УДК 551. 24. 035 [477.8] DOI: https://doi.org/10.24028/gzh.v44i1.253713

# The relationship of the oil and gas fields of the Forecarpathian region with the regional faults system and deep structure

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Received 21 December 2021

The oil and gas fields of Forecarpathian oil and gas region are compared with the structure of earth's crust and regional faults. Most of the oil and gas condensate fields are localized in Borislav-Pokutia nappe over Precarpathian Fault zone. The majority of gas fields are located in under thrusting zone of the Sambir fault, which is a gently dipping detachment connected with the Forecarpathian fault and other faults of autochthonous basement. The regional gravity low of Carpathian Foredeep is also limited from northeast by the Sambir fault and from the southwest by the Uzhok fault. The Forecarpathian fault tends to the central part of gravity low. Transverse Tyachev-Nadvorna fault displaces the gravity low and delimits the oil and gas condensate fields. Velocity model along the wide-angle reflection and refraction PANCAKE profile shows a deep (25 km) sedimentary trough under the Carpathian Orogen. The Forecarpathian fault coincides with a jump of the Moho under the trough. Along the RomUkrSeis profile under Carpathian Orogen there were revealed a sedimentary trough as deep as 15 km and a low-velocity domain under the trough. From northeast, the trough is limited by the Forecarpathian fault, which goes up to the keel structure of the Moho discontinuity. Structure of the trough under Carpathian Orogen reflects development of East European Platform margin. The earliest stage of the formation of Baltica paleocontinent passive margin is seen in the structure of the trough's lower part. Autochthonous basement under Borislav-Pokutsky and Skiba nappes includes a Riphean Massif limited by the Krakovets, Forecarpathian and Uzhok faults. The oil and gas condensate fields are located above the Riphean Massif.

The purpose of this article is to analyze the fault system and the structure of the earth's crust in the Forecarpathian oil and gas region, as well as their relationship with the distribution of oil and gas deposits, taking into account new WARR profiles and other geological and geophysical data.

**Key words**: Forecarpathian oil and gas region, Borislav-Pokutianappe, basement fault, gravity field, seismic profiles.

**Introduction**. The Forecarpathian oil and gas region is one of the oldest in Europe. Geologists from different countries have been studying them since the 18th century, and especially intensively over the last 200 years. Well-known Ukrainian oil geologist G.N. Dolenko revealed some features in the spatial arrangement of the oil and gas deposits in the Carpathian region — their multilevel structure and connection with the fault zones of the autochthonous basement [Dolenko, 1980]. In the classic work [Glushko, Kruglov, 1971] it is written that «the problem of deep faults and their role in the development of the Carpathian arc is of great importance.» These issues remain relevant to this day.

R.I. Kutas correlates distribution of oil and gas fields in the Carpathian region with fault tectonics and geodynamic processes. Oil and gas fields are localized in fault zones and their intersections, and relate with an increase in temperature and heat flow, intense migration

of deep fluids, and changes in the composition and properties of fluids [Kutas, 2005, 2021].

Proponents of both organic and inorganic origin of oil and gas recognize the secondary occurrence of hydrocarbons (HC) in reservoirs as a result of their redistribution and migration over tectonic fault zones [Krupskyi, 2001]. Detection of migration channels of hydrocarbon fluids — zones of tectonic faults — is usually carried out mainly by geophysical methods, including deep seismic sounding (DSS). The DSS method for studying the deep structure of the Ukrainian Carpathians and the Carpathian Foredeep was demonstrated for the first time by S. Subbotin [1955], V. Sollogub, A. Chekunov [1967]. The current stage of the deep study the region is represented by a new generation of WARR (wide-angle reflection and refraction) seismic profiles [Starostenko et al., 2013, 2020] and by CDP study using reflected waves [Zayats, 2013], which provides detailed information on the deep structure of the Ukrainian Carpathians to a depth of 20 km and about the faults in autochthonous basement.

The purpose of our paper is to analyze the system of faults and the structure of the Earth's crust in the Carpathian Foredeep oil and gas region, as well to investigate their link with the position of oil and gas fields, taking into account the new DSS profiles and other geological and geophysical data.

*The Carpathian Foredeep oil and gas region* includes the Bilche-Volicia and Borislav-Pokuttya oil and gas regions, as well as the oil and gas one of the platform autochthon [Krupskyi, 2001]. Oil and oil-and-gas-condensate fields are located in the Inner zone of the Carpathian Foredeep, and gas deposits - in the Outer zone of the Foredeep. The Inner zone is composed of Sambir and Boryslav-Pokuttya nappes. Some recent studies have attributed the Boryslav-Pokuttya nappe to the Outer (Flysch) Carpathians (see, for example, [Shlapinsky…, 2012; Hnilko, 2012; Hnilko et al., 2021]).

**Some features of the Boryslav-Pokuttya nappe structure.** Oil and oil-and-gas-condensate fields are located within the Boryslav-Pokuttya nappe and in the frontal slices of the Skyba nappe. The Boryslav-Pokuttya nappe consists of 2—4 layers of Paleogene and Upper Cretaceous flysch anticlinal folds thrusted over each other and overlain by Miocene molasses (Fig. 2) [Shlapinsky, 2012; Nakapelukh et al., 2017].

A spectacular feature of the Boryslav-Pokuttya nappe is its napped-and-folded structure, in contrast to the overlying Skyba nappe and other ones of the Outer Carpathians, which show a napped-and-thrusted structure [Patalakha et al., 2003; Gonchar, 2012]. It should be noted that the frontal slices of the Skyba nappe (were the second band of hydrocarbon fields is localized), as well as the Boryslav-Pokuttya one, are characterized by a napped-and-folded internal structure (Fig. 2).

