CLIMATE & BIOTA EARLY PALEOGENE
Austrian Journal of Earth Sciences | Volume 105/1 | 240 - 247 | Vienna | 2012

An olistolith interpretation for the Paleocene Szydłowiec sandstones in the stratotype area (Outer Carpathians, Poland)

Marek CIESZKOWSKI[1)*], Jan GOLONKA[2)] & Anna WAŚKOWSKA[2)]

[1)] Jagiellonian University, Institute of Geological Sciences, Oleandry 2a, 30-063 Kraków, Poland;

[2)] AGH University of Science and Technology, Faculty of Geology, Geophysics and Environmental Protection, Al. Mickiewicza 30, 30-059 Kraków, Poland;

[*)] Corresponding author, marek.cieszkowski@uj.edu.pl

KEYWORDS

Szydłowiec sandstones
Subsilesian Unit
coralline algae
Paleocene
olistolith

Abstract

The thick-bedded complex of the Szydłowiec sandstones belongs to the lithological succession of the Subsilesian sedimentary area in the Polish Outer Carpathians. These sandstones contain abundant carbonate biogenic fragments, redeposited from shallower parts of the basin. Their Paleocene age is documented by autochthonous assemblages of agglutinated foraminifera as well as by the microflora occurring within the limestone clasts. The Szydłowiec sandstones in its type locality (*locus typicus*) at Szydłowiec in the vicinity of Wadowice forms, together with the Gorzeń sandstones, an isolated block surrounded by deformed flysch of the Oligocene-Miocene Krosno Formation, and contains shale clasts of older deposits. According to our results this block represents an olistolith which slided into the Skole part of the Menilite-Krosno basin during the Late Oligocene/Early Miocene deformational phase linked to the development of the Carpathian accretionary prism.

1. Introduction

The Polish Outer Carpathians (Fig. 1a) are built up from thrusted and imbricated Upper Jurassic to Neogene flysch sediments which were deposited in several sedimentary basins (Ślączka et al, 2006; Golonka et al., 2009 and references therein): the Magura, Dukla (Fore-Magura), Silesian, and Skole basins. These basins were separated from each other by ridges characterized by distinctive depositional areas, e.g. the Subsilesian sedimentary area (Fig. 2). During the Miocene orogenic movements, the deposits filling the Outer Carpathian basins were folded, uprooted from their basement, and thrust one upon another as nappes. The following Outer Carpathian nappes have been distinguished: the Magura Nappe, the Fore-Magura group of nappes, and the Silesian, Subsilesian and Skole nappes (Fig. 1a). The outer allochthonous nappes are thrust over the Carpathian Foredeep. The Magura Nappe is separated by the Pieniny Klippen Belt from the Inner Carpathians.

The aim of this study is to investigate the exact position of the Szydłowiec sandstones within the Carpathian basins and the Carpathian nappe system. Special attention was given to the olistolithic nature of this sandstone. The authors also refine its stratigraphic position within the Carpathian flysch successions.

