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POKUTTIA DEEP FAULT AND ITS INFLUENCE ON TECTONICS AND THE OIL- AND GAS-BEARING OF THE SOUTH-EASTERN SEGMENT OF THE CARPATHIANS

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Objective. The objective of this study is to analyze the influence of the Pokuttia deep fault on tectonics and the oil- and gas-bearing structures in the south-eastern part of the Ukrainian Carpathians. ***Methodology.*** It is presented in a detailed complex analysis of the geological-geophysical data in the given area. ***Results.*** The influence in the Pokuttia deep fault on the flysch structure has revealed itself in the Boryslav-Pokuttia nappe as a series of dislocations with a break of continuity at the north-eastern orientation at the boundary between the Hutsulkyi and Boikivskyi segments with the structures horizontally displaced 10 km off and up to 1.5 km vertically- left-strike slip fault. In the Skyba nappe this is truncation of its front part of the Hutsulskyi segment. In the Dukla-Chornohora nappe and the Bitlya-Svydovets sub-nappe these are sigmoid curvature of their parts in the fault zone with amplitudes of horizontal displacements of up to 10 km. As a result, the Krasnoshora and Hoverla units are joined into a single sub-nappe, and the thrust-folds of the Bitlya-Svydovets sub-nappe to a considerable extent are overlapped by it and by the Skupiv sub-nappe. Owing to post-overthrusting vertical movements the Hutsulskyi segment was uplifted during Pliocene-Pleistocene. The rise of the area with the Duklya –Chornohora nappe was the most intensive. The structures of the Bitlya-Svydovets sub-nappe are fragmentally outcropped from under it. In the territory of Romania the nappes structurally correspond from the north - the thrust-sheet with olistostrome Slon in the Lower Verkhovyna deposits of Oligocene, and from the south - tectonic units Toroklezh and Makla. The Pokuttia fault displaces the Precarpathian regional minimum (amplitude of about 10 km), and the Uzhok deep fault with the signs of right-shift. There is a perceptible impact of the Pokuttia fault on the sub meridional Radekhiv-Viktoriv fault. Sites of intersections of the mentioned faults, so-called knots, if the traps are available, are known to be favourable zones for hydrocarbon accumulation on commercial scales. In the light of new data on the geological structure of the region, the perspective estimate is raised for the distinguished structures Vorohta-Yasynia (Lazeshchynska, Yasynska and Voronenkivska), as well as Semakivska and Hryniavska, where commercial influxes of hydrocarbons were obtained. This observation also concerns the structures of the basement of the Lopushna subzone of the outer zone of the Carpathean Foredeep under the overthrust of the Carpathians. ***Scientific novelty.*** For the first time, using new geological data it was possible to prove the influence of the Pokuttia fault in the zone of its action in a form of the left-strike-slip on the structures of the flysch cover. The structural parallelization of the Bitlya-Svydovets sub-nappe of the Krosno nappe of the Ukrainian Carpathians was carried out with the tectonic units of the Romanian Eastern Carpathians. Interaction of the given fault with the Precarpathian regional minimum and the Uzhok deep fault has a character of the right shift. Areas connected with these dislocations are prospective for hydrocarbon accumulations of commercial value. ***Practical Value***. As a result of investigations essential corrections have been inserted concerning the geological structure of the south-eastern part of the Ukrainian Carpathians. Together with geochemical indications this presents new possibilities in searching for hydrocarbon deposits in this region.

Key words: deep fault, flysch, basement, shift, oil- and gas-bearing.

Introduction

A great number of faults of different orientation intersect the Carpathians: longitudinal, transverse to their extension, submeridional, and diagonal ones, distinguished on the basis of geophysical, remote, and geological data. In most cases it is considered that they don't cut the flysch cover, but are localized in the basement of the Carpathians. Some of them developed over a long period of time and stretch far beyond the platform limits. Such zones of transverse faults belong to the category of deep ones. In particular, these are Stryi and Pokuttia zones of faults the existence of which finds depiction in gravitational and magnetic fields [Subbotin, 1955]. The Pokuttia fault, known as the Hutsulsky fault, had been singled out by S. I. Subbotin in 1955 on the basis of gravimetrical studies, In opinion of some researchers, the Pokuttia fault originated in the Early Proterozoic, together with the Manyava fault, and probably compose a single deep zone 30 to 35 km wide at the boundary between the Pokuttia-Bukovyna uplift and the Pannonian-Volyn depression [Dolenko et al., 1976]. V. V.Glushko broadened its spatial range to a great extent and noted that uplifted position of the pre-flysch basement of the Pokuttia folds and their comparatively fast dipping to the north-west should be connected with the transverse fault in the region of Berezova (the River Liuchka) which mainly crosses the fault known as the Hutsulsky one. It should be of regional importance because it exactly restricts Apusenides, Marmarosh nappe, Pokuttia folds from the north-west and are traced in the direction of the Ustechko dislocations on the River Dniester [Kuzovenko, 1990].

In 1969 M. A. Beer had distinguished the Verkhnya Tysa zone of faults in the south-eastern part of the Carpathians that was interpreted by him as a system of the left-strike dislocations of sub latitudinal (60–70°) direction with the amplitude of dislocation across the basement up to 10–15 km. He had noted that in the zone of faults one can observe sigmoidal changes in the extension of the structural elements of the Rakhiv, Porkulets and Chornohora nappes with the amplitude from 10 to 12 km. This zone coincides with the restriction of the Petros tongue-like tectonic outliers and the nappe of the Skupiv subzone. In its southern part, it restricts the Marmarosh cover, and in the north - Pokuttian Carpathians. On the opinion of M. A. Beer, the greatest influence of the given zone was exposed in the formation of nappes that probably connected with the character of occurrence of blocks to the flysch basement. But sharp changes in stretching of the folded structures or other visible shift phenomena in the flysch cover are fixed with great difficulties [Beer, 1969]. As we shall see from the characterization of the Verkhnya Tysa zone of faults, it can be identified with the Pokuttia fault.

Objective

The objective of this study is the analysis of the influence of the Pokuttia deep fault upon the structure and on tectonics and the oil and gas bearing potential in the south-eastern part of the Ukrainian Carpathians.

Methodology

It is contained in the complex analysis of the geological-geophysical data on the given area.

Results

The Pokuttia fault exists in the basement of the Carpathians and, as the work of M. A. Beer testifies, in the first approach it is reflected in the flysch cover. But is it possible to hole the influence of this fault as to smaller structural elements compared to large covering units using more precise evidential basis. For this purpose let us analyze the recent geological map of the Folded Ukrainian Carpathians compiled in 2007 [Glushko et al., 2007], modernized by the author of the given paper during 2008–2017, in particular its south-eastern part, which is more precise than the geological basis used by M. A. Beer in the 1960s of the 19th century and using drilling data.Also let us note that for convenience V. V.Glushko had proposed to call the Volyn-Pannonian deep and the Pokuttia-Bukovyna uplift as the Boikivskyi and Hutsulskyi megablocks or segments [Shlapinskyi, 2012 a]. These names will be used in the given paper.

The Boryslav-Pokuttia nappe

Let us start the analysis with the structures of the Boryslav-Pokuttia nappe. We remind you about that in the Pokuttia-Bukovyna part of the nappe even B.Sviderski has singled out (from the north-east to the south-west) the following folds: Kamenystyi, Karmatura, Brusnyi, Ploskyi and Maksymets (Fig. 1) that now are attributed to the III-d stage of folds [Glushko, & Kruglov, 1977]. These folds, however, according to the interpretation of V.V. Kuzovenko and the author of this paper, throughout the whole area of their distribution turned out to be thrust-folds moreover in some places they are divided by the fragments of twisted limbs. They are composed mainly of the Cretaceous – Paleogene deposits. The Miocene deposits of the Vorotyshcha and Polyanytsia suites are slightly distributed and are localized in the back parts of the thrust-folds. From the north-west and the north-east the given thrust-sheets are divided from the Sloboda Rungurska anticline by transverse and longitudinal with a break of continuity. This structure, composed of the deposits of the Stryi suite of the Upper Cretaceous-Paleocene in the core part, belongs either to the structures of the IV-th stage of folds of the Boryslav- Pokuttia nappe Glushko, & Kruglov, 1977] or they are singled out into separate Sloboda subzone of the Inner zone of the Carpathian Foredeep [Glushko et al., 1982]. In the zone of junction of these units occur several tectonic remnants of the Oriv thrust with the Stryi deposits in the Miocene of Sloboda Rungurska underlining very inclined character of the overthrust of this thrust as well a remnant of the Beregova thrust composed of the rocks of Menilite of Oligocene (Fig. 1, 2).

Farther north-east of the front of the Kamenystyi thrust-fold occurs an adjacent stretched fold which is probably intermediate between the Pokuttia folds and Sloboda Rungurska. By availability of Sloboda conglomerates in its composition it gravitates rather towards the second one. More inner units of the Boryslav-Pokuttia nappe farther surface are absent, but are exposed in a number of boreholes of the Delyatyn area. They also belong to the III-d stage of the thrust-folds. The nearest of these boreholes (3-Delyatyn) that was spud in the Skyba nappe and separated from the axial line of the Brusnyi fold is 3 km away periclinal part of the latter only. Under the Stryi suite of the Oriv thrust are exposed successively the Vorotyshcha, Polyanytsia, and Menilite deposits. But they don’t belong to the Brusnyi fold, as one can expect taking their territorial nearness into consideration, because from the thrust-folds’ balance demonstrated in Fig. 2, 3, 4 and 5 such pairs of identical thrust-folds of the Pokuttia- Bokovyna and Delyatyn parts of the Boryslav- Pokuttia nappe are divided plausibly: Teresnyanska-Kamenystyi, Mykulychyn-Karmatura, Southern Mykulychyn-Brusnyi, Nothern Kremenets-Ploskyi and Kremtnets–Maksymets (the borehole Delyatyn-3 has exposed the frontal Teresnia fold, but not the Brusnyi fold).