***The position of oil and gas deposits on the cross-section.*** To illustrate the position of oil and gas deposits at depth, we projected some nearby industrial deposits (according to the data of the State Scientific and Production Enterprise «Geoinform Ukraine», which are freely available) on the CDP P-2 profile (Table). The CDP P-2 profile (Fig. 3) crosses the Outer Carpathians, the Carpathian Foredeep, and the Lviv Paleozoic Trough. The nappes of the Outer Carpathians thrusted over the Carpathian Foredeep along the Main Carpathian Thrust, that is associated with a gentle fault — detachment and comes out to the Earth's surface in the front of the Sambyr nappe. The top of the crystalline basement of the East European Platform (EEP) is dipping beneath the Carpathians and has reached a depth of about 20 km under the Skyba nappe's front. The descension of the EEP margin under the Carpathian allochthon, as well as the change in the thickness of the Neoproterozoic and Meso-Paleozoic deposits, occurs along the system of normal faults in the autochthonous basement. On the cross-section (Fig. 3, *b*) the Forecarpathian and Krakovets faults are the most expressive. The displacement up to 3 km of the crystalline basement and the overlying complexes of Neoproterozoic, Meso-Paleozoic and Miocene age is recorded along the Forecarpathian Fault. A number of steep faults of the pre-Alpine base-

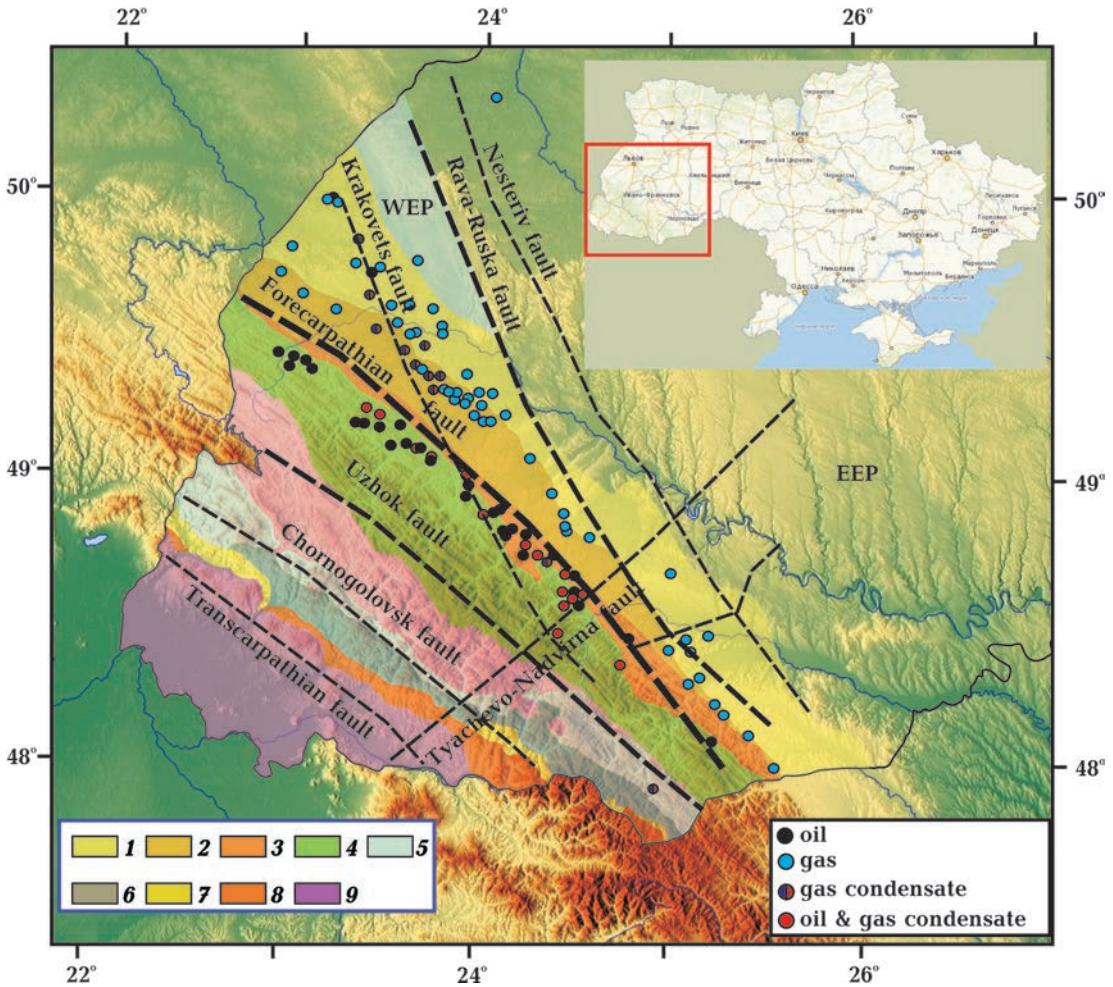


Fig. 1. Oil and gas fields (after GNPP «Geoinform Ukraine») on the tectonic scheme of the Ukrainian Carpathians after [Krupskyi, 2007]; *1* — Outer zone of the Carpathian Foredeep, *2* — Inner zone of the Carpathian Foredeep, *3* — Boryslav-Pokuttya nappe, *4* — Skyba nappe, *5—9* — other tectonic units. The faults according to [Zayats, 2013] are indicated by black dashed lines. The study area is shown with a red rectangle in the map inset.

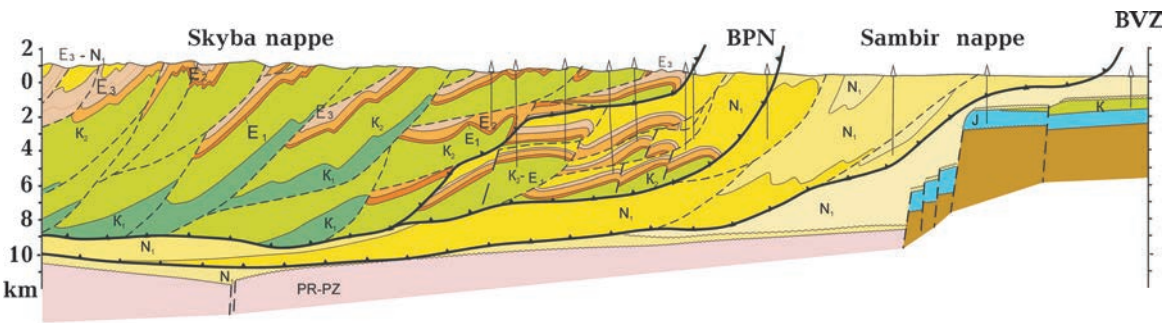


Fig. 2. Internal structure of Borislav-Pokutia and Skiba napps, fragment of the Svalyava—Urych—Gai geological cross-section [Krupskyi, 2007], БПП — Boryslav-Pokuttya nappe, БВЗ — Bilche-Volicia zone. For the cross-section location see Fig. 3, *a*.

