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THE HYDRODYNAMIC CONDITIONS OF THE VOLYN-PODILLYA OIL AND GAS-BEARING REGION

В. Ю. Гарасимчук, Г. Б. Медвідь, О. В. Телегуз, М. В. Кость. ГІДРОДИНАМІЧНІ УМОВИ ВОЛИНО-ПОДІЛЬСЬКОЇ НАФТОГАЗОНОСНОЇ ОБЛАСТІ. *Мета роботи полягала у дослідженні параметрів та генези природної гідродинамічної системи Волино-Подільської нафтогазоносної області та її впливу на механізми формування і просторового розміщення газових покладів. Регіон дослідження охоплює структури Східноєвропейської та Західноєвропейської платформ у межах Західної України. Для роботи використано дані, отримані з фондів ДП «Львівгазвидобування» та ДП «Західукргеологія». Методика досліджень базувалася на аналізі зміни величин пластових тисків і коефіцієнта гідростатичності по площі та по вертикалі перетину. Встановлено, що гідрогеологічна система верхньопротерозойського, кембрійського та нижньодевонського водоносних комплексів має ознаки елізійної. Гідробаричне напруження спрямоване від центральної частини басейну ЛПП до його периферії. Для периферійних частин середньо-верхньодевонського комплексу притаманні ознаки інфільтраційної системи. У порівнянні з відкладами, що залягають нижче, у середньо- та верхньодевонському водоносних комплексах ЛПП гідрогеобаричне напруження спрямоване від периферії до його центральної (найбільш зануреної) частини. Таку гідрогеобаричну обстановку можна пояснити різними генетичними типами водонапірних систем, що існують у розрізі артезіанського басейну ЛПП. Верхньопротерозойський, кембрійський та нижньодевонський водоносні комплекси сформовані, в основному, теригенними утвореннями де водовмісними є високопористі, часто тріщинуваті піщані породи. Середньо- та верхньодевонський водоносні комплекси сформовані, головним чином, карбонатними породами, водовмісними серед яких є горизонти кавернозних, рідше тріщинуватих відкладів. У латеральному плані газові родовища пов'язані з районом підвищеної гідродинамічної напруженості. У вертикальному перетині газові поклади також тяжіють до горизонтів з надгідростатичними тисками. Відсутність витриманих літологічних та тектонічних екранів не сприяла достатній гідродинамічній ізольованості структур і збереженню тут великих покладів вуглеводнів.*

Ключові слова*: гідродинамічні умови, нафтогазоносна область, пластовий тиск, коефіцієнт гідростатичності, газовий поклад.*

В. Ю. Гарасимчук, Г. Б. Медвидь, О. В. Телегуз, М. В. Кость. ГИДРОДИНАМИЧЕСКИЕ УСЛОВИЯ ВОЛЫНО-ПОДОЛЬСКОЙ НЕФТЕГАЗОНОСНОЙ ОБЛАСТИ. *Цель работы заключалась в исследовании параметров и генезиса природной гидродинамической системы Волыно- Подольской нефтегазоносной области и ее влияния на механизмы формирования и пространственного размещения газовых залежей. Регион исследования охватывает структуры Восточно и Западноевропейской платформ в пределах Западной Украины. Для работы использованы данные, полученные из фондов ГП «Львивгазвыдобування» и ГП «Захидукргеология». Методика исследований основана на анализе изменения величин пластовых давлений и коэффициента гидростатичности по площади и по вертикали сечения. Установлено, что гидрогеологическая система верхнепротерозойского, кембрийского и нижнедевонского водоносных комплексов имеет признаки елизионной. Гидробарическое напряжение направлено от центральной части бассейна ЛПП к его периферии. Для периферийных частей средне-верхнедевонских комплекса присущи признаки инфильтрационной системы. По сравнению с отложениями, залегающих ниже, в средне- и верхнедевонских водоносных комплексах ЛПП гидрогеобарическое напряжение направлено от периферии к его центральной (наиболее погруженной) части. Такую гидрогеобарическую обстановку можно объяснить разными генетическими типами водонапорных систем, существующих в разрезе артезианского бассейна ЛПП. Верхнепротерозойский, кембрийский и нижнедевонские водоносные комплексы сформированы в основном терригенными образованиями, где водовмещающими являются высокопористые, часто трещиноватые песчаные породы. Средне- и верхнедевонских водоносные комплексы сформированы, главным образом, карбонатными породами, водовмещающими среди которых являются горизонты кавернозных, реже трещиноватых отложений. В латеральном плане газовые месторождения связаны с районом повышенной гидродинамической напряженности. В вертикальном сечении газовые залежи также тяготеют к горизонтам с надгидростатическими давлениями. Отсутствие выдержанных литологических и тектонических экранов не способствовала достаточной гидродинамической изолированности структур и сохранению здесь больших залежей углеводородов.*

Ключевые слова*: гидродинамические условия, нефтегазоносная область, пластовое давление, коэффициент гидростатичности, газовая залежь.*

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Introduction. Formation pressure is an important feature that characterizes the energy of the aquifers, oil-bearing and gas-bearing horizons. Clarification of formation pressure genesis and its parameters gives an understanding of the structure and nature of the hydrodynamic systems, patterns of formation, spatial location and conservation of hydrocarbon accumulations. The main factors that determine dynamics of fluids within the oil and gas-bearing structures are the actual hydrostatic pressure due to the influence of boundary conditions; geostatic pressure; geotectonic pressure; hydraulic connections among the aquifers with different pressures; chemical interaction of waters and rocks and the secondary cementation of pore space [1].

