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GEODYNAMICS OF FORMATION OF THE TRANSITION ZONE BETWEEN THE DNIEPER-DONETS BASIN AND THE DONBAS FOLDBELT. TECTONIC REGIMES AND KINEMATIC MECHANISMS OF INVERSION

The article studies the tectonic conditions and natural mechanisms of tectonic inversion of the Dnieper-Donets Basin and the Western Donets Graben. Method. The research uses the original method of reconstruction of fields of tectonic stresses and deformations. It also makes tectonophysical analysis of geostructures was used. The analytical base of the research consisted of the latest materials of geo-mapping, numerical modeling of deformations of the southern edge of the Eastern European platform and comparison of model and reconstructed stress fields. Results. In the geodynamic environment of the interference of the intraplate submeridional collision compression with the regional strike-slip stress field, the inversion deformations of the rift-like geostructure took place in the uplift-thrust and strike-slip modes. This led to significant horizontal movements of geomass of sedimentary rocks, deformation folding with the formation of three inversion floors – Late Hercynian (Saal-Pfalz), Early Alpine (Laramian) and Late Alpine (Attic). They formed structural ensembles of scaly tectonic covers of transverse displacement of geomass a from axial to onboard zones, folded covers of longitudinal approach from the Donbas Foldbelt and long linear anti- and synforms, the axes of which are oriented orthogonally to the direction of geomass advancement. Together they form the body of the Segment of Tectonic Wedging of geomass, which is distinguished as part of the Cover-Folded System of Tectonic Thrusting of regional scale. A feature of the tectonic framework of the Segment is the curvature of the planes of the main thrusts, which limit it, and smaller plumage thrusts, which control the folded covers of the thrust. It is associated with a change in the extension of the thrusts from the north-west in the territory of the Western Donets Graben to the western direction in the extreme south-east of the Basin. Significant horizontal displacements of sedimentary geomas within geoblocks have led to the bending of the axes of near-fracture anti- and synforms with a tendency to adjust the axes of the folds to the extension of the thrusts. Due to the displacement of geomas from the zones of maximum compression in the axial part of the Graben to the zones of geodynamic shadow – in the direction of the Oryl depression and Graben boards, the West Donets Cover-Folded Tectonic Region was formed within the transition zone. Scientific novelty. The study completed an original kinematic model of tectonic inversion of the Western Donets Graben was completed. The mechanism of inversion, due to which the riftogenic structure is completely destroyed by folded deformations of platform orogeneses, is caused by the pressure of the "tectonic stamp" of the Donbas Foldbelt. Under its influence, a segment of tectonic wedge was formed in the Graben, which was diagnosed with oroclin of transverse extension of the sliding type. The body of the Oroclin is formed by echeloned, rock-articulated ensembles of anticlinal uplift -folds, synclines and scaly plates–covers of pushing. A geodynamic injection band was formed in the foreland of the Tectonic Orocline extension, where folded zones of geomas displacement were formed, which consist of coulisse articulated uplift-anticlines. At the top of the Orocline, at the ends of dynamically conjugate main thrusts, an advanced tectonic compression fan is formed. In the rear of the Oroclin – hinterland are tectonic sutures – the roots of the folding covers of the approach. Practical significance. Development of a structural-kinematic model of tectonic inversion of the Western Donets Graben will allow to improve the geodynamic model of tectonic inversion of the Dnieper–Donets paleorift, on the basis of which regional schemes of tectonic and oil-gas-geological zoning will be adjusted.

Key words: Dnieper-Donets paleorift, Dnieper-Donets Basin, Wesern-Donets Graben, tectonic inversion, kinematic mechanism, megablock- tectonic stamp, orocline of transverse extension, advanced tectonic compression fan, geodynamic compression zones.

Introduction

There are several theoretical concepts on the natural mechanisms of formation of post-rift folded deformations of the Dnieper–Donets Basin (DDB) and Donets Foldbelt (DF). Below we consider the content of the main models of tectonic inversion of the rift structure.

According to the model of "tectonic oscillations of the crust" [Mikhalev, & Borodulin, 1976], the inversion folding of the DF was formed under the influence of vertical backward tectonic movements, which were simultaneously experienced by two surrounding DDB crystalline massifs – Voronezh Anteclise and Ukrainian Shield. Deformations of the riftogenic structure are considered in geodynamic conditions of tangential compression, but the influence of the strike-slip component on the structure formation during modeling has not been evaluated.

The "unique induction" model is realized only under rare geological conditions of interference of intersecting regional geotectonic structures [Maidanovich, & Radziwill, 1984]. This geotectonic model explains the tectonic inversion of the DF by its exceptional tectonic position within the Eastern European Platform (EEP). It consists in its specific location in the tectonic node of the intersection of two "planetary" super-deep fault zones of the lithosphere, which lie in the foundations of the Greatdonbas Depression and the Stepnoy Shaft. Favorable conditions for the formation of the inversion fold of the DF are seen in the fact that the latter, starting with the Carboniferous, was a mobile belt with a tendency to rise. Thus, its tectonic activation could initiate the above vertical tectonic movements, which led to tectonic inversion of the eastern part of the Dnieper-Donets Paleorift (DDP).

According to the "magmatogenic" model [Milanovsky, & Nikishin, 1991], tectonic activation and inversion folding was caused by the introduction of the mantle cell into the earth's crust under the DDP and its subsequent cooling. Moreover, at the initial stage, in the Cimmerian epoch, this magmatogen caused its "thermal stress state", and in the Alpine epoch its cooling and the resulting relaxation of tectonic stresses caused deformation structure formation.

In accordance with the "physicochemical" model of tectonic inversion [Korchemagin, & Emets, 1987, Korchemagin, & Ryaboshtan, 1987], the folding mechanism of DF is seen in the structural and material transformations of sedimentary clays. They cause a general volumetric expansion of the sedimentary layer, which causes subsequent stress compensation in the form of deformation structure formation. This model can be implemented only in the conditions of regional metamorphism of the sedimentary cover, which is not developed within the rifting structure.

