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PROSPECTS FOR THE GAS AND CONDENSATE PRODUCTION FROM THE SOUTH HRABYNE ZONE OF THE PRECARPATHIAN FOREDEEP

The main problems of prospecting and exploration of gas and gas condensate fields in the lithological and stratigraphic strata of the southwestern and central parts of the Bilche-Volytsia zone are due to the complex tectonic and lithological and stratigraphic conditions for the hydrocarbon deposits formation. The objective factors include the complex geological structure of reservoir rocks due to tectonic disturbances in the process of trap formation, the presence of various types of voids and clay material, as well as flooding of productive formations at the final stage of development. In addition, it is necessary to note the decrease in the information content and efficiency of both ground and borehole electrical exploration. At the same time, lithotypes with a complex petrographic and petrophysical thin layer structure of the rock matrix are observed in the Neogene deposits. Thus, in order to increase the information content of the results of geophysical well surveys (GWS) and the efficiency of hydrocarbon prospecting, it is necessary to form an optimal set of the latest geophysical methods, in particular: high-frequency induction logging with isoparametric sounding (HFILIS), nuclear magnetic logging (NML), as well as acoustic and radioactive studies. The introduction of this type of innovation will increase the information content of geological and geophysical studies. The main basis of this approach is the petrographic and petrophysical base for specific territories and prospecting areas. In view of the foregoing, we identified gas-saturated reservoir rocks, established the structure of their seal rocks, as well as determined the effective thicknesses of rocks and developed correlation schemes for their distribution within the Sarmatian, Badenian, and Helvetian deposits.

Key words: gas-saturated reservoir rocks; petrophysical parameters; water saturation and flooding of rocks; fracturing; cavernosity; a complex of geophysical studies; tectonic disturbances.

Introduction

The main part of hydrocarbons not withdrawn during the development of oil and gas fields is due to the complex structure of the reservoir rocks matrix of the lithological and stratigraphic strata of the Bilche-Volytsia zone of the Precarpathian foredeep (Fig. 1). A common problem is to establish reliable results of geophysical well surveys (GWS) obtained in prospecting and exploration wells that uncovered the Neogene stratum, due to their thin-layer structure with a rhythmic change in the physical, mechanical and petrophysical parameters of rocks.

According to the results of geological survey work at the South Hrabyne, gas and condensate deposits are formed in rocks with a complex matrix structure. As a result, they have different types of porosity (fractured, cavernous, and granular), which greatly complicates the identification of reservoir rocks and obtaining unambiguous conclusions about their productivity. In this case, the identification of this type of reservoir rocks occurs due to the construction of new information petrophysical models of deposits, taking into account production drilling data, as well as the results of reinterpretation of seismic survey materials and geophysical well surveys using modern technologies.

Increasing the information content of the geological and geophysical work results in the process of studying complex lithological and stratigraphic sections, as well as the structure of the rocks performing them will help identify new objects of gas and condensate accumulation, and will also significantly increase the volume of hydrocarbon reserves by increasing the gas recovery factor. Taking into account the peculiarities of the geological structure of the Neogene lithological and stratigraphic strata, it becomes necessary to justify the information content of complex methods of geological and geophysical studies. Optimization of the complex of geological and geophysical studies will make it possible to unambiguously identify reservoir rocks, assess the nature of their saturation, and establish the limiting values of the porosity and petroleum saturation coefficients.

