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REPRESENTATIVE GEOSITES OF THE ROZTOCZE HILLS

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Abstract. The paper is an overview of the geological structure of Roztocze and its geological history. It is especially concentrated on the Miocene deposits. The lithology, sedimentary structures and microfacies of these deposits indicate a high-energy, shallow-water, normal marine environment which is mainly connected with the shore zone. Moreover, during the Badenian in the Roztocze area the deposition was connected with the evolution of the Carpathian Foredeep. Brusno, Huta Różaniecka, Nowiny, Józefów, Żelebsko and Łysaków present the most interesting and the most representative geosites of Roztocze. These geosites allow to observe different types of rocks, sedimentary and biogenic structures. Due to this fact, it is possible for pupils, students and other people to learn about the geology of the Roztocze Hills.

Key words: geosites, sedimentary environments, Miocene, Roztocze, Poland.

Abstrakt. Praca prezentuje przegląd wiedzy na temat budowy i historii geologicznej Roztocza. Koncentruje się przede wszystkim na utworach mioceńskich. Litologia, struktury sedymentacyjne i mikrofacje tych utworów wskazują na wysokoenergetyczne, płytkomorskie środowisko sedymentacji, związane ze strefą brzegową. Przebieg sedymentacji w badenie wykazywał na tym obszarze silny związek z ewolucją zapadliska przedkarpackiego. Najbardziej interesujące i reprezentatywne dla utworów mioceńskich geostanowiska to: Brusno, Huta Różaniecka, Nowiny, Józefów, Żelebsko i Łysaków. W tych geostanowiskach możliwe jest prowadzenie obserwacji różnych typów skał, struktur sedymentacyjnych i biogenicznych. W związku z tym dla uczniów, studentów i innych stanowią one doskonałe punkty do nauki geologii obszaru Roztocza.

Słowa kluczowe: geostanowiska, środowiska sedymentacji, miocen, Roztocze, Polska.

INTRODUCTION

The Roztocze Hills area is unusual for its geological, floristic and other landscape values. For these reasons, the Roztocze National Park has been created alongside with many other landscape parks in this region. However, the specific geological features of this region are not sufficiently known. The aim of this paper is an overview of the geological structure of Roztocze and its geological history. It is especially concentrated on the Miocene, since the development of the majority of interesting geological and geomorphological forms are related to this interval. Unfortunately, the Miocene rocks are not readily accessible on the surface, hence our knowledge of their geological structures comes from the studies of quarries.

Brusno, Huta Różaniecka, Nowiny, Józefów, Żelebsko and Łysaków present the most interesting geosites of Roztocze. The data on these sites come from explorations conducted by many authors (i.e. Czarnocki, 1935; Brzezińska, 1957, 1961; Areń, 1959, 1962; Ney, 1969; Bielecka, 1967; Jaroszewski, 1977; Jakubowski, Musiał, 1979; Pisera, 1985; Musiał, 1987a, b; Łuczkowska-Schiller, 1987; Kurzawa, 1990; Heflik, 1996; Jasionowski, 1996, 1998; Jasionowski, Wysocka, 1997; Roniewicz, Wysocka, 1997, 1999; Buraczyński, 1997; Wysocka, 2002).

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GEOLOGICAL SETTING

Roztocze is an elevated area in the southern part of the Lublin Upland, stretching from north-west to south-east. It covers an area from Kraśnik, through Zwierzyniec, reaching Horyniec and is continuing up to Lviv (Fig. 1).

Roztocze is a tectonically uplifted block bordering in the south with the Carpathian Foredeep (Fig.1). The direct substratum of the Miocene deposits in Roztocze is formed of Upper Cretaceous rocks, mainly Maastrichtian. Today, Miocene rocks do not form a continuous cover and are present only in the form of erosional patches.