The "membrane" geotectonic model [Lukinov, Pymonenko, 2008] predicts that the mechanism of rifting and inversion folding in DDP was determined by the so-called membrane stresses in the earth's crust [Turcotte, 1974]. They are considered sufficient for the rupture and displacement of the cold consolidated lithosphere at the stage of rifting and its subsequent deformation during compression with the formation of folded forms at the stage of tectonic inversion. The model is speculative due to insufficient substantiation by geological data.

According to the "tectonic insertion" model [Istomin, 1996], DF is considered to be the advanced folded geostructure of the Crimean-North Caucasian Hercynian Orogen, which also covers the Karpinsky Shaft. The formation of the Foldbelt is the result of the insertion of part of the advanced folds of orogen into the "tectonic bay" between the south-eastern slope of the Voronezh Anteclise and the Azov-Rostov ledge of the Ukrainian Shield. Deformations of the sedimentary cover are considered only in geodynamic conditions of tangential compression. However, the determining influence of horizontal movements of sedimentary rocks geomass on the tectonic inversion mechanism in the model is not evaluated.

The "induction-resonance" model is quite logical. It is based on the data of reconstruction and modeling of tectonic stress fields of DF [Gonchar, 2019]. According to it, tectonic inversion and deformation structure formation within the DDP were caused by resonant deformation processes under the influence of geographically distant inductive tectonic sources. At the stages of platform tectonic activation, the earth's crust of the paleorift is a weakened intra-plate zone of concentration of interplate deformations [Leonov, 2012]. Therefore, it is considered that the type of induced deformations within the rifting sedimentary basin located in the rear of the compression orogen was determined by the nature of the interaction of tectonic plates in the active vicinity of the EEP. Due to this, the folding phases and the tectonic inversion of DDB and DF caused by them reflect spatially distant collisional deformation processes of Late Hercynian, Cimmerian and Alpine orogenes.

At the second stage of research, we made an attempt to reconstruct the kinematic mechanisms of tectonic inversion of the rift structure to study the geodynamics of the formation of the joint zone of Basin and Foldbelt. It was based on tectonophysical interpretation of new materials of geomapping of the Western Donets Graben (WDG) territory. The study took into account the analysis of previous models of inversion structuring, data of reconstruction of DF stress fields and numerical modeling of deformations of the southern outskirts of the EEP.

Analysis of previous research

Researchers conducted the reconstruction of the tectonic stresses fields of DF [Korchemagin, & Ryaboshtan, 1987; Korchemagin, & Emets, 1987; Dudnik, & Korchemagin, 2004; Kopp, Korchemagin, 2010; Kopp, Kolesnichenko, et al., 2017; Meijers et al., 2010] They also compared model DDP stress fields and reconstructed ones [Gonchar, 2019]. The results of this research indicate that the beginning of tectonic inversion and folding in the South-East of the DDB and within the DF occurs at the end of the early Permian-Zaal and Pfalz phases of the Late Hercynian orogeny. It is believed that at the first stage inversion deformations occurred according to the model of oblique left-hand collision. They were influenced by orogenic movements of the northern front of the collision orogen formed on the active plate within the Paleotetis Ocean [Kazmin, & Tikhonova, 2005]. In the body of the Sarmatian Plate, this collision event led to the formation of a stress field of tangential compression in the north-eastern direction (Fig. 1).

At the second stage of tectonic inversion, in the Mesozoic and Cenozoic, a strike-slip field of right-hand kinematics of movements with variable tangential compressive component was formed on the territory of the paleorift. On this territory strike-slip deformations with formation of structural paragenesis of right-hand kinematics prevailed. The progression of the deformation of the general compression caused structural complications of Hercynian folded forms.

It shows the structure of the Earth's crust paleorift at the neotectonic stage of geological evolution continues to develop in geodynamic conditions a combination of general deep collision compression and near-surface tension in the regional horizontal-shear stress field [Bartashchuk, 2021]. Moreover, the regime of deep compression in Phanerozoic was conditioned by collisional geodynamic processes of interaction of active plates and orogenic belts on the northern edge of the Tethys Paleocean, invasion at the late stage of rifting of hot mantle [Natal'in, Sengor, 2005; Stampfly, Borel, 2002]. Horizontal-shear deformations with formation of structural paragenesis of right-hand shift formed on the territory of the paleorift at the second stage of tectonic inversion, in the Mesozoic and Cenozoic in the shear field of right-hand kinematics of movements with a variable tangential compressive component. Structural complications of Hercynian folded forms by progression of the deformation of the general compression. The previous article discovered, the natural geological phenomenon of longitudinal tectonic advancement of sedimentary geomass from DF to the north-west in the direction of DDB. It was revealed on the geo-mapping actual materials of the transition zone territory between Basin and Foldbelt [Bartashchuk, Suyarko, 2020]. Tthe structural consequence of this inversion process is the formation of a system of folding coverings of regional scale, which was identified within the WDG as the West Donets Cover-Folded Tectonic Region.

The purpose of research

The purpose of regional geotectonic research is to determine the geodynamic regime of tectonic inversion and the natural mechanism of deformations of the rift structure for modeling the geodynamics of the formation of the West Donetsk Cover-Folded Region.