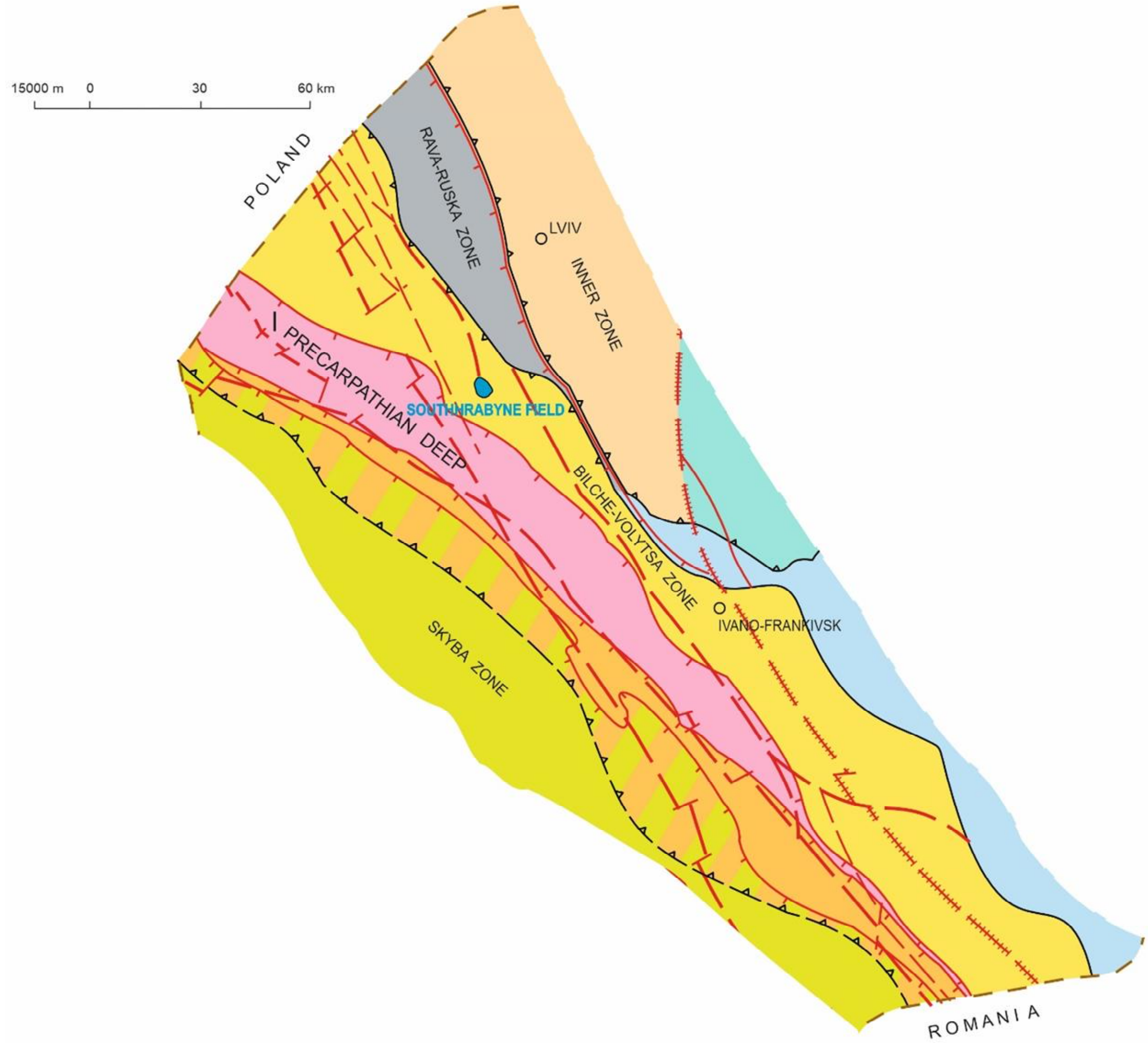

Fig. 1. Overview map of the Bilche-Volytsia zone of the Precarpathian foredeep [Krupskyi, 2001].

State-of the-art

Taking into account that the production of hydrocarbons from prospecting and exploration wells in the fields within the territories of the Bilche-Volytsia zone of the Precarpathian foredeep requires the availability of reliable geological and geophysical information, many geologists and geophysicists devoted their scientific works to the study of the geological, tectonic and physical conditions for the formation of productive reservoir rocks in the process of sedimentation and storage of hydrocarbons [Honarpour, Nagarajan and Sampath, 2006; Tissot and Welte, 1984; Larsen and Fabricius, 2004; Catuneanu, 2006; Miall, 2000, 2006]. A significant role in the study and research of the geological structure of the lithological and stratigraphic strata of the Cenozoic and Mesozoic erathems was played, e.g.: Yu. M. Senkovskyi, 2018; O. S. Stupka, 2010; M. I. Pavliuk and I. M. Naumko, 2009; V. V. Kolodii, 2010; Yu. Z. Krupskyi, 2001; Kh. B. Zaiats, 2013; V. Yu. Maksymchuk, V. O. Fedyshyn, 2005; D. D. Fedoryshyn, 1999; Ya. H. Lazaruk, 2013; H. Yu. Boiko, 1989; et al.].

In particular, in work Yu. Z. Krupskyi [Krupskyi, 2001] substantiated and established the gas-and-oil presence and prospects of the Mesozoic and Cenozoic strata. He determined and established the patterns and conditions for the hydrocarbon deposits formation in tectonic and geomorphological conditions. In their works, Kh. B. Zaiats [Zaiats and Havrylko, 2007; Zaiats, 2013] and [Ya. H. Lazaruk, 2013] justified the formation of tectonic faults and the creation of structural objects potentially rich in hydrocarbons [Lazaruk, et al., 2013]. In their works, D. D. Fedoryshyn [Fedoryshyn, 1999] and V. O. Fedyshyn [Fedyshyn, 2005] identified productive reservoir rocks, substantiated their petrophysical parameters, and built graphical petrophysical dependencies.

In addition, they highlighted and substantiated new methodological approaches to the assessment and study of the tectonic and stratigraphic structure of the Bilche-Volytsia and Boryslav-Pokuttia zones, and also established the prospects for reservoir rocks within the Mesozoic and Cenozoic erathems. Based on the core experimental studies results, the condensed values, in particular, the coefficients of porosity, permeability, water saturation, and residual water saturation for complex reservoir rocks were established.

Depending on the peculiarities of the geological structure of the Neogene lithological and stratigraphic strata, it becomes necessary to substantiate complex methods of geological and geophysical studies. As a result of this approach, there will be an unambiguous identification of reservoir rocks, as well as an assessment of their saturation nature and the establishment of limit values for the calculation parameters.

Uninvestigated Parts of General Matters Defining

To solve these problems, it is necessary to identify and classify reservoir rocks, evaluate their effective thickness, establish the matrix structure, as well as set limit values for petroleum saturation coefficients with justification of the conditions for hydrocarbon extraction.

Statement of Basic Materials

Analysis of the results of prospecting and exploration works results within the Bilche-Volytsia zone of the Precarpathian foredeep [Pavliukh, 2009] made it possible to establish the structural features of the reservoir rocks of the Neogene deposits and determine the distribution directions of the Sarmatian, Badenian, and Helvetian deposits. In order to perform laboratory petrophysical studies, an information collection of core material and thin sections was formed to establish the limit values of the calculated parameters of productive horizons reservoir rocks. Experimental studies of the structure and texture of the selected core material of lithological and stratigraphic thin sections of the Sarmatian and Helvetian stages were carried out in the laboratories of the territorial subdivision of the Zakhidukrheolohiia State Geological Enterprise, Ivano-Frankivsk National Technical University of Oil and Gas and the Lviv branch of the Ukrainian State Geological Prospecting Institute.

According to results, it was found that in most rocks of the Neogene are sandstones of greenish-grey and brownish-grey colour, which is due to the content of glauconite, as well as the presence of uneven-grained (from fine- to medium-grained) dense, calcareous, calcareous lithotypes in some cases with lenticular inclusions of silicon [Prokopiv and Fedoryshyn, 2003].

Siltstones of the Sarmatian sediments are dark grey with a slight greenish tint, limestone, hard, slightly micaceous.