ment are connected to a gentle detachment, providing opportunities for both vertical and horizontal fluid dynamics. The Outer zone of the Carpathian Foredeep has an autochthonous structure. A thick (up to 4 km) Miocene cover rests on platform terrigenous-carbonate rocks of the Jurassic and Cretaceous age as thick as 1000 m, which unconformably overlie

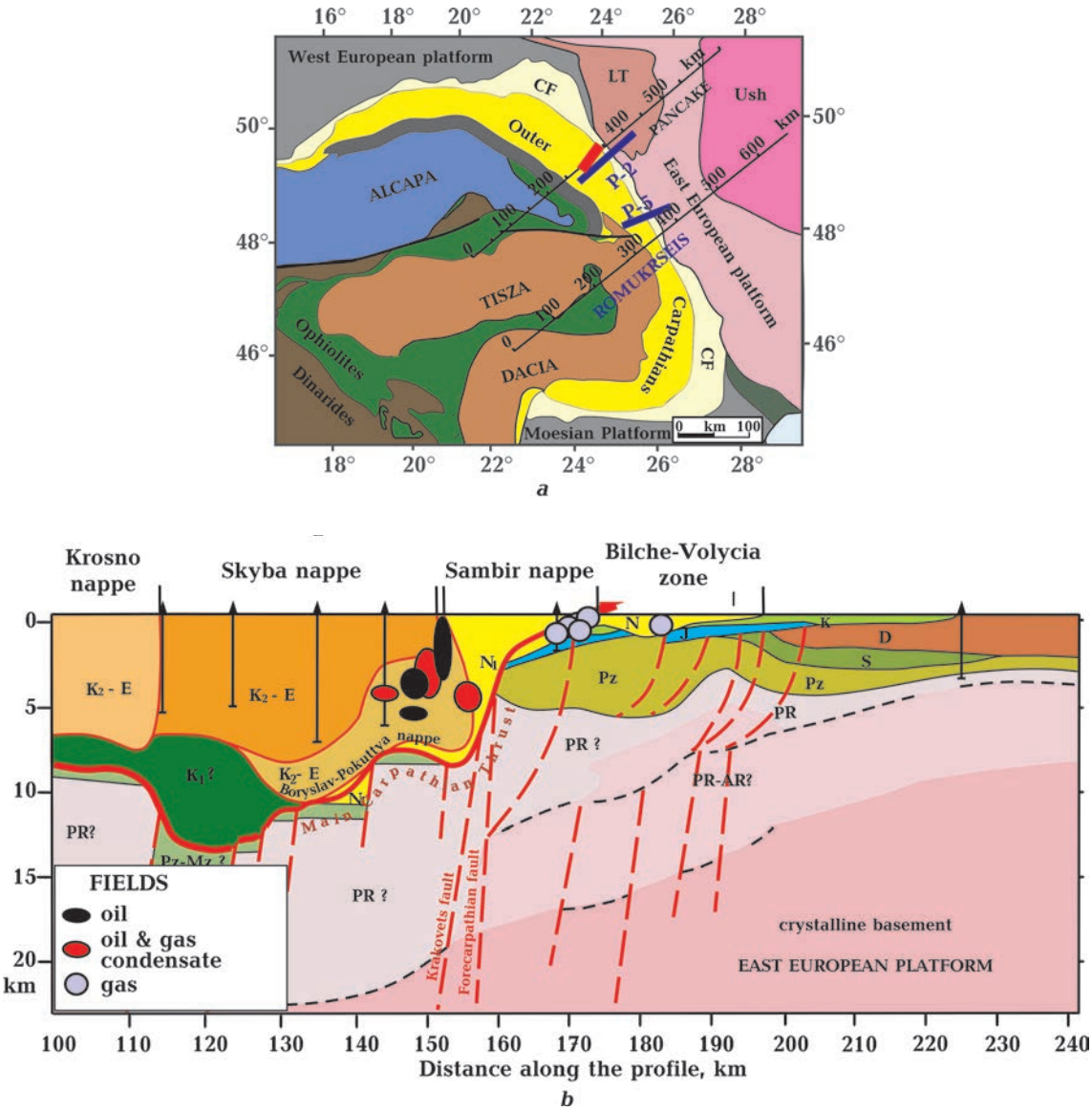


Fig. 3. Position of deep seismic refraction profiles (black lines), reflection seismic profiles (blue lines) and geological cross-section (red line) on the tectonic scheme of the Carpathian-Pannonian region (*а*); Oil fields (black fill), oil with dissolved gas (red fill) and gas (blue fill), projected on the P-2 profile [Zaiats, 2013] (*б*). ВЕП — East European Platform, ВК — Outer Carpathians, ЛП — Lviv Trough, ПКП — Carpathian Foredeep. The Main Carpathian Thrust in Fig. 3b is indicated by solid red line. The faults in the basement are indicated by dashed red lines.

the Paleozoic and Riphean folded formations (Kruglov and Tsypko, 1988). A number of pre-Miocene faults are distinguished in the sedimentary cover of the EEP, the most famous of which is the Rava-Ruska fault.

