Austrian Journal of Earth Sciences | Vienna | 2016 | Volume 109/2 | 160 - 165 | DOI: 10.17738/ajes.2016.0011

Albian microfossils in the calcarenite limestone from Dopplerhütte and Tulbingerkogel quarries (Northern Zone of the Rhenodanubian Flysch Zone, eastern Austria)

Andrzej ŚLĄCZKA[1) *)], M. Adam GASIŃSKI[1)], Godfrid WESSELY[2)] & Patrycja WÓJCIK-TABOL[1)]

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

[2)] Siebenbrunnengasse 29, 1050 Wien, Austria;

[*)] Corresponding author: slaczka31@o2.pl

KEYWORDS Rhenodanubian Flysch; Northern Zone; Wolfpassing Formation; Albian; foraminifera

Abstract

Calcareous arenitic rocks exposed in the Dopplerhütte and Tulbingerkogel quarries northwest of Vienna were studied to establish their stratigraphic age. The whole succession is a part of the "Northern Zone" – the Tulbingerkogel thrust sheet – which represents the external part of the Wienerwald Flysch. These rocks were regarded commonly as Neocomian, however the analyses of the foraminifera within the intercalations of marly limestones proved the presence of *Globorotalia* sp. and assemblages with the index species *Spiroplectinata annectens* (Parker et Jones). Therefore, the depositional age of the studied rocks can be estimated neither older than Albian nor younger than Cenomanian. This indicates that also during the Albian calcareous sedimentation persisted within the northernmost unit of the Rhenodanubian Flysch Zone, which probably represented a detached part of the southern slope of the European continental margin and/or the Penninic Ocean.

Es wurden die arenitischen Kalkgesteine, die in den Steinbrüchen bei der Dopplerhütte und am Tulbinger Kogel nördlich von Wien aufgeschlossen sind, einer Studie unterzogen, um ihr stratigraphisches Alter zu erhärten. Die gesamte Abfolge ist Teil der „Nordzone" – Tulbingerkogel Schuppe – welche den externen Abschnitt des Wienerwald-Flysches vertritt. Diese Gesteine wurden herkömmlich als Neokom- Klippen bezeichnet, jedoch erbrachten Untersuchungen der Foraminiferen aus Einschaltungen von mergeligen Kalken den Nachweis der Anwesenheit von Vergesellschaftungen mit *Globorotalia* sp. und der Leitform *Spiroplectinata annectens* (Parker et Jones). Daher können nach der Altersabschätzung die untersuchten Gesteine nicht älter als Albium und nicht jünger als Cenomanium sein. Dies zeigt an, dass im jüngeren Albium kalkige Sedimentation innerhalb der Nordzone andauerte, welche letztere wahrscheinlich einen abgetrennten Teil des südlichen Hanges der Europäischen Platte bzw des penninischen Ozeans darstellt.

1. Introduction

The so-called "Northern Zone" (Tulbingerkogel thrust sheet) (Figure1) occurs in the northern marginal part of the Rhenodanubian Flysch Zone (Grün et al. 1972; Sauer et al., 1992; Schnabel, 1992; Oberhauser, 1995; Schnabel, 2002; Wessely, 2006; Egger and Wessely, 2014) in the Wienerwald area. Towards the North it is thrusted over the Molasse Zone of the Alpine Foreland, and towards the South it is overthrusted by the main part of the Greifenstein nappe of the Rhenodanubian Flysch Zone. The Tulbingerkogel thrust sheet is usually regarded as the Lower Cretaceous part of the Greifenstein Nappe (Sauer et al, 1992, Plöchinger and Prey, 1993; Egger and Wessely, 2014). Due to tectonic deformation only a part of the sedimentary succession is preserved. In the study area , situated NW of Vienna, the Tulbingerkogel thrust sheet is built up of grey, dark grey pelitic marls and less amounts of dark claystones with intercalations of complexes of bioclastic turbiditic limestones with cherts, calcareous sandstones and marls (Wolfpassing Formation, Grün et al., 1972; Egger and Wessely, 2014). These complexes were earlier referred to as 'klippen' (Calcareous Flysch, see Schnabel, 2002). For the Wolfpassing Formation a stratigraphic time interval from Barremian to Aptian was proposed (see Grün et al., 1972; Egger and Wessely, 2014) or from Barremian to Albian if this formation also contains black shales with glauconitic, quartzitic sandstones of the "Gault Flysch" (see also Sauer et al., 1992; Schnabel, 1992; Plöchinger and Prey,1993; Oberhauser, 1995). Main complexes of turbiditic limestones together with those exposed in the Dopplerhütte and Tulbingerkogel quarries (Figure1) were regarded as Neocomian (Grün et al., 1972; Plöchinger and Prey,1993) or Barremian – Lower Aptian by Egger and Wessely (2014). Only the highest (third) level of bioclastic limestones within the black shales distinguished by Grün et al., (1972) near Tulbingerkogel was regarded as Albian. In this paper we provide new insight into the stratigraphic age of the biocalcarenites exposed in the Dopplerhütte and Tulbingerkogel quarries.