The Helvetian sediments include sandstones and siltstones, as well as marls (Baraniv suite), from which a collection of 47 samples was formed for experimental research. According to the studies of lithological and stratigraphic Neogene horizons , fine-grained, quartz sandstones with porous, carbonate cement were found. In some cases, rocks with semi-rolled quartz grains of a sustained size (from 0.15 to 0.3 mm) are distinguished. They make up the main part of the clastic mass, while individual well-rolled grains of size (0.5–0.9) mm are no more than 1–2 %. The cement of the Sarmatian stage rocks is represented by recrystallized fine-grained calcite [Fedoryshyn, et al., 2016].

The rocks of the Helvetian Stage are underlain by organogenic and detrital as well as fine and detrital limestones of the Turonian stage. The cryptocrystalline rock groundmass is saturated with small skeletal fragments, most of which cannot be identified. Fragments of single crystals of echinoderm inclusions' skeletons, as well as particles of spicules and incomplete shells of foraminifera, are confidently references .

The Baraniv suite marls serve as the seal for the Helvetian stage. According to their structure, marls are clayey, limestone, and organogenic with the content of foraminifers. In addition, they may contain sandy and silty inclusions. The main carbonate and argillaceous pelitomorphic mass contains inclusions of numerous organic remains, i.e. foraminifera (globigerine, globorothalia, glombelins and more massive shells). Individual inclusions References of foraminifera are sometimes filled with significant amounts of glauconite or pyrite. In individual sections of silty and sandy rocks, small fragments of shells, brachiopods, ostracods, and phosphate residues are observed. This mass of remains contains angular grains of quartz of 0.02–0.25 mm in size, as well as liquid grains of glauconite from a mixture of dark brown organic matter, bitumen, and nests (caverns) filled with kaolinite. A characteristic feature is the shells filled with pure limestone material.

The porosity coefficient of reservoir rocks, which are considered when calculating reserves, varies within 14.0–17.5 %; with a permeability of (0.18–52.9) $\times 10^{-3}$ μm^2. The carbonate content of the studied samples fluctuates in the range of 0.7–32.2 %.

The coefficient of seal rocks porosity is 1–2.9 %; carbonate content is 41.2–57.2 % with permeability of (< 0.01–0.03) $\times$ 10^{-3} μm^2.

The core material, which was taken from the rocks of the Lower Sarmatian sediments from the horizons of the lower Dashava subsuite (ND-10, ND-11, ND-13), is represented by interbedding of grey sandstones, grey and dark grey brittle siltstones, limestone mudstones with interlayers of tuffs and tuffites that are insignificant in thickness. The reservoir rocks of this type of geological section are terrigenous sandy and siltstone interlayers represented by fragile and weakly cemented siltstone fragments.

From the horizons of the lower Dashava subsuite the ND-10 horizon, a core was taken from wells No. 6 and No. 9-SH (Fig. 2) for laboratory analysis in order to establish petrophysical and physical parameters and substantiate their limiting values.

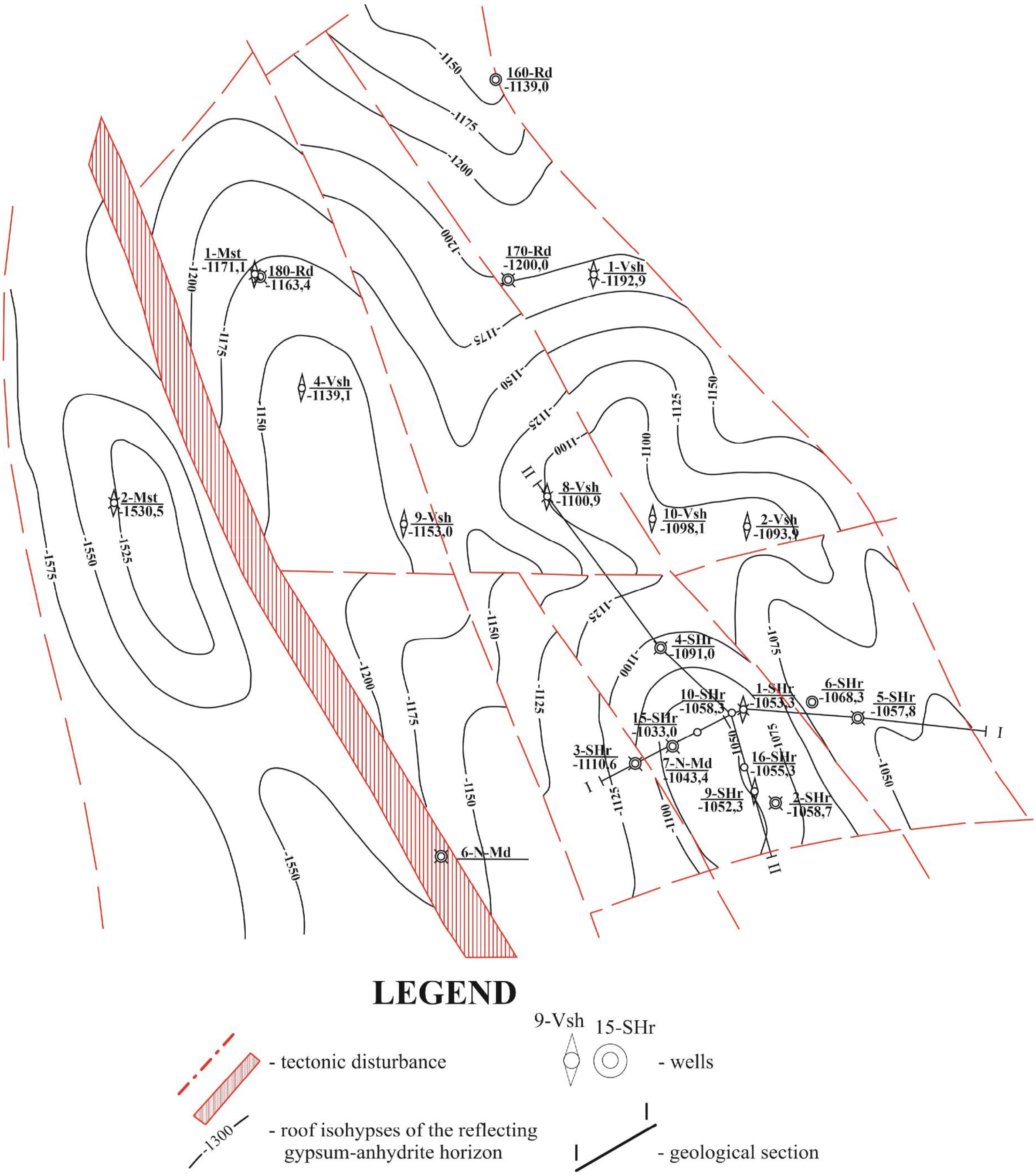

Fig. 2. Structural map of the reflecting gypsum and anhydrite horizon based on drilling data. [Lazaruk, 2009].