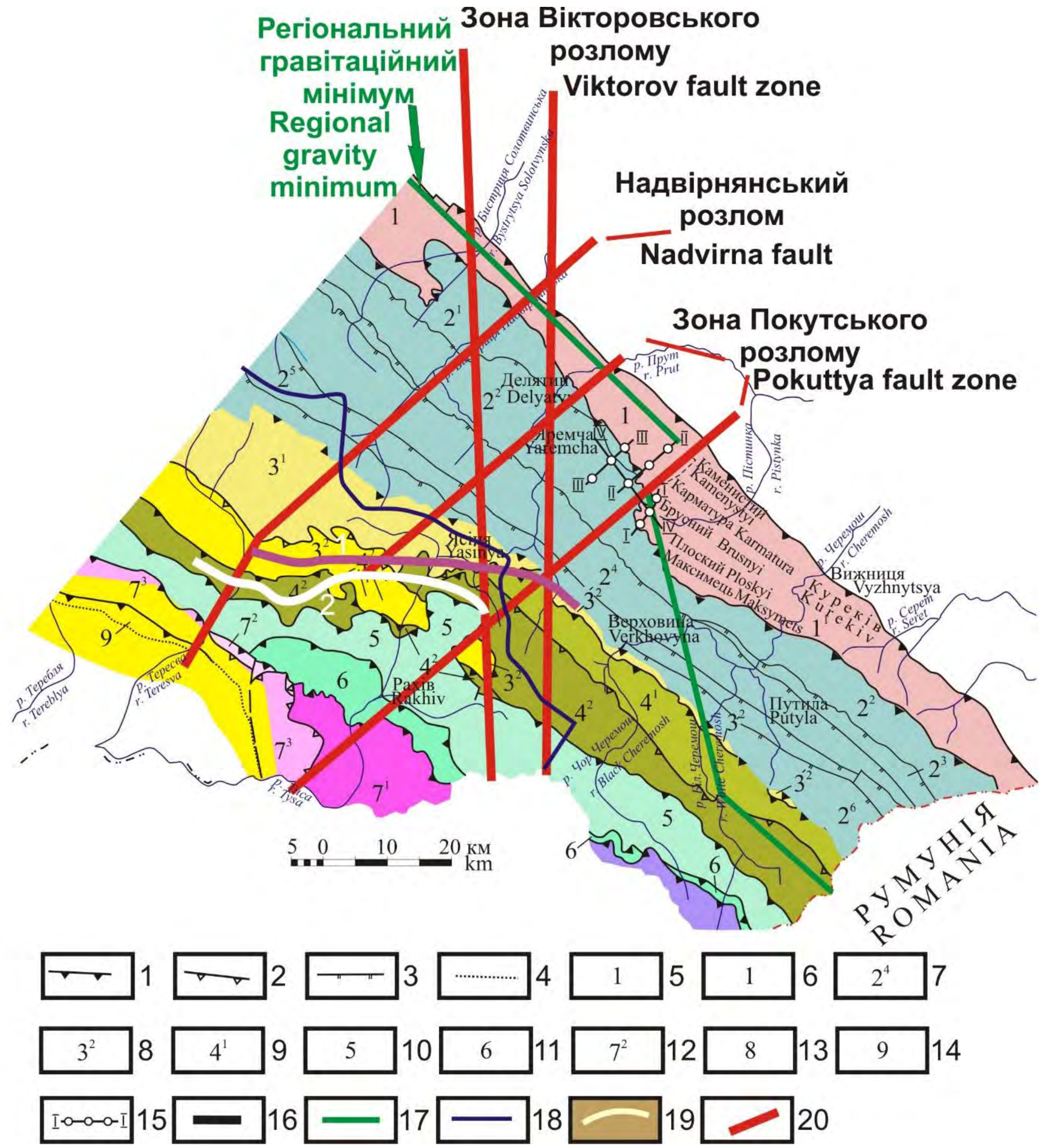

Fig. 1. Tectonic map of Ukrainian Carpathians with elements of fault tectonics:
1 – Frontal thrusts of nappes; 2 – Frontal thrusts of sub-nappes; 3 – Frontal thrusts of thrusts; 4 – Boundaries of occurrence of transgressive Miocene deposits of Transcarpathian Depression; 5 – Boryslav-Pokuttya nappe; 6 – Pokuttya-Bukovyna folds; 7 – Skyba thrust: 2^1 – Berehova, 2^2 – Oriv, 2^3 – Skole, 2^4 – Parashka, 2^5 – Zelemyanka, 2^6 – Rozhanka; 8 – Krosno nappe with sub-nappes: 3^1 – Turka, 3^2 – Bitla– Svydovets; 9 – Dukla-Chornohora nappe with sub-nappes: 4^1- Skupov, 4^2- Krasnoshoa-Hoverlai 10 – Burkut (Porkulets) nappe; 11 – Rakhiv nappe; 12 – Marmarosh nappe with sub-nappes: 7^1- Dilove+Bilopotik+Kaminopotik, 7^2 – Vezhansk, 7^3 – Monastyrets; 13 – Peniny nappe; 14 – Transcarpathian Depression; 15 – Lines of thrusts; 16 – Projections of deep faults at the surface; 17 – Regional gravity minimum; 18 – Line of the main Carpathian watershed; 19 – Sigmoidal curves in the Bitla-Svydovets and Krasnoshora-Hoverla sub-nappes; 20 – Fault disclocations (downthrow-shifts)

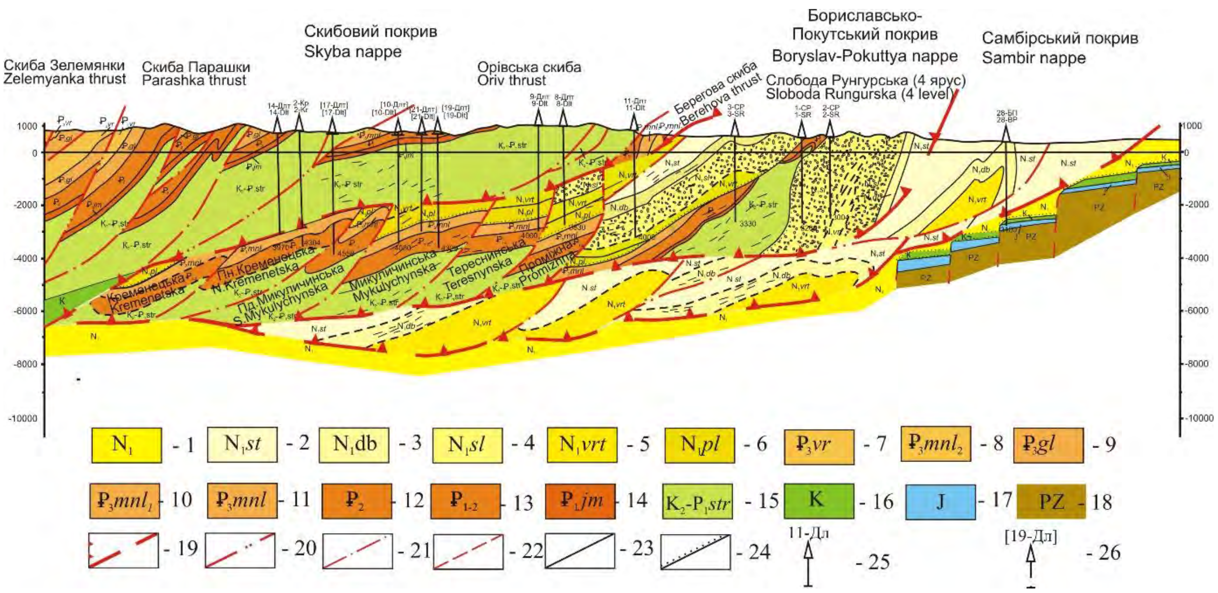

Fig. 2. Geological cross-section along the line of boreholes 14-Dlt – 28-Bp
1 – Lower Neogene; 2 – Stebnyk suite; 3 – Dobrotiv suite ; 4 – Slobidska suite ;
5 – Vorotyshcha suite; 6 – Polyanytsya suite ; 7 – Verkhovyna suite;
8 – Middle Menilite sub-suite ; 9 – Golovetska suite; 10 – Lower Menilite sub-suite;
11 – Menilite suite not subdivided; 12 – Eocene; 13 – Paleocene-Eocene not subdivided ;
14 – Yamna suite ; 15 – Stryi suite ; 16 – Upper Cretaceous; 17 – Jurassic; 18 – Paleozoic;
19 – boundaries of nappes; 20 – boundaries of thrusts; 21 – boundaries of thrust-folds;
22 – transverse faults; 23 – geological boundaries (normal); 24 – geological boundaries
(with stratigraphic hiatuses); 25 – boreholes on the profile line;
26 – boreholes projected to the profile line

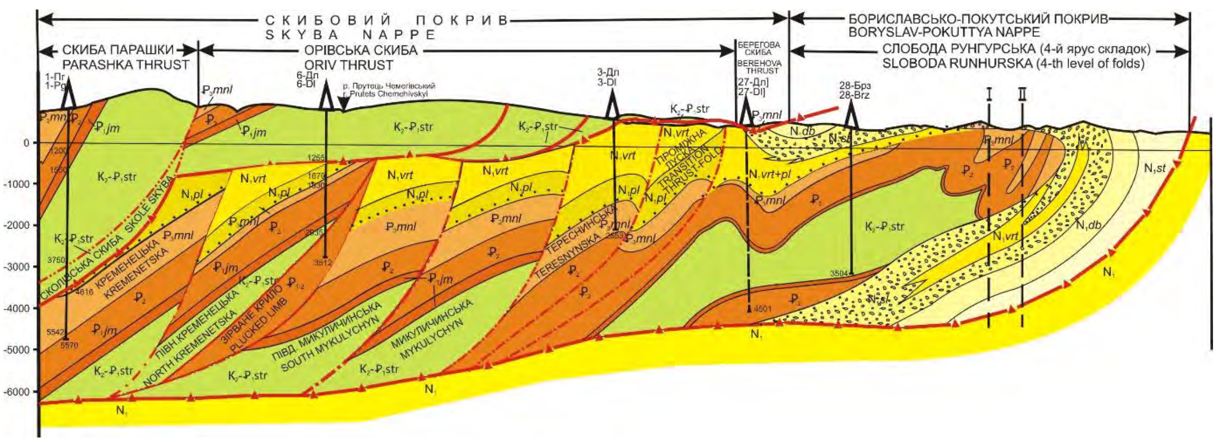

Fig. 3. Geological cross-section along the line
of boreholes 1-Pigy – 28-Bereziv
(legend see Fig. 2)

