Revised position and age of the Eocene deposits on the northern slope of the Gorce Range (Bystrica Subunit, Magura Nappe, Polish Western Carpathians)

NESTOR OSZCZYPKO, EWA MALATA & MARTA OSZCZYPKO-CLOWES

Institute of Geological Sciences, Jagiellonian University, Oleandry 2a, 30-063 Kraków, Poland

Abstract: In the Bytrica Subunit of the Magura Nappe on the southern margin of the Mszana Dolna tectonic window new regional thrust-sheet located on the northern slope of the Gorce Range has been established. The Tobołów-Turbaczyk thrust sheet (TTT) is 25 km long and 3 to 5 km wide. This thrust-sheet is composed of the Lower to Middle/?Upper Eocene deposits which reveal facies connection both with the Bystrica and Krynica subunits. The TTT is characterized by a strongly tectonized 100-250 m thick sequence of the Lower to Middle Eocene basinal turbidites similar to those of the Zarzecze Fm. from the Krynica Subunit. It also cantains an extremely thick (up to 2250 m) complex of the Middle/? Upper Eocene chanel/lobe turbidite system similar to the Maszkowice Mb. of the Magura Sandstone Formation from the Bystrica Subunit. The TTT is wedged between Bytrica and Krynica subunits. The Maszkowice Mb. of TTT probably represents the deposits of the axial zone of the Middle Eocene Magura sandstone fan.

Key words: lithostratigraphy, foraminifera, calcareous nannoplankton, Eocene, Tobołów-Turbaczyk thrust sheet, Bystrica Subunit, Magura Nappe, Western Carpathians.

Introduction

The characteristic feature of the middle part of the Magura Nappe in the Polish Outer Carpathians is an occurrence of the Mszana Dolna tectonic window (MDW). The central and most uplifted part of this window is dominated by the Oligocene Krosno Formation of the Dukla Unit (Żytko et al., 1989), whereas the narrow, marginal part of it is occupied by the Cretaceous-Oligocene deposits of the Grybów Unit (Fig. 1). The area of MDW and its surroundings were the subject of fundamental geological investigations (see Burtan et al., 1978 a, b; Mastella, 1988). Well exposed deposits of the Magura Nappe belong to the Rača and Bystrica subunits. According to the detailed geological map of the Mszana Dolna sheet (Burtan et al., 1978 a) the southern margin of MDW is build up of the Cretaceous-Paleogene deposits of the so called "south peri-window" zone, which could be correlated with the Bystrica Subunit (Fig. 2). Three thrust-sheets were distinguished by mentioned authors in this zone. From north to south there are: the Poręba Wielka, Koninki-Jasień-Kustrzyca and Szumiąca-Frączkowa-Lubomierz. The first two trust-sheets are exclusively built up of the Cretaceous-Paleocene deposits and have only local significance, whereas the third one is composed of the Cretaceous-Eocene deposits and is of regional importance.

For the last few years, the southern margin of the MDW has been the subject of geological investigations of the first author and his students, during the courses of geological mapping. The biostratigraphical studies have been carried out by the other authors. These studies enable us to recognize better the stratigraphy of the N slope of the Gorce Range and to provide a new structural interpretation of the Bystrica Subunit in this area. The aim of this work is to determine the litho- and biostratiraphy of the Eocene deposits, explain the structural pecularities of the Bystrica Subunit in the Gorce Range, and to show paleogeographical implications of our findings.

Lithostratigraphy

In the Magura Nappe three turbidite complexes are distinguished: Campanian / Maastrichtian-Paleocene, Lower-Upper Eocene and Upper Eocene-Lower Miocene (Oszczypko, 1992; 1998). Each complex begins with variegated shales and passes upwards into basinal turbidites, then into chanel-lobe, thick-bedded turbidites and finally into basinal turbidites. These complexes represent stratigraphic sequences and the groups of formations in the lithostratigraphic sence. In the investigated area only two first turbidite complexes have been recognized that belong to the Grajcarek (Albian-Paleocene) and Beskid (Lower-Upper Eocene) groups (see Birkenmajer & Oszczypko, 1989; Oszczypko, 1991).

Grajcarek Group

The Upper Cretaceous-Paleocene strata occur between Olszówka and Lubomierz (Fig. 2; see also Burtan et al. 1978 a). The formal and informal lithostratigraphic units are used in parallel for these deposits. The oldest strata

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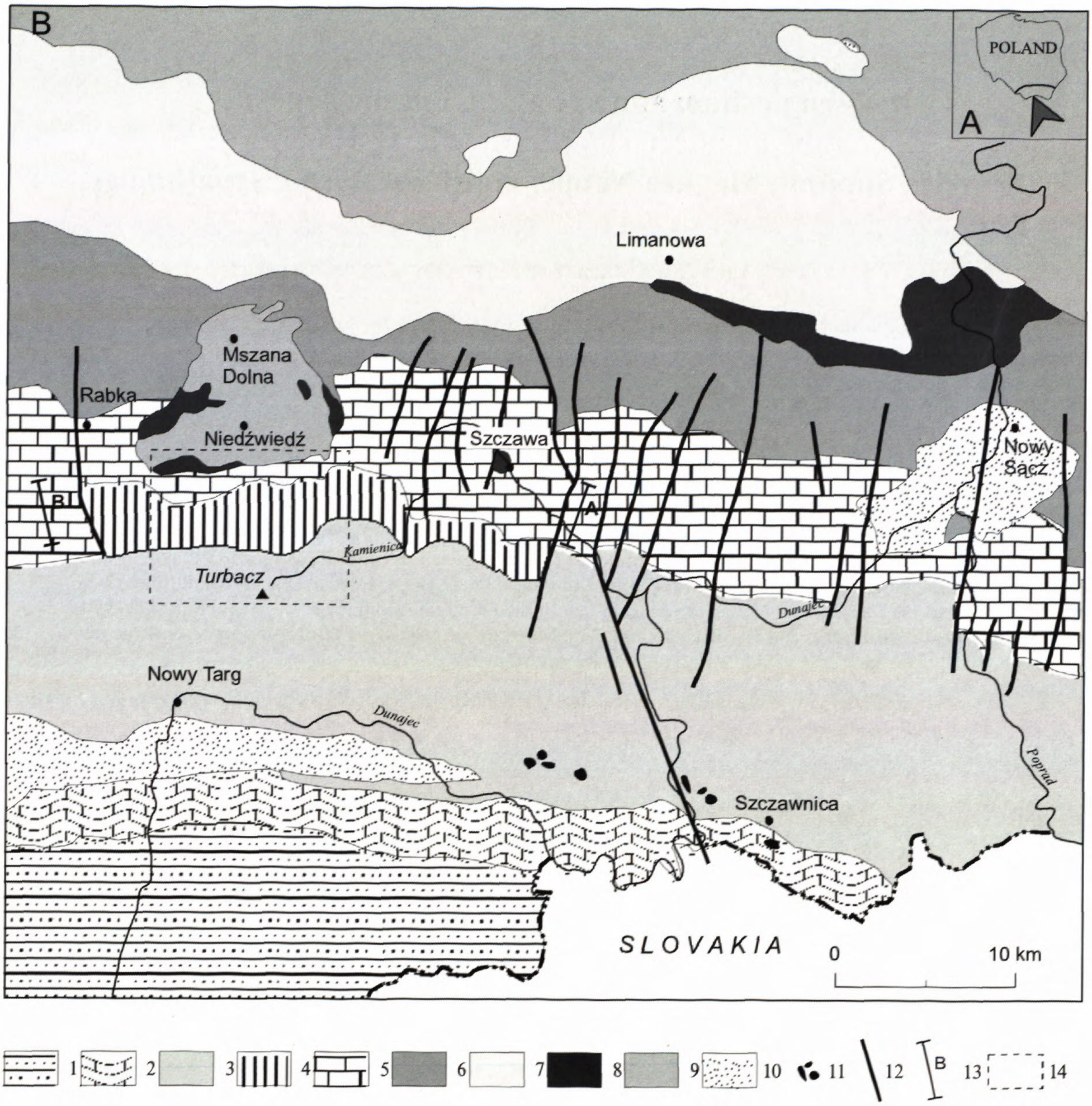

Fig. 1. A-Position of the investigated area. B-Sketch-map of the middle part of the Polish Carpathians. 1-Podhale Flysch, 2-Pieniny Klippen Belt; Magura Nappe: 3-Krynica Subunit, 4-Tobołów-Turbaczyk thrust sheet, 5-Bystrica Subunit, 6-Raca Subunit, 7-Siary Subunit, 8-Grybów Unit, 8-Dukla Unit, Silesian & Sub-Silesian units, 9-Miocene onto the Carpathians, 10-Miocene andesites, 11-Chabówka (B) and Zbludza (A) sections, 12-study area.

(Albian ?-Cenomanian), represented by spotty shales (Hulina Fm.), are exposed only on the slumped bank of the Koninki Stream (Fig. 2, see also Burtan et al., 1978 a, b; Birkenmajer & Oszczypko, 1989). The Turonian-Senonian variegated shales of the Malinowa Fm. usually form the base of the Magura Nappe sequence (Birkenmajer & Oszczypko, 1989; Malata & Oszczypko, 1990). The Senonian-Paleocene turbidite deposits overlying the Malinowa Fm. and followed by the Lower Eocene variegated shales (Łabowa Fm.) are traditionally referred as the so called "Inoceramian beds", though the name Ropianka Beds has also been used. Within these deposits there are several lithostratigraphic units of a lower rank (Fig. 3). There are: Hałuszowa Fm. (Birkenmajer & Oszczypko, 1989; Malata & Oszczypko, 1990), Kanina beds (Burtan et al., 1978 a, b; Oszczypko et al., 1991), Jaworzynka beds (Burtan et al., 1978 b), Szczawina Sandstone (Sikora & Żytko, 1959; Oszczypko et al., 1991) and the Ropianka beds. In the Olszówka-Lubomierz area these deposits are 200-250 m thick and can be subdivided into three members. The lower member (Kanina beds, Campanian) is composed of thin-bedded turbidites with intercalations of turbidite limestones (Cieszkowski et al. 1989). These deposits are followed by the thick-bedded sandstones and granule conglomerates of the Szczawina Ss. (?Maastrichtian-Paleocene, see Malata et al., 1996). The uppermost member belongs to the Ropianka beds (Paleocene) and is composed of thin-

