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Palaeoenvironments and facies on a progressively flooded rocky island (Upper Cenomanian – Lower Turonian, Bohemian Cretaceous Basin)

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Abstract. The first attempt to reconstruct the sedimentary environments on a small Late Cretaceous (Upper Cenomanian - Lower Turonian) rocky island (Plaňany, Bohemian Cretaceous Basin) is presented. Based on preservation of deeply weathered crystalline bedrock with burrows (*Thalassinoides*) and the features of overlying sedimentation, the western island flank was the most sheltered coastal section during the whole studied interval. The main wave force affected especially the northern and eastern island coasts where many deep depressions and downslope channels were eroded. Based on palynology, foraminifers and selected macrofauna, the strata around the island were correlated. The shallow-water, highly variable coarse clastic to sandstone and limestone sedimentation prevailed in the Upper Cenomanian. An erosion event and following condensation interval with mineralization (glauconitization, phosphatization), deposition of the dark grey, $C_{org.}$ enriched, and later the greenish glauconitic sediments were remarkable during the basal Lower Turonian (*Whiteinella archaeocretacea* Biozone). All the Lower Turonian strata are relatively fine-grained (claystones, siltstones, marlstones) and evidence the rapid deepening of the sea. During the *Helvetoglobotruncana helvetica* Biozone, the Plaňany island was deeply submerged and covered by light siltstones. The Early Turonian sea-level rise is well documented by changing microfaunal and macrofaunal (mainly sponge) populations.
Keywords. Cretaceous island, weathering, geomorphology, sedimentary environments, biostratigraphy, Upper Cenomanian-Lower Turonian, Bohemian Cretaceous Basin.

INTRODUCTION

During more than 25 years of studies of so-called surf facies occurring abundantly on southern margin of the Bohemian Cretaceous Basin (BCB), the features of the bedrock and transgressing sediments of the Late Cenomanian – Early Turonian age have been carefully registered. Due to the post-Cretaceous denudation, the ancient coastal morphology of the BCB including island-like structures was partly exhumed. However, old and

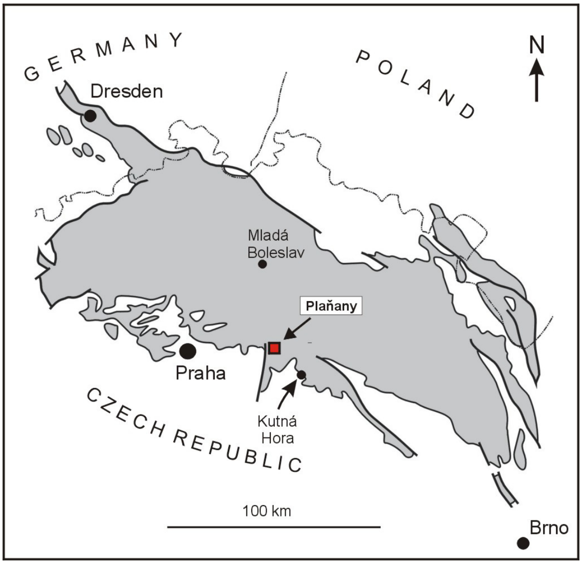

Fig. 1. A map with the locality Plaňany. Grey fill – Bohemian Cretaceous Basin.

presently abandoned quarries were mostly opened only in one side of an elevation (possible island) and there is no evidence that a true island is concerned. In some other cases, the true rocky island was recognized but only partly observed due to destructions by quarrying (e.g. Velim and Nová Ves near Kolín, central Bohemia; see Ziegler 1966, Žítt et al. 1997). Very nice example of a rocky island of distinct shape was exposed at Markovice near Čáslav, but with one side strongly disturbed many years before our studies have begun. Some further examples of possible islands destructed by quarrying have been described (e.g. Kuchyňka near Brázdim – see Žítt et al. 2002; Černovičky – see Žítt et al. 1999; Tuchoměřice-Kněžívka – see Žítt & Nekvasilová 1990; Chrtníky – see Žítt et al. 2006). The locality Tuchoměřice-Pazderna represents very nice example of a couple of low lydite elevations, which are, however, only partly exposed (Žítt & Nekvasilová 1997).

If all relief and sediment distributional and preservational features are considered, the only recent example of an island exposed on all sides is that at Plaňany near Kolín (Fig.1). The below presented most important features of this locality are intended as a basic framework for future more detailed and specialized papers.