The Miocene deposits that occur in Roztocze are included in the Badenian and the Sarmatian (Fig. 2) (i.e. Musiał, 1987a; Bogucki *et al*., 1998). Generally, the Miocene succession of the Roztocze Hills begins with transgressive quartz sands and sandstones of Early Badenian age. Towards the top, the sands pass laterally into marls and *Lithothamnium* limestones. Those deposits are overlain by a continuous level of gypsum and/or Ratyń Limestones — both included into the Evaporitic-Chemical Beds. Various shallow-water carbonate and terrigenous deposits of Late Badenian age overlie the Evaporitic-Chemical Beds. The carbonate and terrigenous rocks are represented mainly by calcarenites and quartz sands or sandstones with an admixture of glauconite, siltstone and clay. The biogenic rocks are represented by various shell coquinas and reefal-type deposits (Pisera, 1985).

The Miocene succession of Roztocze is terminated by deposits of Sarmatian age (Fig. 2). These are represented by serpulid-vermetid reefs and serpulid-microbial build-ups (Jasionowski, 1996, 1998).

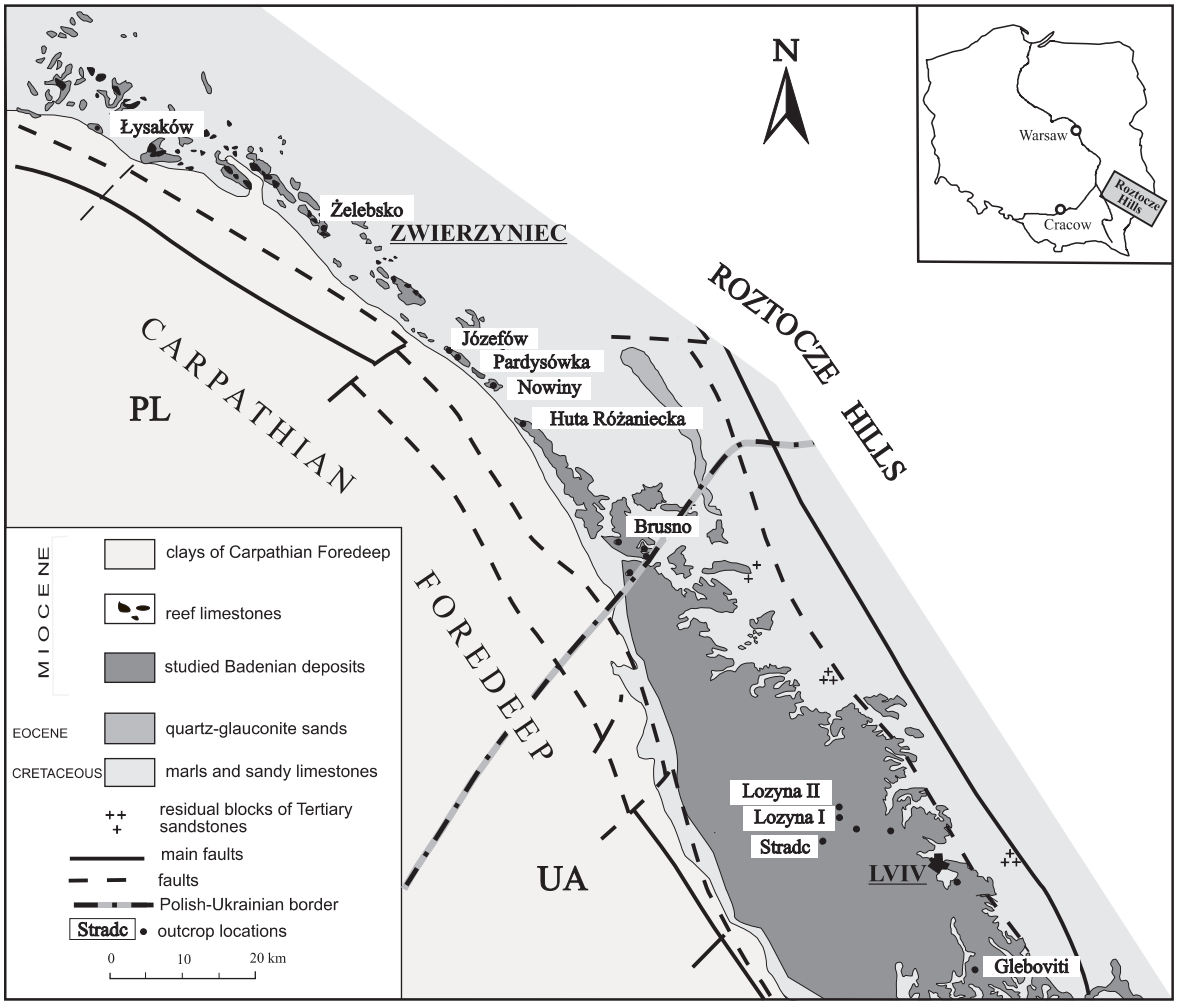

Fig. 1. Location of representative geosites of Roztocze (geological map adopted from Musiał, 1987a; Buraczyński, 1997)

