GEOLOGY

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GEODYNAMICS OF FORMATION OF THE TRANSITION ZONE BETWEEN THE DNIEPER-DONETS BASIN AND THE DONBAS FOLDBELT. TECTONIC STYLE OF INVERSION DEFORMATIONS

Aim of the work is to conduct tectonophysical identification of the totality of the deformation structures of the collisional evolutionary stage, which determine the tectonic style of the Transition Zone between Dnieper-Donets Basin and the Donbas Foldbelt. **Methods.** For the research, we used the author's technique for reconstructing the fields of tectonic deformations and tectonophysical analysis of geostructures. The analytical base of the research was made up of new materials of geological mapping of the territory of the transition zone between the Basin and the Foldbelt. **Results**. Inversion deformations of the Dnieper-Donets Paleorift were controlled by lattices of tectonites of regionally stable submeridional directions of movements. The analysis of structural patterns of tectonites indicates the riftogenic faults of the basement in the sedimentary cover of the transition zone. They form echeloned stages of plumage, composed of thrusts with a significant component of horizontal displacement. The tectonic style of the Transition Zone is determined by the pushing on the low dislocation autochthon of the Basin which is repeatedly deformed, crumpled into the folds of sedimentary geomas from the Foldbelt. The allochthon structural and tectonic framework consists of thrusts, coulisse-jointed structural ensembles of thrusts, folded covers of transverse extrusion of geomas from axial to side zones, and folded covers of longitudinal thrust towards the depression. All together it forms the Western Donets Cover-folded Region, the main structural element of which is the Segment of the Tectonic Wedging of geomass. The north-eastern flank of the Segment is formed by such linear anticlinal zones, as Torsky-Drobishivska, North-Donets, Matrossko-Toshkovska. The south-western flank is composed of- Petrovsko-Novotroitska zone. The structural apex of the Segment is a tectonic junction at the ends of dynamically conjugated thrusts in the area of the joint of the salt-dome shafts of the axial part of the Basin. **Scientific novelty**. The tectonic inversion is responsible for the formation of three folded structural floors, including the Herzinian, Laramian and Attic floor. According to the dynamically coupled lattice, a cover-folding system of tectonic thrusting was formed in them. It was first established as a Segment of Tectonic Wedging of geomas by the Donbas Foldbelt. On the basis of this, within the Transtition Zone, a Western-Donetsk cover-folded Region was separated, covering two tectonic areas in intensity and style of deformation of the sedimentary cover – Kalmius-Toretsky area of scaly covering in the southwestern part, which is limited to the South Donbass Melange Zone in the south, and the Lugansk-Kamyshuvakhsky area of the coulisse-jointed uplift-folding on the northeastern part, which from the north is limited by the low-folded Mesozoic-Cenozoic cover. They are separated by the Central Zone of Strike-slip control along the axial folded zone of large stage-jointed uplift-folds, which include Great-Kamyshuvakhska, Novotroitska, Druzhkovsko-Konstantinovska and Main anticlines. **Practical significance.** Based on the actual geo-mapping data, it is proved that the riftogenic structure in the southeast of the Dnieper-Donets Paleorift is destroyed by folding at the stages of platform activation. Allocation of territory of the Western Donets Cover-folded Region allows correcting the scheme of tectonic zoning of the Dnieper-Donets Basin, which is the basis for modeling the geodynamics of the Transition Zone formation

Key words: tectonite framework; thrust cover; uplift folds; tectonic wedging segment; cover-folded region.

Introduction

The Dnieper-Donets basin (DDZ) is a constituent geostructural element of the paleorift system of the transregional Sarmatian-Turan lineament, which stretches from the Pripyat depression to the mountain-folded Tien Shan [Atlas…, 1984; Geology…, 1989]. The north-western part of the lineament is the Dnieper-Donets Paleorift (DDP), which was formed in the body of the Sarmatian Plate of the Eastern European Platform by the Middle Paleozoic intra-platform avlacogen, with the Upper Paleozoic superizone-Caucasian and Rifle basin-Caucasian basin superimposed on it. (Fig. 1). This system of rifting deflections distinguishes the crystalline massifs of the Ukrainian Shield (US) in the southwest and the Voronezh anteclisis (VA) in the northeast. The formation of marginal deep faults and the formation of the DDP in the Middle Devonian is associated with the invasion of the lithosphere of the Sarmatian plate of the hot mantle diapir [Geological ческая, 1993]. Deep seismic sounding presupposes the occurrence of the Early Riphean graben formed in its south-eastern part in the basement of the Middle Paleozoic paleorift., [Sollogub et al., 1980]

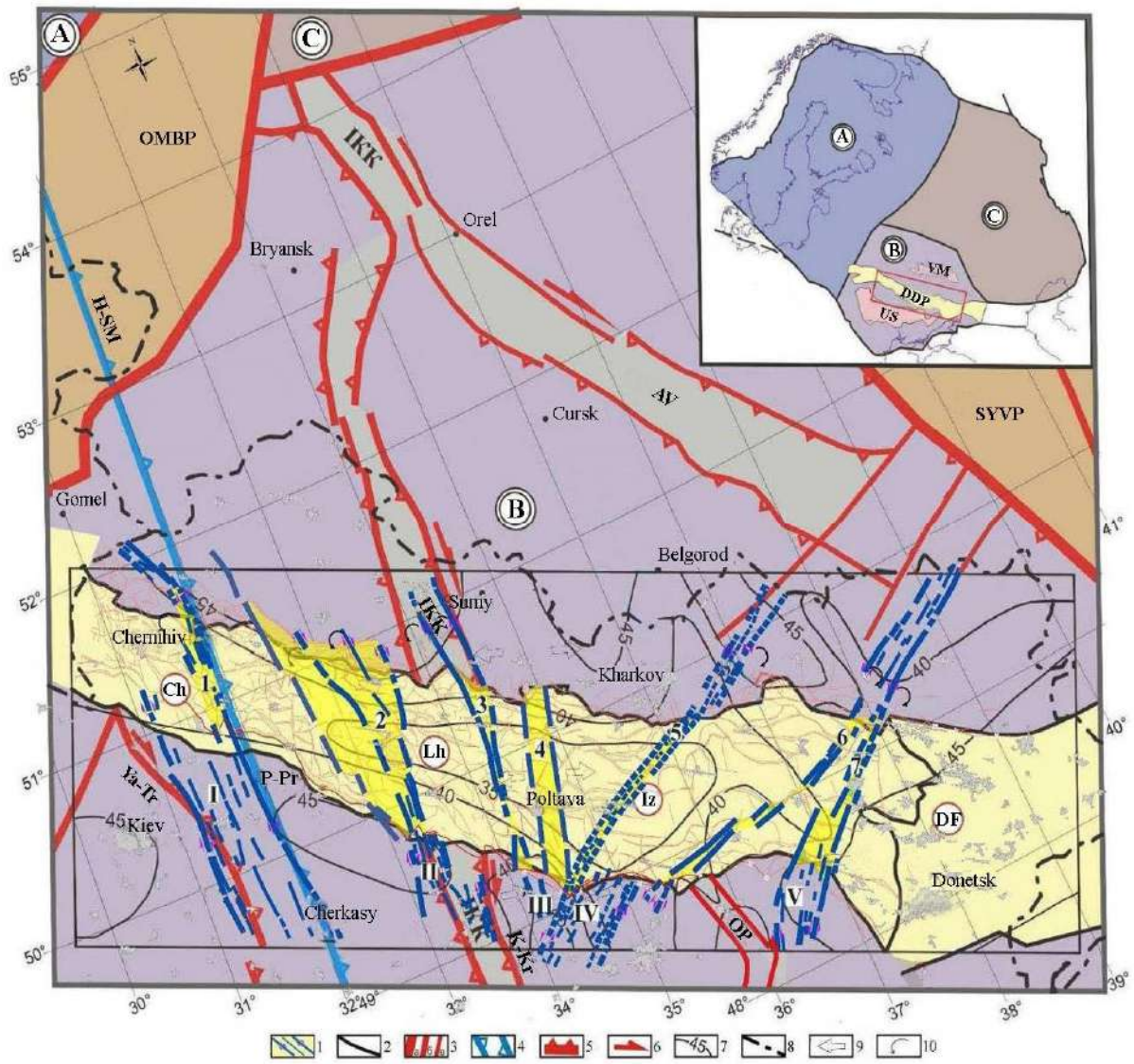

Fig. 1. Tectonic position and segmentation of the Dnieper-Donets paleorift on the schemes of the Sarmatian geosegment [Nenakhov et al., 2007] and the Eastern European platform (inset) [Structural map, 1992] with additions [Bartashchuk, 2018]