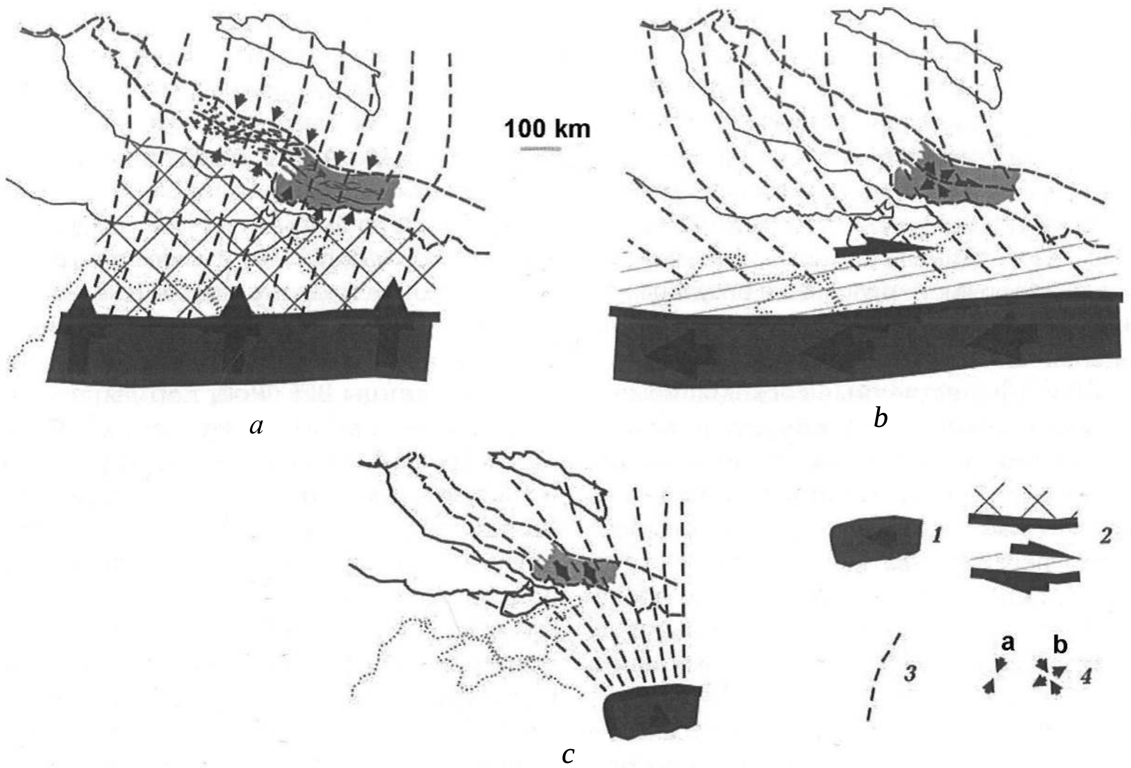

Fig. 1. Schemes of geodynamic regimes of tectonic inversion of the Dnieper–Donets paleorift [Gonchar, 2019]:

a – collision mode of the initial stage of inversion; b – local transtension in the mode of right shift of the main stage of inversion; c – the scheme of induction influence of the remote collision orogen. Symbols: 1 – mobile area of the active environment; 2 – deformation conditions: top – collisions, bottom – strike-slip deformations; 3 – model trajectories of compression stresses; 4 – modes: a – tangential compression; b – strike-slip deformation.

Materials and methods of research

When diagnosing the kinematic mechanism of inversion deformations, we applied the original method of reconstruction of stress and strain fields, as well as and tectonophysical analysis of geostructures [Bartashchuk, 2019]. As an analytical cartographic material, we used a comparative scheme of tectonites of the Hercynian, Laramian and Attic structural floors at a scale of 1: 200,000 according to geo-mapping [Goryainov, & Sklyarenko, 2017].

Research results

The tectonic inversion of DDB and DF is assumed to covers at least three stages. The deformation structure formation took place at the Initial Stage of inversion of the riftogenic structure, during the Zaal and Pfalz phases of late Hercynian tectogenesis. It happened in the conditions of the inversion rise of the Foldbelt in the geodynamic mode of transformation. Transverse compression of the rifting structure with a northeastern slope of the axis of maximum compressive stresses б 1 was accompanied by moderate longitudinal stretching of the WDG structure in the thrusting and strike-sliping mode with a small left component [Kopp, Korchemagin, 2010; Kopp, Kolesnichenko, et al., 2017]. The inclination of the axis of the average compressive stresses б 2 in the western and northwestern rhumbs caused horizontal displacements of the geomass of sedimentary rocks toward the less compressed territory of the depression. This shows that the riftogenic structure has undergone inversion folded deformations in the geodynamic mode of interference of general-plate collisional compression with the regional strike-slip stress field [Bartashchuk, Suyarko, 2019].

At the Initial Stage of tectonic inversion, in the axial zone of the Graben, numerous surfaces of tectonic failure emerged and echelons of uplifts and thrusts were formed in the tectonic field of intense strike-slip deformations (Fig. 2). Together, they formed a separate Hercynian thrusting framework, which controlled the southwestern direction of the horizontal movements of the sedimentary geomass (see Figs. 3–6 in [Bartashchuk, Suyarko, 2020]). Behind this tectonic framework, the structural paragenesis of the thrust cover plates was formed, which significantly complicated the rifting structure of large axial structural basins – Komyshuvaska, Bakhmutska and Kalmius-Toretska. Thus, the south-western direction of tectonic transport is defined as the main one at the initial stage of tectonic inversion is defined as south-western. According to it, the geomass of the sedimentary cover was wedged to the southern side of the Graben.

The Hercynian cover-folded tectonic region was formed as a result of horizontal displacements of Hercynian tectonic blocks behind the lattice of thrusts of the south-western direction of movements with amplitudes of tens of kilometers within the Graben. From the South-Donbas Melange Zone, formed simultaneously on the northern slope of the Azov Crystalline Massif, it is limited in the south by the main Hercynian thrusts – Kotlinsky and Mertsalivsky northwestern extension and Novoselivsky sub- latitude (see Figs. 3–6 in [Bartashchuk, Suyarko, 2020]).