Aliyev, in addition to the above stated main factors which control the dynamics of fluids, also adds gas penetration through tectonic faults from the lower horizons, the possibility of preserving the primary pressure in the submerged structures, and the influence of the temperature of the circulating water [2]. *Formation water pressure (hydrostatic)* and *conditional hydrostatic pressure (estimated)* are distinguished in oil and gas hydrogeology. In order to evaluate the characteristics of the aquifers, *the hydrostatic coefficient (P f/P e)* is used – the ratio of the formation pressure to the estimated pressure.

Excess of formation pressure over the estimated pressure is called *overpressure* (abnormal). The necessary conditions for the emergence and conservation of overpressures are the isolation of the fluid-saturated horizons and the addition of external fluids [3]. Taken separately, syngenetic and epigenetic factors of the formation of overpressures are singled out. The first ones include compaction of clay rocks during sedimentogenesis and pressing of pore solutions into collectors, while others are processes that occur after consolidation of clayey strata [4]. Recent studies on the origin and characteristics of superhydrostatic systems are outlined in the works [5, 6, 7].

However, there are many cases where the formation pressure is less than the conditional hydrostatic pressure. Inadequate formation pressure [8] is defined as "fossil", and its nature explains the immersion of isolated aquifers with primary hydrostatic pressures to a greater depth.

New ideas about the nature of hydrodynamic zoning and water exchange in the regional hydrogeological structures are considered in the article [9].

Research area. The Volyn-Podillia oil and gas-bearing region (OGR) is located in the western Ukraine and covers the structures of the Eastern European and the Western European platforms (Fig. 1). At present, Lokachi and Velyki Mosty gas fields are discovered here in the deposits of the Middle and Upper Devonian. Also, non-commercial volumes of gas and oil were obtained in some exploration wells.

Review of previous researches. Due to small number of wells, the study of hydrodynamic conditions of the Volyn-Podillia OGR is currently rather weak. The vast majority of studies relates to the individual structures where dense grid of the wells is drilled for the purpose of exploration and assessment of gas reserves (Lokachi, Velyki Mosty fields).

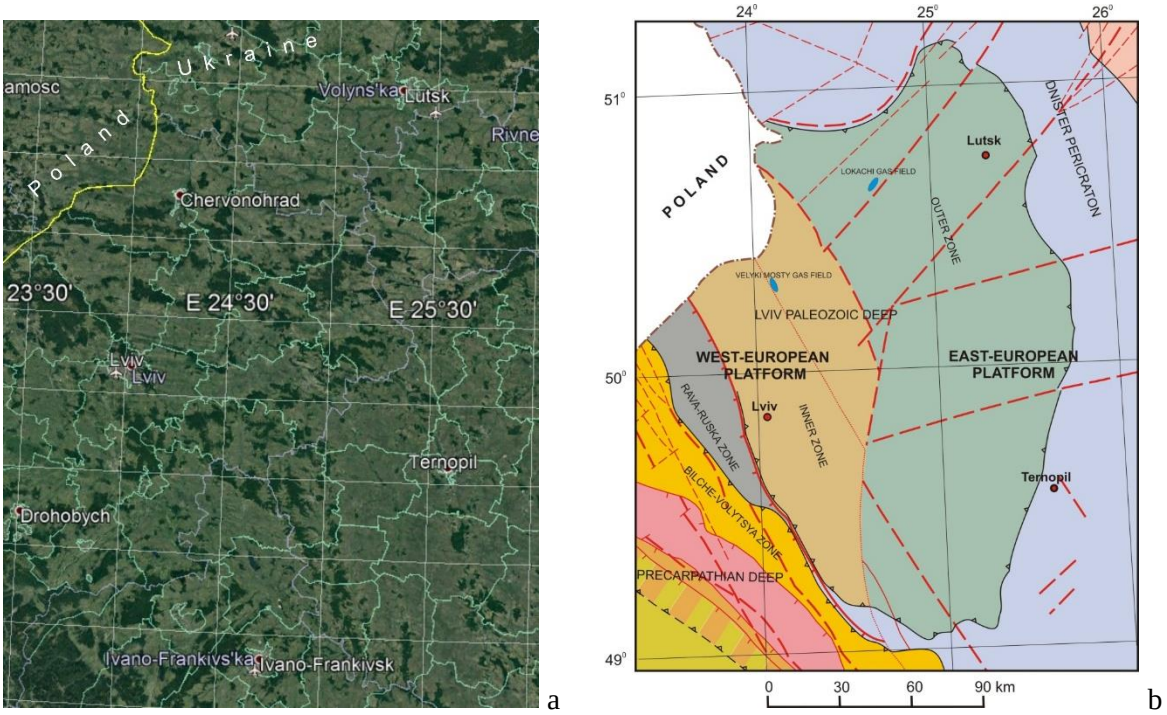

Fig. 1. Geographic (a) [10] and tectonic (b) [11] maps of the western oil and gas region of Ukraine

According to studies of Venglinsky, the water flows in the Precambrian and Cambrian aquifers of the Volyn-Podillia Plate are oriented, mainly in the eastern and western directions from the Ustyluh-Rogatyn zone of deep faults. This area is considered a zone of hydraulic overflows of exfiltration waters of the Archean and Proterozoic aquifers into the upper aquifer complexes. He considers the western slopes of the Ukrainian Crystalline Shield and the Nesteriv anticline the areas of surface water discharges [12].