It should be noted that during the core sampling, mainly the densest varieties of rocks, the capacitive and filtration characteristics of which do not determine the porosity and permeability of the reservoir rocks as a whole along the section of the Neogene sediments, were recovered.

The Sarmatian and Helvetian sediments composed of rocks that, according to the conditions of accumulation, are classified as sedimentary, were also discovered at the South Hrabyne gas field. The reservoir rocks in this field are sandy and silty varieties, which in their composition belong to the terrigenous type, with an intergranular structural structure of the pore space.

The rocks of the Dashava suite are widespread in the Bilche-Volytsia zone of the Precarpathian foredeep. According to its shape and lithological composition, the Dashava suite is divided into two subsuites: upper and lower [Krupskyi, 2001].

One of the characteristic features of the Sarmatian sediments is the rhythm of their structure. At the bottom of the rhythm there are thin layers of clayey rocks which are gradually replaced by sandstones and siltstones towards the top. The rhythm roof in the Sarmatian stage is almost completely filled with sandstone and siltstone lithotypes. The rhythm end is marked by a sharp replacement of sandy and silty rocks by clays. At the bottom of these clays, layers of tuffs and tuffites, which are insignificant in thickness, are often found. These rocks often contain inclusions of carbonate particles, pyrite, magnesite, potassium, and ilmenite. The increased presence of iron minerals inclusions affects the electrical characteristics of the rocks, which, according to the results of electrical methods, is marked by a sharp decrease in the apparent resistivity and infrequent positive anomalies in the SP diagrams. All these features are widely used to construct correlation schemes in the Lower Sarmatian sections.

Based on the results of the interpretation of GWS materials in the lower Dashava horizons (ND-5 – ND-13), it was established that the gas deposits are confined to the sediments of the lower Dashava suite of the ND-9 horizon, which was confirmed by the results of its testing. These horizons sediments are characterized by a thin layer filled with a huge number of often interchangeable layers of sandstones, siltstones, mudstones, and clays. In this case, their ratio fluctuates over a wide range, where clay interlayers usually dominate. Then the geophysical characteristic of this section type takes the form of curves in the clay section, which in general creates a heterogeneous reservoir system, the study of which by industrial and geophysical methods is a difficult task.

The Helvetian sediments are also represented by sandstones with low clay and carbonate content, which is reflected in the GWS curves, commensurate with the Sarmatian sediments. The lithologic and stratigraphic strata of the Helvetian are characterized by a particularly clear geophysical characteristic against the background of the gypsum and anhydrite of the Tiras suite. They occur higher in the section, as well as sediments of the Baraniv layers and carbonate lithotypes of the Mesozoic. A characteristic distinguishing feature of the Helvetian sediments is, in many cases, anomalously low apparent resistivity and increased values of natural gamma activity in comparison with sandstones of the Mesozoic complex.

As a result of petrophysical and X-ray studies of core samples of Helvetian sediments taken from wells in nearby areas, it was found in the laboratories of Ivano-Frankivsk National Technical University of Oil and Gas and Ukrainian State Geological Prospecting Institute that they differ from each other both in mineral composition and in the cement type [Prokopiv and Fedoryshyn, 2003]. Anomalous lithotypes include reservoir rocks with cement composition, which includes clay material of hydromicaceous and montmorillonite types, which significantly reduces electrical resistivity, even if they are saturated with gas. Their distribution patterns are not well understood. Increased values of gamma ray logging (GRL) impressions are due to both the influence of clay formations and the presence of radioactive elements of the uranthorium series in clay cement [Trubenko, et al., 2021; Khomyn, et al., 2019].

In the case of the presence of a carbonate component in the cement of the Helvetian sediments rocks, the electrical resistivity increases, the natural radioactivity decreases, and the formations with this characteristic can be conditionally classified as monomictic.

Thus, the results of a comprehensive study of the lithological and stratigraphic structure of the rocks of the of the South Hrabyne gas field allow us to confidently carry out lithological subdivision and correlation of the distribution of productive rocks within the exploration areas of the Bilche-Volytsia zone of the Precarpathian foredeep (Fig. 3, 4).

On the example of the Sarmatian stage deposits, the substantiation of the prospects for the production of gas and condensate from the rocks of the ND-12 and ND-13 horizons of the lower Dashava subsuite of the Neogene was also carried out by comparing the geological and petrophysical parameters established for similar rocks in the wells No. 7 – Bystrytsia, No. 7 – North Medenychi, No. 10 – South Hrabyne, No. 6-South Hrabyne and No. 1 – South Hrabyne.

