A NEW NANNOFOSSIL ZONATION SCHEME FOR THE BOREAL CAMPANIAN

Jackie Burnett, Dept. of Geological Sciences, University College London.

INTRODUCTION

In 1975, the Institute of Geological Sciences (now the British Geological Survey) drilled the Trunch Borehole (located in north-eastern Norfolk, eastern England) in order to sample as complete a section of the Upper Cretaceous on the British mainland as possible, to be used as a standard section for correlation purposes in the northern English and southern North Sea area (Gallois & Morter, 1975). Approximately 220m of the borehole are Campanian in age.

As part of an extensive correlation project between macrofossil and nannofossil zonation schemes, approximately 260m of Campanian chalk from the Lagerdorf and Kronsmoor Quarries, located near Hamburg, north-western Germany, were examined for their nannofloral content.

It became apparent that the Campanian nannofloras of the two areas are comparable, both containing a number of Boreal-restricted forms, with a number of characteristically Tethyan zonal marker species being absent. The application of Sissingh's (1977, 1978) standard numbered zonation scheme, supplemented by Perch-Nielsen's nannofossil event observations (1979, 1983, summarised in Bolli et al., 1985) fails between NF Zones CC18 and CC22B, due to the non-, or very rare and stratigraphically sporadic occurrences of *Bukryaster hayii, Ceratolithoides verbeekii, Marthasterites furcatus spp., Ceratolithoides aculeus, Quadrum sissinghii, Quadrum trifidum* and *Lithastrinus grillii.* Additionally, in northern chalks, where calcitic overgrowth on nannofossil specimens tends to obscure fine detail, it is sometimes very difficult to differentiate between *Reinhardtites levis* and *R. anthophorus* when routinely dating by light-microscope, thus the identification of the bases of standard NF Zones CC22C and CC23A can be less than precise.

Correlation between the identifiable Campanian NF zones of the Trunch Borehole and the German quarries revealed a number of interstitial nannofloral events which bridge the gap in Sissingh's (1977) scheme and provide a workable alternative for the Boreal region, possibly including the North Sea area. The new zones are fitted within the framework of Sissingh's scheme (but are distinguished from his zones by the prefix B, for Boreal), in order that their relative positions, with respect to the standard cosmopolitan events, are continuous. Integrated macro- and microbiostratigraphical data on the sections involved will be published elsewhere.

NANNOFOSSIL BIOZONATION

New NF Zones CC/B18 to CC/B22 replace Sissingh's (1977) NF Zones CC18 to CC22, whilst Sissingh's Zone CC17 is divided into Subzones CC/B17a, CC/B17b and CC/B17c, and his Subzone CC23A is subdivided into CC/B23Aa, CC/B23Ab and CC/B23Ac, herein. The zones are defined in Appendix 2.

Figure 1 shows the correlation between the English and German nannofossil events used to define the new (sub-)zones. The stage and macrofossil zonation of the Trunch Borehole is attributed to Morter (1984, unpublished B.G.S. data). Stage and macrofossil data was taken from Schulz et al. (1984) for the German material. Age definitions for the new (sub-)zones are estimated from the German scale, as this has a more refined macrofossil zonation control than has the Trunch Borehole.

Sissingh's (1977) standard nannofossil zones are correlated with the new Boreal zones and, for interest, with the Campanian part of the Sr-isotope curve of McArthur et al. (in press: based on the Trunch Borehole) in Figure 2. A high degree of age-refinement was not possible in the Trunch Borehole, with which to correlate the Sr-isotope curve. From the correlation of nannofossil data between England and Germany, more refined age-assignments can be extrapolated for the curve. A nannofossil species index is given in Appendix 1.