Investigating the filtration parameters of the aquifers complexes, Venglinsky calculated the velocity of water filtration. For the intensive water exchange zone (aquifers C_1, D_1, D_2) it is 2.5-9.0 cm / year, for the zone of difficult water exchange (S, D_1, D_2 lp) – 0.5-1.8 cm / year, for the zone of very difficult water exchange (Єm, O) – 0.01-0.04 cm / year, for the zone of stagnation mode (PR, AR) – <0.005 cm / year. The velocity of water filtration was calculated in accordance with Darcy's formula.

According to the data of Kolodiy, etc., the absolute static levels of the Cambrian aquifer complex from the Lokachi to Buchach areas decrease in the south-east direction from 275 m to 100 m and lower. The water flow in this complex is in the same direction. Absolute static levels and hydrodynamic of the PR_3v_1 aquifer complex have also the south-east direction. Static levels of the PR_3r_3 aquifer complex also decrease in the south-east direction from 350 m to 125 m [13].

Hydrostatic pressures of the Cambrian aquifer system to depths of 2 km in most cases do not exceed the conditional hydrostatic pressures, according to recent studies. A gradual excess of reservoir pressures over hydrostatic (wells Velyki Mosty -30, Noviy Vitkiv-3, etc.) are observed deeper of this mark. Most of the Cambrian aquifer complex of BPP is described by the researchers as a zone of stagnant water exchange according to hydrogeochemical parameters [14]. There are zones of difficult and free water exchange in the extreme eastern parts of the trough.

Based on the values of the hydrostatic pressures of individual wells, measured at different depth intervals, the researchers [13] assume that «…the basic discharge of deep water occurs in the north-eastern and eastern parts of Volyn-Podillia by successive multistage flowing from the zones of the edge dislocations into the zone of intensive water exchange, perhaps, into the Styr, Ikva, Goryn', Seret, Strypa rivers». Within the Volyn-Podillia Plate, these researchers distinguish two genetic hydrodynamic systems. Infiltration system (Paleozoic complexes) is formed by zones of intensive, difficult and very difficult water exchange. Postex filtration system (Proterozoic and Archean) is characterized by ascending flow of fluids. The conditions of the postex filtration system are favourable for the accumulation of hydrocarbons in the raised traps.

Data and research methods. The analysis of hydrodynamic conditions and the distribution of values of the hydrostatic coefficient were carried out in order to detect the connection with the zones of the existence of gas deposits.

Our calculations and research were based on the study of initial formation pressures obtained from the cases of wells from the State Enterprise "Lvivgazvydobuvannia" and State Enterprise "Zakhidukrgeologia", which were clarified during testing of exploration wells from 1966 to 2002. A total of 110 measurements of reservoir pressure and static levels from 48 wells from 15 Volyn-Podillia areas have been obtained.

If the measurements of hydrostatic pressures are absent, but there are static level data in the well, the formation pressure is calculated as the product of the water column height in the well for the average value of its specific gravity, taking into account the temperature correction.

If the values of hydrostatic pressure for one well within the same aquifer range are different, then their greatest significance is taken into account, based on possible technical deficiencies during their measurements.

Transformation of hydrostatic pressures to one plane of comparison was carried out according to the Silin-Bekchurin method [15]:

$$P = h_1\gamma_1 + (\gamma_1 + \gamma_2) / 2z, \qquad (1)$$

Where:

P – the transformed hydrostatic pressure (MPa),

h_1 – the height of the water column in the well (m),

γ_1 – the water density in the well (kg L^{-1}),

γ_2 – the water density in the selected plane of comparison (kg L^{-1}),

z – the height of the metering point over the comparison plane (m).

Transformation of the hydrostatic pressures within one aquifer complex has been carried out to the altitude that corresponds to the most common values of depths of this complex.

Results. ***The Upper Proterozoic aquifer complex*** unified the aquifers of the common Upper Proterozoic (PR_3), the Polissia series of the Upper Riphean (PR_3pl) and the Volyn series of the Lower Vendian (PR_3vl). It is discovered by the wells within the Horokhiv, Lutsk, Berestechko, Ovadno, Lytovezh, Chernivtsi areas of the Volyn-Podillya OGR at depths of 510 to more than 3400 m. The hydrostatic levels of the complex were set at depths of 11 to 279 m.

We have constructed maps of hydrostatic pressure, transformed to the plane of -3000 meters using computer programs Surfer and Corell Draw. The map of the Upper Proterozoic aquifer complex (Fig. 2a) depicts a decrease in values of hydrostatic pressure

from the central to the peripheral parts, which is generally spatially correlated with its morphology. Maximum values were measured in the wells of the Horokhiv area (34.1 MPa), the minimum – in the wells of the Litovezh area (31.1 MPa).

In our opinion, the hydrodynamic field that was formed and is existing within the aquifer complex, or individual aquifer of regional water-pressure systems, generally reflects only the potential energy of water that can be changed into kinetic energy (action) only under the following conditions: available supply and discharge areas of the aquifer complex; the total spatial spreading of the complex; absence of stratigraphic and lithologic-facial substitutions, tectonic screens; sufficient capacitive and filtration characteristics of the aquifers.

It is clear that the fulfilment of all the above conditions in natural artesian basins is quite problematic. Only the upper horizons (zone of active water exchange) have more or less favourable conditions for the regional lateral movement (filtration) of water. Its thickness varies in different artesian basins and depends on the impact of the geological, tectonic, paleohydrogeological, geomorphological factors.

Tkhostov is critical to the «establishment of the water motion direction » in the natural geohydrodynamic systems: «The conclusions about the directions of regional flows are made mainly on the basis of a small grid of measurements of the pressures or static levels of groundwater» [1].