Symbols: 1 – intersegmental zones; 2 – boundaries of the paleorift; 3 – faults: a – intergeoblock, b – intermegablock: Ya-Tr – Yadlivsko-Traktemyrivsky, K-Kr – Kryvyi Rih-Kremenchug; in – interblock; 4 – suture zones: IKK – Inguletsko-Kryvorizko-Krupetska, AV – Oleksiyivsko-Voronezhska, OP – Orikhovo-Pavlogradska; 5 – H-SM – tectonic seam Kherson-Smolensk; deep faults: 6 – thrusts; 7 – landslides; 8 – depth of the Moho surface, km; 9 – state border; 10–11 – directions of general and rotational tectonic movements in intersegmental zones. Letters on the diagrams: AB – geosegments of the Eastern European platform: A – Fennoscandia, B – Sarmatia, C – Volga-Urals. Segments of the Dnieper-Donets paleorift: Ch – Chernihivsky, Lh – Lokhvytsky, Iz – Izyumsky; DF – Donets foldbelt. Volcanic intergeosegmental belts: OMVP – Osnytsko-Mikashevychsky; SYVP – Stavropol-Yertil. Inter-block zones of the Ukrainian shield: I – Kirovohrad; II – Ingulets-Kryvyi Rih-Kremenchug; III – Dniprodzerzhynsk; IV – Odessa; V – Central Priazovsko-Slavyanogirskaya [Map of …, 1988]. Intersegmental zones: 1 – Kirovograd; 2 – Inguletsko-Kryvyi Rih; 3 – Dniprodzerzhynsk; 4 – Verkhovtsivsko-Lhovska; 5 – Kolomatsko-Kobeliatska; 6 – Balakliysko-Synelnykivska; 7 – Central Priazovsko-Slavyanogirskaya [Chebanenko et al., 1991]

Tectonic zoning of DDZ provides for the selection of longitudinal tectonic elements – northern and southern sides, covering, respectively, the northern slopes of the US and the southern immersion of the VA and the Dnieper graben, separated from the sides by regional marginal deep faults [Atlas ..., 1984]. Transverse segmentation of the rifting structure is carried out along the zones of deep-rift deep faults, with the Chernihiv segment in the north-

western part, the Lokhvytsia segment in the central part and the Izium segment in the south-eastern part of the DDZ. In the marginal, south-eastern part of the depression, in the transition zone between the DDZ and the Donetsk folded structure (DSS), a number of researchers single out the West Donets graben (ZDG). Along the Central Priazovsko-Slovyanogirskaya zone of deep faults, which is manifested in the earth's crust by a shaft-like structure at the Moho surface, DDZ borders on DSS [Chebanenko et al., 1991].

Well-known geologists have devoted their works to the problems of origin, structural evolution and geodynamics of DDZ and DSS, which have traditionally been debatable for many years: Karpinsky, A. D. Arkhangelsky, N. S. Shatsky, V. G. Bondarchuk, V. S. Popov, M. L. Levenstein, I. I. Чебаненко, G. H. Dolenko, V. G. Sollogub, M. B. Чирвінська, A. B. Chekunov, V. K. Gavrish, A. Ya. Radziwill, I. A. Майданович, B. A. Korchemagin, M. L. Kopp, S. N. Stovba, V. V. Potter and others.

The south-eastern part of the DDP in the Late Hercynian and Cimmerian-Alpine epochs underwent tectonic regime inversion and deformation folding. As a result,the Donetsk Ridge, the Azov Upland, and further to the southeast, the Karpinsky Ridge, were formed. Until recently, it was believed that the northwestern part of the DDP, including the Pripyat Deflection and the DDZ, in the Mesozoic-Cenozoic experienced only a slow platform syneclise immersion. However, the rifting sedimentary basin did not undergo significant structural transformations [Tectonics ..., 1988; Geology ..., 1989; Geological…, 1993; Pillar, 2008; Starostenko et al., 2017].

Recently, the materials of field instrumental determinations of tectonite vergence have helped to establish that the earth's crust of the Sarmatian plate had been subjected to repeated stresses and deformations due to collisional interaction with adjacent folded belts and active tectonic plates [Goryainov, 1999, 2004; Stampfli, Borel, 2002, Natal'in, Sengor, 2005, Gintov, 2005; Kopp et al., 2017; Orlyuk, Ishchenko, 2019; Potter, 2019]. The geodynamic conditions of the inversion stages of the structural evolution of DDZ and DSS were determined by the general-plate collision stress in the conditions of the regional horizontal-shear stress field. As a result, the rifting structure underwent significant transformations and formed its own plan of deformation at each stage [Maidanovich, Radziwill, 1984; Korchemagin, Ryaboshtan, 1987; Chebanenko and others, 1991; Kopp, Korchemagin, 2010; Potter, 2019; Bartashchuk, 2019].

DDZ is the main oil and gas production region of Ukraine, which concentrates most of the explored reserves and hydrocarbon production of the country. Despite the reduction in the volume of exploration work, new hydrocarbon deposits are discovered in the depths of the Dnieper-Donets oil and gas province every year. Improving the efficiency of oil and gas exploration works largely depends on a correct understanding of the patterns of formation and location of oil and gas deposits in the subsoil. They are primarily determined by geotectonic and geodynamic conditions of the region. Based on this, the topical problem of regional geotectonics includes purposeful studies of structural manifestations of tectonic inversion of DDZ. Its solution is important both from a theoretical point of view (i.e.to understand the natural mechanisms of structural and kinematic evolution of the earth's crust) and from a practical point of view (i.e. to predict deformation structural forms shaped during tectonic inversion of DDZ which contain potential hydrocarbon traps).

Data

In structural and tectonic terms, the territory of the transition zone between DDZ and DSS has a complex, multi-storey tectonic structure, due to the alternation of epochs of sedimentation and folded deformations, sometimes accompanied by magmatism [Tectonic map…, 2007; Stratigraphy ..., 2013] (Fig. 2). The factors include the repeated overlapping of sliding-sliding, horizontal-sliding, folding and cover-folding deformations of different epochs of tectonic activation, steep angles of rock fall (up to 50–700), significant dislocation of Paleozoic sedimentary strata and its saturation with heterochronous tectonites and high paleotemperatures. This led to the increased density and catagenetic transformations of sedimentary rocks and coal of Donbass, active volcanism of acidic composition and related hydrothermal-metasomatic manifestations [Geological ..., 2007]. Due to the zonal distribution of deformations of several epochs of tectogenesis on the territory of ZDH, not only vertical but also lateral discrepancies arose between dislocation structural floors, which in some tectonic areas have different degrees of stratigraphic filling. Except for the weakly deformed syneclise cover of a graben, together with the remains of the world and the stratified formations saved from denudation, each structural floor, contains complexes of newly formed tectonites which cross through ancient structural floors [Tectonic ..., 2007, Gorya. 2004; Goryainov et al., 2009]. Tectogenesis deformations of the Cimmerian stage have not been studied because of denudation of the Mesozoic sedimentary complex in the pre-Cenozoic in the study area.

