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SHORT COMMUNICATION

CARBON-OXYGEN STABLE ISOTOPE STRATIGRAPHY OF THE CRETACEOUS-TERTIARY BOUNDARY INTERVAL; DATA FROM THE BIARRITZ SECTION (SW FRANCE)[1]

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ABSTRACT

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The patterns displayed by the ratios of stable Carbon and Oxygen isotopes of calcareous nannofossil assemblages from the Cretaceous-Tertiary boundary interval in a section near Biarritz closely match those from the same interval in the Gredero section (SE Spain). The data give additional support to the occurrence of a catastrophic event at the end of the Cretaceous that was probably coupled with a drastic increase in temperature and a decrease in marine phytoplankton productivity.

INTRODUCTION

There is probably no other part of the stratigraphic column to which so much attention has been paid in the past two years as the Cretaceous-Tertiary boundary interval. In spite of the joined efforts of a wide spectrum of specialists (varying from micropaleontologists to astrophysicists) the crucial question 'what happened at the end of the Mesozoic?' has still not been answered unambiguously. Heated discussions continue between advocates of a catastrophic, extraterrestrial cause for the drastic changes at the boundary, and others which favour a terrestrial, gradual cause. We think that the argument can only be settled satisfactorily by detailed studies of all aspects of as many as possible, continuous boundary sections using all available techniques.

A rather new technique in paleoceanography is the measurement of the $^{18}O/^{16}O$ and $^{13}C/^{12}C$ ratios of marine calcareous microfossils. In a recent paper (ROMEIN & SMIT, 1981) we already argued that calcareous nannofossils form the most suitable group for this type of investigation in the boundary interval. From measurements on the continuous Gredero section (SE Spain) we arrived at the conclusion that the final

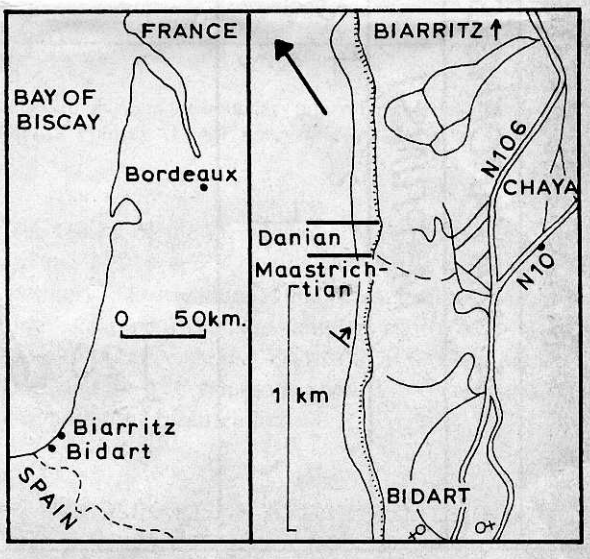

Fig. 1
Location of the Biarritz section (after Perch-Nielsen, 1979)

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Cretaceous event probably was of a catastrophic nature. We here confirm that conclusion with isotopic measurements on the same fossil group from a section near Biarritz (SW France).

THE SECTION

A short section across the Cretaceous-Tertiary boundary is exposed in the coastal cliffs some three kilometers south of Biarritz (PERCH-NIELSEN, 1979; Fig. 1). The sequence consists of grey marls of Late Maastrichtian Age and red and green marls and marly limestones of Early Danian Age, separated by a boundary clay (1 cm.). This clay is rather thin in comparison with the boundary clay in the Gredero section (10 cm.) and the Kef section (30 cm.; ROMEIN & SMIT, in prep.). Iridium was not detected above 12 ppb. (SMIT, 1981; SMIT & TEN KATE, in press).

From the presence of the *Micula prinsii* Zone (latest Maastrichtian) and the *Globigerina eugubina* Zone (earliest Danian) it may be concluded that the section is fairly complete (PERCH-NIELSEN, 1979).

The calcareous nannofossil assemblages are well preserved, although S.E.M. investigations showed a slight degree of calcite overgrowth. The succession of nannofloras is almost identical to the one found in the Gredero section (ROMEIN, 1977): up to the boundary clay (samples 1-8) the assemblages are rich and well diversified, the clay (samples 10a, 10b) contains only Maastrichtian species, and the acme of species of *Thoracosphaera* occurs just above the clay bed (sample 10c). Reworked Maastrichtian nannofossils are, however, less