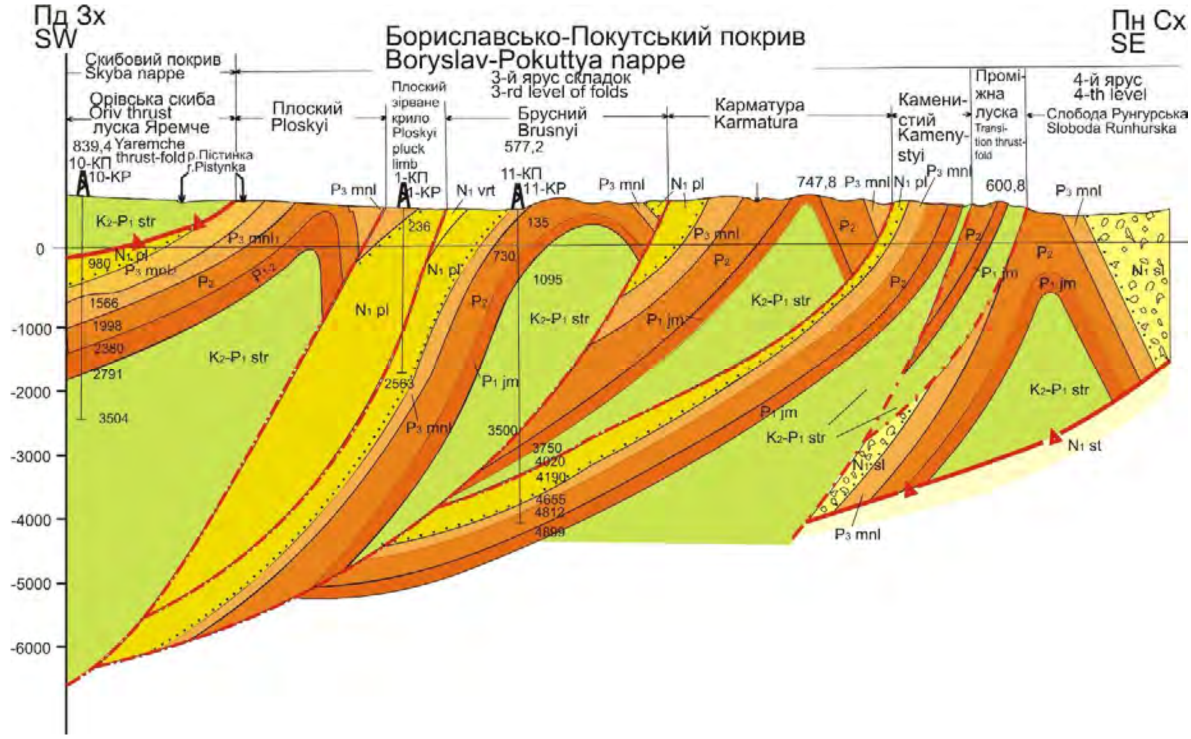

Fig. 4. Geological cross-section along the line of boreholes 10-11-Kosmach-Pokutskyi (lLegend see Fig. 2)

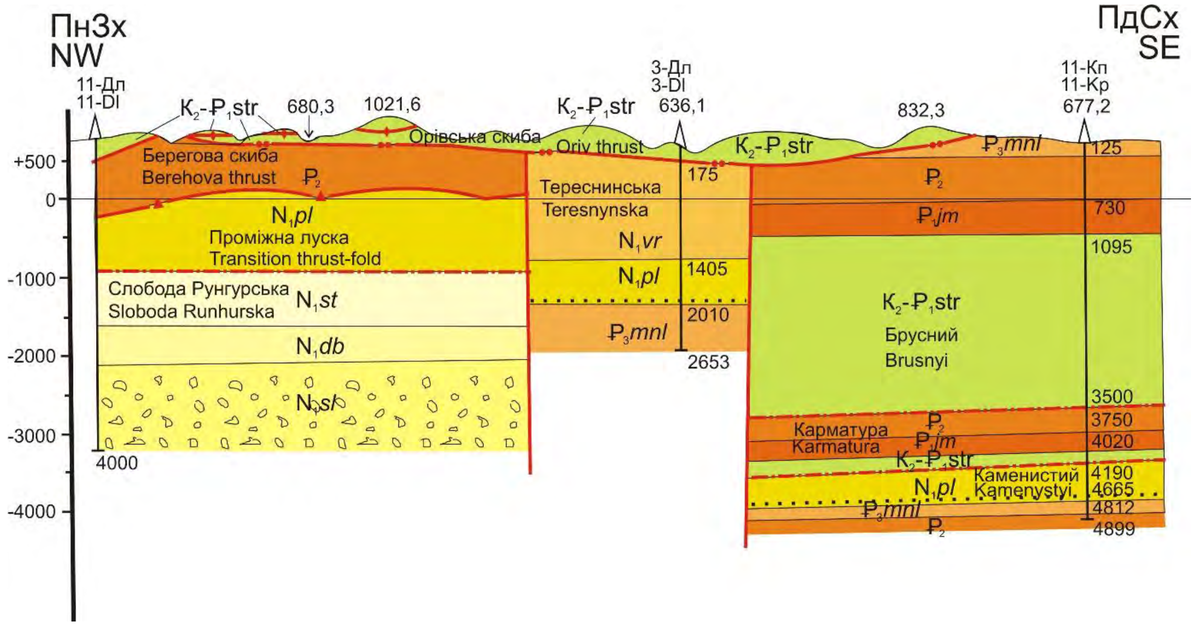

Fig. 5. Geological cross-section along the line of boreholes 11-Delyatyn – 11-Kosmach-Pokutskyi (longitudinal) (legend see Fig. 2)

In that case a horizontal displacement between identical folds is from 8 to 10 km. Amplitude of the vertical displacement between one-age deposits of adjacent folds, proceeding from the situation shown in Fig. 5, is estimated by the value of 1.5–2 km. So this is a left- strike- shift. Its spatial orientation is determined owing to groups of the 11 boreholes Delyatyn-3,6, Pigy-1 and 10, Kosmach Pokutsyi-1, located at minimum distance in different directions of this strike-slip (Fig. 1). According to drilling data and borehole location on the geological map it is understood that the formers have exposed the buried folds (Delyatyn ones), and the latter – the uplifted ones (Pokuttia ones). Dislocation must pass between two groups of these boreholes approximately on azimuth 50. That is to say, the orientation of this is north-eastern, but not sub longitudinal, as M. A. Beer has considered.

The Skyba nappe

The influence of the fault is also noticeable in the example of the Beregova thrust and three frontal thrust-folds in the Oriv nappe that representthe frontal part of the Skyba nappe. Farther south-east of the fault the Beregova thrust “goes out into an air” and then it is not traced. Here the extension of the Oriv thrust is clearly changed from subcarpathian to submeridional at the section of about 10 km, and farther south- east it attains the north-west orientation again (subcarpathian) (Fig. 1, 2). However, here took place not a sigmoidal turn of the northern thrust-folds in the south-eastern direction, but their truncation as a result of thrust uplift of the Pokuttia folds in that block. Tectonic outliers of the Beregova and Oriv thrusts, that lie on the Pokuttia folds, testify to that fact. It looks as if they are located easterly than the front sloping scales of these thrusts, Here before, were the massif of these thrust-folds, which were later eroded,. It is significant that farther south-west within the limits of the more inner thrusts of the Skyba nappe (Parashka, Zelemyanka and Rozhanka) the influence of the Pokuttia fault is imperceptible. Mountain ranges farther east of Vorokhta (their stretching is subcarpathian) are not shifted. Traces of vertical abnormal displacements also are absent. Let us assume that the influence of the Pokuttia fault has manifested itself here only as increased fracturing of rocks. This is evidenced by the huge zone of sulphide mineralization in the very faulted sandstones of Paleogene of the Parashka thrust-folds exposed in the mapping borehole Chornohirya-1 in the near-channel part of the stream Piga and identified by the method of VES [Vashchenko et al., 1985]. The situation changes if we consider the behavior of more southern tectonic units of the Carpathians: the Krosno and Dukla-Chornohora nappes. Due to special features of the Carpathian’s structure at this site it should be convenient to consider first the behavior of the latter.

The Dukla-Chornohora nappe

In the south-eastern segment of the Carpathians farther south-west of the Skyba nappe in the reverse cross of Vorohta-Yasynia in the Yasinia ravine, the structures of the Turka subnappe of the Krosno nappe occur that are overlapped by the overthrust of Hoverla subnappe of the Dukla-Chornohora nappe. Farther south of the latter along the river Chorna Tysa deposits of the Bitlya –Svydovets subnappe of the Krosno nappe or of called Svydovets (Blyznytska) zone are localized. The deposits of the Upper Cretaceous-Paleogene of this unit are localized on both sides of the Flavantuch-Svidovets Range, with the Blyznytsia mountain (1881 m) inclusive (Fig. 6).
unit of the Chornohora zone and in most cases such a position of the covering units in the Carpathians pointed out the character of the correlation between them, so then it exercised hypnotic influence on geologists. Owing to that it is considered that the Svydovets zone is thrust over the Chornohora one. Such a wrong estimate for succession of the localization of these tectonic units became the reason owing to which it was impossible to determine correct rations between the covering units of the north-western and south–eastern sectors of the Ukrainian Carpathians. Meanwhile, O. S. Vyalov emphasized that greatest amount of problems were connected with the central part of the Carpathians where the western and eastern zones are joined. Attempts to solve them led to rise of newer versions of their correlation. On his opinion, just here occurs the most important from the point of view of the solution of the problem of tectonic regionalization of the Carpathians and at the same time the most composite of their locality (Vyalov et al., 1969). Indeed, already even for the time of publication of the above mentioned paper many schemes of the comparison between tectonic units of the western and the eastern sectors of the Ukrainian Carpathians existed, but in due course their amount increased.