HISTORY OF INVESTIGATION

The first locality description was carried out by Urbánek (1924) and later by Soukup (1936, 1966, 1971) who published important geological and biostratigraphical data. Palaeontological investigations of glauconitic sediments were performed by Augusta & Soukup (1936). Some investigations were also realized by Svoboda (1982, 1985), Ziegler (1992), Vlačiha (2000) and Sviták et al. (2003). Detailed investigation by present authors started in the year of 1999 when the intensity of quarry works rapidly increased and the majority of new structures were progressively uncovered (Žítt 2001, Žítt et al. 2002, 2008, Čech et al. 2004).

The quarry was opened in a hill situated on western margin of the small town of Plaňany, about 12 km west of Kolín, central Bohemia. The quarrying began from the south and continued in northern direction. The central part of the hill was gradually removed and in 1999 only the northern part of the original bedrock top surface was preserved. At present day only the western and central quarry parts are active while in the other parts the Cretaceous rocks on the quarry margins are locally covered by soils and are being recultivated.

GEOMORPHOLOGY

It is rather difficult to define the shape and size of an ancient island if there is no reference level (i.e. the sea level in a concrete time moment). When, however, the dimensions of presently exposed crystalline massif (Proterozoic migmatites and amphibolites with younger aplite and pegmatite dikes, etc.) with Cretaceous sedimentary rim around is considered, we can speculate that before the sedimentation of the oldest preserved sediments, the island was elongated, about 600 m long (in roughly S-N direction) and 400 m wide (Fig. 2B). Its shape and dimensions were, however, rapidly reduced during the Late Cenomanian transgression. The record of Cretaceous sedimentation on the island flanks and later even the top parts depends on the erosional processes and water dynamics forming the detailed morphology of the bedrock. The initial sedimentation started within erosional depressions. The small erosional depressions and channels are mainly concentrated on the eastern island flank. Their depth increases in northeastern part of island and on the northern slope the most extensive and deep but wide channel dipping to the north is developed. This channel was formed by fusion of partial shallower channels, observed on the successive northern quarry walls before the present position of the wall was achieved. The western flank of the island was relatively flat and, mainly in its southern part, steeply inclined to the west. Deep pre-transgression weathering of the crystalline massif is preserved in this area, while in all remaining parts it was removed by erosion (see below). Very old (Upper Cenomanian) sediments described by Urbánek (1924) and later interpreted by Soukup (1966) as a surf pile were situated on southern slope of the island. The morphology of the bedrock is not known here because of destruction by quarrying. The erosional coastal cliff or its remains similar to that of Tuchoměřice-Kněžívka (Žítt & Nekvasilová 1990) were not confirmed.

CRETACEOUS SEDIMENTS

The occurrence of lithologically variable Cretaceous sediments in the Plaňany area is well known from the literature (see above). However, due to rapid lateral changes of sediments and changes in locations during quarrying, identification of the true positions of previous author´s samples is difficult. For that reason, in this study, we prefer our own observations and samples. Distribution of sediments around the island is illustrated by several sections (Fig. 2A). The composite and simplified character of these sections must be emphasized.

