LATE ALBIAN AND CENOMANIAN REDEPOSITED FORAMINIFERA
FROM LATE CRETACEOUS-PALEOCENE DEPOSITS OF THE RAČA
SUBUNIT (MAGURA NAPPE, POLISH WESTERN CARPATHIANS)
AND THEIR PALEOGEOGRAPHICAL SIGNIFICANCE

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Abstract: Late Albian abundant and diversified foraminifers and calcified radiolaria representing the Planomalina
buxtorfi-Rotalipora appenninica Zone, and single Cenomanian planktonic foraminifers have been found as redepos-
ited assemblages within lower-middle Campanian and Paleocene flysch deposits of the Rača Subunit, Magura Nappe,
Polish Western Carpathians. The Late Albian foraminifers derived from the source area located at the NW margin of
the Magura Basin, whereas the Cenomanian foraminifers derived from the SE periphery of the basin. The presence of
such microfauna is interpreted as an occurrence of a submarine plateau with pelagic deposition, under lower neritic-
upper bathyal depths in the marginal parts of the Magura Basin, during the Late Albian–Early Cenomanian. This
assumption was used for reconstruction of the Late Albian–Early Cenomanian paleogeography of the Magura Basin.

Key words: Western Carpathians, Magura Nappe, Late Albian, Cenomanian, paleogeography, Foraminifera.

Introduction

The results of paleontological studies of Late Albian and
Cenomanian redeposited foraminifers from the Campanian
and Paleocene deposits of the Magura Nappe (Western Car-
pathians) within the Rača Subunit are discussed in this paper.
These studies may give a better understanding of the early
sedimentation history in the Polish part of the Magura Basin
(a part of the Outer Carpathian realm), which is poorly docu-
mented.

The Magura Nappe was almost completely uprooted from
its substratum during the overthrust movements, mostly
along the ductile Upper Cretaceous rocks. For this reason,
the Lower Cretaceous deposits are very scarce. Exposures with
Lower Cretaceous deposits in this nappe were described from
Southern Moravia (Bubik et al. 1993; Švabenická et al.
1997) and from Poland (Birkenmajer 1965, 1973; Ciesz-
kowski & Sikora 1976; Burtan et al. 1976, 1978; Burtan &
Lydka 1978).

Most stratigraphical data concerning the oldest deposits in
the Polish part of the Magura Nappe were connected with the
Grajcarek Unit (Birkenmajer 1965, 1973) — the southern-
most tectonic-facies zone of the Magura Nappe, incorporated
into the Pieniny Klippen Belt during the Laramian folding
(Birkenmajer 1986). The oldest deposits of the Grajcarek
Unit, represented by black turbidites, are ?Toarcian-Aalen-
ian in age (e.g. Birkenmajer 1977). They were followed by
deep-water, condensed sedimentation of Bajocian through
Lower Cretaceous. The Albian and ?Cenomanian rocks were
attributed to the Wronine and Hulina formations (Birkenma-
jer 1977), represented mostly by argillaceous, marly, sili-
ceous, bituminous, black or dark-green shales with pyrite,
siderite and ferruginous dolomite concretions (Wronine Fm.),
and radiolarian cherts (Hulina Fm.).

The oldest deposits (green spotty shales) of the Krynicka
Subunit were described in the Obidowa IG-1 borehole
(2453–2510 m; Cieszkowski & Sikora 1976). Their age was
determined as the Cenomanian, however, no paleontological
data was presented there. According to Birkenmajer & Osz-
czycko (1989), these deposits could be included as a part of
the Hulina Formation (Albian–Cenomanian in the Grajcarek
Unit; Birkenmajer 1977), based on lithofacies.

