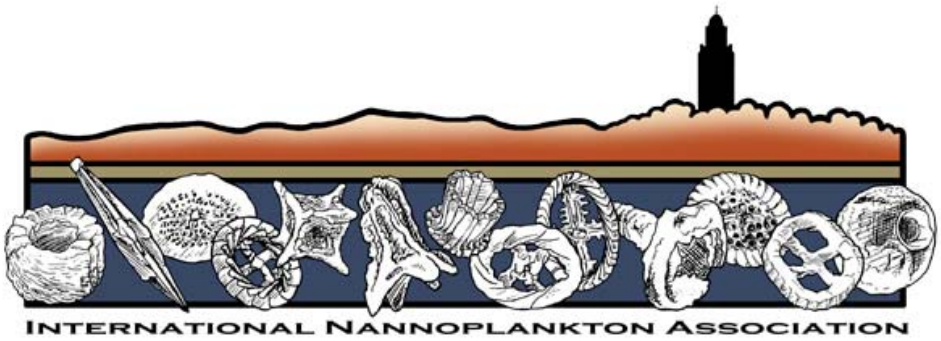
PROGRAM WITH ABSTRACTS

LINCOLN, NEBRASKA

SEPT. 24 - 29, 2006

11TH INTERNATIONAL NANNOPLANKTON ASSOCIATION CONFERENCE



PROGRAM WITH ABSTRACTS

24TH – 29TH SEPTEMBER 2006
LINCOLN, NEBRASKA

THIS CONFERENCE IS HOSTED BY:
UNIVERSITY OF NEBRASKA-LINCOLN

International Nannoplankton Association 11

Schedule of Events

Monday, 25 September

9:00 AM **Welcome and Opening Remarks - David K. Watkins**

Morning Session - Chaired by Paul R. Bown

9:20 AM **Appendage-bearing Syracosphaeraceae - Function and Phylogeny**. Jeremy R. Young, Karen Henriksen, & Markus Geisen

9:40 AM ***Calcidiscus leptoporus* as a Proxy for Summer Warm Subtropical Waters in Lisbon Bay**. Alexandra Silva, Sofia Palma, Teresa Moita, & Paulo Oliveira

10:00 AM **Seasonal and Interannual Dynamics of Coccolith Carbonate Production in the Gulf of Lions (NW Mediterranean Sea)**. K.J. Sebastian Meier, Luc Beaufort, & Serge Heussner

10:20 AM **Morphological and Morphometric variations of *Braarudosphaera bigelowii.*** Kyoko Hagino, Yoshihito, Takano, Yuichiro Tanaka, Takeo Horiguchi, & Hisatake Okada

10:40 AM Break

11:00 AM **Lateral and Vertical Distribution Patterns of Distinct Coccolithophore Morphotypes from a Transect through the South Atlantic Ocean**. Babette Boeckel & Karl-Heinz Baumann

11:20 AM **Holocene Calcareous Nannofossils from the Mira Core (SW Portugal): A Sunspot Proxy in a Coastal Paleo-Ria?** Mário Cachão & M. Conceição Freitas

11:40 AM **Calcareous Nannoplankton as a Proxy of Sedimentary Dynamics in Nazaré Submarine Canyon (West off Portugal)**. C. Guerreiro, M. Cachão, A. Oliveira, & A. Rodrigues

12:00 PM **Coccoliths, dinoflagellates, foraminifers and diatoms in the Late Quaternary Cariaco Basin: the importance of taphonomical overprinting**. Kenneth Mertens & Stephen Louwye

12:20 PM **Multivariate Morphon Analysis Updated**. Áurea Narciso, Mário Cachão, & Rui Taborda

12:40 PM **Lunch**

Afternoon Session - Chaired by Giuliana Villa

2:00 PM **Normalized (Paleo)biogeography: A New Tool for (Paleo)oceanography and (Paleo)ecology.** Mário Cachão

2:20 PM **Calcareous Nannofossil Productivity and Climate Interactions during Pleistocene in a S-N Transect from Antarctic Basin to Chatham Rise**. Claudia Lupi & Miriam Cobianchi

2:40 PM **Carbon Isotopes of Calcareous Nannofossils as a Paleoproductivity Indicator**. Chuanlian Liu

