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Depositional and palaeoenvironmental variation of lower Turonian nearshore facies in the Bohemian Cretaceous Basin, Czech Republic

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ABSTRACT

Dark grey strata belonging to the basal horizons of the Bílá Hora Formation (lower Turonian) were exposed during quarrying at the locality of Plaňany (Bohemian Cretaceous Basin). Based mainly on quarry maps, the early Turonian rocky bottom was reconstructed in the area of about 14,800 m^2. Two sedimentologic and palaeoecological settings were recognized in the area. Dark grey deposits form part of the first setting, representing a fill of large and deep depressions on the northern foot of the Plaňany elevation. The second setting with a phosphatic lag is located on the elevated part of the area. Dark grey sedimentation belongs to the UC6a and particularly to the UC6b nannoplankton zones. During the latter zone the dark sedimentation passed upwards into light siltstones. The enrichment of C_{org} and S, clay minerals with an important kaolinite peak, formation of framboidal pyrite and the enrichment of macrofauna and phosphatic particles are characteristic of the basal portions of the dark deposits. The sulphate reduction zone is suggested for this sedimentary environment. In the associations of phosphatic particles, shark coprolites, faecal pellets and sponge fragments prevail. No phosphatic lag is developed. On the other hand, the phosphatic lag directly overlying the Cenomanian relics is most characteristic of the second setting. This lag is a product of sedimentary condensation, characterized by a long-lasting concentration of phosphatic particles and phosphogenesis, accompanied by encrustation of closely adjacent free rock surfaces by a faunal community with *Terebella*. Additional biostratigraphic data presently contributed to a proposed correlation of both settings. Micropalaeontological data (foraminifera, palynomorphs, nannoplankton) indicate that the phosphatic lag and basal dark grey deposits may be approximately coeval. The stagnant depositional conditions with only very slow sea-level rise are thought to have lasted for a relatively long period that includes a significant part of the *Whiteinella archaeocretacea* Zone (lowermost Turonian). In elevated parts, condensation could proceed under conditions of prevailingly weak currents and strong oxidation of organic matter, while decomposition of organic matter was probably very slow and incomplete in depressions below the elevation. The sedimentary condensation in both settings is highlighted by the remarkable formation of abundant glauconite in local deposits.

1. Introduction

Interesting coprolitic deposits have recently been described from the quarry of Plaňany in Central Bohemia by Žítt and Vodrážka (2013). These phosphatic accumulations form part of Upper Cretaceous fills in several depressions which were exposed on quarry faces. Remains of unique encrusting faunal community (tubes of the worm *Terebella phosphatica*, bivalves, encrusting foraminifera) occur on migmatite boulders close above the upper boundary of the phosphatic lag. However, in the close vicinity of the mentioned depressions, another interesting facies of Upper Cretaceous rocks was most recently studied. This section shows the so far thickest sedimentary succession exposed in the quarry of Plaňany and is unique because of extraordinary sedimentologic and faunal features concentrated in its basal parts. Several years of sampling and field studies carried out by the first two authors revealed interesting relationships within coprolitic deposits previously described (see above). Intense studies summarized all the data including new palaeoecological and biostratigraphic information

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based on palynomorphs, foraminifers and nannofossils, and helped to understand, at least in general, the types and timing of processes governing the character of sedimentary environments and distribution of organic remains and matter in Plaňany during the early Turonian. The present study is intended to improve our understanding of geological and palaeontological events that took place during the Cenomanian – Turonian boundary interval and which were exceptionally recorded in the present Plaňany quarry (for references see Žítt and Vodrážka, 2013).

2. Geological and geographical settings

The Plaňany locality lies about 10 km west of the city of Kolín in Central Bohemia and is situated in the large active quarry (Fig. 1). This quarry was opened in an elevation formed mostly of Proterozoic migmatites, gneisses and amphibolites (Fišera, 1981). This elevation is likely to have been shaped by pre-transgression continental weathering and reworking but mainly during the late Cenomanian transgression and flooding of the Bohemian Cretaceous Basin (BCB). The resulting near-shore coastal scenery with islands, peninsulas, protected bays, shore and headland cliffs reflects the dynamics of the Cretaceous transgression. The flooded surface of the Plaňany elevation was progressively altered by high-energy erosion (Žítt et al., 2010; Žítt and Vodrážka, 2013 and references therein), resulting in formation of numerous channel-like depressions sloping down to the foot of the elevation. Concurrent sedimentation resulted in a gradual filling of depressions with sandy and conglomeratic or bioclastic deposits (Korycany Member of the Peruc-Korycany Formation). Large oyster, coral, gastropod, brachiopod and locally even the rudist remains of varying degree of taphonomic degradation are typical for these beds. These deposits probably accumulated during the following late Cenomanian regression but mainly during the early Turonian sea-level rise, in part locally reworked, and are overlain by the Bílá Hora Formation. When the initial high energy transgression phase ceased, the sedimentary stagnation and condensation, temporary blooms of macrofauna, production and local accumulation of coprolites and faecal pellets (and other phosphatic particles), enrichment of glauconite and C_{org}, and phosphogenesis were principal features of the sedimentary environment. The condensation episode most probably coincided with a basinwide glauconitic bed, lying at the base of the Bílá Hora Formation (Čech et al., 2005).

