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AGGLUTINATED FORAMINIFERAL STRATIGRAPHY OF THE SILESIAN FLYSCH TROUGH

by

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With 3 figures

ZUSAMMENFASSUNG

Sedimentologie und Tektonik des silesischen Flyschtroges werden kurz zusammengefaßt und eine stratigraphische Gliederung der polnischen Äußeren Karpaten präsentiert. Dazu wird die Paläoökologie der benthonischen Foraminiferenvergesellschaftungen des Silesischen Beckens vom Tithon bis zum Oligozän diskutiert. Die stratigraphische Reichweite von 45 wichtigen, agglutinierten Foraminiferenarten wird entsprechend ihrer Vorkommen in den wichtigsten, lithostratigraphischen Einheiten tabellarisch aufgelistet.

ABSTRACT

The sedimentologic and tectonic history of the Silesian Flysch Basin is reviewed and a stratigraphic scheme is presented for the Polish Outer Carpathians. The paleoecology of Tithonian to Oligocene benthic foraminiferal assemblages in the Silesian Basin is discussed, and stratigraphic ranges of 45 important species of agglutinated foraminifera are reported in terms of their occurrence in major lithostratigraphic units.

INTRODUCTION

The Silesian Flysch Trough of the Polish Outer Carpathians contains a thick sequence of Upper Jurassic to Lower Miocene sediments. A number of authors have attempted to synthesize the stratigraphy of the Silesian Basin, including Bieda (1949), Bieda *et al.* (1963), Geroch *et al.* (1967), Koszarski and Slączka (1976), Nowak (1976) and Książkiewicz (1977). The paleogeography of the Outer Carpathians and paleotransport directions in the Silesian Basin are presented in the "Geological Atlas of Poland" (Książkiewicz 1962).

The Silesian Basin is a classic locality for agglutinated foraminifera, and biostratigraphic data can be found in papers by Grzybowski (1897, 1898), Hiltermann (1943, 1975), Bieda (1949), Guzik and Pożaryska (1949), Geroch (1960, 1966), Jurkiewicz (1960, 1967), Hanzliková (1966, 1972, 1973), Morgiel and Olszewska (1981a,b), Olszewska (1984a,b) and Geroch and Nowak (1984). In this study, we present a synoptic lithostratigraphic scheme and report the stratigraphic ranges of important agglutinated foraminifera in the Silesian Basin.

GEOLOGIC SETTING

The Silesian nappe occupies a central position in the Polish Flysch Carpathians (figure 1). In Poland and Czechoslovakia, the Silesian unit is made up of a continuous sequence of uppermost Jurassic to Oligocene sediments. In the eastern part of the Carpathians to the Lower Miocene, these sediments range in age (figures 2 and 3). Sedimentation took place in an extensive trough which can be traced in a SE direction to the Czarnohora-Audia nappe and still farther to the great bend of the Carpathian arch

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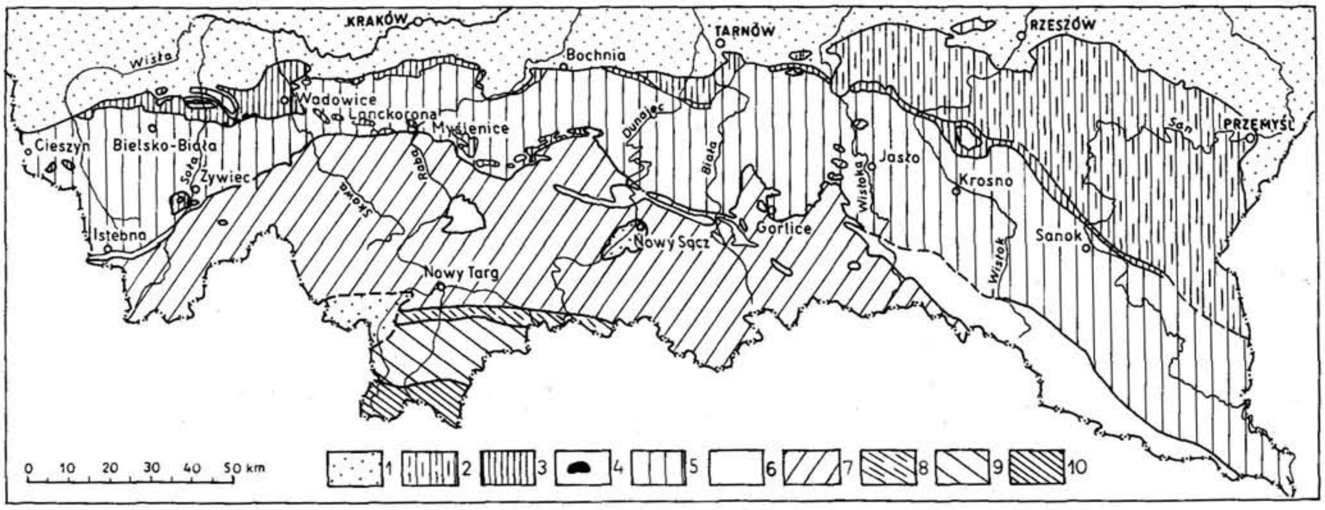