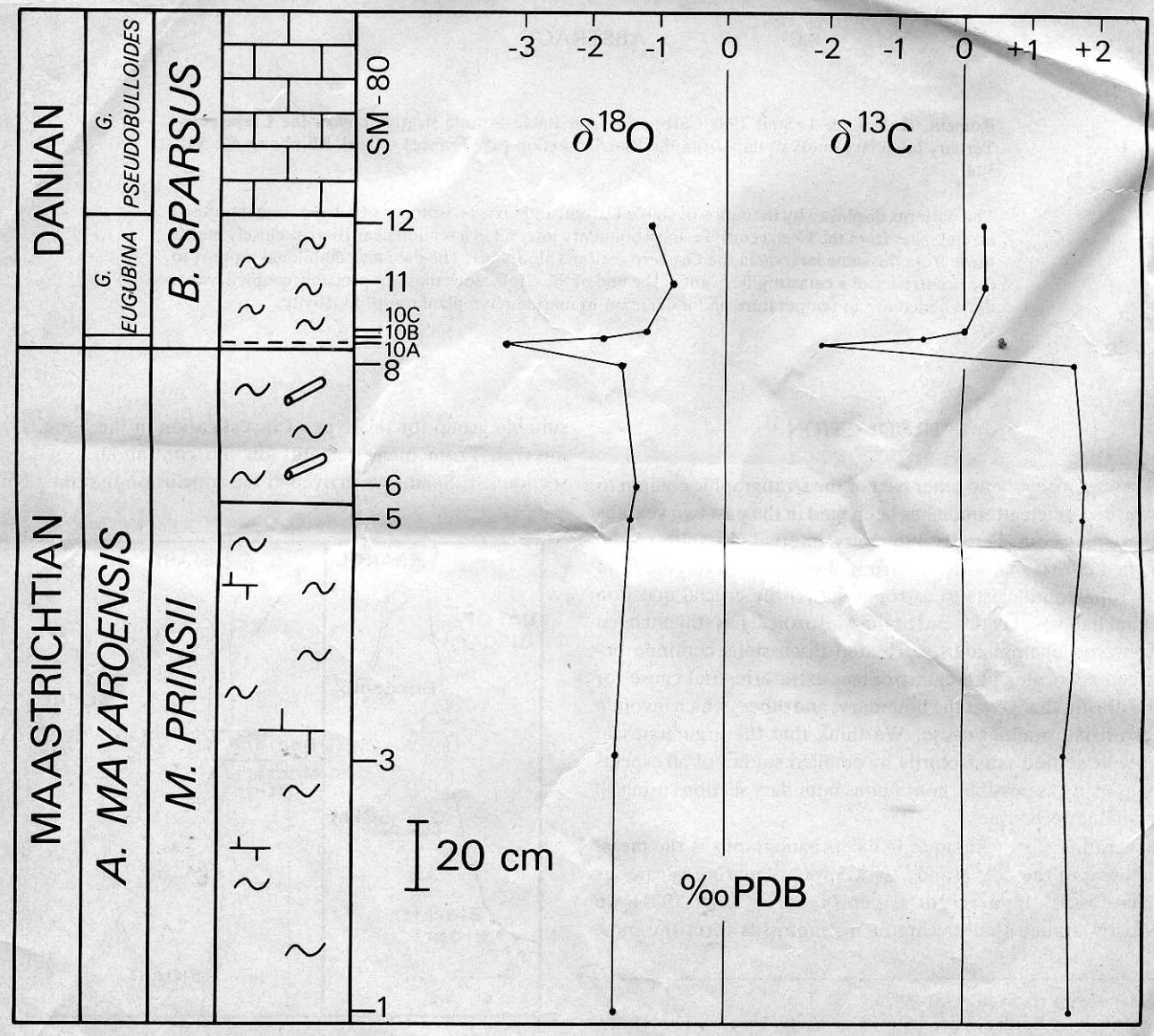

Fig. 2
Chrono-, bio- and lithostratigraphy of the Biarritz section, position of the samples, and isotopic ratios.