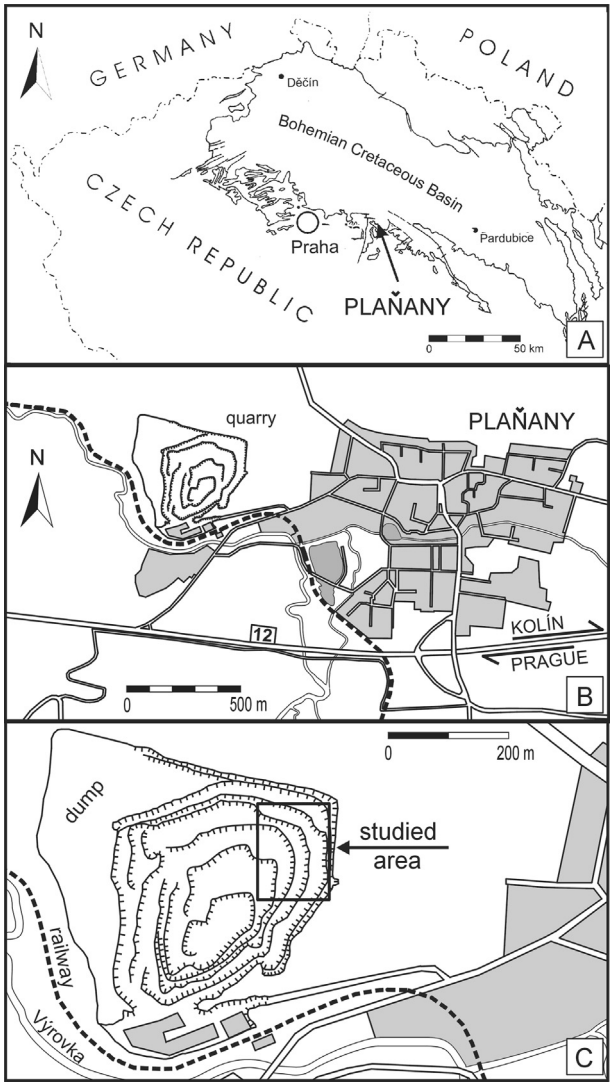

Fig. 1. A, Sketch map of the Bohemian Cretaceous Basin (modified after Košťák et al., 2010). B, the quarry and nearby town Plaňany. C, close-up of the quarry with the studied area (reconstructed rocky bottom). B and C modified after Žítt and Vodrážka (2013).

The great majority of data are derived from a relatively thick geological section, which we call the Northern section. It is situated to the North of previously described sections with *Terebella* (Žítt and Vodrážka, 2013). The samples were taken in 2006. The section is currently covered by soil and recultivated. The mutual position of all the mentioned sections is shown in Fig. 2. The Northern section and the sections with *Terebella* were the basis for examination of biostratigraphic and palaeoenvironmental characteristics of the study area. For more detailed geological aspects see Žítt and Vodrážka (2013).

3. Material and methods

Rock samples from the Northern section were used for all investigations, i. e., the lithology, nannofossils, foraminifers, palynomorphs, C_{org} and S contents, glauconite and phosphatic particles as well as clay minerals. The study of macrofauna was based on its content in residua after washing and on hand specimens collected in the exposed sections. The data obtained were compared with those from the *Terebella* section (Žítt and Vodrážka, 2013), but improved by using microbiostratigraphy (nannofossils and foraminifers). Rock samples were washed for foraminiferal, macrofaunal and phosphatic particle studies using the sieve mesh 0.063, 0.5 and 2.0 mm.

Calcareous nannofossils were investigated in the fraction of 2–30 μm separated by the decantation method using 7% solution of H_2O_2. The coarse-fraction was allowed to settle for 3 min in a 45 mm water column and removed, and the fine-fraction was saved for slide preparation after 45 min. Simple smear-slides were mounted by Canada balsam and inspected at 1000× magnification, using an oil-immersion objective on a Nikon Microphot-FXA transmitting light microscope. The photodocumentation was processed using digital camera Nikon DXM1200F and SW ACT-1.

Biostratigraphic data were interpreted applying the Burnett (1998) UC zones. The method of Burnett and Whitham (1999) was applied for semiquantitative analyses. Between 100 and 500 specimens were counted from each slide in randomly chosen fields of view. A total of 21 outcrop samples were collected from the Northern section of the Plaňany quarry. Samples were processed for palynology at the laboratory of the Czech Geological Survey following standard palynological techniques for pre-Quaternary samples (Batten, 1999), including treatment with hydrochloric acid, 40% hydrofluoric acid, and oxidation in 36% nitric acid followed by heavy liquid separation. Sample residue was filtered on