

## TECHNOLOGY FOR THE IDENTIFICATION OF HYDROGEN ACCUMULATIONS AND FORECAST OF GEODYNAMIC PHENOMENA

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The analysis of the results of a complex of fundamental and applied studies conducted by the Institute of Geological Sciences, in particular gas-emanation areal surveys, that include H and He, made it possible to re-approach one of the components of hydrocarbon gases, the main energy component of the Universe, hydrogen. The conceptual interpretation of the results of the search schematic diagram of structural-thermo-atmo-hydrologic-geochemical studies allowed to allocate 25 offshore and 98 onshore productive oil and gas areas, at the preliminary regional search stage, as well as not only to record significant hydrogen concentrations in single productive gas wells within the study areas, but also to confirm the results of previous studies in the oil and gas productive areas, in industrial mining wells, in zones of geodynamic phenomena of mine fields.

*Key words:* hydro-geosynergic biogenic-mantle theory; hydrocarbons; hydrogen; structural-thermo-atmo-hydrologic-geochemical studies.

## ТЕХНОЛОГІЯ ВИЯВЛЕННЯ ВОДНЕВИХ СКУПЧЕНЬ ТА ПРОГНОЗУ ГЕОДИНАМІЧНИХ ЯВИЩ

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Аналіз результатів комплексу фундаментальних та прикладних досліджень, проведених Інститутом геологічних наук, в тому числі газово-еманаційних площових зйомок, що включають H і He, дозволив по-новому підійти до одного зі складових вуглеводневих газів – головного енергетичного компоненту Всесвіту – водню. Концептуальна інтерпретація результатів пошукової принципової схеми структурно-термо-атмо-гідролого-гідрогеохімічних досліджень дозволила вже на попередньому регіональному пошуковому етапі виділити 25 морських і 98 на суші продуктивних нафтогазоносних площ, а також не тільки зафіксувати в рамках досліджуваних площ значні концентрації водню в одиночних продуктивних газових свердловинах, а і підтвердити результати попередніх досліджень на ділянках нафтогазопродуктивних площ, у промислово-видобувних свердловинах, у зонах геодинамічних явищ шахтних полів.

*Ключові слова:* гідро-геосинергетична біогенно-мантійна теорія; вуглеводні; водень; структурно-термо-атмо-гідролого-геохімічні дослідження.

## ТЕХНОЛОГИЯ ВЫЯВЛЕНИЯ ВОДОРОДНЫХ СКОПЛЕНИЙ И ПРОГНОЗА ГЕОДИНАМИЧЕСКИХ ЯВЛЕНИЙ

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Анализ результатов комплекса фундаментальных и прикладных исследований, проведенных Институтом геологических наук, в том числе газово-еманационных площадных съемок, включающих H и He, позволил по-новому подойти к одному из составляющих углеводородных газов – главного энергетического компонента

Вселенной – водорода. Концептуальная интерпретация результатов поисковой принципиальной схемы структурно-термо-атмо-гидролого-гидрогеохимических исследований позволила уже на предварительном региональном поисковом этапе выделить 25 морских и 98 на суше продуктивных нефтегазоносных площадей, а также не только зафиксировать в рамках исследуемых площадей значительные концентрации водорода в одиночных продуктивных газовых скважинах, а и подтвердить результаты предыдущих исследований на участках нефтегазопродуктивных площадей, в промышленно-добывающих скважинах, в зонах геодинамических явлений шахтных полей.

*Ключевые слова:* гидро-геосинергетическая биогенно-мантийная теория; углеводороды; водород; структурно-термо-атмо-гидролого-геохимические исследования.

One of the main problems of today, above all in the development of scientific progress, is the use of existing energy sources that carry irreversible destructive processes in the environment and lead to global natural disasters, despite the rather costly environmental measures. New approaches to the search for environmentally friendly energy sources are needed.

Almost all of these processes are closely related to the increasing use of morally outdated energy sources, their production and exploitation, that does not meet today's demands for the development of progress.

Currently, the most serious problem that impedes the development of environmentally friendly hydrogen energy is not only the high cost of hydrogen obtained by the electrical decomposition of water and other extremely costly methods, but also the complete lack of scientific-fundamental and applied ecological-geochemical studies of energy development in the conditions of catastrophic environmental degradation – pollution of the atmosphere and water, colossal waste of nuclear energy, which require huge costs for their disposal and storage. In this regard, the extremely significant range of the proposed latest hydrogeochemical studies, the possibility of detecting and mapping of industrial accumulations of environmentally friendly endogenous hydrogen is very relevant. That is, the hydrogen problem has, along with the energy one, geological and geochemical aspects that are not yet fully understood due to the exclusive, as mentioned above, focus on traditional hydrocarbon feedstocks. At the same time, it is obvious that the hydrogen-energy revolution can fundamentally change the foundations of the world energy and the environmental situation of the future. In this regard, the substantiation and organization of work on assessing the prospects for identifying industrial accumulations of endogenous hydrogen in the lithosphere should be carried out in the framework of scientific research of the NAS of Ukraine.