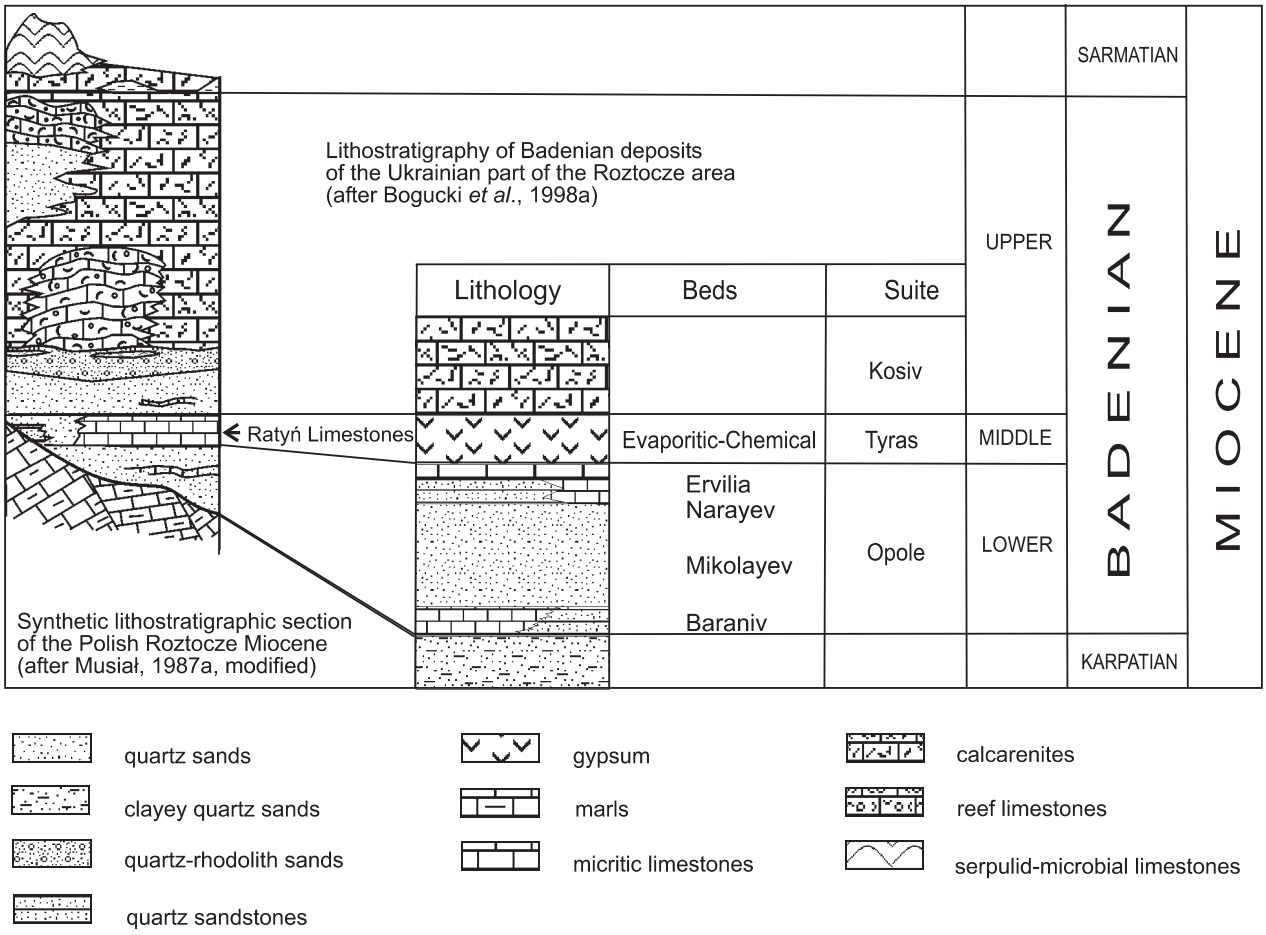

Fig. 2. Lithostratigraphical scheme of the Miocene deposits from the Polish and Ukrainian parts of Roztocze (after Wysocka, 2002)

CHARACTERISTIC OF THE REPRESENTATIVE GEOSITES

The description of the geosites is based on Wysocka, Roniewicz and Jasionowski papers (i.e. Jasionowski, 1996, 1998; Jasionowski, Wysocka, 1997; Roniewicz, Wysocka, 1997, 1999; Wysocka, 2002).

Brusno. There are numerous exposures on the Brusno Hill, the best of which are in a series of vast disused quarries. The section begins with marly *Lithothamnium* limestones (Fig. 3). They are overlain by a thick layer of quartz-glauconite sands, with an admixture of finer fractions, clay minerals and glauconite, and with an increase in the content of organodetritic material. Above it rests a lithologically monotonous, thick set of calcarenites. They are composed of fragments of calcareous algae, foraminifera and variously fractured shells of gastropods and bivalves. Despite the monotonous lithology, these calcarenites exhibit a varied set of sedimentological structures, mainly stratification. Cross- and ripple cross-stratification predominates, accompanied by horizontal and trough cross-stratification. Due to the occurrence in the calcarenites of the index *Bolboforma badenenis* and *Velapertina* sp., these deposits were included in the Upper Badenian (Szczechura, 1998).

Huta Różaniecka. Close to Huta Różaniecka village, there are numerous exposures on the southern side of a long elevation, elongated parallel to the southern edge of the Roztocze Hills. The section (Fig. 3) starts with poorly coherent, sandy-rhodolithic deposits, with rhodoliths of up to 4 cm diameter. They are cross and trough cross-stratified, and the north-eastern component predominates among the stratification dip directions. Lithification of the quartz-rhodolithic deposits changes from unconsolidated sands to strongly cemented sandstone interlayers.

Above the quartz-rhodolithic deposits, an abundant accumulation having a form of a continuous layer of bivalve casts and shells, with a character of a coquina bed occurs. It is overlain by quartz and quartz-glauconite sands. The sands are alternately cross- and horizontally-stratified. Above them rests a thick complex of cross-stratified calcarenites, with a variable degree of sandiness (Fig. 4D). In the uppermost part of the section the degree of sandiness of the deposits increases, and thick sets of cross-stratified sandy calcarenites start to occur. Based on the dip directions of the cross-stratification in

