Annales Societatis Geologorum Poloniae (2004), vol. 74: 237–256.

STRATIGRAPHY AND PALAEOGEOGRAPHIC POSITION OF THE JURASSIC CZERTEZIK SUCCESSION, PIENINY KLIPPEN BELT (WESTERN CARPATHIANS) OF POLAND AND EASTERN SLOVAKIA

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Wierzbowski, A., Aubrecht, R., Krobicki, M., Matyja, B. A. & Schlögl, J., 2004. Stratigraphy and palaeogeographic position of the Jurassic Czertezik Succession, Pieniny Klippen Belt (Western Carpathians) of Poland and Eastern Slovakia. *Annales Societatis Geologorum Poloniae*, 74: 237–256.

Abstract: The Czertezik Succession has been closely re-examined in its most classical sections of the Pieniny Klippen Belt (Western Carpathians) in Poland and eastern Slovakia. The study revealed the presence of the "lower nodular limestones" (Niedzica Limestone Formation), and resulted in discovery of Early Bajocian ammonite fauna in grey crinoidal limestones of the Smolegowa Limestone Formation/Flaki Limestone Formation, and the latest Bajocian to Early Bathonian ammonite fauna in the Niedzica Limestone Formation. These new data proved closer similarity between the Czertezik Succession and the Niedzica Succession than between the Czertezik Succession and the Czorsztyn Succession as it was suggested up to now. On the other hand, the Czertezik Succession represents deeper palaeogeographical position within the Pieniny Klippen Basin than the Niedzica Succession and it has been deposited near the Branisko/Kysuca Succession.

Key words: Jurassic, Western Carpathians, Pieniny Klippen Belt, Czertezik Succession, stratigraphy, ammonites, palaeogeography.

Manuscript received 29 January 2004, accepted 13 August 2004

INTRODUCTION

The sedimentary basin of the Pieniny Klippen Belt included several facies zones, each characterized by specific sequence of rocks – especially well marked during Jurassic and Early Cretaceous. These zones have been recognized as the Klippen Successions (called earlier series), such as: the Czorsztyn Succession and the Niedzica/Pruské Succession – deposited on the southern slope of the northern ridge (Czorsztyn Ridge), the Branisko/Kysuca Succession, and the Pieniny Succession deposited in the central part of the basin, as well as still fragmentarily known successions deposited on a northern slope of the southern ridge (Andrusov Exotic Ridge) – the Nižna Succession, and the Haligovce Succession (see Andrusov, 1926, 1938; Birkenmajer, 1963, 1977, 1986, 1988, 2001; Scheibner, 1968; Mišík, 1997; Golonka *et al.*, 2003; and other papers cited therein).

The Czertezik Succession was originally established by Birkenmajer (1959). It was characterized by special development of the Middle-Upper Jurassic deposits. This included occurrence of thick white and/or grey crinoidal limestones, sometimes with cherts, corresponding to the Smolegowa Limestone Formation and/or Flaki Limestone Formation, but also development locally of red crinoidal limestones of the Krupianka Limestone Formation. Younger deposits were recognized as follows: the radiolarites attributed to the Czajakowa Radiolarite Formation (green-coloured corresponding to the Podmajerz Radiolarite Member below, and red-coloured of the Buwałd Radiolarite Member above), as well as the overlying red nodular limestones of the ammonitico-rosso type of the Czorsztyn Limestone Formation, and white micritic *Calpionella* limestones (Birkenmajer, 1959, 1976, 1977).

The most characteristic feature of the Czertezik Succession appeared to be the lack of "lower nodular limestones" of the Niedzica Limestone Formation (Birkenmajer, 1959,

