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GEOLOGICAL ENVIRONMENTS FORMING THE EOCENE BLACK-SHALE FORMATION OF THE SILESIAN NAPPE (UKRAINIAN CARPATHIANS)

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Objective. To elaborate the geological structure and stratigraphy of the Eocene black shale formation of the Silesian Nappe, to recreate the depths and processes of its accumulation, and to reconstruct paleogeography and geodynamics of the Eocene sedimentatary Silesian Sub-basin. **Methodology** includes geological mapping, studing the lithostratigraphy and sedimentological features of the deposits (elements of Bouma sequence et al.) in a natural sedimentary succession, as well as paleobathimetric analyses of the foraminiferal assemblages. **Results**. The geological position of the studied sediments has been refined: the Eocene black-shale formation (Soimy Formation) developed within the Silesian Unit, and the variegated Paleocene-Eocene clayey deposits are distributed along the borders of the Silesian Unit in the Rozluch Structure (Subsilesian Nappe) and in the olistostrome strata. It is established, that the Soimy Formation is composed mainly of both products of the different density turbidity flows and the dark to black hemipelagic mud sediments. This formation was deposited in the Silesian Sub-basin at the bathyal-abyssal depths below the calcite compensation depth (CCD) which is indicated by the deepwater agglutinated foraminifera (assemblages "*Glomospira-Haplophragmoides*", "*Recurvoides*", "*Glomospira*", "*Rhabdammina-Reticulophragmium*" and fauna "A"-type). The Silesian Sub-basin was limited by the uplifts such as Bukovets (branch of Silesian Kordiliera) and Subsilesian ones, on which in the Late Paleocene, the pelagic calcareous sediments enriched with planktonic foraminifera were deposited at the bathyal depths above the CCD and above the foraminiferal lysokline. In the Eocene on these uplifts, the clayey (hemi)pelagic deposits with the agglutinated foraminifera (assemblages "*Rzehakina*", "*Glomospira*", "*Glomospira-Karrerulina*" and fauna "B-type and "*Rhabdammina-Reticulophragmium*") were settled below the CCD. In the Eocene, on the south-eastern wedge-shaped ending of the Silesian Sub-basin, there was a semi-isolated deep-water area, bounded on the northeast by the Sub-Silesian uplift, on the south-west by the Silesian (Bukovetsky) elevation, and on the south by the Fore-Marmarosh accretionary prism. Into this area, the circulation of the bottom-oxygen currents was limited and organic-enriched deposits (Soimy Formation) were deposited. At the end of Eocene, as a result of the subduction of the sedimentary basis of the Outer Carpathian Basin, the flysch strata was torn off from this basis and was thrust towards the platform and tectonically covered the submarine uplifts. Thrust movements caused the shallowing of the sedimentatary Outer Carpathian (including Silesian) Basin during the end of Eocene. **Scientific novelty**. A new paleogeographic model of the Eocene black shale (Soimy Formation) accumulation was proposed. According to the model, these deposits were accumulated by the turbidity flows and (hemi) pelagic sedimentation in the south-eastern semi-isolated deep-water section of the Silesian Sub-basin partly limited by uplifts. **Practical Value**. The geological characteristic of the Eocene black-shale formation, which may be potentially oil-generating, is given. Taking into account its availability, it can considerably expand the directions of the search of such work in the Carpathians.

Key words: Ukrainian Carpathians, Silesian Nappe, black-shale formation, turbidites, foraminifera

Introduction

The Silesian Nappe belongs to the Outer (Flysch) Carpathians filled with the Late Jurassic-Miocene mostly flysch deposits and thrust on the Carpathian Foredeep Miocene molasse. Outer Carpathians are composed of a tectonic nappes package and are considered as the Cretaceous-Neogene accretionary prism formed as a result of subduction of the Carpathian sedimentary basin basement under the Alcapa and Tisza-Dacia terranes, which is now located in the Inner (Central) Carpathians (Fig. 1) [Csontos and Vörös, 2004; Picha & Golonka, 2005; Oszczypko, 2006; Hnylko, 2012; Kováč et. al 2016, 2017].

The Silesian Nappe is one of the oldest oil-producing regions of the Carpathians. Within it, there are more than 40 oil fields in the territory of Poland, which gives hope for the opening of new deposits in Ukraine [Krupskyi et al., 2014].

Rich in organic matter thin scale argillites (black shales) have developed in the Ukrainian Carpathians, mainly in the Lower Cretaceous (Spas and Shypot formations) and Oligocene (Menilite Formation) sediments, the characteristics of which, are possible sources of hydrocarbons, given in works [Krupskyi et al., 2014; Sachsenhofer & Koltun, 2012 and references therein]. It is believed that the main source of oil and gas in the Outer (Flysch) Carpathians is the black-shale strata of the Menilite Formation

(Oligocene – Lower Miocene) [Curtis et al., 2004; Picha & Golonka, 2005; Kotarba et al., 2009]. The total organic carbon content (TOC) in the black shales of the Menilite Formation in the outer (north-eastern) tectonic units of the Carpathians (including Boryslav-Pokuttya structural-facial unit) reaches 20 %, although on average varies between 4 and 8 %. TOC varies from 0.47 to 6.39 % in the Oligocene black shales of the Silesian Nappe [Sachsenhofer & Koltun, 2012].

However, in the Carpathian flysch, black shales are known not only in the Oligocene and Lower Cretaceous sediments. They also occur in the Eocene sediments, in particular, in the Silesian Nappe, where these shales are part of the Soimy Formation [Vialov et al., 1981], which represents the black-shale formation. In the Polish Carpathians, the TOC content reaches 1–2 % in the so-called "Black Eocene" of the Silesian Nappe [Waskowska, 2015]. In the Ukrainian Carpathians, these deposits were insufficiently studied as a possible source of hydrocarbons. In our previous works, stratification was detailed and some conclusions were drawn about the sedimentary conditions of the Soimy Formation on the basis of studing both the lithological/sedimentological features of the deposits and agglutinated foraminifera microfauna [Hnylko, Hnylko, 2010, 2011].