2. Area of research

We have investigated an old quarry near the Dopplerhütte beside the Neuwaldegger Road (48° 17.646` N, 16° 09.586` E) and an old quarry situated along the forest road north of the hotel near the summit Tulbingerkogel (48° 17.665`N, 16°08.815`E) (Figure1B). The sections exposed in both quarries are composed of light grey, fine to medium grained turbiditic calcarenites up to 0.5 m thick, sporadically with cherts, inter-

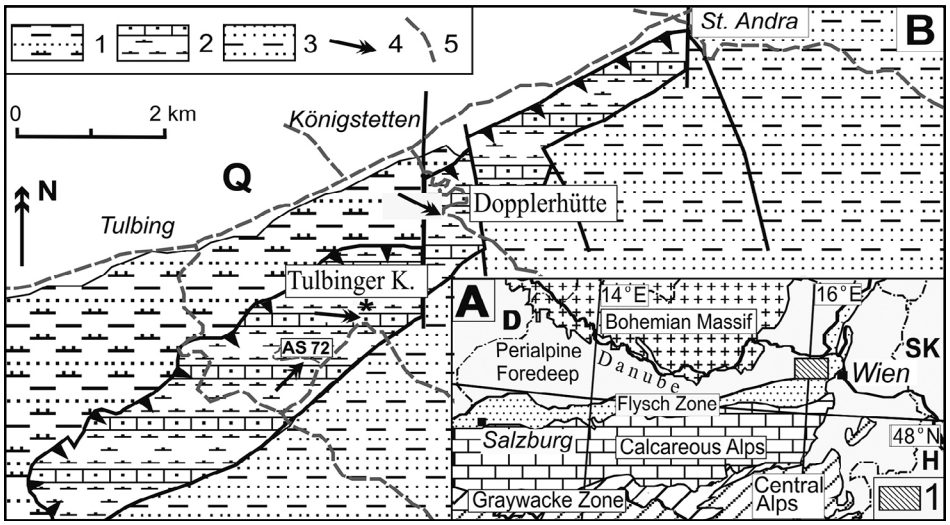

Figure 1: A – Geological sketch of the Eastern part of the Alps and the Rhenodanubian Flysch Zone, 1 – location of the study area; B – Location of the Dopplerhütte and Tulbingerkogel quarries (based on Plöchinger and Prey, 1993; Schnabel, 2002), 1 – Allochtonous (subalpine) molasse, 2 – Northern Zone, 3 – Greifenstein Nappe, 4 – sampling sites, 5 – roads, Q – Quaternary deposits, AS 72 – site of samples AS 72, AS 73, AS 74.

calated by thin layers of grey and dark grey marls and marly shales up to 30 cm thick (Figure 2a and 2b). The rocks exposed at the Dopplerhütte were regarded as typical examples of intervals containing bioclastic limestones within the Wolfpassing Formation (Grün et al., 1972; Plöchinger and Prey, 1993; Schnabel, 2002).

3. Methods

For a micropalaeontological analysis, materials from pelitic intercalations as well as from bioclastic limestones were used. Ten samples were collected: six (no. AS 65, AS 66, AS 67, AS 68, AS 68a) from the Dopplerhütte quarry, and four (no. AS 69, AS 70a, AS 70b, AS 71) from the Tulbingerkogel quarry. For comparative purposes, three samples (AS 72, AS 73, AS 74) were additionally collected from black shales with thin-bedded glauconitic sandstones that occur above the third level of the biocalcarenites. They represent the highest and thus youngest part of the profile described by Grün et al. (1972, their sampling points G and H) and are outcropping along the forest road south from the Tulbingerkogel (Figure 1).

Standard processing methods (Glauber salt, multiple heating and freezing) have been applied for the preparation and analyses of the foraminifera content within the pelitic rocks. The dried residuum was sieved, with a final sieve size of 63 µm. Limestones samples have been analysed only in thin sections.

