



## Selected geosites of Cretaceous deposits in Central and Eastern Poland

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**Abstract.** Eight proposed Cretaceous geosite candidates, from the area of Central and Eastern Poland, are shortly characterized. They include: waterfalls on the Szum, Sopot, Jeleń, and Tanew rivers, exposures of Albion sandstones near Nagórzycze, Dobromierz brachyanticline, Opoczka quarries, Janików quarries, and abandoned quarries of Piotrawin, Kazimierz, Bochothnica, and Nasilów. Five latter exposures, located along the middle section of the Vistula river, give an access to the famous middle Vistula section, representing a key section to the Upper Cretaceous succession in this part of Europe, being a site of an outstanding scientific importance. Of high scientific value are also other of the proposed sites. The waterfalls on the Tanew river represent, moreover, a unique landscape, which may also be of a great interest due to recreation and tourist reasons.

**Key words:** geosites, Upper Cretaceous, middle Vistula section, Eastern and Central Poland.

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**Streszczenie.** Scharakteryzowano osiem wybranych stanowisk przyrody nieożywionej w utworach kredy z obszaru Polski środkowej i wschodniej. Wśród proponowanych obiektów znalazły się: progi kredowe na rzekach Szum, Sopot, Jeleń i Tanew, odsłonięcie piaskowców albskich koło Nagórzycze, brachyantykлина Dobromierza, kamieniołomy w Opoczce, kamieniołomy w Janikowie oraz odsłonięcia w Piotrawinie, Kazimierzu Dolnym, Bochothnicy i w Nasilowie. Pięć ostatnich wymienionych odsłonieć znajduje się na obszarze tzw. górnokredowego profilu środkowej Wisły, dostarczającego standardowego profilu kredy górnej w tej części Europy. Jest to obszar o wyjątkowym znaczeniu w badaniach facjalnych, stratygraficznych oraz paleontologicznych górnej kredy. W skali regionu istotne są oczywiście również i pozostałe proponowane miejsca. Progi wodospadowe na rzece Tanew reprezentują ponadto unikalną formę krajobrazową w tej części kraju i mają duże znaczenie jako obiekt turystyczno-rekreacyjny.

**Słowa kluczowe:** geostanowiska, kreda górna, profil środkowej Wisły, Polska środkowa i wschodnia.

Cretaceous deposits of the epicratonic Poland form a thick cover (exceeding 2000 m at maximum) developed, with the exception of the Lower Cretaceous clastics, in a uniform carbonate succession. Lithologically represented by marls, marly limestones, chalks, opokas, sporadically gaiszes, these rocks are very susceptible to erosional processes. Moreover, in a larger part of their extension they are covered with a more or less thick blanket of the younger, Tertiary deposits (Fig. 1). Bearing in mind the uniform morphology of this area, the rarity of good exposures of these rocks becomes obvious. However, particularly in the regions of young tectonics, there are some sites where Upper Cretaceous deposits come to the surface and provide these seldom occasions of a direct access to the Cretaceous strata, and the opportunity for their detailed sedimentological and palaeontological studies. The palaeobiogeographical

position of the territory of Poland during the Cretaceous time, being located in the middle between the western and eastern, and between northern (Boreal) and southern (Mediterranean) parts of the European Palaeobiogeographical Province implies the importance of these sites as well as the general interest in the studies of the Cretaceous period. It was an area of the occurrence of various Cretaceous facies and of the fauna exchange and mixing, placing the materials from Poland among the most important for palaeobiogeographical and biostratigraphical investigations.

### Selected geosite candidates

Only a few of the selected and listed here exposures are purely natural outcrops. Usually they are represented by abandoned quarries or sites of seasonal, local exploitation. Most of these sites are already world-wide famous spots in the Cretaceous community and very important localities for present and further studies. The presented list comprises 8 localities (Fig. 1),

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Fig. 1. Distribution of the Upper Cretaceous rocks in extra-Carpathian Poland with location of the selected Cretaceous geosites; boxed area presented in text — Fig. 2; 1 — waterfalls on the Szum, Sopot, Jeleń, and Tanew rivers, 2 — Nagórzyce, 3 — Dobromierz brachy-anticline

of which 5 are located along the middle Vistula gap (Fig. 2), giving a direct insight into the Upper Cretaceous succession of Central Europe.

**1. Waterfalls on the Szum, Sopot, Jeleń and Tanew rivers** in Eastern Roztocze (southern margin of the Lublin Upland), about 20 km SW of Tomaszów Lubelski (130–150 m a.s.l.; 50°23'N/23°09'E).

*Main features:* waterfalls, Upper Cretaceous deposits.