3:00 PM **Paleoceanographic significance of calcareous nannofossils in sediments of the Shaban Deep (northern Red Sea)**. Heiko-Lars Legge & Jörg Mutterlose

3:20 PM **Sea Surface Temperature during Heinrich Events in the NE Atlantic, Evidence from Coccolithophore-based Proxies.** Craig Koch, Jeremy Young, Vicky Peck, & Antoni Rosell

3:40 PM Break

4:00 PM **Poster Session Introductions chaired by Jean Self-Trail & Alyssa M. Peleo-Alampay**

5:20 PM **Poster Session**

Tuesday 26 September

Morning Session - Chaired by Elizabetta Erba

9:00 AM **Trial and Error, Environmental Forcing or Mere Chance – what controls coccolithophore evolution?** Hanno Kinkel, Daniela Crudeli & Jeannette Lezius

9:20 AM **The Uplift of Panama - the Coccolith Side of the Story.** Jeannette Lezius, Hanno Kinkel, Daniela Crudeli, Nils Andersen, & José-Abel Flores

9:40 AM **Upper Miocene Calcareous Nannofossils from Transylvania, Romania**. Carmen Chira

10:00 AM **Middle/Upper Miocene (Sarmatian/Pannonian) Endemical Calcareous Nannoplankton from the Central Paratethys.** Stjepan Ćorić

10:20 AM **High Resolution Calcareous Nannofossil Bioevents: An Example from the Basal Middle Miocene of the Gulf of Mexico**. Richard A. Denne

10:40 AM Break

11:00 AM **A Statistically-derived Microfossil Biozonation of the Miocene and its Application to a Deepwater Gulf of Mexico Field**. Andrew R. Bowman, Roger J. Witmer, Felix M. Gradstein, & Anthony Gary

11:20 AM **Calcareous Nannoplankton Dynamics through the Eocene-Oligocene Boundary – a New Record from the Western Equatorial Indian Ocean**. Tom Dunkley Jones, Paul R. Bown, Paul N. Pearson, Bridget S. Wade, Ian K. McMillan, Chris J. Nicholas, Caroline H. Lear, & Helen K. Coxall

11:40 AM **Middle-Late Eocene Environmental changes and Biomagnetochronology as recognized by calcareous nannofossils at Kerguelen Plateau, Site 738.** Giuliana Villa, Davide Persico, Fabio Florindo, Silvia Palandri, & Luigi Jovane

12:00 PM **Surface-Water Chemistry and Fertility Variations in the Tropical Atlantic across the Paleocene/Eocene Thermal Maximum as Evidenced by Calcareous Nannoplankton from ODP Leg 207, Hole 1259B.** Shijun Jiang & Sherwood W. Wise, Jr

12:20 PM **Lunch**

Afternoon Session -Chaired by Mário Cachão

2:00 PM **Quantification of Plankton Size and Flux Changes Across the Cretaceous/Paleogene Extinction**. Timothy J. Bralower, Sara Geleskie, Michael A. Arthur, & Laurie Eccles

2:20 PM **The Kilwa Group (Cretaceous-Paleogene) Sedimentary Succession from the Kilwa and Lindi areas of Coastal Tanzania (Tanzania Drilling Project): a Nannofossil Konservat-lagerstätte**. Paul R. Bown, Tom Dunkley Jones & Jackie A. Lees

2:40 PM **Differential Interoceanic Surface Water Cooling during the late Campanian as Indicated by Calcareous Nannofossil Assemblage Changes**. Leah J .Schneider & David K. Watkins

3:00 PM **Calcareous Nannofossils from the Crow Creek Member (Pierre Shale): A Hypothesized Resuspension Event from the Late Cretaceous (Campanian) Western Interior Seaway**. Ryan D. Weber & David K. Watkins

3:20 PM **Correlation between Late Cretaceous Calcareous Nannofossil and Strontium Isotope Data from the North Carolina Coastal Plain, USA**. Jean M. Self-Trail & W. Burleigh Harris

3:40 PM Break

4:00 PM **Response of Calcareous Nannofossil Assemblages to Regression of the Niobrara Sea**. Todd M. Boesiger & David K. Watkins

