STOP 6 Paleocene-Eocene at Anthering near Salzburg

Hans EGGER

Topic: Paleocene/Eocene-boundary section in a succession of deep-water turbidites and hemipelagites
Lithostratigraphic unit: Rhenodanubian Group, Anthering Formation
Age: upper part of calcareous nannoplankton Zone NP9 to upper part of NP10
Tectonic unit: Rhenodanubian Flysch Zone
Location: Outcrops in the Kohlbachgraben near Anthering
Coordinates: E 13° 01' 17'', N 47° 53' 19''
Specialities: carbon isotope event, *Apectodinium* acme, Lower Eocene bentonites
References: Heilmann-Clausen & Egger, 1997, Egger, Heilmann-Clausen & Schmitz (2000), Crouch et al. (2001), Egger et al. (2003), Huber et al. (2003), Egger & Brückl (2006), Egger, Heilmann-Clausen &Schmitz (2009),

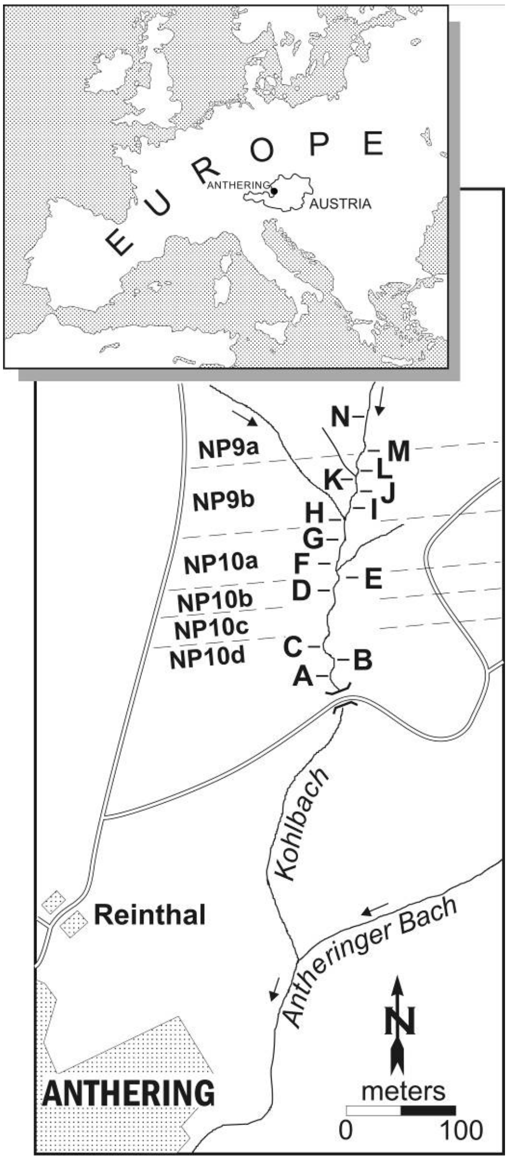


Fig.13. Location of the Anthering section (A-N … outcrops)

The 250 m thick Anthering section (Fig. 13) contains deposits from calcareous nannoplankton zones NP9 and NP10 and displays the global negative carbon isotope excursion (CIE) and the acme of the dinoflagellate genus *Apectodinium* in the upper part of zone NP9. The outcrop across the CIE displays a two-fold lithological subvision (Fig. 14).