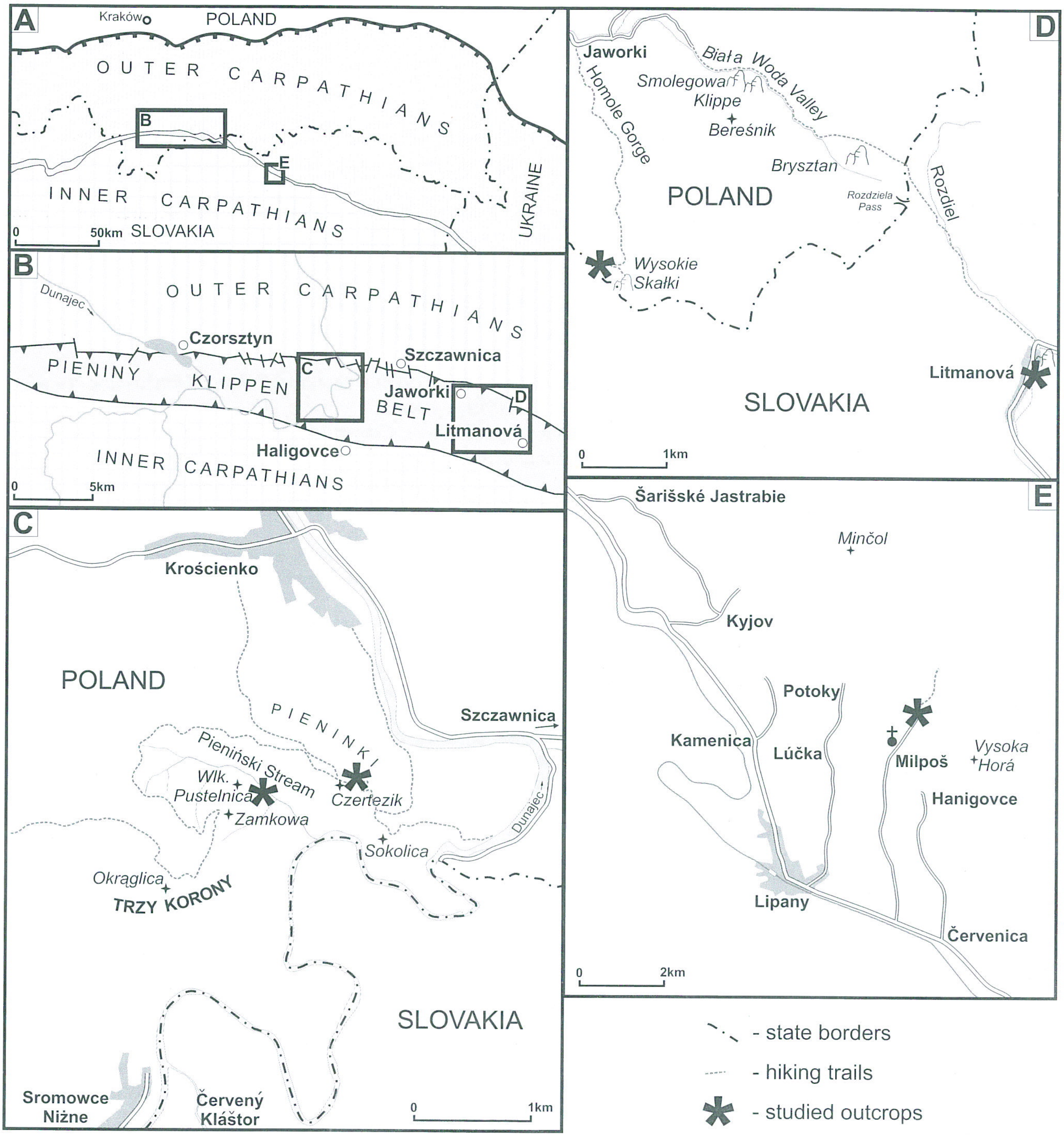

Fig. 1. A and **B**. Location of the Pieniny Klippen Belt (*in grey*) within the Carpathians. **C–E**. Location of the studied sections in central and eastern parts of the Pieniny Klippen Belt in Poland (C and D) and in eastern Slovakia (D and E)

1976, 1977). These deposits have been well known in the Niedzica Succession where they occurred directly above crinoidal limestones, and yielded abundant ammonites of the latest Bajocian to Late Callovian/Early Oxfordian age (Birkenmajer & Znosko, 1955; Wierzbowski *et al.*, 1999). On the other hand, the age of radiolarites of the Czertezik Succession, interpreted as directly overlying crinoidal limestones, were regarded as Oxfordian by Birkenmajer (1958, 1977). In consequence, the crinoidal limestones of the Czertezik Succession were classified as representing a very long time-interval from Bajocian till the end of Callovian (Birkenmajer, 1959, 1977), markedly longer than the time of deposition of crinoidal limestones in the other klippen successions (see Wierzbowski *et al.*, 1999).

The palaeogeographical position of the Czertezik Succession in the Pieniny Klippen Basin was always somewhat disputable. Its close relation to the Czorsztyn Succession and the Niedzica – Branisko (Kysuca) successions was already indicated by Birkenmajer (1959). A special mixture of features recognized in deposits attributed to the Czertezik

Succession was treated as typical of a shallower water Czorsztyn Succession (thick crinoidal limestones showing wide stratigraphical range), but also – of a deeper water Niedzica and Branisko successions (well developed radiolarites). This resulted in interpretation of the Czertezik Succession as originated in a fairly deep water, and deposited on the southern slope of the Czorsztyn Ridge between more elevated areas where the Czorsztyn Succession, and the Niedzica Succession were formed (Birkenmajer, 1959, 1977, fig. 5). Somewhat different interpretation gave Aubrecht & Ožvoldová (1994, fig. 3) who suggested facies changes in the basin related to the existence of tectonic escarpment: this brought both the Czorsztyn and the Czertezik successions in direct lateral contact with the Pruské (Niedzica) Succession. Still other interpretation was given by Książkiewicz (1972, pp. 90–92) who interpreted the original position of the Czertezik Succession in the Pieniny Klippen Basin as lying south of that of the Niedzica Succession, and in close proximity of the Branisko Succession. Similar interpretation was given by Golonka & Rączkowski (1984) on the occasion of geological mapping of the eastern part of the Pieniny Klippen Belt in Poland.

