PALEOGEOGRAPHY OF THE ALGAE–BEARING JURASSIC–PALEOGENE LIMESTONES AND SANDSTONES IN THE POLISH OUTER CARPATHIANS

J. GOLONKA[1], M. CIESZKOWSKI[1], J. RAJCHEL[2] & A. ŚLĄCZKA[1]

[1]*Jagiellonian University, Institute of Geological Sciences, Oleandry Str. 2a, 30–063 Kraków, Poland;*

[2]*University of Mining and Metallurgy, Faculty of Geology, Geophysics and Environmental Protection, Mickiewicza Str. 30, 30–059 Kraków, Poland*

Abstract: The flysch deposits of the Outer Carpathians contain numerous algae-bearing Jurassic-Paleogene limestones and sandstones. The calcareous algae play a major role in ecological and paleogeographical reconstructions of the Outer Carpathians basins by determination of facies and paleoenvironmental zones. They occurrence of algae-bearing rocks reflects the existence of ridges originated during the synrift stage as well as during the closing of flysch basins.

Key words: paleogeography, Tethys, Carpathians, algae

Introduction

The calcareous algae play a major role in ecological and paleogeographical reconstructions. They determine shallow and littoral zones. The character of algal assemblages closely determines the facies environment – reef, lagoon, bahamite or others. The algae occurring in flysch sediments indicate the existence of intrabasinal ridges and carbonate platforms along the basin margins. The abundance of algae in flysch deposits indicates the time of geotectonic activity, development of rifted basins and/or closing of flysch basins.

Jurassic – Early Cretaceous

The Mesozoic and Cenozoic paleogeography of the Outer Carpathians reflects the series of continental break-ups, rifts and collisions. The Magura Basin originated as part of the Penninic-Pieniny Klippen Belt-Magura Ocean, created during Early-Middle Jurassic time and separated Apulia, Eastern Alps and Inner Carpathian blocks from Eurasia. The Czorsztyn ridge separated this Pieniny basin from the Magura basin (Birkenmajer, 1986, Golonka et al, 2000). The pelagic deep-water cherty limestones (Maiolica) were deposited during latest Jurassic – Early Cretaceous in the Magura Basin. This pelagic cherty limestones are build of the planctonic alga *Nannoconus* with radiolarians (Golonka & Sikora, 1981).

During the Late Jurassic the southern part of the North European Platform, north from the Pieniny/Magura realm started to be rifted (Fig. 1) and small basins (e.g. proto-Silesian

Basin in the Western Carpathians and Sinaia basin in the eastern Carpathians), with black, mainly redeposited marls (?Kimmeridgian-Tithonian) have been created (Pescatore and Ślączka, 1984). The rapid supply of shallow water clastic material to the basin could be an effect of the strong tectonoeustatic sea-level fluctuations known from that time. The marls pass gradually upwards into calcareous turbidites (Cieszyn limestones) which created several submarine fans. Occurrence of deep-water microfauna indicates that subsidence of the basin must have been quite rapid. The Outer Carpathian basin reached its greatest width during the Hauterivian-Aptian time. With the widening of the basin, several subbasins (troughs) began to develop and to show their distinctive features. These subbasins, e.g. Fore-Magura, Dukla, Silesian, Sub-Silesian, Skole, Dukla, Tarcău basins, were locally separated by uplifted areas (Golonka *et al*. 2000).

The shallow-water carbonate sedimentation with coral reefs (so-called Štramberk limestones) took place on the Eurasian platform during Late Jurassic-Easy Cretaceous. These limestones represent various types of carbonates formed on platforms, developed along the northern shore of the Tethys or around intraoceanic Silesian Ridge (cordillera), separating the Silesian Basin from the Pieniny-Magura realm. The remnants of such carbonate platforms with reefs were results of the fragmentation of the European platform in this area.

The calcareous flysch of Cieszyn limestones contains numerous green algae: *Clypeina jurassica* Favre, *Salpingoporella annulata* Car. and *Actinoporella podolica* Alth among the others. These algae have been growing in shallow marine water, forming sediments of bahamite type (Golonka 1974). From these shallow water banks they were transported with turbidity currents to the flysch basin (Fig. 1). The material was transported to the Silesian Basin from the Eurasian Platform as well as from the Silesian Ridge. The pelagic intercalation within the Cieszyn limestones contain the calcareous dinocysts *Stomiosphaera, Colomisphaera and Cadosina*.

The Tithonian-Berriasian shallow water carbonates with numerous *Dasycladaceae, Codiaceae* and red algae are known from the Andrychow Klippes (Olszewska and Wieczorek, 2001), which represent fragment of Eurasian platform incorporated into Outer Carpathian basin. The Late Jurassic and Early Cretaceous algae-bearing shallow water limestones are also known from numerous exotic pebbles known from all Outer Carpathian units. These limestones were delivered from the Eurasian Platform and from the Silesian Ridge to Silesian, Sub-Silesian and Skole Basin, from the Silesian Ridge to Fore-Magura zone and from the Silesian Ridge as well from the Inner Carpathian-Pieniny realm to the Magura Basin.