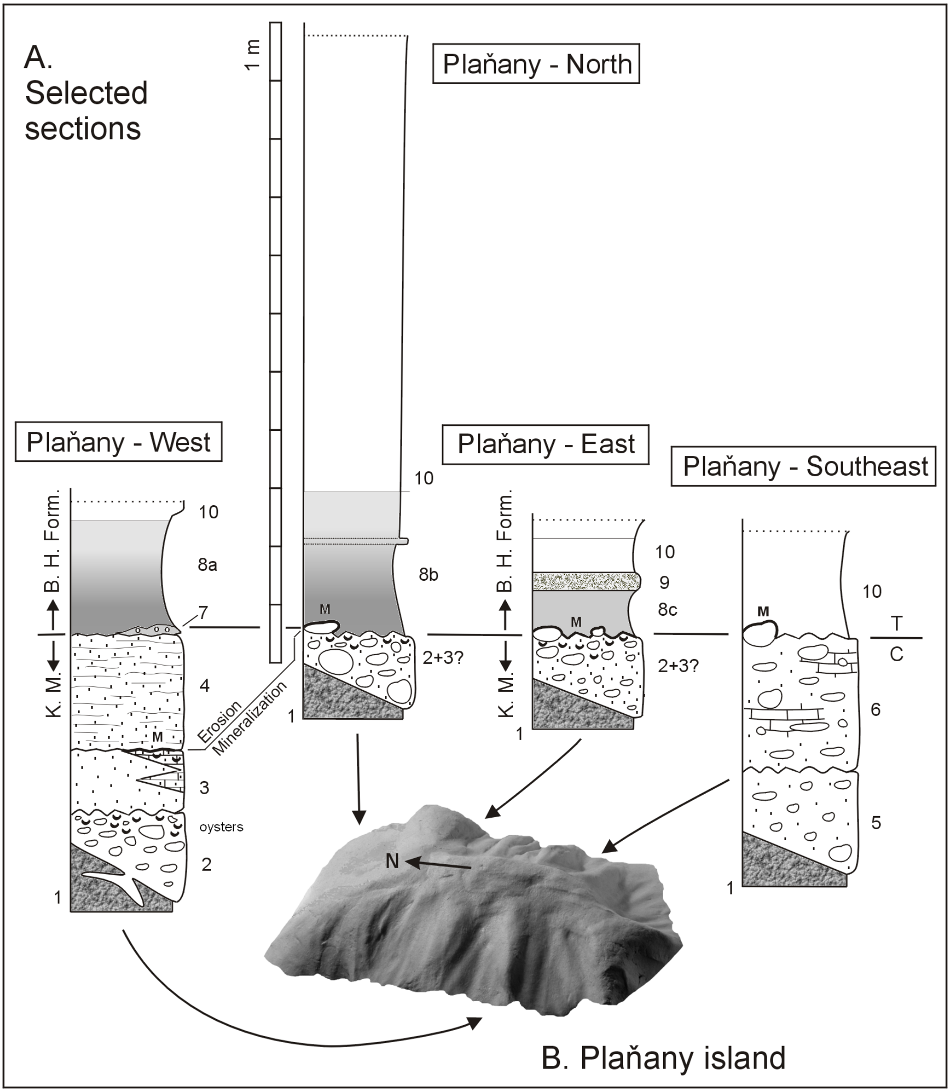

Fig. 2. A - Selected sections (simplified) related to different parts of the Plaňany island (arrows). K. M. – Korycany Member of the Peruc-Korycany Formation (Upper Cenomanian), B. H. Form. – Bílá Hora Formation (Lower Turonian), C – Cenomanian, T – Turonian. M – mineralized surfaces. 1 – crystalline (migmatite and amphibolite) bedrock; 2 – variegated conglomerate with sandy-clayey limestone matrix preserved also in burrows (*Thalassinoides*; see section West); 3 – slightly lithified sandstone locally passing to sandy limestone; 4 – coarse-grained massive sandstone; 5 – coarse cobble to boulder conglomerate with mostly sandy matrix; 6 – coarse cobble to boulder conglomerate with highly varying clay to hard limestone matrix; 7 – well sorted pebble conglomerate with grey clayey matrix; 8a – basal dark grey claystone upwards passing into glauconitic marlstone with large fragments of sponges; 8b – dark grey glauconitic claystones and siltstones with sponges, bivalves and