In the course of the researches the world experience, academic and own achievements of the scientists of the Institute of Geological Sciences of NAS of Ukraine were used.

Mantle synthesis with the variety of elements present forms, in addition to the gas component of hydrocarbons, two energy phenomena – the decay products of uranium, radium –  $^4\text{He}$ , and the hydrogen isotope  $^3\text{He}$  – the most energy-ecological product of hydrogen.

The global character of genetic accumulations of hydrocarbons is considered by us in the framework of the teachings of V.I. Vernadsky on the cycle of matter in nature, where one of the main genetic components of hydrocarbons, both in volume and in percentage, is hydrogen, which is the energy basis of lithospheric processes. Therefore, according to the theory of V.I. Vernadsky on the renewable circulation of matter, it is quite obvious that the problem of the origin of hydrocarbons is, first of all, the problem of the main source of hydrogen.

Thus, the synthesis of the germinal elements of the circulation of water-soluble hydrocarbons that come with pore gravitational waters through infiltration zones [Бабинец, 1961; Бабинец, Белявский, 1973], creates the conditions for obtaining both complex hydrocarbon elements and products of their synthesis H, C, since, according to the hydro-geobiogenic-mantle paradigm (HGBMP), the reserves of hydrogen and carbon in the mantle in contact zones are constantly replenished from the upper shells of the Earth in the conditions of the cycle of matter in nature as a result of geodynamic processes, and in the conditions of synthesis in the mantle strata gas and energy components are created – the hydrocarbons spectrum, hydrogen and their accumulations.

Therefore, it can be assumed that not only oil-forming systems are formed during mantle synthesis, but also hydrogen, as the initial germinal component of hydrocarbons, as a result of thermodynamic and geochemical processes according to the proposed HGBMP of hydrocarbons origin.

Such an interpretation of the relationship between the main components of hydrocarbons has served as the basis for the creation of a new concept of the origin of hydrocarbons, that reflects a wide range of scientific approaches (geology, geochemistry, hydrology, hydrogeology, geothermics, etc.) and takes into account the recoverability of the constituent elements (carbon and hydrogen) and their regeneration, which leads to the restoration of hydrocarbon deposits. Ultimately, this allowed us to approach not only an important issue – substantiation of the new concept-paradigm of hydro-geobiogenic-mantle origin of hydrocarbons and their main energy component – hydrogen, as well as to provide scientific argumentation for the restoration of depleted deposits, and on this basis to create a new highly efficient direct search technology of structural-thermo-atmo-hydrologic-geochemical studies (STAHGS) of hydrocarbons and their component – hydrogen [Баррий, 2016]. This technology has been implemented at almost 200 oil and gas objects for forecasting of prospective traditional and non-traditional areas of the mapping features of hydrocarbons and hydrogen spectrum on land and in the waters of the seas with a success rate of almost 80-100%.

Hydrocarbon and hydrogen mapping can be successful only with full consideration of modern own academic achievements in the field of petroleum geology and geochemistry. It should be noted that in recent years the processes of genesis, migration and formation of industrial oil and gas deposits are often mistakenly associated only with large deep faults in different zones of the Earth's crust and upper mantle [Доленко, 1962; Порфір'єв, 1968; Субботин, 1964; Павлюк, 2012], which, in our opinion, serve only as zones of multidirectional migration of gases and fluids, and not the genetic conditions of their origin and, most importantly, not prediction characteristics.

The literary data characterizing the hydrogen degassing of the planet as a whole, as well as of its individual regions, are extremely scarce, fragmentary and obtained by different authors at different times, often contradictory and almost unsubstantiated scientifically. On their basis, it is practically impossible to make a holistic view of the spatial and temporal patterns of hydrogen degassing.

Studies conducted by Russian and some domestic scientists in the field of hydrogen production indicate the connection of the prospects for hydrogen production with volcanic activity and fire belts,

which, in our opinion, is incorrect both from a practical and scientific point of view. In addition, they associate hydrogen accumulations with minor depressions and hearths that are mistakenly interpreted as ring structures [Ларин, 2019], referring to the results of numerous studies, cartographic materials of wetlands in Russia and many foreign countries that have no relation to ring structures. This, in our opinion [Гожик, 2011; Молодых, 1982; Баррий, 2003], are common elements of landscape formations that are mistakenly interpreted as hydrogen lakes.

Our measurements for the presence of hydrogen in such landscape elements (Kyiv Polissya and Dnieper-Donets depression) did not reveal the presence of H<sub>2</sub> hydrogen concentrations at all.