4:20 PM **Calcareous Nannofossil Zonation of the Coniacian/Santonian Stage Boundary, Western Interior and Northern Gulf of Mexico Regions**. Stacie A. Blair & David K. Watkins

4:40 PM **Paleoecological signals in nannofossil assemblages of the Monte Petrano section, Italy.** Andrea Fiorentino

5:00 PM **Calcareous nannoplankton from the Sarcheshmeh Formation in the Kopet-Dogh Range, Northeast Iran**. Fatemeh Hadavi & Maryam Shokri

5:30 PM **Poster Session**

Wednesday 27 September

Morning Session - Chaired by Jörg Mutterlose

9:00 AM **Lower Cretaceous (Aptian-Albian) Calcareous Nannofossil Assemblages from the Southern Apuseni Mountains, Romania.** Ana-Maria Vulc, Carmen Chira, & Alin Igriţan

9:20 AM **Nannofossil Biostratigraphy and Paleoecological Reconstruction of the Turonian-Santonian Interval at ODP Site 1261 (Leg 207): Preliminary Results**. Paola Tamagnini

9:40 AM **Calcareous Nannofossil Biostratigraphy and Paleoecology of the Cenomanian-Turonian Boundary Interval of ODP Leg 207 at the Demerara Rise (Equatorial Atlantic)**. Petros Hardas & Jörg Mutterlose

10:00 AM **Albian-Cenomanian Calcareous Nannofossil Biostratigraphy and Paleoceanography from ODP Site 1258, Demerara Rise.** Denise K. Kulhanek & Sherwood W. Wise, Jr.

10:20 AM **Nannofossils as paleothermometers of the mid-Cretaceous Greenhouse.** Elisabetta Erba & Daniele Tiraboschi

10:40 AM Break

11:00 AM **Pelagic Carbonate Production by Nannoplankton Across the Early Toarcian Anoxic Event**. Emanuela Mattioli, Bernard Pittet, Ivan Bour, Samuel Mailliot, Laurent Petitpierre, Letizia Reggiani, Guillaume Suan

11:20 AM **Spatial and Temporal Changes in Calcareous Nannofossil Assemblages during the Late Callovian-Middle Oxfordian in Southeastern France.** Fabienne Giraud

11:40 AM **Reworked Pliensbachian-Aalenian Nannofossils from Jara Dome, Kutch: Early Jurassic Paleobiogeography of Western India.** Jyotsana Rai

12:00 PM **Lunch**

2:00 PM **INA Business Meeting - Chaired by David K. Watkins**

3:40 PM **Break**

4:00 PM **Workshop on Gulf Coast**

6:30 PM Drinks on 2nd Floor, University of Nebraska State Museum (Morrill Hall)

7:30 PM **INA Banquet, Elephant Hall in University of Nebraska State Museum (Morrill Hall)**

INA11 Poster Presentations

1 **Late Quaternary development of the Java upwelling system (eastern Indian Ocean) as revealed by coccolithophores.** Harald Andruleit, Andreas Lückge, Michael Wiedicke, & Sabine Stäger

2 **Cretaceous and Cenozoic Nannofossil Biochronostratigraphy and Biochronohorizons in Indian Basins.** Qazi Asad Ali

3 **Biogeography and Morphometry of *Calcidiscus leptoporus* s.l. in the Equatorial and South Atlantic**. Karl-Heinz Baumann. Babette Böckel, & Carola Ott

4 **The Use of Triangular Coordinate Diagrams for Paleoenvironmental Interpretation of the Northeastern Brazilian Continental Margin.** Edmundo Camillo, Juliana Quadros, Felipe Toledo, & Karen Costa

5 **Biostratigraphic events in Upper Jurassic and Cretaceous outcrops of Cuba**. Ana Marina Escobar Castro

6 **Upper Cretaceous Calcareous Nannofossils from the Northeastern Trascau Massif – Southern Apuseni Mountains, Romania**. Carmen Chira, Ramona Balc, & Igriţan Alin

7 **Floral changes in calcareous nannofossils and their paleoceanographic significance in the equatorial Pacific Ocean during the last 500,000 years**. Shun Chiyonobu, Tokiyuki Sato, Reika Narikiyo, and Makoto Yamasaki