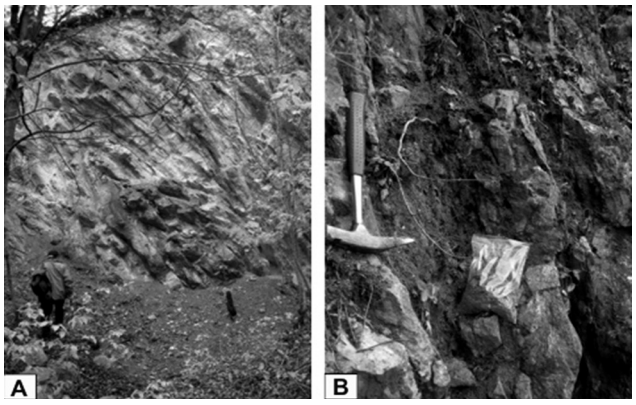

Figure 2: A – View of the Dopplerhütte quarry, B. View of the Tulbingerkogel quarry. Intercalations of marly shale between calcarenitic limestones.

4. Results

Samples from pelitic material in general contain very poorly preserved foramininiferal assemblages, and half of them were almost barren without identifiable taxa. Only one sample collected from black shales exposed along the forest road (AS 72) contains a relatively well preserved foraminiferal assemblage. Planktonic taxa comprise about 70% of the foraminifer taphocoenose. The presence of the species *Hedbergella* cf. delrioensis (Carsey), *Globigerinelloides bentonensis* (Morrow) and G. caseyi (Bolli et al.), and *Praeglobotruncana* sp., allows a correlation with the Albian, probably Late Albian using the zonation by Robaszynski and Caron (1995) and Premoli-Silva and Verga (2004). This age interpretation confirms earlier dating of an adjacent bioclastic level by Grün et al. (1972).

The foraminiferids from the thin sections from the bioclastic limestones generally are not age diagnostic, however, in few cases an approximate stratigraphic age correlation can be given.

4.1 Dopplerhütte quarry

In sample AS-66 it was possible to recognize (Figure 3) *Glomospira*, sp., *Trochammina* sp., *Trochamminoides* sp., *Pleurostomella* sp., *Marssonella* cf. *oxycona* (Reuss), *Textularia, Hedbergella* sp., *Quinqueloculina* sp. that indicate an age not older than Albian; in sample AS-67a the species: *Glomospira*, sp., *Trochammina* sp., *Trochamminoides* sp., *Pleurostomella* sp., *Marssonella* cf. *oxycona* (Reuss), *Textularia*, *Hedbergella* sp., *Heterohelix* sp., *Rotalipora* sp., *Quinqueloculina* sp., *Glandulina* sp., *Dentalina* sp. were identified. Based on the presence of *Rotalipora* sp. the interpreted stratigraphic range is from late Albian to late Cenomanian. Sample AS-68 (Figure 3) contains an assemblage with *Glomospira* sp., *Trochammina* sp., *Trochamminoides* sp., *Spiroplectinata* cf. *annectens* (Parker et Jones), *Spiroplectinata* sp., Marssonella cf. *oxycona* (Reuss), *Textularia* sp. of the Cretaceous age. Sample AS-68a (Figure 3) yields *Glomospira* sp., *Trochammina* sp., *Trochamminoides* sp., *Spiroplectinata annectens* (Parker et Jones), *Marssonella* cf. *oxy-*

cona (Reuss), *Textularia*, *Hedbergella* sp./*Globigerinelloides* sp., *Quinqueloculina* sp,. and gives an Albian to early Cenomanian age range.

4.2 Tulbingerkogel quarry

Sample AS-70a contains (Figure 4) *Glomospira* sp., *Trochammina* sp., *Trochamminoides* sp., *Ataxophragmium* sp., *Spiroplectinata annectens* (Parker et Jones), *Marssonella* cf. *oxycona* (Reuss), *Textularia*, *Hedbergella* sp./*Globigerinelloides* sp., *Dentalina* sp. that suggested an Albian to early Cenomanian age. Sample AS-70b (Figure 4) yields an assemblage with *Ammodiscus* sp., *Glomospira* sp., *Trochammina* sp., *Trochamminoides* sp., *Arenobulimina* cf. *preslii* (Reuss), *Spiroplectinata* cf. *annectens* (Parker et Jones), *Tritaxia gaultina* (Morozova), *Marssonella* cf. *oxycona* (Reuss), *Textularia*, *Hedbergella* sp./*Globigerinelloides* sp. ?-fragments, *Quinqueloculina* sp., *Glandulina* sp., *Lenticulina* sp., *Dentalina* sp. that allowed to correlate it again with the Albian and early Cenomanian.