DISCUSSION

A number of industry-orientated Boreal nannofossil zonation schemes have been produced for the Late Cretaceous, based on North Sea well samples. These schemes suffer from having little, or no, biostratigraphical control with which to correlate onshore material, and from the nannofloras being generally much less well preserved than in onshore material. Mortimer (1987) produced a Cenomanian to Maastrichtian scheme for the southern Norwegian and Danish North Sea area, and equated his zones to Sissingh's (1977) scheme by extrapolation. In

particular, he divided the uppermost Hod and lowermost Tor Formations (representing the Lower and Upper Campanian, respectively) into four nannofossil zones, based on the LOs (= first downhole occurrences) of *Orastrum campanensis, Helicolithus trabeculatus, Cylindralithus asymmetricus* (= *C. biarcus*?), *Broinsonia enormis* and *Phanulithus* (=*Calculites*) *obscurus*. In my study, *O. campanensis* was found not to have a correlatable LO between Germany and England, whilst *H. trabeculatus, C.biarcus* and *B. enormis* were found to range beyond the limits defined by Mortimer (probably due to preservation). Varol (1989) used Mortimer's (1987) scheme with some additional events, one of which (the LO of *Tortolithus caistorensis*) approximates to the findings of this study.

CONCLUSIONS

It is hoped that the extensive geographical application of this new biozonation already evinced by this study is applicable to the North Sea area (although I appreciate that the new scheme uses mostly FOs, whereas LOs are of more use, industrially), where correlation of nannofloral events with macrofossil/stage data would prove useful for industrial and research purposes.

ACKNOWLEDGEMENTS

The nannofloras of the Trunch Borehole were first investigated as part of a Ph.D. study funded by the N.E.R.C. in collaboration with B.P. Research plc., the material kindly being made available by the B.G.S.. Supplementary investigation of Trunch Borehole material and of the German material was undertaken as part of a post-doctoral study, funded by the N.E.R.C. (Research Grant No. GR3/6767). Collection of the German material was aided by Dr. Joachim Schonfeld (Bundesanstalt fur Geowissenschaften und Rohstoffe, Hannover), Prof. Jake Hancock, Mr. Ray Parrish and Mr. Graeme Burnett, permission to sample most kindly being given by the Alsen-Breitenburg Cement Company. Thank yous to Dr. K. von Salis Perch-Nielsen and Dr. A.R. Lord for critically assessing the text.

REFERENCES

Gallois R.W. & Morter, A.A. 1975: East Anglia and South-East England District. Mundesley (132) sheet. Trunch Borehole (TG 2933 3455). I.G.S. boreholes 1975, *Inst. Geol. Sci. Rep.* **76/10**, 8-10.

McArthur J.M., Thirlwall M.F., Kennedy W.J., Burnett, J.A., Gale, A.S., Lord, A.R. & Mattey, D. 1990: A Strontium Isotope Stratigraphy for the Upper Cretaceous. *Nature*, in press.

Mortimer C.P. 1987: Upper Cretaceous Calcareous Nannofossil Biostratigraphy of the Southern Norwegian and Danish North Sea Area. *Abh. Geol. B.-A.*, **39**, 143-175.

Perch-Nielsen K. 1979: Calcareous nannofossils from the Cretaceous between the North Sea and the Mediterranean. *IUGS Series A*, **6**, 223-272.

Perch-Nielsen K. 1983: Recognition of Cretaceous stage boundaries by means of calcareous nannofossils. In: Birkelund T., Bromley R., Christensen W.K., Hakansson E. & Surlyk F. (Eds.). "Abstracts - Symposium on Cretaceous Stage Boundaries, Copenhagen, October 18-21, 1983", 152-156.

Perch-Nielsen K. 1985: Mesozoic calcareous nannofossils. In: Bolli, H.M., Saunders, J.B. & Perch-Nielsen, K. "Plankton Stratigraphy", 329-426.

Schulz M.-G., Ernst G., Ernst H. & Schmid F. 1984: Coniacian to Maastrichtian stage boundaries in the standard section for the Upper Cretaceous white chalk of NW Germany (Lagerdorf-Kronsmoor-Hemmoor): Definitions and proposals. *Bull. geol. Soc. Denmark*, **33(1/2)**, 203-215.

Sissingh W. 1977: Biostratigraphy of Cretaceous calcareous nannoplankton. *Geol. Mijnbouw*, **56(1)**, 37-65.

Sissingh W. 1978: Microfossil biostratigraphy and stage-stratotypes of the Cretaceous. *Geol. Mijnbouw*, **57(3)**, 433-440.