The oldest deposits in the Grybów Subunit and the Koninki
thrust-sheet of the Magura Nappe are known from a few small
exposures at the southern margin of the Mszana Dolna tecton-
ic window (Burtan et al. 1976, 1978; Burtan & Lydka 1978).
They include dark and green, spotty shales with manganifer-
ous concretions (?Albian-Cenomanian) and dark shales with
siliceous sandstones and benthonites (?Albian-Cenomanian).
According to a recent investigation (Oszczycko et al. 1999),
the Koninki thrust-slice could be assigned to the Rača Subunit.
Birkenmajer & Oszczycko (1989) compared these deposits
with the Hulina Formation (Albian-Cenomanian). The assem-
blage of small foraminifers, described from the green, spotty
shales at Koninki village, consists of exclusively agglutinated
taxa, corresponding to the Plecturecurvoides alternans Zone
sensu Geroch & Nowak (1984). In the Polish Carpathians,
this zone represents the Middle Albian–Early Cenomanian accor-
ding to Geroch & Nowak (1984) and Bąk (in print), and the
Middle–Late Albian according to Olszewska (1997).
Study area

The study area is located along the Lososina stream in the Półrzeczki village, within the SE part of the Beskid Wyspowy Range, close to Mogilica Mt. (Figs. 1, 2). This area belongs to the Rača Subunit of the Magura Nappe, building up the eastern periphery of the Mszana Dolna tectonic window (Fig. 1; see also Burtn et al. 1976, 1978; Burtn & Lydka 1978). This part of the Rača Subunit is composed of the Upper Cretaceous-Middle Eocene deposits belonging to: Malinowa Formation, Jaworzyńska and Ropiánka beds, and Łabowa and Beloveža formations (Fig. 2; Oszczypko et al., submitted paper).

The Malinowa Shale Formation (see Birkenmajer & Oszczypko 1989) is represented by cherry-red, non-calcareous shales, which occur in 30–50 cm layers, intercalated by grey-greenish shales, a few up to 25 cm thick. In this area, the formation contains a few intercalations of thick-bedded, coarse to medium-grained quartz-glaucnite sandstones, laminated quartzitic mudstones and hornstones. The thick-bedded quartz-glaucnite sandstones revealed the paleotransport from W and WNW. The frequency of the grey-greenish intercalations increases in the upper part of the formation, displaying features of the Haltetowa lithofacies described from the Zasadne section (Malata & Oszczypko 1990). The thickness of the Malinowa Formation reaches at least 50 m (Oszczypko et al.,
argillaceous shales with sideritic concretions and layers of black silicified mudstones (hornstones, see sample Pół-0/93; Fig. 4). The thickness of the Kanina beds reaches 100 m.

The Jaworzynka beds are composed of thick-bedded sandstones, dirty-green in colour, medium to coarse-grained, rich in feldspars and admixture of glauconite and biotite (Burtan et al. 1976, 1978; Burtan & Lydka 1978; Osszczypko et al., submitted paper). These sandstones revealed the paleotransport direction from W and NW. The Jaworzynka beds are upper Senonian in age. Their maximum thickness is about 200 m.

The Ropianka beds are represented by thin to medium-bedded, green-greyish sandstones, dark, muscovite mudstones, enriched with coalfield plant flakes and dark-grey, blue, usually carbonate-free shales. In the upper part of the beds, intercalations of dark-grey medium-bedded and very fine-grained, glauconite and biotite non-calcareous sandstones occur. A few layers of turbiditic limestones and siderites have also been found. Flute-foast measurements display paleotransport from WNW (280°) in the lowermost portion of the beds, to ESE and SES (100–160°) in their upper part. The Ropianka beds (150 m thick) are Maastrichtian to Paleocene in age (Osszczypko et al., submitted paper) in the Półrzeczki section.

The Labowa Shale Formation (Osszczypko 1991) is represented by a few meters thick, repeated packets of soft, carbonate-free, red and green shales, intercalated with very thin-bedded turbidites in its lower part, and thick (2–3 m) packets of red shales in its middle part. Locally, green and blue shales with intercalations of thin-bedded sandstones have been observed at the Półrzeczki section. The thickness of the formation attains up to 150 m. According to biostratigraphical studies (see Osszczypko 1991; Osszczypko et al., submitted paper), the Labowa Shale Formation represents the Early Eocene.