Fig. 1.
Tectonic sketch-map of the Outer (Flysch) zone, Polish Carpathians.
1 = Early-mid Miocene molasse of the Carpathian Foredeep and mid-Miocene–Pliocene in the Carpathians; 2 = Skole Nappe; 3 = Sub-Silesian Nappe; Andrychów Klippen; 5 = Silesian Nappe; 6 = Pre-Magura scales, units that occur in the tectonic windows of the Magura Nappe, Dukla folds and imbricated folds; 7 = Magura Nappe; 8 = Pieniny Klippen Belt; 9 = Postorogenic cover of the inner units (Podhale Flysch); 10 = Tatra units (inner pre-Paleogen, supposedly pre-upper Cretaceous units).
Modified after KSIAZKIEWICZ (1962, 1975) and GEROCH & NOWAK (1984).

in Romania. These sediments are exposed over a distance of about 1000 km. In the west, flysch sediments which correspond to those of the Silesian nappe, occur in the outer zone of the Alpine flysch (the Greifensteiner Schuppenzone of the Wienerwald in Austria).

In the Polish Carpathians, the width of the folded Silesian nappe attains about 50 km. The nappe consists of several large imbricated folds. To the east, the folds become steep and can be traced in deep wells up to a depth of 6 km. The primary width of the Silesian Basin, excluding the continental shelves, was at least 100-150 km.

In its inner part of the Silesian nappe, the total thickness of sediments is about 8 km. In the eastern part of the nappe, The Late Jurassic sediments are missing and the Cretaceous deposits are reduced in thickness. However, the Oligocene and Early Miocene Krosno Beds attain here a thickness of 3.5 km. The lack of the Jurassic and the reduction of the Cretaceous sediments in this area are at least partly due to tectonic shearing. In addition, the youngest flysch sediments were removed by erosion.

On the south, the Silesian Basin was bordered by the Silesian Cordillera (Książkiewicz 1962), which served as a source area for much of the clastics. During Early Cretaceous and Oligocene time, however, part of the clastic material was derived from northern sources. There are no visible remnants of the Silesian Cordillera and the higher tectonic units (from the west: Fore-Magura, Dukla, Sukhov-Teleajen) are thrust onto the Silesian nappe from the south. The sediments of the southern slope of the Silesian Basin occur in the form of isolated blocks in olistostromes and as small tectonic scales. These sediments include pelagic shales and marls.

The Silesian nappe is underlain by the highly folded and tectonically disturbed sub-Silesian nappe. The sediments of the sub-Silesian nappe include flysch members or dark shales of Early Cretaceous age; variegated marly pelagic sediments of Late Cretaceous-Eocene age deposited on a submarine high and its slopes; and the Menilite and Krosno beds of Oligocene age.

The succession of flysch sediments in the Silesian unit is made up of thick units of turbidites and fluxoturbidites. The turbidites are interlayered by a more pelagic type of sediment and in places by members of true pelagic shales. The latter were deposited during periods of reduced tectonic activity.

Three stages of pelagic sedimentation can be differentiated (Koszarski 1963): from Late Jurassic to Early Cenomanian time, the pelagic sediments were laid down under more or less reducing conditions and occur mostly in the form of dark and black shales or marly shales. From the Late Cenomanian to the Late Eocene, the pelagic sediments were deposited under oxidizing conditions and occur in the form of variegated, chiefly red-brown shales. In the Oligocene, euxinic conditions reappeared and the sediments include dark and black Menilite shales.