Investigating the characteristics of many geohydrodynamic systems, he came to the conclusion that «the active circulation of water between the areas of supply and discharge in the sense, as it is accepted by a number of researchers, in general, does not exist in nature». «In the Paleozoic aquifers of the Eastern European Platform, infiltration extends over the short distances, unloading mainly by the natural wellsprings» [1].

The Cambrian aquifer complex, which unifies the aquifers of the Lower, Middle and Upper Cambrian deposits, is discovered by the wells in the areas of Horokhiv, Noviy Vitkiv, Peremyshliany, Velyki Mosty, Buchach at an interval of 1300 to 4200 m.

The hydrostatic levels of this complex within the region of research have been stabilized at the depths from 64 to 395 m. The complete dependence of water levels on the depth of the water-bearing rocks of the complex is not observed. Even within one area and close depths, the hydrostatic levels are characterized by quite significant fluctuations. This may testify to weak hydrodynamic relationship between the individual aquifers of the complex, their different water filling and various capacitive-filtration characteristics.

Morphology of the hydrodynamic background of the Cambrian aquifer complex is similar to the morphology of the Upper Proterozoic complex – a decrease in values of hydrostatic pressures transformed to one plane of comparison, from the center of the Lviv Paleozoic deep to its peripheral parts (Fig. 2b). The piezo-maximum is displaced to south-west – from Horokhiv to Novy Vytkiv area.

The Lower Devonian aquifer complex is discovered by the wells of Kamianka-Buzka, Nesteriv, Velyki Mosty, Lokachi areas.

Deposits of the complex are distributed at depths of 980 to 2560 m. The wells sometimes overflow; maximum depths of the hydrostatic levels reach 385 m. As in previous complexes, in the Lower Devonian aquifer complex there is no complete relationship between the hydrostatic levels and the depths of water-bearing rocks. Different values of the static levels of the aquifer complex within one area and one well also are quite characteristic. The relevant signs may indicate a certain hydrogeological isolation of individual aquifer within the complex.

The morphology of the hydrodynamic field of the Lower Devonian aquifer complex is similar to the morphologies of the lower complexes. The hydrodynamic power is directed from the central part of the basin to its periphery. The piezo-maximum is displaced to Velyki Mosty area (Fig. 2c).

The Middle-Upper Devonian aquifer complex. Due to community of the hydrodynamic conditions (hydrodynamic connection) of the Middle and Upper Devonian aquifers, they are united into a single complex. The complex is discovered by the wells in the Kamyanka-Buzka, Velyki Mosty, Dubliany and Lokachi areas at depth range of 750 to 2380 m. The wells often overflow (north-eastern section of the Lviv Paleozoic deep, Lokachi area), then the static levels fall in the south-western direction to depth of the first tens, sometimes hundreds of meters. In some wells, due to low watering, hydrostatic levels stopped at the depths below 1000 m.

In comparison with the lower complexes the hydrodynamic power of the Middle-Upper Devonian aquifer complex is directed from the periphery to its central (most submerged) part (Fig. 2d).

This hydrodynamic situation can be explained by various genetic types of water-pressure systems existing in the formation of the artesian basin of the Volyn-Podillia OGR. The Upper Proterozoic, Cambrian and Lower-Devonian aquifers are formed mainly by terrigenous formations (argillites, siltstones, sandstones), which are high-porosity, often cracked rocks. Such composition of the rocks, the conditions of paleohydrogeological development and tectonic peculiarities have caused the formation of an exfiltration water-pressure system, the hydrodynamic tension in which extends from the more abyssal places of the sedimentary basin to its peripheral parts. The formation pressures are caused by an increase in

the volume of fluid due to its squeezing out of high capable for compression clay formations into weakly capable for compression sandy rocks.

The Middle-Upper Devonian aquifer complex is formed mainly by the carbonate rocks, water-containing among which are the horizons of cavernous, rarely cracked formations. The cracking and the cavity are not massive, but mainly they are spread along the tectonic deformations. Both lateral and vertical hydrodynamic connections between the individual horizons are weakly expressed, or even completely absent. The peripheral parts of the basin, in places of shallow locality of this complex, can be attributed to the infiltration water-pressure system. The hydrodynamic energy, and in the classical case, water filtration occurs here from the power supply areas to the areas of discharge. Water dynamics in the deep aquifers of the Middle-Upper Devonian complex is considerably limited, or even completely absent.

The hydrodynamic characteristics were studied in this work on the basis of the hydrostatic coefficient *(P f/P e)* in order to evaluate the impact of the factors that determine the nature and form the state of the hydrodynamic field. This approach allows us to level out different values of specific gravity of groundwater and different depths of measurements of the hydrostatic pressures within the aquifers. It also allows us to estimate the capacity of hydrodynamic energy caused by the impacts of geostatic, geodynamic, postsedimentary geochemical, deep-fluid-migration and other factors.

In the Upper Proterozoic, Cambrian and Lower-Devonian aquifer complexes of the Volyn-Podillya OGR, which are predominantly formed by the terrigenous formations, the values of the hydrostatic coefficients in general are much higher and have much less dispersions (0.91-0.98, 0.80-0.98, 0.82-1.03, accordingly) in comparison with the Middle-Upper Devonian complex. In the Middle-Upper Devonian complex, whose water-containing collectors are mainly represented by carbonate formations, the vast majority has low values for large dispersions (0.25-1.10).