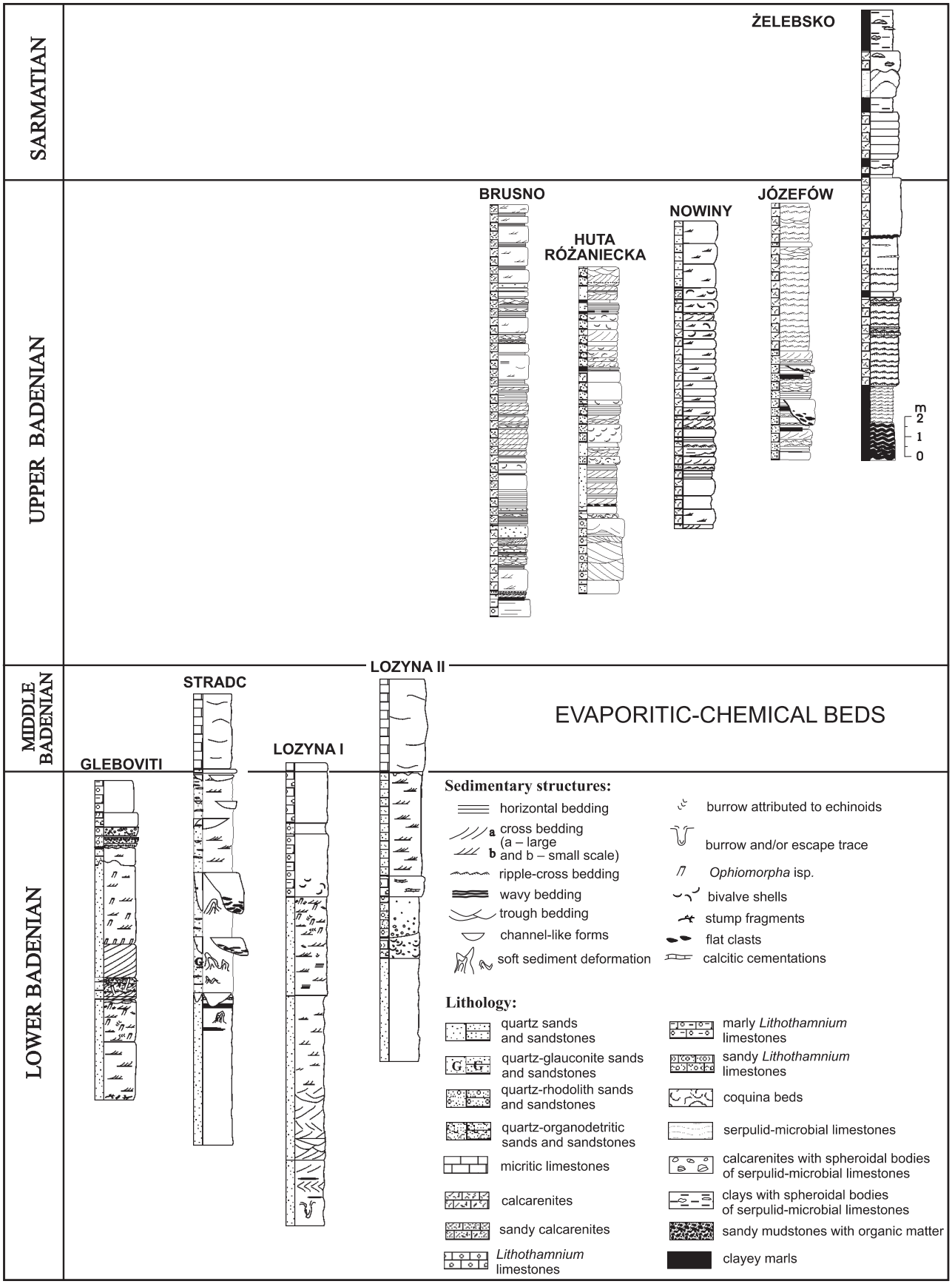

Fig. 3. The sections of representative geosites of Roztocze
(arranged from southeast to northwest – for location see Figure 1)

Correlation based on position in relation to the Evaporitic-Chemical Beds, present-day hipsometry and rare biostratigraphical data (adopted from Wysocka, 2002)