Varol O. 1989: Quantitative analysis of the Arkhangelskiella cymbiformis Group and Biostratigraphic usefulness in the North Sea Area. *J. Micropalaeontol.*, **8(2)**, 131-134.

APPENDIX 1: NANNOFOSSIL TAXONOMICAL INDEX

References for, and illustrations of, these species can be found in Perch-Nielsen (1985).

Biscutum dissimilis Wind & Wise in Wise & Wind, 1977
B. magnum Wind & Wise in Wise & Wind, 1977
Broinsonia parca (Stradner, 1963) Bukry, 1969
Calculites obscurus (Deflandre, 1959) Prins & Sissingh in Sissingh, 1977
Heteromarginatus bugensis (Gorka, 1963) Crux in Crux et al., 1982
Monomarginatus quaternarius Wind & Wise in Wise & Wind, 1977
Neocrepidolithus cohenii (Perch-Nielsen, 1968) Perch-Nielsen, 1984a
Orastrum campanensis (Cepek, 1970) Wind & Wise in Wise & Wind, 1977
Prediscosphaera stoveri (Perch-Nielsen, 1968) Shafik & Stradner, 1971
Reinhardtites anthophorus (Deflandre, 1959) Perch-Nielsen, 1968
R. levis Prins & Sissingh in Sissingh, 1977
Staurolithites mielnicensis (Gorka, 1957) Perch-Nielsen, 1968 *sensu* Crux in Lord, 1982

Tortolithus caistorensis Crux in Crux et al., 1982
Tranolithus orionatus (Reinhardt, 1966a) Reinhardt, 1966

APPENDIX 2: FORMAL DESCRIPTION OF ZONES

CALCULITES OBSCURUS PARTIAL RANGE (P.R.) ZONE (CC17) — Sissingh (1977).
Definition: FO of *Calculites obscurus* to the FO of *Broinsonia parca.*
Age: Late Santonian to early Campanian.

CALCULITES OBSCURUS P.R. SUBZONE (CC/B17a) — New subzone
Definition: FO of *Calculites obscurus* to the FO of *Orastrum campanensis.*
Age: Late late Santonian to early early Campanian. Type locality: Lagerdorf Quarry.

ORASTRUM CAMPANENSIS P.R. SUBZONE (CC/B17b) — New subzone
Definition: FO *Orastrum campanensis* to the FO of *Biscutum magnum.*
Age: Early early Campanian. Type locality: Lagerdorf Quarry.

BISCUTUM MAGNUM P.R. SUBZONE (CC/B17c) — New subzone
Definition: FO of *Biscutum magnum* to the FO of *Broinsonia parca.*
Age: Early early Campanian. Type locality: Lagerdorf Quarry.

BROINSONIA PARCA P.R. ZONE (CC/B18) — New zone
Definition: FO of *Broinsonia parca* to the FO of *Staurolithites mielnicensis.*
Age: Early early Campanian. Type locality: Lagerdorf Quarry.

STAUROLITHITES MIELNICENSIS P.R. ZONE (CC/B19) — New zone
Definition: FO of *Staurolithites mielnicensis* to the FO of *Monomarginatus quaternarius.*
Age: Early to middle early Campanian.
Type locality: Lagerdorf Quarry.

MONOMARGINATUS QUATERNARIUS P.R. ZONE (CC/B20) — New zone
Definition: FO of *Monomarginatus quaternarius* to the FO of Reinhardtites levis.
Age: Middle early to early late Campanian. Type locality: Lagerdorf Quarry.
Remarks: *Prediscosphaera stoveri* FOs around the CC22B/CC22C boundary, probably within this zone, and may be useful in cases where the FO of *Reinhardtites levis* is difficult to distinguish.

BISCUTUM DISSIMILIS P.R. ZONE (CC/B21) — New zone
Definition: FO of *Reinhardtites levis* to the LO of *Biscutum dissimilis.*
Age: Early late Campanian. Type locality: Lagerdorf Quarry.