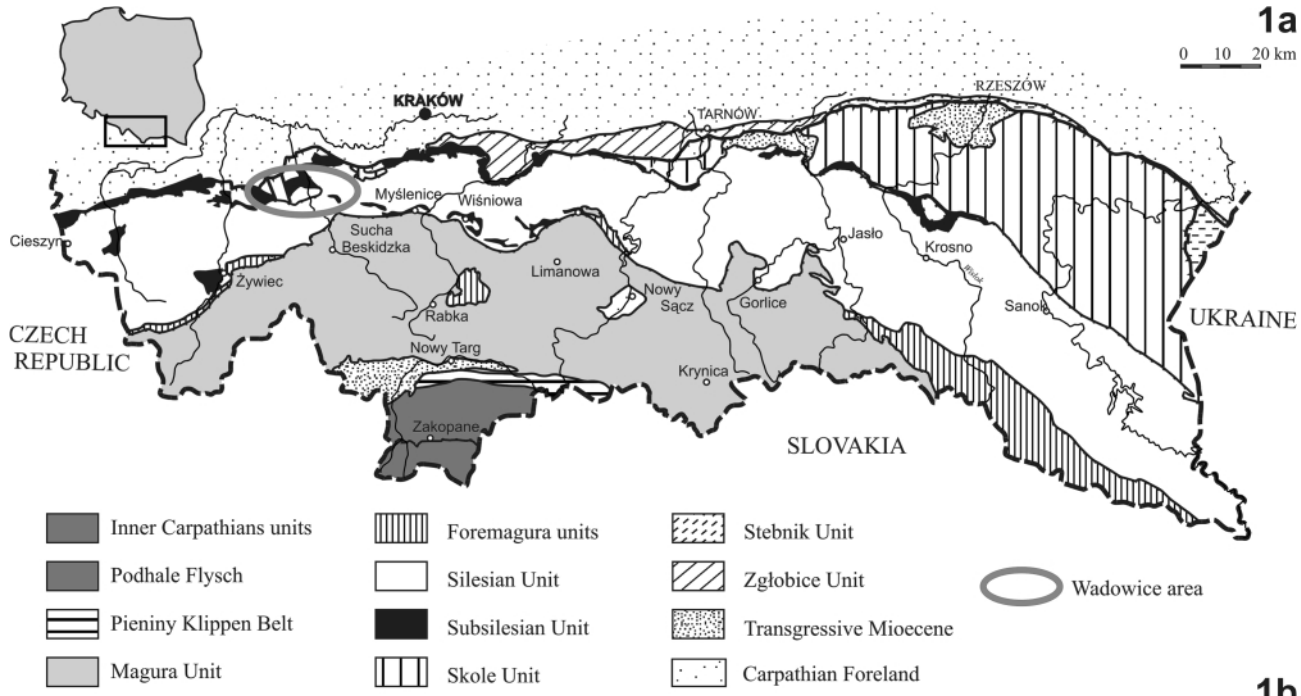
2. Study area and geological setting

The investigated region is located southeast of Kraków in the vicinity of Wadowice. The Silesian Nappe constitutes the major tectonic unit in this area. Its northern border with the Subsilesian Nappe and the Skole Nappe is clearly tectonic, but reshaped due to erosion. The northern part is built by Cretaceous rocks, mainly by sandstones of the Godula Formation (Golonka and Waskowśka-Oliwa, 2007). The southern zone forms a large syncline with the Eocene-Oligocene Menilite and Krosno formations. This nappe border displays a significant offset along the Skawa fault zone. The eastern part of the nappe is located 10 km north of the western part (Cieszkowski et al., 2006; Golonka et al., 2009). The western part is thrusted over the Subsilesian and Skole nappes.

Several imbricated folds build up the Subsilesian Nappe, which occurs along the northern margin of the Silesian Nappe, as well as in tectonic windows within this nappe (Figs. 1a, 2). In the Andrychów area west of Wadowice several blocks known as Andrychów Klippen contain crystalline rocks as well as Jurassic, Cretaceous and Paleogene limestones (Fig. 1b). Traditionally, they were considered as tectonic slices linked to the Silesian Nappe. More recently, an interpretation as olistostromes was put forward (Ślączka et al., 2006; Golonka and Krobicki 2006a, b, c; Cieszkowski et al., 2009a, b and references therein).

The relationship between the Silesian and Skole nappes in the area of Wadowice and Andrychów remains somewhat speculative. The tectonic unit located north of Andrychów and Wadowice contains deposits of the basinal and slope part of the Skole Basin as well as deposits originating within the Subsilesian sedimentary area (Fig. 2). Książkiewicz (1951a, b) described these rocks as so-called outer flysch and later included them into the Subsilesian Nappe (Książkiewicz, 1977), but other authors attribute these rocks to the Skole Unit (e.g. Nemčok and Poprawa, 1988-1989). Besides that controversy, some of these bodies may be interpreted as huge olistoliths within the Neogene deposits in the frontal part of the Outer Carpathians as outlined by Golonka et al. (2009).

The investigated Szydłowiec sandstones occur in the southern outskirts of Wadowice (Fig. 1b), and are attributed to the Subsilesian Ridge, which was active since the Late Cretace-



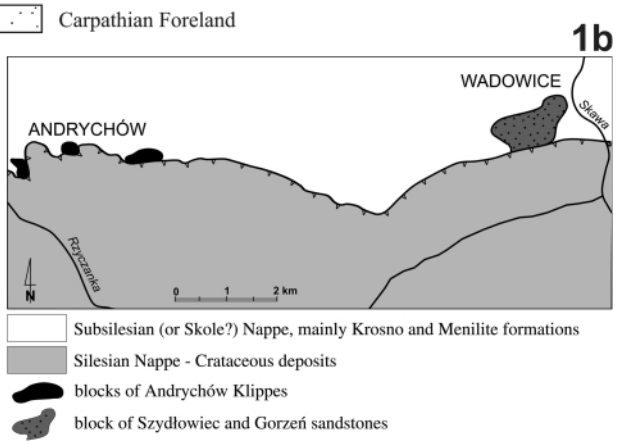


Figure 1: 1a. Location of the study area (grey ellipse) on the tectonic sketch-map of the Polish sector of the Carpathians. 1b. Position of the Szydłowiec – Gorzeń block and Andrychów Klippes in the surrounding of Wadowice.

ous, separating the Skole and Silesian basins (Fig. 2). Abundant fragments of biogenic carbonate rocks were redeposited from the shallower parts of the sedimentary basin and intervening ridges, and form a characteristic feature of these rocks. For a long time the age of the Szydłowiec sandstones was interpreted as Maastrichtian (Bieda, 1946, 1948; Gerochet al., 1967; Książkiewicz, 1951b, 1977; Sokołowski, 1972). This view changes due to new micropalaeontological studies presented below, which indicate a Paleocene age of these unit.

Outcrops of the Szydłowiec sandstones are known from only a few isolated places in the Polish Outer Carpathians. The slopes of the Goryczkowiec (previously known as Szydłowiec) hill in Wadowice form the largest outcrop. Other outcrops are known from Żywiec and Wiśniowa (Geroch and Gradziński, 1955; Burtan, 1978). These outcrops of the Szydłowiec sandstones are located in the vicinity of tectonic windows in which rocks of the Subsilesian Nappe crop out below the Silesian Nappe. Therefore, this lithostratigraphic unit was commonly placed within the succession of the Subsilesian unit. In the older lithostratigraphic scheme of the Subsilesian unit, the Szydłowiec sandstones were regarded as being underlain by Upper Cretaceous marl (variegated Węglówka marls, or grey Fydek marls with exotics) and covered by Paleogene flysch deposits with prevailing sandstones (Gorzeń, Czerwin, Radziechowy sandstones; Książkiewicz, 1951a; Geroch and Graziński, 1955; Burtan, 1978; Leśniak et al., 2001, Waśkowska-Oliwa, 2001; Cieszkowski and Waśkowska-Oliwa, 2002).