The character of planktonic taxa in the clastic material indicates that this material was primary deposited on an external shelf and/or on a slope of the basin (cf. Sliter, 1972, Sliter and Baker, 1972; Olsson and Nyong, 1984) and was later redeposited by turbidity currents to deeper parts of the basin where sedimentation of grey marls dominated.

4. Discussion and conclusions

The age of the samples studied can be estimated as being not older than Albian, on basis of the sample AS 67a with *Rotalipora* sp. and samples AS 68, 70 a, b with the index species *Spiroplectinata annectens* (Parker et Jones), and not younger than Cenomanian (cf. Gasiński, 1978: late Albian – early Cenomanian; Szarek et al., 2000: late Albian; Tyszka and Thies, 2001: Albian). The species *Spiroplectinata annectens* (Parker et Jones) has been recognized in marly sediments regarded as of late Aptian – late Albian age in the "Spherosideritic beds" of the West Carpathians (Salaj and Samuel, 1966). However the age of these beds has been later revised and changed by Marschalko and Kysela (1980) as Albian – Cenomanian. In the *Stratigraphic dictionary of the Western Carpathians* (Andrusov and Samuel, 1985) the age of the Spherosideritic beds is regarded as late Albian-Cenomanian. Weidich (1990) noted *S. annectens* from the ?late Aptian – late Albian (Vraconian) of southern Germany as well as from the middle Albian- early Cenomanian of northern Germany. The occurrence of this species is noted in the early Albian (cf. Tyszka and Thies, 2001). Holbourn et al. (2001) recognized this species in the late Albian black shales of Site 1049 (ODP Leg. 171). In the Treatise by Loeblich and Tappan (1988) this species is dated as early Albian. Szarek et al. (2000) noted *S. annectens* from the late Albian of northeast Germany. Therefore, the bioclastic limestones exposed in the Dopplerhütte and Tulbingerkogel quarries, previously regarded as Neocomian, ought to be assigned in large parts to the Albian, and sedimentation of bioclastic limestones continued also during the Albian and were more common than suggested by Grün et al. (1972). A Cenomanian age seems to be unlikely as in that time interval already the siliciclastic carbonate-free Reiselberg Formation or Hütteldorf Formation had been deposited in the Rhenodanubian Flysch basin (e.g. Wagreich, 2008; Egger and Wessely, 2014).