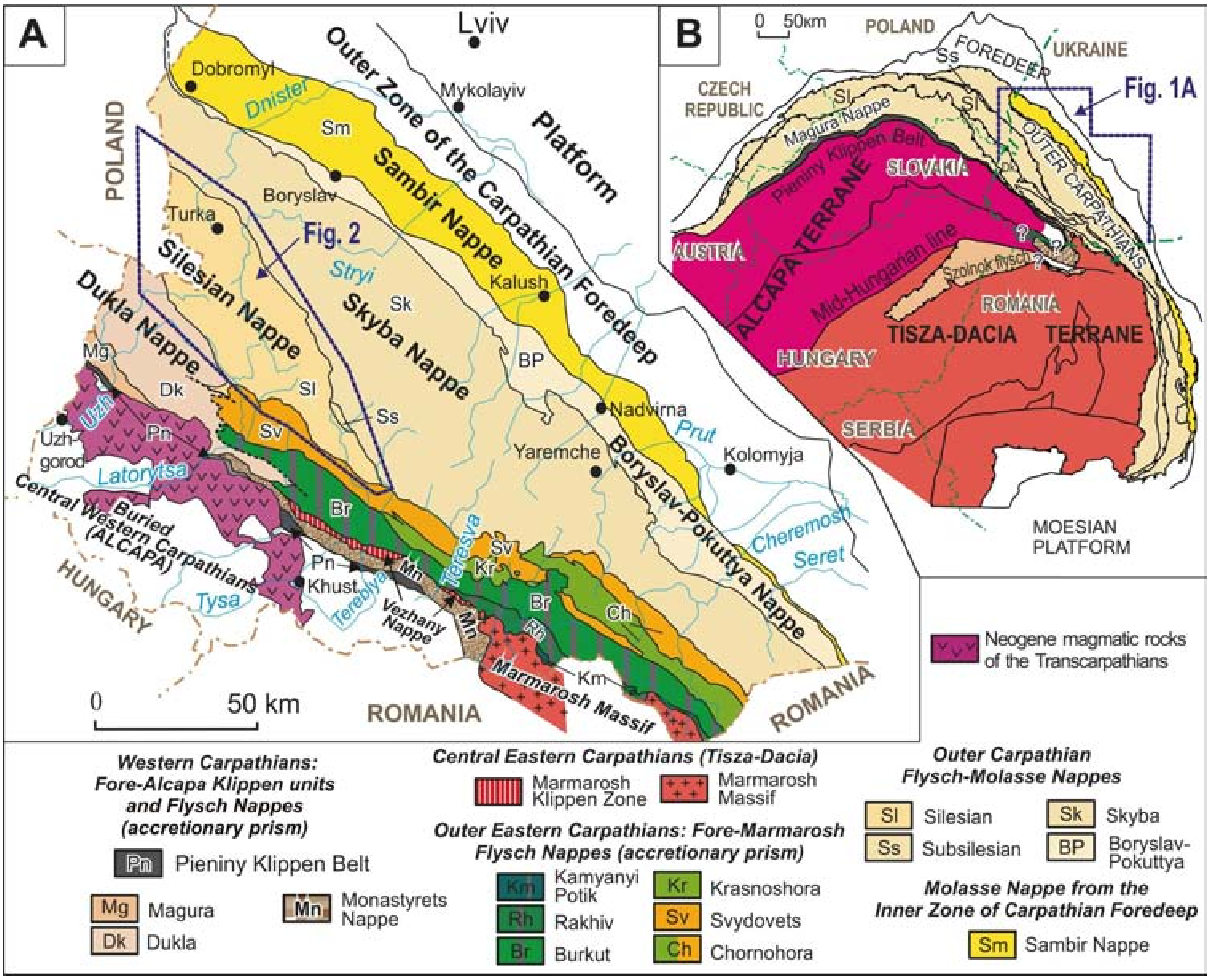

Fig. 1. A – main tectonic units of the Ukrainian Carpathians (Hnylko, 2012, modified); **B** – tectonic setting of the Ukrainian Carpathians, position of the terranes and main geological boundaries after Csontos and Vörös (2004); Schmid et al. (2008); Kovaè et al. (2016, 2017); simplified, partly modified

Objective

The aim of the work is to detail the geological structure and stratigraphy of the Eocene black shale formation of the Silesian Nappe as well as the sediments of adjacent tectonic elements, the reconstruction of the depths and the processes of their accumulation by both analyzing foraminiferal assemblages and sedimentological features of the rocks, and on this basis – the reconstruction of the paleogeography and geodynamics of the Eocene Silesian sedimentary Sub-basin.

Geological setting

The Silesian Nappe belongs to one of the largest tectonic units in the Outer (Flysch) Carpathians (see Fig. 1, Fig. 2). The greater part of it was developed in the Western Carpathians in the territories of Poland and the Czech Republic. It is filled with a thick complex of the Late Jurassic-Miocene predominantly flysch deposits [Picha & Golonka, 2005]. In the Ukrainian Carpathians, the boundaries and the filling matter of the Silesian (another name – Krosno) tectonic Unit are interpreted differently by various researchers [Glushko & Kruglov, 1971; Byzova & Beer, 1974; Glushhenko et al., 1980; Vialov et al., 1981; Kuzovenko, 2003; Picha & Golonka, 2005; Hnylko, 2010 and references therein].

Fig. 2. Location of the studied sections and samples on the scheme of the Silesian and Subsilesian nappes. Figure location see Fig. 1A

The nature and position of the north-eastern frontal border of the Silesian Nappe is particularly debatable. In field work carried out from 2006 to 2010, one of the authors, together with V. O. Vash-chenko (chief of the geological party of the Lviv Expedition), carried out special mapping research. As a result, the Silesian Nappe thrust zone, (marked by the melange and the olistostrome) extending from the Dniester River basin near the state border with Poland up to the Holatyn Structure (fragment of the Subsilesian Nappe) in the Rica River basin, was traced and mapped. [Hnylko, 2010]. According to such trace of the nappe frontal boundary, the Silesian Unit contains the Lower Cretaceous flysch (single outcropps in the tectonic lenses) and the Paleogene-Lower Neogene sediments. The Silesian Unit almost completely tectonically overlaps the SubSilesian Unit and was thrust on the more northern Skyba Unit. The Dukla Unit was thrust on the Silesian Unit from the southwest and the Svydovets Unit was thrust on the Silesian One from the south (see Fig. 2).

Typical for the Outer Carpathians, Oligocene-Miocene Menilite, Verets (transitional) and Krosno formations occupy most of the Silesian Nappe territory. Pre-Oligocene deposits locally developed in the central parts of the Silesian Nappe are composed mainly of the Eocene black-shale formation (the Soimy Formation). This formation is exposed in the vaulted parts of the several anticlines in the Rika River basin near the village of Soimy [Vialov et al., 1981] as well as in the so-called "Smozhe Structure" – a transpressional duplex (tectonic lens) where the Eocene is squeezed to the surface among the Oligocene strata [Hnylko & Hnylko, 2010, 2011] (see Fig. 2).

From the northeast, the Silesian Unit is limited by the so-called "Rozluch (Weglowka) Structure" – a narrow strip of highly dislocated (up to tectonic melange) rocks. Other types of the pre-Oligocene sediments were developed here. Paleocene-Eocene variegated (red and green) flysch and red shales are present in this strip [Vialov et al., 1981]. Variegated shales and marls with the Late Cretaceous microfauna are also described in it [Glushko & Kruglov, 1971 and references therein]. The tectonic position of the Rozluch Structure is controversial, some researchers believed that it could be a continuation of the Western Carpathian SubSilezian Nappe [Glushko & Kruglov, 1971 and references therein; Vialov et al., 1981; Picha & Golonka, 2005]. The SubSilezian Nappe is distinguished in the Polish and Czech Carpathians, where it includes the Upper Cretaceous – Eocene red and green shales and marls [Picha & Golonka, 2005].

In previous work [Hnylko, 2010; 2012; Hnylko, Hnylko, 2011], we followed the published State Geological Map of Ukraine, Scale 1: 200 000 [Kuzovenko, 2003] and attributed the Rozluch Structure to the Silesian Unit. New data (see below) leads us to the point of view of comparing the Rozluch Structure with the SubSilezian Nappe. The Holatyn Structure developed in the Rika River basin is also compared with the SubSilezian Nappe [Byzova & Beer, 1974; Hnylko, 2010].

The Rozluch Olistostrome developed ahead of the front of the Rozluch Structure [Hnylko, 2011] and contains olistoliths of the red marl sediments (see Fig. 2). Probably, the olistostrome was formed by the erosion of the moving uplifted front of the Sub Silesian Nappe. The age of the olistostrome is probably Oligocene or Early Miocene.

The olistostrome also developed in the southwestern back part of the Silesian Nappe ahead the front of the Dukla Nappe [Glushhenko et al., 1980; Kuzovenko, 2003]. We named it "Volosyanka Olistostrome", because the most indicative is near the village of Volosyanka-Zakarpatska in the upper reaches of the Uzh River. Olistoliths of the Dukla Nappe rocks [Hnylko, 2000; 2011], as well as olistoliths of "exotic" red and variegated marls, were identified in the olistostrome (see Fig. 2). Volosyanka Olistostrome overlaps the Oligocene flysch (the Krosno Formation) and its age is likely to be Oligocene or Oligocene-Miocene. The composition of the olistoliths suggest that the olistostrome was formed as a result of erosion of the uplifted Dukla Nappe front moved onto the Silesian sedimentary Subbasin [Hnylko, 2000]. The thrust sheets were involved not only in the Dukla Subbasin sediments, but also in red and variegated marls previously lying on the uplift between the Dukla and Silesian Subbasins. The erosion of the thrust sheets led to the olistostrome accumulation.

Consequently, the Eocene black-shale formation developed in the Silesian Unit central part and the Paleocene-Eocene "non-flysch" red marls/shales are situated along the Silesian Unit edges.

Materials and methods

The geological situation in the research area was clarified and detailed by geological mapping conducted within the framework of the geological study program and prepared for the publication of the Stryi Sheet of the State Geological Map of Ukraine at a scale of 1: 200,000. The black-shale Soimy Formation as well as the bordered deposits were studied in several natural sections (Fig. 3). The structural and textual sedimentological features of the turbidity (Bouma elements), debris-flow/olistostrome and hemipelagic/pelagic sediments were studied in the outcrops. The materials of this study of some sections of the Silesian Nappe are partially published [Hnylko, Hnylko, 2010, 2011]. In the presented paper, they are supplemented and presented in complex with new data of the study of adjacent sections as well as with palaeobathymetric analysis of the foraminiferal assemblages.