The fields of oil and gas condensate, projected on the cross-section (see Fig. 3, Table) are located within the flysch deposits of the Boryslav-Pokuttya nappe in the depth range of 31—5292 m and in the bend of 20 km width, limited by the Forecarpathian fault. The major of the oil fields of the Forecarpathian oil and gas region are located above the Forecarpathian fault zone — StaroSambirske, Boryslavske, Stynavske, Semiganivske, Dolynske, Pivnichno-Dolynske, Bytkiv-Babchinske, Pnivske, Gvozdetske oil fields. A smaller parallel strip of oil fields stretches 20–30 km southwestwards of the Forecarpathian fault— Novoskhidnitske, Dovbushanske, Bystrytske

fields [Mykhailov et al., 2009]. Majority of the fields of dry gas containing up to 95–99% methane are localized in the Outer Bilche-Volycia Zone of the Carpathian Foredeep at the depths of 40—1233 m (see table) in the form of two bands (see Fig. 1, 3, *b*). Most of the gas deposits of the Outer Zone are located in the underthrusting zone of the Sambir Thrust — the so-called «Tolvinsky line». Majority of gas fields are covered mainly by clay deposits of the Sambir nappe, which act as a seal [Glushko, Kruglov, 1971]. The second band of the gas deposits runs northeastwards and parallel to the first one at a distance of about 20 km. The cross-section (see Fig. 3, *b*) shows that both bands are associated with faults in the sedimentary cover, which are connected at depth with the Forecarpathian fault.

***Gravity field***. Faults of the autochthonous basement are displayed in the gravity field

**Table. Information on oil and gas fields (according to the data of the SSPE «Geoinform Ukraine»), projected on the geological cross-section along the CDP R-2 profile**

| Number | Field name | composition | Tectonic position | Collector age | Collector depth, m |
|---|---|---|---|---|---|
| 225 | Bilche-Volytske | Gas | Bilche-Volycia Zone (BVZ), Carpathian Foredeep (CF) | Neogene | 508—672 |
| 206 | Ugerske | Gas | BVZ, CF, anticline | Neogene | 239—950 |
| 221 | Pivdenno-Ugerske | Gas | BVZ, CF, brachianticline | Neogene | 746—1194 |
| 304 | Glynkivske | Gas | BVZ, CF, brachianticline | Neogene, верхний мел | 1197—1233 |
| 77 | Kavske | Gas | BVZ, CF, Kavska brachianticline | Neogene | 472—790 |
| 78 | Dashavske | Gas | BVZ, CF, brachianticline | Neogene | 40—180 |
| 238 | Yankovske | Oil | Boryslav-Pokuttya nappe (BPN), | Eocene | 5175—5292 |
| 69 | Tanyavske | Oil gas condensate | BPN, anticline, Skyba nappe, Beregova slice | | 3675—3820, 3735—3875, 3755—3793, 3865—4005, 3975—4100, 2415—2450 |
| 63 | Semyganivske | Dissolved gas | BPN, anticline | Menilite formation, Vygodska formation | 4150—4350, 4500—4800 |
| 320 | Pivdenno - Stynavske | Oil, Dissolved gas | BPN, anticline | Menilite formation | 4610—4712 |
| 127 | Stynavske | Oil, gas condensate | BPN | Menilite formation, Vygodska formation | 31—72, 43—110, 2800—3600 |
| 300 | Nyzhnye-Stynavske | Oil | BPN, anticline | Menilite formation, Vygodska formation | 4375—4460 4630—4711 |

pattern and limit the area where the oil and gas fields are located (Fig. 4). On the margin of the EEP towards the Carpathian thrust-and-fold belt one can see a gradual decrease in intensity of the Bouguer gravity field from –50 to –100 mGal beneath its frontal part. The regional gravity low is limited by the Sambir fault (No. 2) from the northeast and by the Uzhok fault (No. 7) from the southwest. The Forecarpathian fault (№1) coincides in direction with the gravity low and is located in its central part. The gravity low is consistent with the basement deflection beneath the Outer Carpathians. The regional gravity low above the Carpathian Foredeep is also related with significant thickness of the light molasse and saliferous rocks presented here [Zayats, 2013]. The transverse Tyachivo-Nadvirna fault (№. 11) limits the gravity low and the zone of oil and gas condensate fields from the northwest. The Stryi-Latorica transverse fault (№. 10), studed by [Hnilko, 2012] on the Earth's surface, we traced in the basement along the strike of the zone of thickening of the isolines of the gravity field (no. 10'). The fault limits from the west a zone of maximum concentration of oil fields.

***Faults at the margin of the East European platform according to seismic data.*** Resent international WARR seismic profiles PANCAKE [Starostenko et al., 2013] and RomUkrSeis [Starostenko et al., 2020] made it possible to obtain velocity cross-sections and tectonic models of the southwestern margin of the EEP. The velocity model along the RomUkrSeis profile, on the margin of the EEP under the Carpathian fold-thrust belt, revealed a two-story sedimentary trough as