20 **Separation of nannofossil Size Fractions by Microfiltration: Innovations, Modifications, and Results.** Jackie A. Lees & Fabrice Minoletti

21 **Nannofossil Preservation and Paleoenvironmental Analysis.** Jackie A. Lees, Stuart Robinson, Paul R. Bown, & Jeremy R. Young

22 **Calcareous Nannofossil Biostratigraphy of the Gramame Formation, Pernambuco-Paraíba Basin, Northeast Brazil.** Francisco Henrique De Olivera Lima

23 **Refining Calcareous Nannofossil and Planktonic Foraminiferal Integrated Biostratigraphy of the Last 1.07 Ma: New High-resolution Data from the East New Zealand Pacific Ocean (Chatham Rise IMAGES Core MD97-2114).** Claudia Lupi, Valeria Luciani, Miriam Cobianchi, & Stefano Fabbri

24 **The Pleistocene-Holocene Calcareous Nannoplankton Record off the Coast of Vietnam.** Alyssa M. Peleo-Alampay, Rikki Pamela Pineda, & Martin G. Wiesner

25 **Response of Eocene-Oligocene Nannofossils to Southern Ocean Temperature Variations.** Davide Persico, G. Villa, C. Fioroni, & L. Pea

26 **Contribution to Paleoceanographic Studies of the Western South Atlantic: Preliminary Results of a Nannofossil Survey.** Juliana Quadros, Felip Toledo, Edmundo Camillo, & Karen Costa

27 **Late Cretaceous Nannoplankton zones of South Caucasus.** Azer Rahimli

28 **High Resolution Biostratigraphy of a Well in Campeche Bay.** Ma. Antonieta Sánchez-Rios, Daniel García-Urbano, Patricia Padilla-Avila, Bruno A. Reyna-Tellez, Janett Sánchez-Durán, Mónica Ayala-Nieto, Aaron del Valle-Reyes, Antonio Reyes-Vázquez, José Vicente Ortega González, José Robles Nolasco, Elia Pliego Vidal, Carlos Medina, & Rocio Noriega Nieto

29 **High Resolution Biostratigraphy in Sediments of Two Wells in the Western Gulf of Mexico.** Ma. Antonieta Sánchez-Rios, Mónica L. Ayala-Nieto, Julio C. González-Lara, Aarón del Valle-Reyes, Janett Sánchez-Durán, Patricia Padilla-Avila, Daniel García-Urbano, Cristina Pérez-Castillo, Bruno A. Reyna-Téllez, Antonio Reyes-Vázquez, Paula A. Fuentes-Franco, Guillermo Quintanilla-Rodríguez, Juan Rico-Pérez, & Lidia Aguirre-Meza

30 **Age Range of *Heterolepa* (*Cibicides*) *salensis* Zone of the Northern Caucasus and its Correlation According to Nannofossils**. Andreyeva-Grigorovich Aida Sergeivna & Daniel Odhiambo Waga Dennis

31 **Latest Quaternary High-resolution Nannofossil Biostratigraphy from the Ursa and Brazos-Trinity Minibasins, Gulf of Mexico: Preliminary Results from IODP Expedition 308.** A. Shumnyk, P.B. Flemings, J. Behrmann, C. John, and the Expedition 308 Shipboard Scientific Party

32 **Calcareous Nannofossils from the Upper Cretaceous and Paleogene of the Eastern Azov Region (Ukraine).** Eugene Solyanik

33 **Short-term Climatic Changes in the North Atlantic (ODP Site 980) during the Last 150,000 years as Revealed by Coccolithophore Assemblages.** Katharina Stolz, Karl-Heinz Baumann, & Katharina Jank

34 **Nannofloral Expansion during the Middle Miocene Transgression, Carpathian Foredeep, Czech Republic.** Lilian Švábenická

35 **Calcareous Nannofossil Biostratigraphy and Stable Isotope Stratigraphy (C and O) from the Middle Slope, Quaternary of the Northern Campos Basin, Brazil.** Lucio Riogi Tokutake

36 **Evidence of productivity changes in the western South Atlantic during the last 20 kyr.** Felip Toledo, Karen Badaraco Costa, Maria Gomez Pivel, & Juliana Quadros