V. V. Kuzovenko was the only Carpathian geologist who voiced a supposition that not the Svydovets zone is thrust over the Hoverla one, but just vise a versa (not a retro overthrust, but the pinging thrust) - verbal report in 1984, that was confirmed later and allowed us to determine the correct correlation between the majority of the tectonic units of the Ukrainian Carpathians [Glushko et al., 1984] to a considerable extent. From the south-west the Krasnoshora subnappe is thrust over the structures of the Bitlya-Svydovets subnappe, with the same set of rocks as the Hoverla one has. This overthrust is rather inclined, about that testifies the availability of a number tectonic outliers of the Krasnoshora subnappe in the upstream of the river Kosivska in the left slope of its valley which overlap the deposits of para-autochthon. The most northern of them stretches almost to the top of the Blyznytsia Mountain. First these outliers, composed of rocks of the Shypot suite of the Lower Cretaceous, were mapped by P. N. Tsarnenko [Tsarnenko, 1989]. In the opposite direction (to the north) from the Flavantuch-Svydovets Range the author of the given paper has singled out just two tectonic outliers. One is in the upper current of the Svydovets stream (left branch), another – between the tops of the Stig Mountain (1704,3) and Kotel Mountain (1770,8), four kilometres from the first outlier to the north-west (field data of V. O. Vashchenko and own observations are used) with the Shypot deposits in their composition that overlap Paleogene deposits of the Bitlya-Svydovets subnappe and already are comparable to the structures of the Chorna Tysa protrusion of the Hoverla subnappe [Shlapinskyi, 2014]. Thus, taking the presence of coeval rocks lithologically of the same type in the Krasnoshora and Hoverla subnappes, the identical style of tectonics (zones of distribution of small thrust-folds) and the availability of connecting compact link between them in a form of coeval tectonic outliers in the consideration, one can state with confidence, that given subnappes were connected by the cross-piece transverse to the Carpathians extension, forming sigmoid.

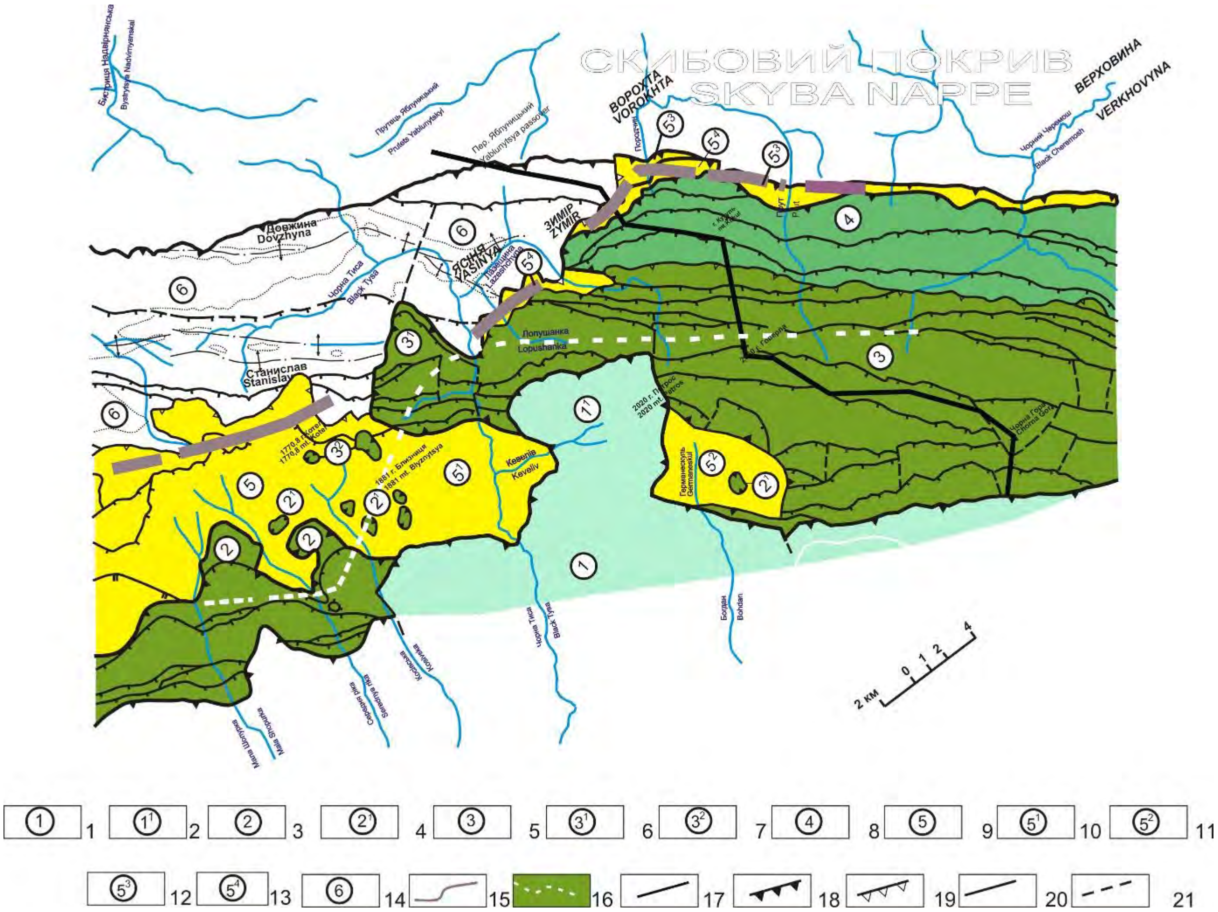

Fig. 6. Fragment of tectonic map of the Outer Carpathians in the interfluve of Bystrytsya Nadvirnyanska – Cornyi Cheremosh

1 – Burkut nappe; 2 – Petros thrust-fold; 3 – Krasnoshora sub-nappe; 4 – Tectonic remnants Krasnoshora sub-nappe; 5 – Hoverla sub-nappe; 6 – Upper-Tysa bulge; 7 – Tectonic remnants Hoverla sub-nappe; 8 – Skupiv sub-nappe; 9 – Bitla-Svydovets sub-nappe; 10 – Keveliv tectonic half-window; 11 – Lolyn tectonic window; 12 – thrust-fold Porodchyn-Ropochel; 13 – thrust-fold Yasinya-Porodchyn with Lazeshchyna half-window; 14 – Turka sub-nappe; 15 – Sigmoidal bend of Bitla-Svydovets sub-nappe; 16 – Sigmoidal bend of Krasnoshora-Hoverla sub-nappe; 17 – line of the main Carpathian watershed; 18 – Thrusts of nappes; 19 – Thrusts sub-nappes; 20 – Thrusts of thrust-folds; 21 – Faults

This conclusion is reconfirmed by the following. In the upper part of the Yalivets suite, transitional to the Chornohora suite in both subnappes in this region there are olistostrome horizons present [Shlapinskyi, 2009]. Both redeposited more ancient rocks of the flysch formation, in particular the Shypot suite of the Lower Cretaceous, and exotic ones were fixed in their composition. The same olistostrome was described in many outcrops of the Krasnoshora and Hoverla units beyond the limits of the given area [Gabinet, 1976, Kuzovenko, 2007].