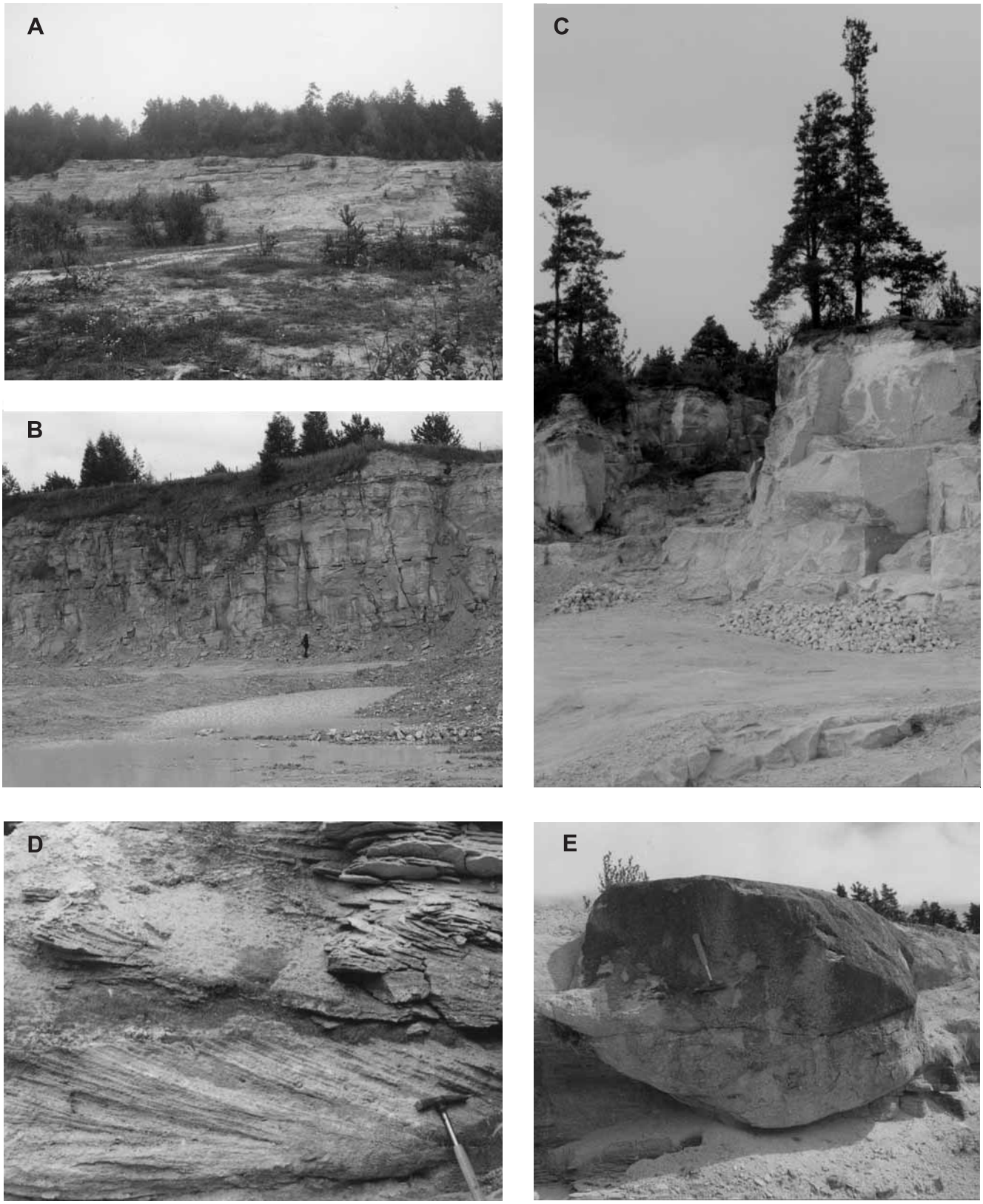

Fig. 4. Representative geosites of Roztocze

A — general view of the Nowiny quarry; **B** — general view of the Żelebsko quarry; **C** — general view of the Józefów quarry; **D** — tabular sets of cross-bedding calcarenites (Huta Różaniecka section); **E** — small scale channel-like structure cut in coarse grained calcarenites (Józefów section)