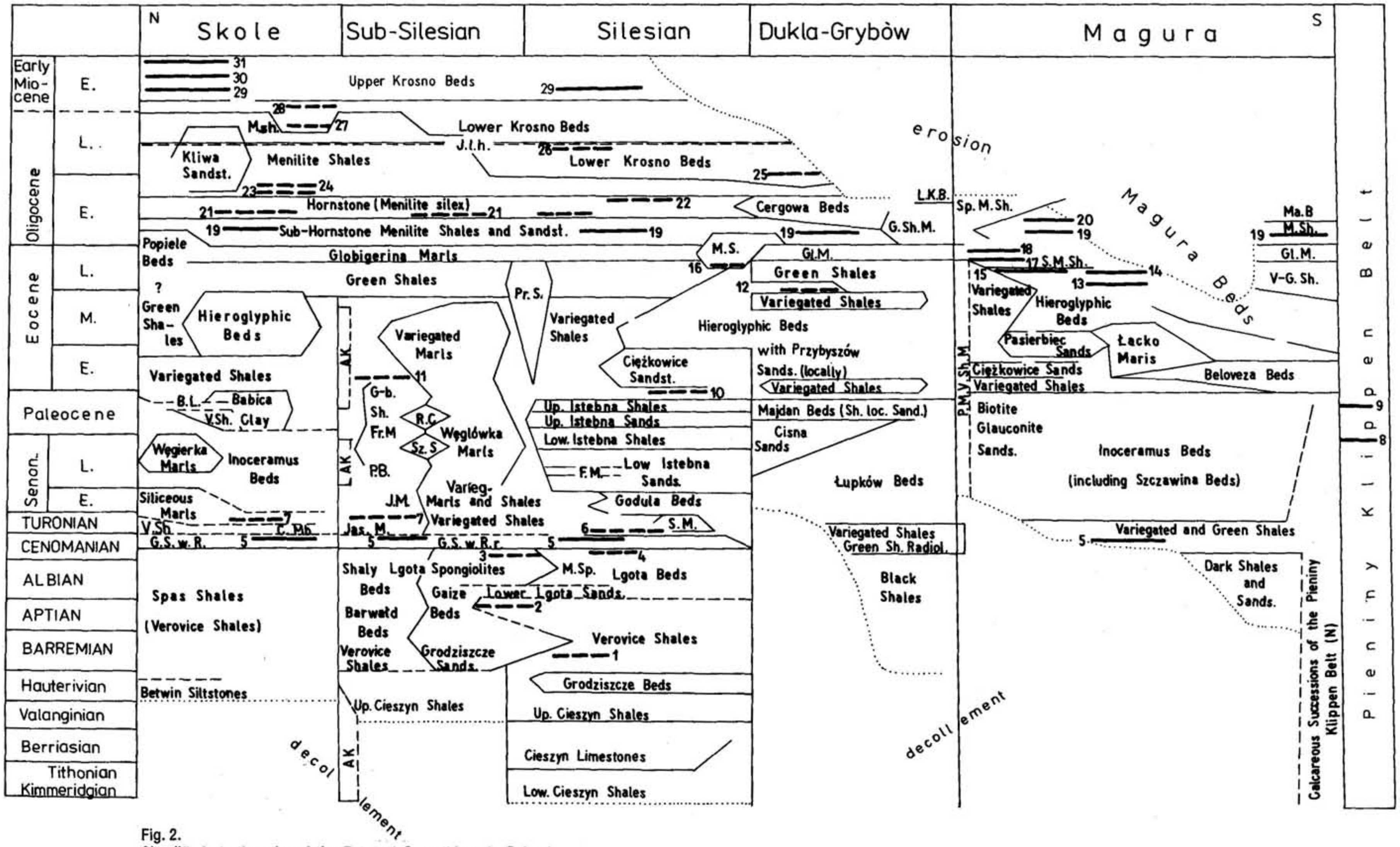

Fig. 2.
Simplified stratigraphy of the External Carpathians in Poland.
Compiled and modified by L. KOSZARSKI based on: Tab. 1 and 2 according to M. KSIAZKIEWICZ in BIEDA et al. (1963); Figs. 37–40 according to M. KSIAZKIEWICZ in GEROCH et al. (1967); Tab. 26–28 in NOWAK (1976); Tab. 53 in KOSZARSKI & SLACZKA(1976); Fig. 10, p. 30 in WIESER (ed. 1985); Fig. p. 38 in KOSZARSKI (ed., 1985). Correlation of tuff horizons according to WIESER and isotopic age data according to NAESER in WIESER (1985).
A.K. = Calcareous successions of External Andrychów Klippen; B.L. = Bircza Limestones; C.Mb. = Cisowa Member; F.M. = "Fucoides" Marls; Fr.M. = Grey Frydek Marls; Gl.M. = Globigerina Marls; G-B.Sh. = Green-Brown Shales; G.Sh.M. = Grybów Shales and Sub-Grybów Marls; G.S.w.R. = Green Shales with Radiolarians; G.S.W.R.r. = Green Shales with Radiolarians and Radiolarites; J.l.h. = Jaslo coccolithic Limestone horizon; J.M. = Jastrzebia Marls (with gaizes); Jas.M. = Jasienica Marls; L.K.B. = Lower Krosno Beds; Ma.B. = Malcov Beds; M.Sh. = Menilite Shales; M.S. = Mszanka Sandstones; M.Sp. = Mikuszowice Spongiolites; P.B. = Pisarzowice Beds; Pm.V.Sh.M. = Pre-Magura Variegated Marls and Shales; Pr.S. = Przysietnica Sanstones; R.C. = Rybie Conglomerates and Sandstones; S.C.M. = Sub-Gergowa Marls; S.M. = Siliceous Marls; S.M.Sh. = Sub-Magura Shales; Sp.M.Sh. = Supra-Magura-Shales; Sz.S. = Szydlowiec Sandstones; V-G.Sh. = Variegated and/or Green Shales; V.Sh. = Variegated Shales.
Tuff horizons (isotopic age in Ma): 1 = Kozlówek; 2 = Porabki 3 = Domaradz; 4 = Straconka; 5 = Miedzybrodzie (91,4±4,7); 6 = Lanckorona; 7 = Rybotycze; 8 = Sromowce (65,3±3,7); 9 = Jaworki (58,5±2,9); 10 = Gorlice; 11 = Bachowice; 12 = Jawornik; 13 = Polany I (41,7±1,7); 14 = Polany II (39,8±1,6); 15 = Zarnówka; 16 = Cisna; 17 = Ciciec (37,9±1,6); 18 = Pewel Mala (35,1±2,2); 19 = Gasiory (34,6±1,4); 20 = Folusz (32,8±1,3); 21 = Grabownica; 22 = Krosno; 23 = Dydnia E.; 24 = Przysietnica; 25 = Berehy Góarne; 26 = Zagórz; 27 = Dydnia W.; 28 = Końskie; 29 = Radziszów (20,5±0,9); 30 = Bandrów (18,4±1,1); 31 = Krzywe (15,6±1,1).