A group of waterfalls on Szum, Sopot, Jeleń, and Tanew rivers (Figs. 1, 3 and 4), flowing to SW, is formed within the Upper Cretaceous rocks — gaizes and marls — of the Campanian age, at the edges of the still active faults, running parallel to the southern margin of the Lublin Upland. The group consists of about 30 waterfalls, in form of small rocky steps, with the highest one, developed on the Jeleń river, not exceeding 1.2 m.

The presence of waterfalls developed within the soft Cretaceous rocks, indicates the recent activity of the fault system in the marginal part of the Lublin Upland. Waterfalls are located within the nature reserves. A picturesque landscape characterizing this area makes it, moreover, a very interesting tourist region.

**2. Nagórzyce outcrops**, about 3 km south of Tomaszów Mazowiecki, at the road leading to Swolszowice (180 m a.s.l.; 51°30'N/19°58'E).

*Main features:* Middle/Upper Albian, sandstones.

The sandstones, dated at the topmost Middle and Upper Albian, form a part of the mid-Cretaceous succession in the NE part of the Tomaszów syncline (Figs 1 and 5) (Witkowski, 1969). This succession is composed of unfossiliferous, sandy-sandstone deposits of the Middle Albian (Cieśliński & Pożaryski, 1970; Marcinowski & Rudowski, 1980), referred by Kobyłecki (1936) to as Biała Góra Series. These are followed by siliceous sandstones with glauconite and phosphatic concretions of the Upper Albian and marls of the Cenomanian age. The sandy succession in the environs of Tomaszów Mazowiecki attains a thickness about 150 m and represents shallow-marine, deltaic deposits, indicating the onset of the mid-Cretaceous transgression over an area of southern Polish Uplands.

In the part exposed in Nagórzyce preserved are artificial caves being remnants of an underground exploitation of sandstones (Fig. 6). Unfortunately, entrances to

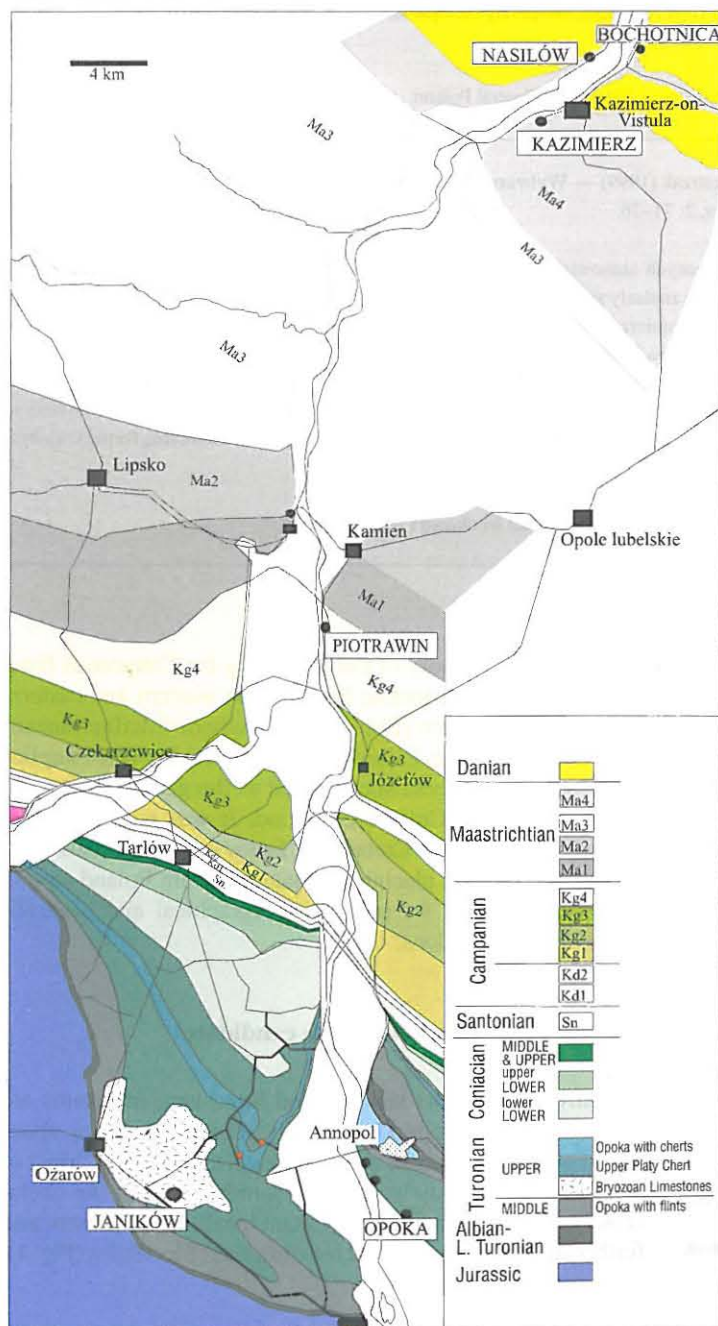


Fig. 2. Geological sketch-map and location of the proposed geosites of the middle Vistula section