Late Cretaceous-Paleogene

During the Cenomanian and Turonian compression embraced the Inner Carpathians and several nappes with northward polarity developed. Subduction consumed the major part of the Pieniny Klippen Belt Ocean. Cherty limestones turned into marls and flysch deposits. With the development of the Inner Carpathian nappes the for-arc basin was formed between uplifted part of the IC terrane (so-called Andrusov ridge) and subduction zone. In the foreland of the folded area, within the Outer Carpathian realm several basins became distinctly separated, namely Magura, Porkulec-Convolute, Dukla, Silesian Charnahora-Audia Skole-Tarcau basins divided by ridges, Silesian and Kumana Ridges (cordilleras) and Subsilesian underwater swell. The orogenic processes in the Western Carpathians produced an enormous amount of the clastic material that started to fill the Outer Carpathian basins. The material was derived from the northern and southern margins as well as from the inner ridges (cordilleras). Each basin had the specific type of clastic deposits, and sedimentation commenced in different time.

In Paleogene the movement of Adria and Alcapa terranes resulted in gradually closing of the flysch basins and development of an accretionary prism. The ridges dividing the flysch basins in Outer Carpathians became more distinguished providing favorable conditions for development of shallow banks with red algal assemblages. The numerous calcareous red algae have been found in flysch and olistostromes the Paleocene-Oligocene deposits within all the Outer Carpathian subbasins (Rajchel & Myszkowska 1998a, b). Fragments of the algae were transported with the turbidity currents to the flysch, forming the so-called *Lithothamnium* limestones and sandstones. These sandstones contain numerous species of coralline algae, belonging to genera *Archaeolithothamnium, Lithothamnium, Lithophyllum, Mesopyllum, Paleothamnium* and *Lithoporella*.The Bircza *Lithothamnium* Limestone Bed is the typical example of such redeposited algal limestones in the Carpathian flysch. These allodapic limestones, which material was derived from the northern margin of the Skole basin, are located in the Paleocene in central part of the Skole Unit. There are also exotic clasts of algal limestones confined exclusively with lithosomes of Babica Clay – dense cohesive flows. Similar clasts exist in Ciężkowice sandstone in the Silesian Unit.

In the southern part of Magura Unit, at its contact with uplifting Pieniny Klippen Belt *Lithothamnium* material occurs in the Złatne sandstone and in the coeval Magura sandstones.

The Silesian cordillera also was alimentation centre of detrital algal material during Paleocene. Lithothamnium detritus was transported to the north to the Silesian basin and to the south to the Magura basin. Another minor centre was located over the Andrychów Klippes swell. It was the source of *Lithothamnium* and bryozoan material to the Szydłowiec sandstone

in the Subsilesian Unit. Similar organodetritic Skalnik limestones are known also from the Menilite formation in the Dukla Unit.

This research has been financially supported by the Polish Committee of Scientific Research (KBN) grant no. 3 PO 4D 020 22

References:

Birkenmajer, K.1986. Stages of structural evolution of the Pieniny Klippen Belt, Carpathians. Studia Geol. Pol., 88: 7-32.

Golonka J. 1974. Calcareous algae and stromatolites of Polish Carpathians and Fore-Carpathian Trough. Proc. X Cong. CBGA Sect. I. Stratigraphy and Paleontology. Bratislava, 1974: 73-79.

Golonka J. 2000. Cambrian-Neogene plate tectonic maps. Wydawnictwa Uniwersytetu Jagiellońskiego, Kraków, 125 pp.

Golonka, J. & Sikora, W. 1981. Microfacies of the Jurassic and Lower Cretaceous sedimentarily thinned deposits of the Pieniny Klippen Belt in Poland (in Polish, English abstract). Biul. Inst. Geol., 31: 7-37.

Golonka J., Oszczypko N. & Ślączka A. (2000) - Late Carboniferous – Neogene geodynamic evolution and paleogeography of the circum-Carpathian region and adjacent areas: Ann. Soc. Geol. Polon., 70: 107-136.

Olszewska, B.& Wieczorek, J. Jurassic sediments and microfossils of the Andrychów Klippes (Outer Western Carpathians). Geol. Carpath., 52:217-228.

