

Integrated biostratigraphy of the Upper Cretaceous–Eocene deposits from Poiana Botizei-Botiza (Maramureș, Romania)

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In the present study, detailed analyses of the Upper Cretaceous–Eocene deposits from Poiana Botizei and Botiza (Maramureș County, northwest Romania) focused mainly on calcareous nannofossils with some additional examination of foraminifera and ichnofossils. The Poiana Botizei Klippen Zone is part of the Pienide units in Romania and is a southeastward extension of the Pieniny Klippen Belt of the Western Carpathians. In the study area, the outcropping formations are included into several south-vergent tectonic scales mainly consisting of “red beds” and “hieroglyphic beds”. The “red beds” (Cretaceous–Paleocene) are predominantly marls with facies variations similar to the analogous “Puchow marls” in Slovakia and Poland. The color of the marls, although dominantly reddish, varies vertically and laterally depending upon physical, chemical, and biotic parameters. The depositional environment was probably bathyal with limited and episodic input of fine-grained sedimentary clastic material. Because of the prevalence of quartz grains and the absence of lithic fragments, the main source area of the clastics could be external to the East European Craton or the inner Dacides.

The middle–upper Eocene succession consists of thin-bedded calcareous turbidites with predominantly Tc–e and Td–e Bouma intervals. Cross and convolute laminations, scour marks (groove and flute casts), and vertical burrows and trails are common in some beds. Studies on provenance of clastic supply, based on orientation of sedimentary structures, show the primary direction of sediment influx was from south to north. The turbiditic depositional system can be considered one of transition from middle to outer fan into a well-oxygenated environment.

The foraminiferal samples were quite difficult to process in the laboratory due to their marly nature, but where present, benthic specimens dominated (agglutinated genera *Bathysiphon*, *Placentamina*, *Haplophragmoides*, *Lituotuba*, and *Recurvoides* and some calcareous benthics of the genus *Eponides*). Planktonic foraminifera occurred in low percentages (consisting only of *Heterohelix* sp.). The foraminiferal assemblage indicates a bathyal environment above the carbonate compensation depth.

At Botiza, the calcareous nannofossil assemblages contained very frequent *Lucianorhabdus maleformis*, *Micula murus*, *M. staurophora*, *M. cubiformis*, and *Watznaueria barnesiae*, along with lower numbers of *Broinsonia parca*, *Cribrosphaerella ehrenbergii*, and *Microrhabdulus decoratus*. Entire coccospheres were rarely present. In the lowest part of the Poiana Botizei section, the “red marls” contain abundant and diversified calcareous nannofossils: *Arkhangelskiella cymbiformis*, *A. maastrichtensis*, *Micula staurophora*, *M. prinsii*, *M. murus*, *Ceratolithoides aculeus*, *Eiffellithus*

turriseiffelii, *E. eximius*, *Prediscosphaera cretacea*, *Placozygus fibuliformis*, *B. parca*, *Lithraphidites carniolensis*, *M. decoratus*, *C. ehrenbergii*, and sometimes entire coccospheres. The calcareous nannofossil assemblages from the “red marls”, both at Botiza and Poiana Botizei, indicate a Late Cretaceous (Maastrichtian) age.

The oldest Paleocene calcareous nannofossils are small coccoliths, *Cruciplacolithus* spp., *Ericsonia* spp., *Markalius* spp., *Biantholithus sparsus*, and *Zeugrhabdotus sigmoides*, along with reworked Cretaceous taxa. Eocene calcareous nannofossils include discoasters, *Coccolithus pelagicus*, and *Reticulofenestra* cf. *dictyoda*. A few samples were barren of calcareous nannofossils.

The trace fossils were grouped toponomically into hypichnia, epichnia, and endichnia. Ethologically, the genera were mixed domichnia–fodinichnia (*Ophiomorpha*, *Thalassinoides*, *Arenicolites*), fodinichnia (*Rhizocorallium*, *Planolites*, *Taenidium*), repichnia (*Scolicia*), and cubichnia (*Lockeia*) forms. These trace fossils suggest a *Cruziana* ichnofacies. The turbiditic depositional system was a transition from mid- to outer fan into a well-oxygenated environment.

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