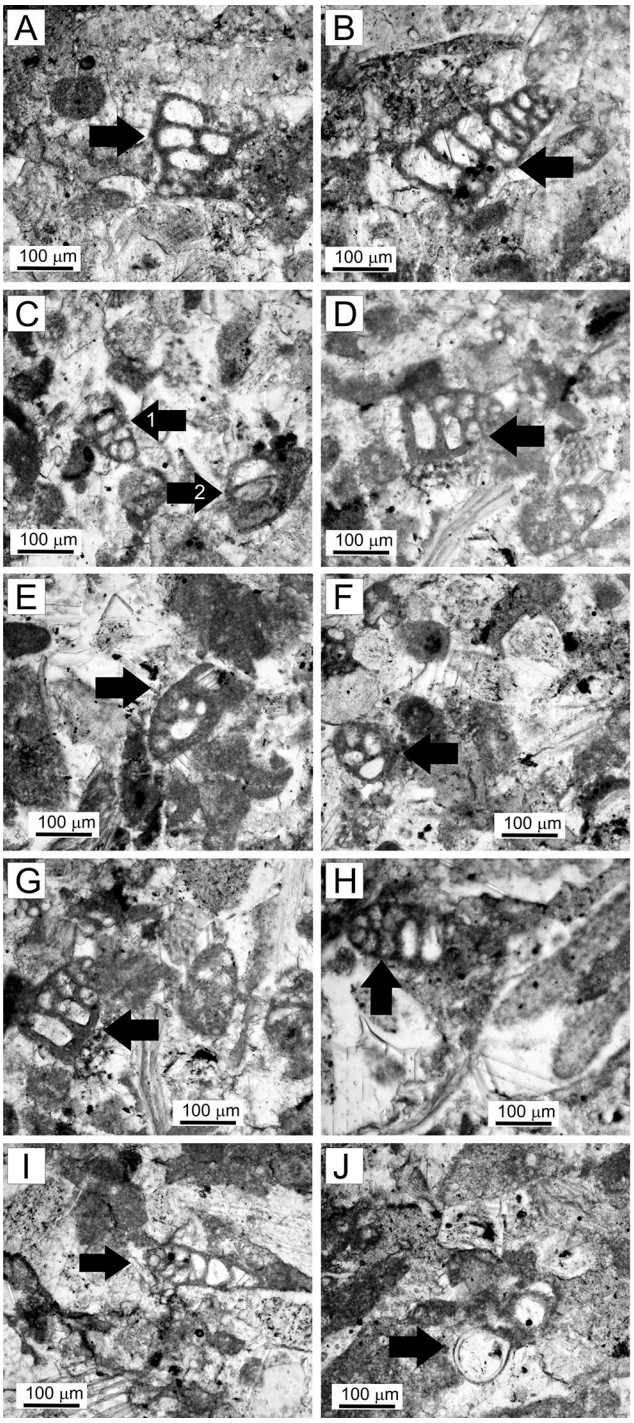

Figure 3. Foraminiferids from thin sections:
A, B – Marssonella cf. oxycona; C – Marssonella cf. oxycona (1). Quinqueloculina sp. (2); D, E, F, G, H – Spiroplectinata sp.; I – Spiroplectinata cf. annectens; J – Hedbergella sp./Globigerinelloides sp. Tests observed in the sample AS 68a, excluding picture I., which shows the sample AS 68. All pictures were taken under transmitted, plane-polarized light.

An open question is still, how the Wolfpassing Formation of the Northern Zone was linked with other units of the Rheno-