The materials of geo-mapping of the transition zone between DDZ and DSS are important for understanding the structural features of inversion tectonics of DDZ. They were obtained, using field instrumental measurements of tectonite versatility [Forecast…, 2017]. According to geomapping data, three main angular and stratigraphic discrepancies have been identified in the Paleozoic sedimentary cover of ZDH. They fix the main stages of tectonic inversion: 1 – between weakly dislocated Miocene and undislocated Pliocene-anthropogen due to attic phase; 2 – between the Upper Cretaceous and the Oligocene due to the manifestation of the Laramian phase of the Early Alpine movements, which formed the Laramian tectonites; 3 – on the border of the Mesozoic and Paleozoic, as a manifestation of the Zaal folding phase , during which Hercynian tectonites were formed. In this case, each generation of tectonites has its own vergence, controlling the inversion structure of the three dislocation floors – Hercynian, Laramian and Attic.

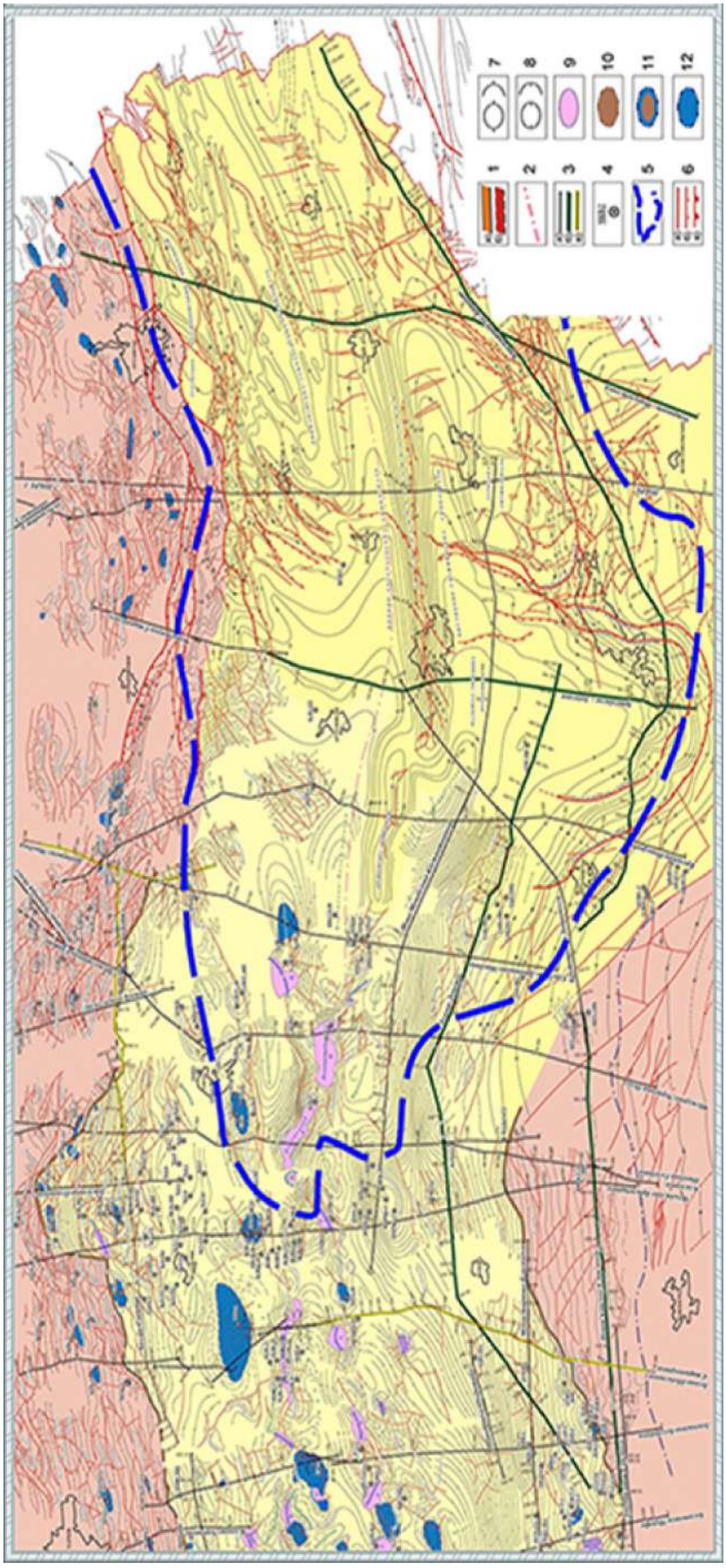

Fig. 2. Fragment of a tectonic map of Ukraine (territory of the transition zone between the Dnieper-Donets depression and the Donetsk foldbelt) [Tectonic map…, 2007].

Symbols: 1 – edge regional faults: a – established, b – predicted; 2 – axis of the Western Donets Graben; 3 – regional seismic profiles: a – past years, b – new, 4 – wells; 5 – West Donets Tectonic Segment; 6 – faults: a–b: agreed and reverse discharges; 7 – antiforms; 8 – synforms; 9 – salt rods; 10–12- fields: 10 – oil, 11- oil and gas condensate, 12 – gas condensate and gas

The Hercynian structural floor was formed in the Zaal phase of orogenesis by collision movements in the south-western rhumbs [Forecast ..., 2017]. Its folded structure on the territory of the ZDG is controlled by a lattice of tectonites of the "stylistic" dynamo-metamorphic complex [Goryainov et al., 2009] (Fig. 3). Throwing-sliding type of Hercynian floor tectonics was revealed according to the stratigraphic correlation of most wells, in which the Paleozoic complex was discovered, where repetitions of different parts of the coal section were recorded (Fig. 4).

The intensity of Hercynian fold deformations is maximal in the southwestern part of the ZDG. It decreases to the center and northeastern side of the graben, determining the depth of pre-Mesozoic erosion and stratigraphic completeness of the sedimentary section. In the north-eastern and central parts of the graben, the sole of the Mesozoic rests on the erosion surface. In the south-western part, the Hercynian floor with a sharp angular disagreement is covered by an unlocated Oligocene-Miocene cover. And in the south-east and south, Pliocene-Anthropogen deposits rest on the erosional surface (Figs. 4–6).

The Hercynian sliding lattice controls the cover-folded region in the ZDG, which is formed by echelons of tectonic plates-covers and rockerically articulated throw-folds (Figs. 2–6). The north-eastern wing of the system is bounded by the Sviatohirsky, Drobyshivsky, and Novy thrusts (Figs. 3, 5). The southwestern wing borders on the Kotlynsky, Mertsalivsky, and Novoselivsky thrusts, which separate it from the Don-South crystalline massif formed on the northern slopes. It is divided in half by the backstage of the axial Sulino-Konstantinovsky landslide.

In the axial zone of the graben, the echeloned rows of thrusts control the structural ensembles of interstitial tectonic blocks of elongated shape of eastern and northeastern extension. They complicate the geological structure of Bakhmut, Komyshuva-Lyman and Kalmius-Torets structural basins, Fig. 2. Their frontal parts form linear near-fracture throw-anticlines with steep north-eastern wings and sloping south-western ones. They turn into monoclines in the rear parts of the blocks. On the western flank, the sole of the Mesozoic cover sinks to the west, to a depth of more than 3 km within the Orchykivska DDZ basin. Remains of the Lower Permian hemogenic stratum are preserved in the submerged parts of the axial basins of the graben, in the castles of the synclines.The plantar part of the section of Paleozoic sediments and the foundation are divided into large blocks by relics of the rift stage (Figs. 4, 5).