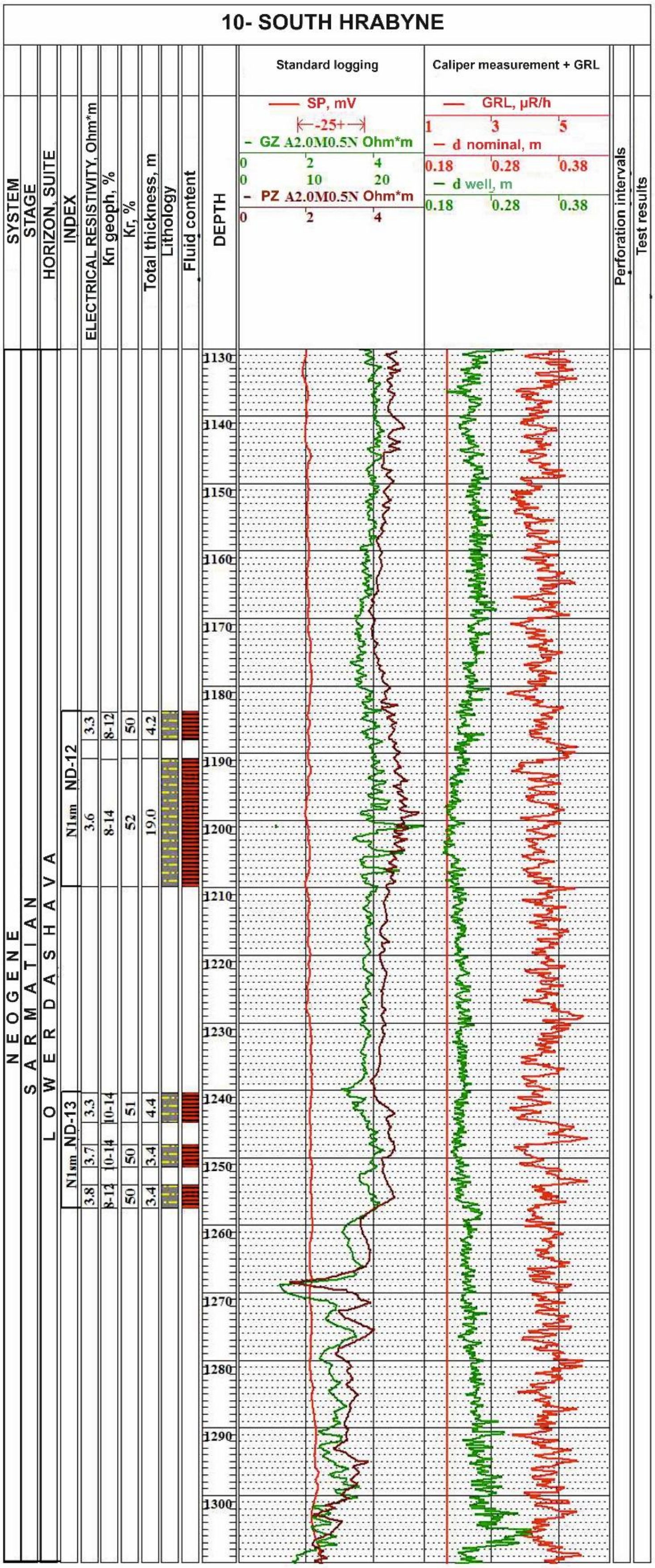

Fig. 3. Geological and geophysical characteristics of productive horizons ND-12 and ND-13 in the well No. 10 – South Hrabyne.