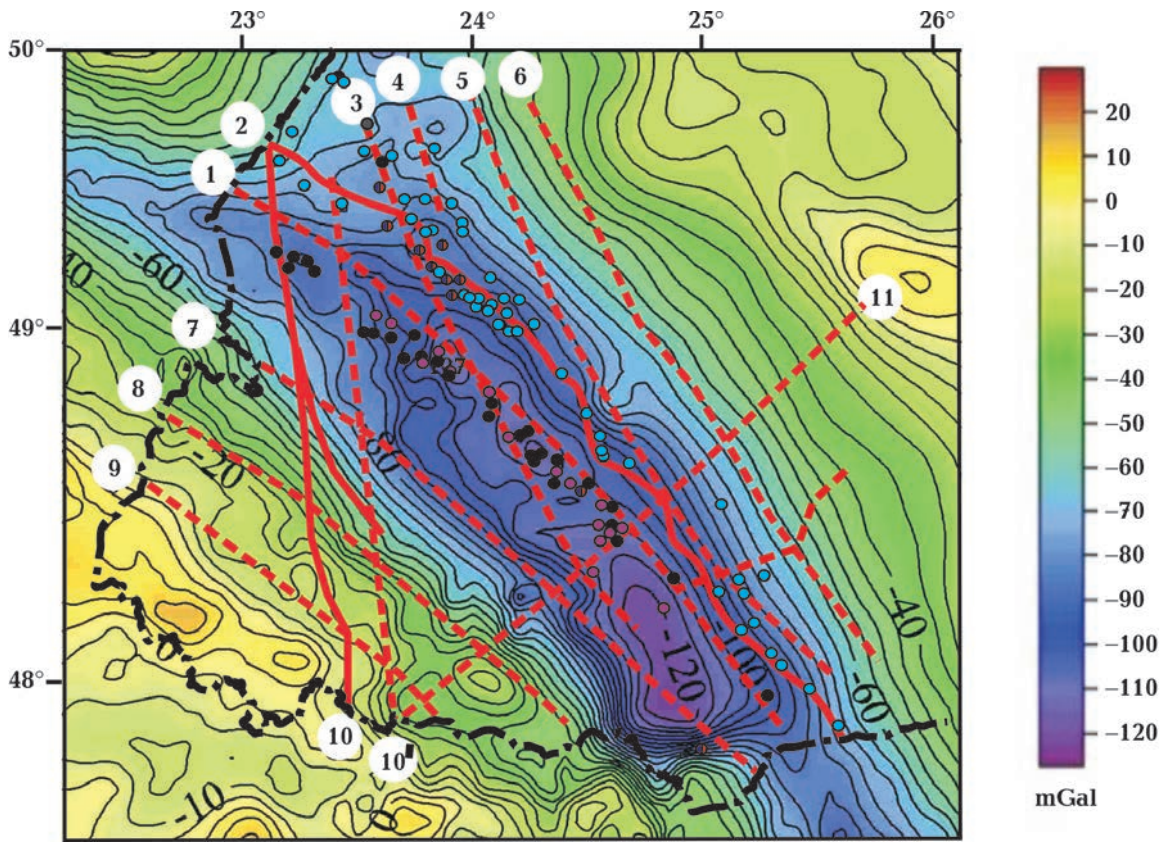


Fig. 4. Faults in the autochthonous basement according to reflection seismic profilling (red dotted line) [Zaiats, 2013], faults mapped on the surface (solid red lines) and oil and gas fields against the background of the gravity field (Bouguer anomalies). Faults: 1 — Forecarpathian, 2 — Samborskiy, 3 — Krakovetskiy, 5 — Rava-Ruskiy, 6 — Nesterovskiy, 7 — Uzhokskiy, 8 — Chernogolovskiy, 9 — Transcarpathian, 10 — Striisko-Latoritskiy [Hnylko, 2012], 11 — Tyachevsko-Nadvornyansky. The oil and gas deposits are shown as in Fig. 1.

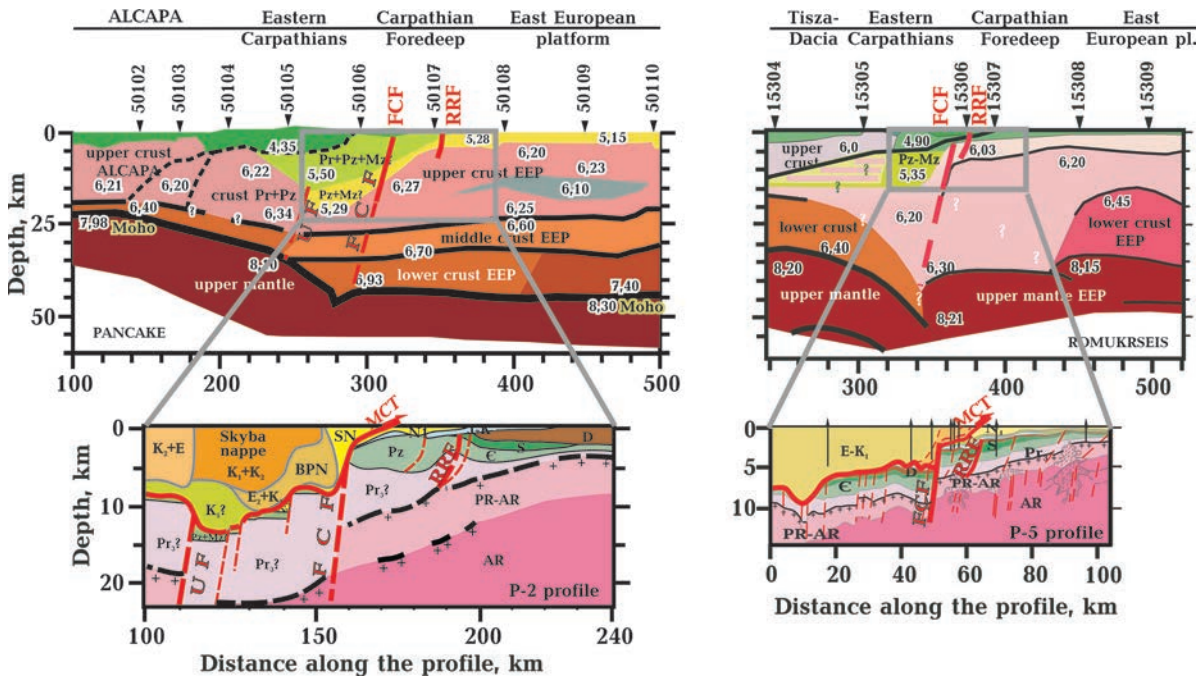


Fig. 5. Deep structure of the earth's crust of the Ukrainian (Eastern) Carpathians and the position of the Forecarpathian fault along the DSS profiles PANCAKE [Starostenko et al., 2013] (left) and RomUkrSeis [Starostenko et al., 2020] (right); CDP profile according to [Zaiats, 2013] (below). The profiles location are shown in Fig. 3, *a*. РРР — Rava-Ruskiy fault, ГКН — Main Carpathian thrust, УР — Uzhokskiy fault.

deep as 15 km that overlain the crystalline crust of relatively reduced P- wave seismic velocities beneath the sedimentary trough for the entire thickness of the earth's crust. To analyze the sedimentary trough at the EEP margin, we used the nearby CDP P-5 profile, which characterizes the crustal structure in more detail down to the depths of 15—20 km (Fig. 5). We have identified the Forecarpathian fault on the RomUkrSeis profile, taking into account its known position on the CDP profile P-5. The fault coincides with a sharp step of the velocity isoline in the depth range of ~8—18 km, and its hypothetical continuation went down to the keel-like structure at the Moho discontinuity separating segments of the Earth's crust of different structure.