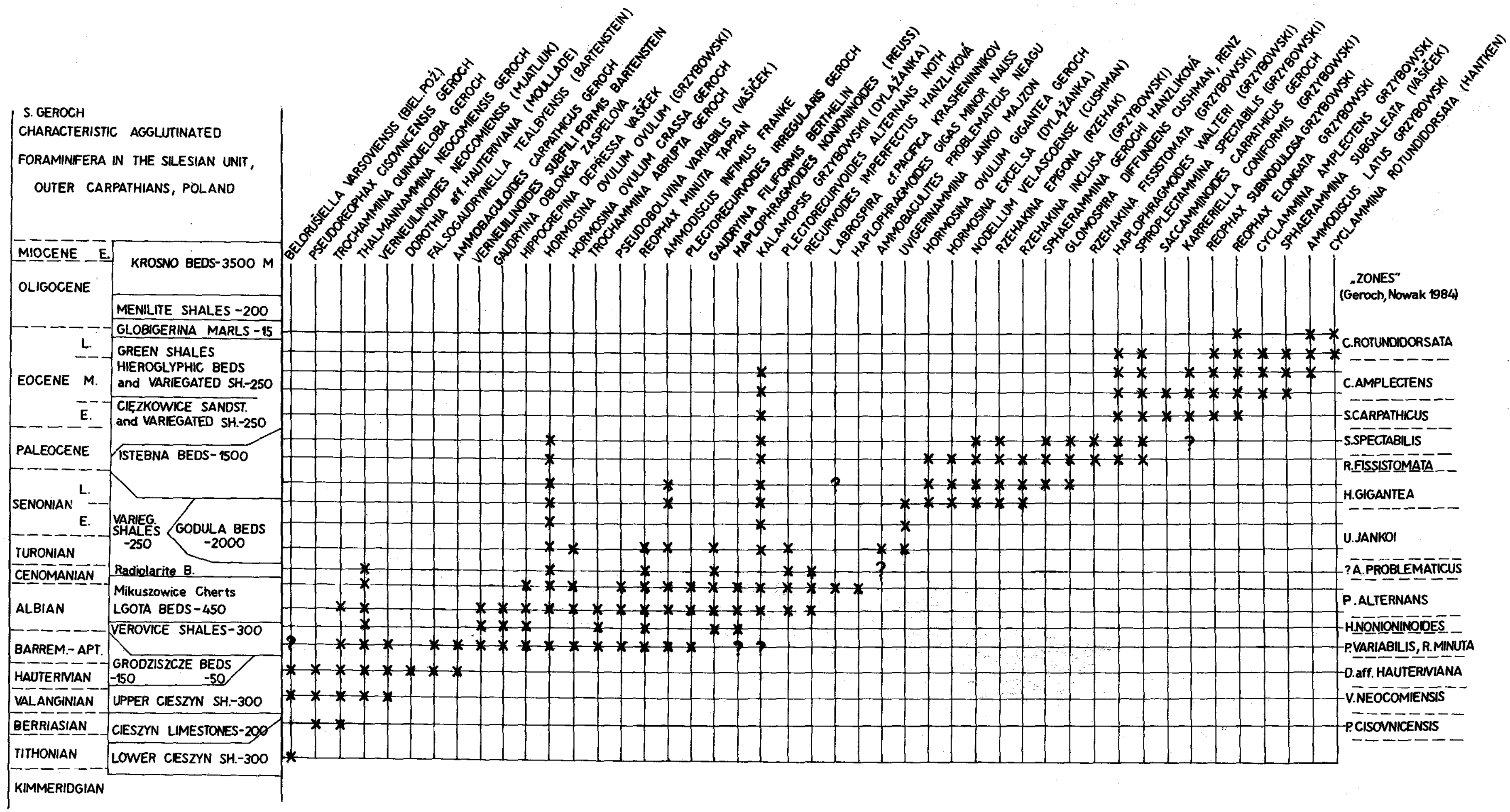

Fig. 3.
Stratigraphic ranges and zonation of agglutinated foraminifera in the Silesian sedimentary unit, outer Carpathians, Poland.

FORAMINIFERAL STRATIGRAPHY

The character of foraminiferal assemblages reflects vertical and lateral changes in pelagic sediments (Koszarski and Żytko 1965; Olszewska 1984b). These changes in microfossil assemblages and sedimentary facies are associated with a gradual subsidence of the Silesian Basin in the Early Cretaceous (from the Barremian to the Late Eocene, the sea floor was presumably below CCD) and the subsequent shallowing of the basin during the Oligocene to Early Miocene, culminating in the final uplift above sea level.

Characteristic agglutinated foraminifera useful for stratigraphic correlation in the Silesian sedimentary sequence are indicated on figure 3. Illustrations of these species have been presented in different papers e.g. Grzybowski (1896, 1898, 1902); Grün *et al.* (1964); Geroch (1960, 1966); Hanzliková (1966, 1972, 1973); Jurkiewicz (1967); Mjatliuk (1970); Samuel (1977); Gradstein and Berggren (1981) and especially Morgiel and Olszewska (1981); Geroch and Nowak (1984); and Olszewska (1984b).

Książkiewicz (1975) expressed his opinion of the paleobathymetry of the Silesian Basin: "... A singular problem is posed by the presence of assemblages composed of exclusively agglutinated species. This is used by Brouwer (1965) and Koszarski and Żytko (1965) as an indication of flysch deposition below CCD, at abyssal depth. It should, however, be emphasized that in nearly all members of the Carpathian flysch, calcareous benthic and/or planktonic species are found occasionally ...". Consequently, Książkiewicz (1975) assumed that the sediments of the flysch troughs were deposited at bathyal, mostly upper bathyal depths above the CCD. However, in Barremian to Late Eocene sediments, the sporadically occurring calcareous foraminifera are presumably redeposited by turbidity current and related mass movements.

