Early Miocene (Ottnangian) coastal upwelling conditions along the southeastern scarp of the Bohemian Massif (Parisdorf, Lower Austria, Central Paratethys)

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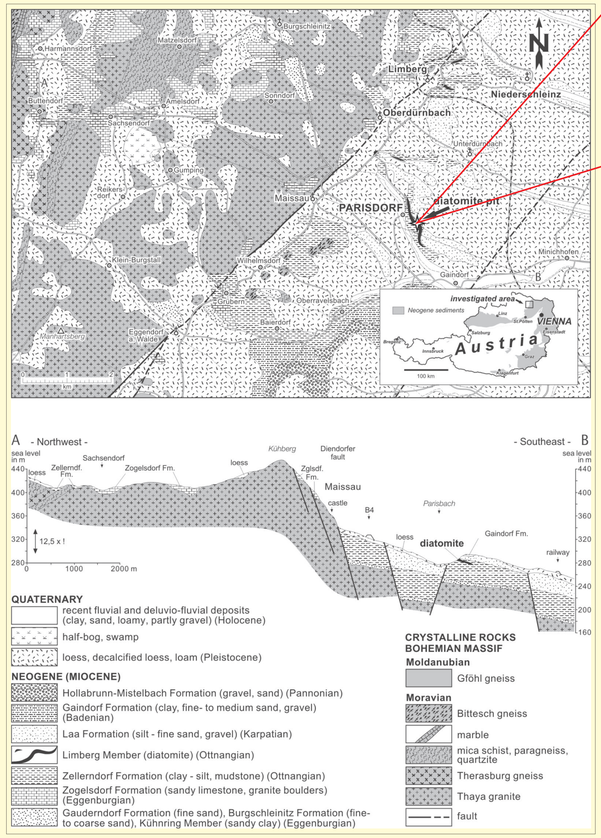


Eastern part (left) and north-western part (right) of the Parisdorf pit. Diatomites of the Limberg Member overlain by pelites of the Zellerndorf Formation. In the left picture a clayey layer (arrow) is dividing the diatomites in two parts.

Rhythmic bedding laminations of the diatomites in the Parisdorf pit.

In the Alpine-Carpathian Foredeep, Lower Miocene clays of the Zellerndorf Formation and intercalated diatomites of the Limberg Member occur between the villages Parisdorf, Oberdürnbach, Limberg and Niederschleinz, E to NE of Maissau (Lower Austria). These sediments show distinct features for coastal upwelling conditions along the steep southeastern scarp of the Bohemian Massif during the Ottnangian. They were deposited in a deep marine sublittoral environment. The communities of diatoms, calcareous nannoplankton and planktonic foraminifera clearly point to the influence of cold and nutrient-rich deep-water currents, typical for upwelling zones. The very high content of smectitic clay minerals in both the sediments and volcanoclastics of time-equivalent strata in this area indicate prominent acidic volcanic input. Thus, besides the nutrient-rich deep-water currents, the induced high silica content in the sea also boosted biogenic productivity, especially for diatoms. The diatomites show rhythmic bedding laminations which are probbably cyclic. The finer and light layers with rich accumulations of well-preserved, mostly planktonic diatoms represent rapid sedimentation rates. In contrast, the thicker and darker interlayers with higher inorganic siliciclastic content and mostly fragmented siliceous plankton tests are an indication for slower sedimentation (tending to obscure annual events) and thicker bedding units.

***Bathysiphon filiformis* in the basal layers of the Zellerndorf Fm.**

Heavily folded diatomites with dark menilitic layers at the western end of the pit with multiple duplex stacking indicating a southwest- (left) directed compression

Foraminifera

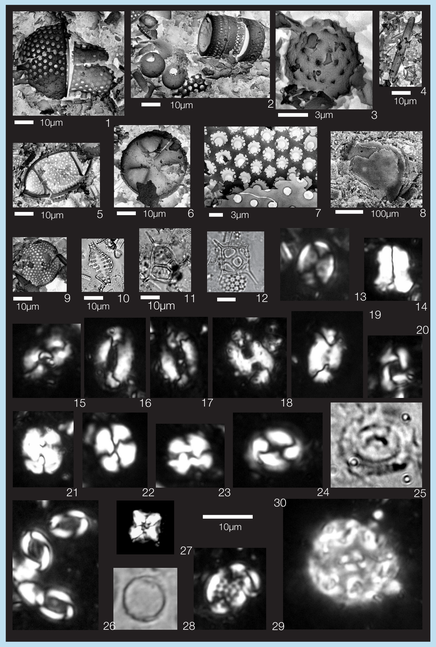
Within the lower part of the sequence, overlying the Limberg Member diatomites, a horizon of agglutinated *Bathysiphon filiformis* was observed. The foraminiferal fauna in more calcareous clays is dominated by very small planktonic species, with floods of *Tenuitellinata selleyi, Tenuitella* and *Turborotalita*. Other common small globigerinids are *Globigerina lentiana, G. ottnangiensis* and *G. praebulloides*. The planktonic foraminiferal assemblages show high numbers of *Globigerina ottnangiensis* and few *Globigerinoides* specimens together with *Globoturborotalita woodi*, indicating an Early Miocene age. The calcareous benthic fauna consists of small species or specimens, often in small numbers but with high species diversity. The richest assemblage was observed in the marly bed. Most common are *Amphimorphina haueriana, Myllostomella advena, M. recta, Fursenkoina halkyardi, Bolivina dilatata, Pseudoparella exigua*, in some samples also *Melonis* and *Nonion*. In marly sediments from Parisdorf and Niederschleinz the fauna changes to a *Lenticulina-Uvigerina* assemblage. For the first time in Ottnangian sediments, *Uvigerina acuminata* occurs frequently, together with *U.* cf. *saprophila* and *U. mantaensis*. The new species *Nonion gudrunae* Rögl n. sp. is described from the Ottnangian Zellerndorf Formation in the diatomite pit Parisdorf, and a lectotype of *Nonion commune* (d'Orbigny, 1846) is designated.