The uppermost part of the Rača Subunit sequence belongs to the Bełoveża Formation in the study area. The formation is represented mainly by thin- to medium-bedded turbidites. Shales, varying in colour (green, grey, blue, brown and yellowish) prevail distinctly over sandstones. In the basal part of the formation, a few intercalations of red shales have been observed in the studied section. The thickness of the formation reaches about 50 m. Its age has not been investigated at the Półrzeczki section, however, by comparison with the Zasadmie section (see Osszczypko 1991), it could correspond to the Middle Eocene.

Material and methods

Samples of black and dark siliceous shales of the Kanina beds were taken from the Półrzeczki section (Figs. 2, 3) for micropaleontological study. Seven samples (Pół-33/94–Pół-39/94) were collected from two limbs of an overturned anticline. The samples weighing 500–750 g were dried and integrated in a solution of sodium carbonate. One sample (Pół/093), taken from a 10 cm thick, black, silicified mudstone layer was dissolved in 5% dilute hydrofluoric acid. The material was then washed through sieves with mesh diameters of 63 μm and 1500 μm. The microfauna were picked from 63–1500 μm fraction and mounted on cardboard slides for microscopic examination.
The microfaunal slides are housed in the Institute of Geography, Cracow Pedagogical University (collection No. 07 Mg).

**Microfaunal assemblages**

The black and dark silicified shales contain scarce and poorly diversified deep-water agglutinated foraminifers with *Caudammina gigantea* (Geroch), which is important for stratigraphy. The assemblage is dominated by tubular, mostly pyritized forms of the superfamiy Astrorhizacea (Fig. 4; Pls. I, II). Specimens of the genera *Paratrochamminoides*, *Trochamminoides*, *Reophax*, *Trocchammina*, *Recurrevoides* as well as *Saccamminella placenta* (Grzybowski), *S. grzybowskii* (Dylązanka) and *Caudammina ovulum* (Grzybowski) also occur frequently.

The occurrence of *Caudammina gigantea* in these deposits, the species used as an index taxon in most zonations of non-calcareous, Late Cretaceous facies (e.g. Geroch & Nowak 1984; Kuhnt et al. 1992; Bubik 1995; Bąk in print) and the stratigraphical data of younger deposits in the studied section suggest the early-middle Campanian age of the black, silicified facies.

However, one sample (Pól-0/93), taken from a 10 cm thick chert layer (silified mudstone) includes a well-preserved and rich assemblage of planktonic and benthic (calcareous and agglutinated) foraminifers (Fig. 4; Pl. III). The species *Hedbergella delrioensis* (Carsey), accompanied by other hedbergellids, such as *H. planispira* (Tappan), *H. simplex* (Morrow) dominates there (more than 140 specimens). Other common planktonic forms include species of *Planomalina buxtorfi* (Gandolfini) (10 specimens), *Rotalipora appenninicu* (Renz) (8 specimens), *Globigerinelloides ultramica* (Subbotina) (6 specimens), *Praeglobotruncanata delrioensis* (Plummer) (3 specimens) and *Heterohelix moremani* (Cushman) (2 specimens). Benthic foraminifers are represented by single forms (1–5 specimens) of *Gyroidinoides infracretacea* (Morozova), *Lenticulina gautinna* (Berthelin), *Gavelinella intermedia* (Berthelin), *Dentalina sp.*, *Marginulina sp.*, *Rhabdammina sp.* and *Ammodiscus cretaceous* (Reuss). Silicified (all recrystallized) small radiolaria (Pl. IV; undeterminable, *pers. inf.* by Marta Bąk) are a significant element (50 specimens) of this assemblage.