The composition of the foraminiferal assemblages in the stratigraphic sequence of the Silesian nappe is influenced by changing paleoecologic conditions and paleobathymetry of the basin and from evolutionary turnovers among foraminifera.

The marly Lower Cieszyn Shales of Late Kimmeridgian to Tithonian age are regarded as pre-flysch and contain a neritic microfauna of calcareous foraminifera dominated by *Trocholina*, *Palzowella*, polymorphinids, nodosariids, and more rarely agglutinated foraminifera such as *Belorussiella varsoviensis*. Ostracods, echinoderm debris, molluscs and radiolarians locally occur (Bielecka and Geroch 1977). The overlying Cieszyn Limestones of Tithonian to Berriasian age are turbidites and contain redeposited shallow marine assemblages comprised of *Trocholina*, miliolids and skeletal debris of other organisms. However, the intercalating shales already contain assemblages of agglutinated and calcareous foraminifera such as *Trochammina*, *Recurvoides*, *Ammodiscus*, *Glomospira*, *Pseudoreophax* and nodosariids which indicate a considerable deepening of the basin.

In the shaly arenaceous flysch of the Upper Cieszyn Shales and Grodziszcze Beds (Valanginian-Barremian), agglutinated foraminifera predominate. During the sedimentation of these deposits, parts of the Silesian Basin probably subsided below the CCD level.

In the younger autochthonous pelagic sediments in the flysch sequence, associations of *Recurvoides-Rhabdammina* type occur up to the Late Eocene. These are sometimes associated with radiolarians. Assemblages made up predominantly of calcareous forms occur in turbidites or in blocks of various pelagic sediments redeposited by gravity slides. These assemblages are derived from more shallow parts of the basin slopes.