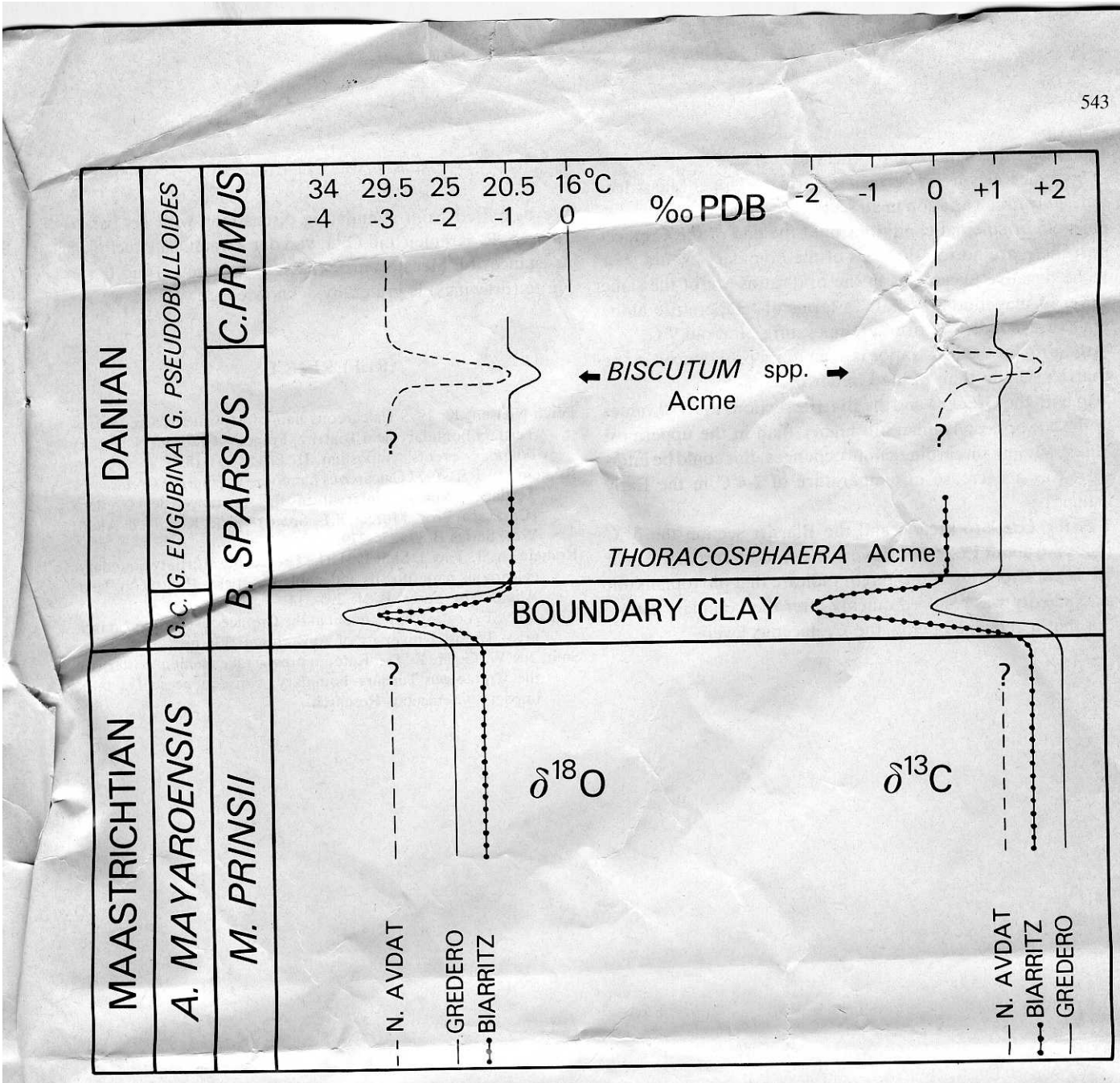

Fig. 3
Composite diagram showing the $\delta^{18}0$ and $\delta^{13}C$ ratios of calcareous nannofossil assemblages in the boundary interval of the Nahal Avdat section (Israel), the Gredero section (Caravaca, SE Spain) and the Biarritz section (SE France). G.c= *Guembelitria cretacea* Zone (Smit, 1981). Relative order of events indicated; no vertical scale.

frequent in the *G. eugubina* Zone than in the same interval in the Gredero section.

THE MEASUREMENTS

The preparation of the samples and the isotopic measurements on these followed standard procedures. The results of the measurements are given in the δ-terminology as per mil deviation relative to the PDB-standard (Cretaceous belemnite from the Pee Dee Formation). Duplicate measurements on all samples showed the accuracy to be of the order of 1 ‰.

The results of the measurements are plotted in figure 2. Both the $\delta^{18}0$ and $\delta^{13}C$ ratios show little variation in the uppermost Maastrichtian. A major excursion towards more negative values occurs in the boundary clay ($\delta^{18}0$: 1.9‰; $\delta^{13}C$: 3.8‰). In the *G. eugubina* Zone, the $\delta^{18}0$ values are slightly higher, and the $\delta^{13}C$ values are about 1‰ lower than those in the uppermost Maastrichtian.

COMPARISON AND CONCLUSIONS

A comparison with data from the Gredero section and the Nahal Avdat section in Israel (ROMEIN & SMIT, 1981) allows the

following observations and conclusions (Fig. 3):

– both the Carbon and Oxygen ratios in the Upper Maastrichtian show little variation in all sections, which points to stable paleoenvironmental conditions until the end of the Cretaceous; there are no foreshadows of the boundary event;

– the negative excursions in the $\delta^{18}0$ ratios are of the same order of magnitude (≈2‰). In terms of temperature alone this corresponds to a rise in temperature of about 9°C;

– the drop in the $\delta^{13}C$ ratios is even more pronounced in the Biarritz section than in the Gredero section;

– in both the Gredero and the Biarritz sections the $\delta^{18}0$ values in the lowermost Danian are higher than in the uppermost Maastrichtian; discarding salinity changes, this could be interpreted as a decrease in temperature of 2-4°C in the Early Danian;

– in the Gredero section and the Biarritz section the $\delta^{13}C$ ratios are about 1‰ less positive in the earliest Tertiary than in the latest Cretaceous; this might indicate that phytoplankton productivity was restored quickly after the boundary event, but that it remained below the Cretaceous level.

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