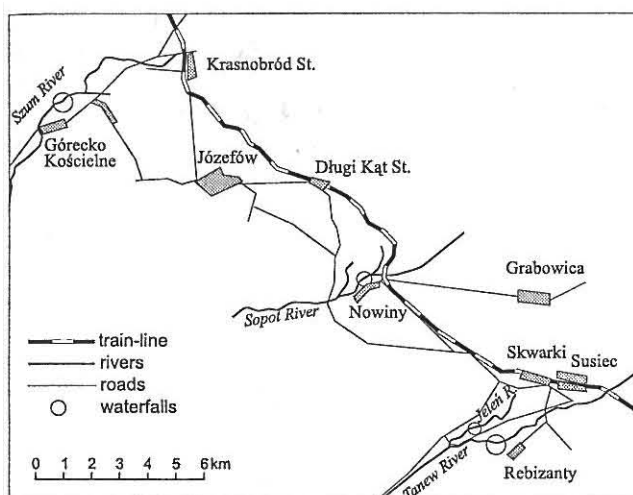


Fig. 3. Waterfalls (so-called szumy) on the Szum, Sopot, Jeleń, and Tanew rivers



Fig. 4. Waterfall on the Tanew river

the caves and the caves themselves are often covered with rubbish.

**3. Dobromierz brachyanticline**, in the Przedbórz–Małogoszcz Range, about 10 km SE of the town of Przedbórz (220–250 m a.s.l.; 51°01'N/19°55'E).

*Main features:* brachyanticline, Upper Jurassic limestone, Albian deposits.

The Dobromierz brachyanticline, running WNW–ESE, is a part of the Przedbórz–Małogoszcz Range in the western, Mesozoic margin of the Holy Cross Mts. (Fig. 1) (Cieśliński, 1956; Cieśliński & Pożaryski, 1970). An axial part of the brachyanticline is composed of relatively easily weathering carbonate rocks of the Upper Jurassic (Oxfordian and Kimmeridgian). The flanks are built of the Albian sandstones (so-called Przedbórz Sandstones) (Fig. 7), relatively resistant to weathering. The brachyanticline represents an important section to study the mid-Cretaceous succession in Central Poland. Moreover, it provides an insight into the contact between the Jurassic and Cretaceous in the region in question.

The Dobromierz brachyanticline is well seen in morphology of the area. Taking into account the lithological characteristics of particular members of the structure and some

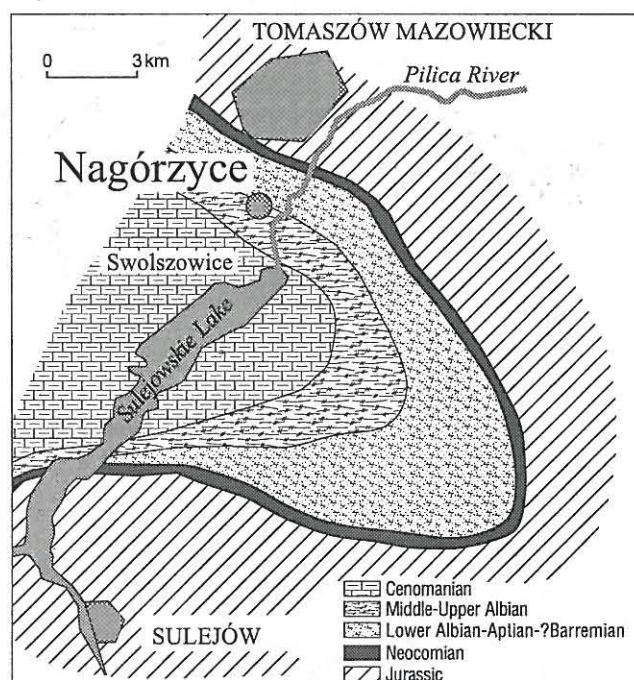


Fig. 5. Geological sketch-map of the Tomaszów Syncline and location of Nagórzycze



Fig. 6. Sandstones with caves (after exploitation of sandstones) in Nagórzycze, at the road to Swolszowice

other tectonic indices the brachyanticline is a site of recent uplifting movements.