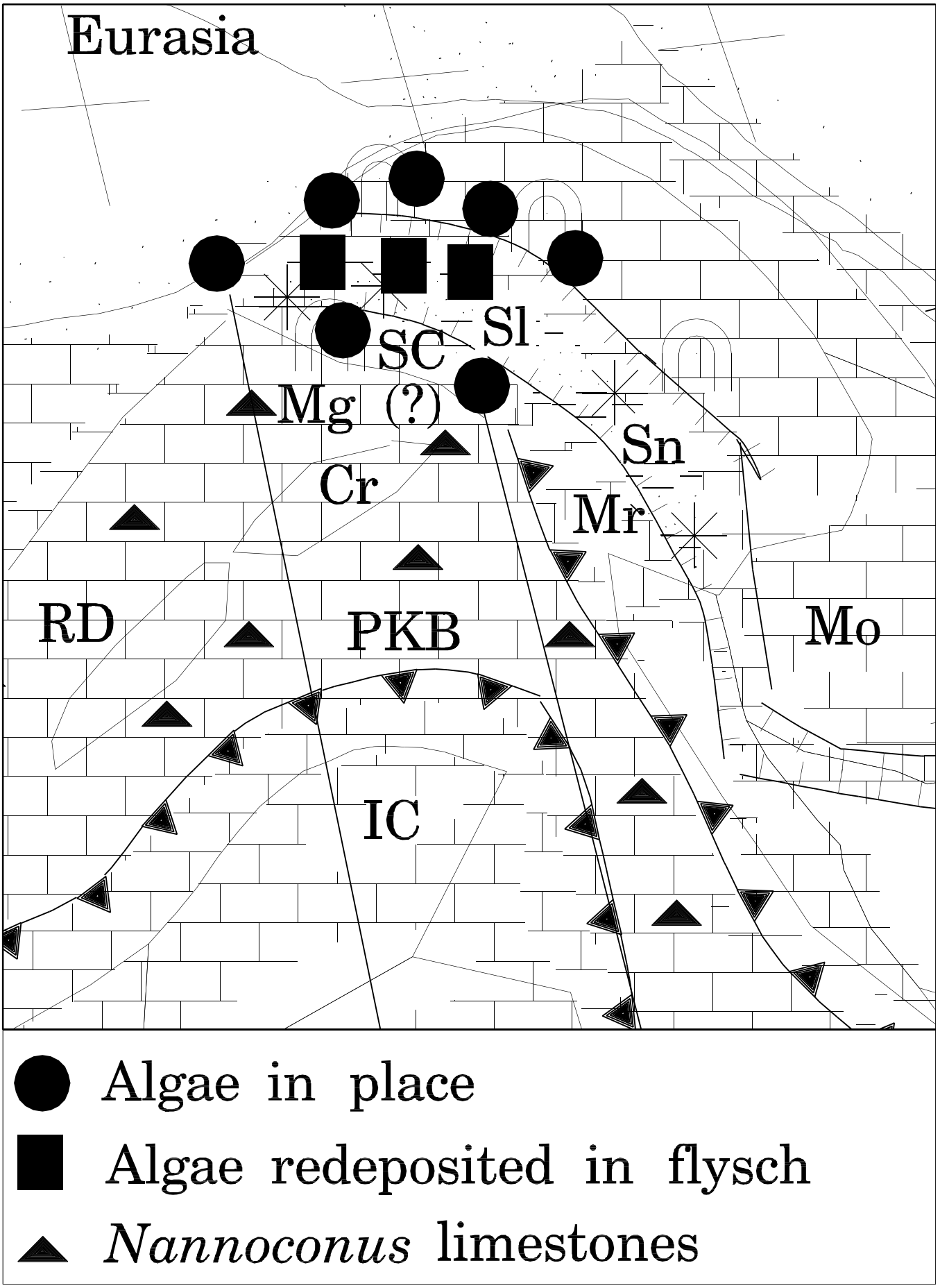
Pescatore T. and Ślączka, A., 1984. Evolution models of two flysch basins: the Northern Carpathians and the Southern Appenines. Tectonophysics, 106: 49-70.