The cover-fold structure of the Hercynian structural floor was formed due to the manifestation of late Hercynian collision movements and deformations. It consists of anticline folded zones of the north-western extension in the DDB and a linear uplift-folding of variable directions of extension, with a length of tens to hundreds of kilometers in the ZDG. In the Luhansk-Komyshuvakha Tectonic Area of the rocky linear fold, large anticlinal and synclinal forms were formed. They include the Main anticline, and smaller uplift-folds of the north-western extension. According to morphological and genetic features, folding is due to the kinematic mechanism of longitudinal bending of sedimentary horizons in the geodynamic mode of transformation. So the uplift-folds are identified by disfault duplexes of compression [Sylvester, 1988].

The Paleozoic complex is wedged to the southern side of the Graben behind the framework of Hercynian thrusts of southwestern vergence (Figs. 2). There are remnants of the Mesozoic cover, preserved from complete erosion in the rear of the thrust system, in the central parts of the axial basins of the Graben, on the Hercynian neoautochthon with sharp erosion and angular mismatch hercynian blocks have an elongated scaly shape of the north-western extension within Bakhmutsky and Kalmius-Toretsky basins (see Figs. 3–6 in [Bartashchuk, Suyarko, 2020]). In the frontal parts of the blocks, small fracture anticlines with steep and short south-eastern wings and long and sloping north-western ones are formed. In the rear parts of the blocks, they turn into sloping synclines or monoclines.

In the Forland system, in the extreme southeast of the DDB, the immersion of the sole by the Mesozoic in the same direction causes a gradual exit from the erosion and an increase in the completeness of the incision of the Mesozoic cover. The roof of the Hercynian structural floor lies at depths of more than 3 km on the Eastern slopes of the Orylsky basin of the axial zone of the depression.

Thus, the analysis of geomapping data shows that a specific inversion tectonic style of the Transition Zone between DDB and DF was established as a result of tectonic inversion processes with the formation of the Hercynian cover-folded region. Collisional tectonic movements of the northern direction took place at the Main and Neotectonic stages of tectonic inversion, in the Cimmerian and early Alpine (Laramian phases) of the Orogenesis epoch, formed the Laramian structural floor. Favorable geodynamic conditions were created due to the location in the central part of the WDG of the area of concentration of the axes of maximum compression of the north-western orientation (Fig. 3) In such conditions the geomass of the sedimentary cover began to move from Foldbelt to the northwest within Basin.

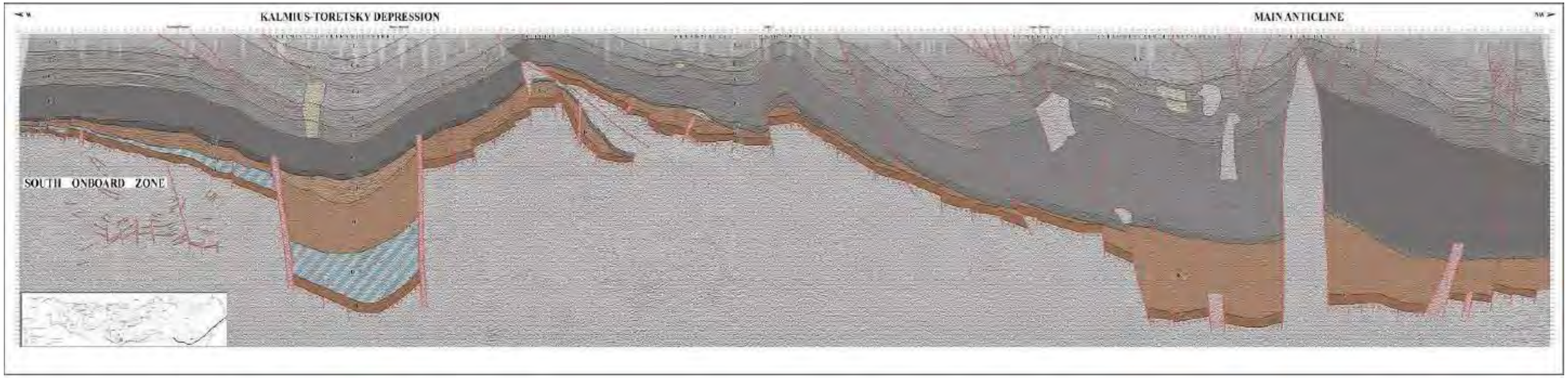

Fig. 2. Seismic section according to the regional profile Krasnoarmeysk–Biryukove, according to the materials of the State Enterprise "Ukrgeofizika" [Pobedash, 2014].
On the insert – the profile line on the map.