The hydrodynamic energy of the adjacent Bilche-Volytsya ORG) (the Outer zone of the Precarpathian deep) have a much higher values (Fig. 3). The hydrostatic coefficients of the Neogene aquifer complexes, formed by powerful terrigenous strata (the clay with the layers of sandstones), from depths of 1500 m exceed 1.00, reaching the values of 1.56. Also, with increasing depths, the hydrodynamic energy increases in the Upper Cretaceous and the Upper Jurassic aquifers. In spite of the absence of powerful clay formations, at a depth of more than 4000 m hydrostatic coefficient exceeds 1.5.

The factor of exfiltration plays a decisive role in the creation of this tension in the Outer zone. It is caused both by primary squeezing out of pore water and dehydration of clayey strata. The powerful lithological and widely developed tectonic screens contribute to conservation this of tension and existing hydrocarbon deposits.

By the complex of paleohydrogeological, hydrodynamic and hydrogeochemical researches it has been established that clay-salinity molasses of the covers of the Inner zone and the Carpathian are the source of exfiltration waters for the lower aquifer complexes of the autochthon deposits of the Outer zone of the Precarpathian deep [17, 18].

The alteration of the lateral hydrodynamic field on the basis of the hydrostatic coefficient of the Volyn-Podillya OGR (Fig. 4) was studied by combining the Upper Proterozoic, Cambrian, and Lower Devonian aquifers into a single hydrogeological floor because of proximity of their hydrodynamic characteristics. Absence of sufficient data did not allow carrying out relevant researches for the upper floor (the Upper Devonian aquifer complex).

Hydrodynamic indicators of the lower hydrogeological floor of the Volyn-Podillia OGR shows the increase in hydrodynamic tension from the south to the north part, which reflects the more intense effect of exfiltration processes and better hydrogeological isolation of aquifers.

Also, a certain spatial relationship of the isolines of hydrostatic coefficient with diagonal disjunctive breaks is observed. This can determine them as a way of migrating of the water-hydrocarbon mixtures, which in its turn leads to an increase in fluid volumes in the porous space and, as a consequence, the increase in hydrostatic pressures.

In general, lateral distribution of the Lokachi and Velyki Mosty gas deposits among the general hydrodynamic background of the Volyn-Podillya OGR is marked by higher values of the hydrostatic coefficient.

Actually, the northern part of the Lviv Paleozoic deep in the structure of the Volyn-Podillya OGR is considered «the most promising area» in the oil and gas-bearing sense, based on total capacity of the porous sand collectors and favourable hydrogeological conditions for hydrocarbon accumulation. There are the Lokachi gas field, promising Semyryn and Ludyn structures within this part. Volodymyr-Volynsk, Tuminsk, Buzhkovitsk, Voynitsk, Vichyn and Knyazhe structures are predictable. «Medium-term prospect areas» are to the south and south-west. Velyki Mosty gas field, Tsebrovsk and Korchiv prospective areas, Krasnosilky, Raty and Boriv forecasts structures are located here [20].

Distribution of hydrostatic coefficients in the structure of the Lokachi gas field clearly indicates the connectivity of its overhydrostatic values with existing gas deposits (Fig. 5). In the wells with undiscovered gas deposits, the formation pressure in most