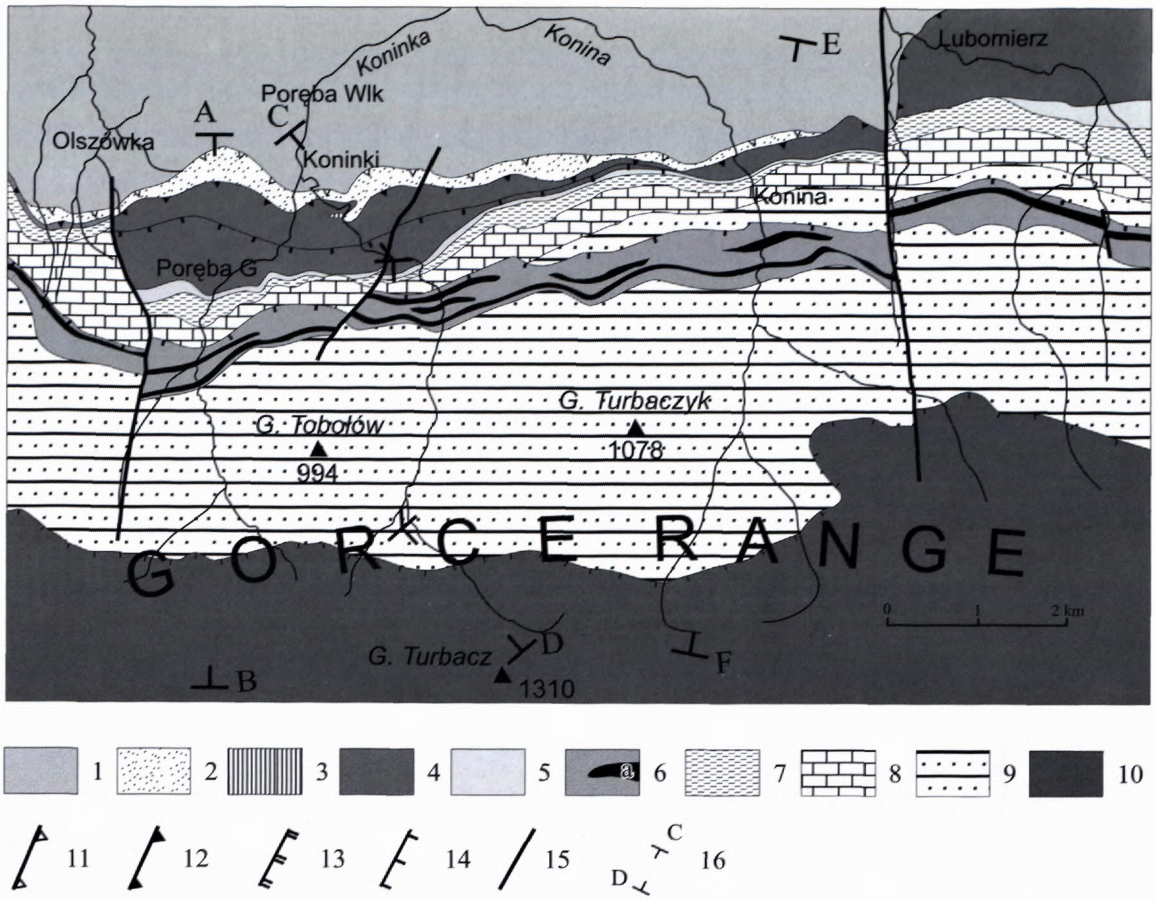

Fig. 2. Geological map of the Magura Nappe on the southern margin of Mszana Dolna tectonic window (Lubomierz area partly after Cabaj, 1993, simplified). 1-Oligocene Krosno beds of Dukla Unit, 2-Grybów Unit, (3-9) Magura Nappe - Bystrica Subunit: 3-Albian-Cenomanian deposits, 4-Cenomanian-Paleocene; Eocene: 5-Łabowa Fm., 6- Zarzecze Fm., a-variegated shales, 7-Beloveza Fm., 8- Bystrica and Żeleźnikowa fms., 9-Maszkowice Mb. of the Magura Fm., 10-Krynica Subunit, 11-Grybów overthrust, 12-Magura overthrust, 13-Bystrica Subunit internal overthrusts, 14-Krynica overthrust, 15-faults, 16-cross-sections.

bedded turbidites with thin intercalations of variegated shales. The Senonian-Paleocene sequence of the Bystrica Subunit reflects global sea-level fluctuations from the Turonian HST through Maastrichtian-Paleocene LST to Early Eocene HTS (see Haq et al, 1987).

Beskid Group

According to earlier publications (see Burtan et al., 1978 b), on the northern slope of the Gorce Range the Eocene deposits of the Bystrica Subunit form the continuous sequence incorporated into the Szumiąca-Frączkowa-Lubomierz thrust sheet. However, the results of our investigations of the Eocene deposits show the presence of two sequences more or less the same in age. Based on this fact it has been possible to establish two new thrust-sheets: the Konina-Lubomierz (N) and Tobołów-Turbaczyk (S). Lithostratigraphy of these sequences are described separately.

Konina - Lubomierz sequence

Łabowa Shale Formation. Deposits belonging to the Łabowa Sh. Fm. (Oszczypko, 1991) occur in a narrow belt between Olszówka and Lubomierz (Fig. 2). The lower boundary of this formation is tectonic in some places. The best exposures are known from the Lubomierz and Poręba Górna sections (Fig. 3). The lowermost portion of the formation is represented by a few metres of red shales passing upwards into very thin-bedded turbidites. The turbidite sequence usually begins with thin-bedded (1-6 cm), very fine-grained (Tc), green, carbonate-free sandstones passing up to a few centimetres of the green shales, and finally to a few centimetres of red shales. The shales are mainly soft and carbonate-free. The green or blue shales with intercalations of thin-bedded sandstones are observed less frequently. In the Poręba Górna section the lowermost part of this formation contains one or two layers of thick-bedded sandstones (up to 2 m) and intercalations of grey marls. The thickest sandstone bed reveals paleotransport from ESE. The thickness of the formation attains up to 50 m.

Beloveža Formation. This formation is dominated by thin to medium-bedded turbidites (Tc+conv. and Tcd). Shales, varying in colour (green, grey, blue, brown and yellowish), distinctly prevail over sandstones. In the basal part of the formation there occur sequences of alternating

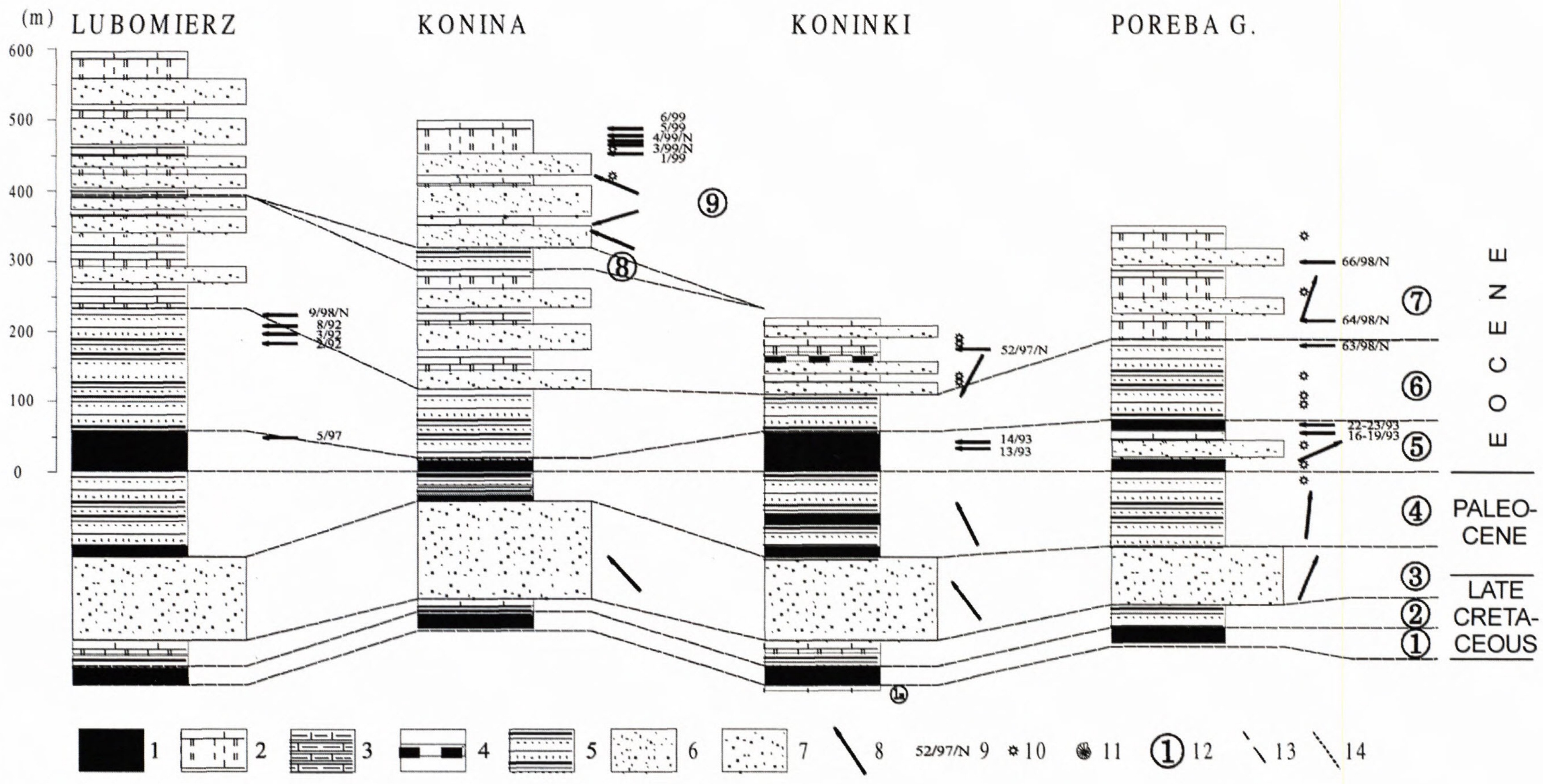

Fig. 3. Lithostratigraphic section of the Konina-Lubomierz sequence of the Bystrica. 1-red shales, 2-turbidite limestones, 3-turbidite marls, 4-hornstones, 5-thin to medium-bedded turbidites, 6-thick-bedded turbidites, 7-thick bedded sandstones and conglomerates, 8-paleotransport direction, 9-numbers of samples, 10-barren samples, 11- Reticulophragmium amplectens (Grzybowski), 12-litostratigraphic units, 13-TTT sole thrust, 14-faults. Litostratigraphic units: (1-11) Bystrica sububit: 1a- Hulina Fm., 1-Malinowa Sh. Fm. and Haluszowa Fm., 2-Kanina beds, 3-Szczawina Ss., 4-Ropianka beds, 5-Łabowa Sh. Formation, 6-Beloveža Formation, 7-Bystrica Fm., 8 -Żeleźnikowa Fm., 9-Maszkowice Mb.of the Magura Fm., 10-Mniszek Sh. Mb., 11-Poprad Ss. Mb., TTT: 12-Zarzecze FM., 13-Maszkowice Mb.

layers of different coloured shales. Yellowish and brown shales are usually calcareous, while the green ones are, as a rule, carbonate-free. The accompanying muscovite sandstones are very fine-grained and thin-bedded (5-12 cm). The medium-bedded T_{bc} sandstones (20-40 cm) appear less frequently. The thickness of the Beloveža Fm. reaches 50 to 120 m (Fig. 3).

The *Beloveža* Fm. of the Konina – Lubomierz sequence could be regarded as an equivalent of the Vychylovka Fm. described from the northern Orava (Potfaj, 1989).

Bystrica Formation. Outcrops of the Bystrica Fm. (see Oszczypko, 1991) are very easily visible in morphology, forming a W-E trending belt of round-off hills. In other papers (see Burtan et al., 1978 a, b) this formation was described as the "Łącko beds". It comprises thick -bedded sandstones with intercalations of the Łącko marls. The sandstones, 80-200 cm thick, are massive, medium to coarse-grained, glauconite/muscovitic with carbonate-free cement. The flute-casts reveal paleotransport from SW. The sandstone layers pass into massive marls, sometimes silicified, brown or blue-to-grey and whitish where weathered. The thickness of the individual beds of the Łącko marls ranges from 2 to 5 m. In the Koninki section (Figs. 2, 3) the marls contain 1-20 cm intercalations of black hornstones. The thickness of the formation is up to 150 m (Fig. 3).