The velocity structure of the Earth's crust at the Carpathian belt according to the PANCAKE profile is generally similar to the structure of the crust along the RomUkrSeis profile (see Fig. 5). Within the crust beneath the Carpathians, along the PANCAKE profile, one can see a three-layer, deeper and wider sedimentary trough. To analyze the sedimentary trough under the Carpathian fold — and thrust belt, we used the CDP P-2 profile [Zayats, 2013]. The interpretated continuation of the Forecarpathian fault down to the lower crust shows its spatial coincidence with the depth step of the Moho discontinuity.

**Discussion.** ***Forecarpathian fault as a rift margin of the Baltica paleocontinent***. Based on the RomUkrSeis and PANCAKE profiles, we argued the deep nature of the Forecarpathian fault (the most expressive fault in the structure of the Carpathian Foredeep) and showed its possible spatial connection with the structure of the Moho discontinuity [Amashukeli, 2021]. In accordance with our interpretation, the Forecarpathian Fault limits a deep trough in the Earth's crust from the northwest, the floors of which correspond to various stages in the EEP margin development. The earliest stage, at which the margin of the recent EEP (at that time, the Proterozoic paleocontinent Baltica) was formed, is reflected in the structure of the lower part of the trough and the underlying crust.

In the period between the Riphean and the

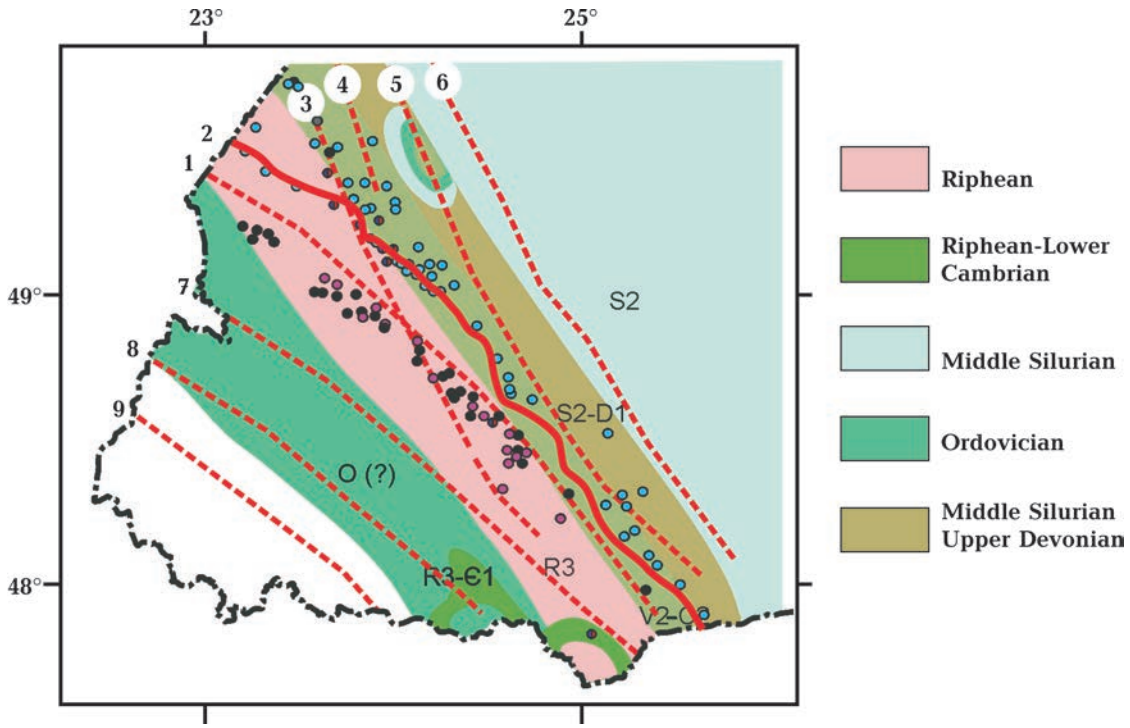


Fig. 6. Position of the basement faults in the region of Ukrainian Carpathian and location of oil and gas fields on the geological map of the pre-Devonian surface according to [Galetskyi, 2001]. For the names of the faults see Fig. 4.

Vendian, on the southwestern margin of the EEP (within the Volyn-Polesie trough), basaltic lava of the Volyn series's trap formation poured out, that indicates a tectonic reorganization of the margin of the EEP (paleocontinent Baltica). In the Ediacaran (630—542 Ma), the formation of the EEP sedimentary cover begins, when a thick sequence of sedimentary-volcanogenic deposits is formed in paleotroughs (Kruglov and Tsypko, 1988). In the Outer zone of the Carpathian Foredeep, some drilling reached the Riphean and Ediakaran-Cambrian rocks being witnesses of the global restructuring of the EEP margin.

The Riphean greenstone schists of the Lezhaisky massif are separated from the Ediacaran-Cambrian folded strata of the Kokhanivska zone at the northeast by the Krakovets fault. Upper Vendian and Lower Cambrian volcanic-sedimentary deposits are associated with the breakup of the Rodinia paleocontinent and the ending of the global glaciation, when the Tornquist rift (Bogdanova et al., 2008), or the Dniester pericraton [Kruglov, Tsypko, 1988] formed along the southwestern margin of the EEP. At the same time, the Volyn-Orsha aulacogen, which spatially inherited the suture zone of Fennoscandia-Sarmatia, originated. The Tornquist rift and the Volyn-Orsha autocagen were the branches of a single system of triple rift junction [Bogdanova et al., 2008]. The development of the Volyn-Orsha aulacogen stopped at the initial stage of the continental rifting, while the Tornquist rift opened into the Yapetus Ocean [Metelkin et al., 2014].