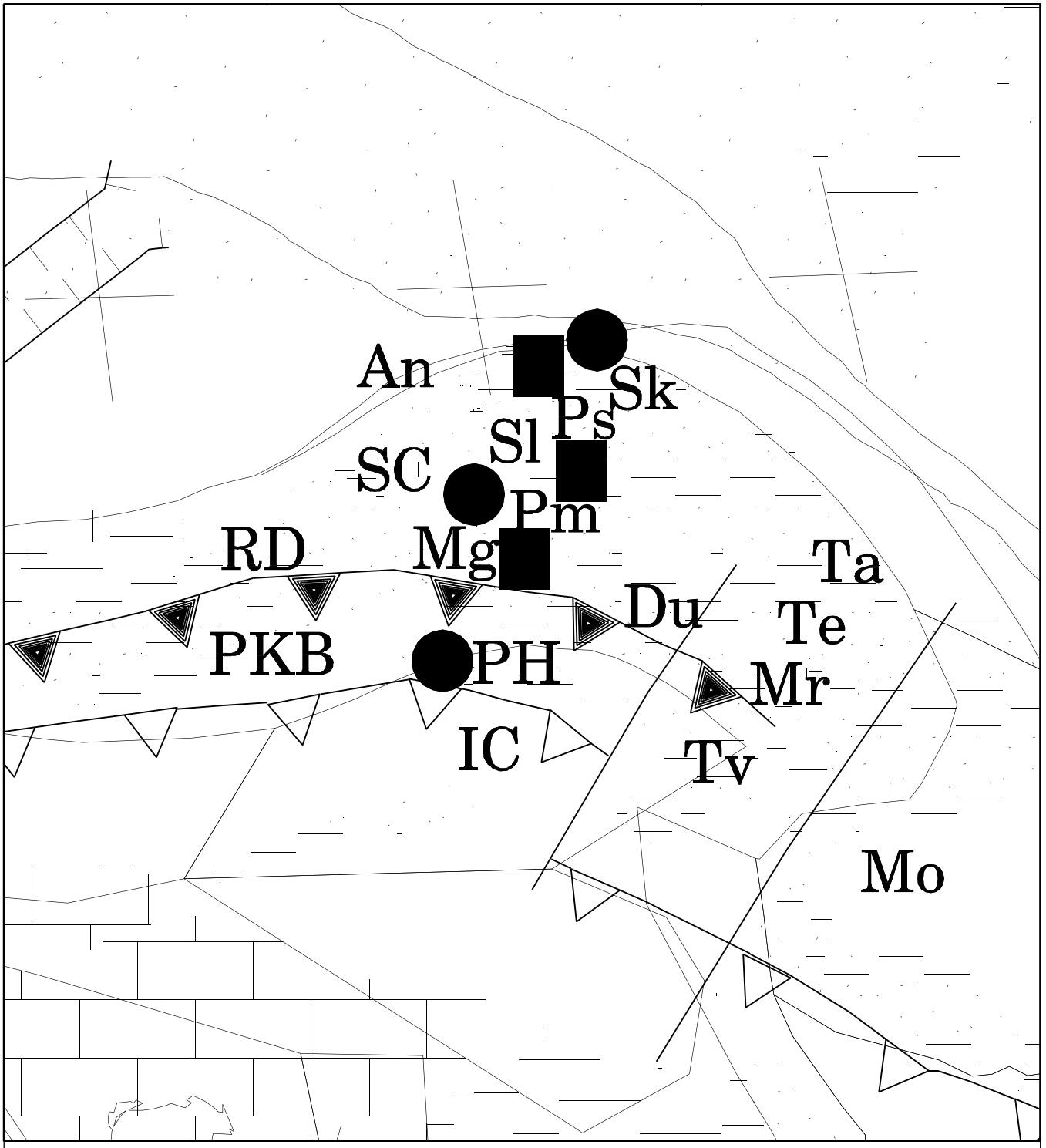
Rajchel J. & Myszkowska J. 1998a). Exotic clasts of organodetritic algal limestones from lithosomes of the Babica Clay, Skole Unit (Outer Flysch Carpathians, Poland). Ann. Soc. Geol. Polon., 68: 225-235.

Rajchel J. & Myszkowska J. (1998b) - Litologia wapieni z warstwy wapienia litotamniowego z Birczy /wt/ - jednostka skolska, zewnętrzne Karpatry fliszowe. Przegl. Geol., 46: 1247-1253.

Fig. 1. Paleogeography and occurrence of algae in the Northern-Carpathian area during latest Late Jurassic–earliest Lower Cretaceous; plates position at 140 Ma . Abbreviations: Cr – Czorsztyn Ridge, EA – Eastern Alps, IC – Inner Carpathians, Mg – Magura Basin, Mo – Moesia plate, Mr – Marmarosh, PKB – Pieniny Klippen Belt Basin, RD – Rheno-Danubian, SC – Silesian Ridge (cordillera), Si – Silesian Basin, Sn – Sinaia.

Fig. 2. Paleogeography and occurrence of algae in area during Eocene; plates position at 45 Ma. Abbreviations: An _ Andrychow Ridge, Du – Dukla, EA – Eastern Alps, IC – Inner Carpathians, Mg – Magura Basin, Mo – Moesia plate, Mr – Marmarosh, PH – Podhale Flysch, PKB – Pieniny Klippen Belt Basin, Pm – Fore-Magura, Ps – Fore-Silesian, RD – Rheno-Danubian, SC – Silesian Ridge (cordillera), Si – Silesian Basin, Sk – Skole, Sn – Sinaia, Ta – Tarcau, Te – Teleajen, Tv - Transilvanian.


Eurasia
SC
Sl
Mg (?)
Sn
Cr
Mr
RD
PKB
Mo
IC
Algae in place
Algae redeposited in flysch
Nannoconus limestones



Algae in place

Algae redeposited in flysch