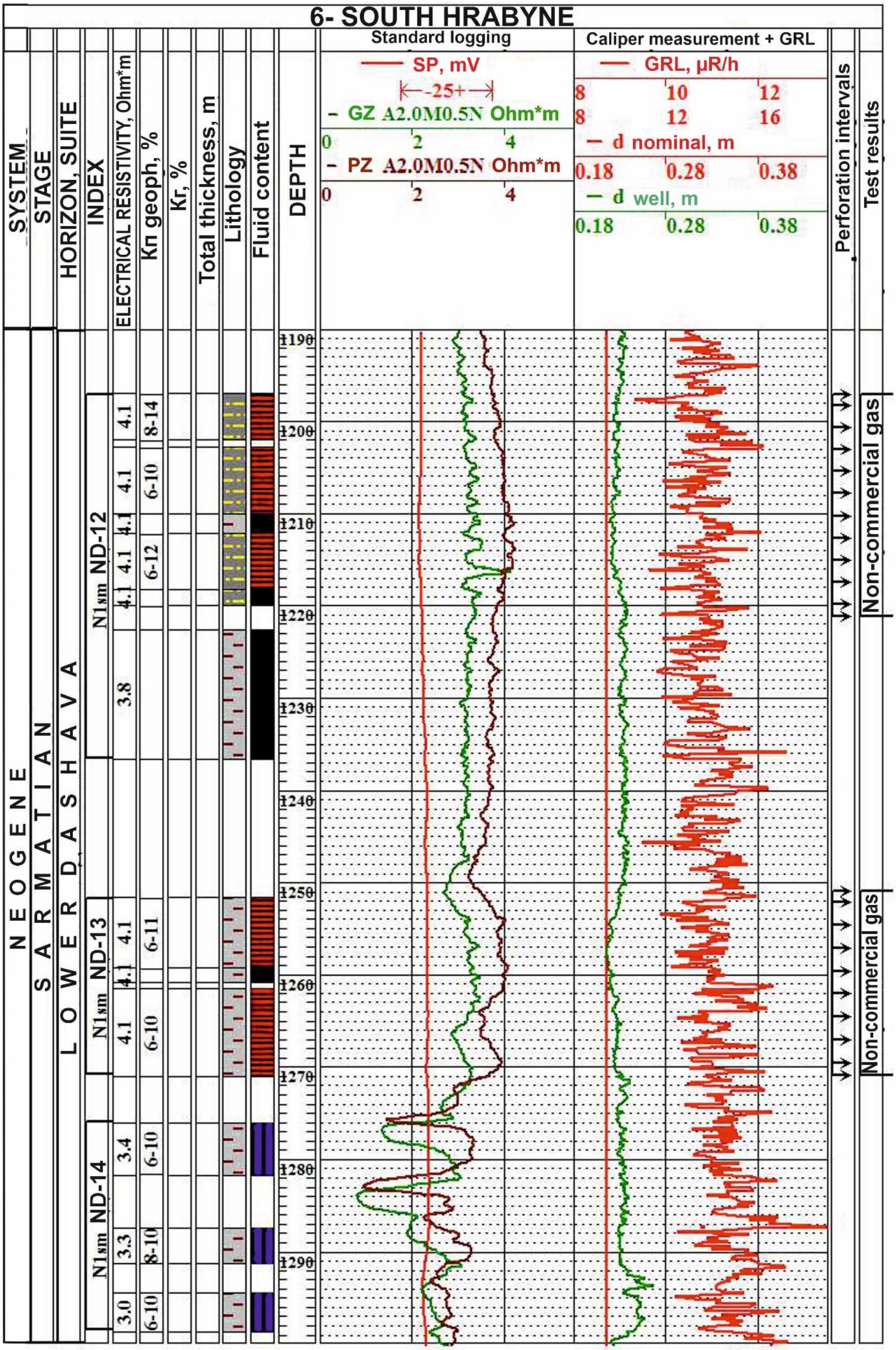

Fig. 4. Geological and geophysical characteristics of productive horizons ND-12, ND-13 and ND-14 in the well No. 6 – South Hrabyne.

In the well No. 7 – North Medenychi, during stationary testing of Helvet and Baden reservoir formations (intervals 1338.0–1335.0 m, 1335.0–1332.0 m, 1331.0–1323.0 m), an insignificant gas inflow with traces of condensate was obtained [Lazaruk, 2009]. When testing the layers of the ND-9 horizon of the lower Dashava subsuite (1080.0–1017.0 m), an inflow of a gas and water mixture was

Taking into account the results of reinterpretation of GWS methods and operational data obtained in the course of complex geophysical surveys carried out by the Ivano-Frankivsk Expedition of Geophysical Well Surveys, a correlation scheme of horizons ND-10 – ND-14 was built along the line of wells No. 7 – Bystrytsia, No. 7 – North Medenychi, No. 10,6 – South Hrabyne, No. 1 – Hrabyne (Fig. 5).

The productive horizons have the following characteristics:

- horizon ND-10 – represented by siltstones with petrophysical parameters: ρ_n = 5–6.5 Omm; K_n = 10–16 %; Kг = 60 % (in the wells No. 7 – Bystrytsia and 1-Hrabyne – productive);
- horizon ND-11 – represented by siltstones and compacted siltstones, with ρ_n = 4.3–6.3 Omm; K_n = 10–15 %; K_n = 10–15 % (in the well No. 1 – Hrabyne – gas-saturated);
- horizon ND-12 – represented by siltstones with petrophysical parameters: ρ_n = 3.6–5.0 Omm; K_n = 8–15 %; Kг = 52–60 % (in the wells No. 7 – Bystrytsia and No. 7-North Medenychi – gas-saturated);
- horizon ND-13 – represented by siltstones with petrophysical parameters: ρ_n = 3.6–4.7 Omm; K_n = 6–14 %; Kг = 51–53 % (in the well 1 – Hrabyne – gas-saturated);
- horizon ND-14 – represented by siltstones with petrophysical parameters: ρ_n = 3.0–3.5 Omm; K_n = 6–10 % (in the well No. 6 – South Hrabyne – water-saturated),

Conclusion

The horizons of the lower Dashava subsuite of the Sarmatian stage of the Neogene ND-12-ND-13 overlie the surface of the Kosiv suite. They are represented by thick strata of micaceous, sandy, limestone clays of grey and dark grey colour. These strata are separated by interlayers of sandstones and siltstones; the thickness of these formations ranges from a few centimetres to 1 1–2 m.

The optimal GWS set carried out in the wells the South Hrabyne field, as well as the quality of the obtained materials, made it possible to identify reservoirs, determine their porosity and permeability characteristics and effective thicknesses, and evaluate the gas saturation coefficient of reservoir rocks within the ND-12, ND-13 horizons.

The porosity of the reservoir formations was assessed based on the results of the electrical resistance method interpretation, the acoustic logging method, the methods of self-driving polarization and natural radioactivity. The petrophysical basis for determining the porosity coefficients of reservoirs based on the GWS results was the correlation dependencies of the “core-core”, “core-geophysics” type between open porosity $К_п$ and geophysical characteristics: P_n, α_{nc}, ΔJ_γ, $\Delta J_{n\gamma}$, ΔT, etc., which are established both for the rocks of the Sarmatian stage of this deposit and for similar deposits in neighbouring deposits.

Determination of the productive formations gas saturation was carried out through the interpretation by the method of electrical resistance, which is typical for this section reservoirs.

The effective gas-saturated thicknesses of reservoir rocks of the Dashava suite of the Sarmatian stage were determined by qualitative and quantitative criteria, taking into account the limiting values of porosity coefficients, gas saturation, and other parameters determined in similar sections of neighbouring deposits.

Considering the above, we can draw the following conclusions:

- reservoirs of horizons ND-10-ND-14 of the lower Dashava subsuite of the Sarmatian stage of the Neogene in wells No. 7 – Bystrytsia, No. 7 – North Medenychi, No. 10, 6 – South Hrabyne, No. 1 – Hrabyne are filled with the same type and similar lithological and stratigraphic sediments;
- they are identical in their geological and geophysical characteristics;
- lie at approximately the same depth and are sustained over the entire area with a change in total thickness with a slight lithological replacement by impermeable interlayers or interlayers with degraded porosity and permeability characteristics.

Accordingly, reservoirs of horizons ND-12, ND-13, discovered in wells No. 7 – Bystrytsia, No. 6 – South Hrabyne, and in the South Hrabyne deposit as a whole, are promising for the production of gas and gas condensate.