New data were gathered by the present authors during field-studies in 2001 to 2003 in the most important sections of the Czertezik Succession in Poland – at Pieniński Stream and Czertezik Mt – treated as the most classical areas of occurrence of the Czertezik Succession (Birkenmajer, 1959), as well as at Wysokie Skałki area, and in Slovakia – at Litmanovské Klippen and at Milpoš village (Fig. 1). These studies resulted in discovery of "lower nodular limestones" (Niedzica Limestone Formation) occurring directly below radiolarites (Czajakowa Radiolarite Formation) in almost all the sections studied, as well as of ammonite faunas of Early Bajocian and latest Bajocian to Early Bathonian age unknown so far from the Czertezik Succession. All these new data make possible a revision of stratigraphical log, and biostratigraphy of the Czertezik Succession, and in consequence the reconstruction of palaeogeographical position of the Czertezik Succession within the Pieniny Klippen Basin.

The ammonites collected are deposited in the Museum of Geology, University of Warsaw (collection number IGPUW/A/28), and in Department of Geology and Paleontology of the Comenius University in Bratislava.

DESCRIPTION OF SECTIONS OF THE CZERTEZIK SUCCESSION

Pieniński Stream (Figs 1C, 2, 3/1)

The northern slopes of the Wielka Pustelnica Mt at the right side of the Pieniński Stream – a left tributary of Dunajec River, show well exposed deposits of the Czertezik Succession (Birkenmajer, 1977, text-fig. 7 and 21B; see also Birkenmajer, 1958, p. 19).

The oldest deposits crop out in western side of a narrow gorge, about 700 m from the Dunajec River. They consist of crinoidal limestones exposed in overturned position (70/60N) attaining at least (base not exposed) a thickness of 43.90 m (section A; Figs 1C, 2A–C, 3/1), or even about 55–60 m (according to Birkenmajer, 1959, 1977). Some number of smaller scale rock units can be recognized in the sequence on the basis of lithology supported by thin sections study.

Unit 1 (see Figs 2C/1, 3/1) includes beds 1–13 of total thickness 10.2 m (base not exposed). It consists of well bedded (from medium to thick-bedded – 0.25 m to 0.80 m in thicknesses of beds), mostly grey-coloured crinoidal limestones (except a single markedly red-coloured bed no. 5b). The beds differ in size of biogenic particles oscillating from fine-grained to coarse-grained. It may be difficult to recognize bedding planes in weathered rocks, as they show tendency towards splitting into several centimetres thick flags. In thin sections the deposits are crinoidal grainstones, locally with presence of unwashed micrite matrix. In red-coloured variety the grains are stained by dark opaque Fe-Mn oxides. Besides the dominating crinoid ossicles, detritus of bivalves and brachiopods is sometimes present; the siliciclastic sand portion is represented by quartz grains. Edges of crinoidal ossicles are sutured, and the ossicles are twinned, whereas the rock itself contains frequent microstylolites.

Unit 2 (see Figs 2C/2, 3/1) includes beds 14–17 of total thickness 9.10 m. It consists of very thick-bedded grey-coloured crinoidal limestones (bed 14 – 2.45 m, bed 15 – 1.10 m, bed 16 – 2.10 m, bed 17 – 3.45 m). The limestones are crinoidal-spiculitic grainstones, locally with presence of unwashed micrite matrix; the chalcedony cement is developed locally. Crinoid ossicles associated with monaxone spicules (often with chalcedony infillings), and rhaxa spicules are the most common. Rarely encountered are indeterminable foraminifers, and bivalve shell detritus.

Unit 3 (see Figs 2C/3, 3/1) includes beds 18–19 of total thickness 1.10 m (bed 18 – 1.0 m, bed 19 – 0.10 m). It consists of medium-bedded reddish crinoidal limestones. These are crinoidal grainstones with strongly sutured allochems. The grain surfaces, but locally also their interiors, are stained by dark opaque Fe-Mn oxides. Crinoid ossicles are the most common; they are associated with less commonly encountered bryozoans fragments, and foraminifers (*Textularia* sp.); the sandy admixture is strongly dominated by quartz grains with a marked admixture of dolomite clasts (attaining up to 2–3 mm in diameter); single grains of chlorite are also recognized.

Unit 4 (see Figs 2C/4, 3/1) includes beds 20–22 of total thickness 7.70 m. It consists of very thick-bedded grey-coloured crinoidal limestones (bed 20 – 1.55 m, bed 21 – 3.90 m, bed 22 – 2.25 m) with commonly occurring grey cherts from a few centimetres to about 40 cm in length. The rocks are: crinoid-rhaxa grainstone to packstone, and crinoidal packstone with a marked admixture of detrital quartz grains, locally even sandstone. Besides ubiquitous crinoid ossicles sometimes associated with spongy spicules (mostly rhaxa), some other biogenic components occur less commonly: foraminifers (*Lenticulina* sp., nodosarids and nubecularids), ostracodes, and bivalve shell detritus.

Unit 5 (see Figs 2C/5, 3/1) includes beds 23–27 of total thickness of 10.75 m. It consists of thick-bedded and very thick-bedded grey-coloured crinoidal limestones (bed 23 – 1.25 m, bed 24 – 1.10 m, bed 25 – 1.40 m, bed 26 – 5.60 m, bed 27 – 1.40 m). When weathered, the limestone beds split