The methods of palaeobathymetric analysis of the foraminiferal assemblages are based mainly on the study of the taxonomic composition and morphology of the specimens in accordance with the principle of actualism. Today, two main groups of such methods can be identified. The first group includes the study of the microfauna from the calcareous hemipelagic/ pelagic sediments. According to these methods, the percentage of the planktonic foraminifera specimens relative to benthic ones increased with the deepening of the basin. In this case, the predominance of benthic speciments is characteristic for sublittorial zone, and the advantage of planktonic ones is characteristic for bathyal zone [Murray, 1976].

The second group of the methods includes the study of the deep-water microfauna of the flysch deposits as well as the (hemi) pelagic clay sediments deposited near or below the calcite compensation depth (CCD). For such a microfauna, the dominance of agglutinated benthic foraminifera with siliceous composition is characteristic.

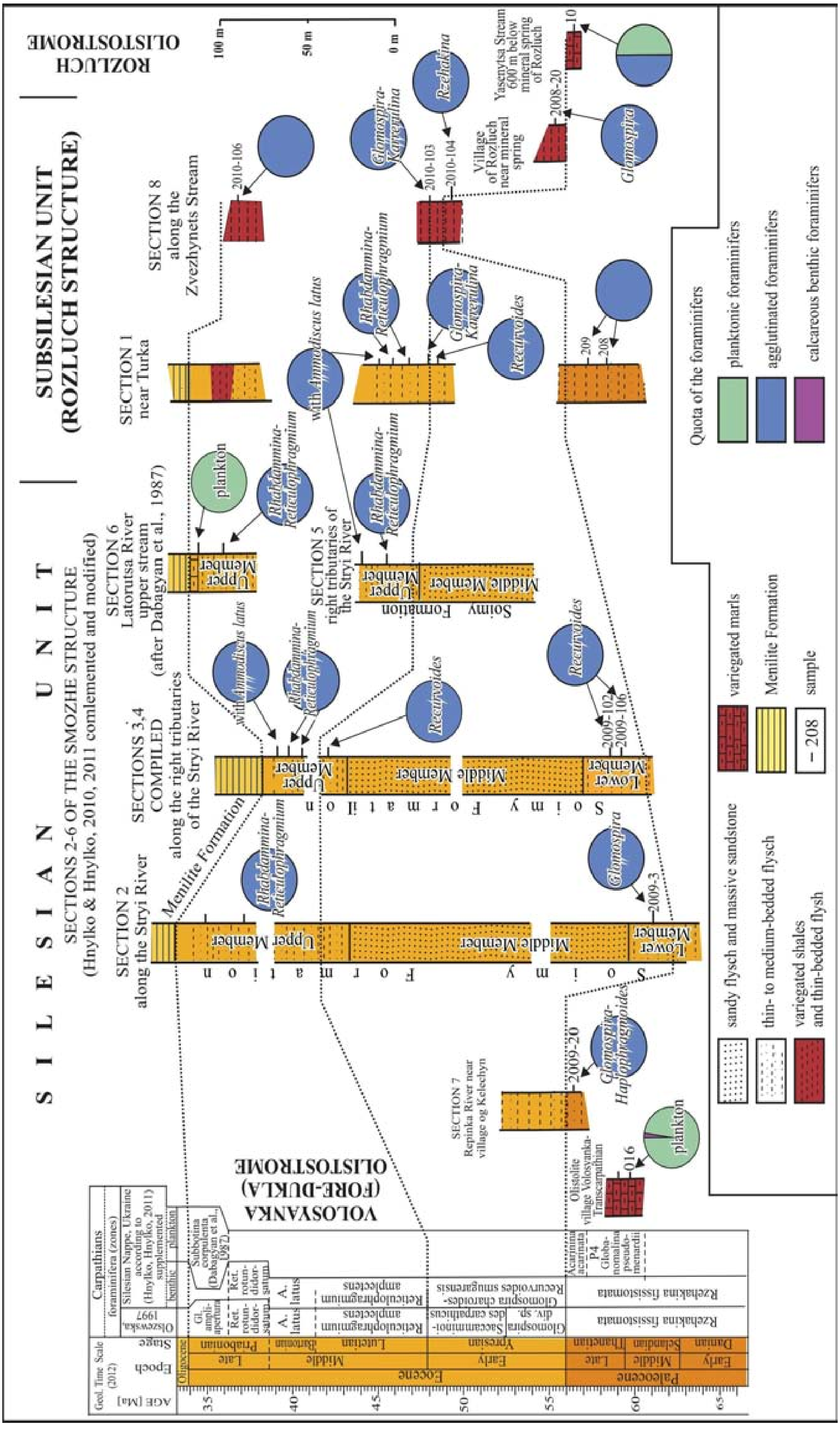

Fig. 3. Correlation of the section studied and foraminiferal assemblages of the Paleocene-Eocene deposits in the Silesian and Subsilesian nappes.

These fossils are interpreted as deep-water agglutinated foraminifera (DWAF) [Kaminski et. al, 1988; Kaminski et. al, 1989; Kaminski, Gradstein, 2005; Kuhnt, Kaminski, 1989; Olszewska 1984; Waśkowska, 2015]. According to the classification [Kaminski et. al, 1988 and references therein], the fauna of the "A"-type is represented by large, coarse-grained tests and the fauna of the "B"-type is expressed by small-sized forms with a fine-grained wall, often smooth surface in the tests. The A-type fauna characterizes the basin slopes and depressions with rapid sedimentation, and the "B"-type fauna is typical for deep-water conditions below the CCD with slow sedimentation. Both methods were used by us for reconstruction of the paleobathymetry of the Carpathian Basins depending on the type of sediments.

Samples for micropalaeontological studies (weighing 300 g) were collected from (hemi) pelagic sediments: 1) marls; 2) variegated (red and green) shales; 3) gray shale in the rhythmic flysch.

Results

Stratigraphy and sedimentological features of the studied deposits

Silesian Nappe. Eocene black-shale Soimy Formation are developed here. Its lower contacts are cut off by the faults, and the upper ones are expressed by a gradual transition to the Oligocene Menilite Formation. Near the village of Soimy in the Rika River Basin, the Soimy Formation is composed of dark to black medium-rhythmic flysch (medium-grained turbidites) with thick layers of quartz sandstone (probably grain flow deposits) in places (Fig. 4). Thin-layered and homohenius argillite intercalations are present and indicate the (hemi) pelagic origin of these intercalations. Argillites are dark-gray, dark-green and black, moreover black ones dominate.

Fig. 4. Dark to black flysch of the Soimy Formation of the Silesian Nappe. Repinka River, near the village of Repinne, Rika River Basin

These deposits in general are low in microfauna. Near the village of Kelechyn we found agglutinated foraminifera (see. Fig. 3, section 7, sample 2009-20) including *Rzehakina minima* Cushman et Renz and *Recurvoides varius* Mjatliuk (Paleocene), numerous *Glomospira charoides* (Jones and Parker) and *G. gordialis* (Jones and Parker), which indicate the proximity of the Paleocene-Eocene boundary.

In the upper reaches of the Stryi and Latorytsa River basins, the Soimy Formation is developed in the Smozhe Structure. Here, the formation was subdivided into three members in the studied sections 2–5 (see Fig. 3) [Hnylko, Hnylko, 2010, 2011].

The Lower Member (thickness of the exposed part up to ~200 m) is represented by thin- and medium-bedded alternation of the black and green mudstones, gray mudstones, siltstones, finely and middle-grained sandstones. Textures of Bouma sequence T_{cde}, T_{bcde} are developed in the rocks. Black and green mudstones are characterized by thin-parallel textures indicating their (hemi) pelagic origin.

The Middle Member (thickness ~350–400 m) is composed of thick-bedded different-sized sandstones, of which some are gravelites. It is characterized by massive and pudding-like textures that suggest its sedimentation by the grain- and high-density turbidity flows.

Fig. 5. The lens of the debris-flow deposits among the fine-grained turbidites in the Upper Member of the Soimy Formation, Silesian. Nappe, Smozhe Structure. Stryi River, beneath the village of Klymets

The Upper Member (thickness ~200 m) consists of a thin and rarely middle-bedded alternation of the black and green mudstones, siltstones, and finely and middle-grained sandstones. It is similar to the Lower Member and characterized by the same texture features. Horizons (thickness to the first meters) of the debris-flow deposits are observed with fragments of the flysch rocks in some outcrops (Fig. 5).

It is noted that the number of the black mudstone layers in the Smozhe Structure Soimy Formation is much smaller compared to the deposits of the same formation in the Rika River basin.