Żeleźnikowa Formation. Equivalents of the Żeleźnikowa Fm. (Oszczypko, 1991) have been found in a few stream sections on the east of the Koninki Stream. As a rule, these deposits occur at the top of the Bystrica Fm. and at the base of the Maszkowice Mb. They are composed of the thin to medium-bedded turbidites of the Beloveža lithofacies with numerous intercalation of the Łącko marls. The thickness of the formation is up to 50 metres (Fig. 3).

Maszkowice Member of the Magura Formation. The Maszkowice Mb. (Oszczypko, 1991) is exposed only in the Lubomierz and Konina sections (Fig. 2, 3). In other interpretations (see Burtan et al., 1987), these beds were also covered by the term "Łącko beds". The best exposures are located in the Konina section. This member is represented by the thick and medium-bedded muscovite sandstones with infrequent intercalations of the Łącko marls. The sandstones are 40-200 cm thick, medium to coarse grained, muscovitic with illite-carbonate cement. They are massive, sometimes amalgamated and often contain muddy intraclasts and coalified flakes in the upper portion of the beds. The intercalations of the Łącko marls range from 80 to 200 cm in a thickness. The marls are greyish and whitish where weathered. In the Konina section the thick-bedded sandstone and marl complex is followed by a 60-100 metres sequence of thin to medium-bedded sandstone/marly turbidites. The tectonically reduced thickness of the Maszkowice Mb. is up to 200 m. The flute casts reveal paleotransport from SE (Fig. 3).

The Maszkowice Mb. of the Magura Fm. is an equivalent of the Kycera Mb. of the Zlin Fm. described from the northern Orava (Pivko, 1998).

Tobołów-Turbaczyk sequence

Zarzecze Formation. The term "Zarzecze beds" was introduced by Oszczypko (1979) for the flysch strata in the Krynica Subunit previously distinguished as the "Beloveža beds", "hieroglyphic beds" or "sub-Magura beds". Ten years later the Zarzecze Fm. was established as a formal lithostratigraphic unit in the Krynica Subunit (Birkenmajer & Oszczypko, 1989; Oszczypko et al., 1990). In this paper we propose to distinguish this formation in the southern part of the Bystrica Subunit, previously known as "hieroglyphic beds" sensu Burtan et al. (1978 a, b). Our investigations have documented that the lower boundary of the Zarzecze Fm. ("hieroglyphic beds") is tectonic what contradicts the previous opinion of Burtan et al. (1978 b) who considered this boundary as stratigraphic. This strongly deformed formation reveals the numerous, small, imbricated folds and trust sheets. The upper boundary of the formation is represented by the gradual transition to the Magura Fm. In the all sections (Fig. 4) the Zarzecze Fm. is dominated by the very thin-bedded basinal turbidites (Fig. 5). These deposits are formed by blue-greyish shales with subordinate intercalations of very thin (1-5 cm), fine grained, ripple-cross laminated, calcareous sandstones (Tc). The shales where weathered, reveal the alternating yellow and green "zebra" like sequences. The thin (1-2 cm) yellow shales are usually calcareous and rich in *Nereites irregularis* (Schafthautl) known also as *Helminthoidea irregularis* (see Uchman,1998), whereas the olive-green shales up to 10 cm thick are bioturbated and calcereous-free. In the lower and upper part of the sections, thin (1-5 cm) intercalations of the cherry-reddish shales are observed. In the Poręba stream the lower horizon of the red shales joins from the south with a complex of thin to medium-bedded turbidites, about 100 m thick. This overturned sequence is dominated by blue-greyish, fairly calcareous mudstones and sandstones with a few intercalations of turbidite limestones. These deposits are very rich in trace-fossils with dominating *Noviculichnum marginatum* Książkiewicz (Fig. 6) and *Scolicia plana* Książkiewicz (see Uchman, 1998). Higher in the section, in normal position once more, appear the "zebra" like turbidites with a few thin layers of red shales. The last portion of the Zarzecze Fm. in the Poręba section is characterized by a 10-15 m thickening-upward sequence followed by the first layer of the thick-bedded sandstones, which marks the lower boundary of the Magura Fm.. In the Koninki section in the middle part of the Zarzecze Fm., a complex of at least 10 metres of the medium to thick-bedded strata resembling the Paleocene/Lower Eocene Szczawnica Fm. from the Krynica Subunit (Birkenmajer & Oszczypko, Oszczypko et al., 1990) has been noticed. It is followed by a set, a few metres thick, of the very thin-bedded turbidites with thin intercalations of red shales and then by a few metres of the zebra-like yellow-green shales. The upper portion of the formation is represented by 20-25 m of thickening-upward turbidite sequence terminated by the first thick-bedded sandstone of the Magura Fm. A similar sequence with the overturned middle portion of the Zarzecze Fm.

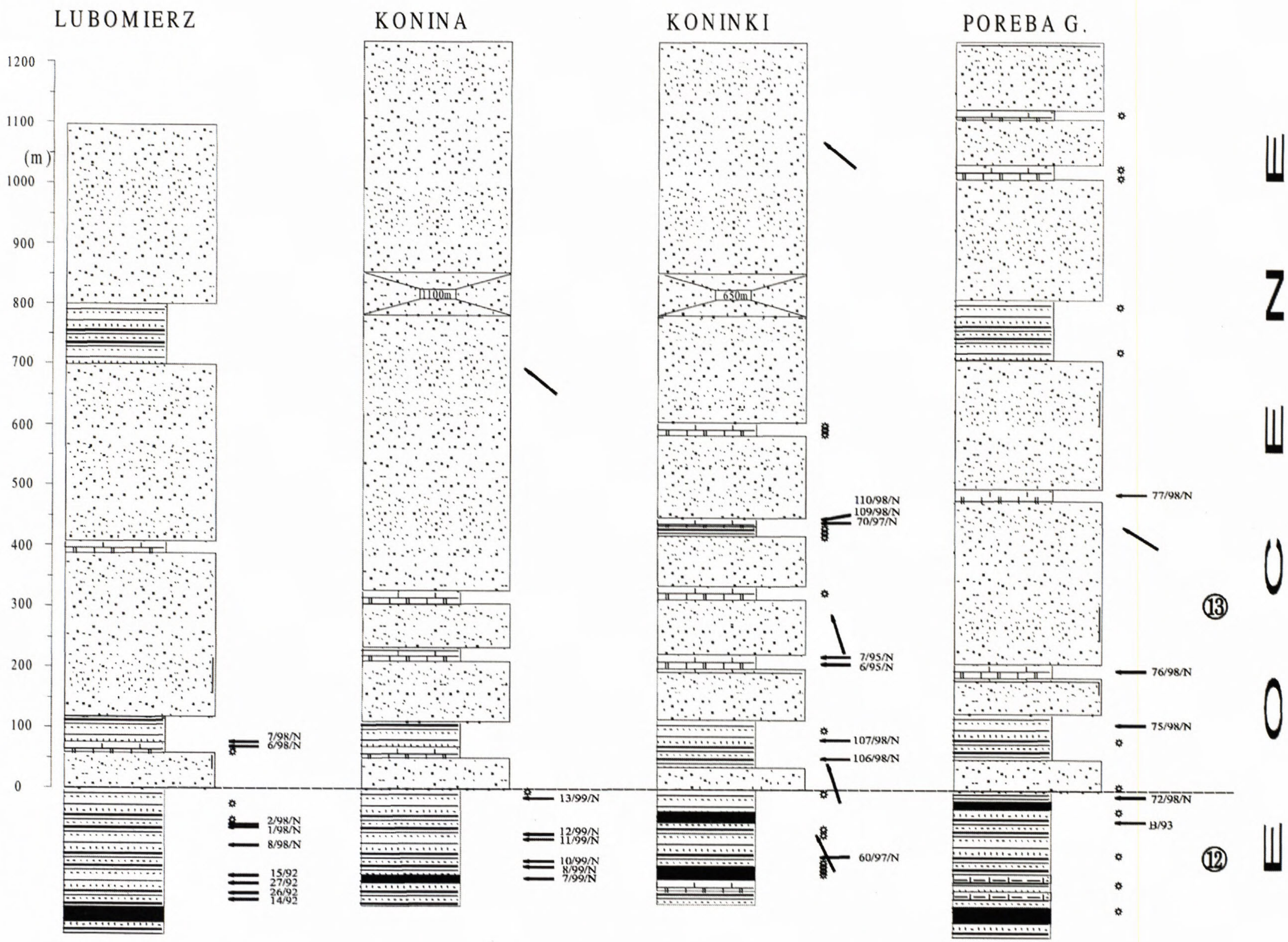

Fig. 4. Lithostratigraphic section of the Tobołów-Turbaczyk sequence of the Bystrica Subunit. For explanations see Fig. 3.

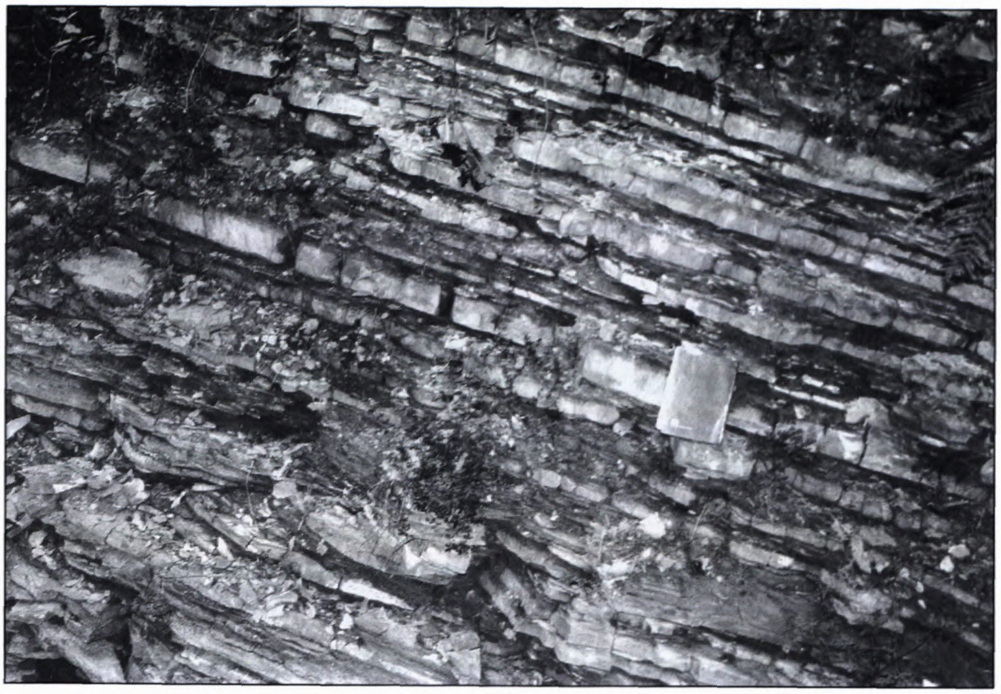

Fig. 5 . Thin-bedded turbidites of the Zarzecze Fm. of TTT in the Poręba Stream.

Fig. 6. Noviculichnium marginatum KSIĄŻKIEWICZ. *Zarzecze Fm. of TTT in the Poręba Stream.*

has been observed in the Konina section. The thickness of the Zarzecze Fm. could be roughly estimated as being between 100 and 200 m metres (Fig. 4). The flute cast measurements indicate paleotransport direction from SW in the lower to SE in the upper part of the formation.