Pelagic shales of Aptian to Early Turonian age (the upper Verovice Beds, Lgota Beds, and green shales) are commonly silicified to a certain degree and may contain radiolarians in addition to agglutinated foraminifera. In places, there are true radiolarites which are accompanied by green pelagic radiolarian shales of Late Cenomanian to Early Turonian age.

During Late Cretaceous to Eocene time, thick deposits of sandy flysch were laid down. These are Godula, Istebna, Ciężkowice, and Hieroglyphic Beds. In the outer zone of the Silesian Basin, these sandy deposits grade laterally into pelagic non-calcareous sediments. The deposition of these red-brown pelagic variegated clays was very slow, presumably 2-4 mm per 1000 years. Assemblages of smooth-walled agglutinated foraminifera occur in the variegated clays. In the laterally equivalent shales in the turbidite deposits, the assemblages are less diverse and contain common astrorhizids.

Spanning the Eocene-Oligocene boundary, there is a thin member of *Globigerina* marls that was deposited above CCD. About 40 planktonic species have been identified in these marls (Blaicher 1970; Van Couvering *et al.* 1981; Olszewska 1983). The benthic foraminifera represent only a small fraction of the microfauna. However, there is a considerable diversity of species, including about 100 calcareous benthic and 24 agglutinated forms. The latter belong to astrorhizids, ammodiscids, hormosinids, lituolids and ataxophragmiids. Higher up in these marls the proportion of benthic foraminifera decreases (Olszewska 1984a).

Assemblages of foraminifera are very poor in the black, bituminous shales, but more differentiated in marly shales, both belonging in the overlaying Menilite Beds of the Silesian unit. Olszewska (1985) listed 17 planktonic species and 24 of the benthic calcareous.

In the youngest flysch deposits, the Krosno Beds of Oligocene to Early Miocene, gray marly shales contain more frequent foraminifera, which are almost exclusively calcareous. Olszewska (1982, 1984b) identifies about 20 planktonic and 25 calcareous benthic species. The shales of the Krosno Beds are predominantly of turbiditic origin and occasionally contain reworked fossils.

The amount of agglutinated foraminifera in the autochthonous assemblages of microfossils in the Menilite and Krosno Beds is insignificant. Occasionally, specimens of these foraminifera occur in light-colored shales, intercalating sandstone complexes in the Menilite Beds near Jasło and Gorlice (Olszewska 1985). These foraminifera belong mostly to astrorhizids, ammodiscids and trochamminids and till now do not have stratigraphic value.

The drastic changes in microfauna assemblages at the transition between the Eocene and Early Oligocene in the Outer Carpathians may be related to the global drop in CCD and the onset of euxinic conditions in the basin. Such conditions might have resulted from isolation of the basin, which preceded its shallowing and final uplift.

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REFERENCES

BIEDA, F., 1946: Stratygrafia fliszu Karpat polskich na podstawie dużych otowornic. La stratigraphie du flysch des Carpates centrales polonaises basée sur les grands foraminifères. -Ann. Soc. Géol. Pol., v. 16, pp. 1-52.

BIEDA, F., 1949: O nowych i malo znanych otwornicach z fliszu Karpat polskich. Sur quelques foraminifères nouveaux ou peu connus du flysch des Carpates polonaises. -Ann. Soc. Géol. Pol., v. 18, pp. 151-179.

BIEDA, F., GEROCH, S., KOSZARSKI, L., KSIĄŻKIEWICZ, M. and ŻYTKO, K., 1963: Stratigraphie des Carpates externes polonaises. -Inst. Geol., Biul. 181, pp. 5-174.

BIELECKA, W. and GEROCH, S., 1977: Quelques foraminifères du Jurassique supérieur des Carpates externes polonaises. -Actes du VIe Colloque Africain de Micropaléontologie-Tunis 1974. Annales des Mines et de la Géologie, Tunis, v. 88, pp. 185-199.

BLAICHER, J., 1970: "Globigeryny" podmeniliatowych margli globigerynowych polskich Karpat zewnętrznych. "Globigerininae" of the Sub-Menilite Globerigerina Marls. -Inst. Geol., Biul. v. 221, pp. 137-204.

BROUWER, J., 1965: Agglutinated foraminifera from the turbiditic sequences. -Proc. K. Nederl. Acad. Wet., Sect. B, v. 68, pp. 309-334.

GEROCH, S., 1960: Zespoly mikrofauny z kredy i paleogenu serii slaskiej w Beskidzie Slaskim. Microfaunal assemblages from the Cretaceous and Palaeogene Silesian unit in the Beskid Slaski Mts. Western Carpathians. -Inst. Geol., Biul. v. 153, pp. 1-138.