The Bitlya-Svydovets subnappe of Krosno nappe

Pokuttia fault on the behavior of mentioned tectonic units the possibility arose to explain the origin of the fourth structural link of the Carpathians affected by this fault – so called Pre-Chornohora tectonic element. The latter was singled out by the author [Shlapinskyi, 2012 b]. At that time it was considered that it was represented by a relatively narrow thrust-fold with Ologocene rocks in it and stretches within the bounds of the Hutsulian segment from the Porodchyn stream (left tributary of the River Prut) in the region of the settlement Vorokhta to the Romania frontier (Fig. 1.6) for 70 km (slice Porodchyn-Ropochel). From the north-east this thrust-fold along the thrust contacts with the Oligocene of hinterload thrust-folds of the Rozhanka thrust, and from the south-west in the vicinity of Vorokhta the rocks of Paleogene are thrust over it in the composition of thrust-fold, which was incorrectly considered by the author as belonging to the Skupiv subnappe of the Dukla-Chornohora nappe. Here are arguments of the author for substantiation of this version. In the stream Porodchyn Nymakovskyi (is the left tributary of the River Prut in the vicinity of Vorokhta) to the south of the Porodchyn Ropochel thrust-fold thick deposits of the Middle- Upper Eocene were mapped with considerable content of striped, in places strongly carbonate argillites, on which in its turn the rocks of Gnyletska suite of the Paleocene-Eocene of the Skupiv subnappe are thrust (Fig. 6). In the same thrust-fold higher links of Eocene are also outcropped, as well as the Oligocene layers with undersilicious series and lower silicious level that normally increase the section of the Eocene. On the basis of such thoughts this slice that was localized farther south-west of the Porodchyn Ropochel slice, was attached by the author to the Skupiv unit. Analogues rocks of Oligocene and Eocene were distributed also in the plot of sub-latitudinal closing of the Chornohora nappe (between it and deposits of Oligocene of the Turka subnappe) through its outlying area from the streamlet Zymir to the streamlet Lopushanka (both are left tributaries of the River Lazeshchyna) ten kilometres away (Fig. 6). Owing to that in places they are somehow in the hinterland in regard to slices of the Skupiv subnappe, until the author considered that they are localized in their composition as more southern slices that influenced the estimate and structural belonging of deposits of the same type in the vicinity of Vorokhta just to this subnappe. But the critical review of field data gives another particularly conspicuous in the point of intersection of the River Lazeshchyna, Here the Eocene layers of Porodchyn type are found 3.5 km away to the south-east along the river valley and its tributaries on either side are, surrounded by the deposits of the Upper Cretaceous–Paleocene of the Skupiv and Hoverla subnappes which hypsometrically are located higher, and more upstream as the outcrops of the Eocene rocks became narrower. Thus, the Eocene of Porodchyn type occurs here in the tectonic semi-window (Lazeshchynian). On the previous version of the geological map of this region in the given area older Paleocene-Eocene deposits of one of thrust-folds of the Skupiv subnappe were described by mistake. But they strikingly differ from the Eocene of Porodchyn type. The presence of abnormally great number of microfauna and nannoplankton of different type (definition of A. S. Grygorovych, N. Ya. Boyaryntseva, N. V. Dabagian and A. D. Gruzman), the majority of which are absent in the Chornohora Paleogene, is its special feature. Moreover, the Eocene of given type is recognized correctly by the presence, exclusively in the field of its development, of a number of great globe shaped sand concrecions (d- up to 1.5 m) that were marked by the author both in the basins of the River Chorna Tysa and the River Prut. Thus, the Oligocene deposits of Porodchyn type distributed along the Chornohora thrust do not belong to the Skupiv subnappe, but are outcropped from under it, repeating the knee-like configuration of its external contour. These are an axis of sigmoid and its right limb (the line Yasinia-Zymir-Vorokhta-Romanien frontier). The left (western) limb, taking the behavior of the Krasnoshora-Hoverla sigmoid into consideration, should be stretched from the line Yasinia-Vorokhta under the Chorna Tysa protrusion of the Hoverla subnappe to the north- west and should be connected with the main massif of the Bitlya-Svydovets unit. The configuration of this sigmoid somewhat differs from the Krasnoshora-Hoverla one, because the north- western continuation of the Bitlya-Svydovets subnappe, that probably occurred in the Yasinia hollow, composed of less strong rocks of Oligocene and Eocene, was eroded completely unlike more hard outliers of Shypot of the first pair of tectonic units. If they were saved, the axis of sigmoid would have the north-eastern or similar to it orientation, but not sub-longitudinal. Excepting the considerations of structural order, the reason to include the Pre-Chornohora unit to the Bitlia-Svydovets subnappe is known to be a mutual lithological facies character of the same type. For example, the Oligocene layers of the Porodchyn and Bitlia lithotypes, are unlike the adjoining coeval deposits of the Skyba nappe and the Turka subnappe of the Krosno nappe. If to compare the Oligocene deposits of the Pre-Chornohora slip with the cross-sections of the Oligocene of other plots of the Bitlia-Svydovets subnappe, then all of them belong to the same Bitlya subtype of the Krosno lithotype. It is characterized by very insignificant content of black menilite-like argillites, only from the first to one hundred metres higher through the section from the lower siliceous level in the bottom of the Hoverla suite, thin lower siliceous and the considerable content of grey coloured carbonate argillites in the bottom of the Oligocene higher menilite–like pack that lithologically reminds the Middle-Upper Verkhovyna subsuites (Middle- Upper Krosno) of the northern thrusts and the Turka subnappe. Moreover, at two stratigraphic levels of the Oligocene olistostrome has been fixed in comparison to the upper while the lower olistostrome horizon has restricted distribution both through the area and vertically. It is localized in the very bottom of Oligocene in the underchert pack and just above cherts of the lower chert horizon and is marked by the presence of redeposited red, quite often highly-limy argillites of Eocene age. Such redeposited rocks as well as olistolites, particularly are present in the left tributary of the stream Porodchyn Nimakovskyi (upper current) in the outcrop № 5606 Chornohirria area in the exploring shaft in the same area in the watershed between the stream Porodchyn Nimakovskyi and Porodchyn Middle (here green and red highly-limy argillites lie on the inclined layers of brown cherts and argillites of underchert pack) and in the stream Plytovatyi (left tributary of the River Lazeshchyna –outcrop №5418 of the same area). In such position is olistostrome described by V. V. Kuzovenko in the Holovets suite of Oligocene of the Bitlia subnappe in the basin of Rika and Tereblia [Kuzovenko et al., 1982]. Above the marker horizons of the stripped limestones and cherts already in the Upper Verkhovyna subsuite one more olistostrome horizon exists. It is described in many outcrops from the Polish frontier to the Romanian frontier. Rocks of flysch formation of the Lower Cretaceous – Lower Oligocene range appear in olistolites. In the composition of olistolites one can comparatively rarely fix the rocks that are absent in the native occurrence in the flysch. There are pelecypoda limestones of Lower Oligocene age (near of Polish frontier) and gypsum found in two cross-sections (the River Chornyi Cheremosh in rollow Krasnyk and the basin of Putyla in the left tributary of the stream Ripen) close to red argillites of the olistostrome horizon.

In the section of Krasnyk [Shakin & Sandler, 1963; Gruzman & Smirnov, 1982, 1985) several isolated sites of dislocated clays with interlayers of gypsum (up to 3–5 cm) and thin beds of sandstones were described. In another section near redeposited argillites the author has found the massive block (1-4 m) of gypsum within grey clayey Lower Verkhovyna deposits [Shlapinskyi, 2012 b]. United spatial nearness of gypsum and red argillites of Eocene age in both cases gives the grounds to suspect that they together are included into the olistostrome complex. Eocene of such a type could be formed in the shallow water precordillera occurrence of the paleobasin, probably in lagoons. Gypsum in the structure of Eocene is not an exceptional phenomena. For example, in the Eocene in the Pannonian deep (of marine type) some thick levels of gypsum were fixed (Dolenko, 1962).

A. D. Gruzman and S. E. Smirnov also described olistostrome horizon in Krasnik, Ripen, and Ropochel not only in the Lower Verkhovyna deposits, but,by mistake in the structure of probable Upper Krosno (Upper Verkhovyna) subsuites in the back thrusts of the Skyba nappe. Following Romanian geologist M. Stefanescu, they call it olistostrome Slon [Gruzman & Smirnov, 1982, 1985]. Meanwhile, there are enough arguments that testify to localization of this olistostrome not in the Upper Verkhovyna deposits, but in the structure of the Lower Verkhovyna deposits: these are data on geological survey and drilling [Shlapinskyi, 2012 b]. In the Holovets suite sandstones are prevailing, and in the Lower Verkhvyna subsuite olistostrome is localized from 30 to 70 m above the marker of attributing given deposits to the Upper Krosno. A narrow strip of the Pre-Chornohora Oligocene is traced in the Romanian Eastern Carpathians at a distance of more than 400 km, with hiatus (Fig. 7). Romanian geologists considered by mistake that olistostrome Slon is localized in the Miocene deposits of the Tarkeu unit [Stefanescu, 1980]. In reality, as it follows from the situation in Ukraine, olistostrome is localized in the Oligocene layers of the Lower Verkhovyna strata lithologically similar to the Middle and Upper Verkhovyna strata of back thrusts of the Skyba nappe. Detailed substantiation of mistaken views of the Romanian geologists as to the interpretation of the age and structural position of olistostrome Slon is in the above mentioned work of the author [Shlapinskyi, 2012 b]. Their main mistake is dismemberment of deposits of Oligocene exceptionally by lithological criteria, without considering the marker horizon of striped limestones, almost a long way off the slice with this olistostrome from the south-west and west is restricted by the thrust of Audia unit (the latter is the analogue of the Chornohora nappe).

Farther south of the valley of the River Buzeu, the Audia zone is tectonically pinched out and farther south it is not continued. Instead of this, Oligocene deposits of Porodchyn type have a continuation in this direction and the given thrust filled with them (now it is possible to name its structural belonging to the Bitlia-Svydovets subnappe), borders already upon the tectonic unit of Makla coming from the south. Before its thrust the continuation of the Porodchyn-Ropochel thrust within the limits of the latter, the outcrop of olistostorome was fixed in the locality of Slon, in the absence of the Audia zone. This confirms the conclusion about that the Pre-Chornohora Paleogene of the Ukrainian and Romanian Carpathians is not a constitution part of the Dukla-Chornohora nappe as the author has considered by mistake.

In regards to the question what tectonic unit at the Ukrainian territory Makla corresponds to, then one should return to the situation on the River Chorna Tysa in the vicinity of the town Yasinia. Here the south-western part of the Bitlia-Svydovets subnappe in the form of the Kevelivske half-window and the Lolynske window (Fig. 6) is squeezed between the Dukla-Chornohora and Burkut (Porkulets) nappes, and farther to the south-east it is completely overlapped by them in the territory of Ukraine. In Romania, in the continuation of these tectonic units between Audia and Telyazhen zones (analogues to Hoverla subnappe and Burkut nappe correspondingly) in the region of the Commune of Stulpikani (50 km away the Ukrainian frontier) from under their thrust a new zone of Toroklezh appears (Bucur, 1971) which consists of flysch of Albian- Coniacian age that stretches to the south- east at a distance of 150 km in the form of the narrow strip (Fig. 7). In spite of that, the zone of Toroklezh is in the area of the Audia zone, the contract between them in the interpretation of I. Bucur has a character of fault, but not the thrust (due to the presence of younger rocks in the first inner zone). Farther south of the Toroklezh zone is the zone of Macla in the structure of which red carbonate argillites of the upper Albian-Turonian age, the analogues of the Yalovets suite, are distributed. It is possible that these two zones are the parts of one covering unit. The Makla zone also is separated from Audia by fault (Macla Zagon) from the configuration of the line of this fault between Covasna and Siriu follows that this is thrust of the Audia zone on Makla- Zagon moreover the plane of fault is inclined to the north-east – Author).

This corresponds to the situation in the Ukrainian Carpathians, farther north-east of Yasinia where in the Kevelivske half-window, and south easterly in the Lolynske window the Burkut, Bitlia-Svydovets, and Krasnoshora-Hoverla tectonic units contact in succession. In connection with this it is possible that the Makla zone is corresponding to the south-west of the Bitlia-Svydovets subnappe. To this testifies the fact that in the Makla unit, as follows from the description, are present deposits of the Yalovets suite type. The same rocks are outcropped in the Lolyn tectonic window too. It means that in the territory of Ukraine and in Romania at a considerable distance farther south-west of the Dukla-Chornohora nappe (Audia zone) a strip of thrusts of the Bitlia-Svydovets subnappe is located so that in places they are almost completely overlapped by it and the Burkut nappe. From the north-west and north- east the Dukla- Chornohora nappe to a great extent overlaps the external parts of the given subnappe (thrusts Lazeshchyna-Porodchyn and Porodchyn-Ropochel). Farther south of the valley of the River Buzeu, where the

Audia Zone comes to the air, both parts of the Bitlia-Svydovets nappe are connected in the form of thrusts and continue probably up to the Southern Carpathians.