Maszkowice Member of the Magura Formation. On the geological map of Burtan et al. (1978 a) the Maszkowice Mb. was distinguished as the "Magura beds" of the south "peri-window" facial zone. Its age was considered as the Late Eocene by the comparison with the Magura beds in the Babia Góra area. The Maszkowice Mb. can be traced in a belt a few kilometres wide, which is very well pronounced in morphology of the Gorce Range. This belt is dominated by a few mounts up to 1078 m asl high (Brody – 940 m, Tobołów – 994 m, Turbaczyk – 1078 m, and Kiełbasna – 950 m). From the south the Maszkowice Mb. is limited by the overthrust of the Krynica Subunit (Fig. 2).

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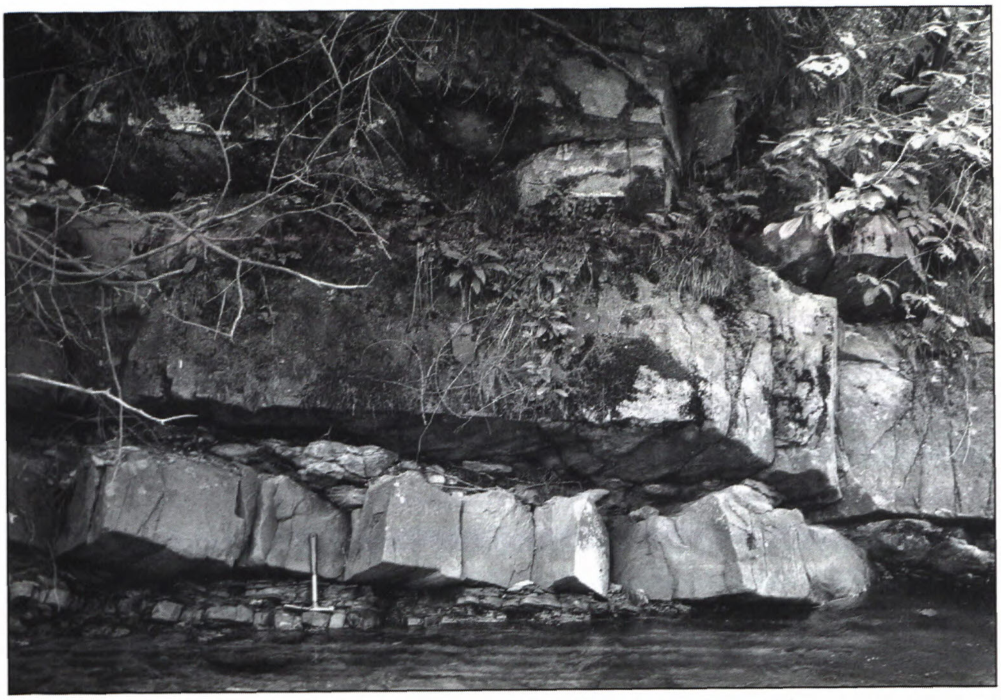

Fig. 7. Base of the Maszkowice Mb. of the Magura Fm. of TTT in the Koninki Stream.

The northern edge of the Gorce Range, at the altitude of 700-750 m asl, is built up by the lower part of the member up to 150 m thick. This portion of the Magura Fm. was described by Burtan et al. (1978 a) as the "sub-Magura beds". The base of the formation is composed of a few layers of thick-bedded (up to 250 cm) sandstones (Figs. 4, 7). They are massive, sometimes amalgamated, greyish in colour, fine to medium-grained and usually slightly carbonate. In the lowermost portion of the formation the middle-bedded (40 cm) slumped sandstones have been observed in the Poręba i Koniny sections. The imbricated slump folds reveal the paleotransport from SE (150-160°), whereas the big flute casts indicate paleotransport from ESE (110-120°). Higher up in the section, 15-20 m thick assemblage of thin to medium-bedded (up to 2-20 cm) turbidites occur, resembling the upper portion of the Zarzecze Fm. They also contain 5-6 m thick set of the thick-bedded sandstones. The thin-bedded turbidites are accompanied by rare intercalations of dark-greyish marls of the Łącko type and thin layers of turbidite limestones.

Above the "sub-Magura beds" the thick-bedded (80-150 cm) and sometimes very thick-bedded amalgamated sandstones dominate. The thick-bedded sandstones usually occur in a few metre to several metre assemblages, whereas individual sandstone beds are separated by blue-greyish mudstones rich in the coalified flakes and pyrite, rusty where weathered. The thick-bedded sandstones are intercalated by thin to medium-bedded turbidites of a few metres, which contain 0,8 to 6 m layers of the dark marls. In comparison with typical Łącko marls those in question are more hard and partly silicified.

The thick layer of the thin-bedded flysch up to 150 m has been recognized in the Poręba Górna section about 700 m above the base of the Magura Fm. (Fig. 4). They are dark-greyish, fine-grained, cross-laminated and/or convoluted calcareous sandstones accompanied by strongly bioturbated, yellow, calcareous mudstones and dark green calcareous-free shales.

The uppermost portion of the Maszkowice Mb. is dominated by the thick-bedded sandstones, pebbly sandstones and granule conglomerates with rare mudstone/ shale intercalations. The thickness of the Maszkowice Mb. increases from 1200 m in the Poręba Wielka section to 1800 m in the Koninki section and finally up to 2250 m in the Konina section (Fig. 4). The flute cast measurements indicate paleotransport from the east-south-east (90-120°).

As it has already been mentioned, the Maszkowice Mb. of the Magura Fm. is an equivalent of the Kycera Mb. of the Zlin Fm. described from the northern Orava (Pivko, 1998).

Krynica sequence

The southern periphery of the investigated area belongs to the Krynica Subunit, which build up the higher part of the Gorce Range. The frontal part of this subunit is composed of the Szczawnica, Zarzecze and Magura formations (Fig. 2). The Szczawnica Fm. (Paleocene/ Lower Eocene) is represented by the thin to medium-bedded flysch consisting of calcareous sandstones alternating with carbonate-free or slightly calcareous shales, grey, bluish or black (see Birkenmajer & Oszczypko, 1989). This formation is followed by thin-bedded turbidites of the Zarzecze Fm. (Lower Eocene) with intercalations of thick-bedded sandstones and conglomerates of the Krynica Mb. The youngest deposits of this sequence are developed as the thick-bedded sandstones and represent the Piwniczna Mb of the Magura Fm. (Lower/Middle Eocene, Birkenmajer & Oszczypko, 1989). This member is an equivalent of the Magura Sandstones in the Orava region (Potfaj, 1983)

Biostratigraphy

For the purpose of this paper small foraminifera and nannoplankton studies have been carried out by the second and the third author respectively. More than 30 foraminiferal and 80 samples for nannoplankton research were collected from the Łabowa Shale Fm., Beloveza Fm, Maszkowice Mb. of the Konina-Lubomierz sequence and from the Zarzecze Fm. and Maszkowice Mb. of the Tobołów-Turbaczyk sequence. The position of the samples against litological logs are presented in Figs. 3, 4. Distribution of the foraminifera and calcareous nannoplankton from the selected samples is presented in the Tabs. 1-2.

All samples for nannoplankton studies were prepared with the standard smear slide technique for light microscope (LM) observations. The investigations were carried out under LM at a magnification of 1024x and 1600x using phase contrast and crossed nicols. Several specimens photographed under LM are illustrated in Fig. 8.
It should be noticed that investigated litological units are generally poor both in foraminifera and calcareous nannoplankton. Most of the samples needed very thorough examination to find any microfossils.

Foraminiferal assemblages

Konina – Lubomierz sequence

Łabowa Sh. Fm. Foraminiferal assemblages of this unit display rather low diversity and consist of entirely agglutinated taxa (Tab. 1). Among tubular forms *Nothia excelsa* (GRZYBOWSKI) is the commonest. Very characteristic assemblage has been found in sample 23/93 in the Poręba Górna section (Fig. 3, Tab.1). *Glomospira choroides* (JONES et PARKER) and *G. gordialis* (JONES et PARKER) significantly outnumber the other taxa. This assemblage correlates well with the Early Eocene *Glomospira* acme zone distinguished in the Outer Carpathians (Olszewska, 1997) and also known of in other places (Kaminski et al., 1996). The second type of an Early Eocene assemblage contains quite numerous specimens of *Paratrochamminoides* and *Trochamminoides* beside numerous *Glomospira.* The samples 22/93 (Poręba Górna) and 5/97 (Lubomierz) are examples of the latter. In other samples, though assemblages are impoverished, the mention taxa are relatively dominant so, they can be roughly attributed to the same age (Fig. 3: s. 14/93 - Koninki;16/93, 17/93, 19/93 - Poręba Górna).

Beloveža Fm. Foraminiferal taxa are neither diverse nor numerous. Assemblages are dominated by agglutinated forms. Calcareous specimens have also been found though their poor preservation makes it difficult to identify species and sometimes even genera. Among agglutinated specimens an appearance of *Haplophragmoides walteri* (GRZYBOWSKI) seems to be characteristic. The other species are similar to those in the previous unit though they are much less frequent. Calcareous benthonic forams such as *Nuttallides trumpyi* (NUTTALL) and specimens which are most likely to be representing the family *Nodosaridae* are stable and relatively common element of the foraminiferal fauna. In the upper part of this unit in the Lubomierz section (s. 8/92) piritized forms of *Chilostomella* have also been found. They are represented by the largest population among other taxa (Tab. 1). Rare specimens of the planktonic forms are also present though their species assignment has been impossible. Almost identical microfauna has been noticed in the Beloveža Fm. in the Uhryń Stream. The piritized forms of *Chilostomella* were commonly noticed in deposits of the Magura Unit regarded as the upper part of the Eocene in age (Jednorowska, 1968; Malata, 1981). The most common species, known from the Outer Carpathians, *Ch. chilostomelloides* VASIČEK according to Olszewska has its range from the upper Middle Eocene to Late Eocene (Olszewska et.al., 1996). Recent investigations carried out in the described area as well as in the vicinity of Krynica (Oszczypko et. al., 1999) have shown that the assemblages with piritized *Chilostomella* can also appear slightly earlier than it has been thought. Significant presence of *Nuttallides trumpyi* in the described assemblages cannot determine the age as this species is a common element of the Paleocene and Eocene deep water assemblages (Tjalsma & Lohmann, 1983). Described foraminiferal assemblages from the Beloveža Fm. occur above the Early Eocene *Glomospira* acme zone and most probably represent Middle Eocene.

Maszkowice Mb. In the lower part of the Konina section the assemblages are not very rich but dominated by agglutinated taxa. The presence of planktonic species *Acarinina bulbrooki* (BOLLI) and *Subbotina eoceana* (Gumbel) in sample 1/99 indicates the Middle Eocene age (Toumarkine & Luterbacher, 1985; Olszewska et al., 1996). The specimens identified as *Ammodiscus* cf. *latus* Grzybowski in sample 4/99 points to the upper Middle Eocene (Geroch & Nowak, 1984). The highest sample in the section 6/99 is characterised by very abundant piritized *Chilostomella* and quite numerous specimens of the family *Nodosaridae*. Thus, Maszkowice Mb. in the Konina section is not older than upper Middle Eocene.