Smozhe Structure deposits contain numerous agglutinated foraminifera in the age range from the Early to Late Eocene. The biosons are identified in these sediments [Hnylko, Hnylko, 2011].

The Glomospira charoides–Recurvoides smugarensis Zone (Lower Eocene) was distinguished in the Lower Member (sections 2, 3i, 4, see Fig. 3) and in the lower part of the Upper Member (section 4). In addition, the Lower Member is correlated with Glomospira diversity species Zone (lowermost Lower Eocene of the Polish Carpathians) according Olszewska [1997].

The Ammodiscus latus Zone (section 4 and 5), Reticulophragmium amplectens Zone (sections 3 and 5) and Reticulophragmium rotundidorsatum Zone (section 1) were recognized in the Upper Member.

Samples from the Middle Member were not collected due to the absence of the mudstone intercalations. The stratigraphic position suggests correlating of the Middle Member with the Lower Eocene Cenzhkovice sandstone of the Silesian Nappe of the Polish Carpathians.

In the upper reaches of the Latorytsa River, the Upper Eocene Sheshor Horizon (Gloigerina Marl) developed in the top part of the Soimy Formation (section 6). It is expressed by dark-gray and gray homogeneous and parallel-laminated marls (2 m thick) of hemipelagic origin. Late Priabonian Subbotina corpulenta Zone was identified in this horizon after planktonic foraminifera [Dabagyan et el., 1987].

Rozluch Structure (SubSilesian Nappe). Here, the age analogue of the black-shale Soimy Formation is the Eocene red mudstone and the Paleocene-Eocene green and variegated flysch filling the tectonic lenses developed among the strongly dislocated (up to melange) rocks in the SubSilesian Nappe. Relatively undisturbed parts of the stratigraphic successions in these tectonic lenses were studied in the Zvezhynets Stream (right tributaries of the Stryi River near the Zavadivka and Zvezhinets villages, section 8) and near the mineral spring in the village of Pozluch (Sample 2008-20), as well as those previously described [Hnylko, Hnylko, 2010, 2011] near Turka (section 1, see Fig. 3).

In the several tectonic lenses (Zvezhynets Stream, section 8) the next deposits are exposed.

1. Green and variegated thin and middle-bedded flysch with the Bouma divisions T_{cde}, T_{bcde} typical for the fine-grained turbidites and, possibly, sediments of the bottom currents. Separate layers of the sandstones are characterized by divisions T_{abc} typical for medium-grained turbidites. The thin layers of the red and green mudstones in the flysh are characterized by thin-lamination and are the products of (hemi) pelagic sedimentation. The thickness of this flysch is up to ten meters.

2. Alternating red and green mudstones up to several centimeters, some were decimeters in thickness. The homogeneous massive and thin-laminated textures suggest the (hemi) pelagic origin of the deposits. The thickness of the mudstones in one of the tectonic lenses reach 15–20 m. The Paleocene Rzehakina fissistomata Zone in the lower part of the mudstone succession of this lense (sample 2010-104) was identified based on agglutinated foraminifera including the characteristic species ***Rzehakina fissistomata*** (Grzybowski), ***Recurvoides varius*** Mjatliuk, ***Glomospira diffundes*** Cushman and Renz, ***Hormosina trinitatensis*** Cushman and Renz, numerous ***Caudammina ovula*** (Grzybowski). Agglutinated foraminifers similar to the assemblage of the Lower/Middle Eocene boundary (section 1, see Fig. 3) were identified in the upper part of this mudstone succession.

3. Red homogeneous and unclearly layered mudstones fill the small (several meters) klippen among the mélange matrix. Mudstone is likely of pelagic in origin. Late Eocene ***Reticulophragmium rotundidorsatum*** (Hantken) (sample 2010-106, see Fig. 3) was found in the red mudstones.

Rozluch Olistostrome is developed in the Stryi and Dnister river basins near the Rozluch Structure in front of the SubSilesian Nappe, likely in the back part of the Skyba Nappe [Hnylko, 2011]. It was studied along the Yasenytsa River 600 m below the mineral spring in the village of Rozluch. The olistostrome is represented by the thick body (visible thickness up to the first tens of meters) with unexposed contacts. It consists of the deposits of the several debris-flows. Matrix is composed of semi-lithified gray, green, and red unclearly layered, and chaotic clay-sands sediments. Small (to the first decimeters) blocks of tectonically brecciated gray sandstones, siltstones, and olistoliths (up to the first meters) of destructured red clay-marl sediments (Fig. 6) are included in the matrix.

Fig. 6. Olistolith (to the left) of the destructured red clay-marl sediments in the olistostromic matrix composed of debris-flow deposits (to the right). Rozluch olistostrome, Yasenytsia River, 600 m below the mineral spring in the village of Rozluch

The Late Paleocene planktonic foraminifera represented by *Subbotina triloculinoides* (Plummer) and numerous speciments of *Acarinina acarinata* Subbotina were found in the red clay-marls (sample 10) filling the olistolith (see Fig. 6). Right there, the less numerous benthic foraminifera *Caudammina ovula* (Grzybowski) and *Glomospira charoides* (Jones and Parker), which indicate the proximity of the Paleocene-Eocene boundary, were identified.

Volosyanka Olistostrome in the internal part of the Silesian Nappe sedimentary overlaps the Oligocene Krosno Formation, completes stratigraphic succession of the Silesian Nappe, and tectonically is overlapped by the Dukla Nappe [Hnylko, 2000, 2011]. Matrix of the olistostrome is represented by the gray semi-lithified clay-sandy sediments with chaotic and unclearly layered textures. Olistoliths and large olistoplaks are composed of flysch rocks which when compared, are the same rocks as the Dukla Nappe. In addition, the olistolith (size of the first tens of meters) filled with red and variegated marls unparalleled with the rocks of the Dukla Nappe was found on the left slopes of the Uzh River near the railway station of Volosyanka-Zakarpatska. The red marls contain the intercalations and lenses of the green marls and are the products of (hemi) pelagic sedimentation. Planktonic foraminifera *Globanomalina pseudomenardii* (Bolli), *Subbotina triloculinoides* (Plummer) (Fig. 7 A, B), *Acarinina intermedia* Subbotina (see. fig. 3, sample 016) found in the red marls made it possible to compare the deposits with the P4 Globanomalina pseudomenardii Zone [Gradstein et. al, 2012]

Foraminiferal assemblages

Agglutinated benthic foraminifera is widespread in the studied flysch deposits. Numerical planktonic foraminifera are present in the Upper Eocene Sheshor Horizon ("Globigerina Marl") as well as in the marls filling the olistoliths of the Rozluch and Volosyanka olistostromes. Approximately 60 species of benthic foraminifera and 8 species of planktonic foraminifera have been identified. Species composition and features of the tests, in particular colour, indicate the autochthonous foraminiferal assemblages relative to enclosing sediments. In particular, the reddish tests are located in the red marls and mudstones, the white fossils are placed in the green clay sediments, and the gray tests were found in the flysch deposits.

Agglutinated benthic foraminifera make up to 100% of the investigated foraminiferal remnants of the Paleocene-Eocene flysch. The tests of these foraminifera are densely agglutinated (grafted with each other) grains of siliceous composition (quartz, flint, chalcedony), sometimes with insignificant amounts of the feldspar grains, without the visible cement or with a small amount of predominantly non-calcareous (siliceous, clay-silica) cement.

These foraminifera belong mainly to the genera *Silicobathysiphon, Nothia, Rhabdammina, Saccammina, Hyperammina, Ammodiscus, Glomospira, Rzehakina, Reohax, Subreophax, Hormosina, Caudammina, Haplophragmoides, Recurvoides, Trochamminoides, Paratrochamminoides, Reticulophragmium, Karrerulina* and demonstrate the species diversity.

Several foraminiferal assemblages corresponding to the paleoecological assemblages established in the Cretaceous-Eocene sediments of the Pacific and Atlantic regions were distinguished in the microfossils studied on the basis of their generic composition and morphological features of agglutinated foraminifera.