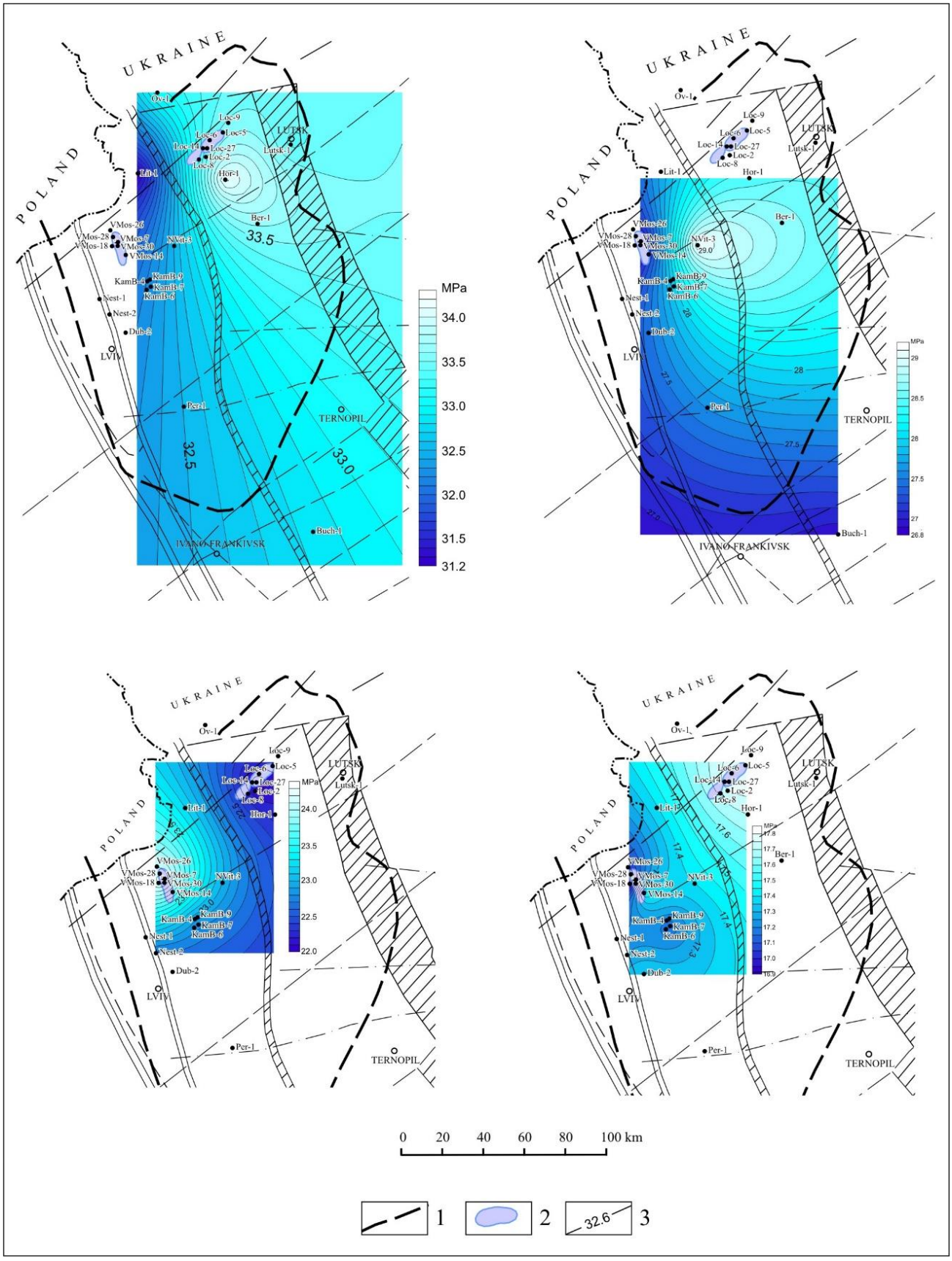

Fig. 2. The map-scheme of the transformed hydrostatic pressures: a – the Upper Proterozoic aquifer complex (-3000 m), b – the Cambrian aquifer complex (-2500 m), c – the Lower Devonian aquifer complex (-2000m), d – the Middle-Upper Devonian aquifer complex (-2000 m), (structural basis [16]); 1 - the boundary of the Lviv Paleozoic deep; 2 – the gas storage; 3 – the hydroisopiezes and their values (MPa)

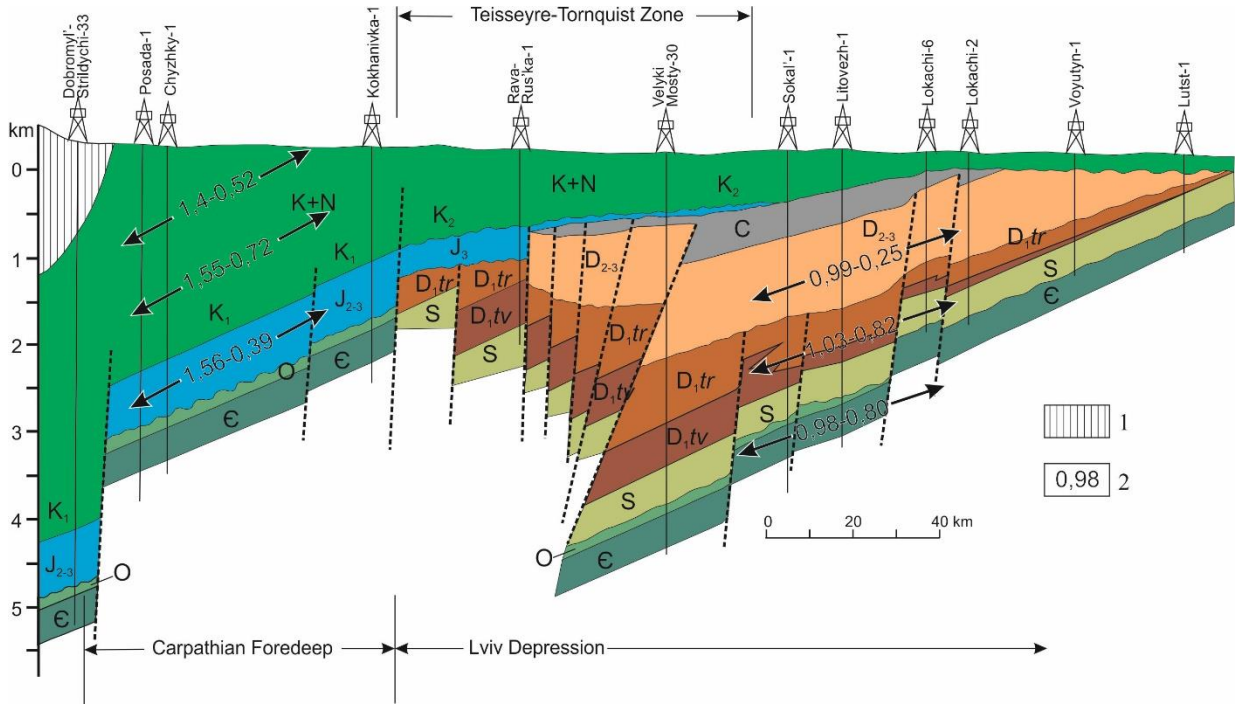

Fig. 3. Geological and hydrodynamic section of the Lviv Paleozoic and the Precarpathian deeps (geological basis [19]): 1 – the Folded Carpathians; 2 – the value of P_f/P_e