Tobołów-Turbaczyk sequence

Zarzecze Fm. Foraminiferal samples of this formation were collected in the Konina, Poręba Górna and Lubomierz sections of the Turbaczyk-Tobołów sequence (Fig. 4). Agglutinated foraminifera are dominant group in the assemblages. They are moderately numerous but all together do not have a very specific character. Sample 7/99 shows some affinities with the assemblages of the Early Eocene *Glomospira* zone. The samples 8/99 and B-93 contain *Haplophragmoides walteri* (GRZYBOWSKI), *Gero-*

chammina conversa (GRZYBOWSKI), *Paratrochamminoides* div.sp. in similar amount, suggesting also some analogy to the microfauna known from the lower part of the Eocene (Kaminski et. al., 1996). *Subbotina linaperta* (FINLAY) found in sample 8/99 is rather long-ranging species known from the Paleocene and Eocene (Olszewska et. al., 1996). In sample 14/99 the presence of very small and piritized forms of *Chilostomella* and other benthonic forms is worth mentioning. The precise age determination based on described foraminifera is rather difficult. The assemblages are Eocene in age and are most likely to represent Early - Middle Eocene.

Tab. 1. Distribution of the foraminiferal taxa in the selected samples. A – abundant not counted.

	ŁABOWA FM.				BELOVEZA FM.			ZARZECZE FM.				MASZKOWICE MB.				
	17/93	22/93	23/93	5/97	2/93	3/93	8/92	7/99	8/99	14/99	B/93	1/99	4/99	5/99	6/99	7/95
Agglutinated foraminifera																
Bathysiphon sp.	3				5		11		10	20		5	A	20	10	1
Nothia excelsa	24	A	A	> 20			8	A	10	4	26	3		12	11	
Rhizammina sp.							2									
Rhabdammina cylindrica	1								15							11
Psammosphaera sp.						1		3					3			1
Saccammina cf. grzybowskii				5			5									
Saccammina sp.									8		6		2			
Ammodiscus cf. demarginatus									3		3					
Ammodiscus cf. latus													2			
Ammodiscus sp.	1				4				1							
Glomospira charoides	}16	}100	}100	70	2	1		4	3		15				2	
Glomospira gordialis					4	3	8	16	6		9	1	2		2	1
Glomospira glomerata		10		3												
Glomospira irregularis	2	2	4			1		2								
Glomospira serpens		6						1							1	
Reophax sp.				2						1						
Subreophax guttifer								1	2				1			
Subreophax scalaris		3										1				
Subreophax splendidus				4					1						1	
Haplophragmoides horridus								1				1				
Haplophragmoides cf. *kirki*			3													
Haplophragmoides walteri					10	3	7		18		27					
Haplophragmoides sp.	7	2		1	8		1	13		10			15		17	3
Paratrochamminoides spp.	15	80	10	32	3	2		20	15	4	20		2	2	5	
Trochamminoides spp.		3	2	17	1	1	1		7		10					
Ammosph. Pseudopauciloculata			2				2		2			1				
Recurvoides spp.	3	26	16	4	2	8	18	10	13	1	6		2	2		5
Spiroplectammina spectabilis																2
Trochammina sp.					3		6		20	8					4	
Gerochammina conversa		3			2		3		14		15	10	2		5	1
Karrerulina cf. *coniformis*										1	3					
Karrerulina horrida		2														
Karrerulina sp.																
Arenobulimina sp.											2					1
Calc. benthonic foraminifera																
Nodosaria longiscata															10	
Nodosaria sp.					1		1									
Nodosaridae indet.					16	2	5					1	6		30	3
Fissurina sp.							1									
Bulimina sp.														2		
Globobulimina sp.										2				1		
Fursenkoinidae indet.										10						
Cibicidoides sp.							1									
Nuttallides trumpyi					7	3	8						2		11	1
Asterigerina sp.														1		
Chilostomella spp.							28			21			7	12	50	
Anomalinoides sp.															1	
Gyroidinoides sp.															1	
Benthonics indet.									3	6	5					
Planktonic foraminifera																
Acarinina bulbrooki												1				
Acarinina rotundimarginata																1
Acarinina sp.							1									
Turborotalia cf. *cerroazulensis*																1
Globorotaloides suteri															1	
Subbotina linaperta									1							
Globigerina cf. *corpulenta*																1
Globigerina eoceana																2
Planktonic indet.						1	3				10	1				1

Maszkowice Mb. Foraminiferal assemblage from the Koninki section consists of agglutinated and calcareous forms (s. 7/95 - Fig. 4; Tab. 1). Neither of taxa are numerous. Planktonic foraminifera though represented by single specimens are important for the age determination. According to the taxon ranges of the species identified as *Acarinina rotundimarginata* SUBBOTINA, *Turborotalia* cf. *cerroazulensis* (COLE), *Globigerina* cf. *corpulenta* Subbotina and *Globigerina eoceana* GUMBEL the age of this assemblage can be interpreted as not older than upper Middle Eocene and not younger than the lower Late Eocene (TOUMARKINE & LUTERBACHER, 1985; OLSZEWSKA et al., 1996).

Tab. 2. Distribution of the calcareous nannoplankton taxa in the selected samples.

	BELO-VEZA FM.		BYSTRICA FM.			MASZ-KOWICE MB.		ZARZECZE FM. (TTT)									MASZKOWICE MB. (TTT)								
	63 98 N	9 98 N	64 98 N	66 98 N	52 98 N	3 99 N	4 99 N	60 97 N	7 99 N	8 99 N	11 99 N	12 99 N	13 99 N	1 98 N	2 98 N	8 98 N	75 98 N	76 98 N	77 98 N	6 95 N	109 98 N	110 98 N	70 97 N	6 98 N	7 98 N
Braarudosphaera bigelowii				X			X				X		X		X	X								X	
Chiasmolithus eograndis										X	X		X		X									X	
Chiasmolithus expansus													X												
Chiasmolithus gigas																			X		X			X	
Chiasmolithus grandis						X	X			X	X		X						X	X			X	X	
Chiasmolithus solitus											X		X												
Coccolithus pelagicus	X		X	X	X	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X	X		X	
Cyclicargolithus floridanus	X		X	X	X	X	X												X		X	X	X	X	X
Dictyococcites bisectus	X				X														X	X					
Dictyococcites scripsae	X		X																	X	X				
Discoaster barbadiensis	X	X				X						X				X			X	X	X	X	X	X	
Discoaster bifax																				X			X	X	
Discoaster binodosus													X	X							X		X	X	
Discoaster deflandrei	X					X										X	X		X	X		X	X	X	
Discoaster delicatus											X														
Discoaster distinctus												X	X			X			X		X	X			
Discoaster kuepperi													X			X			X		X				
Discoaster lodoensis													X	X		X	X	X	X		X	X	X		
Discoaster multiradiatus											X			X	X				X					X	
Discoaster saipanensis														X	X				X	X					
Discoaster strictus													X						X		X		X		
Discoaster tani																	X	X	X	X	X	X	X	X	X
Discoaster tani nodifer																			X	X	X		X	X	
Ericsonia formosa	X			X		X	X		X	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X
Ericsonia subdisticha																			X						
Fasciculithus sp											X														
Helicosphaera bramlettei													X						X		X			X	
Helicosphaera compacta							X						X	X		X								X	
Helicosphaera dineseni													X												
Helicosphaera euphratis																			X						
Helicosphaera heezenii													X												
Helicosphaera lophota				X		X															X			X	
Helicosphaera cf. reticulata																			X					X	
Helicosphaera seminullum																								*X*	
Lophodolithus nascens											X														
Neococcolithes dubius	X						X						X				X		X			X	X	X	
Pemma sp.								X																X	
Pontosphaera multipora							X				X													X	
Reticulofenestra dictyoda			X		X	X												*X*					X		
Reticulofenestra hillae				X																					
Reticulofenestra umbilica						X																			
Sphenolithus editus								X	X				X											X	X
Sphenolithus moriformis	X			X			X	X	X	X	X	X			X	X	X	X	X	X		X		X	X
Sphenolithus pseudradians													X	X				X			X				
Sphenolithus radians				X		X		X	X	X			X		X	X	X	X	X	X			X	X	X
Toweius crassus									X	X	X	X													
Toweius gammation			X			X	X								X			X	X	X	X			X	X
Toweius magnicrassus									X	X										X					
Toweius ocultatus											X														
Transversopontis pulcher							X																	X	
Transversopontis pulcheroides							X																	X	
Tribrachiatus orthostylus									X	X			X	X	X	X	X			X		X			X
Zygrhablithus bijugathus	X		X		X	X	X	X			X	X	X		X	X	X		X	X	X		X	X	X

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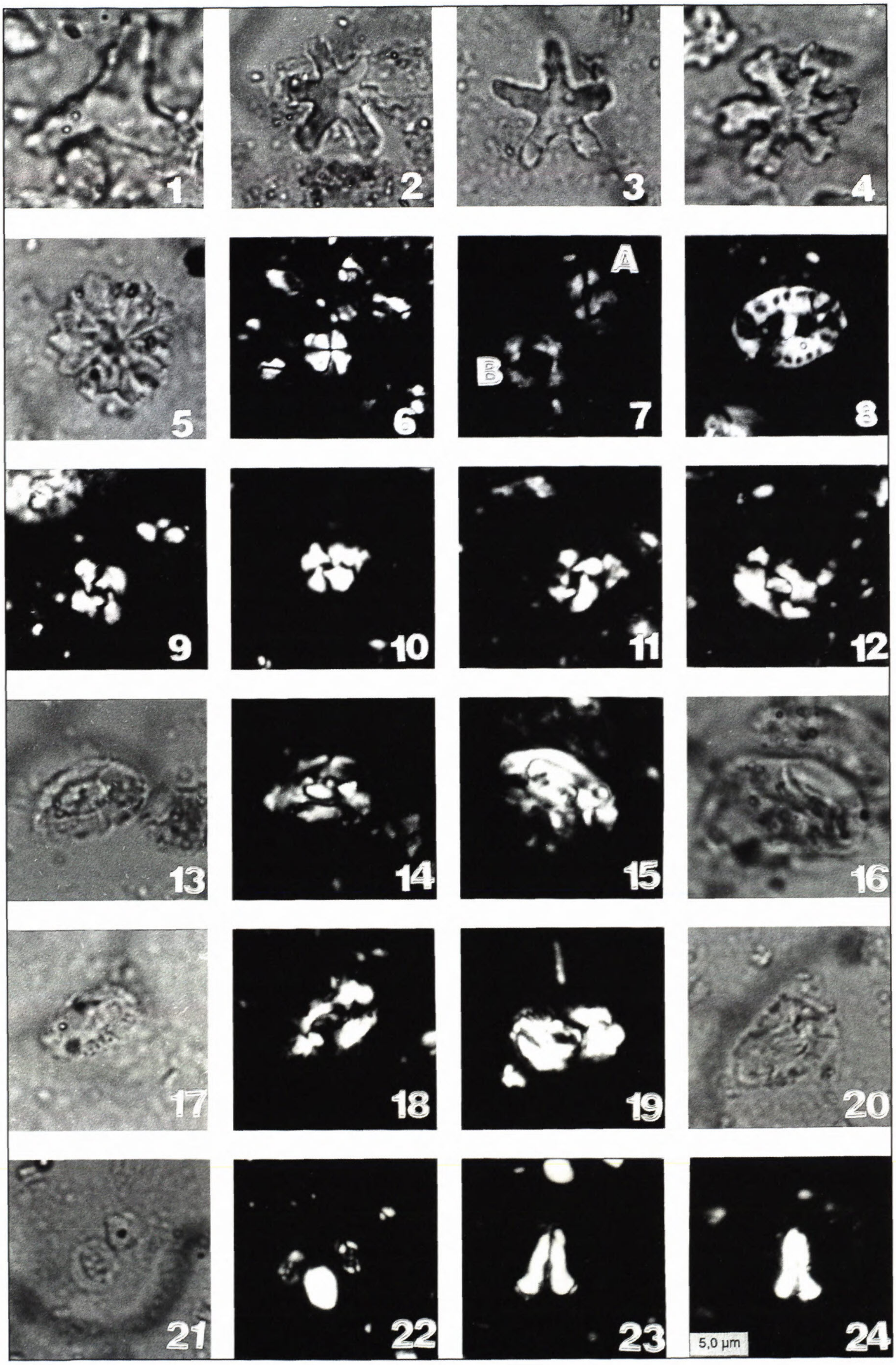

Fig. 8. LM microphotographs of the selected taxa of calcareous nannoplankton.