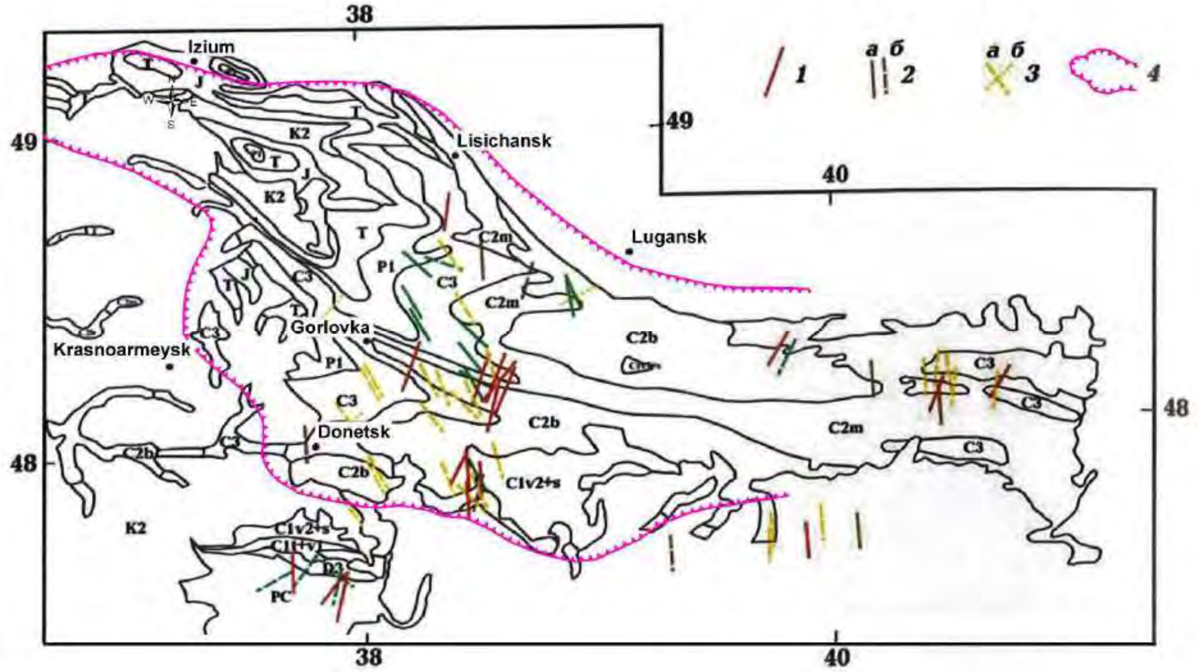

Fig. 3. The scheme of orientation of the axes of compressive stresses on the territory of the West Donetsk Graben [Gonchar, 2019] with addition:
Symbols: 1–3 – orientation of compression axes by different geodynamic models: 1 – collisions; 2 – right-hand transpression: a – uplifting, b – strike-sliping types; 3 – right-hand displacement: a – strike-slip, b – downthrow types; 4 – boundaries of the West Donetsk Segment of Tectonic Wedging.

The tectonic framework of deformations consists of a lattice of thrusts with many kilometers of amplitudes of horizontal movements on them. These include North-Donetsky and Drobyshivsky in the north-eastern part, Diamond and Axial in the axial zone, Samara and Voikovsky in the south-western part of the Graben (see Figs. 3–6 in [Bartashchuk, Suyarko, 2020]). According to the coulisse echeloned system of Laramian thrusts there were strike-slip deformations of Hercynian primary linear folded zones with their fragmentation into spiral articulated branches. Large plates and smaller scales of tectonic thrust covers were also formed. The Laramian cover-folded region was formed on this structural-tectonic framework, the main structural element of which was the West Donets Ssegment of Tectonic Wedging. Its structure will be discussed in detail below.

At the Neotectonic Stage of tectonic inversion, during the Late Alpine epoch of the orogeneses (Attic phase), there were intense collisional movements of the north-western direction of vergence. They formed the Attic structural floor. Due to the late Alpine movements, the Alpine Donets Ridge was formed on the territory of the DF. Within the ZDH, under conditions of lower intensity of deformations, flat plates-covers of tectonic thrust were formed behind the lattice of Attic thrusts in the Oligocene-Miocene sedimentary cover. The main direction of tectonic transport in the last two stages is determined by the north-western one, according to which the cover-folded Mesozoic-Cenozoic allochthon from the territory of WDG approached the weakly located Hercynian neo-autochthonous DDB.

Comparative structural analysis of tectonite lattices of different ages confirms the following conclusion. It is obvious that in the latest stress field the Hercynian thrusting lattice, behind which large linear anticlines and folding wedging covers were laid, was later deformed by the Laramian and Attic uplift-thrusting lattice with a significant strike-slipping component of movements. Due to this, a complex cross-wedging structural-tectonic framework was formed within the transition zone between DDB and DF (see Figs. 3–6 in [Bartashchuk, Suyarko, 2020]).

Because of significant horizontal displacements of the geomass of the Mesozoic-Cenozoic allochthon in the conditions of the limited geological space of the WDG, there was a significant distortion in terms of the primary linear routes of the main thrusts: North-Donetsky, Diamond, Drobyshivsky, Samarsky Laramian and later – Alpine – Maryevsky, Lysychansky, Khrestyshchensky, Dileyvsky and Novoselivsky thrusts (see Figs. 3–6 in [Bartashchuk, Suyarko, 2020]). The most drastic changes in the plane extension of these structure-forming thrusts took place on the flanks of the West Donets Segment of Tectonic Wedging and within the Kalmius-Toretsky axial basin. Moreover, on the north-eastern flank there is a change in the extension of the North-Donetsky, Diamond, Drobyshivsky and Newest thrusts from the north-west to the west. However, on the south-western flank, a change is from the west to east. These inversion deformations of the wedging frame caused the corresponding flexural bending of the axes of anticlinal and synclinal uplift-folds formed in their raised wings, with a tendency to adapt to the extension of their planes. Only the north-western extension of the thrusts of the Axial Zone, Sulino-Konstantinovsky and Axial, remained unchanged, but they were fragmented into separate, coulisse articulated branches.

Thus, the analysis of geomapping data allows us to conclude that a specific inversion tectonic style of the Transition Zone between DDB and DF was formed due to the processes of tectonic inversion, with the formation of the Laramian cover-folded region. The rifting style of Basin characterized by regional south-eastern dipping of the horizons of the platform sedimentary cover. In contrast to it, the inversion style of the Western Donets Tectonic Region is characterized by reverse dipping of the horizons of Hercynian, Laramian and Attic folded structural surfaces. This geological phenomenon can be explained only by the increase in the thickness of the sedimentary cover due to the increase of the section by the allochthonous formation in the volume of folded floors in the limited geological space of the Transition Zone.