The Szydłowiec slice (Szydłowiec sheet) sensu Książkiewicz (1951b, 1977) was tectonically linked to the Subsilesian Nappe occurring in a strongly deformed zone called Lanckorona-Żegocina Zone. There, within several tectonic windows, deposits representing the Subsilesian Nappe occur on the surface from

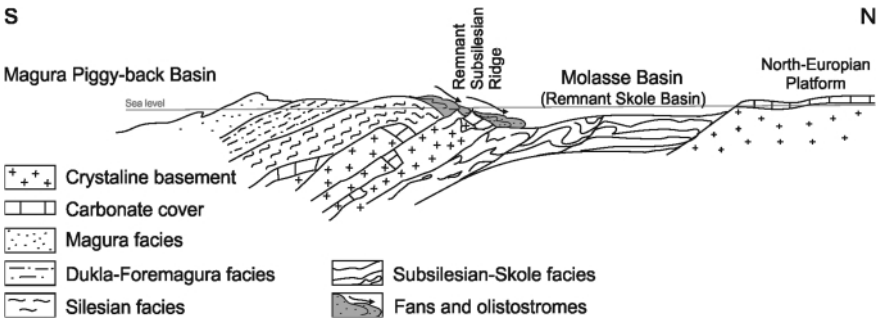


Figure 5: Palinspastic cross-sections of the Outer Carpathians during Late Oligocene – Early Miocene (after Cieszkowski at al., 2009a, modified).

below the Silesian Nappe. Alternatively, the Szydłowiec slice was linked with the Skole Nappe and considered as a tectonic outlier ("xenolith") of this nappe (Balcer and Koszarski, 1990).

3. Results

3.1 Lithology

The Szydłowiec sandstones are 150 m thick at their type locality at Wadowice (Sokołowski, 1972). The sandstones are dominated by thick-bedded medium- to coarse-grained, conglomeratic sandstones (Fig. 3). Thick bedded and conglomeratic sandstones occur in the lower parts of beds while medium and fine-grained sandstones prevail in their upper parts. The beds are massive with amalgamation; sometimes parallel and wavy lamination is visible in their upper parts. Normal graded bedding is quite distinctive. The gravel grains vary in size and range up to 30 cm. Quartz grains of varied degree of roundness dominate in the sandstones. Gray biogenic carbonate grains constitute a distinctive component.

The carbonate, mostly limestone grains contain biogenic fragments (Fig. 4) mainly of coralline algae (frequently in rhodolith form) with less abundant bryozoans, fragments of Lamellibranchiata and gastropod shells, spines of echinoderms, large foraminifera and oncoids. Sometimes the amount of carbonate clasts is significant and dominant, and builds a

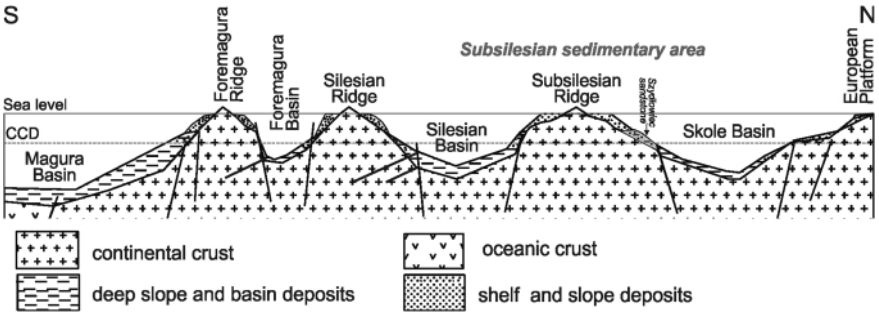


Figure 2: Cross-section through the Carpathian basins during the Paleocene and sedimentary position of Szydłowiec sandstones.