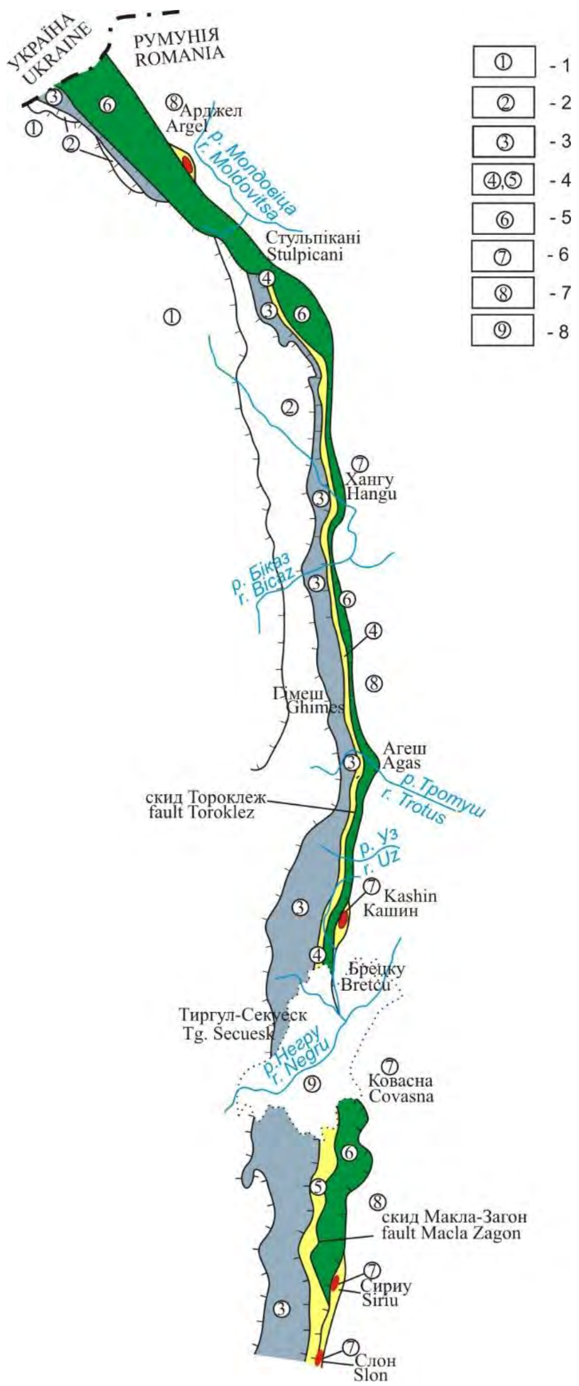

Fig. 7. Tectonic map of Eastern Carpathians (Romania)

Using the data of: J. Bukur (1972), M. Stefanesku (1980), M. Sandulescu, M. Micu, E. Bratu, P. Konstantin (1987): 1 – Marmarosh; 2 – Cahleu (Rakhiv); 3 – Telazen (Burkut); 4 – Toroklez; 5 – Macla-Zagon; 6 – Audia (Chornogora); 7 – Thrust with olistostrome "Slon" – Bitla-Svydovets subnappe (eastern part); 8 – Tarceu (internal part of Skyba nappe) Argel, Slon - indications of cross-sections with "Slon"-like olistostrome; 9 – Pliocene-Quarternary

If to consider that the Bitlya-Svydovets subnappe is the integral part of the Krosno nappe then the latter is the most extended tectonic unit of the western and eastern Carpathians compared to other tectonic units, because it stretches a distance of about 1000 km (from Czech to Romania). in addition, tracing of the Bitlya-Svydovets subnappe to terrain in Romania gives a chance to single out Skyba and Krosno nappes in the structural facial zone of Tarkeu.

Back nappes of the Outer Carpathians

Farther south-west of thrusts of the Krasnoshora unit occur the Burkut (Porkulets), Rakhiv and Marmarosh nappes (the latter is with subnappes). Here the influence of the Pokuttia fault is less visible. Probably, its participation was manifested in the availability of the tongue-like Petros semi outlier (thrust) of the Burkut nappe and the outcrop of the Dilovets, Bilopotok and Kamyanopotok subnappes from under the Monastyrets and Vezhansk thrusts. It is quite possible that this imperceptibility is connected with the erosion of uplifted parts of the abovementioned tectonic units during mountain-forming that changed the post-overthrusting structure of this area of the Carpathians. With continuation of the Pokuttia fault to the south-west the surface of smoothing Urdu (1350 m) is connected which obtained its name from the south branch of the Svydovets Range. It stretches at a distance of 30 km to the south from the Blyznytsi Mountain, cross measuring of the structural units [Hofstein, 1995].

Other manifestations of the Pokuttia fault

<u>Precarpathian regional gravitational minimum</u>

The Pokuttia fault influences the behavior of the Precarpatian regional gravitational minimum, the axis of which in the plot of Bereziv-Kosmach is departed in two wings: Pereginsk- Kosmach and the southern Vorokhta-Hrynyava [Cheban et al., 2002]. The amplitude of displacement between them is about 10 km (Fig. 1). Moreover here the right shift takes place, but not the left shift. Due to that minimum is connected with the biggest dipped part of the basement in the zone of joining of the platform with the Folded Carpathians, then the shift occurs only in the basement. A question arises why in this case the shift is right-handed, and in the flysch cover – left handed? This contradiction may be explained in such a way. The western part of the platform (the part of the Boykivskyi block) behind the shift was much more uplifted relative to the eastern one (Hutsulian segment). Therefore the flysch cover was overlapped on the eastern block with lesser resistance, meeting the greater obstacle in the western part and in that case, the shift in the cover is left-handed. This seems to deny that quite on the contrary, according to data of geophysics and drilling, the basement is more uplifted in the Hutsulian segment now than in the Boikivskyi one. However, it should be taken into consideration that thrusting occurred in the Badenian-Lower

Sarmatian, while after data of I. D. Hofstain (1995) the Hutsulian segment was uplifted actively later – in Pliocene-Pleistocene.

Uzhok fault

The Pokuttia fault in the Vorokhta –Yasinia region is intersected with the Uzhok fault. On the opinion of some experts, the latter delimits the south-western edge of the platform formations and pre-flysch basement of the Carpathians under the flysch cover. The author has grounded the version according to which under the main Carpathian watershed the pre-flysch basement occurs and farther north-east occurs the margin of the platform [Shlapinskyi, 2012 a]. If it is like this, then the Svydovets and Krasnosnoshora units occur not on the platform basement, but on the pre-flysch one, and so far as the influence of the Pokuttia fault has reflected in the structure, as it was demonstrated above, then it cuts not only the margin of the platform, but the flysch basement too. In fact, when we consider the behavior of the watershed in the area of the Pip Ivan - Hoverla Mountain, then here it stretches in the north-western (sub Carpathian) direction (Fig. 1,6). But from the Hoverla Mtn., that is to say from the zone of influence of the Pokuttia fault, the watershed sharply turns through a series of stepped parts on the whole to the north to the not high Yablunytskyi pass, thus, the Pokuttia fault changes the stretching to the pre-flysch basement and so it activity manifested itself later compared to the Uzhok fault. Here, as the case with the regional gravitational minimum, the influence of the right- shift in the basement is noticeable.

The Radechiv-Viktoriv fault

Except the abovementioned two faults, the intersection of which takes place in the Vorokhta-Yasinia region, the presence of a fault of deep deposition is assumed here – submeridional Radekhiv-Victoriv one that divides the East European Pre – Cambrian platform from the young West European [Malskaya, 1983]. In the opinion of R. V. Malskaya, this fault is traced into the region of Bytkiv, about that testify changes in stretching of folds of the Boryslav-Pokuttia nappe: Khrepilivska, Bukhtovetska, Bytkiv deep and Pniv folds (data of drilling and seismic survey) from subcarpathian to submeridional (Fig. 8), and the fault itself restricts the ancient reverse uplift of submeridional direction – Slobidske. Lines of listed structures probably are the reflection of the arch part of this uplift (consedigen). R. V. Malskaya shares the opinion of other investigators who consider that the rocks attain optimum reservoir properties on the slopes of uplifts. Therefore she considers that fields of hydrocarbons of the Bytkiv region are confined to the western slope of the uplift unlike the structures of the Delyatyn sectors that are tending to its arch part. On her opinion the western slope of the uplift stretches from Bytkiv to the south up to the Yasinia town, and that this area should be regarded as the priority object of prospecting for oil and gas. The abovementioned document contains valuable information on the change in stretching of the listed structures. It is very likely that this is really connected with the influence of some sort of dislocation upon the flysch cover in the basement, probably of the Radekhiv-Viktoriv lineament. As to the ancient uplift the western slope of which is perspective, while the arch – is not, then one should note that rocks of flysch have nothing to do with it (if it exists), because they were formed far in the south-west in the flysch basin. This is confirmed also by the discovery of the Mikulychyn oil field in 1991 in “not perspective” Delyatyn sector. And finally, about hypothetical tracing of the Radekhiv-Viktoriv fault in the vicinity of Yasinia and distant regions. This question needs verification. Special attention is paid to the behavior of the valley of the river Prut between Delyatyn and Vorokhta of 40 km long (Fig. 1). In conventional continuation of this line to the south, also the line of the main Carpathian watershed, stretches out just another 20 km up to the Romanian frontier. All of this interval has an orientation similar to submeridional that is obviously not accidental. It is logical to connect all this section with the zone of given fault.