The "*Rzehakina*" assemblage = *Rzehakina* faunas: W. Kuhnt & M. Kaminski [1989] are distributed in the Paleocene sediments of the Rozluch Structure (see Fig. 3, section 8) and located in the red mudstones. Characteristics of the assemblage include: moderate species and generic diversity (12 species belonging to 10 genera); the predominance of rather large (0.6–1 mm) tests with fine-grained walls and smooth surfaces, represented by species of *Silicobathysiphon, Glomospira, Annectina, Hormosina* and *Caudammina.*

The "*Glomospira-Haplophragmoides*" assemblage was identified in the uppermost Paleocene dark colored rocks of the Soimy Formation. Characteristics of the assemblage include: moderate species and generic diversity (approximately 20 species belonging to 10 genera); numerous *Glomospira charoides* (Jones and Parker) (23 % of the forms), large forms of the species *Haplophragmoides walteri* (Grzybowski) (18 %), *Trochamminoides* and *Paratrochamminoides, Lituotuba lituiformis* (Brady). The tests are predominantly large in size (see Fig. 7 D–G).

The "*Recurvoides*" assemblage: D. Haig, [1979] distributed in the lower Lower Eocene green mudstone of the Soimy Formation. The domination of the genera *Recurvoides* and *Thalmannammina* determine the association. Characteristics of the assemblage include: moderate species and generic diversity (22 species belonging to 15 genera); numerous (approximately 50% of the forms) ***Recurvoides smugarensis*** Mjatliuk, ***R. anormis*** Mjatliuk, ***R. nucleolus*** (Grzybowski) and *Thalmanammina subturbinata* (Grzybowski); comparatively numerous *Glomospira charoides* (Jones and Parker) and *Karrerulina horrida* (Mjatliuk). The tests are predominantly small and medium sized (0.4–0.7 mm) with medium-grained wall structure (see Fig. 7 H-K).

The "*Glomospira*" = "PTEM *Glomospira* acme event" assemblage: M. Kaminski & F. Gradstein [2005] distributed in the lower Lower Eocene green mudstone of the Lower Member of the Soimy Formation.

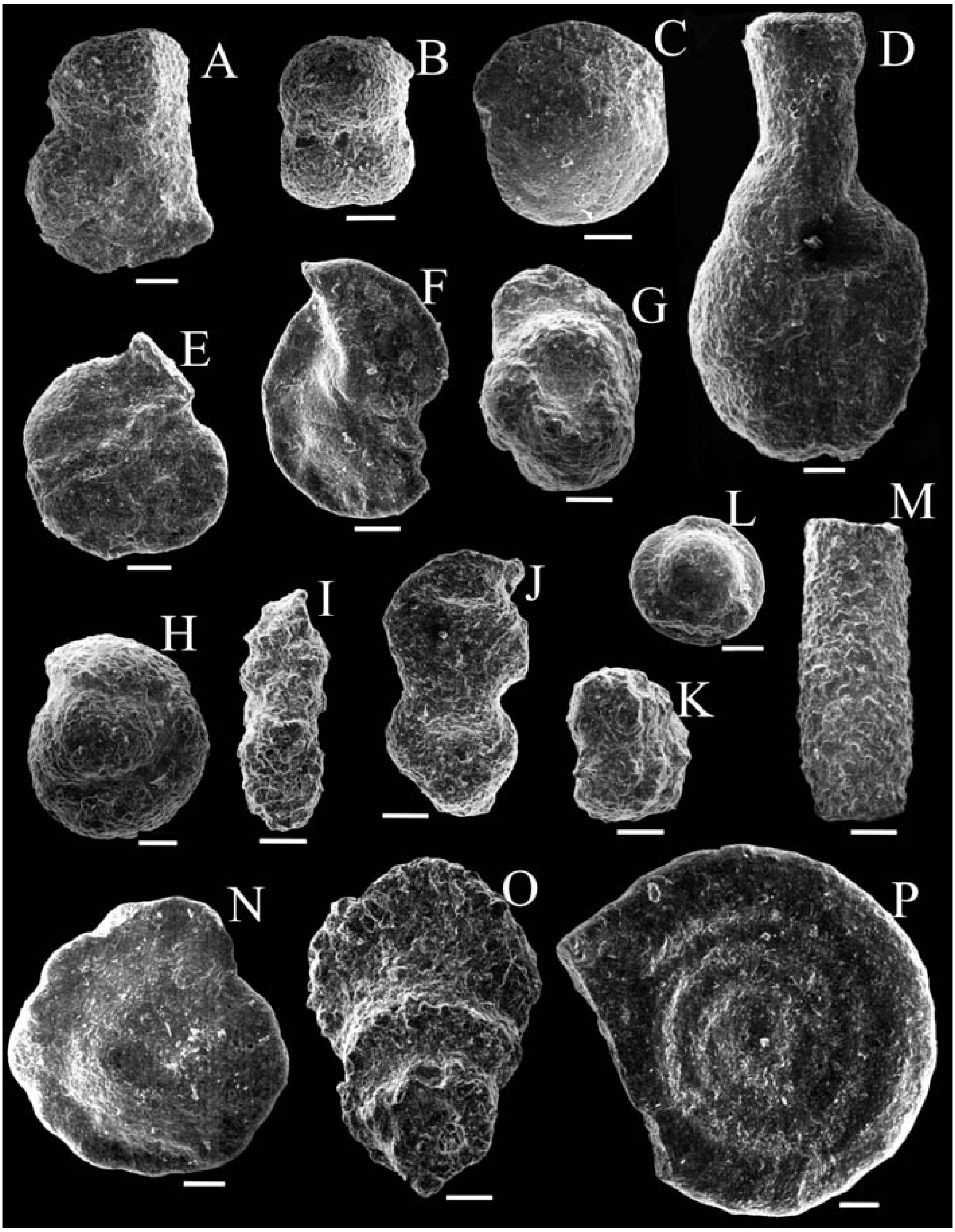

Fig. 7. Characteristic foraminifera in the studied sediments.
A–C – Paleocene (P4 Zone) calcareous species from olistolith of the Volosyanka Olistostrome: A – *Globanomalina pseudomenardii* (Bolli); B – *Subbotina triloculinoides* (Plummer); C – *Oridorsalis umbonatus* (Reuss) (Sample 016). **D–P –** Latest Paleocene – Eocene deep-water silecious species from the Soimy Formation: D – *Lituotuba lituiformis* Brady; E – *Trochamminoides folium* (Grzybowski); sF – *Haplophragmoides walteri* (Grzybowski); G – *Recurvoides varius* Mjatliuk (Sample 2009-20); H – *Recurvoides nucleolus* (Grzybowski) (Sample 2009-107); I – *Karrerulina conversa* (Grzybowski) (Sample 2009-102); J – *Subreophax scalaris* (Grzybowski); K – *Recurvoides smugarensis* Mjatliuk (Sample 2009-106); L – *Glomospira charoides* (Jones and Parker) (Sample 2009-3); M – *Rhabdammina linearis* Brady (Sample 2009-100); N – *Reticulophragmium amplectens* (Grzybowski); O – *Reophax pilulifer* Brady (Sample 2009-103); P – *Ammodiscus latus* Grzybowski (Sample 2009-101). Scale bar 100 μm.

Lower species and generic diversity (several species and genera) and predominance of species *Glomospira charoides* (Jones and Parker) (see Fig. 7 L) and *G. gordialis* (Jones and Parker) (70% of form) are characteristic of assemblage.

The "*Glomospira-Karrerulina*" assemblage was distinguished in the Lower/Middle Eocene boundary layers represented by the red (section 8) and green (section 1) mudstones. Characteristics of the assemblage include: moderate species and generic diversity (approximately 20 species belonging to 15 genera); numerous *Glomospira* (20–40 % of forms), *Karrerulina conversa* (Grzybowski) and *K. horrida* (Mjatliuk) (15–35 % of forms), *Trochamminoides, Paratrochamminoides, Reticulophragmium* and, *Reticulophragmoides.* Tests from the red mudstones have predominantly small sizes (0.2–0.5 mm), fine-grained walls and a smooth glossy surface. They are assignet to the "B"-type fauna according the classification Kaminski et. al [1988].

Tests from the green mudstones have predominantly middle and large sizes (0.6–0.8 mm) and fine- to middle-grained walls.

The "*Glomospira-Karrerulina*" assemblage corresponds both to the "*Glomospira Assemlages*" of the Labrador Sea [Kaminski et. al, 1989] and to the upper "*Glomospira* acme" of the Western Tethys and Atlantic [Kaminski & Gradstein, 2005] on the base of the age and genera/species composition of foraminifera.