Comparing the sections West and Southeast situated on the opposite island flanks, pronounced differences are observed. The Korycany Member of western slope is formed by sandstones (with *Cyclothyris difformis* (Valenciennes in Lamarck)) and only subordinated conglomerates and limestones. The limestones are of two types: (1) those connected with basal conglomerates that underlie sandstone body and so directly overlie the crystalline bedrock (Fig. 2A, lithology 2), and (2) those that represent only locally carbonate-enriched sandstones (Fig. 2A, lithology 3). On eastern slope (section Southeast), the thick and coarse conglomerates with sandy-carbonate matrix dominate (Fig.2A, lithologies 5 and 6). The conglomeratic limestones, often very massive and of pelagic appearance also occurred, even if presently found only in debris and therefore in unknown position. The problematic sandy limestones with the Late Cenomanian fauna collected by Soukup (1936, 1966) and other collectors lying not far to the north from the former southern flank of Plaňany island (here the quarrying started sometime before) can represent local facies of the lower parts of both mentioned sections. If we follow the sandy complex between sections West and North, a rapid reduction of thickness and increased amount of rounded boulders is apparent. A remarkable mineralization (glauconitization, phosphatization) is characteristic for the top part of this deposit (Fig. 2, section West) and for adjoined rockgrounds and surfaces of other older sedimentary bodies (e.g. conglomerates with large oysters, see Fig. 2A, section North, lithologies 2 and 3). Occurrence of overlying dark-grey sediments with high percentage of glauconite, indicating the local base of the Lower Turonian (Bílá Hora Formation) is striking in both sections (Fig. 2A, lithologies 8a,b). The dark-grey claystones are very fine and lack any macrofauna on western flank (section West). They are also relatively thin and rapidly pass upwards into the strongly glauconitic siltstones with rare phosphatic concretions. Large fragments of thin walls of the sponge *Laocoetis* sp. are striking here, but other hexactinellid sponges and lithistid demosponges occur too. On the contrary, on the northern flank (section North) these claystones contain abundant macrofauna – prolific hexactinellid and lithistid sponge skeletons (near the base partly phosphatized), small oysters, ichthyolites and coprolites, while the glauconite content is lower. Probably isochronous are very fine-grained light greenish claystones with abundant and magnificently preserved agglutinated foraminifers uncovered in section East (Fig. 2A, lithology 8c). Finally, all these sediments pass upwards into light calcareous siltstones with locally abundant sponges typical for calcareous siltstones of the Bílá Hora Formation that originated close to rocky substrates (lithology 10). The possible correlation of the coprolitic deposits (both with large vertebrate and small invertebrate faecal pellets) found locally on the base of these siltstones (see Fig. 2A, lithology 9), with the dark-grey claystones developed in other places (mainly in the section North, see above) is probable and presently under study.

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coprolites prevailing; 8c – light green claystone; 9 – coprolitic sandy claystone-siltstone; 10 – light siltstone with sponges. B – Plaňany island – a model of the style of the bedrock morphology. Length of the island in the North-South direction is about 600 m.

NOTES TO BIOSTRATIGRAPHY

Micropalaeontological contribution to the recognition of isochronous facies around the Plaňany island is naturally relatively low due to relatively low biostratigraphic resolution. Only two foraminiferal biozones (*Whiteinella archaeocretacea* and *Helvetoglobotruncana helvetica*) are represented here, and the first of them is, moreover, crossing the Cenomanian/Turonian boundary. However, for overall dating and time approximations of important erosional and mineralization events the micropalaeontology was very useful. The lack of foraminifers or their poor preservation in some important lithologies (e.g. lithologies 6 and 7 in section Plaňany-Southeast) is in part substituted by macrofauna (see below).

The most complete outcrop, even if consisting mainly of the Lower Turonian rocks, is the section Plaňany-North. Palynologic data comprise 54 species of dinoflagellate cysts and acritarchs, 18 species of spores, 10 species of gymnosperm pollen and 14 species of angiosperm pollen. The distribution of the most important taxa is as follows:

1. Dark grey claystone (Fig. 2A, lithology 8b) provides abundant marine microplankton, relatively common triporate angiosperm pollen, occasionally fern spores, and gymnosperm pollen. Most abundant dinocyst forms are *Palaeohystrichophora infusorioides, Spiniferites ramosus, Florentinia mantelli, Pervosphaeridium pseudhystrichodinium, Circulodinium distinctum.* The presence of acritarchs of *Micrhystridium* and *Veryhachium* together with common chitinous foraminiferal linings distinguish the marine microplankton from the dark grey claystone from the assemblage found in the light siltstone. Pteridophyte spores include family Gleicheniaceae (*Gleicheniidites senonicus, G. circiniidites*), Schizaeaceae – *Cicatricosisporites venustus, Plicatella tricuspidata*, and rare monolete forms of *Cicatricososporites* sp. Gymnosperm pollen are less common, consist mainly of *Taxodiaceaepollenites hiatus* and bisaccate conifers of *Pinuspollenites* sp. Biostratigraphically important are triporate pollen from the Normapolles group, namely *Complexiopollis praeatumescens, C. turonis, Atlantopollis verrucosus, A. microreticulatus*.
2. In overlying light siltstones (Fig.2A, lithology 10), some new dinocyst forms, i.e. *Raetiaedinium truncigerum, Spiniferites bulloides, Spiniferites membranaceus, Senoniasphaera rotundata, Pterodinium aliferum* occur. Both number of acritarch species and microforaminifers strongly decrease. Gymnosperm and angiosperm pollen rarely appear. Biostratigraphically important are angiosperm pollen *Atlantopollis microreticulatus, Complexiopollis turonis, Complexiopollis praeatumescens* and dinocysts, i.e. *Senoniasphaera rotundata*.