These foraminifers represent the *Planomalina buxtorfi-Rotalipora appenninicu Zone sensu* Gasinski (1988) and Bąk (1998), corresponding to Vraconian. Unusual micropaleontological results obtained from the sample Pól-0/93, encouraged us to study more samples from this chert layer. Unfortunately, they were devoid of microfauna.

In the author’s opinion the described foraminifers can be interpreted as redeposition of microfauna from the shallower part of the basin, which represented another type of environment. Hieroglyphs measured from the base of this silicified black mudstone layer show paleotransport from the west and north-west.

The younger deposits of the studied section at the Beskid Wyspowy Ms., belonging to the lower Paleocene Ropianka beds, contain single redeposited Cenomanian planktonic foraminifers (Pl. IV). A few specimens of *Rotalipora cushmani* (Morrow), *Praeglobotruncanata gibba* Klaus and *P. delrioensis* (Plummer) have been found in the sample Pól-2/94 (Pl. IV), taken from the uppermost part of the Ropianka beds (early Paleocene; Osyczypko et al., submitted to print).

**Late Albian-Early Cenomanian paleogeographical implications**

The Late Albian-Early Cenomanian paleogeography of the Outer Carpathian sedimentary area was reconstructed mainly for its northern (Silesian/Subsilesian Basin) and eastern (Skole Basin) parts (e.g. Książkiewicz 1962; Birkenmajer 1977; Birkenmajer 1986). The tectonic amputation of the Lower/Middle Cretaceous deposits of the Magura Nappe makes difficult such reconstruction for the Magura Basin.