The axial part of the brachyanticline, overgrown with beech-trees, belongs to the Buczyzna Mt. in the landscape park.

### Middle Vistula section

The so-called middle Vistula section, is a series of natural and artificial exposures extending along the valley of the Vistula river, between the towns of Zawichost and Kazimierz-on-Vistula (Fig. 2). It gives an access to the almost complete Middle Albian through Upper Cretaceous and lowermost Palaeocene succession being a unique example in that part of Europe (Pożaryski, 1938, 1948; Cieśliński & Pożaryski, 1970; Błasz-



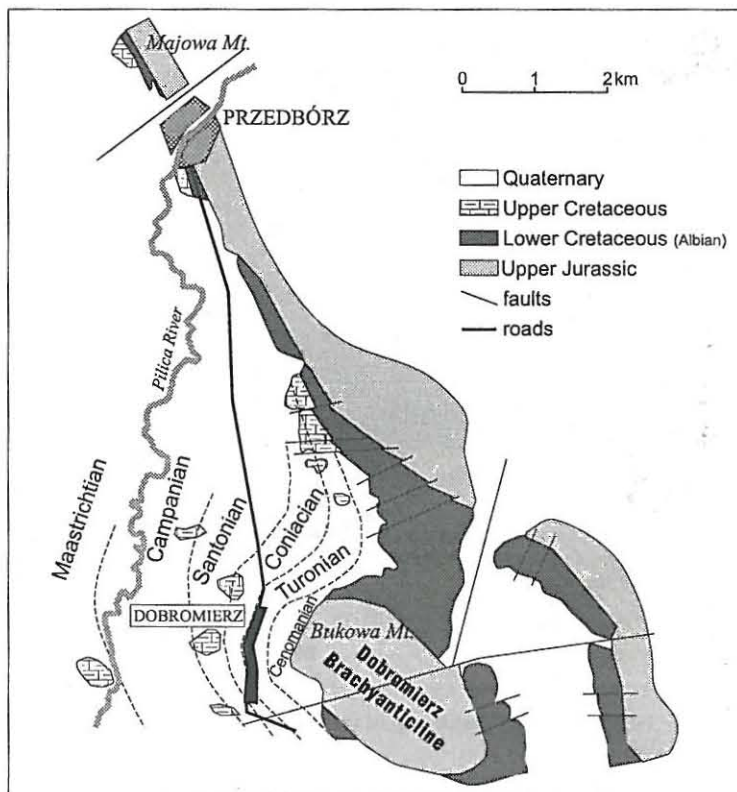


Fig. 7. Geological sketch-map of the Dobromierz brachyanticline and Majowa Mt. near Przedbórz



Fig. 8. Abandoned Piotrawin quarry



Fig. 9. Abandoned and partly recultivated old town quarry in Kazimierz-on-Vistula

kiewicz, 1980; Marcinowski & Radwański, 1983; Walaszczyk, 1992). Its completeness, fauna abundance and still relatively good access designate this section not only as the reference point for the whole Upper Cretaceous of the extra-Carpathian Poland but also as one of the most important reference points of Central Europe.

The middle Vistula valley is situated within the Border Synclinorium with the Cretaceous strata being a part of the south-western limb of this geotectonic structure, and the axial part of which is located further to the east. The Albian–Upper Cretaceous strata are arranged monoclinally, dipping very gently to NE, with younger and younger strata exposed when going northward (Fig. 2).

**4. Opoczka quarries** in the southern part of the middle Vistula valley, in the eastern, high bank of the Vistula river, 2 km W of the town of Annopol (150 m a.s.l.; 50°52'N/ 21°50'E).

*Main features:* middle Vistula section, Turonian, opoka facies.

The quarries expose the Upper Turonian rocks at the southern limb of the Annopol brachyanticline located in the southern part of the middle Vistula valley. The whole exposed succession represents opokas with cherts, a unit introduced by Pożaryski (1948), and comprising the whole Upper Turonian (Walaszczyk, 1992). The unit is poorly fossiliferous. It contains rare inoceramids and ammonites (from these quarries come large *Lewesiceras* specimens exposed in the Geological Museum of the Polish Geological Institute in Warsaw). The referred site is important for the studies of the Turonian in the region.

The abandoned quarries in Opoczka situated in the eastern, steep banks of the Vistula river are very picturesque element when crossing the Vistula near Annopol.

**5. Janików quarry** about 6 km south of the town of Ożarów, near the road leading to Zawichost (170–180 m a.s.l.; 50°51'N/21°43'E).

*Main features:* middle Vistula section, Upper Turonian, bryozoan-crinoidal facies.