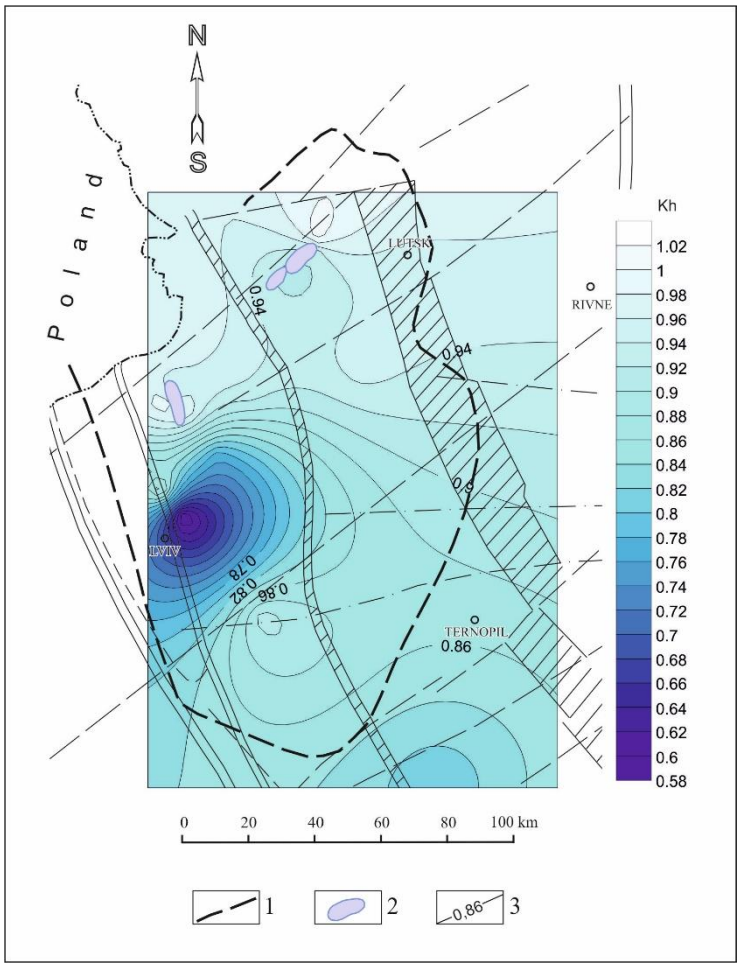

Fig. 4. Map-scheme of the distribution of the values of the hydrostatic coefficient of the Upper Proterozoic-Cambrian-Lower Devonian aquifers of the Volyn-Podillya OGR (structural basis [16]):1 – the boundary of the Lviv Paleozoic deep; 2 – the gas field; 3 –isolines of the values of the hydrostatic coefficient

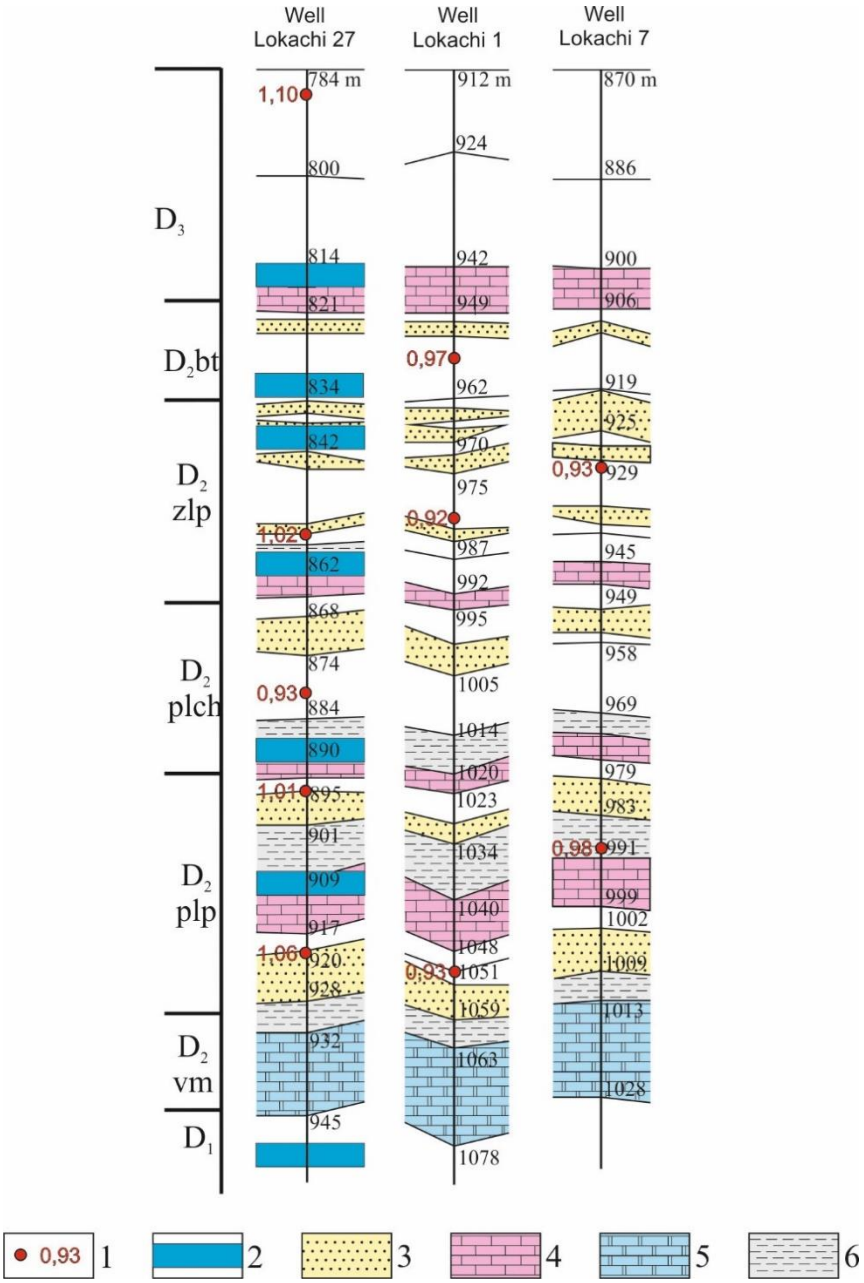

Fig. 5. Distribution of values of the hydrostatic coefficient in the section of the Lokachi gas field (geological basis [20]): 1 – depth of measurement and the value of $P f / P e$; 2 – gas storage; 3 – sandstones, siltstones; 4 – limestone; 5 – dolomites; 6 – argillites

cases does not exceed the estimated pressure. Also overhydrostatic values of this coefficient most often occur in the horizons formed by sandy sediments.