Based on angiosperm pollen and dinoflagellate cysts, the age of both lithologies is most probably Early Turonian. The changes in the composition of the palynomorph assemblages correspond with a gradual deepening of the sea.

Foraminifera in the basal sample close to the erosional base (Fig. 2A, lithology 8b) indicate a lowermost Early Turonian age close to the Cenomanian/Turonian boundary. The species *Gavelinella belorussica* (Akimec) and *Lingulogavelinella globosa* (Brotzen) are frequent here and in overlying beds occur other typical Early Turonian species – i.e. *Cassidella tegulata* (Reuss), *Gavelinella berthelini* (Keller), *G. polessica* Akimec and species of the genus *Frondicularia*. Planktonic forms are mostly globose shallow-water species of the genus *Whiteinella*. While the mentioned species indicate the *Whiteinella archaeocretacea* Zone, keeled forms first appear in the top parts of the gray claystones (Fig. 2A, lithology 8b), indicating the *Helvetoglobotruncana helvetica* Zone (Robaszynski & Caron 1995).

Foraminifera in the section Plaňany-West indicate a late Cenomanian age for the basal clastic strata (Fig. 2A, lithology 2). The same age seems to be indicated for the dark grey claystones (lithology 8a of the same section) with agglutinated species, e.g. *Lingulotrochammina callima* (Loeblich & Tappan), *Spiroplectammina scotti* Cushman-Alexander, *Pseudotextulariella cretosa* (Cushman), *Ammobaculites humei* Nauss, and *Dorothia gradata* (Berthelin). However, this assemblage is most probably redeposited and the dark claystones are of the Early Turonian age, similarly to the immediately overlying strongly glauconitic rocks, where typical early Turonian forms (*Gavelinella* and *Lingulogavelinella*, *Ramulina globulifera* Brady and later even *Tappanina eouvigeriniformis* (Keller) and *Gaudryina* occur. This foraminiferal distribution was found also in the section Plaňany- East (Fig. 2A, lithology 8c).

The middle part of the section Plaňany-Southeast is dated by *Inoceramus pictus* Sowerby into the Upper Cenomanian (Fig. 2A, lithology 6 – gastropod limestone matrix of conglomerate). Old samples with *Codiopsis doma* (Desmarest) and other Cenomanian fauna probably come from this lithology. Of the same character is the find of the ammonite *Schloenbachia varians trituberculata* Spath described by Soukup (1971). The guards of *Praeactinocamax plenus* (Blainville) were rarely found e.g., in eastern parts of the quarry (composite section of Plaňany-East) in the conglomeratic clayey-sandy limestone below marked erosion and mineralization surface (Fig.2A, lithologies 2+3(?)). The guards are, however, also found redeposited above this level in the Lower Turonian sediments (in basal part of lithology 8c, Fig. 2A).

BEDROCK WEATHERING

As mentioned above, the occurrence of deeply weathered superficial parts of the crystalline rock massif (amphibolites, migmatites, etc.) seems to be important for the estimation of sedimentary dynamics and hydrodynamics around the island. This phenomenon is yet more important in the light of the fact that every weathered rock is exceptionally suitable for the wave erosion (Trenhaile 1987). Within the complex of preserved marginal crystalline rock surfaces overlain by Cretaceous sediments only in the southwestern and western parts of the Plaňany island the weathered rocks are *in situ* preserved. The depth of weathering reached around 5 m. The soft nature of this crystalline bedrock part is evidenced by relatively deep (more than 80 cm) burrows (*Thalassionoides* sp.; see Fig. 2A, section Plaňany-West) filled with sediment.

DISCUSSION

The obtained new data on the Late Cenomanian – Early Turonian history of the Plaňany island can be summarized into the following items:

1. Preserved sediments show that the history of the Plaňany elevation in the form of an island was relatively short. The distribution of sediments over the crystalline rock elevation indicates that the island was practically submerged during deposition of the oldest preserved sedimentary rocks (Upper Cenomanian). Probably only the small top parts served as a source of abundant coarse clastics. This oldest preserved sedimentary phase, during which the variegated (red, yellow, greenish) conglomerates with claystone-limestone matrix were formed, is recorded in fillings of burrows and subordinately also in erosional depressions. The origin of burrows was conditioned by the existence of suitable substrates that occurred only on the deeply weathered southwestern flank of the island. In any case, an intact character of weathered bedrock indicates that, unlike the other island parts, the southwestern island slope was protected against the surf and wave erosion (a leeward side). Therefore, the coarse clastic conglomerate component is not of local origin. However, the main period of extreme erosion and modelling of the gross morphology of the elevation was probably already finished on all sides.
2. The western and mainly the southwestern flank were covered by sandstones during the following phase. No erosion of underlying weathered bedrock and conglomerates with limestone matrix indicates extra-island source and high rate of deposition. The highly fragmented and reworked littoral fauna of these sandstones could be transported together with sands but in more northern parts of western flank the local origin of better preserved fauna is estimated. The sandstone passes here to the massive sandy limestone with corals, large oysters and other fauna. The boulder conglomerates and claystone intercalations are of limited extent. In claystone matrix of conglomerates small rudists (*Radiolites* sp.) were encountered.
3. The sandy deposits dominate at the very bases of the majority of deeper depressions over the island, including the eastern flank. Sandy conglomerates and/or sandstones with large massive oysters (e.g. *Lopha* sp.) are common. It is, however, a question if all these sediments are coeval with the western sandstone bodies. As their true equivalents only the basal sandstone with boulders in northern depression (section Plaňany-North, lithology 2+3(?)) and those on the eastern flank of island (section Plaňany-Southeast, lithologies 5 and 6) may be considered. Coarse clastic, sandstone to sandy limestone sedimentation was later interrupted by remarkable erosion event, probably as a result of the sea-level fall. All the island (now probably again partly emerged) flanks, except the southwestern one, have been exposed to erosion and reworking. The main force of these processes was concentrated to the northern flank (section Plaňany-North), where the large boulders were secondarily concentrated and the depression became practically vacant. The boulder concentrations are, however, developed even in many locations of eastern flank (section Plaňany-East, lithology 2+3(?)). Northern, eastern and southeastern island flanks were therefore at least partly situated on the windward

side. Coarse conglomerates on the southernmost island side (Urbánek 1924) may be of similar character.

4. The Late Cenomanian limestones to sandy limestones of southern island flank (destructed by quarrying), in which the large numbers of fossils have been collected (Soukup 1936, 1966; the echinoid specimen collected in 1960s by O. Nekvasilová was described as *Novasalenia* Žítt & Geys, 2003) are rather enigmatic. If they were coeval with sandstones of southwestern flank (section Plaňany-West, lithologies 3 and 4), some type of a barrier (e.g. some narrow southward progressing island promontory) had to separate both areas. Sandy limestones of southern flank can be also correlated with conglomerates with sandy-carbonate matrix in the section Plaňany-Southeast (see Fig.2A, lithologies 5 and 6).
5. The island was again completely flooded during the Early Turonian sea-level rise and a deposition of the Bílá Hora Formation started. The cliff-like top (if there ever existed) of the island was probably completely consumed by erosion and the shallow sublittoral conditions could persist only on the topmost preserved parts of submerged elevation. The supply of coarser clastic particles was therefore completely stopped. The redeposition of the Cenomanian sediments and their fauna was, however, still locally common (*Praeactinocamax plenus*).
6. During gradual deepening of the sea, the environmental conditions led to sedimentary starvation and later the mineralization of all exposed substrates. The clasts in all exposed coarse accumulations and the interstices in sandy limestones were coated or filled with glauconitic clay or locally directly glauconitized. Co-occurring phosphatic coatings were very thin in these sites. However, relatively thick (several millimetres) phosphatic crusts were at the same time formed on the more raised sites of the elevation. The dysoxic conditions and temporal suppression of bottom macrofauna (short episodes of encrusting *Atreta* community between the phosphatic laminae) agree well with other similar localities (see Žítt et al. 1997).
7. For the succeeding time interval, the organic matter burial is typical. Nevertheless, the restriction of these conditions to the southwestern and northern flanks of elevation is striking. Formation of the dark grey claystones on the southwest (section Plaňany-West) was probably very slow and macrofauna was lacking. Coincident redeposition of the fragile Cenomanian agglutinated foraminifers is however characteristic. Their source rocks were probably completely destructed. Nevertheless, the faunal communities on elevated areas of the northern part (section Plaňany-North) of submerged island have not been disrupted. A part of benthic fauna with dominance of sponges (prolific hexactinellis and lithistid demosponges) was postmortally transported downslope over short distance into the dark grey sediments of the depression base. This situation closely resembles that at Velim (Žítt et al. 1997) lying about 8 km to the east of the Plaňany quarry.
8. The C_{org} rich sedimentation gradually turned to the sedimention rich in glauconite (deepening of the sea). Low-energy hydrodynamic conditions and sedimentation deep below storm-wave base are documented e.g., by preserved large fragments of very

