Tatar arch. The South Tatar arch is a very young structure that experienced a significant rise in the surface at the Neogene and Quarter boundary. Tectonic activation on the arch continues today, which leads to the filling of the Romashkino traps with new portions of hydrocarbons (Mingazov et al., 2012).

Conclusion

1. Three main cycles of the carbon circulation participate in the formation of oil and gas extracted from the bowels. But the contribution of each of the cycles depends on the geological history of the formation of the hydrocarbon trap and the technology of the field development. Thus, produced shale gas and oil is mainly composed of the carbon of the geological cycle with τ_3 ~10^8-10^9 years; conventional oil and gas-carbon geological cycle with τ_9 ~ 10^6 years, and in the development of deposits of gas hydrates and deposits with replenished reserves of HC – biosphere cycle with ~ 40 years.

2. During the exploitation of fields, the extracted oil "becomes younger". At the initial stage of development, the oil comes to the surface, formed in accordance with the biogenic theory in the geological cycle of the cycle from τ_9 ~ 10^6 years. However, at the stage of depletion of fields, the share of synthesized HC produced in the biospheric cycle of carbon dominates. An example of this in the deposits of Tataria are "millionaire wells", in which light "young" oil is extracted (Muslimov et al., 2004). The use of enhanced oil recovery methods increases the oil recovery of reservoirs, but does not fundamentally change the situation.

3. Large hydrocarbon traps arise due to powerful tectonic and sedimentation processes caused by the bombardment of the Earth by galactic comets. The last bombardment took place between 5 and 1 million years ago. Taking into account the nature of the processes that took place in this period, it is difficult to expect that the earlier hydrocarbon traps could have preserved to the present day. Due to the delay in the culmination of tectonic processes relative to the time of the last cometary bombardment, it can be assumed that most modern oil and gas fields have formed in the last million years.

4. The age of oil in deposits is determined by the lifetime of hydrocarbon in the trap. Since there are no ideal traps in nature, mobile carbon is constantly circulating through the trap, part of which, having turned into hydrocarbons, remains in the reservoirs. At the same time gaseous, liquid and bituminous fractions of oil have different life times in the trap. Heavy HC remain in the reservoir for a longer time than the light. Industrial development of deposits shortens the time spent in the traps of all hydrocarbon fractions.

It is possible that the life time in traps of the bituminous fraction of oil is not more than 1 million years, liquid and gaseous hydrocarbons are much less.

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