Taking into account all published data from the Magura Nappe (Burtan et al. 1976, 1978; Burtan & Lydka 1978; Cieszkowski & Sikora 1976; Birkenmajer 1977; Bubik et al. 1993;...
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<th>AGE</th>
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<td>Nothia sp.</td>
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<td>Hyperammina sp.</td>
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<td>Hyperammina cf. dilatata</td>
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<td>Kalamopsis grybowskii</td>
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<td>Rhaphammina sp.</td>
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<td>Sacconina grybowskii</td>
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<td>Sacconina placenta</td>
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<td>An모dicsus cretaceus</td>
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<td>Glamosira charoides</td>
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<td>Glamosira serpens</td>
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<td>Aschemocella grandis</td>
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<td>Reophax sp.</td>
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<td>Subreophax cf. splendidus</td>
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<td>Subreophax cf. scalaris</td>
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<td>Pseudonodosinella parvula</td>
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<td>Caudammina cf. crassa</td>
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<td>Caudammina ovulum</td>
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<td>Caudammina gigantea</td>
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<td>Haplophragmoides sp.</td>
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<td>Recurvoides spp.</td>
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<td>Cribrorostielloides cf. trinitatensis</td>
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<td>Trochammina sp.</td>
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<td>Paratrochamminoides vaniolarus</td>
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<td>Paratrochamminoides spp.</td>
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<td>Gerochammina conversa</td>
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<td>Karrerulina coniformis</td>
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<td>Karrerulina sp.</td>
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<td>Dentalina sp.</td>
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<td>Marginulina sp.</td>
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<td>Heterohelix cf. moremani</td>
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<td>Praeglobotruncana delrioensis</td>
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<td>20-100 specimens</td>
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<td>&gt; 100 specimens</td>
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**Fig. 4.** Occurrence of microfauna in the investigated samples; Półrędzce village, Rača Subunit, Magura Nappe; L.A. — Late Albian.
Plate I: SEM photomicrographs of autochthonous Campanian deep-water agglutinated Foraminifera at the Półrzeczki section; Rača Subunit, Magura Nappe, Polish Western Carpathians: Fig. 1. *Pseudammina* cf. *dilatata*, sample Pól-39/94. Fig. 2. *Kalamoposis* grzybowskii (Dylkańska), sample Pól-39/94. Fig. 3. *Subeophax* cf. *splendidus* (Grzybowski), sample Pól-36/94. Fig. 4. *Subeophax* cf. *scalaris* (Grzybowski), sample Pól-39/94. Fig. 5. *Caudammina* gigantea (Geroch), sample Pól-39/94. Fig. 6. *Pseudonodosinella* parvula (Huss), sample Pól-39/94. Figs. 7, 8. *Subeophax* splendidus (Grzybowski), sample Pól-36/94. Figs. 9, 10. *Caudammina* ovalum (Grzybowski), sample Pól-35/94. Fig. 11. *Caudammina* cf. *crassa* (Geroch), sample Pól-39/94. Fig. 12. *Aschemocella* grandis (Grzybowski), sample Pól-34/94. Fig. 13. *Caudammina* ovalum (Grzybowski), sample Pól-38/94. Figs. 14, 15. *Saccammina* grzybowskii (Schubert), Pól-39/94.
Plate II: SEM photomicrographs of autochthonous Campanian deep-water agglutinated Foraminifera at the Półrzeczki section; Rača Subunit, Magura Nappe, Polish Western Carpathians: Fig. 1. Ammodiscus cretaceus (Reuss), sample Pół-39/94. Figs. 2, 3. Glomospira charoides (Parker & Jones), sample Pół-38/94. Fig. 4. Glomospira serpens (Grzybowski), sample Pół-33/94. Fig. 5. Glomospira irregularis (Grzybowski), sample Pół-36/94. Figs. 6, 7. Paratrochaminoides sp., sample Pół-39/94. Fig. 8. Trochammina sp., sample Pół-38/94. Figs. 9, 10. Cribrostomoides cf. trinitatensis Cushman, sample Pół-39/94. Fig. 11. Recurvoides sp., sample Pół-36/94. Fig. 12. Paratrochaminoides cf. variolarius (Grzybowski), sampe Pół-39/94. Figs. 13, 14. Gerochammina conversa (Grzybowski), sample Pół-38/94. Fig. 15. Karrerulina coniformis (Grzybowski), sample Pół-38/94. Fig. 16. Haplophragmoides sp., sample Pół-39/94.
Plate III: SEM photomicrographs of planktonic Vraconian Foraminifera at the Półtrzeczk section (sample Pół-0/93); Rača Subunit, Magura Nappe, Polish Western Carpathians: Figs. 1-3. Planomalina buxtorfi (Gandolfi). Fig. 4. Heterohelix cf. moremani (Cushman). Figs. 5, 6. Hedbergella delrioensis (Casey). Figs. 7, 8. Hedbergella simplex (Morrow). Figs. 9-11. Rotalipora appenninica (Renz). Fig. 12. Globigerinelloides ultramicra (Subbotina). Figs. 13, 14. Praeglobotruncana delrioensis (Plummer). Fig. 15. Globigerinelloides ultramicra (Subbotina).
green claystones, whitish marls and limestones. They are intercalated with carbonate-free clays of the Glomospirra-Rhizammina and Rhabdammina-Rzejakina biofacies, which could be evidence of an environment below the CCD (Świąbencicki et al. 1997).

Towards the Czorsztyz submerged ridge, these deposits were replaced by the calcareous ooze, partly silicified (planktonic foraminiferal-radiolarian microfacies) of the Pomieleny Formation and the Brcznckowa Marl Member (Jaworki Formation) (see Birkenmajer 1977; Birkenmajer & Jednorowska 1987) (Fig. 6). The foraminiferal associations suggest the shelf and upper slope depth of the Czorsztyz Ridge (Birkenmajer & Gasinszki 1992).

Similar, upper Albian-lower Cenomanian facies occur in the Ukrainian part of the Klippen Belt, described as the Tissalo Formation (Vialov et al. 1988). These deposits are represented by 145 m thick, light and dark-grey marls (partly fucoids), with thin intercalations of black shales and grey-green limestones. The Tissalo Formation is underlain by the Neocomian cherty limestones and covered by the Late Cenomanian-Se- nonian variegated marls of the Puchov Formation.