With the immersion of Paleozoic complexes to the northwest, within the Izium segment of the DDZ, the depth of erosion of the Paleozoic section gradually decreases. So, the stratigraphic completeness of the lower Permian section increases in the syncline hinges. At the same time, in the extreme northeast, there is a sharp increase in the north-eastern direction of the depth of the pre-Mesozoic erosional section.

On the southern side of the graben, field studies have identified the South Donbass melange zone [Goryainov et al., 2009] (Fig. 3). It is composed of tectonic blocks of Precambrian crystalline rocks, volcanic-terrigenous Devonian stratum, Lower Carboniferous plate. They are pushed against each other in the southwestern direction along the lattice of "stylistic" thrusts at low angles, which is due to the quasi-layered strata. The melange breaks through the volcanics of the andesite-trachy-andesite and South Donbas complexes, which determine the upper age limit of its formation in the Zaal phase of Hercynian orogeny. The melange zone is the southern boundary of the territory of tectonic coverings distribution of the approach, which is covered by the "Donetsk scaly-sliding zone", standing out as part of the "Hercynian folded region" [Forecast…, 2017].

The Laramian structural floor of the transition zone between DDZ and DSS has an intensively deployed, folded-sliding structure formed by collision movements in the northern rhumbs [Goryainov, 2004]. The boundaries of the floor are the main thrusts: North-Donetsk in the northeast and Samara in the south-west (Figs. 3–5). The slidinglattice controls the Laramia region of folding thrust covers on the territory of ZDH, which consists of echeloned rows of tectonic covers and linear anticlinal throw-folds, separated by narrow synclines. Almost half of the region is delimited by spherically articulated branches of the Diamond, Samara and Axial main thrusts (Figs. 2, 3). Laramian anti- and sin-shaped scales and plates of thrust covers, in addition to large linear folds of the axial zone of the graben, underwent flexural bending of fold hinges and long axes of interstitial tectonic blocks, which will be analyzed in detail below.

The lattice of Laramian thrusts and tilts controls the area of distribution of cover-fold deformations, which is allocated as a part of "Laramian folded region" [Forecast ..., 2017].

The Attic structural floor, as well as the Laramian one, within the ZDH has a cover-sliding structure, which is formed by the "Shumilov" dislocation complex of tectonites [Goryainov, 1999]. The thrusts of the north-eastern vergence form a deformation tectonic lattice, which controls the territory of development of large echeloned covers of tectonic thrust of the dislocated geomas of the sedimentary stratum. Moreover, the cover plates are controlled by the planes of the Axial, Dileyevsky, Marievsky and Lysychansky main thrusts (Figs. 3, 5, 6). The area of sliding scales-covers of smaller size is bounded by Seleznyvsky, Prodovzhny, Pivdenny Pavlovsky, Sanzharovsky, Main Irminsky thrusts of smaller amplitude of zonal wing movements.

Attic movements and deformations caused further fragmentation of the cover into lenticular tectonic blocks, up to the first tens of kilometers in size, and caused tectonic coverings to move in the

north-western direction. This became the basis for the allocation of a "zone of scaly thrusts" on the territory of the ZDG [Forecast ..., 2017]. The set of Attic deformation structures forms the Donetsk ridge and the Azov Upland on the territory of the research.

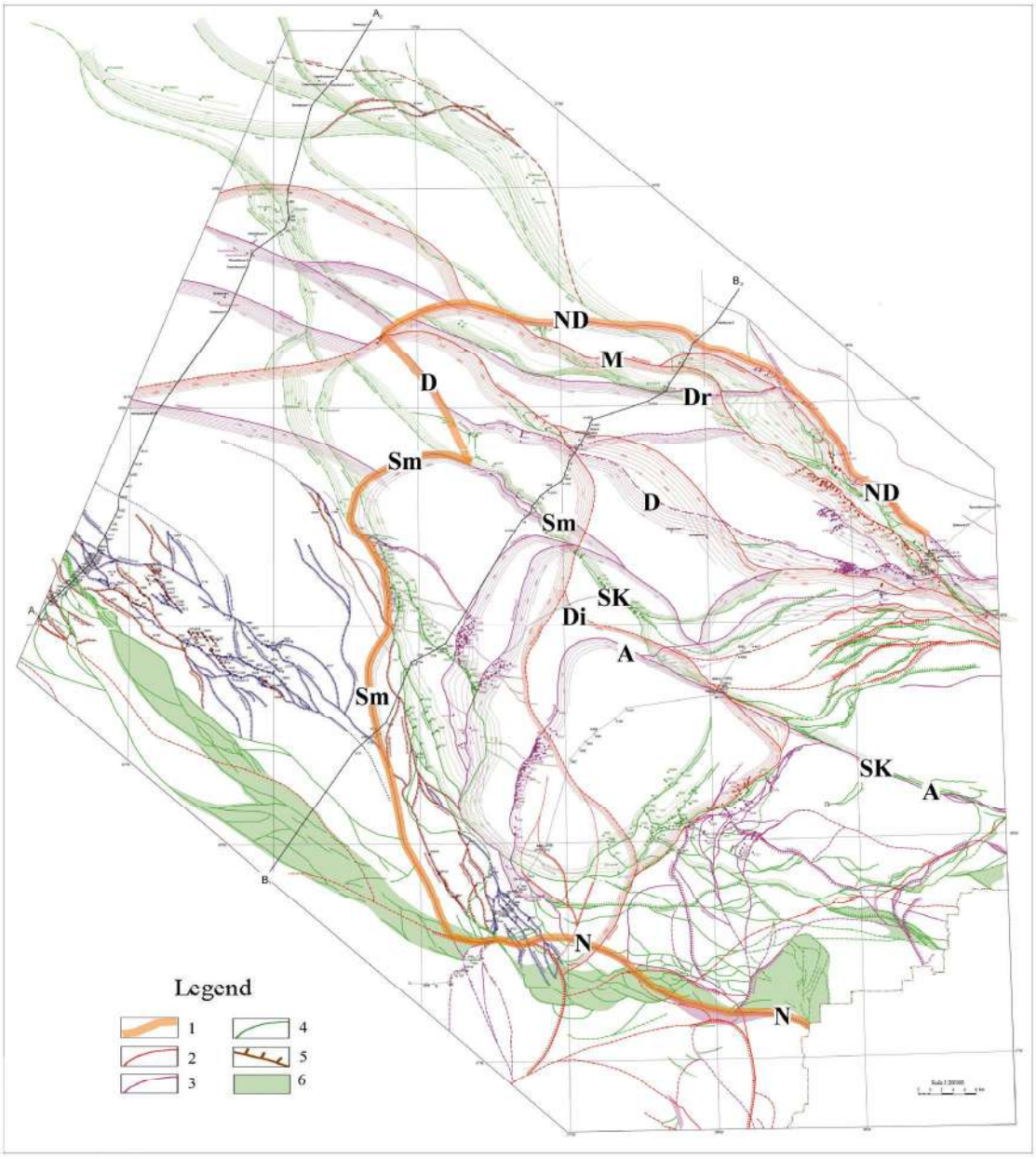

Fig. 3. Comparative scheme of tectonites of the territory of the Western Donetsk Graben, based on geological mapping materials [Forecast…, 2017]

Symbols: 1 – Main landslides and throws: ND – North Donetsk, M – Mariivsky, Dr. – Drobyshivsky, D – Diamond, SM – Samara, Di – Dileevsky, SK – Sulino-Konstantinovsky, A – Axial, N – Novoselivsky; 2–4 – tectonites: 2 – Attic, 3 – Laramian, 4 – Hercynian; 5 – South Donbass Melange Zone

The purpose and objectives

The purpose of regional geotectonic research is to identify a set of deformation structures of the inversion stage of evolution that determine the tectonic style of the joint zone of DDZ with DSS.