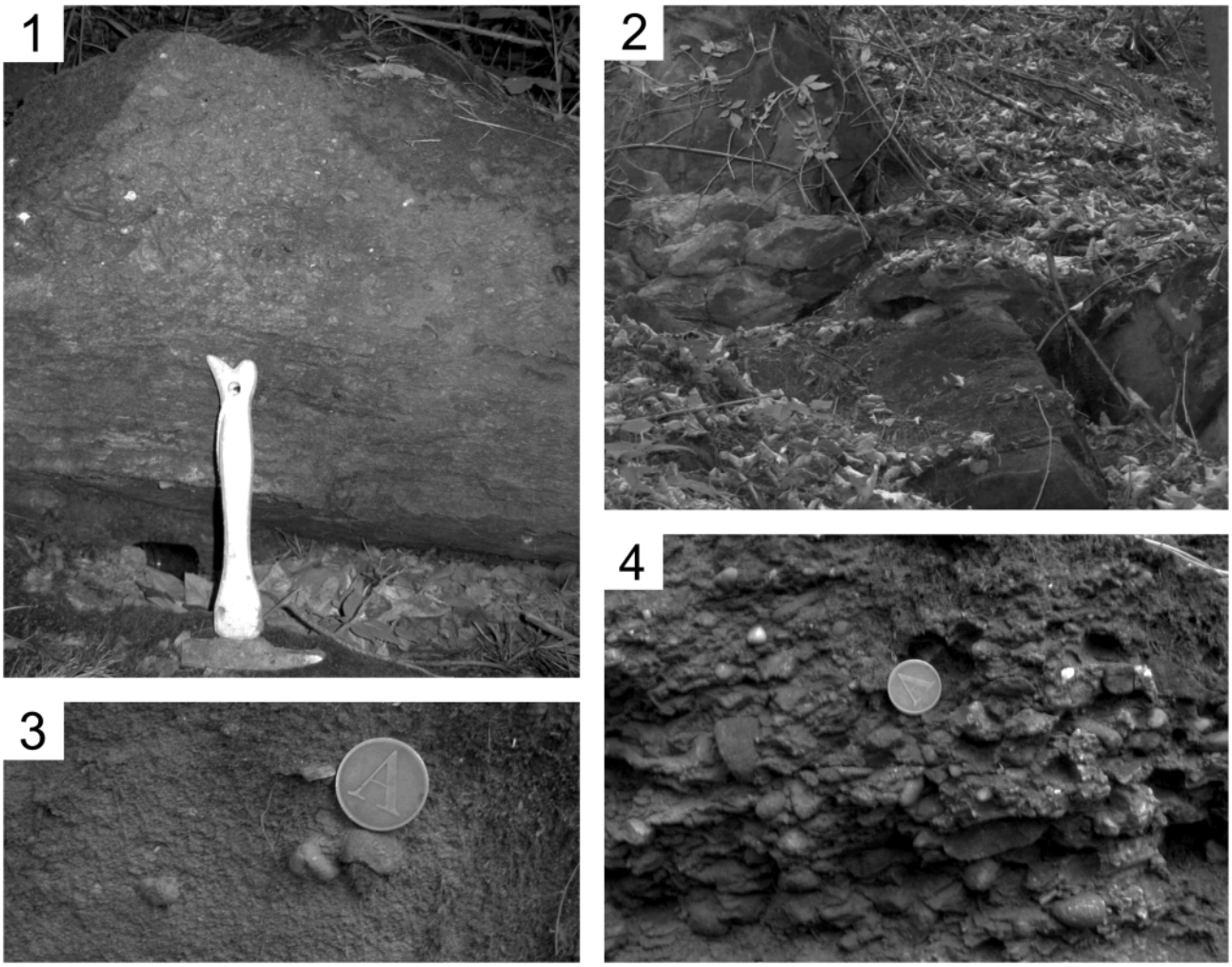


Figure 3: Szydłowiec sandstones outcropped in the type locality: 1 – thick-bedded pebbly sandstone, 2 – thick- and medium bedded sandstone flysch, 3- coarse-grained sandstone with fine pebbles, 4 – conglomerates.

characteristic feature of this formation. Książkiewicz (1951a) highlighted this fact defining them as "bryozoan-lithothamnium" Szydłowiec sandstones.

Glauconite and muscovite flakes also commonly occur. A mixture of detritus from crystalline, mainly metamorphic rocks as well as sedimentary rocks like sandstones and coals constitute the coarser fractions. The sandstone cement is calcareous. Sandstones are interbedded with thin, green, calcareous, often sandy shales. The sandstone layers display a variety of trace fossils at their bottom surfaces, especially when underlain by mudstones. Thick-bedded sandstones prevail within the succession, but thin packages of thin- and medium-layered flysch are also present. The sandstones within these packages are siliceous, grey, quartzitic, and greenish due to the admixture of glauconite.

3.2 Age, position within stratigraphic succession, and source area

Our age analysis is based on autochthonous foraminifera assemblages as well as on the algal material present in the carbonate clasts of the Szydłowiec sandstones. Agglutinated foraminifera prevail in the investigated microfossil assemblages,