fragile thin walls of the hexactinellid sponges *Laocoetis* sp. and *Laocoetis vulgata* (Počta). These sediments later continuously passed to the light siltstones (Fig. 2A, lithology 10) which gradually covered all the surface of the Plaňany submerged island. This sedimentary environment corresponded with yet deeper marine conditions, suggested also by presence of hexactinellid and lithistid sponges. The faunal communities successfully survived only on or close to the sediment free rockgrounds of the deeply (below the storm-wave base) submerged topmost elevation parts, supplying surroundings with skeletal remains (sponge skeletons and cementing organisms represented mainly by small oysters). However, these macrofaunal populations (mainly sponges) also gradually disappeared due to progressing reduction of the rocky bottom areas (covering by fine clayey-silty sediments).

9. The local sedimentary successions found at Plaňany (see above) are in many respects similar to those described from some other localities of the rocky coast facies (e.g. Velim and Chrtníky, see Žítt et al. 1997, 2006). However, the Plaňany Late Cenomanian – Early Turonian successions are exceptional in that they encircle the coasts of the former island. It is important that no large local gaps exist in the course of the coast and the rocky bottom. The problems arise mainly with correlations of the basal fills of depressions (mostly of the Late Cenomanian age) along the coastline. Their separation from each other caused lithological and faunal differences especially between the more distant ones. The research works at Plaňany are not still finished in this respect. In addition to it, some special papers (e.g. on faunal communities, phosphates, coprolites, sponges) are being prepared.

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REFERENCES

Augusta J. & Soukup J., 1936: O glaukonitické vrstvě s rybími zbytky z křídy plaňanské [On a glauconitic layer with fish remains from the Plaňany Cretaceous]. – Věda Přírodní 17: 144-146. [In Czech.]

Čech S., Hradecká L., Rejchrt M., Švábenická L. & Vodrážka R., 2004: Stratigrafická architektura cenomanu české křídové pánve: vztahy sedimentárních systémů a reaktivace struktur podloží křídy [Stratigraphic architecture of the Cenomanian in the Bohemian Cretaceous Basin: relations between sedimentary systems and the reactivation of underlying structures]. – Unpublished report (Etapová zpráva – 3. etapa). Česká geologická služba, Praha, 51 pp. [In Czech.]

Robaszynski F. & Caron M., 1995: Foraminiferes planctoniques du Crétacé: commentaire de la zonation Europe-Méditerranée. – Bulletin de la Société Géologique de France 166: 681-692.

Soukup J., 1936: Několik předběžných sdělení o výzkumu křídy na Kouřimsku [Some preliminary reports on the research of the Cretaceous in the Kouřim region]. – Příroda 29(8): 1-5. [In Czech.] (Pagination of a reprint.)

Soukup J., 1966: Plaňany u Kolína [Plaňany near Kolín]. – In: Exkurzní průvodce XVII. sjezdu ČSMG [Geuide to the exursion of the 17th Meeting of the Czech Society for Mineralogy and Geology]: 296-300. Praha. [In Czech.]

Soukup J., 1971: Ein Fund von *Schloenbachia varians trituberculata* Spath (Mollusca, Ammonoidea) im mittelböhmischen Cenoman. – Věstník Ústředního Ústavu Geologického 46: 77-81.

Sviták C., Labuťa R. & Urban M., 2003: Nové předběžné výsledky výzkumu svrchnokřídových sedimentů v lomu v Plaňanech [New preliminary results of the research of Upper Cretaceous sediments in the Plaňany quarry]. – Zprávy o Geologických Výzkumech v Roce 2002: 145-146. [In Czech.]

Svoboda P., 1982: Srovnání nálezů svrchnocenomanské fauny z Odolena Vody s podobnými lokalitami středních Čech [A comparison of the finds of Upper Cenomanian fauna from Odolena Voda with similar localities of Central Bohemia]. – Bohemia Centralis 11: 159-162. [In Czech.]