Degree of deformation of the flysch cover within the zone of the Pokuttia fault and time limits of its influence on flysch

The Pokuttia deep fault has influenced the flysch in different ways. As one can see from the abovementioned examples, these are the extended dislocations with a break of continuity in flysch (the Boryslav –Pokuttia nappe) and sigmoidal bends (the Dukla-Chornohora and Krosno nappes) or also noticeable absence of the first and the second ones (southern thrusts). What did such selectivity depend on? First, it means that the Pokuttia fault directly influenced the autochthone, and it the allochthone has manifested itself indifferently. Probably, due to its activation in the zone of fault the basement rocks were broken into blocks of different shapes and then a relief. The flysch cover which thrust on such heterogeneous substrate, underwent different resistance that determined differentiation of deformations in its limits. Kilometric shifts in the flysch were caused mainly be considerable horizontal shifts: platform underthrusting and overthrusting of flysch. Because the latter was intensively thrust in the outer Carpathians during the interval of Carpathian – Lower Sarmatian, then this determines time limits of the influence of the given fault upon the flysch cover. After completion of this phase occurred vertical movements although manifested themselves more intensive in the zone of the Pokuttia fault had an effect on the rest of the territory of the Hutsulian segment, as well. This is what I. D. Hofstein noted as to the region of the Petros Mountain: Here the value of local horst uplift is equal to 0.5 km. As a tentative one this figure may be used throughout the whole range (Chornohora). It determines the uplift of the surface already after the formation of the folded-thrust structure. Intensive erosion of the mountains in the

Middle Miocene covered the entire south-eastern part of the Carpathians; independent uplift of Chornohora probably began later, in Late Miocene. The available data allows us to determine the uplift of Chornohora in the Pliocene and Plistoctocene. Pondering over the subject of horst nature of the Chornohora Range we bear in mind the supporting protrusion of the ancient basement of the Carpathians. As to noticeable sedimentary series, so judging by the geological map, during uplift of the basement block it underwent faulting, but not folding deformations [Hofstein, 1995]. In connection with the statement of M. O. Beer, S. L. Byzova and M. G. Lomize [Beer et al., 1984] that during the Pliocene-Peistocene uplift of the Carpathians the vertical movements could cause secondary deformations of thrust and increase the inclination of the thrust planes, is of interest. Commenting upon these thoughts it should be noted that I. D. Hofstein did not account for the deformations having a break of continuity that happened here, invisible while using data of surface geology only, as to the statements of the geologists from Moscow than the author of the given paper really has observed obviously deformed by vertical movements the plane of thrust of the Burkut nappe on the Krasnoshora unit (irregular triangle of dipping plane of its thrust) in the zone of the Pokuttia fault along the river Mala Shopurka.

The Pokuttia fault and oil- and gas-bearing

What are some more signs characterizing the given fault? It is known that deep fault is not a single shift, but a linear zone in which are concentrated breaks, intensive folding and fracturing, traces of crushing, and manifestations of vein mineralization. In fact the increased concentration of transverse and diagonal strike-shifts are observed in the zone of the influence of the Pokuttia fault in the basin of the river Tysa in the belt of about 40 km wide. In the central part of the fault influence in the Yasinia depression, the Oligocene deposits of the Turka subnappe are crumpled into the system of intensive folds (isoclinal, fan-shaped, trunk-shaped). It is obvious that this is connected with that in this part of the Carpathian there occurs the crossing of several lineaments, that is to say, their so-called knots are present. Such places as channels are considered to be especially favorable for influxes of hydrocarbons from the depth. This is confirmed by the availability of oil fields in the fault zone: acting (Mykulychyn) and worked out (Kosmach and Yasinia) as well as of a great amount of natural seeps of hydrocarbons (Fig. 8) in the regions of Akreshory, Vorokhta, Yablunytsia, and Yasinia. To estimate the potential for oil- and gas-bearing in the territory of the folded Carpathians except data on the direct indications (indicators of oil and gas) one can use intermediate indicators, connected with it. Sulphide mineralization of non-hydrothermal origin belongs to such markers. On the northern slope of the Ukrainian Carpathians a positive correlational connection between oil and gas presence and the concentration of sulphides of zinc, lead, copper, and not technogenous native lead in the panned samples from the alluvial deposits was determined. It was proven that rocks of the Cretaceous-Paleogene flysch are the sources of sphalerite, galenite in alluvial deposits of the Carpathian rivers and streams [Shlapinskyi, 1989]. The formation of these sulphides occurred by the way of interaction of underground waters saturated by ions of metals with hydrogen sulphide that comes into section from hydrocarbons' accumulations. To considerable accumulations of the latter (probably this mainly concerns oil) correspond to the greater content of sulphides in the panned samples. The given conclusion is confirmed by the spatial nearness of oil fields with intensive sulphide dispersion. The greatest concentrations of the latters were fixed in the regions of Boryslav, Bytkiv, Lopushna and other (up to 18% from the weight of heavy fraction of the panned sample). Such a regularity may be used in the value of important prospecting criterion for commercial oil-gas-bearing. Areas, where are present intensive by sulphide content ralos of their dispersion, with not revealed hydrocarbon accumulations in the subsurface of the earth, should be considered as potentially perspective areas. In particular, the stripe of Yasinia-Vorokhta, where in most points of sampling were fixed abnormally high contents of sphalerite in the panned samples compared to indications of Boryslav and Lopushna, belong to such areas (Fig. 8). Increased content of naphthein acids in water should be considered to be reliable indication of commercial oil- and gas-bearing potential. In the vicinity of the Yasinia town naphthein acids were determined in four sources with concentration of 0.3; 0.8; 8.4 and 35.0 mg/l. In the two latter samples their concentration on the whole is the greatest in the Ukrainian Carpathians, beyond the limits of hydrocarbon deposits. These data testify to the presence of considerable accumulations of hydrocarbons at a depth in the given region. According to the results of geological survey and seismic survey it was possible, to distinguish here perspective structures Yasinia, Lazeshchyna, and Stebna [Krupskyi et al., 2014] as well as Voronenkivska near the Yablunytskyi pass (all are in the Skyba nappe [Shlapinskyi, 2015]. The area of the Carpathians, abnormal by the amount of natural surface shows of hydrocarbons on the unit of area, is confined to the Vorokhta- Hryniava echelon of the regional gravitational minimum in the Verkhovyna-Konyatyn segment in the understream area of the Chornyi and Bilyi Ceremosh (Skyba nappe). If to take into consideration the fact that in the flysch cover the traps are absent hereby, so the deposits of the Lopushna subzone of the Outer zone of the Carpathian foredeep under the thrust of the Skyba, Krosno nappes and the Skupiv subnappe that may contain more considerable accumulations of hydrocarbons are known to be sources of these indicators (Shlapinskyi, 2017). For revealing of such structure and specification of identified earlier ones it is necessary to conduct detailed seismic survey. And finally such paraautochthone structures under the Skupiv subcover as Hryniava and Semakivska, where commercial influxes of gas and oil were already obtained shouldn't be disregarded as well as their possible structural analogues. These conclusions also give concern for the platform sites of the basement like Lopushna subzone in the Outer zone of the Carpathian foredeep.

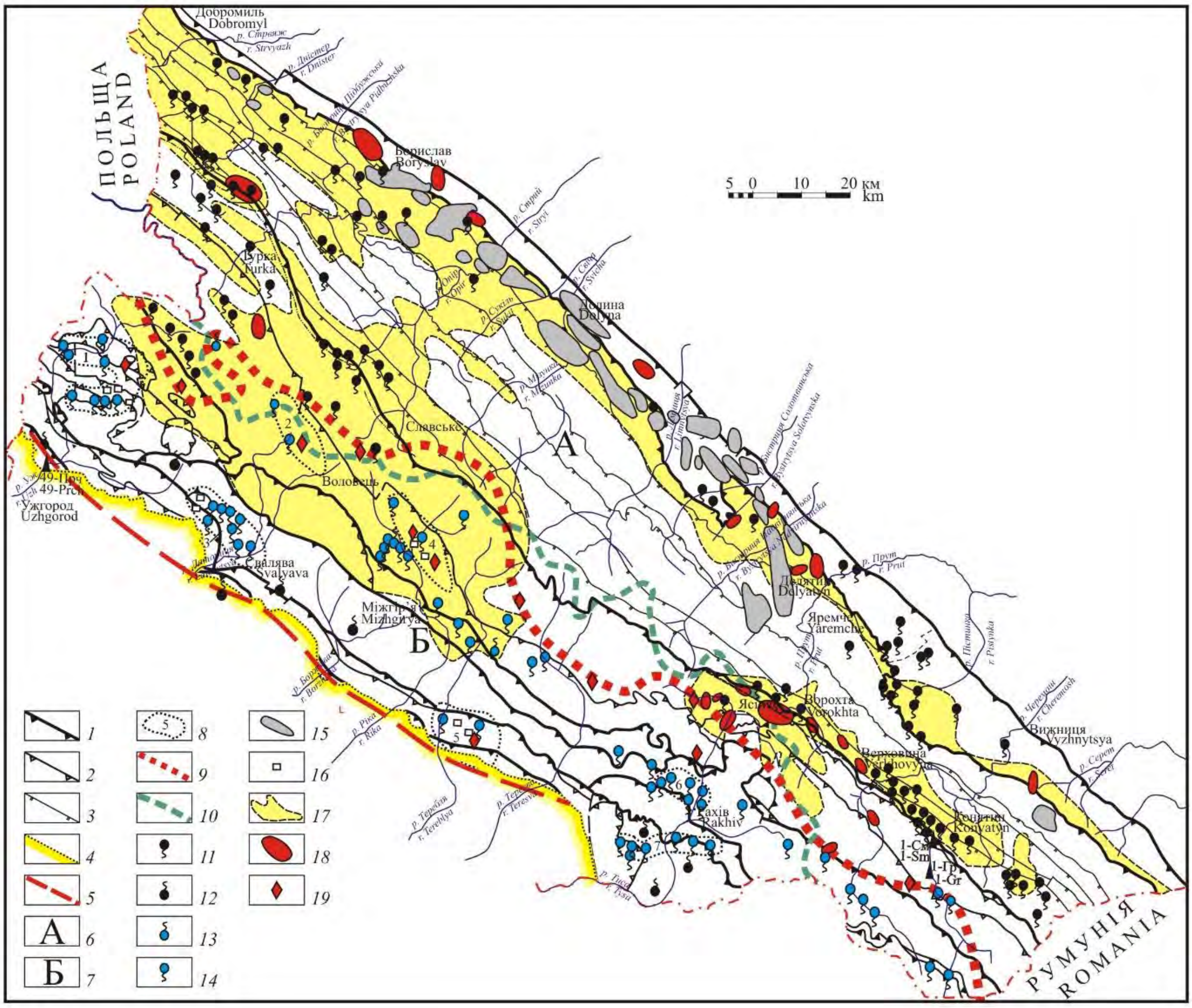

Fig. 8. Direct and indirect indicators of oil- and gas-bearing in the Ukrainian Carpathians
1 – boundaries of nappes; 2 – boundaries of sub-nappes; 3 – boundaries of thrusts; 4 – boundary of Transcarpathian Depression; 5 – Transcarpathian fault; 6 – hydrocarbon area; 7 – hydrothermal area; 8 – abnormal sites of hydrothermal area; 9 – northern boundary of hydrothermal area; 10 – line of the main Carpathian watershed; 11 – oil shows; 12 – methane shows; 13 – carbon dioxide shows; 14 – mineral carbon dioxide springs; 15 – hydrocarbon fields; 16 – sites with sulphide mineralization in bed-rocks; 17 – sites with sulphides of metals content in schlichs up 1 %; 18 – sites with sulphides of metals content in schlichs over 1 %; 19 – sites of "Marmarosh diamonds" occurrence.
For names of tectonic elements see the map of Carpathian regioning Figure 1