Objects of geotectonic research are structural elements of subregional (south-eastern segment of DDZ, ZDG, transition zone between DDZ and DSS, main lineaments) and zonal hierarchical level (planar and linear ensembles of deformation structures of the collision stage of structural evolution). The subject of research is the system organization of inversion deformations of the rifting structure on the territory of ZDG. Based on the structural-kinematic analysis of

the tectonite lattice patterns of the Hercynian, Laramian and Attic folded structural surfaces of the graben sedimentary cover [Forecast ... 2017], the following were studied: 2 – tectonic style of a set of disjunctive and plicative deformations that form the inversion structure of the depression/

Methodology

The studies used structural-kinematic analysis of structural patterns of tectonites and deformation structures [Rebetsky, 2002]. Analytical cartographic materials are the latest materials for geographic mapping of the territory of the ZDH at a scale of 1: 200 000 [Forecast ... 2017].

Results

Analysis of geomapping materials (i.e. a comparative scheme of Late Hercynian (Zaal) and Alpine (Laramian and Attic) tectonites, geological maps and sections) shows that the rifting structure within the transition zone between DDZ and DSS is significantly transformed by Attic, Laramian and Hercynian ectopic tectonics. Moreover, at each of the stages of deformation a separate lattice of tectonites of own vergence was formed.

On the territory of the Bakhmut and Komyshuva-Lyman structural basins, a cross-sliding system of tectonic plates-covers was formed along the echeloned rows of Hercynian, Laramian and Attic thrusts (Figs. 3–6). Moreover, along the Hercynian thrusts, the folded covers are pushed in the southern direction at angles up to 30 ° towards the south side. But along the Laramian and Attic tectonites, they are pushed in the northwest and north direction towards the depression and the north side. On the southern side of the Bakhmut Basin, the Hercynian and Alpine thrusts form a zone of rockerically articulated linear throw-folds. It consists of Velyko-Komyshuvaska, Novotroitska, Druzhkivska-Kostiantynivska and the Main anticlines. This zone is allocated as the Central linear zone of horizontal-shear control.

The results of the structural analysis of the fault lattice of the Hercynian structural floor show that the Hercynian motions within the ZDH formed a sliding lattice of tectonites. It controls the area of distribution of plates and scales of tectonic covers and linear folding fold. On these grounds, a typical integumentary-folded system was identified on the territory of ZDH, according to tectonophysical features (Fig. 7, inset). It is first distinguished as the Hercynian system of transverse tectonic thrust of sedimentary geomas of subregional scale. On the north-eastern slopes of the graben, the front of its approach to the autochthonous formations of the depression is formed by the spirally articulated branches of Svyatogorsky, Drobyshivsky, Novy and Sentyanivsky thrusts (Figs. 3–5), and in the south-east by the Samara and Novoselivsky thrusts. In the axial zone of the graben, the integumentary-folded system is divided almost in half by the spiral articulated branches of the Sulino-Konstantinovsky landslide (Figs. 3, 4).

The latter is considered as a part of the Central linear zone of horizontal-shear control. It divides the Hercynian thrust system into two separate parts according to the tectonic style and intensity of fold deformations. The northern part of the cover-fold system covers the area of plates development of tectonic covers pushed in the southern direction. A linear throw-fold is formed along the curvilinear backstage of Drobyshivsky, Svyatogorsky and Sentyanivsky thrusts on the north-eastern wing of the axis system in the graben area.

International tectonic blocks within the Northern part have an elongated scaly form of sublatitudinal extension (Figs. 3, 5). Sliding linear anticlines with steep north-eastern and sloping south-western wings are formed in their frontal parts. The southern part of the Hercynian cover-fold system is bounded by the Samara, Kotlinsky, Mertsalivsky, and Novoselivsky thrusts in the southwest, encompassing large tectonic cover plates pushed in a southwest direction to the south bord.

The results of the structural analysis of the fault lattice of the Laramian structural floor (Figs. 3–6) show that the Laramian inversion motions within the ZDG formed a tilting-sliding framework of north-north-western vergence. It controls the cover-fold system of tectonic thrust, which covers the structural ensembles of large curvilinear fold folds and synclines, up to the first hundreds of kilometers, formed within the large plates of tectonic covers.

Analysis of the northeastern flank structure of the Laramian folding-sliding system shows that main landslides of northwestern vergence of curvilinear configuration (Figs. 3, 5) form the advance front of intensively crumpled sediment geomass of allochthon into weakly located autochthonous depressions. The peculiarity of their structure is demonstrated by the spiral articulation of the constituent branches and the curvature of the tracks: from southeast to northwest, they gradually change the direction of their planes from northwest to west. Fracture folds are formed in the pushed wings of the North-Donetsk, Drobyshiv and Diamond thrusts . Their axes are adapted to the curvilinear planes of the structure-forming faults. These are North-Donetsk, Torsko-Drobyshivska and Stepkivsko-Korulsko-Slovyanska throw-anticlines (Figs. 2, 5).

The results of structural analysis of the fault lattice of the Attic structural floor (Figs. 3–6) show that Attic movements formed a sliding lattice of tectonites of north-western vergence, which controls the system of transverse displacement of sedimentary geomas from the axial part to the northern side. It consists of large cover plates formed by the curved planes of the Dileyivsky, Khrestyshchensky, Maryevsky and Lysychansky main thrusts. They gradually change their extension from the north-western to the sublatitudinal direction. The advancement of smaller-sized tectonic plates of the Cenozoic allochthon on neo-autochthonous

formations of the Laramian and Hercynian generations is provided by echelons of zonal scales and amplitudes of displacements of the sublatitudinal thrusts wings.

The results of structural analysis of lattice patterns of Late Hercynian (Zaal) and Alpine (Laramian and Attic) tectonites (Figs. 3–6) show that they control a dynamically connected tectonic system of sedimentary geomas in the sedimentary cover of ZDG. It is composed of rocky joints, lines -folded anticline zones and echeloned ensembles of tectonic scales and plates-covers of subregional scale. This became the basis for our allocation within the transition zone between DDZ and DSS of the West-Donetsk cover-folded tectonic region (Fig. 7). According to the tectonic style and intensity of sedimentary strain deformations, two tectonic areas have been distinguished within the region: Luhansk-Komyshuva district of rocky-echeloned, linear fold-fold in the northeast, and Kalmius-Toretsky district of scaly tectonic covers in the south.

The eponymous segment of tectonic wedging is identified as the main structural element of the region in terms of tectonophysical features (Figs. 2, 3, 7). It is assumed that it was formed as a result of the intrusion into the rift structure of sedimentary geomass, intensively crushed in the folds by the DSS. In terms of the segment, the North-Donetsk, Samara and Novoseliv thrusts of the Laramian lattice of tectonites are defined as the boundaries of the wedge-shaped segment. These main thrusts have curvilinear planes due to variable directions of extension (Figs. 3, 7). Moreover, the North-Donetsk thrust changes its extension direction from the north-western to the western branch of the Drobyshiv thrust. The Samara thrust changes the extension direction from north-west to north in the southern riparian zone and further to the west in the foreland of the wedging segment and again to the north-west in the axial zone of the ZDG.

On the north-eastern flank of the tectonic segment, the following rocky articulated zones of throw-folds were formed: Torsko-Drobyshivska, North-Donetsk, Matrosko-Toshkivska (Figs. 2, 4, 6). The folding and thrust covers are controlled by the Drobyshiv and Maryiv thrusts of the Laramian and Attic generations. There is a regular bending of the axes of anticline folds with the approach to the main thrusts of the north-eastern flank – North Donetsk and Drobyshiv, and the axial zone – Diamond, Samara and Axial, with a tendency to adapt to their extension.