In accordance with our interpretation, the Forecarpathian fault marks the passive continental margin of the Baltica, which was formed as a result of the breakup of the Rodinia supercontinent. The crystalline crust of the Baltica at the EEP margin area is extended and overlain by Neoproterozoic-Early Paleozoic metasedimentary deposits [Krzywiec et al., 2018; Starostenko et al., 2020]

***The Riphean Lezhaisky massif at the basement structure of the Ukrainian Carpathians.*** We superimposed faults of the autochthonous basement on the geological map of the pre-Devonian section of the EEP margin (Fig. 6). On the EEP margin, in the central part of the Carpathian autochthon, there is a Riphean

massif, which is limited from the side of the EEP in the southeast by the Forecarpathian fault (No. 1), and in the northwest by the Krakovets fault (No. 3).

It is possible that the Riphean massif is bounded from the southwest by the Uzhok fault (No. 7), which also divides the Carpathian region in terms of gas composition into hydrocarbon and carbon dioxide regions. In the Carpathian Foredeep, methane dominates in gas composition (Kolodii, 2004). In the Flysch Carpathians a gradual decrease in the amount of methane is observed in the southwestern direction, as well as an increase in the amount of nitrogen and carbon dioxide [Pavlyuk et al., 2019; Kutas, 2021].

The influence of the Lezhaisky massif on formation of the the Boryslav-Pokuttya nappe, containing the most of oil and gas condensate fields, is shown in the palinspastic reconstruction made by Hnilko and coauthors (2021). In the early Miocene, in front of the Boryslav-Pokuttya nappe that advanced towards the EEP, a fore-bulge uplift arose, which is identified with the Lezhaisky massif. The frontal Boryslav-Pokuttya nappe, rested against the Lezhaisky massif, as a result its advancement was stalled, and the next Skyba nappe began to move towards the rear of the Boryslav-Pokuttya nappe. The rear part of the Boryslav-Pokuttya nappe was overlain by the Skyba nappe and transformed into scales- duplexes [Hnilko et al, 2021].

The fields of oil and gas condensate are located above the Riphean massif (Fig. 6). In this regard, it is appropriate to refer to the paper [Gribik, 2018], which assumes the oil and gas potential of the basement of the Volyn-Orsha aulacogen, which was also genetically related to the riftogenic margin of the Baltica. In the middle part of the basement of the Orsha depression, as in the Lezhaisky massif, there is distinguished a gravity low associated with the basement rocks of lower density.

***The geodynamic model of oil formation*** made it possible to predict first theoretically and then to discover on practice many hydrocarbon fields in a setting of underthrusting zones worldide that were previously considered unpromising ones (see, for example, [Sorokhtin et al., 2009 and references therein]). This includes the unique basins of the Persian Gulf, Venezuela, the US Midwest, Canada, Alaska, Indonesia, as well as foredeeps's classic deposits of the Appalachian, Ural, Caucasus and Carpathians.

In accordance with the geodynamic model, pelagic sediments are pulled into the subduction zone together with the oceanic lithosphere, where thermolysis of organic matter contained in sedimentary rocks, and sublimation of the resulting hydrocarbons occur. In underthrusting zones, the passive margin of the continent moves beneath the active continental margin and sags under the weight of the accretionary prism, that leads to acceleration of sedimentation and oil and

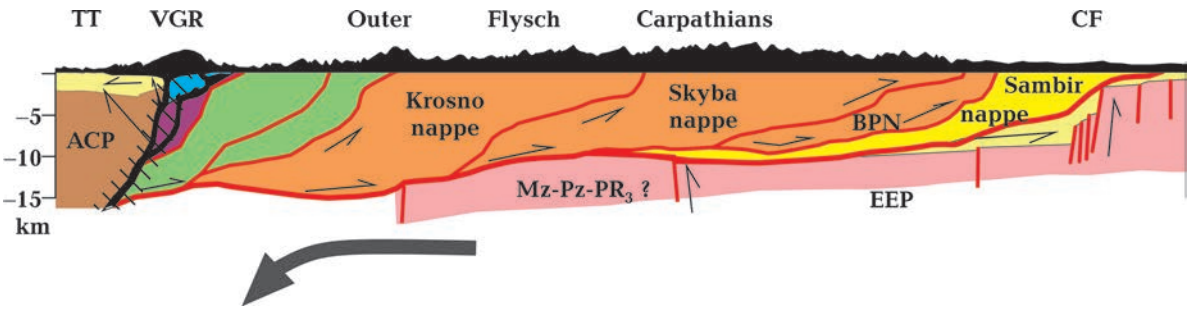


Fig. 7. Oil and gas migration paths from the underthrust zone towards the Carpathian Foredeep (ПКП) as a result of dynamic pressure according to the model of geodynamic oil formation. Geological background after [Gintov et al., 2014; Nakapelyukh et al., 2017]. The large gray arrow indicates the direction of the East European Platform thrusting under the Alcapa microplate. Thin arrows indicate the oil and gas fluid paths from the underthrusting zone towards the Carpathian Foredeep. ВЕП — East European Platform, ПКП — Carpathian Foredeep, БПП — Boryslav-Pokuttya nappe, ЗП — Transcarpathian Trough , ВГГ — Vyhorlat-Gutavolcanic ridge, АКП — Alcapa.

gas formation. The formation of oil and gas in such structures occurs due to next processes: 1) mobilization of dispersed oil and gas of the folded sedimentary strata of the active continental margin, 2) migration of hydrocarbons from plate underthrusting zones. The capacity of the second source of hydrocarbons is much higher than the potential of the first one. The combination of these two mechanisms of enrichment of foredeeps with oil and gas makes them unique hydrocarbon reservoirs.

Such a model was suggested for the first time for the Ukrainian Carpathians by Patalakha et al. (2003). During the thrusting of the Carpathian orogen onto the EEP, the platform cover is pulled to a depth of more than 10 km, where sedimentary rocks experience large thermomechanical loads, dehydration and metamorphism. As a result, the hydrocarbon-bearing fluids are concentrated and squeezed out (the so-called «filter pressing»), accumulating in the Carpathian Foredeep (Fig. 7). Oil has been accumulated within the Boryslav-Pokuttya nappe and in the frontal scales of the Skyba nappe due to the peculiarities of their nappe-and-fold structure — the presence of several layers of thrust folds, which provide the better hydrocarbon preservation .