Scientific novelty

For the first time, using new geological data it was possible to prove the influence of the Pokuttia fault in the zone of its action in a form of the left-strike-slip on the structures of the flysch cover. The structural parallelization of the Bitlya-Svydovets sub-nappe of the Krosno nappe of the Ukrainian Carpathians was carried out with the tectonic units of the Romanian Eastern Carpathians. Interaction of the given fault with the Precarpathian regional minimum and the Uzhok deep fault has a character of the right shift. Areas connected with these dislocations are prospective for hydrocarbon accumulations of commercial value.

Practical Value

As a result of investigations essential corrections have been inserted concerning the geological structure of the south-eastern part of the Ukrainian Carpathians.

Together with geochemical indications this presents new possibilities in searching for hydrocarbon deposits in this region.

Conclusions

On an example of the south-eastern part of the Ukrainian Carpathians it is shown what influence on forming of the flysch cover had on the platform basement under the Carpathian overthrust, in particular the deep faults within its limits. The knots of these dislocations could be the pathways of the influx of hydrocarbons from the depth. For the further development of this theme a complex study of the given part of Carpathians is needed by carrying out the detailed investigations (seismic, gravimetric, geological, and geochemical). Similar investigations should be conducted in the remaining territory of the Ukrainian Carpathians. Proposed scenario of the development of the Pokuttian deep fault confirms with geodynamic concept, recently created for Carpathians (Nakapelukh et al, 2017).

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ПОКУТСЬКИЙ ГЛИБИННИЙ РОЗЛОМ І ЙОГО ВПЛИВ НА ТЕКТОНІКУ І НАФТОГАЗОНОСНІСТЬ ПІВДЕННО-СХІДНОГО СЕГМЕНТУ КАРПАТ

Мета. Метою дослідження є аналіз впливу Покутського глибинного розлому на тектоніку і нафтогазоносність південно-східної частини Українських Карпат. **Методика**. Полягає у детальному комплексному аналізі геолого-геофізичних матеріалів по цій ділянці. **Результати.** Вплив Покутського глибинного розлому на структуру флішу проявився у Бориславсько-Покутському покриві як серія розривних порушень північно-східної орієнтації на границі Гуцульського і Бойківського сегментів зі зміщенням структур на 10 км по горизонталі і до 1,5 км по вертикалі – лівосторонній скидо-зсув. У Скибовому покриві – це розмив передової його частини у Гуцульському сегменті. У Дуклянсько-Чорногорському покриві і Бітлянсько-Свидовецькому субпокриві – це сигмоїдальні вигини їх частин в зоні розлому з амплітудами горизонтальних зміщень до 10 км. У результаті Красношорська і Говерлянська одиниці сполучуються в єдиний субпокрив, а луски Бітлянсько-Свидовецького субпокриву в значній мірі перекриваються ним і Скупівським субпокривами. Внаслідок постпокривних вертикальних рухів у пліоцен-плейстоцені Гуцульський сегмент був піднесений. Найбільш інтенсивно здіймалася ділянка з Дуклянсько-Чорногорським покривом. З-під нього фрагментарно відслонюються структури Бітлянсько-Свидовецького субпокриву. На території Румунії їм структурно відповідають з півночі – луска з олістостромою Слон у нижньоверховинських відкладах олігоцену, а з півдня – тектонічні одиниці Тороклеж і Макла. Покутський розлом зміщує Передкарпатський регіональний мінімум (амплітуда бл. 10 км), а також Ужоцький глибинний розлом, з ознаками правостороннього зсуву. Не помітний вплив Покутського розлому на субмеридіональний Радехівсько-Вікторівський розлом. Місця перетину названих розломів, так звані вузли, за наявності пасток, є сприятливими зонами для концентрації вуглеводнів у промислових масштабах. У світлі нових даних про геологічну будову району підвищується перспективна оцінка виділених раніше структур у флішовому чохлі в районі Ворохти-Ясіні (Лазещинської, Ясінської, Стебнійської і Вороненківської), а також Семаківської і Гринявської, де отримані промислові припливи вуглеводнів. Це зауваження стосується і структур фундаменту Лопушнянської підзони Зовнішної зони Передкарпатського прогину під насувом Карпат. **Наукова новизна**. Вперше, з використанням нових геологічних даних, доведений вплив Покутського розлому у зоні його дії у формі лівостороннього скидо-зсуву на структури флішового чохла. Проведена структурна паралелізація Бітлянсько-Свидовецького субпокриву Кросненського покриву Українських Карпат з тектонічними одиницями Румунських Східних Карпат. Взаємодія цього розлому з Передкарпатським регіональним мінімумом і Ужоцьким глибинним розломом має характер правостороннього зсуву. Ділянки, пов'язані з цими дислокаціями, є перспективними, щодо пошуків скупчень вуглеводнів промислових масштабів. **Практична значущість**. У результаті проведеного дослідження внесені значні корективи стосовно геологічної будови південно-східної частини Українських Карпат. Це в комплексі з геохімічними показниками відкриває нові можливості для пошуків тут вуглеводнів.

Ключові слова: глибинний розлом, фліш, фундамент, зсув, нафтогазоносність.

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ПОКУТСКИЙ ГЛУБИННЫЙ РАЗЛОМ И ЕГО ВЛИЯНИЕ НА ТЕКТОНИКУ И НАФТОГАЗОНОСНОСТЬ ЮГО-ВОСТОЧНОГО СЕГМЕНТА КАРПАТ

Цель. Целью исследования является анализ влияния Покутского глубинного розлома на тектонику и нафтогазоносность юго-восточной части Украинских Карпат. **Методика**. Состоит в детальном комплексном анализе геолого-геофизических материалов по даному участку. **Результаты.** Влияние Покутского глубинного розлома на структуру флиша проявилось в Бориславско-Покутськом покрове как серия разрывных нарушений северо-восточной орієнтации на границе Гуцульского и Бойковского сегментов, со смещением структур на 10 км по горизонтали и до 1,5 км по вертикали – левосторонний сбросо-сдвиг. В Скибовом покрове это розмыв передовой его части в Гуцульском сегменте. В Дуклянско-Черногорском покрове и Битлянсько-Свидовецком субпокрове это сигмоидальные изгибы их частей в зоне разлома, с амплитудами горизонтальных смещений до 10 км. В результате Красношорская и Говерлянская единицы объединяются в единый субпокров, а чешуи Битлянско-Свидовецкого субпокрова в значительной степени перекрываются им и Скуповским субпокрывами. Вследствие постпокровных вертикальных движений в плиоцен-плейстоцене Гуцульский сегмент был приподнятый. Наиболее интенсивно воздымался участок Дуклянско-Черногорского покрова. Из-под него фрагментарно обнажаются структуры Битлянско-Свидовецкого субпокрова. На территории Румунии им структурно соотвествуют: с севера – чешуя с олистостромой Слон в нижневерховинских отложениях олигоцена, а с юга – тектонические единицы Тороклеж и Макла. Покутский разлом смещает также Предкарпатский региональный минимум (амплитуда около 10 км), и Ужокский глубинный разлом, с признаками правостороннего сдвига. Не заметно влияние Покутского розлома на субмеридиональный Радеховско-Викторовский разлом. Места пересечения названых разломов, так называемые узлы, при наличии ловушек являются благоприятными зонами для концентрации углеводородов в промышленных масштабах. В свете новых данных о геологическом строении данного района повышается перспективная оценка выделенных ранее структур во флишовом чехле в районе Ворохты-Ясини (Лазещинской, Ясинской, Стебнийской и Вороненковской), а также Семакивской и Гринявской, где получены промышленные притоки углеводородов. Эти выводы справедливы и в отношении платформенных структур фундамента типа Лопушнянской подзоны Внешней зоны Предкарпатского прогиба под надвигом Карпат. **Научная новизна**. Впервые, с использованием новых геологических данных, доказано влияние Покутского разлома в зоне його действия в форме левостороннего сбросо-сдвига на структуры флишевого чехла. Проведена структурная паралелизация Битлянсько-Свидовецкого субпокрова Кросненского покрова Украинских Карпат с тектоническими единицами Румынских Восточных Карпат. Взаимодействие данного разлома с Предкарпатским региональным минимумом и Ужокским глубинным разломом имеет характер правостороннего сдвига. Участки, связанные с разломными дислокациями, относятся к перспективным, в отношении поисков скоплений углеводородов промышленных масштабов. **Практическая значимость**. В результате проведенного исследования внесены значительные коррективы касательно геологического строения юго-восточной части Украинских Карпат. Это, в комплексе с геохимическими показателями, открывает новые возможности для поисков здесь углеводородов.

Ключевые слова: глубинный разлом, флиш, фундамент, сдвиг, нефтогазоносность.

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