EIFFELLITHUS EXIMIUS P.R. ZONE (CC/B22) — New subzone
Definition: LO of *Biscutum dissimilis* to the LO of *Reinhardtites anthophorus* (or LO *E. eximius*).
Age: Early to late late Campanian. Type locality: Lagerdorf and Kronsmoor Quarries.

TRANOLITHUS ORIONATUS (= *PHACELOSUS*) P.R. ZONE (CC23) — Sissingh 1977
Definition: LO of *Reinhardtites anthophorus* to the LO of *Tranolithus orionatus.*
Age: Latest Campanian to early Maastrichtian.

TRANOLITHUS ORIONATUS P.R. SUBZONE (CC23A) — Perch-Nielsen 1985
Definition: LO *Reinhardtites anthophorus* to the LO of *Broinsonia parca.*
Author: Figured but not defined in Perch-Nielsen (in Bolli et al., 1985).
Age: Latest Campanian to earliest Maastrichtian.

HETEROMARGINATUS BUGENSIS P.R. SUB-SUBZONE (CC/B23Aa) — New sub-subzone
Definition: LO *Reinhardtites anthophorus* to the LO of *Heteromarginatus bugensis.*
Age: Late late Campanian. Type locality: Kronsmoor Quarry.

TORTOLITHUS CAISTORENSIS P.R. SUB-SUBZONE (CC/B23Ab) — New sub-subzone
Definition: LO of *Heteromarginatus bugensis* to the LO of *Tortolithus caistorensis.*
Age: Latest Campanian to earliest Maastrichtian. Type locality: Kronsmoor Quarry.

NEOCREPIDOLITHUS COHENII P.R. SUB-SUBZONE (CC/B23Ac) — New sub-subzone
Definition: LO of *Tortolithus caistorensis* to the LO of *Broinsonia parca.*
Age: Early early Maastrichtian. Type locality: Kronsmoor Quarry.

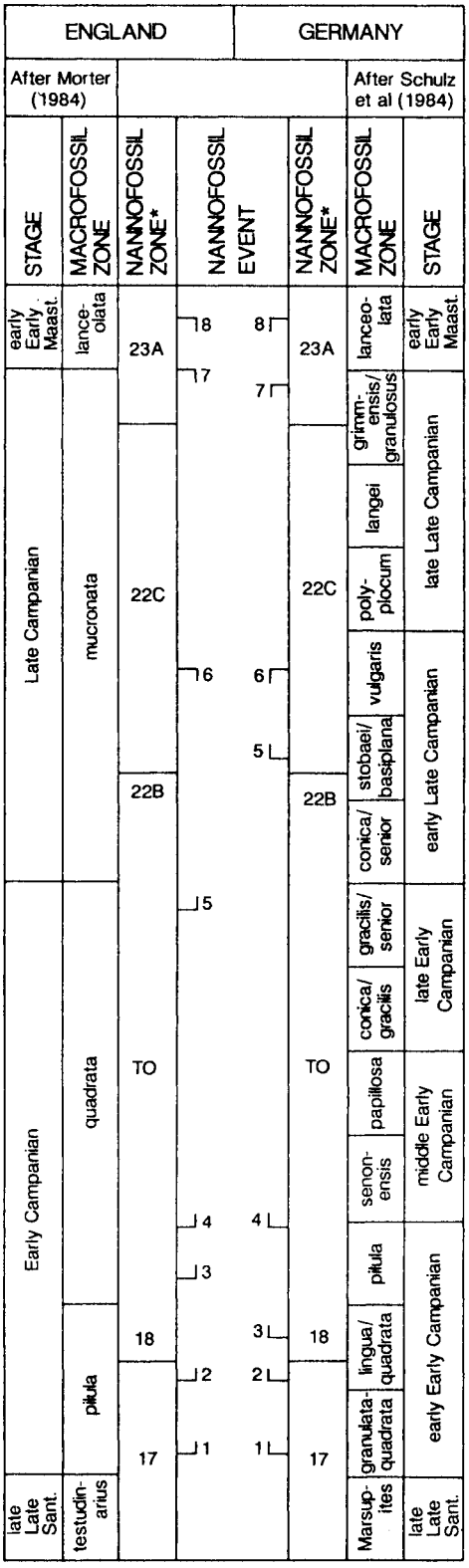

Figure 1: Correlation between English and German Boreal nannofossil events (N.B. macrofossil zones do not necessarily correlate). *After Sissingh (1977, 1978) and Perch-Nielsen (1979, 1983, 1985). Species indicated by numerals explained in Figure 2.