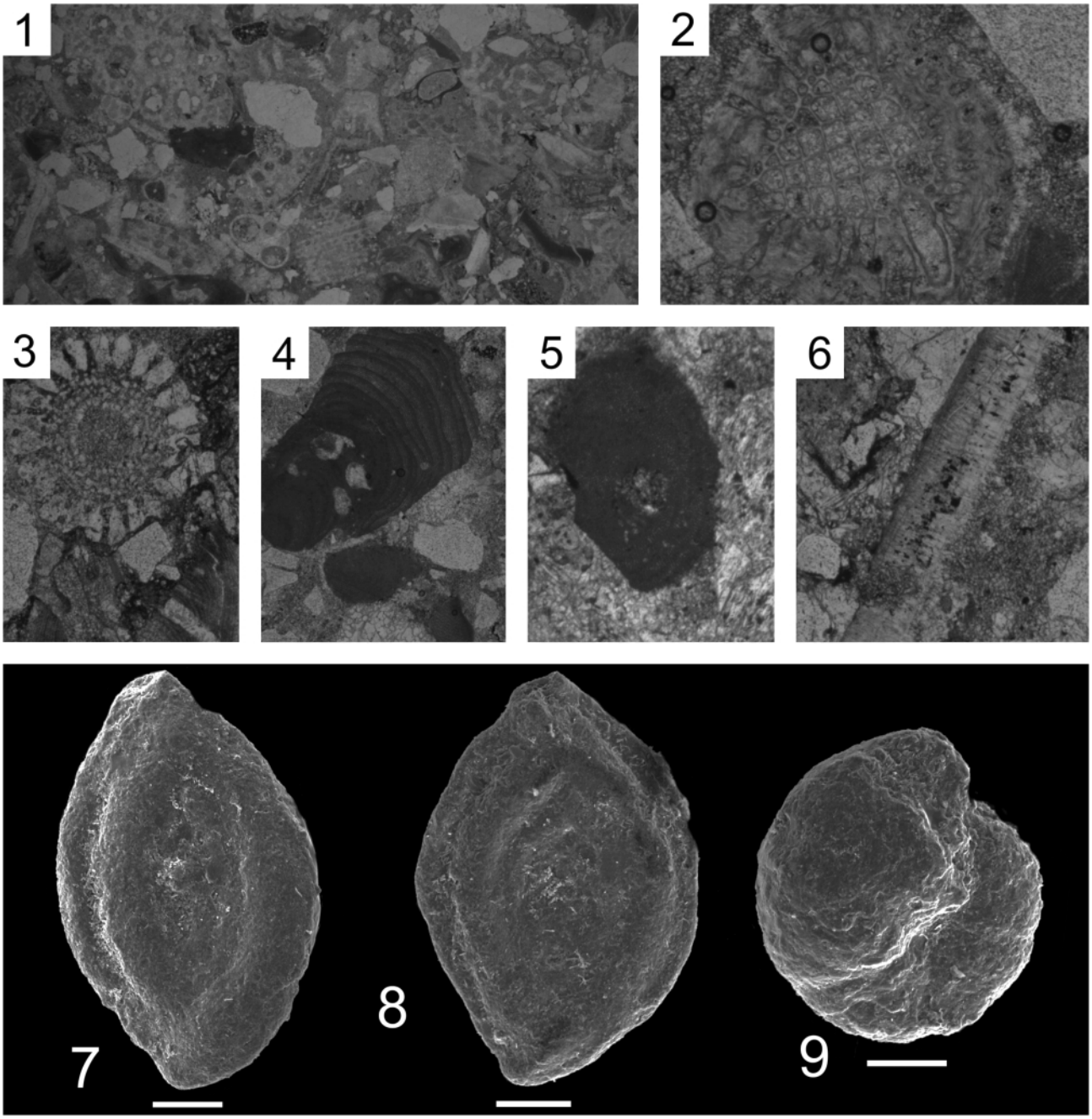


Figure 4: Thin-sections of Szydłowiec sandstones (1-6) and foraminifera from shaly intercalations (7-9): 1 – typical example of Szydłowiec sandstones with quartz, carbonate rocks fragments and bioclasts containg foraminifera, echinoderms and bryozoa, 2 –fragments of bryozoa, 3 – fragment of echinoderm spine, 4 – fragment of red algae Corallinaceae (Archaelithothamnium sp.), 5 - fragment of Corallinaceae red algae (so-called *Lithothamnium* sp.), 6 – fragment of mollusk shell, 7, 8 – *Rzehakina fissistomata* (Grzybowski), 9 - *Haplophragmoides mjatliukae* Maslakova.

which were studied from thin muddy intercalations between thick sandstone beds. *Rzehakina fissistomata* (Grzybowski) and *Haplophragmoides mjatliukae* Maslakova are well represented among cosmopolitan and long-living taxa typical for Upper Cretaceous-Lower Paleogene deep-water deposits. These markers occurred only in the Paleocene within the Carpathians (Olszewska, 1997, Waśkowska-Oliwa, 2008 and references therein). Their ranges define the Paleocene biozone of *Rzehakina fissistomata* well known in the Outer Carpathians (Olszewska, 1997). Planktonic foraminifera are rare. Foraminifera of the genus Subbotina are present in a few shale samples and were also observed in thin sections of medium-grained sandstones. Their range starts at the beginning of the Paleogene (Olsson et al., 1999; Olszewska et al., 1996). Typical Cretaceous planktonic forms are lacking completely.

The biogenic material preserved in the limestone clasts indicates also a Paleocene age. These limestone clasts are allochthonous, they were redeposited from the shallow zones of the Subsilesian Ridge. Fragments of algal reef limestones with abundant red algae of Corallinaceae represent the major components of these clasts, typical for the Carpathian area during Paleocene times (Golonka, 1974, 2011; Cieszkowski et al., 2003, 2009; Golonka and Krobicki, 2006b; Golonka et al., 2004, 2005, 2011). However, older Maastrichtian fossils, mainly larger foraminifera, are also present (Bieda 1946, 1948; Książkiewicz, 1951b; Sokołowski, 1972).

3.3 Position and origin of the Wadowice Szydłowiec sandstones type locality succession

The character of the Szydłowiec type locality at Wadowice is somewhat exotic compared to other Subsilesian outcrops of the region. It belongs to an isolated outcrop 1 km² in area, built of Paleocene deposits of the Szydłowiec and Gorzeń sandstones (both lithostratigraphic units at their type locality; Książkiewicz, 1951a, b; Nowak 1963a, b; Cieszkowski and Waśkowska-Oliwa, 2002). Other occurrences of similar sandstones were described from the remote areas of the Żywiec and Wiśniowa tectonic windows (Geroch and Gradziński, 1955; Burtan, 1974, 1978).