The south-western wing of the tectonic wedge segment is formed by the scenes of Kotlinsky, Udachnensky, Oleksandrivsky, Mertsalivsky and Mushketovsky Hercynsky, Samara and Voykovsky Laramian, Muravyovsky and Kryvyi Rih-Pavlovsky Attic thrusts (Figs. 2–4). The results of the structural analysis of the lattice patterns of thrusts show that behind this dynamically connected tectonic framework, the allochthon geomass is pushed in the south-southwest direction from the axial zone of the ZDH to the Hercynian neo-autochthon of the South Donbas melange zone.

Central linear zone of horizontal-shear control divides the body of the tectonic segment lengthwise almost into a half, from southeast to northwest (Figs. 3, 6, 7). It stands out along the routes of the Axial thrust, the northern branches of the Samara and Diamond thrusts. In their tilted north-eastern wings, large linear fractured spiral articulated throw-anticlines were formed – Velyko-Komyshuvaska, Novotroitska, Druzhkivsko-Kostiantynivska and Holovna.

The structural apex of the wedge segment is defined by a tectonic node in the form of a fan, formed at the ends of dynamically connected thrusts and shear-throws of three generations (Figs. 3, 7). It is located in the foreland of the tectonic thrust system, in the structural zone of connection of the central and southern branches of the axial salt dome shafts of the depression.

The study established the peculiarities of the internal structure of the West-Donetsk segment of tectonic wedging. Firstly, they include the curvature of the planes of the main thrusts, which limit it, and smaller plumage thrusts, which control the plates-covers of the thrust. This is due to the change in the direction of their extension mainly from the north-western in the territory of the ZDG to the western in the extreme south-east of the DDZ. Secondly, it is a coordinated bending of the axes of anti- and synforms, close to the main thrusts and plumage, with a tendency to adjust the axes of the folds to their extension.

Such structural features may indicate significant horizontal displacements of geomas in conditions of limited geological space. Based on this, the formation of secondary deformation folded forms within the segment of tectonic wedging of geomas, which is first identified by structural analysis of tectonite patterns, may be due to the natural kinematic mechanism of tectonic thrust / thrust of dislocated geomas, which is the subject of the next stage of our research/

Scientific novelty

For the first time it was established that significant amplitudes of horizontal movements of sedimentary geomas and collision warping of cover horizons at the stages of tectonic inversion of rift geostructure in the south-east of the depression took place in limited geological space of ZDG and transition zone between DDZ and DSS. The collision tectonic style of deformations was determined by the tilting-sliding tectonic framework, which controls the area of distribution of cover-fold deformations in three structural floors – Hercynian, Laramian and Attic. According to the results of structural-kinematic analysis of tectonite lattices of different ages and deformation structures formed at the inversion stages of structural-kinematic evolution of the earth's crust, it is proved that the rifting structure of DDZ in the transition zone with DSS is complicated at the stages of platform tectonic activation.

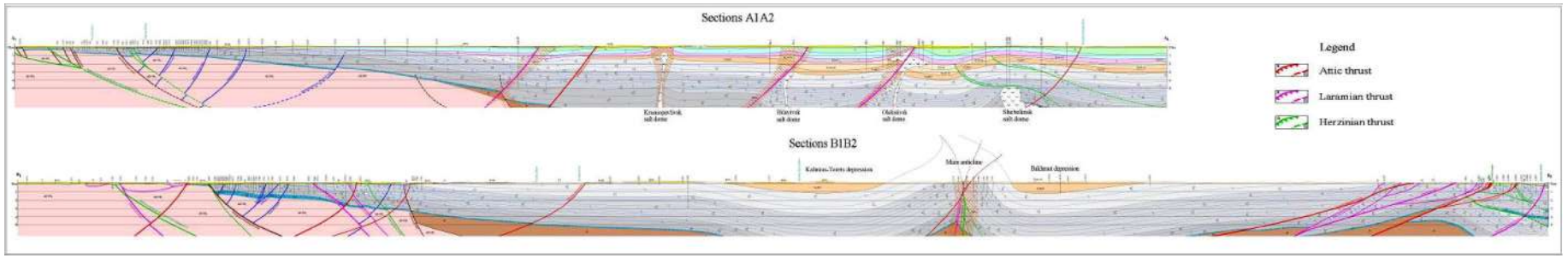

Fig. 4. Regional geological sections, based on geological mapping materials [Forecast…, 2017]. A1A2 – through the south-eastern part of the Izium segment of the Dnieper-Donets basin. B1B2 – through the central part of the Western Donetsk Graben