GEROCH, S., 1966: Male otwornice dolnej kredy serii ślaskiej w polskich Karpat. Lower Cretaceous small foraminifera of the Silesian Series, Polish Carpathians. -Ann. Soc. Géol. Pol., v. 26, pp. 413-480.

GEROCH, S., JEDNOROWSKA, A., KSIĄŻKIEWICZ, M. and LISZKOWA, J., 1967: Stratigraphy based upon microfauna in the Western Polish Carpathians. -Inst. Geol., Biul. v. 211, pp. 185-282.

GEROCH, S. and NOWAK, W., 1984: Proposal of zonation for the Late Tichonian - Late Eocene, based upon Arenaceous Foraminifera from the Outer Carpathians, Poland. -Benthos '83, 2nd Int. Symp. Benthic Foraminifera (Pau, April 1983), pp. 225-239.

GRADSTEIN, F.M. and BERGGREN, W.A., 1981: Flysch-type agglutinated foraminifera and the Maestrichtian to Paleogene history of the Labrador and North Seas. -Marine Micropaleontology, v. 6, pp. 211-268.

GRÜN, W., LAUER, G., NIEDERMAYER, G. and SCHNABEL, W., 1964: Die Kreide-Tertiar Grenze im Wienerwaldflysch bei Hochstrass/Niederösterreich. -Verh. Geol. Bundesanstalt, v. 2, pp. 226-283.

GRZYBOWSKI, J., 1898: Otwornice pokladow cafttonosnych okolicy Krosna. -Ak. Um. Rozpr. Wydz. Mar.-przyr, v. 33, pp. 257-305. (German summary see below).

GRZYBOWSKI, J., 1897: Die Mikrofauna der Karpathenbildungen II. Foraminiferen der naphtafuhrenden Schichten der Umgebung von Krosno. Anz. Akad. Wiss. Krakau, v. 1897, pp. 180-186.

GRZYBOWSKI, J., 1898: Mikroskopowe badania namulow wiertniczych z kopaln naftowych I. Pas potocki i okolice Krosna, II. Uwagiogoline. -Kosmos 22, pp. 393-439. (English translation see below).

GRZYBOWSKI, J., (1898), translation 1969. Microscopic investigations of bore-hole muds from oil wells: I. The Potok Belt and the Krosno area. II. General Remarks. -Ann. Soc. Geol. Pol., v. 39, 1-3, pp. 13-26.

GUZIKK, K. and POZARYSKA, W., 1949: Fald Biecza. Biecz Anticlinale. -Panstw. Inst. Geol., Biul. v. 53, pp. 1-33.

HANZLIKOVÀ, E., 1966: Die Foraminiferen der Ihoaty Schichten. -Acta. Mus. Morav., v. 5, pp. 95-132.

HANZLIKOVÀ, E., 1972: Carpathian Upper Cretaceous Foraminiferida of Moravia (Turonian-Maastrichtian). -Rozpravy ustr. ust. geol., v. 39, pp. 1-160.

HANZLIKOVÀ, E., 1973: Foraminifers of the Variegated Godula Member in Moravie (Cenomanian-Turonian). -Sbornik geol. ved, Paleont., v. 15, pp. 119-184.

HILTERMANN, H., 1943: Zur Stratigraphie und Mikropaläontologie der Mittelkarpaten. -Oel. und Kohle, v. 39, pp. 745-755.

HILTERMANN, H., 1975: Zur Stratigraphie und Mikrofossilführung der Mittlekarpaten. Nachdruck mit Nachtragen, Nomenklatur und Bibliographie. -Bunster. Forca. Geol. Paleont., v. 35, pp. 1-50.

JURKIEWICZ, H., 1960: Otwornice z lupkow czarnorzeckich wschodniej czesci jednostki slaskiej. Foraminifers in Czarnorzeki-shales in the eastern part of the Silesian Unit (Carpathians). - Ann. Soc. Geol. Pol., 30, v. 3, pp. 333-343.

JURKIEWICZ, H., 1960: Otwornice paleogenu podmenilitowego polskich Karpat srodkowych. Foraminifers in the Sub-Menilite Palaogene of the Polish Middle Carpathians. -Inst. Geol., Biul. v. 210, pp. 5-128.

KOSZARSKI, L., 1963: Types fondamentaux des dépots et principales étapes de leur developpement dans le géosynclinal du flysch des Carpates Septentrionales. -Assoc. Geol. Carpato-Balcan., V Congrès, Comm. Scient. III/1 , v. 1, pp. 253-267, Bucresti.

KOSZARSKI, L. *(ed.)*., 1985: Geology of the Middle Carpathians and the Carpathian Foredeep. Guide to Excursion 3. -Carpato-Balkan Geol. Assoc. XIII Congress, Kracow, Poland 1985. Geol. Inst., pp. 1-254.