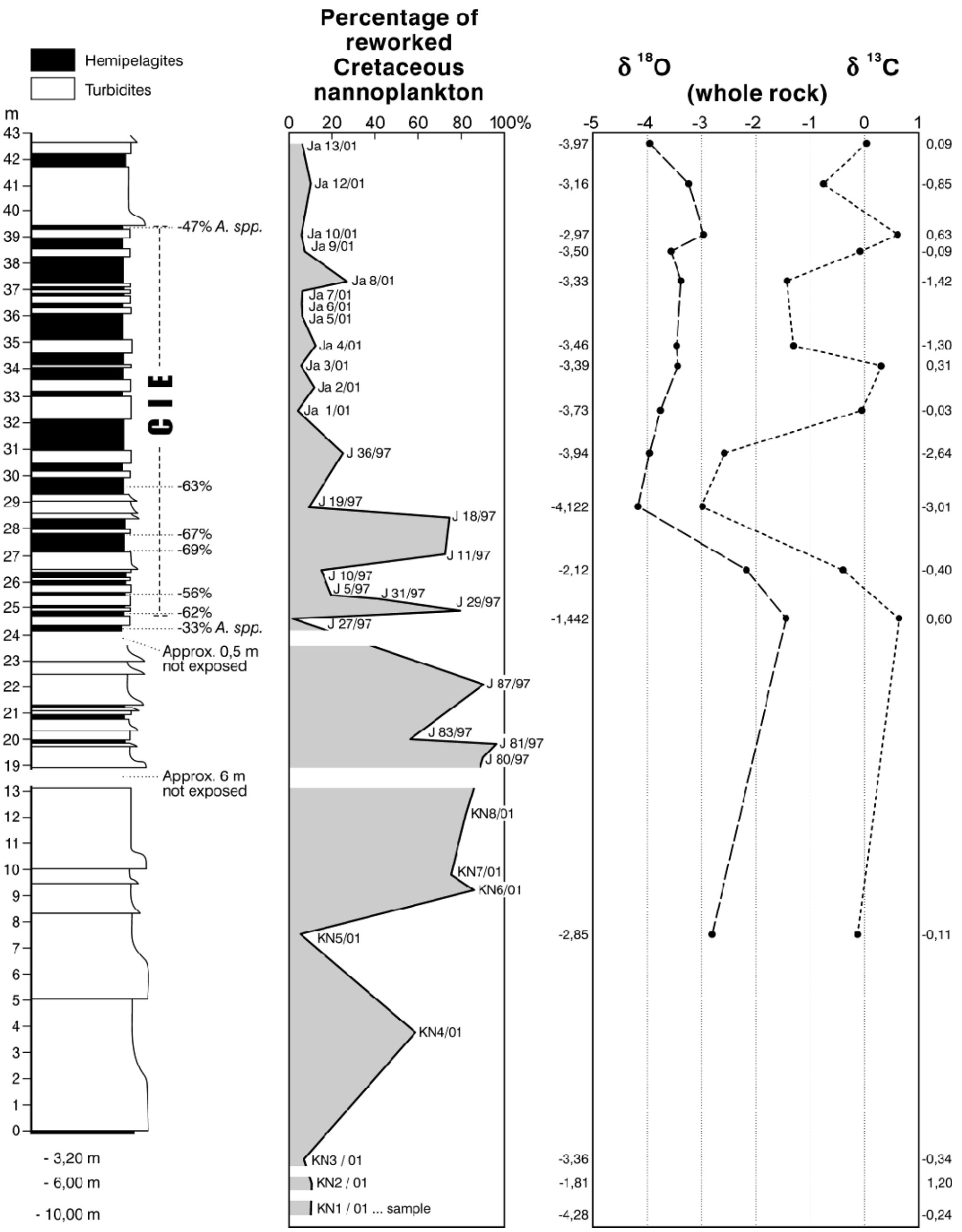


Fig. 14. Lithostratigraphy, percentages of redeposited Cretaceous nannoplankton and stable isotope record of oxygen and carbon across the CIE-interval at Anthering (A. spp…...percentages of the genus *Apectodinium* in the dinoflagellate assemblages).

Below the CIE, the section consists primarily of turbidites (98 %) with bed-thicknesses between 0.1 m and 5 m and an average thickness of 1.08 m. The thicker beds show graded bedding with sand-sized fractions at the base. Altogether, sandstone makes up 29 % of the succession. This is an unusually high percentage, as this fraction counts for only 5 % in the entire Anthering section. Small isolated outcrops below the base of the measured section indicate that the onset of this thick-bedded facies is abrupt, without any transition to the underlying thinner-bedded facies. The turbidite facies displays a thinning and fining upward trend and a gradual transition into a clay-rich facies which dominates the upper part of the outcrop.