The STAHGS technology [Баррий, 2013] created and tested on the basis of HGBMP of the origin of hydrocarbons allowed to identify and map local areas of hydrogen degassing anomalies and open up fundamentally new possibilities for identifying promising sites for conducting detailed exploratory studies not only for industrial extraction of hydrocarbons, but also for significant concentrations of hydrogen and their mapping in hazardous areas during mining of virgin coal.

The detailed areal atmo-gas-geochemical surveys in the framework of the new STAHGS search technology conducted by us at more than 200 prospective licensed oil and gas structures and mine fields made it possible to map the presence of anomalous areas of hydrogen and helium concentrations, which are hundreds or more times higher than background values.

Such sites, mapped by their hurricane concentrations, are of undoubted search interest in broad research not only in terms of energy source phenomena, but also in terms of geocological forecasts for making decisions on the safety of mine workings.

The full range of hydrocarbon components and their derivatives H, CO<sub>2</sub>, He, we recorded almost everywhere in the course of detailed areal surveys. This ultimately allowed to map the anomalous zones of hydrogen degassing sites with the aim of further detalization of the forecast and prospecting work on industrial accumulations of hydrogen. Such anomalous manifestations of H<sub>2</sub> hydrogen have been verified and confirmed by control surveys both by area and in time at oil and gas bearing objects (Nedilna, Obolonska, Bovtyska, Vasyschivska and other areas).

The most probable sites mapped as hydrogen-anomalous, gas-saturated areas, are correlated with hydrocarbon anomalies located, probably, in the conditions of the predominance of mantle processes that generate a gas composition containing almost the full spectrum of carbon, hydrogen, and helium.

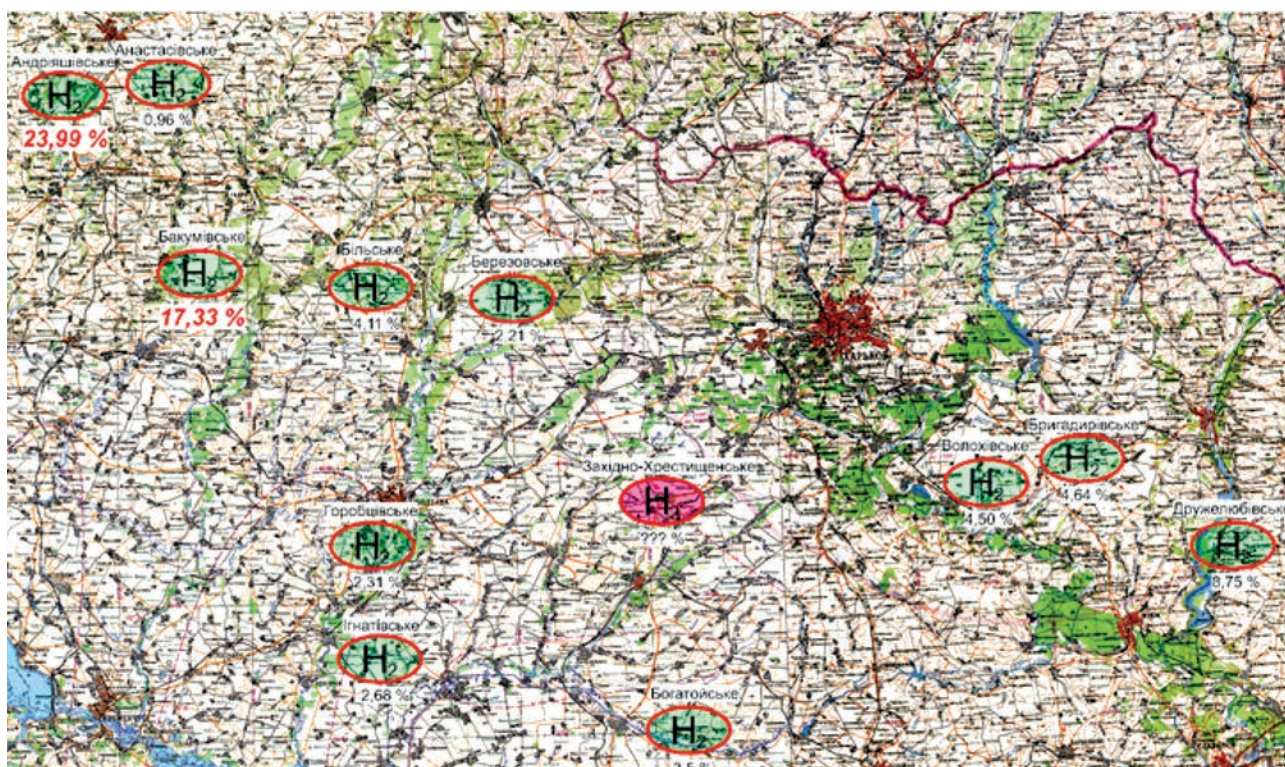
Therefore, having considerable experience in detailed mapping of gas elements (Rn, Tn, CO<sub>2</sub>, He, hydrocarbon spectrum, and H) using STAHS technology at 200 structures – carriers of hydrocarbon-hydrogen-helium components, with a total area of over 20,000 km<sup>2</sup> on land and in the sea, we made the first attempt to summarize the results of our own scientific study on identifying promising areas for more focused research on the search for not only hydrocarbons, but also H, and He.