All the identified structural features of the tectonic structure of the Transition Zone, which are signs of intense deformation of the horizontal displacement, are the basis of the original kinematic model of the Zone formation (Fig. 4). According to this model, at the Mesozoic-Cenozoic stage of tectonic inversion, the general tectonic transport was carried out along the sublatitudinal axis of the middle compression with an inclination to the northwest. Under such circumstances, the displacement of geomass was carried out from the compressed axial WDG to the zones of geodynamic shadow – in the direction of the Orylsky basin of the DDB and to the onboard zones of the Graben. These tectonic movements contributed to the formation of curvilinear coulisse articulated uplift-folded structural paragenesis in the primary linear Hercynian deformation zones of cleavage with the formation of a regional cover-folded system of tectonic thrust (Fig. 4, inset b).

According to the kinematic model, the tectonic framework of the West Donetsk Cover-Folded Tectonic Region consists of three dynamically conjugate Linear Zones of strike-slip control of subregional scale (Fig. 4). The North-Eastern wing of the thrust system is formed by the linear zone of coulisse articulated Laramian North-Donetsky, Diamond and Drobyshivsky thrusts and Attic Mariivsky, Khrestyshchensky, Dileyevsky and Lysychansky thrusts (see Figs. 3–6 in [Bartashchuk, Suyarko, 2020]). The Central linear zone of strike-slip control is formed by the echeloned branches of the Axial, south-eastern branch of the Samarsky and northern branches of the Diamond Laramian thrusts, and Sulino-Konstantinovsky Hercynian thrust. The South-Western wing of the thrust system is formed by the linear zone of spherically articulated branches of the Samarsky and Voikovsky Laramian thrusts, Novoselivsky, Kotlinsky and Mertsalivsky Attic thrusts.

Together, these three Linear Zones could serve as tectonic "rails" along which the cover-folded Mesozoic-Cenozoic allochthonous WDG approached the weakly deployed Hercynian neo-autochthonous of the south-eastern part of the DDB. Moreover, the Central Linear Zone is identified by the axis of longitudinal symmetry, the formation of which caused the tectonic spreading of the geomass of the sedimentary cover from the Axial Zone of the Graben in opposite directions – to its southern and northern sides.

We suppose the structural deformations of the rift-like structure of the Basin diagnosed by us were caused by the invasion of the "tectonic stamp" of the DF. The main structural element of this stamp is the West Donets Segment of Tectonic Wedging of sedimentary geomas. Most probable it is formed by the kinematic formation mechanism of the "orocline of the transverse extension of the pushing type" (Fig. 4, inset a).

It has been established that tectonic orocline displacement is usually bordered by geoblocks-stamps, which have an abnormally high degree of compression, orogenic rise and fold formation in the front of its intrusion [Kopp, 1991]. In accordance with the laws of geomechanics, the transverse bending of the convex part of the orocline forms a mode of longitudinal tension, instead of concave – longitudinal compression, due to lack of geological space in close proximity to the geostructure-stamp. Because of this, the sliding orocline is usually bent in the direction of horizontal movement of the tectonic stamp and, moreover, is often complicated by the wedging second-order orocline moving towards it.

Taking this into account, a gradient geodynamic band of injection of geomass of sedimentary rocks was diagnosed along the entire front of the tectonic invasion of the West Donets Wedge Segment, where folded displacement zones were formed. Morphologically, they are represented by anticlinal throw-folds and folded plates-covers. The North-Eastern wing of the front consists of the Torsko-Drobyshivsky, North-Donetsky, and Matrosko-Toshkivsky linear folded zones (Fig. 4, see Figs. 3–6 in [Bartashchuk, Suyarko, 2020]). The remaining large anticline and syncline zones are located in the Central linear zone of horizontal-shear control. The largest Great-Komyshuvasky, Novotroitsky, Druzhkivsko-Kostiantynivsky and Main linear anticline uplift-fold zones of the Luhansk–Komyshuvasky Tectonic Area were formed in the zones of axial thrusts.