37 **Calcareous Nannofossil and Planktonic Foraminiferal Assemblages and Paleoecological Reconstruction of Sapropel S1 in the Southeast Aegean Sea**. Maria V. Triantaphyllou, Assimina Antonarakou, George Kontakiotis, Margarita Dimiza, Patrizia Ziveri, Graham Mortyn, Alexandra Gogou, Vasilios Lykousis, & Michael D. Dermitzakis

38 **Relation of Living Deformed *Distephanus speculum* (Silicoflagellate) and Environmental Indices in Southern Ocean.** Hideto Tsutsui, Shiro Nishida, & Niichi Nishiwaki

39 **Timing of the Initiation of Antarctic Continental Glaciation based on Nannofossil Assemblages from Cores in the Ross Sea**. David K. Watkins

INA11 ABSTRACTS

Late Quaternary development of the Java upwelling system (eastern Indian Ocean) as revealed by coccolithophores

Harald Andruleit, Andreas Lückge, Michael Wiedicke, & Sabine Stäger

Bundesanstalt für Geowissenschaften und Rohstoffe (BGR), Stilleweg 2, 30655 Hannover, Germany
h.andruleit@bgr.de

The paleoceanographic potential of coccolithophores was used to decipher the paleoproductivity changes in the eastern Indian Ocean during the past 300,000 years. Core SO139-74KL was taken at the seaward limit of a fore-arc basin of the Indonesian continental shelf located beneath the Java upwelling system. Coccolithophores occur in all samples, and total coccolith concentration exhibit distinct variations over the entire section. Peak abundances occur every 20,000 to 25,000 years with the highest peak at isotope stage 7. Abundances increase during the glacials but peak abundances also occur during interglacials. The preservation of coccoliths is good to moderate in most of the samples. The most abundant species is *Florisphaera profunda* with a mean relative abundance of 41.5 % followed by *Gephyrocapsa ericsonii* and *Emiliania huxleyi* (EhuxGeric) and *Gephyrocapsa oceanica*. These four taxa dominate the assemblage throughout the core, forming on average 90.5 % of the total assemblage. The species composition suggests that warm tropical conditions prevailed throughout the investigated time period indicating that temperature was not the driving force for the assemblage variations at this site. The geologic record for present-day and Holocene oceanographic conditions seemed to be predominantly characterised by high productivities in combination with an unstable water-column. Indications for oligotrophic open ocean conditions were sparse. However, during most of the year oligotrophic conditions prevail and upwelling recurs only for a short time period but upwelling indicating proxies dominate the geological record. A contrasting fully oligotrophic scenario characterised by peaks in the abundances of total coccolithophores, *U. irregularis*, and in the percentage ratio of EhuxGeric to *G. oceanica* can be seen with a periodical recurrence every 20,000 to 25,000 years. Synchronously the records of the high productivity indicators TOC and *G. oceanica* are characterised by distinct minima. We believe that upwelling was totally cut off during these times and oligotrophic conditions with a pronounced water column stratification prevailed throughout all seasons. An obvious correspondence between the shut down times of upwelling and insolation minima suggests that surface water conditions were driven by orbital forcing.

Cretaceous and Cenozoic Nannofossil Biochronostratigraphy and Biochronohorizons in Indian Basins

Qazi Asad Al

Paleontology lab, KDMIPE, ONGC, Kaulagarh Road, Dehradun – 248001, INDIA.
asadaliqaziin@yahoo.com