the uppermost part of the section, transport of the material took place generally towards the south-east, varying in azimuth between 49 and 190°. Due to the occurrence in the calcarenites of the index *Bolboforma badenenis* and *Velapertina* sp., these deposits were included in the Upper Badenian (Szczechura, 1998).

Nowiny. Next geosite of Roztocze is the disused quarry on the Krzyżowa Góra Mountain (Fig. 4A), close to Nowiny village. A continuous succession of the Upper Badenian sandy calcarenites, with a thickness of ca. 15 m is exposed here (Fig. 3).

The lower, less diversified part of the exposed succession consists of alternating, apparently massive layers of calcarenites and of horizontally-laminated, fine-grained calcarenites with an admixture of quartz and glauconite. In thicker, apparently massive layers, tabular cross-stratification is visible.

In the western part of the quarry, about 100 m from the main wall, a distinctive set of sediments, up to 6 m thick, is visible over an area of about 200 m. It rests with a sharp, erosional boundary on the rocks of the described section. It is characterised by poor lithification and by poor sorting of the detritic material. It contains common oyster shells, quartz grains, fragments of black flints and clayey-marly intraclasts. The intraclasts have a diameter of up to 50 cm.

Józefów. There are two vast active quarries in Józefów, they are called Józefów (Fig. 4C) and Pardysówka, in a range of hills elongated parallel to the southern edge of the Roztocze Hills. Calcarenites with a variable quartz grain content are exposed here (Fig. 3).

In the Józefów section there are series of channel-like forms of different sizes (Fig. 4E) with a wide range of internal deposits. These forms are orientated N–S, and all dip southwards. In the exposures, the channel-like forms are visible in sections perpendicular to their elongation. Their widths range between 2 and approximately 15 metres, and their depths between 1 and 10 m. Channel-like forms occur at various horizons within the ripple cross-stratified calcarenites. They are filled by deposits that contrast markedly with the underlying sediments. The fills consist of medium- and coarse-grained organodetritic material with numerous intraclasts.

The whole complex of the Badenian deposits from the Józefów region, observed in the Józefów and Pardysówka quarries, dips slightly southwards — towards the Carpathian Foredeep. Because most of the layer sets have a concave bottom, it seems that the observed small dips are of an original, sedimentary character.

Żelebsko. There is an active quarry in Żelebsko (Fig. 4B). A continuous Badenian/Sarmatian transition is visible here (Fig. 3). The Badenian deposits are fine- and medium-grained, ripple cross-stratificated calcarenites. This part of the Żelebsko section is overlain, with a small angular unconformity, by a set of thick, massive calcarenites.

Above them lie a clay layer with thin intercalations of compact micritic limestones, and a few layers of calcarenites containing scarce, small fragments of serpulid-microbialitic limestones. The deposits included in the Sarmatian are calcarenites, with fragments of serpulids, and marly clays, with lenses of serpulid-microbialitic build ups.

Łysaków. It is a big closed quarry, the westernmost of the described sections. It is located in the largest serpulid--microbialite build-up at Roztocze. The build-up, in the present relief, forms an elongate hill just along the Roztocze southern border. A section more than 10 metres thick of serpulid--microbialite limestone is exposed. The build-up overlies uneven surface of Badenian coarse coralline algal carcarenites and marls.

SEDIMENTARY ENVIRONMENT OF THE MIOCENE DEPOSITS OF ROZTOCZE

Most of the sections of the representative geosites of Roztocze are of Late Badenian age. Therefore, to understand the geological history of Roztocze, it is necessary to know the Late Badenian sedimentary environments (Fig. 5).