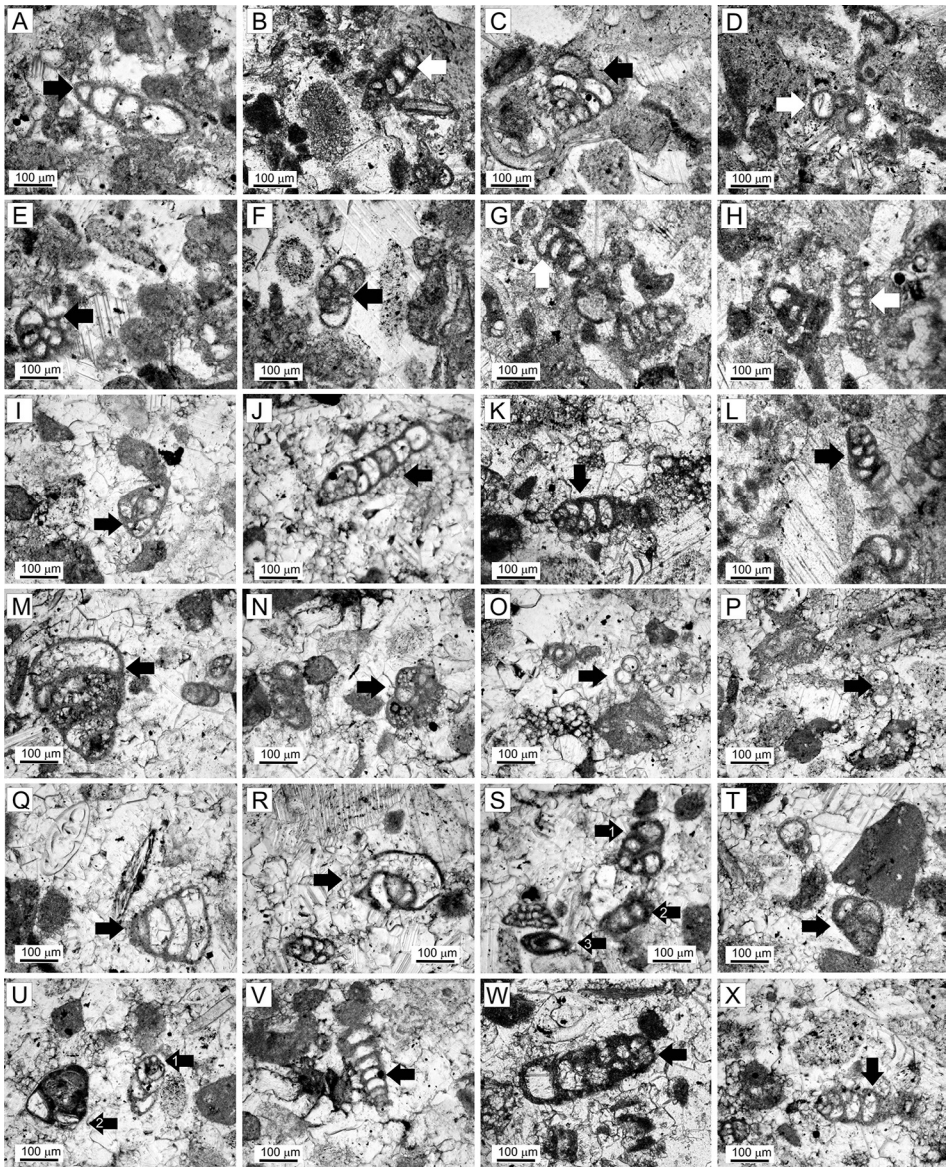

Figure 4. Foraminiferids from thin sections: A – Glandulina sp.; B, G, H, K, L, W, X. – Spiroplectinata cf. annectens; C – Marssonella cf. oxycona; D, O, P – Hedbergella sp. Globigerinelloides sp.? – fragments; E, F, N, R – Trochammina sp./Trochamminoides sp.; I, M,T – Arenobulimina cf. preslii – J. Tritaxia cf. gaultina, Q – Marssonella cf. oxycona; S – Arenobulimina cf. presli (1), Textularia (2), Glandulina sp. (3).; U – Glandulina sp. (1), Quinqueloculina sp. (2); V – Textularia. Tests A-H, L show the sample AS 70a, others depict tests in the sample AS 70b. All pictures were taken under transmitted, plane-polarized light.

danubian Flysch and with the Outer Carpathians. Schnabel (1992) and Oberhauser (1995) stated that Northern Zone represented a separate basin and was connected with the Silesian Basin of the Outer Carpathians. However, Barremian-Albian sediments in the Silesian Basin completely lack bioclastic limestones intercalations (Ślączka et al., 2006). In later papers Schnabel (2002) suggested a link between the Wolfpassing Formation and the succession of the Kahlenberg Nappe. Later, it was concluded that Northern Zone is an independent tectonic unit (Gebhardt, 2013). Eliáš et al. (1990) supposed a link with the Kurovice Klippen at the front of the Magura Nappe. However, a majority of authors, among others Sauer et al. (1992), Plöchinger et al. (1993) and later Egger and Wessely (2014) regarded the Northern Zone with its Wolfpassing Formation as representing the lower part of the Greifenstein Nappe. Picha et al. (2006) pointed out, that the Wolfpassing Formation shows similarities to the Hluk Formation from the Bile Karpaty Unit (Magura Nappe) of Barremian – Albian age which is made up by black shales, marls and bioclastic limestones with cherts. The Bile Karpaty Unit is regarded as a prolongation of the Laab Nappe (Eliáš et al., 1990; Picha et al., 2006), however according to Oberhauser (1995), Trautwein et al. (2001) and Mattern and Wang (2008) this unit may have been originally situated north of the Greifenstein Nappe.

The location of the source area(s) of redeposited material is also open to discussion. Clastic calcareous material with the above described planktonic taxa had to be derived at least partly from a relatively shallow carbonate platform. However, because of lack of detailed sedimentological data and paleogeographic analysis, the exact position of that area is little known. Tentatively, the NE margin of the Penninic Ocean connected with the southern prolongation of the West European platform can be considered as a likely source area to the north. It should be taken into consideration that the Gresten Klippen Zone, which is placed originally north from the Penninic Ocean, did not extend further eastward from eastern Austria – it neither exist in Moravia nor in the Carpathians (Picha et al., 2006). The other possibility is that calcareous clastic deposits were supplied from an island (cordillera) within the Penninic Ocean which was later completely overridden by cover-nappes of the Rhenodanubian Flysch units during Alpine compressional movements.

Nevertheless based on hitherto data it is most probable that the Wolfpassing Formation of the Northern Zone (Tulbingerkogel thrust sheet) represented a slope, base-of-slope and/or basin environment where during the Albian redeposited calcareous sediments prevailed with local clastic fans, and black shales of the "Gault" lithofacies were only subordinate. The

depth of the Northern Zone basin was at least 3000 m. The presence of carbonate pelitic sediments (marls and marly shales) imply that the Wolfpassing Formation exposed in the studied quarries was deposited generally near the calcite compensation depth (CCD), which oscillated around 3000 m (below sea level, b.s.l. at the end of the early Cretaceous (Andel van, 1975; Andel van, et al., 1977; Hay, 1988). The older part of the Wolfpassing Formation, which corresponded to the Tristel Formation (Hauterivian/Barremian) from more western part of the Rhenodanubian Flysch and mainly represented by grey marls with carbonate turbidites (Egger, 1987; Hesse, 2011), was deposited probably slightly above CCD. In the remaining part of the Rhenodanubian flysch basin (Northern Penninic Ocean) deep-water sea environment (below CCD) prevailed during Albian, represented by the "Gault" lithofacies with black shales and during the Late Albian by the Hütteldorf Formation (Wagreich, 2008; Wagreich et al., 2008). The appearance of more numerous intercalations of black shales in the upper part of the Wolfpassing Formations indicates that also the Northern Zone basin deepened during the upper part of the Albian.

