

Strontium isotope stratigraphy and oxygen and carbon isotopes in Upper Cretaceous sections of the Eastern Alps

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Several biostratigraphically well dated Upper Cretaceous sections in the Eastern Alps including the Cenomanian-Turonian, the Santonian-Campanian and the Campanian-Maastrichtian boundary interval, were investigated using $\delta^{18}\text{O}$, $\delta^{13}\text{C}$, and $^{87}\text{Sr}/^{86}\text{Sr}$ ratios. Within the section of the Rehkogelgraben near Gmunden (Ultrahelvetic Zone), the Cenomanian-Turonian boundary was investigated, including distinctive black shale horizons and the transition into red marls. The section starts with cyclic deposition of light grey, spotty limestones and medium grey marls where bioturbation is very common. The occurrence of nanofossils (nanofossil standard zone CC 10) indicates a Late Cenomanian age. Limestones display high abundances of planktonic microfossils, e.g. calcispheres and planktic foraminifera. 3 black shale layers are found within the overlying 1 m thick interval where the largest horizon is 16 cm thick. TOC values range around 5 % in this layer, carbonate contents are below 2%. Rock Eval analysis indicates predominant marine organic matter. Above this interval the base of nanofossil standard zone CC 11 is present. The Lower Turonian is characterized by a 2 m succession of white to light grey marly limestones with missing or thin marl intercalations. The marly limestones have high percentages of planktic foraminifera and their carbonate content varies between 65 and 92 %. $^{87}\text{Sr}/^{86}\text{Sr}$ isotope ratios have been increasingly used for stratigraphical correlations and a $^{87}\text{Sr}/^{86}\text{Sr}$ sea water standard curve has been established for the Phanerozoic. A first attempt to correlate biostratigraphy with strontium isotope stratigraphy was made in this section. First results show a slight but significant positive shift of $^{87}\text{Sr}/^{86}\text{Sr}$ isotope ratios compared to the standard curve. $\delta^{13}\text{C}$ shows a well known peak around the Cenomanian-Turonian boundary interval. $\delta^{18}\text{O}$ values give a rough estimate of mid-Cretaceous sea surface temperatures of about 28 – 30°C. This is fairly high compared to $\delta^{18}\text{O}$ values for the Santonian

and Campanian of the same section which indicate sea surface temperatures between 20 and 24° C.

Ammonite, inoceramid, foraminiferal, and nannoplankton multistratigraphic data allow the recognition of the Santonian-Campanian-boundary interval in sections of the Gosau Group (Northern Calcareous Alps). In the Gosau area a fine-grained sandstone with late Santonian ammonites and inoceramids is overlain by a lower Campanian marly succession. Nannofossil data indicate the Santonian-Campanian-boundary in nannofossil standard zone CC 17. Strontium isotope data from the uppermost Santonian (brachiopod shell) indicate an $^{87}\text{Sr}/^{86}\text{Sr}$ isotope ratio of 0.707468 ± 7 . Sr isotope ratios of planktic foraminifera increase in the Lower Campanian up to 0.707590 ± 20 .

In the Gosau Group of the Lattengebirge section near Berchtesgaden (southern Germany) a marly Santonian-Campanian boundary succession is present. Strontium isotope data from planktic foraminiferal tests can be compared to the standard strontium isotope curve and allow a detailed correlation of the Santonian – Campanian boundary to standard sections (0.707479 ± 5 for England, 0.707472 ± 12 for northern Germany). These values for the Santonian - Campanian boundary correspond to a level well below the first occurrence of *Globotruncanita elevata* in the Lattengebirge section. Strontium ratios increase up section to 0.707540 ± 10 .

The Campanian-Maastrichtian boundary was investigated in Gams and Gosau (Northern Calcareous Alps). The position of the *Globotruncanita calcarata* planktic foraminifera Zone in regard to the standard definition of the lower boundary of the Maastrichtian in northern Germany was investigated. Our strontium isotope data for foraminiferal calcite of this zone (around 0.707670) confirm the results that this foraminiferal zone is of Late Campanian age and cannot be correlated to the Campanian-Maastrichtian boundary in northern Germany.

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