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Mechanochemical origin of fossil hydrogen

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Abstract. More than four decades ago, Russian scientists discovered a previously unknown mechanism for the formation of hydrocarbons in subsurface, which made it possible to explain the origin of oil and gas. This mechanism is a mechanochemical polycondensation synthesis of oil and gas hydrocarbons with the formation of hydrogen, accompanied by the decomposition of a huge amount of water in the rocks of the sedimentary cover of Earth's crust. In this mechanism, the hydrogen donor during the synthesis of hydrocarbons is water, and the carbon donor can be any of its sources (organic substances, carbon dioxide dissolved in water and carbonates). Another discovery of Russian scientists was the previously unknown 40-year (climatic) cycle of carbon dioxide transfer through Earth's surface by meteorogenic waters, which ensures the balance of the carbon and water cycle on our planet, taking into account the formation of hydrocarbons and hydrogen in subsurface and economical activities of people. Until recently, the main priority was to improve the efficiency of oil and gas field development. However, in connection with the transition of the world economy to hydrogen energy, there is a need to pay attention to the possibility of simultaneous production of hydrogen together with hydrocarbons.

1 Introduction

Currently, on the continents, hydrogen degassing of the bowels can be observed everywhere with the naked eye. Thus, in Turkey (Chimaera), gas containing up to 12% hydrogen has been burning on the rocks for several millennia [1]; in Philippines (Zambales), a gas consisting of 60% hydrogen is constantly burning [2]; and in the reservoirs of oases in the Sultanate of Oman, jets of bubbles containing 82-99% hydrogen rise from the bottom [3]. As a rule, we are talking about hydrogen in the composition of free gas outlets in the water areas of reservoirs (gas griffins, bubble outlets), and in gas-liquid inclusions of rocks. In addition, there is a large amount of data on increased hydrogen content in gas jets at the oceans bottom [4]. In addition, coal basins demonstrate increased concentrations of free H_2 in methane gases, reaching up to 9% (on average 2-4%). There are plumes of hydrogen degassing in the rift zones of the oceans, in volcanic chambers and explosion pipes (up to 50% of the total amount of gases). In particular, in the rift of the island of Iceland, the flow of hydrogen is up to 1000 m^3/day [5]. In the Udachnaya kimberlite pipe (Siberian Platform), the hydrogen flow rate reached 100,000 m3/day, which is commensurate with the flow rates in the wells of gas fields.

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So far, the only example of the industrial production of fossil hydrogen is the area of the village of Burakebugu in the Republic of Mali, where, while drilling wells for water, they accidentally encountered with outlet of hydrogen. The gas from the well consists of almost 96% H_2, which made it possible to organize its combustion in a gas turbine on site and thereby provide a small village with electricity [6].

2 Settings or methods

The modern explanation of the observed outflows of deep fluids containing hydrogen is usually associated with the presence of rift zones within the continents and oceans, as well as deep faults that generate numerous "degassing structures" in the form of "hydrogen pipelines". However, over the past four decades, Russian scientists have discovered three new natural phenomena that allow us to revise these ideas [7-9].

The first discovery officially registered in 1982, is associated with the discovery of a previously unknown mechanism for the hydrocarbons formation in the depths. The essence of this mechanism, called geosynthesis [7], is the mechanochemical decomposition of groundwater in Earth's crust rocks with the formation of hydrogen, which is involved in the polycondensation synthesis of oil and gas. In geosynthesis, the hydrogen donor in is water, and the carbon donor are organic matter, water-dissolved carbon dioxide, and carbonate rocks.

The second discovery made in 1993 is the fundamental conclusion that oil and natural gas are non-disappearing minerals on our planet, renewable in the process of field development. The replenishment of hydrocarbons in the fields can be significant and occurs mainly due to methane and other light hydrocarbon fractions.

The third discovery, which supplemented the first two, consists in the discovery of a previously unknown carbon cycle, due to the transfer of carbon dioxide dissolved in water from the atmosphere to Earth's crust rocks by meteogenic waters with a circulation period of 40 years. Either geologists or climatologists did not previously take this 40-year cycle into account, but it plays a key role both in the geosynthesis processes and in the replenishment of hydrocarbon reserves in the developed fields.

All three discovered phenomena were used at create the biospheric concept of oil and gas formation [9]. This concept made it possible to build a model of carbon circulation in the biosphere, which ensured the balance of carbon during its circulation through Earth's surface, taking into account, firstly, the economic activity of people and, secondly, the oil and gas formation in the bowels. The model was the first to offer an adequate explanation of the origin of oil and gas and led to the conclusion that, to some extent, human activity can influence the processes of formation of hydrocarbons in the subsurface and climate change.

3 Results

1) On our planet, the mass of hydrocarbons in the form of oil and gas is ~10^3 times less than free water. However, if ~2/3 of water is in World Ocean and ~1/3 in the upper layer of Earth's crust, then almost all hydrocarbons are concentrated below the surface in the sedimentary cover of Earth's crust, where geological traps can contain ~10^4 billion tons of oil and gas.

2) Estimates show that meteogenic waters annually carry ~10^9 t/year of carbon dioxide, which is involved in geosynthesis, into Earth's crust. In oil and gas basins, the decomposition of these waters during geosynthesis is so great that free water ceases to exist, turning into hydrogen, methane and hydrocarbons. The liquid and solid hydrocarbons and a certain amount of methane remain in geological traps. Whereas hydrogen, methane, helium, and air nitrogen contained in water, as well as unreacted carbon dioxide, escape into the atmosphere.

3) The listed gases entering the surface completely determine the “phenomenon of subsoil degassing”. Due to the outflow of these gases from the geosynthesis zones, there is a deficit of reservoir pressures here – a piezo minimum, which plays the role of an effective pump that intensively “sucks” meteoric waters from Earth's surface.

4 Discussion

Until recently, increasing the efficiency of developing oil and gas fields as sources of hydrocarbons was the main goal. However, due to the orientation of the world economy towards hydrogen energy, it becomes necessary to pay attention to the possibility of simultaneous production of oil, gas and fossil hydrogen generated by the same mechanochemical mechanism of geosynthesis. The possibility of commercial production of fossil hydrogen, along with oil and gas, poses a number of new geological, technological and economic challenges for field developers. These tasks are related to the search and increasing the efficiency of oil and gas fields development as sources of fossil hydrogen. There are strong prerequisites for the fact that, with proper scientifically based exploitation of oil and gas fields, they can turn into "inexhaustible" sources of not only hydrocarbons, but also fossil hydrogen, as another fundamentally important type of minerals.

Trapp deposits are widely developed on all continents of our planet [10]. There is no doubt that the industrial extraction of hydrogen in the near future will become possible in other places, and not only in Mali.

5 Conclusions

The first step in the transfer of oil and gas fields to the simultaneous production of hydrocarbons and hydrogen, in our opinion, should be the monitoring of fossil hydrogen in the production wells. A detailed analysis of this information will make it possible to localize the fossil hydrogen traps in the deposits, as well as to estimate their volume and the rate of their filling with hydrogen, methane and other gases. The presence of fossil hydrogen traps in the deposits largely depends on the quality of the seals in the deposits. In this regard, the best traps are highly porous water-saturated reservoirs overlain by thick deposits of trap’s rocks [6, 11].

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