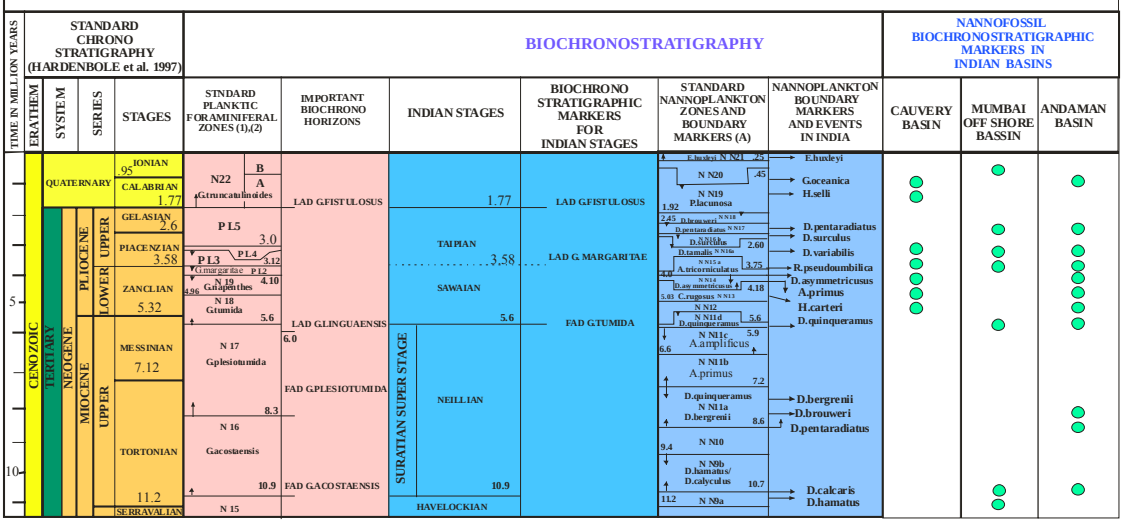
An overview of nannofossil data generated in Indian sedimentary basins is presented. A large amount of data is generated by nannofossil workers on surface sections and sub surface marine sequences of Cretaceous and Cenozoic strata in Indian basins in onshore and offshore. The basins are classified based on tectonic setups and under categories based on relative hydrocarbon prospects also. The sedimentary basins of India, onland and offshore have large aerial extent and twenty six basins have been recognized. The nannofossil data is generated mainly by Paleontologists of Oil and Natural Gas Corporation Limited, Birbal Sahni Institute of Paleobotany, some Universities and researchers. The present work provides an account of calcareous nannofossil events recorded. Fifty five valuable nannofossil events of which twenty seven events in Cretaceous and twenty eight events in Cenozoic basins are recorded. The Hauterivian nannofossils are recorded from Cauvery basin indicating first marine incursion in Early Cretaceous in East coast basins. FAD *Eiffellithus turriseiffelii* indicating (Albian) zone CC-8 is recorded from Dalmiapuram and is also reported from Andaman basin, Narmada Valley and Tethyan Himalaya, FAD *Axopodorhabdus albianus* indicating Albian is recorded from surface section in Trichnapoly area, FAD *Arkhangelskiella cymbiformis* indicating (Campanian) zone CC- 19 is recognized in Manipur, northeastern India, FAD *Quadrum trifidum* of (Campanian) zone CC-21 is recognized in Mud Volcanoes in Baratang Island in Andaman basin. K/T boundary event is recorded in Krishna – Godavari basin, where LAD *Micula murus* has been recorded in the sub surface.
The Paleocene Early Eocene events are recorded in Krishna – Godavari, Cauvery basins and Bombay offshore basins. FAD *Discoaster sublodoensis* indicating (Early Eocene) top of zone NP-13 is recognized in Bombay Offshore Basin and Kutch Basins, LAD *Discoaster barbadiensis / Discoaster saipanensis* (Late Eocene) indicating zone NP 19/20 is recognized in Bombay Offshore basin, Kutch Basin and Krishna- Godavari Basin, LAD *Coccolithus formosus* indicating (Early Oligocene) zone NP-21 is recognized in Bombay offshore basin, Kutch Basin, Krishna - Godavari Basin and Andaman Basin, Precise Paleogene/ Neogene boundary is identified in the sections studied from Kutch basin based on LAD *Reticulofenestra bisecta.* LAD *Helicosphaera ampliaperta* (Early Miocene) indicating zone NN-4 is recorded from, Krishna – Godavari and Bombay off shore basins, the middle Miocene and younger events are recorded from Andaman, Kutch and Bombay off shore basins. An attempt is made to document and tie them with standard biochronostratigraphic scale.