Conclusions: 1. Features of the hydrodynamic fields of the Upper Proterozoic, Cambrian, and Lower-Devonian aquifers complexes of the Volyn-Podillya ORG is displayed in decrease in the values of hydrostatic pressures transformed to one plane of comparison, from its central to peripheral parts.

2. The terrigenous composition of rocks, the conditions of paleohydrogeological development and tectonic peculiarities caused the formation of the exfiltration water-pressure system in the strata of these complexes. The hydrodynamic tension here extends from the most abyssal parts of the sedimentary basin to its peripheral parts. Formation pressures are caused by an increase in the volume of waters due to their squeezing out of clay sediments that have the ability to significant compression into weakly compression sandy rocks.

3. The hydrodynamic energy of the Middle-Upper Devonian aquifer complex is directed from the periphery to its central (the most submerged) part.

4. Peripheral parts of the Volyn-Podillya ORG in places of shallow placing of the Middle-Upper Devonian complex correspond to the characteristics of the infiltration water-pressure system, the hydrodynamic tension directed from the power supply areas to the areas of discharge. The dynamics of water in deep aquifers of this complex is significantly limited, or ev-

en completely absent.

5. The comparative analysis of hydrodynamic conditions on the basis of the hydrostatic coefficient makes it possible to state that the hydrodynamic field of the Volyn-Podillia ORG compared with the Bilche-Volytsya ORG is marked by a much lower power. The reason of this is the weak effect of exfiltration in the aquifers and the absence of sustained lithological and tectonic screens.

6. The values of the lateral hydrodynamic field of the Upper Proterozoic-Cambrian-Lower Devonian aquifer floor of the Volyn-Podillya ORG, investigated on the basis of the hydrostatic coefficient, increase from the south to the north.

7. Gas deposits of Lokachy and Velyki Mosty fields are located in areas with higher values of the hydrostatic coefficient. Distribution of the hydrostatic coefficient in the section of Lokachi gas field indicates the connection of its overhydrostatic values with the existing gas deposits.

8. Presence of a reliable lithologic or tectonic screen in the Volyn-Podillia ORG provides a hydrodynamic isolation of the structure, as well as the conservation of deposits of hydrocarbons from mechanical and biochemical destruction.

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HYDRODYNAMIC CONDITIONS OF THE VOLYN-PODILLYA OIL AND GAS-BEARING REGION

The purpose of the paper was to study hydrodynamic peculiarities of the aquifers of Volyn-Podillya oil and gas-bearing region and their impact on the formation and conservation of gas deposits.

The research area is located in the western Ukraine and covers the structures of the Eastern European and the Western European platforms. At present, Lokachi and Velyki Mosty gas fields are discovered here in the deposits of the Middle and Upper Devonian. Non-commercial volumes of gas and oil were received in some exploration wells.

Research methodology was based on the evaluation of water initial formation pressures and static levels that were obtained from the funds of the State Enterprise "Lvivgazvydobuvannia" and State Enterprise "Zakhidukrgeologia". The formation pressures were transformed to one plane of comparison. Also the hydrodynamic characteristics were studied in this work on the basis of the hydrostatic coefficient (P f/P e) in order to evaluate the impact of the factors that determine the nature and form the state of the hydrodynamic field. The maps of the formation pressures and hydrostatic coefficients were constructed and interpreted.

Results of researches. It was found out that the parameters of hydrodynamic fields of the Upper Proterozoic, Cambrian, and Lower-Devonian aquifers complexes of the Volyn-Podillya ORG have the features of an exfiltration system. The hydrodynamic tension extends from the most abyssal parts of the sedimentary basin to its peripheral parts. Formation pressures are caused by an increase in the volume of waters due to their squeezing out of clay sediments that have the ability to significant compression into weakly compression sandy rocks.

The hydrodynamic energy of the Middle-Upper Devonian aquifer complex is directed from the periphery to its central (the most submerged) part. The peripheral parts have the characteristics of the infiltration water-pressure system.

It was established that the hydrodynamic field of the Volyn-Podillya ORG compared with the Bilche-Volytsya ORG is marked by a much lower power due to weak effect of exfiltration in the aquifers and the absence of sustained lithological and tectonic screens.

The lateral hydrodynamic field, investigated on the basis of the hydrostatic coefficient, increases from the south to the north. A certain spatial relationship of the isolines of hydrostatic coefficient with diagonal disjunctive breaks is observed. This can determine them as a way of the water-hydrocarbon mixtures migration.

Gas deposits of Lokachy and Velyki Mosty fields are located in areas with higher values of the hydrostatic coefficient. Distribution of the hydrostatic coefficient in the section of Lokachi gas field indicates the connection of its overhydrostatic values with the existing gas deposits.

Hydrodynamic isolation of the structures promoted conservation of hydrocarbon deposits from mechanical and biochemical destruction.

Keywords: hydrodynamic conditions, oil and gas-bearing region, formation pressure, hydrostatic coefficient, gas deposit.

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