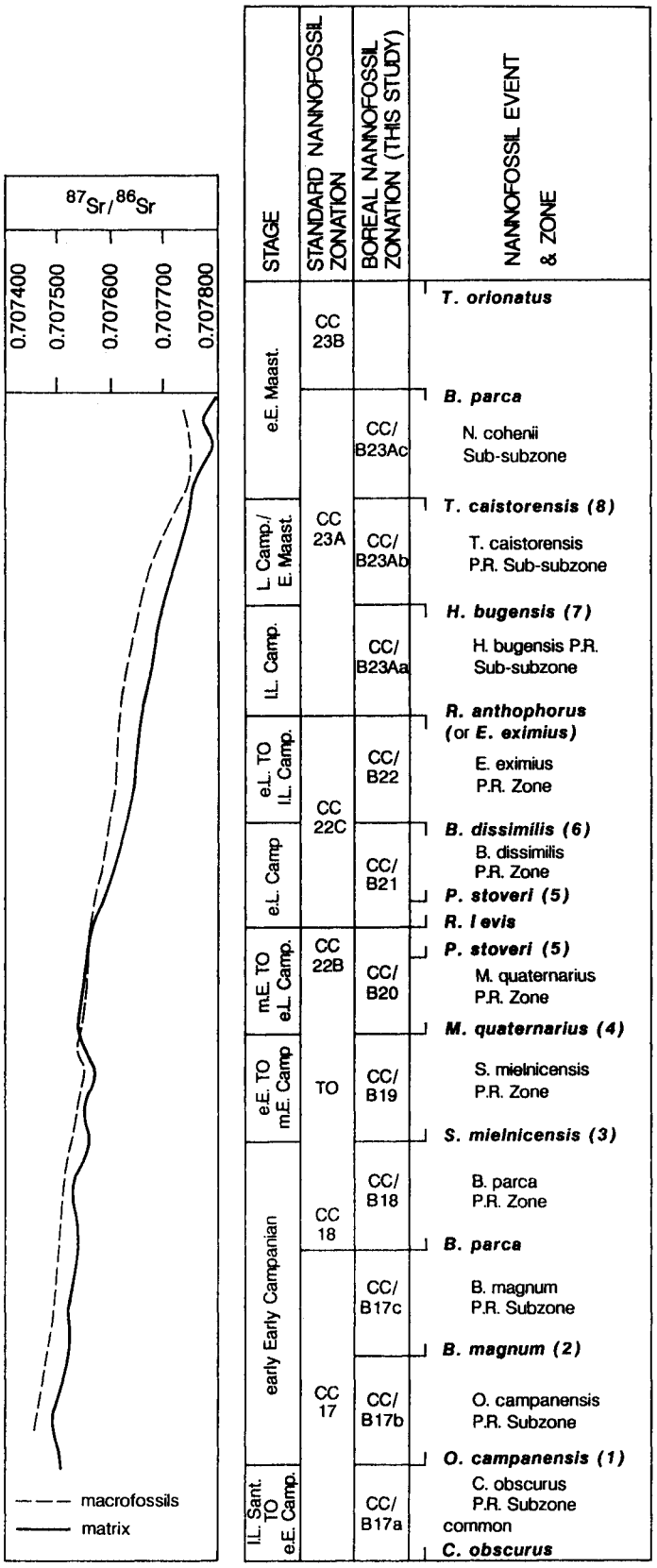

Figure 2: New Boreal zonation scheme correlated with the standard nannofossil zones of Sissingh (1977, 1978) and Perch-Nielsen (1979, 1983, 1985) and the Sr-isotope curve for the Campanian of northern England (after McArthur et al., in press).