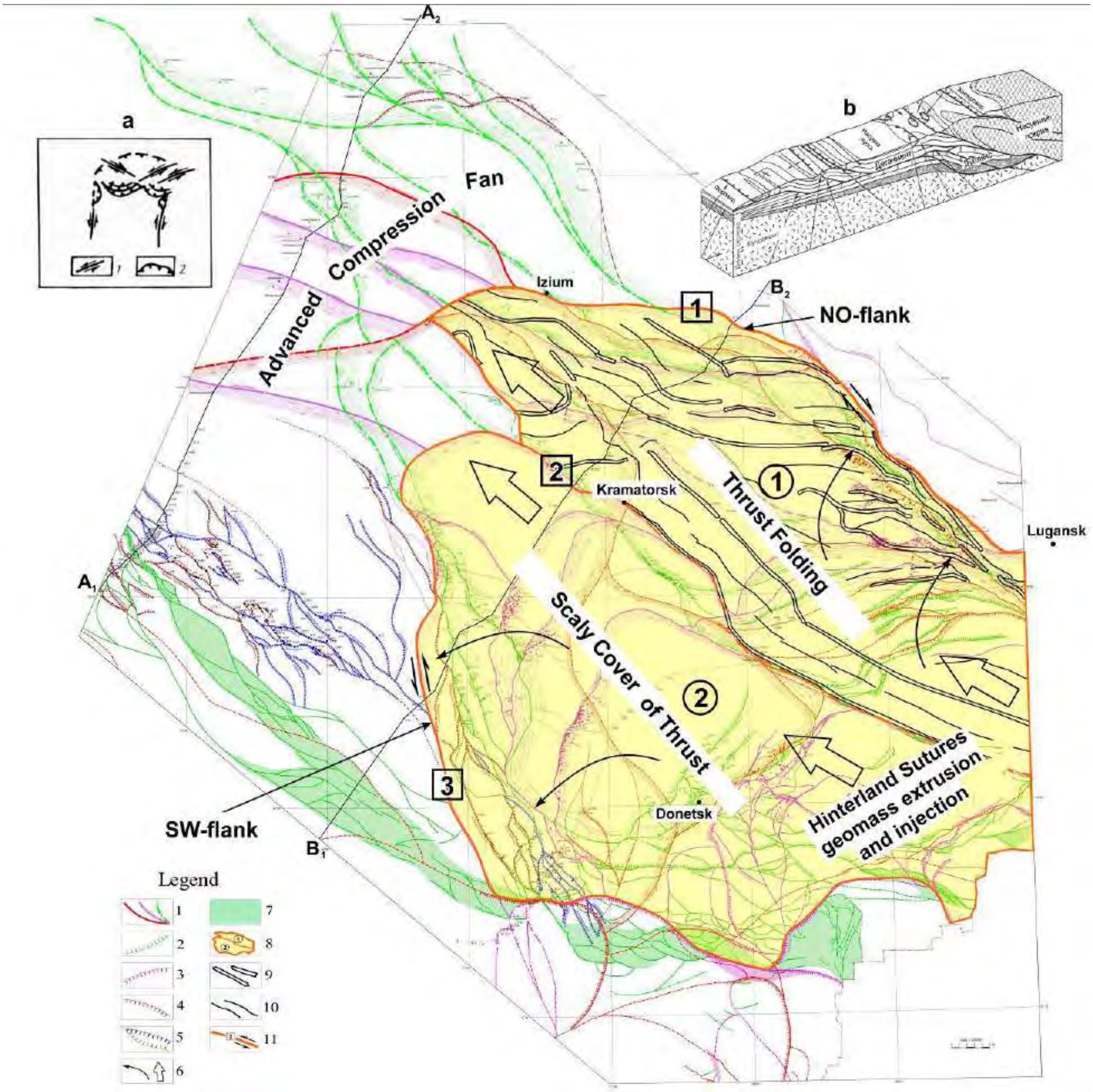

Fig. 4. Scheme of kinematics of formation of the West-Donets Cover-Folded Area:
Symbols: 1 – tectonic compression fan; 2–5 – rift downthrows, agreeable and disagreeable; 6 – directions of spreading and transport of geomass; 7 – South Donets Melange Zone; 8 – Segment of Tectonic Wedging: (1) – Luhansk-Komyshuvakhsky tectonic district of rocky folding, (2) – Kalmius-Toretsky tectonic district of thrust covers; 9 – synforms; 10 – antiforms; 11 – Linear zones of invasion: [1] – North-Eastern zone, [2] – Central zone, [3] – South-Western zone. Insertions: a – scheme of the orocline insertion by [Kopp, 1991], b – principal model of the tectonic wedging system by [Moody, Hill, 1960].

An advanced scaly compression fan is formed in the foreland of the approach of the West Donets Tectonic Segment, in the zone of connection of the central and southern branches of the axial salt dome shafts of the depression. It consists of a tectonic node of dynamically conjugate thrusts and strike-slip faults of three structural floors.

Summarizing the results obtained, the following should be noted. During the Laramian and Attic phases of Alpine tectogenesis, orogenic movements in the DF occurred in the mode of transverse compression with the inclination of the compression axis in the northwestern rhumbs in the uplift-thrust mode and moderate sublatitudinal stretching in the strike-slip field of the right-hand kinematic moves. Due to the formation of the area of concentration of the axes of maximum compression of the north-western orientation in the central part of the WDG (Fig. 3), geodynamic conditions were created. These conditions favoured the advancement and, in some areas, the displacement of the sediment cover geomass from the Foldbelt to the northwest – within the Basin.

Behind the lattice of Hercynian thrusts, the dislplaced Paleozoic cover geomass was pushed from the Axial Zone of the WDG to the south side. Subsequently, the cover-folded allochthon from the DF was pushed on the Hercynian folded neo-autochthon and the weakly dislocated autochthon of the south-eastern part of the Basin behind the dynamically conjugate lattice of Laramian and Attic thrusts. In the front of the regional system of tectonic wedging, a geodynamic injection band was formed, where folded zones of geomas displacement developed. They are formed by spherically articulated linear zones of throw-folds. An advanced scaly compression fan is formed in the foreland of the system, in the area of the joint of the central and southern branches of the axial salt-dome shafts of the depression, at the ends of the dynamically conjugate main thrusts. In the hinterland of the thrust system, tectonic sutures were formed – the deep roots of folded coverings of different ages, which are located on the slopes of the DF.

Thus, the establishment of a collision tectonic style of deformations of the Transition Zone allows us to conclude that the rifting structure in the extreme Southeast of the Basin and within Graben is almost completely destroyed by the folding of the three main phases of platform activation. First, the dislocated geomass of the Paleozoic sedimentary cover from the Axial Zone is wedged along the lattice of Hercynian thrusts to the southern riparian zone of the Graben. Second, tectonic movements behind the lattice of Laramian and Attic thrusts on the weakly deployed Hercynian neo-autochthon of the South-Eastern part of the Basin later wedged the Mesozoic-Cenozoic cover-folded allochthon by the DF.

Scientific novelty

The original geodynamic model of tectonic inversion of DDB and DF provides for the formation of the West-Donetsk Cover-Folded Tectonic Region. It for the first time stands out within the zone of their articulation – on the territory of WDG. The rift tectonic style of Basin is contrasted to the inversion tectonic style of the transitional zone. The former is characterized by regional immersion of the horizons of the platform sedimentary cover to the southeast, consistent with the direction of immersion of the Precambrian crystalline basement. The latter, however, is characterized by reverse immersion of the horizons of the Hercynian, Laramian and Attic folded structural floors in the north-western direction. This geological phenomenon is explained by a significant increase in the thickness of the intensively dislocated surfaces of the sedimentary cover due to the repeated increase of the incision by the cover-folded thick in the limited geological space of the Graben.

The main factor of inversion deformations of the rift structure is determined by the pressure of the "tectonic stamp" Foldbelt. The main structural element of the stamp was diagnosed in the West Donets Segment of Tectonic Wedging of sedimentary geomass. The model of tectonic oroclin of transverse intrusion of pushing type best corresponds to the natural kinematic mechanism of its formation.