Stress fields, reconstructed from tectonophysical field data, show that the main compressive stress in the Ukrainian Carpathians is oriented horizontally and trending northeast [Gintov et al., 2013; Murovska et al., 2019], providing the extrusion of hydrocarbon fluids in the direction of the Carpathian Foredeep. Also, tectonophysical data were obtained on closed and open systems of tectonic fractures within the Skyba nappe and the Inner part of the Carpathian Foredeep. The lack of gas deposits in this part of the foredeep may be due to its extension and the formation of a dense system of open fractures.

V.V. Gonchar considers the development of the Carpathian subduction-collision orogen in the context of two typical accretion settings: 1) lateral accretion and 2) nappe formation [Gonchar, 2012]. The internal structure of the Boryslav-Pokuttya nappe is associated with an increased coefficient of friction at the base of the nappe and the tuberosity topography of the basement surface. The presence of horizontal scales within the Boryslav-Pokuttya nappe may indicate the effect of the gravitational factor — the sliding of rocks from the uplift of the basement, which may be the frontal swell formed on the site of the Lezhaisky massif [Gonchar, 2012; Hnilko et al., 2021].

**Conclusions**. Supporters of both organic and inorganic origin of oil recognize the important role of deep faults in the development of the Ukrainian Carpathians and for the formation of oil and gas fields, as well as the need to study them. The search for channels of migration of hydrocarbon fluids, related to zones of tectonic faults, are undertaken mainly by geophysical methods. The progress in deep studying the Ukrainian Carpathians at the current stage is determined mainly by the processing and interpretation of new generation of WARR seismic profiles.

Most of the oil and gas condensate fields of the Forecarpathian oil and gas region are localized within the Boryslav-Pokuttya nappe above the Forecarpathian fault. The vast majority of gas fields are located in the subthrusting zone of the Sambyr fault, which is a gentle detachment associated with the Forecarpathian and other faults of the autochthonous basement. A number of regional faults, reflected well in the structure of the gravity field, limit the area of oil and gas fields. The regional gravity low is limited from the northeast by the Sambyr fault, and from the southwest — by the Uzhok fault. The Forecarpathian fault coincides in strike with the gravity low and is located in its central part. The transverse Tyachivo-Nadvirna fault displaces the gravity low and limits the zone of oil and gas condensate fields. The Striy-Latorica transverse fault limits the zone of maximum concentration of oil fields from the west.

The velocity model along the WARR seismic profile RomUkrSeis revealed at the EEP margin a two-storied sedimentary trough as deep as 15 km and relatively low of P- wave velocities under the sedimentary trough in the entire crystalline crust. From the northeast, the trough is limited by the Forecarpath-

ian fault, and its hypothetical continuation went down to the keel structure of the Moho discontinuity. The velocity structure of the Earth's crust at the EEP margin along the PANCAKE profile is generally similar to that along the RomUkrSeis profile. On the margin of the EEP, a deeper (up to 25 km) and wider three-story trough was revealed, and the Forecarpathian fault spatially coincides with a sharp step of the Moho discontinuity. We revealed the deep nature of the Forecarpathian fault along the RomUkrSeis and PANCAKE seismic profiles. From the northwest, the fault limits a deep trough in the Earth's crust, the layers of which correspond to different stages in the development of the platform margin. The earliest stage in the formation of the EEP passive margin (Baltica paleocontinent) is reflected in the structure of the lower part of the trough and the underlying crust.

At the base of the Boryslav-Pokuttya and Skyba nappes there is a Riphean massif, limited in the northeast by the Krakovetsky and Forecarpathian faults, and in the southwest by the Uzhok one. Oil and gas condensate deposits are located above the zone of the Riphean massif, which suggests its oil and gas potential.

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# Нафтогазоносність Передкарпатської області у зв'язку із системою регіональних розломів та глибинною будовою

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Просторовий розподіл покладів нафти і газу Передкарпатської нафтогазоносної області зіставлено із структурою земної кори та регіональними розломами. Більшість нафтових і газоконденсатних покладів локалізуються в межах Бориславо-Покутського покриву над зоною впливу Передкарпатського розлому. Переважна частина газових покладів розміщується у піднасувній зоні Самбірського розлому, що є пологим детачментом, який пов'язаний з Передкарпатським та іншими розломами автохтонного фундаменту. Регіональний мінімум гравітаційного поля Передкарпатського прогину з північного сходу обмежений Самбірським, а з південного заходу Ужоцьким розломом. Передкарпатський розлом тяжіє до центральної частини гравітаційного мінімуму. Поперечний Тячівсько-Надвірнянський розлом зміщує мінімум гравітаційного поля та обмежує зону розвитку нафтових і газоконденсатних покладів. На швидкісній моделі за сейсмічним профілем PANCAKE під Карпатською спорудою знаходиться глибокий (25 км) осадовий прогин. Передкарпатський розлом збігається зі стрибком поділу Мохо під прогином. За профілем RomUkrSeis під Карпатською спорудою виявлено осадовий прогин завглибшки до 15 км, швидкості поширення сейсмічних хвиль під прогином знижені. З північного сходу прогин обмежений Передкарпатським розломом, який пов'язаний з кільовою структурою поділу Мохо. Структура прогину під Карпатським орогеном відзеркалює етапи розвитку окраїни Східноєвропейської платформи. Найраніший етап, на якому сформувалася пасивна окраїна палеоконтиненту Балтика, відображений у будові нижньої частини прогину. В автохтонній основі під Бориславо-Покутським та Скибовим покривами знаходиться рифейський масив, обмежений Краковецьким, Передкарпатським та Ужокським розломами. Поклади нафти та газоконденсату розміщуються над зоною розвитку рифейського масиву.

**Ключові слова:** Передкарпатська нафтогазоносна область, Бориславо-Покутський покрив, розломи фундаменту, гравітаційне поле, сейсмічні профілі.