Acknowledgements

We thank Dr. Wolfgang Schnabel and anonymous reviewers for critical comments and suggestions that significantly contributed to the improvement of that paper. We also thank Prof. Marek Wendorf for constructive remarks and Dr. Michael Wagreich for discussions which helped to improve this paper and for the accurate editorial management.

References

Andel van, T.H., 1975. Mesozoic/Cenozoic calcite compensation depth and the global distribution of calcareous sediments. Earth and Planetary Sciences Letters 26/2, 187-194. http://dx.doi.org/10.1016/0012-821X(75)90086-2

Andel van, T.H., Thiede, J., Sclater, J.G. and Hay, W., 1977. Depositional history of the South Atlantic Ocean during the last 125 million years. The Journal of Geology 85/6, 651-698.

Andrusov, D. and Samuel, O. (eds.), 1985. Stratigraphic Dictionary of the Western Carpathians, vol.2. Geologicky Ustav D. Stura, Bratislava, 359p. (in Slovakian).

Egger, H., 1987. Die Geologie der Rhenodanubischen Flyschzone südöstlich von Steyr (Oberösterreich, Niederösterreich). Jahrbuch der Geologischen Bundesanstalt, 13, 139-151.

Egger, H. and Wessely, G., 2014. Wienerwald, Geologie, Stratigraphie, Landschaft und Exkursionen. Gebrüder Borntraeger, Stuttgart, 202p.

Eliáš. M., Schnabel, W. and Stránik, Z., 1990. Comparison of the Flysch Zone of the Eastern Alps and the Western Carpathians based on recent observation. In: D. Minařikova and H. Lobitzer (eds.), Thirty years of geological cooperatiom between Austria and Czechoslovakia, pp.37-46.

Gasiński, M.A., 1978. Dimorphism in Spiroplectinata annectens (Parker et Jones). Geologia 4, 65-69 (in Polish with English summary).

Gebhardt, H., 2013. Geologie der Kartenblätter 55 Ober-Grafendorf und 56 St. Pölten Arbeitstagung 2013 der Geologischen Bundesanstalt. Wien: Geologische Bundesanstalt, 326p.

Grün, W., Kittler, G., Lauer, G., Papp, A. and Schnabel, W., 1972. Studien in der Unterkreide des Wienerwaldes. Jahrbuch der Geologischen Bundesanstalt, 115, 103-186.

Hay, W.W., 1988. Paleoceanography: A review of the GSA Centennial. Geological Society of America Bulletin, 100/12, 1957-1970. http://dx.doi.org/10.1130/0016-7606(1988)100<1957:PPIBRO>2.3.CO;2

Hesse, R., 2011. Rhenodanubian Flyschzone, Bavarian Alps. GSA Field Guides, 22, 51-73. http://dx.doi.org/10.2230/2011.0022(05)

Holbourn, A., Kuhnt, W. and Erbacher, J., 2001. Benthic foraminifers from lower Albian black shales (Site 1049, ODP LEG 171): Evidence for a non "uniformitarian" record", Journal of Foraminiferal Research, 31/1, 60-74. http://dx.doi.org/10.2113/0310060

Loeblich, A.R. and Tappan, H., 1988. Foraminiferal genera and their classification. Van Nostrand Reinhold Co, New York, 1182 p.

Marschalko, R. and Kysela, J., 1980. Geology and sedimentology of the Klippen Belt and Manin Unit between Žylina and Považska Bystrica. Západné Karpaty, Séria Geologicka 6. 105-114 (in Slovakian).

Mattern, F. and Wang P., 2008. Out-of-sequence thrust and paleogeography of the Rhenodanubian Flysch Belt (Eastern Alps) revisited. International Journal of Earth Sciences (Geologische Rundschau). 97, 821-833. http://dx.doi.org/10.107/s00531-007-0200-4

Oberhauser, R., 1995. Zur Kenntnis der Tektonik und der Paläeogeographie des Ostalpenraumes zur Kreide-, Paleozän- und Eozänzeit. Jahrbuch der Geologischen Bundesanstalt, 138, 369-432.

Olsson, R.K. and Nyong, E.E., 1984. A paleoslope model for Campanian-lower Maestrichtian foraminifera of New Jersey and Delaware. Journal Foraminiferal Research, 14, 50-69.

Picha, J., Stranik, Z. and Krejči, O., 2006. Geology and hydrocarbons resources of the Outer Western Carpathians and their Foreland, Czech Republic. In: J. Golonka and F. Picha (eds.), The Carpathians and their foreland: Geology and hydrocarbon resources, , AAPG Memoir 84, pp. 49-175. http://dx.doi.org/10.1306/985607M843067

Plöchinger, B., Prey, S., 1993. Der Wienerwald. 2. Auflage, W.Schnabel (ed.), Sammlung Geologischer Führer, 59, Gebrüder Borntrager, Berlin-Stuttgart. 168 p.