The "*Rhabdammina-Reticulophragmium*" assemblage: B. Olszewska [1984] is developed in the Middle and Upper Eocene rhythmic flysch of the Upper Soimy Formation (sections 2–6) and in the green mudstones of the Rozluch Structure (section 1). Characteristics of the assemblage include: moderate diversity (10–15 species belonging to 10–15 genera); a high content of tubular tests (20–60 %) of *Nothia excelsa* (Grzybowski), *Rhabdammina linearis* Brady; поширення *Reticulophragmium amplectens* (Grzybowski), *R. rotundidorsatum* (Hantken) and *Cyclammina placenta* (Reuss). Lage size (0.8–1.3 mm) and coarse-grained walls are typical for foraminifers of the assemblage and suggest classifying these foraminifers as the "A"-type fauna according Kaminski et. al [1988]. *Reophax pilulifer* Brady (see Fig. 7 M, O) and *Saccammina scabrosa* Mjatliuk are the typical species of the "A"-type fauna in the studied deposits.

Assemblage with *Ammodiscus latus* correspond to the same name uppermost Middle Eocene biozone distributed in the Carpathian region (see Fig. 3). It is distributed in the Upper Soimy Formation (sections 3 and 5) and in the green mudstones of the Rozluch Structure (section 1); and is characterized by a low generic and species diversity, the presence of the species *Ammodiscus latus* Grzybowski (see Fig. 7 P) as well as "A"-type fauna *Reophax pilulifer* Brady and *Saccammina scabrosa* Mjatliuk.

Distribution of the agglutinated foraminifera assemblages is dependent on both age interval and lithofacies in the studied deposits of the Silesian and SubSilesian nappes.

The "*Rzehakina*" assemblage was distinguished in the Paleocene and the "*Rhabdammina-Reticulophragmium*" was identified in the Middle-Late Eocene. "*Glomospira*" and "*Recurvoides*" assemblages are characteristic for the beginning of the Early Eocene. The "*Glomospira-Karrerulina*" assemblage corresponds to the Early/Middle Eocene boundary.

The "*Rhabdammina-Reticulophragmium*" assemblage with high content of the "A"-type fauna (lage forms with coarse-grained walls) is developed in the rhythmic greenish-ghray flysch. "*Recurvoides*" and "*Glomospira-Karrerulina*" assemblages characterized by middle size of the foraminiferal tests with fine- to middle-grained walls are typical for the green mudstone. The "*Glomospira-Karrerulina*" assemblage with high content of the "B"-type fauna (small specimens with smooth surfaces) was identified in the red mudstones.

Planktonic foraminifera made up 50–100 % of the foraminiferal remnants in the studied marly deposits. "Plankton" and "plankton-agglutinated benthic" assemblages were distinguished.

The "plankton" assemblage contains 95–100 % of the plankton foraminifera remnants. It was identified in the red marls filling the olistolith in the Volosyanka Olistostrome (sample 016). The assemblage is represented by the numerous specimens of *Subbotina triloculinoides* (Plummer) and in a smaller quantity specimen of *Acarinina intermedia* Subbotina, *A. acarinata* Subbotina and *Globanomalina pseudomenardii* (Bolli) (Late Selandian-Thanetian). The singles benthic tests reveal *Oridorsalis umbonatus* (Reuss) (see Fig. 7 C).

According to the data of Dabagyan et al. [1987] the "plankton" assemblage was distinguished in the upper Upper Eocene Sheshor Horizon ("Gloigerina Marl") in the Smozhe Structure (section 6, see Fig. 3). The "Gloigerina Marl" contain numerous tests of the characteristic Late Priabonian species *Subbotina corpulenta* (Subbotina), *S. linaperta* (Finlay), *Dentoglobigerina tripartita* (Koch) and *D. galavisi* (Bermúdes).

The "plankton-agglutinated benthic" assemblage is composed of half planktonic and benthic tests. It was identified in the red marls filling the olistolith in the Rozluch Olistostrome (sample 10). Planktonic remnants (red color) are represented by species *Subbotina triloculinoides* (Plummer) and *Acarinina. acarinata* Subbotina. Benthic fossils (light color) are composed of numerous *Glomospira charoides* (Jones and Parker) and *Caudammina ovula* (Grzybowski). Both planktonic and benthic species indicate the late Paleocene near the Paleocene-Eocene boundary.

Interpretation and discussion

Bathymetry of the paleobasins

Paleobatymetry of the agglutinated foraminifera species identified in the investigated sediments correspond mainly to bathyal and abyssal depths according to the Atlas [Kaminski, Gradstein, 2005].

Identified assemblages of the agglutinated foraminifera indicate the following sedimentary environments.

The "*Rzehakina*" assemblage (the Paleocene deposits of the Rozluch Structure) suggests [Kuhnt, Kaminski, 1989] continental slope conditions

The "*Recurvoides*" assemblage (the Early Eocene sediments of the Soimy Formation) points [Haig, 1979] to depths corresponging abyssal floor.

The "*Glomospira*" assemblage (Early Eocene sediments of the Soimy Formation) represents [Kaminski, Gradstein, 2005] deep-water oligotrophic conditions of the bottom fauna.

The "*Rhabdammina-Reticulophragmium*" assemblage and "A"-type fauna (Middle-Late Eocene, sediments of the Soimy Formation and the green mudstones of the Rozluch Structure) suggests [Olszewska 1984; Kaminski et. al, 1988] rapid sedimentation on bathyal depths.

The "*Glomospira-Karrerulina*" assemblage and "B"-type fauna (Early/Middle Eocene boundary in the Rozluch Structure sediments) argue [Kaminski et. al, 1989] about slow sedimentation on the submarine elevations below the CCD.

The "plankton" assemblage (red marls filling the olistoliths of the Volosyanka Olistostrome and Gloigerina Marl) indicates [Murray, 1976] slow (hemi) pelagic sedimentation on bathyal depths above the CCD and above the foraminiferal lysocline.

The "plankton-agglutinated benthic" assemblage (red marls filling the olistoliths of the Rozluch Olistostrome) suggests mixing of same age deep-water and relatively shallow-water foraminifers due to submarine slumping.

Paleogeography and geodynamics of the Silesian Subbasin in the Eocene

The Silesian sedimentary Subbasin belonged to the Outer Carpathian Basin of the Carpathian segment of the Tethys Ocean. The present-day position of the Outer Carpathian flysch tectonic units suggests the Outer Carpathian Basin was located between the Alcapa and Tisza-Dacia terranes (microcontinents in the Tethys) on the one hand, and Eurasia on the other. In addition, the margins of the microcontinents were active, and the edge of Eurasia was passive. The oceanic or suboceanic crust of the Outer Carpathian (Flysch) Basin was subducted under the microcontinents, and the flysch sediments broke off from their substratum forming the accretionary prism [Csontos and Vörös, 2004; Picha & Golonka, 2005; Oszczypko, 2006; Kováč et al. 2016, 2017]. In the Late Cretaceous – Paleogene, the Fore-Marmarosh accretionary prism was formed in the front of the Tisza-Dacia Terrane and Pieniny-Magura-Dukla prism was built in the foreland of the Alcapa Terrane (see Fig. 1).

Note, that the fragment of the Alcapa Terrane now forms the Central Western Carpathians, and the part of the Tisza-Dacia Terrane now make up the crystalline Marmarosh Massif and the Marmarosh Klippen Zone of the Central Eastern Carpathians (see Fig. 1).

The uplifted elongated submarine and the marine areas (ridges or so called "cordilleras") were extended into the Outer Carpathian Basin, and were built up probably by the continental crust. These elevations divided the Carpathian Basin into the several subbasins including the Skyba, Silesian, and Dukla subbasins. The ridges were one of the sources of the clastic material for the Outer Carpathian Flysch Basin [Glushko & Kruglov, 1971; Vialov et al., 1981 and references therein; Picha & Golonka, 2005; Oszczypko, 2006]. The uplifting of the ridges is related to the convergence of the Tethys microplates and Eurasia, and as a result, compression of the Outer Carpathian Basin basement [Picha & Golonka, 2005; Oszczypko, 2006 and references therein].

The Silesian Subbasin was located in the middle part of the Outer Carpathian Basin and was limited from the south-west by the Silesian and Bukowiets ridges; from the north-east by the SubSilesian elevation [Picha & Golonka, 2005; Oszczypko, 2006 and referenced therein] and from the south by the Fore-Marmarosh accretionary prism formed in Cretaceous (Kamyanyi Potik, Rakhiv, Burkut, Krasnoshora and partly Chornohora nappes) and Paleogene (Chornohora and Svydovets nappes) period [Hnylko, 2012] (Fig. 8; see Fig. 1).