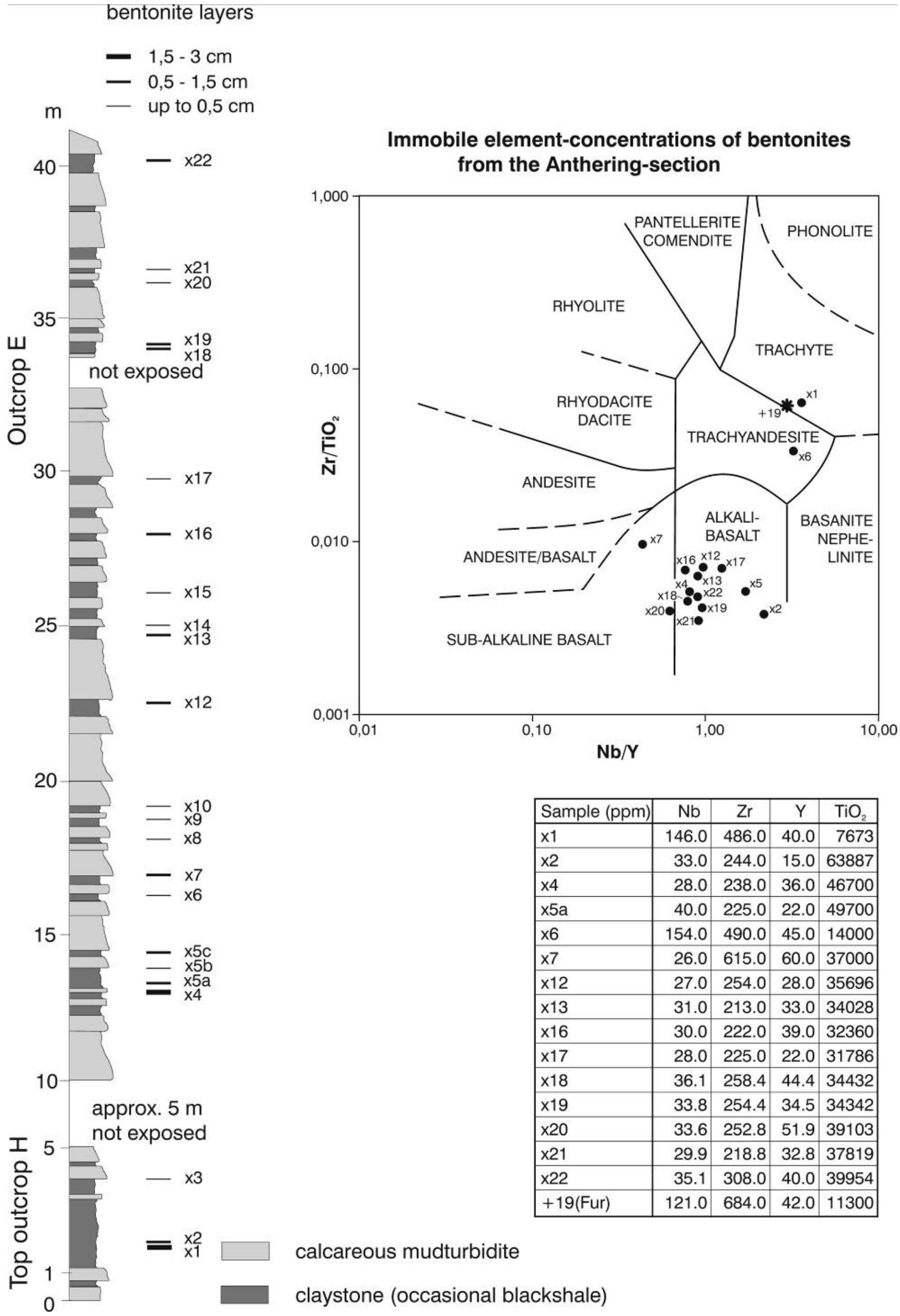
The carbon isotope and dinoflagellate data suggest that the CIE-interval at Anthering attains a thickness of 15 m, comprising turbidites and hemipelagites (Fig. 14). The thickness of the turbidites varies between 0.08 m and 2.25 m, although only the thickest layer exceeds 1 m thickness. The average thickness of the turbidite beds is 0.39 m and sand-grade material, which makes up 2 % of this facies, occurs only in the thickest layers. Excluding the turbidites the remaining thickness of hemipelagic claystone is 8.4 m. Using Fe– and Ca–intensity curves which probably represent precessional cycles, Röhl et al. (2000) calculated that the CIE interval lasted for 170 ky. From this, a hemipelagic sedimentation rate of 49 mmky^{-1} has been calculated for the compacted sediment across the CIE.