Premoli-Silva, I., and Verga, D., 2004. Practical manual of Cretaceous planktonic foraminifera. In: D.Verga and R. Rettori R. (eds.), International School On Planktonic Foraminifera, 3rd Course: Cretaceous. Universites of Perugia and Milano, Perugia, 283p.

Robaszynski F., and Caron M., 1995. Foraminifères planctoniques du Crétacé: commentaire de la zonation Europe-Mé-

diterranée. Bulletin Societe Géologique France, 166/6, 68-692.

Salaj, J. and Samuel, O., 1966. Foraminifera der Westkarpaten – Kreide. Geologický Ústav Dionýza Štúra, Bratislava, 291p.

Sauer, R., Seifert, P. and Wessely, G., 1992. Guidebook to Excursion in the Vienna Basin and the adjacent Alpine-Carpathian thrustbelt in Austria. Mitteilungen der Österreichischen Geologischen Gesellschaft, 85, 1-264.

Schnabel, W., 1992. New data on the Flysch Zone of the Eastern Alps in the Austrian sector and new aspects concerning the transition to the Flysch Zone of the Carpathians: Cretaceous Research, 13, 405-419.

Schnabel, W., (ed.), 2002. Geologie der Österreichischen Bundesländer, Niederösterreich, Geologische Karte 1:200 000 mit Kurzerläuterung. Geologische Bundesanstalt, Wien.

Ślączka, A., Kruglov, S., Golonka, J., Oszczypko, N. and Popadyuk I., 2006. Geology and Hydrocarbon resources of the Outer Carpathians, Poland, Slovakia and Ukraine: general geology. In: J. Golonka and F. Picha (eds.), The Carpathians and their foreland: Geology and hydrocarbon resources, AAPG Memoir 84, 221-258. http://dx.doi.org/10.1306/985607M843070

Sliter, W.V., 1972. Upper Cretaceous planktonic foraminiferal zoogeography and ecology-eastern Pacific margin. Palaeogeography, Palaeoclimatology and Palaeoecology, 12, 15-31.

Sliter, W.V. and Baker, R.A., 1972. Cretaceous bathymetric distribution of benthic foraminiferids. Journal of Foraminiferal Research, 2, 167—183

Szarek, R., Klosowska, B., Prokop, A., Kuhnt, W. and Wagner, T., 2000. Upper Albian agglutinated foraminifera of Northeast Germany. in Hart, M., Kaminski, M. and Smart, C.W. (Editors): Proceedings of the 5th international workshop on Agglutinated foraminifera Krakow: Grzybowski Foundation Special Publication 7, 19.

Trautwein, B., Dunkl, I. and Frisch, W., 2001. Accretionary history of the Rhenodanubian flysch zone in the Eastern Alps – evidence from apatite fission-track geochronology. International Journal of Science, 90/3, 703-213. htp://dx.doi.org/10.107/s005310000184

Tyszka, J. and Thies, A., 2001. Spiroplectinata, key benthic foraminifer genus for palaeoceanographic reconstruction of the Albian Lower Saxony Basin. Palaeogeography, Palaeoclimatology, Palaeoecology, 174/1-3, 199-220. htp://dx.doi.org/10.1p16/S0031-018(01)00294-2

Wagreich, M., 2008. Lithostratigraphic definition and depositional model of the Hütteldorf Formation (Upper Albian – Turonian, Rhenodanubian flysch Zone, Austria). Austrian Journal of Earth Sciences, 101, 70-80.

Wagreich, M., Lukender, A., and Egger, H., 2008. Cretaceous History of Austria. Berichte der Geologischen Bundesanstalt, 74, 12-30.

Weidich, K.F., 1990. Die kalalpine Unterkreide und ihre Foraminiferenfauna. Zitteliana, 17, 312 p.

Wessely, G., 2006. Geologie der Österreichischen Bundesländer, Niederösterreich. Geologische Bundesanstalt, Wien, 413 p.

Received: 30 June 2014
Accepted: 14 September 2015

Andrzej ŚLĄCZKA[1)*], M. Adam GASIŃSKI[1)], Godfrid WESSELY[2)] & Patrycja WÓJCIK-TABOL[1)]

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

[2)] Siebenbrunnengasse 29, 1050 Wien, Austria;

[*)] Corresponding author: slaczka31@o2.pl