Initially, after an episode of deposition of the chemogenic series, Roztocze had the same sedimentary environment as in the Early Badenian. Sand deposits were accumulated in a shallow-water shore zone. A large input of terrigenous material is distinctly marked there. However, organodetritic sedimentation developed on the sea bottom in the zones with lower accumulation rates and energy. The bottom surface was inhabited by red algae, which functioned as specific carbonate buildups of patch.

Shallow-water, open-sea deposition of organodetritic material derived from the destruction of the organic buildups, continued in this zone during the Late Badenian. A zone of high organisms productivity was located outside the study area, and the Roztocze Hills area played only the role of a transit zone for the material that was transported by the currents in the form of sand waves and dunes. The sediments deposited at that time are characterised by an abundance of various-scale cross-stratification. Temporarily, apart from the organodetritic material, terrigenous material was also delivered into the basin. The area remained a zone of shallow-water deposition. A series of probable storm surge channels filled by storm lag deposits cut through the organodetritic deposits.

In the uppermost part of the Upper Badenian succession of the Roztocze Hills, cross-stratified sets at a scale of dozen or so metres, prograding towards the south, can be observed. Large thicknesses of cross-stratified sets and uniform bedding dip directions suggest a series of parallel, straight-crested depositional forms. These lines were induced by the formation of a system of synsedimentary step-faults in the substratum of a latitudinal direction, linked with intensification of tectonical movements within the Carpathian Foredeep. Therefore, the greatest deposit thickness was reached in the lowermost

veloped on the slopes of large depositional forms can also be interpreted as resulting from increased tectonical activity of the substratum. The source of large thickness of organodetritic material near-fault zones were areas of rich red algae development, located on the ridges that developed on the hanging wall of the substrate blocks. Vast areas, characterised by a low deposition rate of fine-grained sediments occurred in the central parts of the blocks, between the fault zones. Such a pattern of sedimentation zones, controlled by the occurrence of synsedimentarily active tectonical zones within the substrate, caused substantial facies and thickness diversity of the deposits. Such a pattern of sedimentation zones within a shallow marine basin also occurred in the study area at the beginning of the Sarmatian. The transition between the Upper Badenian and the Sarmatian deposits is continuous, and the Badenian/Sarmatian boundary occurs within the shallow-water organodetritic deposits. A change in sedimentary environment and structural setting of this part of the basin took place during the deposition of the Sarmatian deposits.

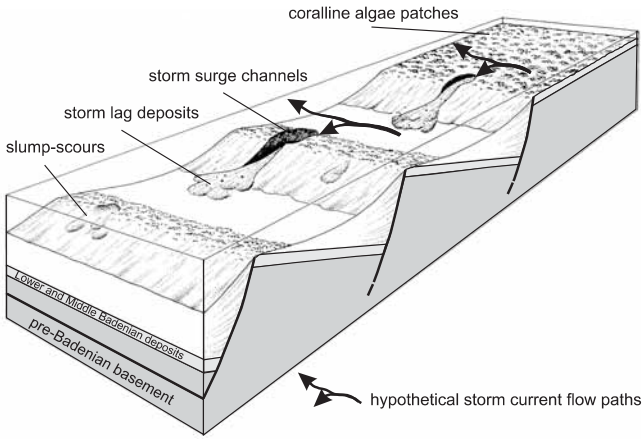

Fig. 5. Model for sedimentary environment of Roztocze in the Late Badenian (after Wysocka 2002)

CONCLUSIONS

The presented geosites allow to observe different types of rocks as well as sedimentary and biogenic structures. Due to this fact it is possible for pupils, students and others to learn about the geology of this interesting region. Therefore, tourist guides should draw more attention to geological data. Educational paths in the Roztocze National Park and other landscape parks should include the biological, historical as well as geological information. Such facts could be a base of a more active and self-reliant education of young people.

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