In the Eocene, the Outer Carpathian Basin had extensive connections with the World Ocean [Picha & Golonka, 2005; Kováč et. al, 2016]. A well-developed global oceanic circulation caused the activity of bottom currents and aeration of the ocean floor. As a result, organic carbon at the bottom of the basin was oxidized during periods of slow (hemi) pelagic sedimentation. There was accumulation of the carbon-depleted red and green hemipelagic clays, later transformed into variegated mudstones and marls. The accumulation of the thick gray and greenish flysch occurred during rapid turbidity sedimentation.

In general, the forming turbidite strata with great content of the variegated clays and marls is typical for most of the Carpathian Basin in the Eocene [Glushko, & Kruglov, 1971; Vialov et al., 1981; Picha & Golonka, 2005].

Other, local environmens existed in the eastern part of the Silesian Subbasin (Ukrainian, partly Polish parts of the Silesian Nappe). Here, the thin and medium-grained turbidites (Lower and Upper Soimy Formation) and coarse-grained turbidites and debris-flow deposits (Middle Soimy Formation) were formed. The black clay sediments (Rika River basin) as well as the black and green ones (Smozhe Structure) were settled here during periods of a (hemi) pelagic sedimentation. It indicates a weak bottom aeration in the east, and an improvement of aeration in the western direction.

The batymetry of the eastern Silesian Subbasin in the lates Late Paleocene – early Late Eocene time corresponds to bathyal-abyssal depths below the CCD. At the basin bottom existed deep-water agglutinated foraminifera *("Glomospira-Haplophragmoides", "Recurvoides", "Glomospira", "Rhabdammina-Reticulophragmium"* assemblages).

On the ridge located between the Silesian and Dukla subbasins were accumulated (hemi) pelagic red and green marls, relics of which are now represented in the olistoliths of the Volosyanka Olistostrome. Tests of the Late Paleocene plankton foraminifera (P4 Globanomalina pseudomenardii Zone) show these red marls (sample 016, see Fig. 2, 3) are enriched, indicating depths greatly above the CCD (above the foraminiferal lysocline).

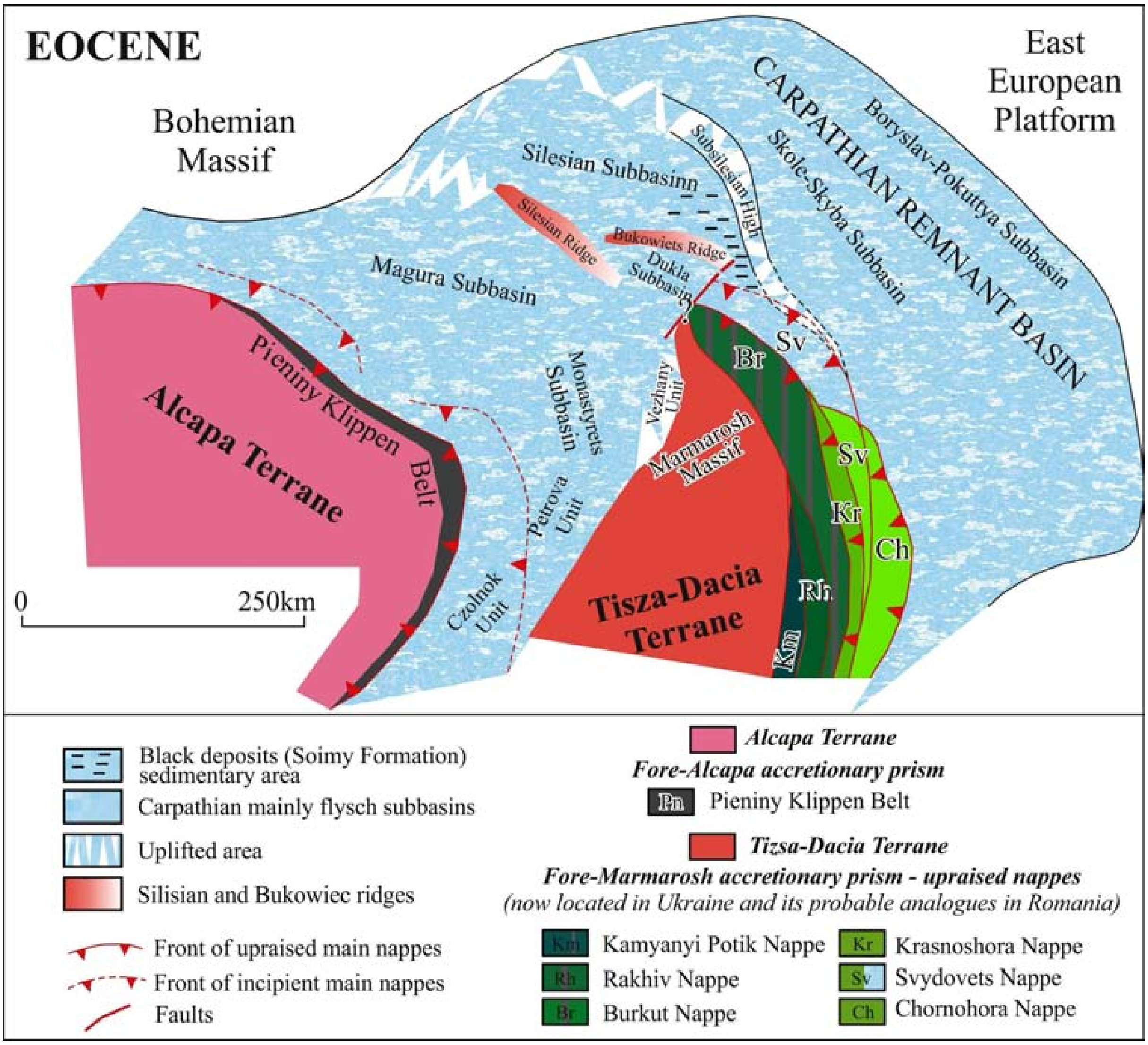

Fig. 8. Schematic paleogeographic situation of the Silesian Subbasin and adjacent tectonic units during the Eocene (after Hnylko & Hnylko, 2016; Kovaè et al. 2016, 2017; modified and supplemented) and the area of black deposit (Soimy Formation) sedimentation

Similar relics: blocks of the Late Eocene shallow-water marls and limestones placed among the Oligocene Krosno Formation were found in the Polish Carpathians, which were interpreted as the remnants of the paleouplift (Bukowiets Ridge) between the Silesian and Dukla basins [Ślączka, 2005; Oszczypko, 2006]. This ridge could be the eastern branch of the Silesian Ridge.

Another elevation limited the Silesian Subbasin from the north and separated it from the Skyba Subbasin. On the elevation below the CCD, variegated noncalcareous clays were settled, and above the CCD, calcareous sediments were accumulated.

Noncalcareous deposits (Section 1.8 and sample 2008-20) with Paleocene-Eocene deep-water agglutinated foraminifera ("*Rzehakina*", "*Glomospira*", "*Glomospira-Karrerulina*" and "*Rhabdammina-Reticulophragmium*" assemblages) were identified in the tectonic blocks of the Rozluch Structure (SubSilesian Nappe).

Calcareous sediments are represented by the red marls filling the olistolith of the Rozluch

Olistostrome. The marls contain Late Paleocene planktonic foraminifera (sample 10).

The elevation with these (hemi) pelagic calcareous/noncalcareous sediments obviously belonged to the SubSilesian High (see Fig. 4).

Variegated and green flysch (turbidity) filling some tectonic lenses of the Rozluch Structure could have been formed in the deeper parts of the basin.

Thus, (hemi) pelagic sedimentation and accumulation of the red and green clays and marls occurred at the above-described elevations and were limited to the Silesian Subbasin. Turbidite sedimentation here did not have a significant effect, since the raised areas were poorly available for the gravitational turbidite flows. The gravitational flows dumped the clastic material into the lowered deep-water parts of the basins.

The configuration of the Silesian Nappe indicates the narrowing and pinching out of the Silesian Subbasin in the south-eastern direction. In the south-eastern termination part of the Silesian Subbasin, local anaerobic conditions could have been formed due to the difficulty of the bottom current's circulation in the area bound by the uplifts. This area was bound by the Silesian (Bukowiets) Ridge on the south-west, by the SubSilesian High on the north-east, and by the Fore-Marmarosh accretionary prism on the south, moreover the uplifts closely converged. The black enriched organic matter sedimens (Soimy Formation) were deposited here, in the area of the south-eastern termination of the Silesian Subbasin (see Fig. 8). It seems, the black-shale Soimy Formation can be a possible source of hydrocarbons.