During our field studies we found numerous blocks of these carbonate sandstones within the Oligocene-Miocene Krosno Formation. They were considered as olistoliths (Cieszkowski et al., 2009a, b), which originated during the collisional stage of the Carpathian accretionary prism development (Golonka et al., 2009, 2011). Two remnant flysch basins, the Magura and Menilite-Krosno basins, were situated within the Carpathian realm during Oligocene-Miocene times. The Menilite-Krosno basin was formed at the beginning of the Oligocene in the area of the Dukla, Silesian, and Skole basins, and was filled by the Menilite Formation and the Krosno Formation. The Carpathian accretionary prism migrated northward overriding the Subsilesian Ridge during Oligocene-Miocene times (Fig. 5). Older shallow-water deposits such as the Szydłowiec sandstones located originally at this ridge were redeposited, gliding down into the deep-water e basinal flysch of the Krosno Formation. Thus, we conclude that the Szydłowiec sandstones at their type locality represent a huge flat olistolith (olistoplaque), which slided into the sedimentary area of the Krosno Formation during Late Oligocene to Early Miocene.

Several observations support this interpretation:

1) The Szydłowiec sandstones display a distinctly different petrological composition than sandstones from the Krosno Formation; they are weathering resistant and the block is well distinguished in morphology.
2) Mapping indicates that the block is underlain and surrounded by flysch deposits of the Krosno Formation (Książkiewicz, 1972).
3) The block is rigid and not folded like the surrounding relatively soft flysch rocks.
4) The Szydłowiec sandstones occur next to chaotic flysch deposits representing debris flows with shale and sandstones matrix containing clasts of variegated shales and soft marls. The foraminifera from these clasts allowed univocal age determination displaying a variety of assemblages. Typical Campanian-Mastrichtian assemblages with a microfauna deposited in slope environments occur together with a Paleocene microfauna representing mixed deep- and shallow-water environments.
5) Some sandstones within the Krosno Formation surrounding the Szydłowiec block contain clasts of green shales (Książkiewicz, 1956) a few centimeters in size. The agglutinated foraminifera assemblages found in these shales indicate a Middle Eocene age (*Ammodiscus latus* zone, see also Książkiewicz, 1956).

The flysch of the Oligocene-Miocene Krosno Formation constitutes the matrix for olistolithic blocks including the large Szydłowiec sandstones olistolith. Several other Jurassic, Cretaceous and Paleocene limestone blocks were found within the Krosno Formation west from Wadowice in the Andrychów area (Olszewska et al., 2010) (Fig. 1b), known as Andrychów Klippen (Ślączka et al, 2006, Golonka and Krobicki, 2006a,b,c). These blocks, interpreted as olistoliths, represent shallow water platform, ridge, slope and basinal facies including organodetritic Paleocene algal limestones similar to the Szydłowiec sandstones. The Szydłowiec block belongs therefore to the same type of olistostromes as the Andrychów olistoliths (Andrychów Klippen).

4. Conclusions

The Szydłowiec sandstones constitute a characteristic lithosome occurring within scattered outcrops in the western part of the Polish Outer Carpathians. Its Paleocene age is documented by agglutinated foraminifera as well as by fossils such as abundant coralline algae occurring within carbonate clasts. The Szydłowiec block at Wadowice represents the type locality of the Szydłowiec sandstones. It displays olistolithic features documented by its position in the Oligocene-Miocene Krosno Formation. The shallow-water sandstone blocks slid towards the Skole part of the Menilite-Krosno Basin during

tectonic shortening in the Carpathian accretionary prism in Oligocene-Miocene times.

Acknowledgment

This research has been financed by scientific projects of AGH University of Science and Technology no 11.11.140.173, and grant MNiSW no N N307 249733.

References

Balcer, J. and Koszarski, L., 1990. Pozycja geologiczna i mikrofauna warstw z Szydłowca i Gorzenia w Karpatach. Sprawozdania z Posiedzeń Komisji Nauk Geologicznych Polskiej Akademii Nauk, 34, 226-228.

Bieda, F., 1946. Stratygrafia fliszu Karpat Polskich na podstawie dużych otwornic. Rocznik Polskiego Towarzystwa Geologicznego, 16, 1-52.

Bieda, F., 1948. Przyczynek do znajomości otwornic fliszu karpackiego. Rocznik Polskiego Towarzystwa Geologicznego, 17, 195-123.

Burtan, J., 1974. Detailed Geological Map of Poland 1: 50 000, Mszana Dolna Sheet. Instytut Geologiczny, Warszawa.

Burtan, J., 1978. Explanations to the Detailed Geological Map of Poland 1: 50 000, Mszana Dolna Sheet. Instytut Geologiczny, Warszawa.

Cieszkowski, M., Leśniak, T. and Waśkowska-Oliwa, A., 2001. Lower Paleogene sediments of the Subsilesian Unit in the Wiśniowa Window (Outer Carpathians, Poland). Biuletyn Państwowego Instytutu Geologicznego, 396, 34-35.

Cieszkowski, M. and Waśkowska-Oliwa, A., 2002. Development and biostratigraphy of the Paleogene Gorzeń beds, Subsilesian Unit, Outer Carpathians, Poland. Geologica Carpathica 53, 57-59.

Cieszkowski, M., Golonka, J., Rajchel, J. and Ślączka, A., 2003. Paleogene organic and organogenic limestones as an indication of the tectonic evolution of the western Outer Carpathians. In: I. Vlahovic (ed.), 22nd IAS Meeting of Sedimentology – Opatija 2003. Abstract Book. pp. 30.