The Albian and Cenomanian deposits are also known in the Ukrainian and Romanian Outer Carpathians, in their parts, which are correlated with the Magura Unit (Fig. 6). According to Sândulescu (1988; see also Oszczyzko 1992), the Silesian Cordillera was a prolongation of the Middle and Outer Dacides, which were tectonized during the Middle Cretaceous.

Thus, since that time, the Marmarosh (Maramuresh) Massif could supply the material to the NE part of the Magura Basin (Rača sedimentary area; see Zytko 1999). The NW prolongation of the Marmarosh Massif is known as the Marmarosh Klippen (Vezhany Nappe; Zytko 1999).

The Marmarosh Massif was transgressively overlapped by the Late Albian-Cenomanian posttectonic Sojmul Formation in the SE part of the Ukrainian Carpathians (Vialov et al. 1988). This formation, up to 120 m thick, overlaying the Triassic folded deposits, includes the shallow-water, marine clastic deposits, coarse-grained in their lower part and fine-grained in the upper ones. The formation includes also deep-water, basinal turbidites, passing upward to the pelagic Puchov Marls (Late Cenomanian-Maastrichtian; see Panamareva in: Vialov et al. 1988) in the area of the Marmarosh Klippen (Dragov section).

It should be stressed that there is a lack of the Aptian-Lower Cenomanian deposits in the Poiana Botizei section (East Carpathians, Romania), the SE termination of the Pieniny Klippen Belt and the Magura Nappe (Bombita et al. 1992). This is probably an effect of a latter (or synsedimentary) erosion in that area.

**Source of the Cenomanian redeposited foraminifers**

The source area for the Cenomanian redeposited foraminifers is reconstructed here on the basis of paleotransport measurements in the upper part of the Ropiana beds. Flute casts on soles of thin- to medium-bedded sandstones suggest the ESE and SES (100-160°) transport directions. These directions were similar to those during deposition of the Campa- nian, thick-bedded, turbidite sandstones, belonging to the Szczawina beds (transport also from SE). Thus, the clastic material of the Ropiana and Szczawina beds derived, most probably, from the peri-Pieninian source area (see Sikora 1970).

**Conclusions**

The presented micropaleontological data confirm that deepwater sedimentation in the northernmost part of the Magura Basin, in its Polish segment, started during the Late Albian. The paleotransport directions of the mudstone layer (from W and NW), in which the foraminifers have been found, and for other turbidity layers of the Kanina beds, show that the Silesian Ridge (or its southern slope) was the source area for the redeposited material. The studied Vraconian foraminiferal assemblage resembles microfauna from the pelagic deposits of the Pieniny Klippen Belt. Taking into account these similarities, the lower neritic-upper bathyal depths and pelagic-type of sedimentation are interpreted for this part of the Silesian Ridge during the Late Albian.

Redeposited Cenomanian planktonic foraminifers, found in the early Paleocene flysch of the Ropiana beds could also be indicators of pelagic sedimentation, but on the southern periphery of the Magura Basin, connected with the peripieninian area.

The published data, concerning the Late Albian-Early Ceno- manian sedimentation in the Magura Basin, have been used
Fig. 6. Late Albian-Early Cenomanian paleogeography of the Outer Carpathians (Magura Basin — this paper; Silesian/Subsilesian and Skole basins after Książkiewicz 1962).

here to reconstruct the main facial zones during this time. The type of deposits and microfossil content show deep-water, mostly pelagic and hemipelagic sedimentation below the calcium compensation depth in the central part, and pelagic sedimentation under lower neritic-upper bathyal depths in the northern (Silesian Ridge) and southern (Czorsztyn Ridge) peripheries of the Magura Basin.

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References