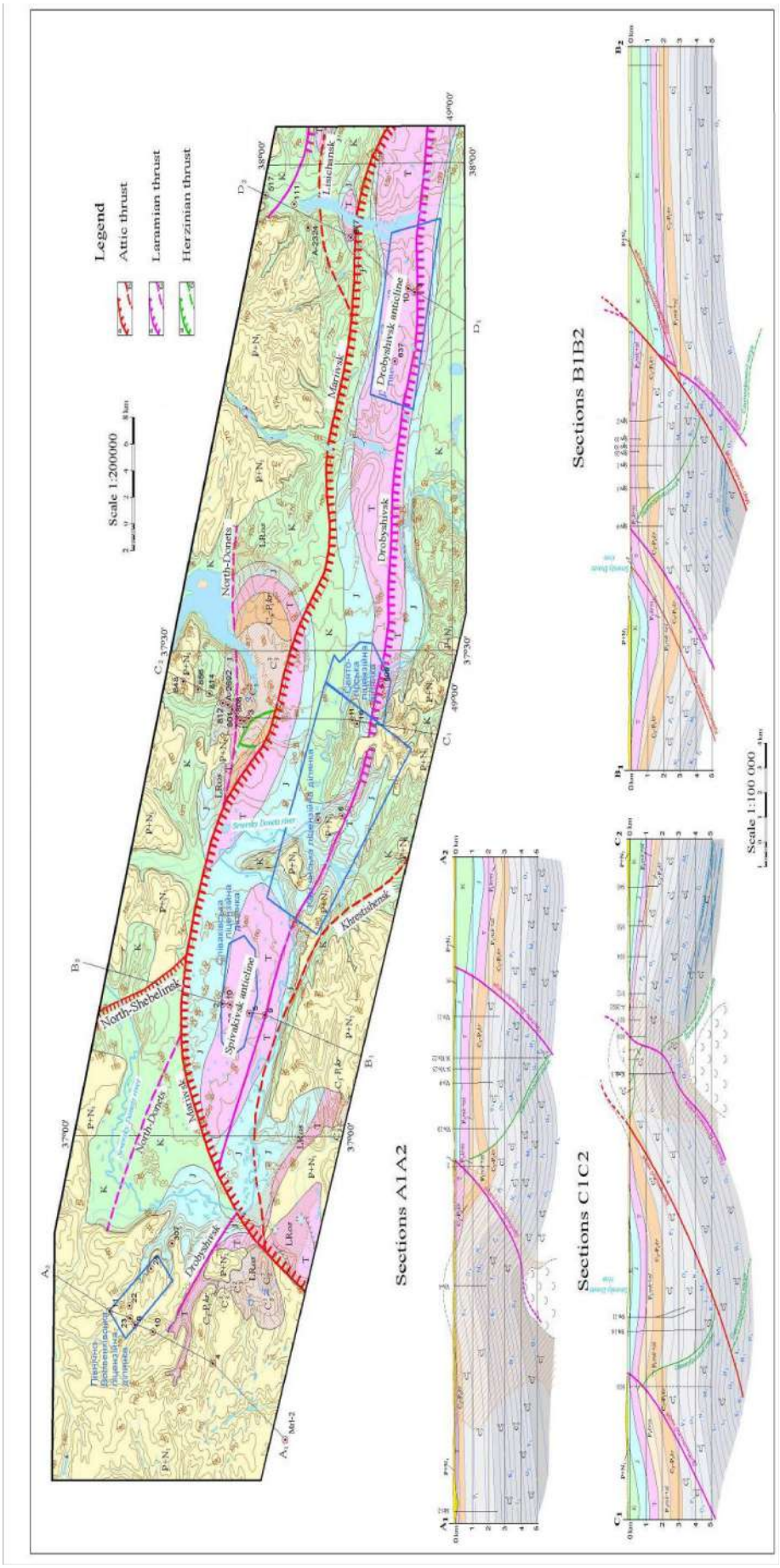

Fig. 5. A fragment of a geological map of the West Donetsk graben territory (northern slope of the Komyshuvakha-Lyman basin), based on geological mapping materials [Forecast…, 2017]. Tectonites: 1 – Attic, 2 – Laramian, 3 – Hercynian.

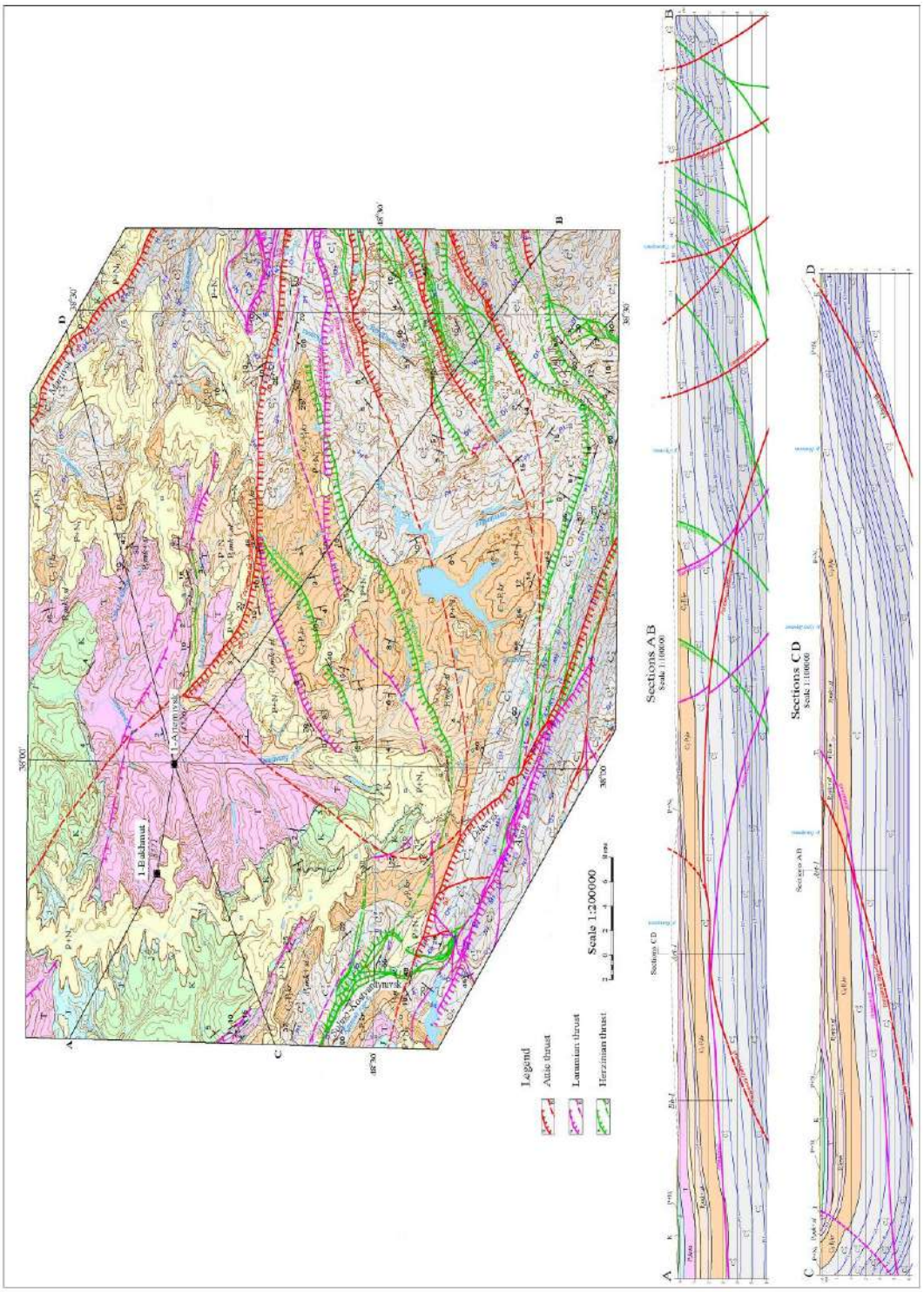

Fig. 6. A fragment of a comparative scheme of tectonites of the Western Donetsk Graben territory (central part of the Bakhmut basin), based on geological mapping materials [Forecast…, 2017]. Tectonites: 1 – Attic, 2 – Laramian, 3 – Hercynian