This CIE-interval sedimentation rate is unusual high compared to the mean sedimentation rate of the Rhenodanubian Group, estimated at 25 mmky^{-1} (Egger & Schwerd, 2008). This value incorporates both turbidites and hemipelagites. The rate of hemipelagic sedimentation in the Paleocene can also be calculated using the Strubach Tonstein, which was deposited during a period of ca. 5 my between the upper part of calcareous nannoplankton zone NP3 and the lower part of zone NP8 (Egger et al., 2002). About 25 % of this 50 m thick lithostratigraphic unit consists of turbidites. Excluding the turbidites, the rate of hemipelagic sedimentation has been calculated as 8 mmky^{-1}. Similar values (7 - 9 mm ky^{-1}) were determined for the middle and upper part of Zone NP10, whereas a hemipelagic accumulation rate of 13 mmky^{-1} was calculated for the lower part of this zone (Egger et al., 2003). Thus, the CIE was associated with a six-fold increase in the siliciclastic hemipelagite sedimentation rate in the Penninic Basin.

Enhanced erosion of land areas around the CIE-interval can also be inferred from the composition of calcareous nannoplankton assemblages. Whereas, in general, reworked Cretaceous species form only 2-3 % of the calcareous nannoplankton assemblages of the Anthering section, substantial Cretaceous admixtures are present in many samples from across the CIE (Fig. 2). The oldest nannoplankton assemblage showing a high percentage (>50 %) of reworked specimens originates from a turbidite bed 22 m below the onset of the CIE. Three metres above the onset of this geochemical marker, the youngest assemblage with a similar percentage of reworked Cretaceous specimens has been found.

Most of the reworked specimens consist of species with long stratigraphic ranges (*Watznaueria barnesae*, *Micula staurophora*, *Retecapsa crenulata*, *Cribrosphaerella ehrenbergii*, *Eiffellithus turriseiffelii*). Biostratigraphically important species that were found in all of the counted samples include *Broinsonia parca*, *Arkhangelskiella cymbiformis* (small specimens), *Calculites obscurus*, *Lucianorhabdus cayeuxii* and *Eiffellithus eximius* whilst *Marthasterites furcatus*, *Eprolithus floralis* and *Lithastrinus grillii* were found only occasionally. This assemblage suggests that predominantly lower to middle Campanian deposits were reworked at the end of the Paleocene. The reworked Campanian nannoflora in the Penninic Basin primarily originates from the inner shelf of the European Plate, whereas the southerly Helvetic unit of the outer shelf displays a stratigraphically much more complete sedimentary record in the Upper Cretaceous and across the Cretaceous/Paleogene boundary.

In the lowermost Eocene (Subzone NP10a) at the Anthering section, 23 layers of altered volcanic ash (bentonites) originating from the North Atlantic Igneous Province have been recorded, about 1,900 km away from the source area (Fig. 15). The Austrian bentonites are distal equivalents of the “main ash-phase” in Denmark and the North Sea basin. Egger & Brückl (2006) have calculated the total eruption volume of this series as 21,000 km^3, which occurred in 600,000 years. The most powerful single eruption of this series took place 54.0 million years ago (Ma) and ejected ca. 1,200 km^3 of ash material which makes it one of the largest basaltic pyroclastic eruptions in geological history. The clustering of eruptions must have significantly affected the incoming solar radiation in the early Eocene by the continuous production of stratospheric dust and aerosol clouds. This hypothesis is corroborated by oxygen isotope values which indicate a global decrease of sea surface temperatures between 1–2°C during this major phase of explosive volcanism.



Sample (ppm)	Nb	Zr	Y	TiO_2
x1	146.0	486.0	40.0	7673
x2	33.0	244.0	15.0	63887
x4	28.0	238.0	36.0	46700
x5a	40.0	225.0	22.0	49700
x6	154.0	490.0	45.0	14000
x7	26.0	615.0	60.0	37000
x12	27.0	254.0	28.0	35696
x13	31.0	213.0	33.0	34028
x16	30.0	222.0	39.0	32360
x17	28.0	225.0	22.0	31786
x18	36.1	258.4	44.4	34432
x19	33.8	254.4	34.5	34342
x20	33.6	252.8	51.9	39103
x21	29.9	218.8	32.8	37819
x22	35.1	308.0	40.0	39954
+19(Fur)	121.0	684.0	42.0	11300

Fig. 15. Immobile element concentrations of the bentonites at Anthering.