And as practice has shown, this approach already in the previous stage of research allows to reasonably determine not only the degree of concentration of prospective oil and gas bearing areas, and to reject virtually unproductive areas, but also to identify anomalous areas of concentrations of one of the main energy components – hydrogen, as a renewable energy source of the circulation of matter in nature, and as a detonator of geodynamic phenomena in mine workings leading to catastrophes and, worst of all, to people death.

The fixation of abnormally extreme manifestations of hydrogen by areal surveys on geological-structural, geothermal and other features (STAHS) at worked objects, as well as individual manifestations of hydrogen in productive oil and gas bearing wells according to the data of «Nauka Geocentr» did not allow to establish patterns of distribution of extreme values of hydrogen in the studied territories (Fig.). Therefore, it is necessary to conduct more detailed areal surveys in the areas of hydrogen anomalies and hydrogen-saturated wells with a mapping detail of hundreds or even tens of meters, which would allow to outline the areal hydrogen anomalies in order to substantiate the setting of scientific and parametric studies in both vertical and horizontal sections.

In addition, in the context of hydrogen-energy issues, we have considered geocological processes in places of possible accumulation-generation of hydrogen and methane gases (mine fields and directly production), which currently traditionally serve as markers of explosion and cause colossal destruction in enclosed mine spaces, leading to material losses, long term stop of production cycles and, most importantly, significant human loss.

Most of gas control in mine workings involves methane fixation. If methane concentrations are



Карта нафтогазоносності з промисловими концентраціями водню. Масштаб 1:500 000

Map of oil and gas potential with industrial concentrations of hydrogen. Scale 1: 500 000

increased to critical levels, the sensors must report about this and disconnect the mine equipment from power sources.

The analysis of explosions at the mines of Ukraine and Russia shows that emergencies and explosions occurred in the complete absence of warning signals about methane hazard.

Thus, analyzing significant materials on the processes of emergencies, we can assume that the possible reasons for the outburst-hazardous processes were not sudden opening of methane-bearing reservoirs and the significant volumes of methane entering the mine workings, but the anomalous areas of high hydrogen content entering the coal rock mass from the mantle horizons. This was established in the study and analysis of huge amount of factual material based on areal gas-geochemical surveys.

Explosions of hydrogen mixtures (oxyhydrogen gas) are accompanied by extremely high temperatures and colossal dynamic loads, leading to the rupture of strong metal structures of mining equipment – rails, dippers, etc.

Mapping of explosion hazard zones and adoption of advanced degassing drilling can be performed according to the results of detailed geochemical areal and profile surveys in accordance with STAHS technology [Багрий, 2011].

Geochemical detailed studies of mine fields have been carried out in recent years, as part of the science topics implementation (Tomashivska area, Lysychanski domes, including the Kapustin, Pryvilynianska, Novodruzhivska, Tomashivska Pivnichna, Tomashivska Pivdena mines, as well as producing Zasyadko and Krasnolymanska mines in the Do-

netsk basin, and Stepova and Lisova mines in the Lviv-Volyn basin).

The analysis of the results of a complex of fundamental and applied studies conducted by the scientists of the Institute of Geological Sciences of NAS of Ukraine, including gas-emanation areal surveys, that include H and He, allowed us to re-approach one of the constituents of hydrocarbon gases – the main energy component of the Universe – hydrogen.

The conceptual interpretation of the results of the STAHS search scheme allowed to allocate 25 offshore and 98 onshore productive oil and gas bearing areas at the previous regional search stage, as well as not only to record significant hydrogen concentrations in single production gas wells within the study areas, but also to confirm the results of previous studies in the oil and gas production areas, in industrial wells, in zones of geodynamic phenomena of mine fields.

The hydrogen-energy revolution can fundamentally change the foundations of the world energy and the environmental situation of the future. In this regard, the substantiation and further studies of the assessment of prospects for the detection of industrial accumulations of endogenous hydrogen in the lithosphere should be carried out within the framework of scientific research of the National Academy of Sciences of Ukraine, which has all the capabilities and should become a world leader in solving the search-ecological and hydrogen-energy problems. Such studies are relevant, timely and have a distinct innovation component that is important for the modernization of the Ukrainian economy and its sustainable socio-economic development.

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