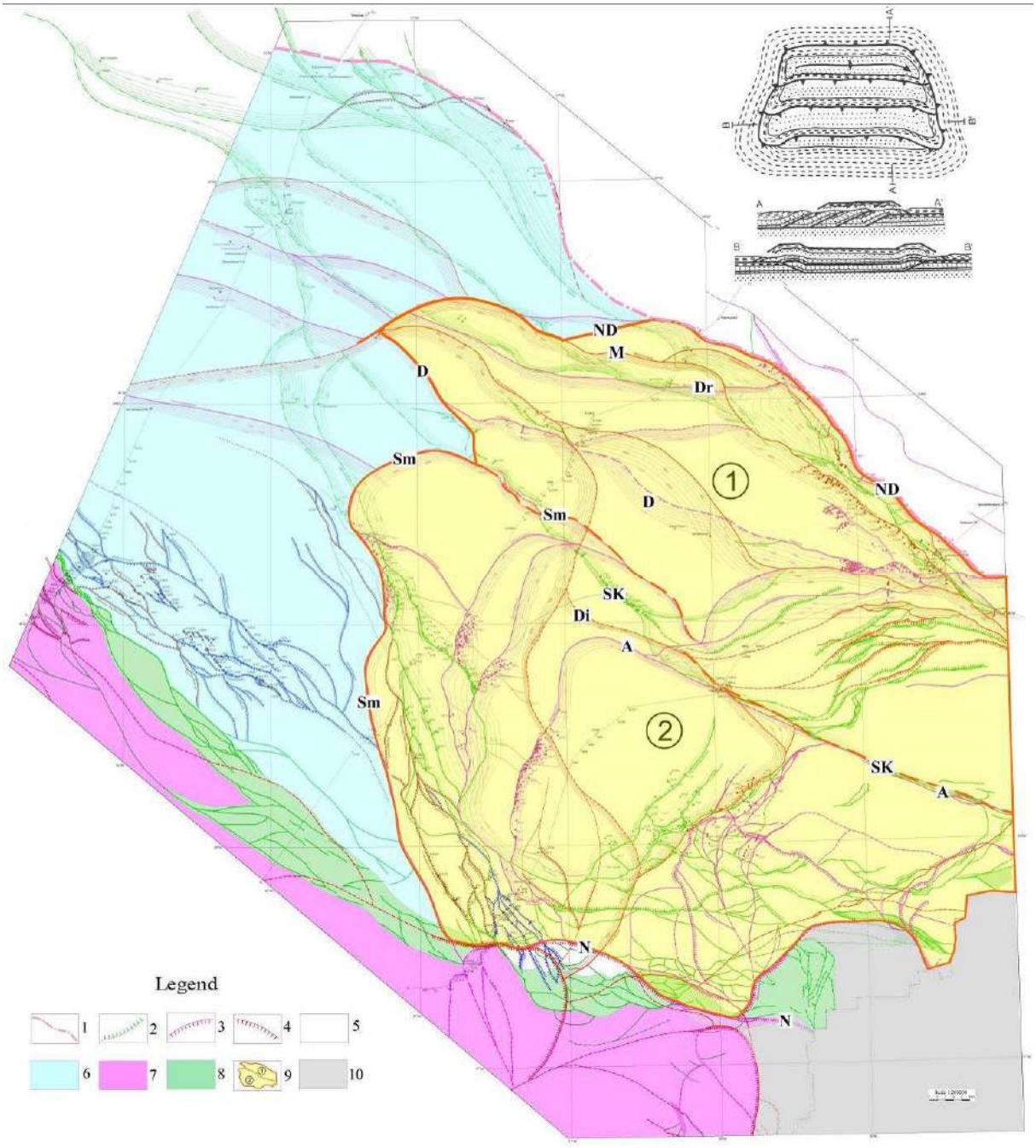

Fig. 7. Tectonic scheme of the West-Donets Cover-folded Region

Symbols: 1 – northern limit of inversion deformations; 2–4 – thrusts: 2 – Hercynian, 3 – Laramian; 4 – Attic; 5 – non-deployed autochthon; 6 – Hercynian neo-autochthon; 7 – Azov crystalline massif; 8 – South Donbass melange zone; 9 – segment of tectonic wedging: (1) Luhansk-Komyshuvakha area of echeloned sub-folding, (2) Kalmius-Toretsky area of scaly intrusions; 10 – Donetsk foldbelt. Insetion – a schematic diagram of the formation of the cover-sliding system (A. M Khudoley, VSEGEI, St. Petersburg, 2003)

These grounds allowed us to single out the Western Donetsk cover-folded tectonic region within the transition zone. It covers two separate areas according to the tectonic style and the intensity of deformation of the sedimentary cover. The Kalmius-Toretsky area of scaly tectonic covers stands out in its south-western part. It is limited in the south by the South-Donbass melange zone. The north-eastern part of the region bordered on the Luhansk-Komyshuva district of the rocky-echelon fold-fold, which is limited by a weakly located Mesozoic-Cenozoic cover in the north. Tectonic areas are divided by the Central linear zone of horizontal-shear control. It is formed by spherically articulated branches of the Axial, Samara and Diamond main thrusts. The main structural element of the West Donetsk region is the segment of tectonic wedging of sedimentary geomas of subregional scale. The body of the wedge-shaped segment is formed by the sedimentary rocks repeatedly crumpled into folds , pushed by the DSS.

Practical

The allocation of the West Donetsk cover-folded region is the basis for clarifying the regional scheme of tectonic zoning of the DDZ. The latter can be used in the practice of oil and gas exploration work to improve the scheme of regional oil and gas zoning and a more reliable assessment of the prospects of the joint area of DDZ and DSS.

Conclusions

The rifting structure in the south-east of the DDZ was destroyed by collision deformations at the stages of tectonic inversion. The lattice of thrusts control Ensembles of plates and scales of tectonic thrust covers and linear folding-folding of Hercynian, Cimmerian and Alpine orogenesis epochs. They formed the West-Donetsk tectonic cover-folded region on the territory of the transition zone between DDZ and DSS. The nature and intensity of deformations allows distinguishing the Luhansk-Komyshuva tectonic region of rocky echeloned linear sub-folding in its northern part. And in the south, Kalmius-Toretsky tectonic region of scaly coverings is singled out. The main structural element of the cover-fold part of the region is the segment of tectonic wedging of geomas by the DSS. The scientific results of the research serve as a theoretical basis for modeling the kinematic mechanism of tectonic inversion of the rifting structure in the south-east of the DDZ.

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ГЕОДИНАМІКА ФОРМУВАННЯ ПЕРЕХІДНОЇ ЗОНИ МІЖ ДНІПРОВСЬКО-ДОНЕЦЬКОЮ ЗАПАДИНОЮ І ДОНЕЦЬКОЮ СКЛАДЧАСТОЮ СПОРУДОЮ. ТЕКТОНІЧНИЙ СТИЛЬ ІНВЕРСІЙНИХ ДЕФОРМАЦІЙ

Мета. На підставі новітніх матеріалів геологічного картування дислокаційних поверхів осадового чохла Західно-Донецького грабена досліджено структурні прояви тектонічної інверсії рифтогенної структури у зоні її зчленування із Донецькою складчастою спорудою. **Методика.** З використанням структурно-кінематичного аналізу рисунків тектонітів різновікових структурних поверхів осадової товщі, з урахуванням інструментальних визначень напрямків тектонічних рухів за ними, вивчено тектонічний стиль та системну організацію колізійних деформацій Дніпровсько-Донецької западини. **Результати.** Показано, що складчасті деформації в трьох структурних поверхах, виділених у чохлі грабена – Герцинському, Ларамійському та Аттичному, контролювалися підкидо-насувними решітками і з істотною амплітудою горизонтальних рухів геомас у північних, північно-західних і південно-східних румбах. Тектонічний стиль інверсійних деформацій території перехідної зони визначається динамічно спряженими решітками тектонітів пізньогерцинського та альпійського (ларамійської та аттичної фаз) етапів тектогенезу, які контролюють ешелоновані покривно-насувні дислокації та кулісно зчленовану підкидо-складчастість у межах Західно-Донецького грабена. **Наукова новизна.** Вперше встановлено, що сукупність пластин та лусок тектонічних покривів та лінійна підкидо-складчастість разом із решітками

тектонітів, які контролюють їх, утворюють на території грабена і перехідної зони систему тектонічного насування неодноразово дислокованих осадових геомас з південного сходу – від Донецької складчастої споруди, на північний захід – на слабкодислокований синеклізний автохтон западини. Головним структурним елементом покривно-складчастої системи визначено сегмент тектонічного вклинювання осадових геомас, ідентифікований за клиноформним структурним рисунком тектонітів. Північно-східний фланг сегмента сформований підкидо-складчастими зонами відкритих палеозойських структур – Торсько-Дробишевської, Північно-Донецької, Матросько-Тошківської, південно-західний – ешелонами лускатих тектонічних покривів насування. Вісь сегмента утворюють кулісні зчленовані Петрівсько-Новотроїцька, Велікокомишуваська, Дружківсько-Костянтинівська та Головна лінійні підкидо-антиклінали. **Практична значущість**. Аналіз системної організації інверсійних деформацій свідчить про руйнування рифтогенної структури в межах перехідної зони між Дніпровсько-Донецькою западиною та Донецькою складчастою спорудою. Структурним результатом тектонічної інверсії у південно-східній частині Дніпровсько-Донецької западини вважається формування Західно-Донецької покривно-складчастої тектонічної області. За стилем та інтенсивністю деформацій в її північній частині виділено Лугансько-Комишуваський район кулісної підкидо-складчастості, на півдні – Кальміус-Торецький район лускатих покривів насування. Це є підставою для коригування схеми регіонального тектонічного районування та основою для моделювання геодинаміки формування перехідної зони.

Ключові слова: решітка тектонітів; пластини та луски покривів насування; підкидо-складчастість; сегмент тектонічного вклинювання; Західно-Донецька покривно-складчаста тектонічна область.

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