Cieszkowski, M., Golonka, J., Waśkowska-Oliwa, A. and Chrustek, M., 2006. Geological structure of the Sucha Beskidzka region – Świnna Poręba (Polish Flysch Carpathians). Kwartalnik AGH Geologia, 32, 155-201.

Cieszkowski, M., Golonka, J., Krobicki, M., Ślączka, A., Oszczypko, N., Waśkowska, A. and Wendorff, M., 2009a. The Northern Carpathian plate tectonic evolutionary stages and origin of olistolithes and olistostromes. Geodinamica Acta, 22, 1-3, 101-126.

Cieszkowski, M., Golonka, J., Krobicki, M., Ślączka, A., Waśkowska, A. and Wendorff, M. 2009b. Olistolith within the Silesian Series and their connections with evolutionary stages of the Silesian Basin. Kwartalnik AGH Geologia, 33, 13-21.

Cieszkowski, M., Golonka, J., Ślączka, A. and Waśkowska, A., 2010. Walory geologiczne melsztyńskiego Wzgórza Zamkowego i jego otoczenia (Karpaty Zewnętrzne). In: J. Rajchel (ed.), Jubileusz Katedry Geologii Ogólnej, Ochrony Środowiska i Geoturystyki Akademii Górniczo-Hutniczej 1920-2010. Wydawnictwa AGH, Kraków, pp. 109-120.

Geroch, S. and Gradziński, R., 1955. Stratygrafia serii podśląskiej żywieckiego okna tektonicznego. Rocznik Polskiego Towarzystwa Geologicznego, 24, 3-62.

Geroch, S., Jednorowska, A., Książkiewicz, M. and Liszkowa, J., 1967. Stratigraphy based upon microfauna in the Western Polish Carpathians. Biuletyn Instytutu Geologicznego, 211, 185-282.

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

Golonka J., 2011. Evolution of the Outer Carpathian Basins. In: M. Bąk, M.A. Kaminski and A. Waśkowska (eds.), Integrating Microfossil Records from the Oceans and Epicontinental Seas. Grzybowski Foundation, Special Publication, 17: 3-14.

Golonka, J. and Waśkowska-Oliwa, A., 2007. Stratigraphy of the Polish Flysch Carpathians between Bielsko-Biała and Nowy Targ. Kwartalnik AGH Geologia, 33, 5-28.

Golonka, J. and Krobicki, M., 2006a. Field trip A – From Tethyan to Platform Facies. Stop A12 – Roczyny – olistoliths (Middle – Upper Jurassic) In: A. Wierzbowski, R. Aubrecht., J. Golonka, J. Gutowski, M. Krobicki, B.A. Matyja, G. Pieńkowski and A. Uchman (eds.), Jurassic of Poland and adjacent Slovakian Carpathians. Field trip guidebook. 7th International Congress on the Jurassic System, 6-18 September 2006, Kraków, Poland, pp. 60.

Golonka, J. and Krobicki, M., 2006b. Field trip A – From Tethyan to Platform Facies. Stop A13 – Targanice – olistoliths (Upper Jurassic – Lower Cretaceous) In: A. Wierzbowski, R. Aubrecht, J. Golonka, J. Gutowski, M. Krobicki, B.A. Matyja, G. Pieńkowski, and A. Uchman (eds.), Jurassic of Poland and adjacent Slovakian Carpathians. Field trip guidebook. 7th International Congress on the Jurassic System, 6-18 September 2006, Kraków, Poland, pp. 60-61.

Golonka, J. and Krobicki, M., 2006c. Field trip A – From Tethyan to Platform Facies. Stop A14 – Inwałd – olistoliths (Tithonian) In: A. Wierzbowski, R. Aubrecht., J. Golonka, J. Gutowski, M. Krobicki, B.A. Matyja, G. Pieńkowski and A. Uchman (eds.), Jurassic of Poland and adjacent Slovakian Carpathians. Field trip guidebook. 7th International Congress on the Jurassic System, 6-18 September 2006, Kraków, Poland, pp. 61-62.

Golonka, J., Cieszkowski, M., Kiessling, W., Krobicki, M., Marko, F., Matyszkiewicz, J., Olszewska, B., Oszczypko, N., Potfaj, M., Rajchel, J., Ślączka, A., Słomka, T., Tłuczek, D. and Wieczorek, J., 2004. Paleocene reef patterns - global and Carpathian view. In: A. Zlinska (ed.), 5. Paleontologická Konferencia, Zbornik abstraktov, Bratislava, jún 2004. Statny Geologicky ustav Dionyza Stura, Bratislava, pp. 39-40.

Golonka, J., Krobicki, M., Matyszkiewicz, J., Olszewska, B., Ślączka, A. and Słomka, T., 2005. Geodynamics of ridges and development of carbonate platform within the Carpathian realm in Poland. Slovak Geological Magazine, 11, 5-16.

Golonka, J., Pietsch, K., Marzec, P., Stefaniuk, M., Waśkowska, A. and Cieszkowski, M., 2009. Tectonics of the western part of the Polish Outer Carpathians. Geodynamica Acta, 22, 81-97.

Golonka, J., Pietsch, K. and Marzec, P., 2011. Structure and plate tectonic evolution of the northern Outer Carpathians. In: D. Closson (ed.), Tectonics. INTECH, Rijeka, Croati, pp. 65-92.

Książkiewicz, M., 1951a. General Geological Map of Poland 1: 50 000, Wadowice Sheet. Instytut Geologiczny, Warszawa.