The upper Upper Eocene is represented in most of the Outer Carpathian territory by so-called "Gloigerina Marl" (called Sheshor Horizon in Ukraine). This Horizon contains numerous planktonic for a-minifera [Dabagyan at al., 1987] including the sediments of the Silesian Nappe (section 6, Structure Smozhe). The assemblage indicates a bathyal depth above the foraminiferal lysocline.

The shallow-water upper bathyal – sublittoral conditions continued to exist in the Oligocene [Ponomaryova et al., 2010].

Change in the basin depth from bathyal–abyssal to upper bathyal–sublittoral occurred at the end of the Eocene could be due to synsedimentary tectonic movements. Probably, at the end of Eocene, the flysch sediments were detached from the Outer Carpathian Basin sedimentary substratum subducted under the microcontinents and began to thrust on the Eurasia (platform). The thrust sheets covered the high ridges including the Silesian and Subsilesian ones. The horizontal component of the thrust movements was fixed by the shallowing of the sedimentary basin.

At the Eocene/Oligocene boundary another important event such as closing of the Alpine deep-water basin as the connection link between the World Ocean and the Carpathian Basin occurred. The Carpathian Basin was transformed into the segment of the Paratethys: systems of isolated and semi-isolated basins [Picha & Golonka, 2005; Kováč et. al 2016, 2017].

As a result, the bottom current's circulation became not intense or stopped, which led to a lack of oxygen at the bottom of the sedimentary basins. This favored the efficient accumulation of organic matter in the sediments and formation of the rich in organic matter black shales of the Menilite Formation which is the main oil-generating strata in the Carpathians [Curtis et al., 2004; Picha & Golonka, 2005; Kotarba et al., 2009].

Scientific novelty

Refined stratigraphy and geologic structure reconstructed the sedimentary and geodynamic environments during the building of the Eocene black-shale formation of the Silesian Nappe. The black-shale formation was deposited by turbidide flows and (hemi) pelagic settling in the south-eastern semi- isolated deep-water part of the Silesian Subbasin bounded by the uplifts (see Fig. 8).

Practical Value

The geological characteristic of the Eocene black-shale formation, which can be potentially oil-generating, is presented. Taking into account its availability one can considerably extend areas of research work in the Carpathians.

Conclusions

1. The Eocene black-shale flysch Soimy Formation developed in the Silesian Nappe and is represented mainly by the products of variable density turbidide flows and dark to black (hemi) pelagic clay sediments. The Paleocene-Eocene (hemi) pelagic red and variageted mudstones and marls developed ahead of the NE front of the Silesian Nappe in the SubSilesian Nappe in the tectonic blocks of the Rozluch Structure as well as in the olistolith of the Rozluch Olistostrome. The Paleocene variegated marls are identified in the SW back part of the Silesian Nappe in the olistolith of the Volosyanka (Fore-Dukla) Olistostrome.

2. At the end of the Paleocene and in the Eocene the bathymetry in the central part of the Silesian Subbasin correspond to the bathyal–abyssal depth below the CCD as indicated by the deep-water agglutinated foraminifera *("Glomospira-Haplophragmoides", "Recurvoides", "Glomospira", "Rhabdammina-Reticulophragmium"* assemblages and "A"-type fauna). The submarine elevations such as Bukowiets Ridge (branch of the Silesian Ridge) and SubSilesian High were located on the edges of the Silesian Subbasin. In the Late Paleocene, the pelagic calcareous sediments rich in plankton foraminifera were settled on these elevations above the CCD and the foraminiferal lysocline. In the Eocene, (hemi) pelagic clay deposits with the agglutinated for aminifera *("Rzehakina", "Glomospira", "Glomospira-Karrerulina"* assemb-

lages and "B"-type fauna ***and "Rhabdammina-Reticulophragmium"*** assemblage) were deposited on these elevations below the CCD.

3. In the Eocene in the south-eastern termination part of the Silesian Subbasin, the semi-isolated deep-water area existed. It was bound by the Silesian (Bukowiets) Ridge on the south-west, by the Sub-Silesian High on the north-east, and by the Fore-Marmarosh accretionary prism on the south. The local anaerobic condition could be formed here due to the semi-isolation and difficulty of the bottom currents circulation in the area bound by the uplifts. The black enriched organic matter sediments (Soimy Formation) were deposited here. These sediments can be a source of hydrocarbons.

4. At the end of the Eocene, the flysch sediments were detached from the Outer Carpathian Basin sedimentary substratum and subducted under the Alcapa/Tisza-Dacia terranes, covered the high ridges and were thrust on the Eurasia (platform). The horizontal component of the thrust movements was fixed by shallowing of the sedimentary basins including the Silesian Subbasin.

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ГЕОЛОГІЧНІ УМОВИ ФОРМУВАННЯ ЧОРНОСЛАНЦЕВОЇ ФОРМАЦІЇ ЕОЦЕНУ СІЛЕЗЬКОГО ПОКРИВУ (УКРАЇНСЬКІ КАРПАТИ)

Мета. Деталізувати геологічну будову та стратиграфію еоценової чорносланцевої формації Сілезького покриву, відтворити глибини та процеси її накопичення та реконструювати палеогеографію і геодинаміку еоценового Сілезького седиментаційного суббасейну. **Методика**. Геологічне картування, вивчення літостратиграфії та седиментологічних рис порід (елементів Боума тощо) в природних розрізах відкладів, палеобатиметричний аналіз фораміниферових асоціацій. **Результати**. Уточнена геологічна позиція вивчених відкладів: еоценова чорносланцева формація (сойменська світа) розвинена в межах Сілезької тектонічної одиниці, а строкатокольорові палеоцен-еоценові відклади поширені по краях цієї одиниці в Розлуцькій структурі (Субсілезький покрив) та в олістостромових товщах. Встановлено, що сойменська світа складена переважно продуктами діяльності турбідитних потоків різної густини та темними до чорних геміпелагічними глинистими утвореннями. Вона накопичувалась в Сілезькому суббасейні на батиаль-абісальних глибинах нижче CCD, на що вказує поширення глибоководних аглютинованих бентосних форамініфер (асоціації “*Glomospira-Haplophragmoides*”, “*Recurvoides*”, “*Glomospira*”, “*Rhabdammina-Reticulophragmium*” і фауна “А”-типу). Сілезький суббасейн обмежували підняття – Буковецьке (відгалуження Субсілезької кордільєри) та Субсілезьке, на яких у пізньому палеоцені на батиальних глибинах вище CCD і форамініферової лізоклини утворювались пелагічні вапнисті осади, збагачені планктонними форамініферами, а в еоцені – нижче CCD – глинисті (гемі)пелагічні відклади з аглютинованими форамініферами (асоціації “*Rzehakina*”, “*Glomospira*”, “*Glomospira-Karrerulina*” і фауна “В”-типу та “*Rhabdammina-Reticulophragmium*”). В еоцені, на південно-східному клиноподібному закінченні Сілезького суббасейну існувала напівізольована глибоководна ділянка, обмежена на північному сході Субсілезьким пасмом, на південному заході – Сілезьким (Буковецьким) підняттям, а на півдні – Примармароською акреційною призмою, де циркуляція придонних насичених киснем течій була затруднена і накопичувались збагачені органікою відклади (сойменська світа). В кінці еоцену, внаслідок субдукції підфлішової основи Зовнішньокарпатського басейну, флішева товща зривалась з цієї основи, насувалась в бік платформи, тектонічно перекривала підводні пасма-кордільєри та конседиментаційно підіймалась, зумовлюючи обміління Зовнішньо-карпатського (в т. ч. Сілезького) седиментаційного басейну. **Наукова новизна**. Запропонована нова палеогеографчна модель накопичення чорносланцевих відкладів еоцену Сілезького покриву, відповідно якої ці відклади нагромаджувались турбідитними потоками та (гемі)пелагічним осадженням у південно-східній напівізольованій глибоководній ділянці Сілезького суббасейну, частково обмеженій припіднятими підводними пасмами. **Практична значущість**. Подана геологічна характеристика еоценової чорносланцевої формації, яка може бути потенційно нафтогенеруючою. Врахування її наявності може значно розширити напрямки пошукових робіт в Карпатах.

Ключові слова: Українські Карпати; Сілезький покрив; чорносланцева формація; турбідити; форамініфери.

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