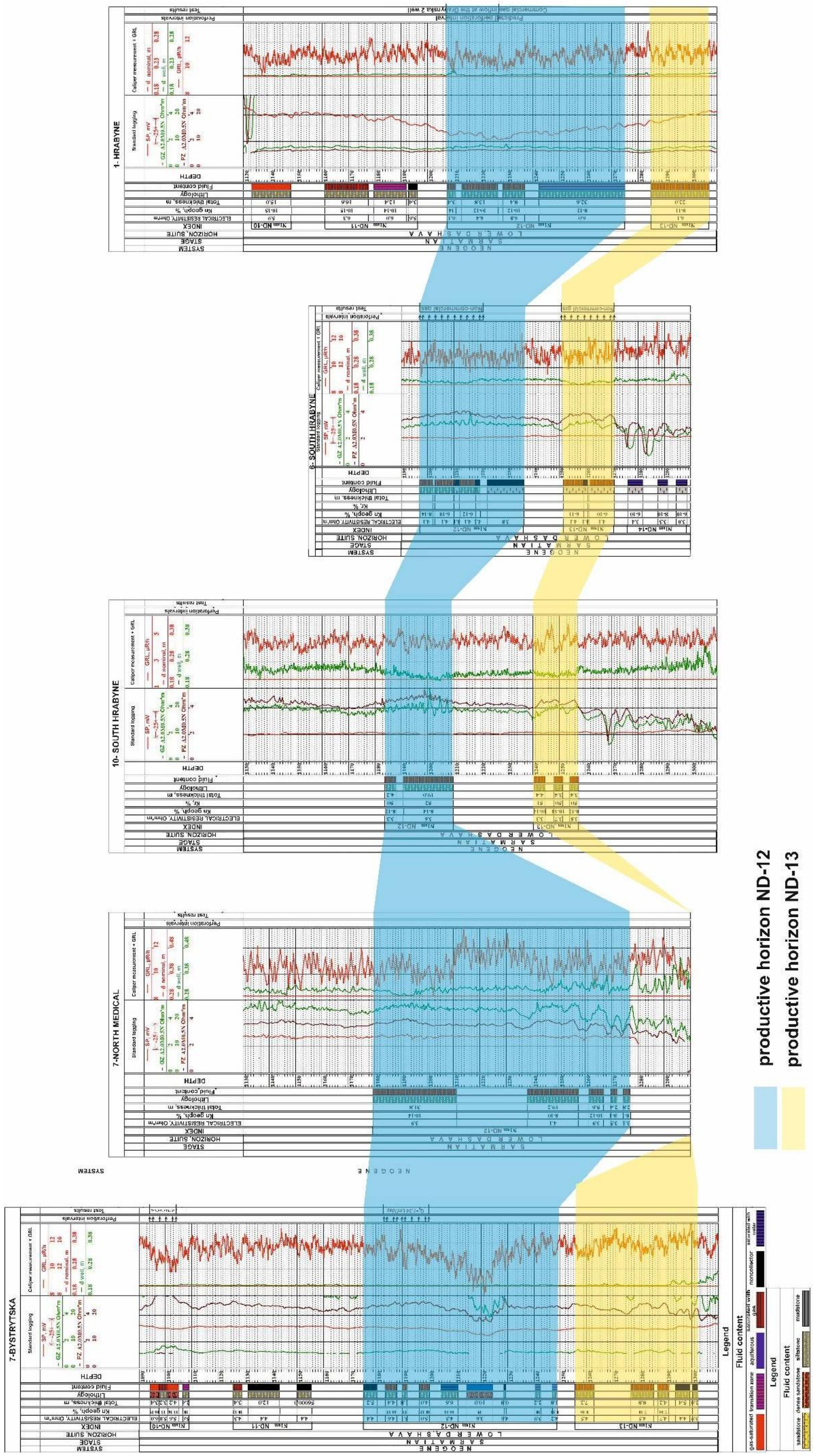

Fig. 5. Correlation scheme for horizons ND-10-ND-14 along the line of wells No. 7 – Bystrytsia, No. 7 – North Medenychi, No. 10, 6 – South Hrabyne, No. 1 – Hrabyne.

References

Boiko H. Yu. (1989) Tectogenesis and oil and gas content of sedimentary basins. Kyiv, Naukova dumka. 204. (in Ukrainian).

Catuneanu O. (2006). Principles of sequence stratigraphy. Amsterdam: Elsevier, 375 p.

Fedyshyn, V. O. (2005). Low-porosity rocks-collectors of industrial purpose gas: Monogr. UkrDGRI, Kyiv, 147 p. (in Ukrainian).

Fedoryshyn, D. D. (1999). Theoretical and experimental bases of petrophysical and geophysical diagnostics tonkoprosharkovyh species of oil and gas (for example, Carpathian oil and gas province). Dr. geol. sci. diss. Lviv., 289 p. (in Ukrainian).

Fedoryshyn, D., Trubenko, A., Fedoryshyn, S., Ftemov, Y., & Koval, Y. (2016). Prospects of nuclear-physical methods for the distinction of gas-saturated reservoir rocks in complicated neogene sediments. *Geodynamics*, (21), 134–143. (in Ukrainian). https://doi.org/10.23939/jgd2016.02.134

Honarpour, M. M., Nagarajan, N. R., and Sampath, K. (2006). Rock/luid characterization and their integration–Implications on reservoir management, *Journal of Petroleum Technology*, 58, 120–131. https://doi.org/10.2118/103358-JPT

Khomyn, V., Tsiomko, V., Goptarova, N., Bronitska, N., & Trubenko, A. (2019). Geological and industrial features of disclosure and testing of low-permeable gas-saturated sediments. *Visnyk of Taras Shevchenko National University of Kyiv: Geology,* 1(84), 42–48. (in Ukrainian). https://doi.org/10.17721/1728-2713.84.06

Kolodii V. V. Pankiv R. P. (2010). Paleohydrogeologic reconstructions of sedimentary strata of the Outer Zone of the Fore-Carpathian Trough in connection with oil and gas bearing capacity. Lviv. 285 p. (in Ukrainian).

Krupskyi, Y. Z. (2001). Geodynamic conditions of formation and oil and gas content in Carpathian and Volyno-Podilsk regions of Ukraine. Kyiv, UkrDGRI, 144 p. (in Ukrainian).