Conclusions

The tectonic inversion of the Dnieper-Donets Basin and the Donets Foldbelt began in the Late Hercynian epoch in the mode of oblique left-hand collision as a consequence of orogenic movements on the southern outskirts of the Eastern European Platform. The folded anticline zones in the South-East of the Basin and the linear uplift-folding within the Western Donets Graben were formed due to the collisional warping of the platform cover horizons by the kinematic mechanism of longitudinal bending of the layers.

In the Mesozoic and Cenozoic tectonic inversion of the riftogenic structure continued in the strike-slip field of the right-hand kinematics of movements with a variable tangential compressive component. Under the influence of the tectonic stamp of the DF there was an intrusion of the Tectonic Wedging Segment crumpled into the folds of geomass was diagnosed with oroclin transverse pushing type. Flexural deformations of primary linear Hercynian uplift-folds took place under the geodynamic conditions of wedging and pushing geomasss in the limited geological space of the Graben. In addition, there was uncompensated increase of the sedimentary cover section due to cover-folded allochthonous thick. According to this kinematic mechanism, the West Donetsk Cover-Folded Tectonic Region was formed. It is a structural expression of the tectonic inversion of the Dnieper Donets Paleorift.

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ГЕОДИНАМІКА ФОРМУВАННЯ ПЕРЕХІДНОЇ ЗОНИ МІЖ ДНІПРОВСЬКО–ДОНЕЦЬКОЮ ЗАПАДИНОЮ І ДОНЕЦЬКОЮ СКЛАДЧАСТОЮ СПОРУДОЮ. ТЕКТОНІЧНІ РЕЖИМИ І КІНЕМАТИЧНІ МЕХАНІЗМИ ІНВЕРСІЇ

Мета. В статті вивчалися геодинамічні умови та природні механізми тектонічної інверсії Дніпровсько-Донецької западини та Західно-Донецького грабена. Методика. Використовувалася оригінальна методика реконструкції полів тектонічних напруг і деформацій та тектонофізичного аналізу геоструктур. Аналітичну базу досліджень склали новітні матеріали геокартування, чисельного моделювання деформацій південної околиці Східноєвропейської платформи та зіставлення модельних і відновлених полів напруг. Результати. В геодинамічній обстановці інтерференції внутрішньоплитного субмеридіонального колізійного стискання з регіональним горизонтально-зсувним полем напруг інверсійні деформації рифтогенної геоструктури відбувалися у підкидо-насувному та зсувному режимах. Це зумовило значні горизонтальні рухи геомас осадових порід, деформаційну складчастість з утворенням трьох інверсійних поверхів – пізньогерцинського (заальсько-пфальського), ранньоальпійського (ларамійського) та пізньоальпійського (аттичного). В них сформовано структурні ансамблі лускатих тектонічних покривів поперечного витискання геомас від осьової до бортових зон, складчастих покривів поздовжнього насування з боку Донецької складчастої споруди та протяжних лінійних анти- і синформ, простягання осей яких орієнтовано ортогонально до напрямку насування геомас. Спільно вони складають тіло сегменту тектонічного вклинювання геомас, що виділено у складі покривно-складчастої системи тектонічного насування регіонального масштабу. Особливістю тектонічного каркасу сегменту є криволінійність площин магістральних насувів, що його обмежують, та дрібніших насувів оперення, які контролюють складчасті покриви насування. Зміна простягання насувів з північно-західного напрямку на території Західно-Донецького грабена на західний на крайньому південному сході западини обумовлена вторгненням сегменту тектонічного вклинювання. Суттєві горизонтальні переміщення осадових геомас в межах геоблоків зумовили вигинання осей прирозломних анти- та синформ з тенденцією прилаштування осей складок до простягання насувів. Через витискання геомас від зони максимального стискання в осьовій частині грабена у зони геодинамічної тіні в межах Орільської улоговини та бортів грабену, в умовах обмеженого геологічного простору перехідної зони сформувалася Західно-Донецька покривно-складчаста тектонічна область. Наукова новизна. Створено оригінальну структурно-кінематичну модель тектонічної інверсії Західно-Донецького грабену. Механізм інверсії, завдяки якому рифтогенна структура зруйнована складчастими деформаціями платформного орогенезу, зумовлений тиском мегаблоку-“тектонічного штампу” Донецької складчастої споруди. Під його впливом у грабені сформувався сегмент тектонічного вклинювання, який діагностовано ороклином поперечного висування підсувного типу. Тіло ороклину утворюють ешелоновані, кулісно зчленовані ансамблі антиклінальних підкидо-складок, синкліналей та лускатих покривів насування. У форланді ороклину висування утворилися геодинамічні смуги нагнітання, де сформувалися складчасті зони витискання геомас, які складаються з кулісно зчленованих підкидо-антикліналей. У вершині ороклину, на закінченнях динамічно спряжених магістральних насувів, сформоване передове тектонічне віяло стискання. В тилу тектонічного ороклину, в хінтерланді покривно-складчастої системи на корінні складчастих покривів насування утворені тектонічні сутури. Практична значущіст**ь.** Розробка структурно-кінематичної моделі тектонічної інверсії Західно-Донецького грабену дасть змогу удосконалити геодинамічну модель тектонічної інверсії Дніпровсько-Донецького палеорифту, на підставі чого коригуватимуться регіональні схеми тектонічного та нафтогазогеологічного районування.

Ключові слова: Дніпровсько-Донецький палеорифт, Дніпровсько–Донецька западина, Західно-Донецький грабен, тектонічна інверсія, кінематичний механізм, мегаблок-тектонічний штамп, ороклин поперечного висування, передове тектонічне віяло стискання, геодинамічні зони витискання та нагнітання геомас.

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