Siliceous microfossils

In the Limberg Member, the diatoms are the most abundant siliceous microfossils. Together with the less abundant silicoflagellates, as well as chrysomonads with archeomonad cysts and ebridians, they are the principal rock-forming components of the diatomites. The diatom assemblages show low species diversity with about 90 taxa belonging to 46 genera. The most frequent genera are *Thalassionema, Chaetoceros, Coscinodiscus, Rhizosolenia, Stephanopyxis* and *Thalassiosira*. In the Parisdorf pit the whitish layer surfaces commonly comprise horizontally oriented, large disc-shaped *Coscinodiscus* tests. In the upper part of the Parisdorf profile, tests of genera *Thalassionema, Chaetoceros, Rhizosolenia, Thalassiosira* and *Stephanpyxis* dominate. The diatom flora of the Limberg Member stratigraphically belongs to the upper part of the Lower Miocene (Ottnang-Karpatian).

Calcareous nannofossils

The diatomites of the Limberg Member from Parisdorf lack calcareous nannoplankton. Laminated calcareous layers of the Zellendorf Formation in the Parisdorf pit are very rich in well-preserved nannoplankton assemblages dominated by two taxa:*Coccolithus pelagicus* and *Coronosphaera mediterranea*. The accompanying assemblages consist of *Coccolithus miopelagicus, Cyclicarholithus floridanus, Helicosphaera ampliaperta, H. carteri, H. euphratis, H. mediterranea, Pontosphaera multipora, Reticulofenestra bisecta, R. daviesii, R. pseudoumbilica, Sphenolithus dissbelemnos* and *Sphenolithus moriformis*. *Helicosphaera ampliaperta* (stratigraphic range: from upper NN2 to the NN4/NN5 boundary) is rare but present in investigated sediments from Parisdorf and Niederschleinz. Although *Sphenolithus belemnos* was not observed, the co-occurrence of *S. disbelemnos* with *H. ampliaperta* and *H. mediterranea*, as well as the absence of *Sphenolithus heteromorphus*, indicate the uppermost part of nannoplankton Zone NN2 and Zone NN3 (Martini, 1971). This corresponds with the regional Ottnangian position of the succession.



Siliceous microfossils (Figs. 1.-12.) from the Limberg Member and calcareous nannofossils (Figs. 13-30.) from the Zellerndorf Formation