Calcareous nannoplankton

Konina–Lubomierz sequence

Beloveža Fm. (ss. 63/98/N, 9/98/N). The examined samples from this formation (Fig. 3, Tab. 2) contain fairly well preserved calcareous nannoplankton assemblages of low diversity. The autochthonous assemblage is dominated by *Cyclicargolithus floridanus* (ROTH & HAY) and *Coccolithus pelagicus* (WALLICH) whereas *Zygrhablithus bijugathus* (DEFLANDRE), *Reticulofenestra dictyoda* (DEFLANDRE & FERT) and *Sphenolithus radians* GRASSE are less common. Because of a lack of diversity the zone assignment was difficult to establish. The only species which indicates the age is *Cyclicargolithus floridanus* (ROTH & HAY). According to Aubry (1986) its first occurrence takes place in the upper part of NP 16 (Middle Eocene).

Bystrica Fm. (ss. 64/98/N, 66/98/N, 52/98/N, Fig. 3). The examined samples yielded the poorly preserved calcareous nannoplankton assemblage of very low diversity. The autochthonous assemblage is dominated by *Cyclicargolithus floridanus* (ROTH & HAY) and *Coccolithus pelagicus* (WALLICH) whereas *Zygrhablithus bijugathus* (DEFLANDRE), *Reticulofenestra dictyoda* (DEFLANDRE) and *Sphenolithus radians* GRASSE are less common. The only species which indicates the age, zone NP 16, is *Cyclicargolithus floridanus* (ROTH & HAY) (see Aubry, 1986).

Maszkowice Mb. (ss. 3/99/N, 4/99/N, Fig. 3, Tab. 2). The samples from this strata yielded fairly well preserved and moderately diverse calcareous nannoplankton assemblages, characterised by the occurrence of *Cyclicargolithus floridanus* (ROTH & HAY), *Ericsonia formosa* (KAMPTNER), *Zygrhablithus bijugathus* (Deflandre), *Neococcolithes dubius* (DEFLANDRE), *Chiasmolithus grandis* (BRAMLETTE & RIEDEL), *Coccolithus pelagicus* (WALLICH), *Sphenolithus radians* GRASSE, *Discoaster deflandreii* BRAMLETTE & RIEDEL, *Discoaster binodosus* Martini. Furthermore, the species *Helicosphaera compacta* BRAMLETTE & WILCOXON was identified in the sample 4/99/N, whose biostratigraphic range is problematic. This taxon was reported by Martini and Muller (1986), Perch-Nielsen (1985) from the upper part of NP 17, although, according to Aubry (1986), *Helicosphaera compacta* BRAMLETTE & WILCOXON ranges from as low as the upper part of NP 16 (see also THEODORIDIS, 1984). Therefore the zone assignment of the described formation should be based on the first occurrence of *Cyclicargolithus floridanus* (ROTH & HAY) and *Helicosphaera compacta* BRAMLETTE & WILCOXON. In conclusion, the calcareous nannoplankton from the Maszkowice Mb. belongs to zone NP 16 and it is not older than Late Middle Eocene.

Tobołów-Turbaczyk sequence

Zarzecze Fm. (ss. 60/97/N, 7/99/N, 8/99/N, 11/99/N, 12/99/N, 13/99/N, 1/98/N, 2/98/N, 8/98/N, Fig. 4, Tab. 2). The samples collected from the lower part of the formation (7/99/N, 8/99/N, 11/99/N, 12/99/N, 13/99/N) contain poorly to moderately well preserved calcareous nannoplankton assemblages of low diversity except for sample 13/99/N. The assemblages determined from samples 7/99/N, 8/99/N, 11/99/N, 12/99/N, do not contain any index species except for *Tribrachiathus orthostylus* SHAMARAI, whose first occurrence is within NP 10. At the same time the presence of *Sphenolithus moriformis* (BRONNIMANN & STRADNER) would indicate the age of the samples as being not older than NP 12. The lower boundary of NP 12 zone is usually marked by the FO of *Discoaster lodoensis* BRAMLETTE & RIEDEL, which was not found in the assemblages from the samples 7/99/N, 8/99/N, 11/99/N, 12/99/N. In the absence of *Discoaster lodoensis* BRAMLETTE & RIEDEL the first occurrence of *Toweius gammation* (BRAMLETTE & SULLIVAN) and *Discoaster kuepperi* STRADNER can be used to approximate the lower boundary of Zone NP 12 (see VAROL, 1989). However, the above mentioned species were not found either. It is also necessary to discuss the biostratigraphic range of *Toweius crassus* (BRAMLETTE & SULLIVAN). PERCH-NIELSEN (1985) following BUKRY (1973), suggested that the bottom of the Zone NP 13 can be approximated by the first occurrence of this species. However, on the Black Sea coast, north-east of Istanbul, *Toweius crassus* (BRAMLETTE & SULLIVAN) was found in NP 11 (Varol, 1989). Taking into account all above information the age of the samples 7/99/N, 8/99/N, 11/99/N, 12/99/N should be determined as not older than NP 12.

Younger assemblage was obtained from sample 13/99/N (Fig. 4). The assemblage is characterised by the occurrence of *Chiasmolithus eograndis* PERCH-NIELSEN,

◄

1-Tribrachiatus orthostylus SHAMRAI (Konina 8/98N), 2- Discoaster tani BRAMLETTE & RIEDEL (Koninki 110/98N), 3- Discoaster tani BRAMLETTE & RIEDEL (Poręba 77/98N), 4 - Discoaster deflandrei BRAMLETTE & RIEDEL (Poręba 77/98N), 5 - Discoaster barbadiensis TAN (Poręba 77/98N), 6 - Sphenolithus moriformis (BRONNIMANN & STRADNER) (Konina 8/98N), 7a - Coccolithus pelagicus (WALLICH) (Lubomierz 6/98N), 7b - Reticulofenestra dictyoda (DEFLANDRE & FERT) (Lubomierz 6/98N), 8 - Transversopontis pulcher PERCH-NIELSEN (Lubomierz 6/98N), 9 - Cyclicargolithus floridanus (ROTH & HAY) (Koninki 52/97N), 10 - Cyclicargolithus floridanus (ROTH & HAY) (Poręba 63/98N), 11 - Cyclicargolithus floridanus (ROTH & HAY) (Koninki 109/98N), 12 - Helicosphaera lophota BRAMLETTE & SULLIVAN (Lubomierz 6/98N), 13 - Helicosphaera cf. dineseni PERCH-NIELSEN (Poręba 66/98N), 14 - Helicosphaera cf. dineseni PERCH-NIELSEN (Poręba 66/98N), 15 - Helicosphaera compacta BRAMLETTE & WILCOXON (Konina 13/99N), 16 - Helicosphaera compacta BRAMLETTE & WILCOXON (Konina 13/99N), 17 - Helicosphaera cf. reticulata BRAMLETTE & WILCOXON (Lubomierz 6/98 N), 18 - Helicosphaera cf. reticulata BRAMLETTE & WILCOXON (Lubomierz 6/98N), 19 - Helicosphaera cf. euphratis HAQ (Poręba 77/98N), 20 - Helicosphaera cf. euphratis HAQ (Poręba 77/98N), 21- Ericsonia subdisticha (ROTH & HAY) (Poręba 77/98N), 22 - Ericsonia subdisticha (ROTH & HAY) (Poręba 77/98N), 23 - Zygrhablithus bijugathus (DEFLANDRE) (Lubomierz 6/98N), 24 - Zygrhablithus bijugathus (DEFLANDRE) (Poręba 77/98N).

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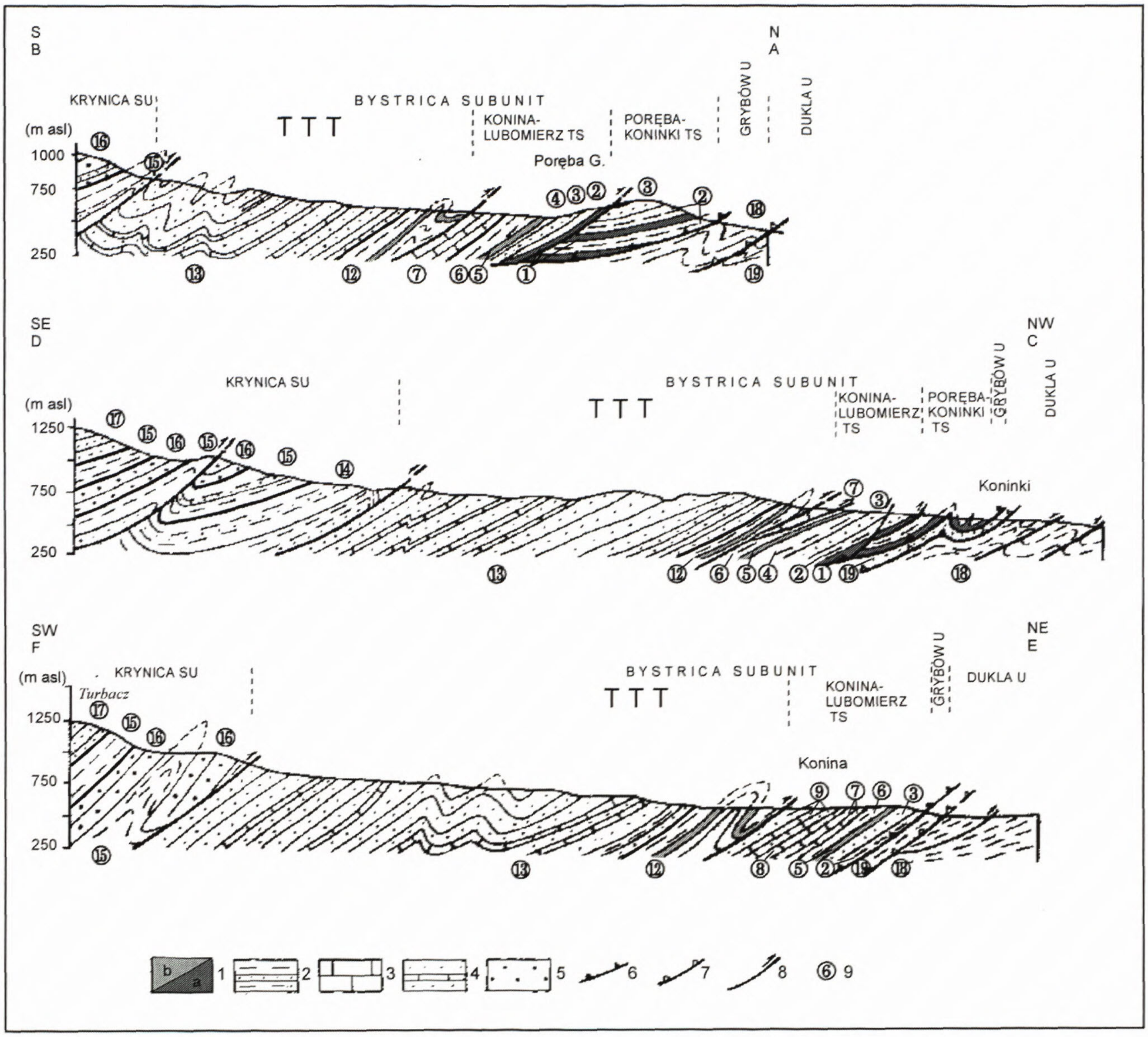