Larsen J. K. and Fabricius, I. L. (2004). Interpretation of water saturation above the transitional zone in chalk reservoirs, *SPE Reservoir Evaluation and Engineering,* 7, 155–163. https://doi.org/10.2118/69685-PA

Lazaruk, Ya., Zayats, Kh., & Pobigun, I. (2013). Gravitational tectogenesis of the Bilche-Volitsa Zone of the Precarpathian Trough. *Geology and Geochemistry of Combustible Minerals, 1–2* (162–163), 5–16. (in Ukrainian). file:///C:/Users/%D0%93%D0%B0%D0%BB%D1%8F/Downloads/giggk_2013_1-2_3.pdf

Maksymchuk V. Yu, Kuznietsova V. H., Verbytskyi T. Z. et al. (2005). Study of modern geodynamics of the Ukrainian Carpathians. Kyiv, Naukova dumka. 255. (in Ukrainian).

Miall A. D. (2006). The geology of fluvial deposits. Sedimentory facies, basin analysis, and petroleum geology. *Springer*. 582 p. https://doi.org/10.1007/978-3-662-03237-4

Miall A. D. (2000). Principles of Sedimentary Basin Analysis. Springer Berlin Heidelberg. 618 p. https://doi.org/10.1007/978-3-662-03999-14, 55–62 (in Ukrainian).

Pavliuk M. I., Naumko I. (2009). Fluid-conductive fault zones as an indicator of migration processes in coal-bearing massifs and oil and gas bearing layers and their fixation by thermobaric and geochemical methods. *Scientific works UkrNDMI NAN Ukraine,* 5, 114–121 (in Ukrainian).

Pavliukh, O. (2009). The peculiarities of the geological construction and the formation of gas deposits of the Outer zone of the Carpathian foredeep. *Geology and Geochemistry of Combustible Minerals, 3–4* (148–149), 31–43, (in Ukrainian). http://dspace.nbuv.gov.ua/handle/123456789/58960

Prokopiv, V. I. & Fedoryshyn, D. D. (2003). Evaluation of geological and geophysical irregularities at studying reservoir rock with the complicated structure. *Prospecting and Development of Oil and Gas Fields*, 2(7), 28–34 (in Ukrainian). http://elar.nung.edu.ua/handle/123456789/6307

Senkovskyi Yu. M. (2018). Genesis of sedimentary complexes of the Tethys Ocean. Carpathian-Black Sea segment. Kyiv: Naukova dumka, 157 p. (in Ukrainian).

Stupka O. S. (2010. Formation of the Carpathian flysch in the evolution of the Tethys – a new look at the problem. *Geology and minerals of the World Ocean,* 2, 51–62. (in Ukrainian).

Tissot, B. P. and Welte, D. H. (1984). Petroleum Formation and Occurrence, Springer-Verlag, Berlin, Germany, p. 699. https://doi.org/10.1007/978-3-642-87813-8

Trubenko, O. M., Fedoryshyn, D. D., Artym, I. V., Fedoryshyn, S. D., & Fedoryshyn, D. S. (2021). Geophysical interpretation methods' improvement of Bilche-Volytska zone of Pre-carpathian foredeep complex geological cross-sections' comprehensive research results. *Prospecting and Development of Oil and Gas Fields,* (4 (81)), 33–40. https://doi.org/10.31471/1993-9973-2021-4(81)-33-40

Zaiats Kh. (2013). Deep subsurface structure of the Western region of Ukraine based on seismic research and directions of exploration for oil and gas. Lviv: Center of Europe, 136 p. (in Ukrainian).

Zaiats, Kh., & Havrylko, V. (2007). Comparative characteristics of the geological structure and seismic data of the Lopushna (Ukraine) and Lonkta (Poland) deposits. *Geology and Geochemistry of Combustible Minerals.*

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ПЕРСПЕКТИВИ ВИДОБУТКУ ГАЗУ ТА КОНДЕНСАТУ ПІВДЕННО-ГРАБИНСЬКОГО РОДОВИЩА ПЕРЕДКАРПАТСЬКОГО ПРОГИНУ

Основні проблеми пошуків та розвідки газових і газоконденсатних родовищ у літолого-стратиграфічних товщах південно-західної та центральної частини Більче-Волицької зони зумовлені складними тектонічними та літолого-стратиграфічними умовами формування покладів вуглеводнів. До об’єктивних чинників можна зарахувати складну геологічну будову порід-колекторів, що зумовлена тектонічними порушеннями у процесі формування пастки, наявність різного типу пустот та глинистого матеріалу, а також обводнення продуктивних пластів на завершальній стадії розробки. Окрім цього, необхідно відзначити зниження інформативності та ефективності електророзвідки, як наземної, так і свердловинної. Разом з цим, у неогенових відкладах відмічаються літотипи зі складною петрографічною та петрофізичною тонкошаруватою будовою матриці породи. Отже, з метою підвищення інформативності результатів методів геофізичних досліджень свердловин (ГДС) та ефективності пошуків вуглеводнів необхідно сформувати оптимальний комплекс новітніх геофізичних методів, зокрема: високоточного індукційного каротажного ізопараметричного зондування (ВІКІЗ), ядерно-магнітного каротажу (ЯМК) разом з акустичними та радіоактивними вимірюваннями. Упровадження такого типу інновацій дасть змогу підвищити інформативність геолого-геофізичних досліджень. Базою такого підходу є петрографічна та петрофізична основа для конкретних територій і пошукових площ. З урахуванням наведеного вище ми виділили в неогенових відкладах газонасичені тонкошаруваті породи-колектори, встановили будову їхніх порід-покришок, а також визначили їхні ефективні товщини і побудували кореляційні схеми їх поширення по латералі у межах сарматського, баденського та гельветського ярусів.

Ключові слова: газонасичені породи-колектори; петрофізичні параметри; водонасичення та обводнення порід; тріщинуватість; кавернозність; комплекс геофізичних досліджень; тектонічні порушення.

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