Svoboda P., 1985: Svrchní cenoman v Plaňanech u Kolína [Upper Cenomanian in Plaňany near Kolín]. – Bohemia Centralis 14: 25-32. [In Czech.]

Trenhaile A.S., 1987: The geomorphology of rock coasts. – Oxford: Clarendon Press, 373 pp.

Urbánek L., 1924: Křídový útesový ráz v Plaňanech u Kouřimi [A Cretaceous cliff in Plaňany near Kolín]. – Sborník Klubu Přírodovědeckého v Praze 24: 71-77. [In Czech.]

Vlačiha V., 2000: Odkrytý křídový útes v Plaňanech u Kolína (česká křídová pánev) [The exposed Cretaceous cliff in Plaňany near Kolín (Bohemian Cretaceous Basin)]. – Zprávy o Geologických Výzkumech v Roce 1999: 138-140. [In Czech.]

Ziegler V., 1966: Křídové lokality v okolí Velimi a Nové Vsi u Kolína [Cretaceous localities in the vicinity of Velim and Nová Ves near Kolín]. – Vlastivědný Zpravodaj Polabí 3-4: 41-44. [In Czech.]

Ziegler V., 1992 [1991]: Stratigrafie a vrstevní sled křídových sedimentů v kolínské oblasti České křídové pánve [Stratigraphy and sequence of layers of Cretaceous sediments in the Kolín part of the Bohemian Cretaceous Basin]. – Časopis Národního Muzea, Řada Přírodovědná, 160: 29-46. [In Czech.]

Žítt J., 2001: Zajímavý profil s akumulací koprolitů, ústřic a červů (Plaňany, česká křídová pánev) [An interesting cross-section with an accumulation of coprolites, oysters and worms (Plaňany, Bohemian Cretaceous Basin)]. – Zprávy o Geologických Výzkumech v Roce 2000: 25-27. [In Czech.]

Žítt J. & Geys J.F., 2003: *Novasalenia* gen. nov.: a remarkable Late Cenomanian echinoid from the Bohemian Cretaceous Basin (Czech Republic). – Cretaceous Research 24: 23-30.

Žítt J & Nekvasilová O., 1990: Upper Cretaceous rocky coast with cemented epibionts (locality Kněžívka, Bohemian Cretaceous Basin, Czechoslovakia). – Časopis pro Mineralogii a Geologii 35: 261-276.

Žítt J. & Nekvasilová O., 1997: New data on nearshore marine environments of the Bohemian Cretaceous Basin (Tuchoměřice-Pazderna locality; late Cenomanian-early Turonian). – Bulletin of the Czech Geological Survey 72: 359-365.

Žítt J., Kopáčová M., Nekovařík Č. & Peza L.H., 2002: New data on the Late Cenomanian taphocoenose at Kuchyňka near Brázdim (Bohemian Cretaceous Basin). – Journal of the Czech Geological Society 47: 55-64.

Žítt J., Nekvasilová O., Hradecká L., Svobodová M.& Záruba B., 1999 [1998]: Rocky coast facies of the Unhošť – Tursko High (Late Cenomanian – Early Turonian, Bohemian Cretaceous Basin). – Acta Musei Nationalis Pragae (B) 54: 79-116.

Žítt J., Nekvasilová O., Bosák P., Svobodová M., Štemproková-Jírová D.& Šťastný M., 1997: Rocky coast facies of the Cenomanian-Turonian Boundary interval at Velim (Bohemian Cretaceous Basin, Czech Republic). – Bulletin of the Czech Geological Survey 72: 83-102, 141-155.
Žítt J., Peza L.H. & Nekovařík Č., 2002: Nové nálezy rudistů v české svrchní křídě [New records of rudists from the Bohemian Upper Cretaceous]. – Zprávy o Geologických Výzkumech v Roce 2001: 114-116. [In Czech.]
Žítt J., Vodrážka R., Hradecká L., Svobodová M. & Zágoršek K., 2006: Late Cretaceous environments and communities as recorded at Chrtníky (Bohemian Cretaceous Basin, Czech Republic). – Bulletin of Geosciences 81: 43-79.
Žítt J., Vodrážka R., Čech S., Hradecká L. & Svobodová M., 2008: Taphocoenoses of the Cenomanian/Turonian boundary interval: the case study of Plaňany, Bohemian Cretaceous Basin. – In: 9th Paleontological Conference, Warszawa, 10-11 October 2008, Abstracts: 108-109.