KOSZARSKI, L. and SLĄCZKA, A., 1976: The Outer (Flysch) Carpathians. The Cretaceous. In: Geology of Poland, Vol. I Stratigraphy, Part 2 Mesozoic. Geol. Inst. Warszawa.

KOSZARSKI, L. and ŻYTKO, K., 1965: Le problème de la profondeur de la mer géosynclinale Carpatique de flysch. - Reports, Carpatho-Balkan Geol. Assoc. VII Congress, II/2, pp. 81-86, Sofia.

KSIĄŻKIEWICZ, M. *(ed.)*., 1962: Geological Atlas of Poland. Stratigraphic and facial problems. Fasc. 13. Cretaceous and Early Tertiary in the Polish Carpathians. Geol. Inst. Warszawa.

KSIĄŻKIEWICZ, M., 1975: Bathymetry of the Carpathian Flysch Basin. -Acta. Geol. Pol., 25, v. 3, pp. 309-367.

KSIĄŻKIEWICZ, M., 1977: Trace fossils in the Flysch of the Polish Carpathians. -Palaeont. Pol., v. 36, pp. 1-208.

MORGIEL, J. and OLSZEWSKA, B., 1981a: Biostratigraphy of the Polish External Carpathians based on agglutinated Foraminifera. -Micropaleontology, 27, v. 1, pp. 1-30.

MORGIEL, J. and OLSZEWSKA, B., 1981b: Analogie w rozwo ju fauny otwornicowej Rifu Marokanskiego i polskich Karpat zewnetrznych. On analogies in development of foraminifera fauna in the Moroccan Riff and Polish External Carpathians. -Kwart. Geol. 25, v. 2, pp. 351-364.

MYATLIUK, E.V., 1970: Foraminifera from the flysch deposits of the Eastern Carpathians (Cretaceous-Paleogene). Leningrad. - Vses. Neft.Nauchno-Issled. Geol.-Razved. Inst. (VNIGRI), Trudy, v. 282, pp. 1-351.

NOWAK, W., 1976: The Outer (Flysch) Carpathians. The Jurassic. *In:* Geology of Poland, Vol. I Stratigraphy, part 2 Mesozoic. -Geol. Inst. Warszawa.

OLSZEWSKA, B., 1982: Uwagi o biostratygrafii serii menilitowo-kros-nienskiej w polskich Karpatach zewnetrznych. Some remarks on biostratigraphy of the Menilite-Krosno Series in the Polish Outer Carpathians. -Kwart. geol., 26, v. 1, pp. 134-145.

OLSZEWSKA, B., 1983: Przyczynek do znajomosci otwornic planktonicznych podmenilitowych margli globigerinowych polskich Karpat zewnetrznych. A contribution to the knowledge of planktonic foraminifera of the *Globigerina* Submenilite Marls in the Polish Outer Carpathians. -Kwart. geol., 27, v. 3, pp. 547-570.

OLSZEWSKA, B., 1984a: Otwornice bentoniczne podmenilitowych margli globigerinowych polskich Karpat zewnetrznych. Benthic Foraminifera of the Submenilite *Globerigerina* Marls of Polish Outer Carpathians. -Prace Inst. Geol., v. 110, pp. 1-37.

OLSZEWSKA, B., 1984b: Interpretacja paleoekologiczna otwornic kredy i paleogenu polskich Karpat zewnwtrznych. A paleoecological interpretation of the Cretaceous and Paleogene foraminifera of the Polish Outer Carpathians. -Inst. Geol. Biul., v. 346, pp. 7-62.

OLSZEWSKA, B., 1985: Otwornice warstw menilitowych polskich Karpat zewnetrznych. Foraminifera of the Menilite Beds (Polish Outer Carpathians). -Ann. Soc. Geol. Pol., v. 55, pp. 201-250.

SAMUEL, O., 1977: Agglutinated foraminifera from Paleogene flysch formations in West Carpathians of Slovakia. – Zapadne Karpaty, ser. Paleont., v. 2-3, pp. 7-70.

VAN COUVERING, J.A., AUBRY, M.P., BERGGREN, W.A., BUJAK, J.P., NAESER, C.W. and WIESER, T., 1981: The Terminal Eocene event and the Polish connection. -Paleogeogr., Paleoclimat., Paleoecol., v. 30, pp. 321-362.

WIESER, T. *(ed.)*., 1985. Researches in the Western part of the Polish Carpathians. Guide to Excursion 1. -Carpatho-Balkan Geol. Assoc. XIII Congress, Krakow, Poland 1985. Geol. Inst., pp. 1-102.