Fig. 10. Abandoned quarry in Nasilów with the Cretaceous/Tertiary boundary section



The quarry exposes the succession of the crinoidal-bryozoan limestones, dated at the latest Middle/Upper Turonian (Samsonowicz, 1934; Alexandrowicz, 1978), referred to as Janików limestones (Łuniewski, 1923). This untypical lithofacies in the area is limited to the south-western part of the middle Vistula area, and disappears quickly when going further to N and E. These deposits interpreted formerly as bryozoan reef represent actually a wedge-shaped body of detrital crinoidal-bryozoan material, coarsening upwards. In the upper parts it is dominated by crinoidal detritus. The other macrofauna is represented mostly by small oysters and brachiopods. Rare inoceramids and echinoids are also known.

The importance of the quarry is outstanding. It is a sole locality with the exposed bryozoan-crinoid facies, a peculiar facies in the Turonian of Central Europe, and extremely important for environmental and fauna studies.

**6. Piotrawin abandoned quarry** in the eastern, high bank of the Vistula river, about 150 km south of Warsaw (130–140 m a.s.l.; 51°05'N/21°48'E).

*Main features:* middle Vistula section, Campanian, opoka facies.

The Piotrawin quarry exposes a 30 m thick series of relatively monotonous opokas with a very rich and well preserved macrofauna (Fig. 8). The exposed succession comprises the topmost Campanian strata of the *Nostoceras hyatti* Zone, being of extreme importance for palaeontological and stratigraphic studies of the Campanian and the Campanian/Maastrichtian boundary in Europe. In Central Europe it is one of a few points where this interval is exposed, and inevitably the most fossiliferous (Błaszczewicz, 1980; Burnett *et al.*, 1992). It is also a section of monographic description of ammonites (Błaszczewicz, 1980), belemnites (Kongiel, 1962) and of the bivalve-gastropod molluscs (Abdel-Gawad, 1986).

The section exposed in the Piotrawin quarry, representing the topmost Campanian, *Nostoceras hyatti* Zone is of an outstanding value for the palaeontological and stratigraphic studies of the Campanian stage.

**7. Kazimierz, Bochothnica and Nasiłów quarries** in the southern outskirts of the town of Kazimierz-on-Vistula, in the eastern, high bank of the Vistula river (130–160 m a.s.l.; 51°19'N/21°55'E) (Fig. 2); the Nasiłów quarry is located in the western bank of the Vistula river, opposite to the town of Kazimierz (130–160 m a.s.l.; 51°20'N/21°28'E); the Bochothnica quarry is located on the eastern side of the Vistula river, close to the northern boundary of the Bochothnica village (150 m a.s.l.; 51°23'N/21°59'E) (Fig. 2).

*Main features:* middle Vistula section, Maastrichtian, Cretaceous/Tertiary boundary.

The Kazimierz, Bochothnica and Nasiłów quarries (Figs. 9 and 10) are located in the northernmost part of the middle Vistula gap valley, and represent the uppermost Maastrichtian strata including the Maastrichtian/Danian, i.e. the Cretaceous/Tertiary boundary (exposed in Nasiłów and Bochothnica) (Pożaryski, 1938, 1948; Pożaryska, 1952; Machalski & Walaszczyk, 1987; Hansen *et al.*, 1989). All three sections provide

a continuous succession across the *Belemnella kazimiroviensis* Zone of the topmost Maastrichtian up to, and including the Maastrichtian/Danian boundary. All three became already classical sites for the Maastrichtian studies in Europe.

The three mentioned sections are of an outstanding value for the palaeontological and stratigraphic studies of the Upper Cretaceous and the Cretaceous/Tertiary boundary. Moreover, it has to be mentioned that the Nasiłów and Bochothnica sections are the only spots in Poland with the exposed Maastrichtian?Danian (i.e. Cretaceous/Tertiary) boundary. The Kazimierz quarry is situated within the Kazimierz Landscape Park, and the quarry itself is partly restored. Similarly, the quarry in Bochothnica is a geological documentary site within the Kazimierz Landscape Park.

### Final remarks

Besides the waterfalls on the Szum, Sopot, Jeleń, and Tanew rivers, all other Cretaceous geosite candidates from Central and Eastern Poland represent the localities of the outstanding or high scientific value for differently oriented studies in the Upper Cretaceous. Most of them, particularly those representing the middle Vistula section, are actually long recognized and appreciated sections. It concerns particularly the quarries in Piotrawin or Nasiłów, which represent unique exposures in European scale. At the same time most of the selected sites are represented by abandoned quarries or other type exposures, which, if not protected very quickly, will disappear from a list of valuable and important Cretaceous localities.

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