Książkiewicz, M., 1951b. Explanations to the General Geological Map of Poland 1: 50 000, Wadowice Sheet. Instytut Geologiczny, Warszawa, 283pp.

Książkiewicz, M., 1956. Przewodnik wycieczki w Karpaty Wadowickie XXVII Zjazdu Polskiego Towarzystwa Geologicznego. Rocznik Polskiego Towarzystwa Geologicznego, 4, 421-433.

Książkiewicz, M., 1972. Geological Building of Poland, Vol. IV, part 3. Tectonic. Carpathians, 228 pp.

Książkiewicz, M., 1977. Tectonics of the Carpathians. In: W. Pożaryski (ed.), Geology of Poland. Vol. IV. Tectonics. Wydawnictwa Geologiczne, Warszawa, pp. 476-604.

Leśniak, T., Waśkowska-Oliwa, A. and Cieszkowski, M., 2001. Dolnopaleogeńskie utwory jednostki podśląskiej w oknie tektonicznym Wiśniowej. Nauki o Ziemi w badaniach podstawowych, złożowych i ochronie środowiska na progu XXI wieku. Jubileusz 50-lecia Wydziału Geologii, Geofizyki i Ochrony Środowiska AGH – Kraków, 28 – 29 czerwiec 2001, 39 – 42.

Leśniak, T., Cieszkowski, M., Golonka, J. and Waśkowska-Oliwa, A., 2005. Pozycja geologiczna piaskowców z Czerwina w jednostce podśląskiej polskich Karpat fliszowych. In: M. Cieszkowski and J. Golonka (eds.), Wapienie organogeniczne i oragnodetrytyczne w Karpatach zewnętrznych i ich znaczenie dla rekonstrukcji paleogeograficznych Tetydy. Seminarium naukowe, 21 kwietnia 2005, Kraków, 13-17.

Nemčok, J. and Poprawa, D., coord., 1988-1989. Geological Atlas of Western Outer Carpathian and their Forelad. Państwowy Instytut Geologiczny, Warszawa.

Nowak, W., 1963a. Detailed Geological Map of Poland 1: 50 000, Wadowice Sheet. Instytut Geologiczny, Warszawa.

Nowak, W., 1963b. Detailed Geological Map of Poland 1: 50 000, Bielsko-Biała Sheet. Instytut Geologiczny, Warszawa.

Olsson, R.K., Hemleben, C., Berggren, W.A. and Huber, B.T. (red.), 1999. Atlas of Paleocene plankctonic forminifera. Smithsonian Contributions to Paleobiology, 85, 1-252.

Olszewska, B., 1997. Foraminiferal biostratigraphy of the Polish Outer Carpathians: A record of basin geohistory. Annales Socetatis Geologorum Poloniae, 67, 325-337.

Olszewska, B., Odrzywolska-Bieńkowa, E., Giel, M.D., Pożaryska, K. and Szczechura, K., 1996. Rząd Foraminiferida Eichwald, 1830. In: L. Limanowska and M. Piwocki (eds.), Budowa geologiczna Polski. Atlas skamieniałości przewodnich i charakterystycznych. Kenozoik. Trzeciorzęd. Paleogen, T 3, cz. 3a, Wydawnictwa Geologiczne, 45-215.

Olszewska, B., Paul, Z. Ryłko, W. and Garecka, M., 2010. New data on the position of so called „klippes" in successions of the marginal units of the Outer Carpathians. Geologica Balcanica, 39, 278.

Sokołowski, S., 1972. Geological building of Poland. Volume I. Stratigraphy, part 2. Mesozoic. Wydawnictwa Geologiczne, Warszawa, 806 pp.

Ślączka, A., Kruglow, S., Golonka, J., Oszczypko, N. and Popadyuk, I., 2006. The General Geology of the Outer Carpathians, Poland, Slovakia, and Ukraine. In: J. Golonka and F. Picha (eds.), The Carpathians and their foreland: Geology and hydrocarbon resources. American Association of Petroleum Geologists, Memoir, 84, 221-258.

Waśkowska-Oliwa, A., 2001. Analiza biostratygraficzna zespołów otwornic z wczesnopaleogeńskich osadów jednostki podśląskiej w profilu potoku Lipnik (okno tektoniczne Wiśniowej). In: M. Bąk and K. Bąk (eds.), Streszczenia referatów i posterów Trzecich Ogólnopolskich Warsztatów Mikropaleontologicznych Mikro 2001, Zakopane, 35.

Waśkowska-Oliwa, A., 2008. The Paleocene assemblages of agglutinated foraminifera from deep-water basin sediments of the Carpathians (Subsilesian Unit, Poland) – biostratigraphical remarks. In: M.A. Kaminski and R. Coccioni (eds.), Proceedings of the Seventh International Workshop on Agglutinated foraminifera. Grzybowski Foundation, Special Publication, 13, 227-265.

Received: 30 December 2011
Accepted: 16 March 2012

Marek CIESZKOWSKI[1)*], Jan GOLONKA[2)] & Anna WAŚKOWSKA[2)]

[1)] Jagiellonian University, Institute of Geological Sciences, Oleandry 2a, 30-063 Kraków, Poland;

[2)] AGH University of Science and Technology, Faculty of Geology, Geophysics and Environmental Protection, Al. Mickiewicza 30, 30-059 Kraków, Poland;

[*)] Corresponding author, marek.cieszkowski@uj.edu.pl