Fig. 9. Geological cross-sections. 1-variegated shales, a-Turonian-Senonian, b-Eocene, 2-thin-bedded turbidites, 3- marls, 4- thick-bedded sandstones and marls, 5-conglomerates and sandstones, 6-Grybów overthrust, 7-Magura overthrust, 8-other overthrusts, 9-lithostratigraphic units: 14- Szczawnica Fm., 15-Zarzecze Fm., 16-Krynica Mb. of the Zarzecze Fm., 17-Piwniczna Ss. Mb. of the Magura Fm. For other explanations see Fig. 3

Chiasmolithus expansus (BRAMLETTE & SULLIVAN), *Tribrachiatus orthostylus* SHAMARAI, *Discoaster binodosus* MARTINI, *Discoaster lodoensis* BRAMLETTE & RIEDEL, *Discoaster kuepperi* STRADNER, *Discoaster strictus* STRADNER, *Ericsonia formosa* (KAMPTNER), *Helicosphaera compacta* BRAMLETTE & WILCOXON, *Sphenolithus pseudoradians* BRAMLETTE & WILCOXON, *Sphenolithus radians* GRASSE, *Zygrhablithus bijugathus* (DEFLANDRE). The youngest taxon of this assemblage is *Helicosphaera compacta* BRAMLETTE & WILCOXON, having its first occurrence in NP 16 (see Aubry, 1986), whereas the occurrence of *Tribrachiatus orthostylus* SHAMARAI and *Discoaster lodoensis* BRAMLETTE & RIEDEL is believed to be the result of reworking.

In the Lubomierz section (Fig. 4) the youngest calcareous nannoplankton assemblages were obtained from samples 1/98/N, 2/98/N, 8/98/N (Fig. 4, Tab. 2). *Coccolithus pelagicus* (WALLICH), *Ericsonia formosa* (KAMPTNER) are the most commonly recorded species. The species which are also common, though to lesser extent are *Discoaster saipanensis* BRAMLETTE & RIEDEL, *Sphenolithus moriformis* (BRONNIMAN & STRADNER), *Sphenolithus radians* GRASSE , *Zygrhablithus bijugathus* (DEFLANDRE). The zone assignment is based on the first occurrence of *Helicosphaera compacta* BRAMLETTE & WILCOXON, as upper part of NP 16. In conclusion, the age of the Zarzecze Fm. could be established as the Early to Middle Eocene (NP 11-16)

Maszkowice Mb. (ss. 75/98/N, 76/98/N, 77/98/N, 6/95/N, 109/98/N, 110/98/N, 70/97/N, 6/98/N, 7/98/N, Fig. 4, Tab. 2). The examined samples yielded fairly well preserved and diverse calcareous nannoplankton assemblages, characterised by the occurrence of *Cyclicargolithus floridanus* (ROTH & HAY), *Coccolithus pelagicus* (WALLICH), *Chiasmolithus grandis* (BRAMLETTE & RIEDEL), *Dictyococcites bisectus* (HAY), *Discoaster strictus* STRADNER, *Discoaster tani* (BRAMLETTE & RIEDEL), *Discoaster tani nodifer* (BRAMLETTE & RIEDEL), *Discoaster saipanensis* BRAMLETTE & RIEDEL, *Ericsonia formosa* (KAMPTNER), *Helicosphaera compacta* BRAMLETTE & WILCOXON, *Sphenolithus pseudoradins* BRAMLETTE & WILCOXON. Such an association of calcareous nannoplankton is believed to be indicative of the upper part of NP 17 as the first occurrence of *Dis-*

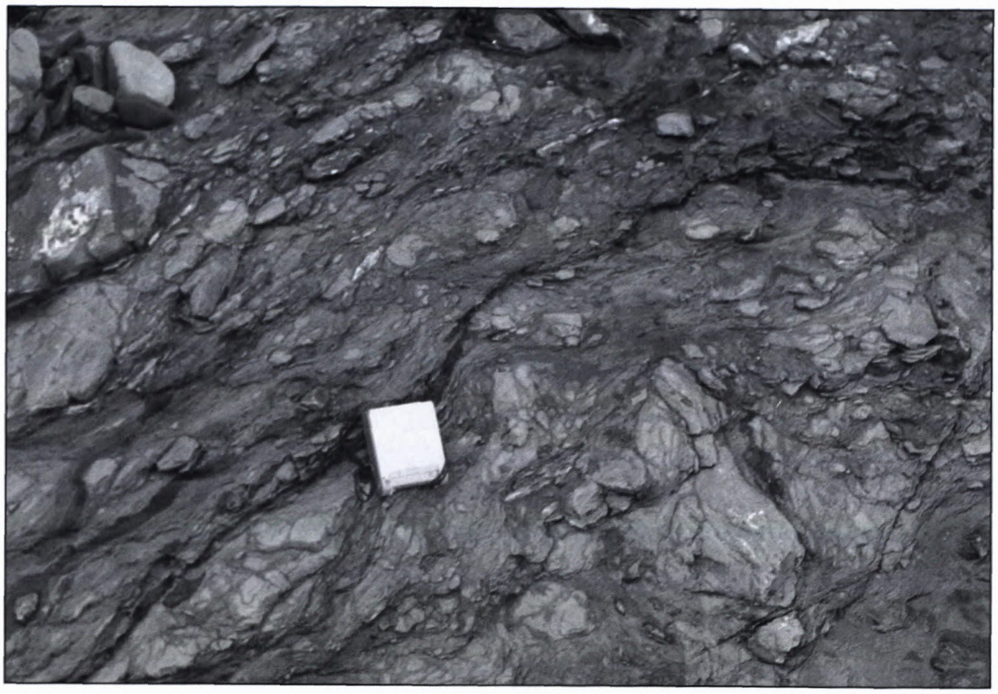

Fig. 10. Chaotic "melange" type deformation immediately above the Magura sole thrust (Lower Senonian deposits) in the Poręba Stream.

Fig. 11. Mesoscopic recumbed NW- SE trending folds in the Kanina beds (Senonian). Poręba Stream.

Fig. 12. Mesoscopic fault-thrust related fold in the Zarzecze Fm. of TTT. Poręba Stream.

coaster tani (BRAMLETTE & RIEDEL) is taking place in the middle part of NP 17 (see Bukry, 1973). The absence of *Chiasmolithus solitus* (BRAMLETTE & SULLIVAN) whose last occurrence marks the lower boundary of NP 17 is proof of such zone assignment. An exception is sample 77/98/N in which the species *Helicosphaera euphratis* HAQ was found. According to PERCH-NIELSEN (1985) this taxon appears for the first time in the middle part of NP 18 Zone. In conclusion, the lower part of Maszkowice Mb. of TTT should be assigned to zones NP 17 and NP 18 (Middle/ Late Eocene). However, the younger age of the upper part of the formation (NP. 19/20) cannot be excluded (see CABAJ, 1993) as only the samples from the lower part of this formation contained calcareous nannoplankton assemblages, which allowed age determination.

Structure

The area in question is located in the middle part of the Magura Nappe on the southern margin of the MDW and about 15 km southward from the front of the nappe (Fig. 1). The Magura Nappe is very flatly overthrust onto the Oligocene Krosno Fm. of the MDW (see Burtan et al., 1978 a; Mastella, 1988). The narrow and discontinuous Grybów Unit is wedged between the Dukla and Magura units. The Bystrica Subunit builds up the frontal thrust of the Magura Nappe between Olszówka and Lubomierz and consists of three thrust-sheets which contain characteristic sequences of deposits. From the north to the south there are: Poręba Wielka-Koninki (Albian-Paleocene), Konina-Lubomierz (Turonian-Middle Eocene) and Tobołów-Turbaczyk (Lower-Middle/ ?Upper Eocene) thrust-sheets (Figs. 2, 9). The lower, Poręba Wielka-Koninki thrust sheet reveals a decreasing degree of deformation from the 40-50 metre complex of chaotic "melange" type deformation (Fig. 10), described by Burtan et al. (1978 b) as "wildflysche" immediately above the Magura sole thrust, through the mesoscopic recumbed NW-SE trending folds (Fig. 11) to the NW-SE trending imbricated folds. The next thrust-sheet is 1,5-2 km wide (Figs. 2, 9) and forms a moderately south-dipping monocline. Along this thrust, numerous mesoscopic WNW-ESE and NW-SE trending folds have been observed. On the boundary between the complexes with different competence (eg. Łabowa/ Beloveža and Beloveža/Bystrica fms.) inverse faults, parallel to the frontal thrust have been documented. They caused a reduction of the thickness of the Łabowa and Beloveža fms. The TTT is characterized by strongly deformed Zarzecze Fm. and monoclinally, south-dipping Magura Fm. The lower part of the Zarzecze Fm. displays numerous mesoscopic thrust-fault propagating folds (NE-SW and NW-SE) (Fig. 12). In the Poręba Górna and Konina sections, the middle part of the formation reveals a segment of the south-dipping overturned strata, measuring 100 m in length. Distinguished in this paper, the Tobołów-Turbaczyk thrust sheet (TTT) has been documented along a 25 km long belt. This structure is cut from the west and east by the Rabka and Zbludza-Zalesie transversal, submeridian, normal faults respectively (Fig. 1). The Krynica and Bystrica (TTT) subunits are separated by W-E trending overthrust (Figs. 1, 2, 9). The Krynica subunit are thrust onto the youngest deposits (Middle/ ?Upper Eocene) of the Bystrica (TTT) subunit. The frontal part of the Krynica thrust is build up by a few imbricated folds composed of the Szczawnica and Zarzecze fms., followed by a syncline filled with the Piwniczna Mb. of the Magura Fm. The Magura Nappe on the southern margin of the MDW is disturbed by three