Fig. 1. *Stephanopyxis turris* (Greville) Ralfs; Sample N 22/48-4/94 (Niederschleinz)
Fig. 2. *Melosira sulcata* (Ehrenberg) Cleve; Sample N 22/48-4/94 (Niederschleinz)
Fig. 3. *Archeomonas* cf. *mangini* Deflandre; Sample Roetzel P-2 (Parisdorf)
Fig. 4. *Thalassionema nitschiides* (Grunow) Grunow; Sample Roetzel P-1 (Parisdorf)
Fig. 5. *Hemianulus hungaricus* Pantocsek; Sample Roetzel P-1 (Parisdorf)
Fig. 6. *Actinoptychus senarius* (Ehrenberg) Ehrenberg; Sample N 22/48-4/94 (Niederschleinz)
Fig. 7. *Coscinodiscus oculus iridis* Ehrenberg; Sample Roetzel P-1 (Parisdorf)
Fig. 8. *Coscinodiscus radiatus* Ehrenberg; Sample Roetzel P-1 (Parisdorf)
Fig. 9. *Fyxidicula minuta* Grunow; Sample Roetzel P-9 (Parisdorf)
Fig. 10. *Rhaphoneis elegans* (Pantocsek & Grunow) Hanna; Sample N 22/48-6/94 (Niederschleinz)
Fig. 11. *Distephanopsis hannai* (Bukry) Desikachary & Prema; Sample N 22/48-6/94 (Niederschleinz)
Fig. 12. *Distephanopsis crux parvus* (Bachmann) Desikachary & Prema; Sample N 22/48-6/94 (Niederschleinz)
Fig. 13. *Pontosphaera discopora* Schiller, 1925; Sample RÖ 65/93 (Parisdorf)
Fig. 14. *Zygrhablithus bijugatus* (Deflandre, 1954) Deflandre, 1959; Sample RÖ 65/93 (Parisdorf)
Fig. 15. *Helicosphaera euphratis* Haq, 1966; Sample Roetzel P-2 (Parisdorf)
Fig. 16. *Helicosphaera ampliaperta* Bramlette & Wilcoxon, 1967; Sample RÖ 65/93 (Parisdorf)
Fig. 17. *Helicosphaera ampliaperta* Bramlette & Wilcoxon, 1967; Sample Roetzel P-2 (Parisdorf)
Fig. 18. *Helicosphaera mediterranea* Müller, 1981; Sample Roetzel P-2 (Parisdorf)
Fig. 19. *Helicosphaera carteri* (Wallich, 1877) Kamptner, 1954; Sample N 22/48-2/94 (Niederschleinz)
Fig. 20. *Reticulofenestra pseudoumbilica* (Gartner, 1967) Gartner, 1969; Sample RÖ 65/93 (Parisdorf)
Fig. 21. *Reticulofenestra bisecta* (Hay, 1966) Roth, 1970; Sample N 22/48-2/94 (Niederschleinz)
Fig. 22. *Watznaueria barnesae* (Black, 1959) Perch-Nielsen, 1968; Sample N 22/48-2/94 (Niederschleinz)
Fig. 23. *Cyclicargolithus floridanus* (Roth & Hay, 1967) Bukry, 1971; Sample N 22/48-1/94 (Niederschleinz)
Figs. 24, 25. *Coccolithus pelagicus* (Wallich, 1871) Schiller, 1930; Sample RÖ 65/93 (Parisdorf)
Fig. 26. *Coronosphaera mediterranea* (Lohman, 1902) Gaarder, 1977; Sample RÖ 65/93 (Parisdorf)
Fig. 27. *Micula decussata* Vekshina, 1959; Sample N 22/48-1/94 (Niederschleinz)
Fig. 28. *Coronocyclus nitescens* (Kamptner, 1963) Bramlette & Wilcoxon, 1967; Sample RÖ 65/93 (Parisdorf)
Fig. 29. *Pontosphaera multipora* (Kamptner, 1948) Roth, 1970; Sample RÖ 65/93 (Parisdorf)
Fig. 30. Coccosphaera cf. *Coccolithus pelagicus* (Wallich, 1871) Schiller, 1930; Sample RÖ 65/93 Parisdorf

Microfossil Sample RÖ 65/93, Parisdorf, marly layer

Fig. 1. *Lenticulina meynae* Vespermann
Fig. 2. *Flanularia moravica* (Karrer)
Fig. 3. *Pyramidulina continuicosta* (Schubert)
Fig. 4. *Amphimorphina haueriana* Neugeboren
Fig. 5. *Myllostomella advena* (Cushman & Laiming)
Fig. 6. *Siphonodosaria adolphina* (d'Orb.)
Fig. 7. *Eulimina striata striata* (d'Orb.)
Fig. 8. *Caucasina schischkinskayae* Samoylova
Fig. 9. *Fursenkoina halkyardi* (Cushman)
Fig. 10. *Valvulineria complanata* (d'Orb.)
Fig. 11-12. *Nonion gudrunae* Rögl n. sp.
Fig. 13. *Melonis pompilioides* (Fichtel & Moll)
Fig. 14. *Bolivina hebes* Macfadyen
Fig. 15. *Bolivina dilatata* Reuss
Fig. 16. *Uvigerina acuminata* Hosius
Fig. 17. *Uvigerina* cf. *saprophila* Daniels & Spiegler
Fig. 18. *Uvigerina mantaensis* Cushman & Edwards
Fig. 19-20. *Charltonina tangentialis* (Clodius)
Fig. 21-22. *Globigerina ottnangiensis* Rögl
Fig. 23. *Globigerina dubia* Egger
Fig. 24. *Globigerina* cf. *ottnangiensis* Rögl
Fig. 25. *Globigerina praebulloides* Blow
Fig. 26. *Globigerinoides diminutus* Bolli
Fig. 27. *Globoturborotalita woodi* (Jenkins)
Fig. 28, 28a, 29. *Tenuitellinata selleyi* Li, Radford & Banner
Fig. 30-31. *Tenuitella clemenciae* (Bermudez)
Fig. 32, 32a -34. *Turborotalita quinqueloba* (Natland)
Fig. 35. Siliceous sponge spiculae: Hexactinellidae
Fig. 36. Siliceous sponge spiculae: tetraxon needle
Fig. 37. Siliceous sponge spiculae: *Oxyaster*
Fig. 38. Siliceous sponge spiculae: *Sterraster*
Fig. 39. Fish tooth, *Trichiurus* sp.