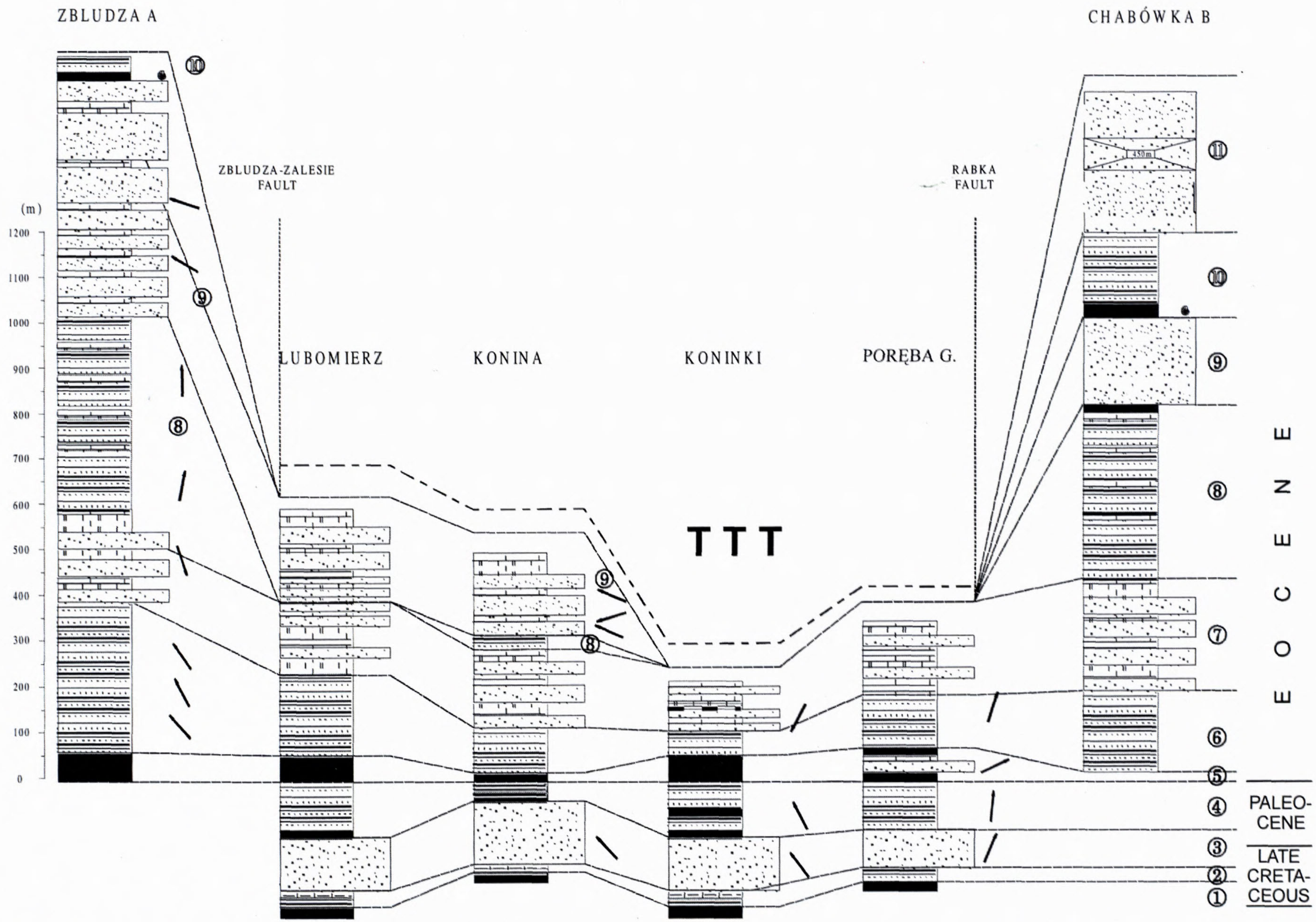

Fig. 13. Lithostratigraphic correlation of the Bystrica Subunit on the southern margin of MDW with Chabówka (B) and Zbludza (A) sections (after Oszczypko, 1991). For explanations see Fig. 3.

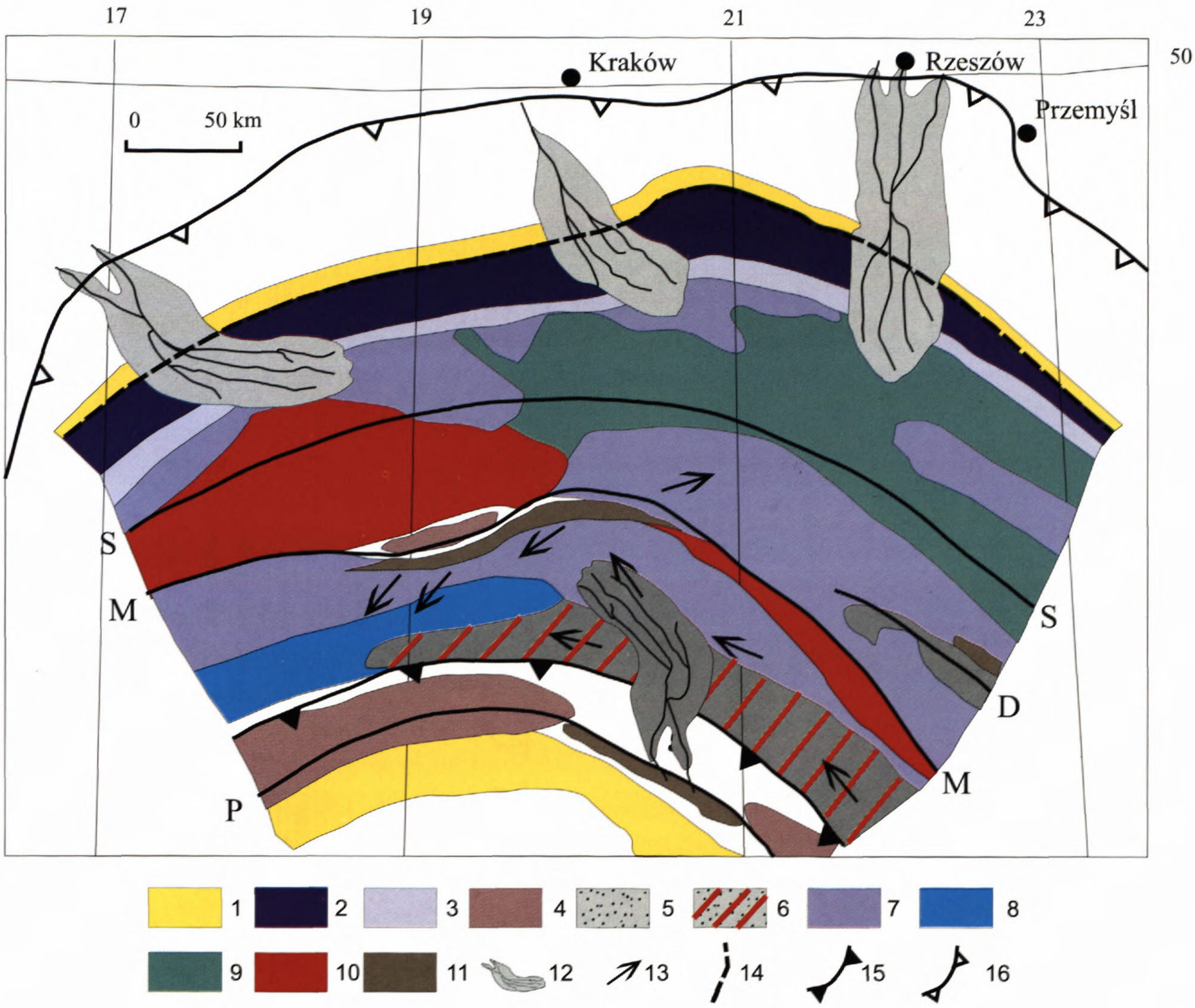

Fig. 14. Middle/ Late Eocene paleogeography of the Polish sector of the Outer Carpathian basin (after Książkiewicz, 1962; Oszczypko, 1998, suplemented). 1-littoral facies, 2-shelf facies, 3-slope facies, 4-pelagic slope marls, 5-chanel-fan deposits, 6-variegated shales of the Mniszek Mb.,7-distal turbidites, 8-silico-carbonate turbidites, 9-hemipelegic green shales, 10-hemipelagic variegates shales, 11- intrabasinal source area, 12-delta, 13-paleotransport, 14- zero line of Wiese vector, 15-active margin of accretionary wedge, 16-present-day front of the Carpathians.

submeridional faults located at the western (Olszówka) and eastern margins of the window.

Lithostratigraphic correlation and paleogeographical implications

The Eocene deposits of the Konina-Lubomierz and Tobołów-Turbaczyk sequences have themselves been compared as well as, with the Zbludza and Rabka sections (Figs. 1, 13). Generally, there is good lithostratigraphic correlation between Konina-Lubomierz trust sheet sections and Zbludza and Rabka sections, though some differences can be observed. In the comparison with complete Zbludza and Rabka sections the Poręba Górna, Koninki, Konina and Lubomierz sections display a reduction in thickness of the Beloveža and Żeleźnikowa fms. and the Maszkowice Mb. of the Magura Fm. For example, the thickness of the Eocene strata in the Poręba Górna is about 200 m., up to 250 m in Koninki and about 500 m. in Konina sections, whereas in the Zbludza and Rabka sections it reaches more than 1500 m. The lack of the Mniszek and Poprad members of the Magura Fm. is also very significant. The reduction in thickness of the Beloveža Fm. is probably of sedimentary and partly tectonic nature, whereas reduction in thickness and disappearing of the youngest lithostratigraphic units are tectonic in origin. It could be connected with formation of the Tobołów-Turbaczyk trust-sheet and extentional motions during the Middle Miocene uplifting of the Mszana Dolna tectonic window. The sections of the Konina-Lubomierz and Tobołów-Turbaczyk thrust sheets indicate the significant facies differences, particularly below the base of the Magura Fm. In the TTT, the Zarzecze Fm. (Lower-Middle Eocene) replaces the following litostratigraphic units typical of the Bystrica facies zone: the variegated shales of the Łabowa Fm. (Lower Eocene), Beloveža Fm. (Lower/Middle Eocene) and Bytrica and Żeleźnikowa fms. (Middle Eocene, see also Oszczypko, 1991). These facies differences could have been caused by the more southern positioning of the TTT sedimentary area in the Magura basin, with respect to the Bystrica facies zone. Thus, the Zarzecze Fm. of TTT was deposited in the northern, deeper and nonchanelized part of the Krynica facies zone, whereas all the other formations were deposited in the Bystrica facies zone. This is shown by the occurrence of the variegated shales, calcareous-free character of the majority of shales and lack of the Krynica Cgl. Mb. During the late Middle Eocene (NP 17 Zone) the Magura Sandstone fan first reached the TTT sedimentary area and then expanded into the Bystrica facies zone (Fig. 14). Towards the axes of the basin the sandstones of the Maszkowice Mb. were replaced by the sandstones and marls (Bystrica Fm) and basinal turbidites (Beloveza Fm), whereas the abyssal plain was occupied by the Middle Eocene red shales (Łabowa Fm.) of the Rača facies zone (Oszczypko, 1992). From the comparison of the thickness of the Maszkowice Mb. in different parts of the Bystrica Subunit and TTT (see Oszczypko, 1991) it can be concluded that TTT represents the SE-NW (150-160ş) trending axial zone of the Middle Eocene Magura sandstone fan. At the beginning of Late Eocene (NP 18) during the HLS (Haq et al., 1987) the peripheral part of the Magura sandstone fan probably reached CCD. This resulted in the deposition of variegated shales of the Mniszek Sh. Mb. of the Magura Fm. In the TTT area the Mniszek Mb. was probably not deposited. Its equivalent could be represented by thin-bedded turbidites in the Poręba Górna and Lubomierz sections. These deposits occur about 700 m. above the base of the Magura Fm (Fig. 4). The strongly tectonized Zarzecze Fm. could represent a suture zone of the early Middle Eocene accretionary wedge, overlapped by the Magura sandstone fan. During the Lutetian/Bartonian time, this suture zone was probably dormant and then (Priabonian) reactivated before the deposition of the Malcov Fm. (see Oszczypko, 1998). The Middle/Late Eocene paleogeographic situation of the Magura basin as a part of the Northern Tethys is shown in figure 14. Present-day fault boundaries of TTT located in Rabka and Zbludza probably developed along the former margin of the fan. According to Malata et al. (1996) the Zbludza-Zalesie normal fault, which bounded TTT from the east, was formed after the Middle Badenian and prior to Late Badenian-Sarmatian deposition in the Nowy Sącz Basin.

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