Reference:

Hardenbol, J., Therry, M.B., Farley, Jaquinn, T., Degraciansky, P.C., & Vail, P.R. 1997, Mesozoic Cenozoic sequence chronostratigraphic framework, in DeGracianski, P.C., Hardenbol, J., Jacquin,T., Vail, P.R.and M.B. Farley, eds., Sequence stratigraphy of European Basins: SEPM Special Publication (Preprint)

Raju ,D.S.N (1997) Cretaceous and Cenozoic Biochronostratigraphy with standard and Indian Stages. Bull. of ONGC Vol.34 No.2 pp-31-36

TABLE -2a : CENOZOIC NANNOFOSSIL BIOCHRONOSTRATIGRAPHY



(1)-Cenozoic planktic foraminiferal and calcareous nannofossil biochronostratigraphy and biochronohorizons are after Berggren et al. (1995) ,Coordinated by M. P. Aubry .(see Hardenbol et al., 1997). Data on Indian stages, after Raju, D.S.N (1995)

Biogeography and Morphometry of *Calcidiscus leptoporus* s.l. in the Equatorial and South Atlantic

Karl-Heinz Baumann. Babette Böckel, & Carola Ott

FB Geowissenschaften, Universität Bremen, Postfach 330440, D-28334 Bremen, Germany
baumann@uni-bremen.de

Recent research has indicated that at least some of the apparently globally distributed coccolithophorid species are composed of two or more genotypically discrete species (or sub-species). These species often show subtle morphological differences but may have rather strong ecological differences (e.g., Sáez et al. 2003; Geisen et al., 2004; Quinn et al., 2004). In fact, the biogeographical distributions of several of these discrete species, or sub-species are still poorly known. Thus, we present here a morphometrical evaluation and a revision of the biogeographical distribution of the three (sub-)species of *Calcidiscus leptoporus* in the equatorial and South Atlantic Ocean. The mapping is solely based on surface sediments whereas sediment trap data is added for the morphometrical evaluation of the species.

Calcidiscus leptoporus is a well-established, robust, globally distributed species that has been shown to consist of three sub-taxa or species, variously described as large, intermediate and small morphotypes (e.g., Quinn et al., 2004). It has recently been demonstrated that at least the large and intermediate morphotypes do represent distinct biological species, *C. quadriperforatus* and *C. leptoporus* respectively. Our study of coccolith size measurements and element counts reveals a tri-modal distribution, but also

broadly overlapping margins. Thus, we have not used size as a sole character to distinguish the morphotypes in our mapping, but have added qualitative characters, such as differences in the inner part of the distal shield, to separate them. In the South Atlantic abundances peaks are at higher latitudes, approximately corresponding to the sub-Antarctic polar front and extending north along the Benguela eastern upwelling. Here, the intermediate *C. leptoporus* by far dominates the assemblage, indicating that this species may have an affinity for cooler, nutrient-enriched waters. In contrast, the small *C. leptoporus* morphotype and the large *C. quadriperforatus* both are mainly found in the warm equatorial Atlantic.

References:

Geisen, M., Young, J.R., Probert, I., Garcia Sáez, A., Baumann, K.-H., Bollmann, J., Cros, L., De Vargas, C., Medlin, L.K. & Sprengel, C. 2004. Species level variation in coccolithophores. In: Thierstein, H.R. & Young, J.R. (Eds.), *Coccolithophores – From Molecular Processes to Global Impact*. Springer-Verlag, Heidelberg, pp. 327-366.

Quinn, P.S., Garcia Sáez, A., Baumann, K.-H., Steel, B.A., Sprengel, C. & Geisen, M. 2004. Coccolithophorid biodiversity: Evidence from the cosmopolitan species *Calcidiscus leptoporus*. In: Thierstein, H.R. & Young, J.R. (Eds.), *Coccolithophores – From Molecular Processes to Global Impact*. Springer-Verlag, Heidelberg, pp. 299-326.

Sáez, A.G., Probert, I., Geisen, M., Quinn, P., Young, J.R. & Medlin, L.K. 2003. Pseudo-cryptic speciationin coccolithophores. *Proc. Nation. Acad. Sci. USA*, 100: 7163–7168.

Calcareous Nannofossil Zonation of the Coniacian/Santonian Stage Boundary, Western Interior and Northern Gulf of Mexico Regions

Stacie A. Blair & David K. Watkins

Department of Geosciences, University of Nebraska, Lincoln, NE 68588-0340, USA
smiles_72981@hotmail.com

The Ten Mile Creek area (Dallas, TX) is a proposed Global Stratotype Section and Point (GSSP) candidate for the Coniacian/Santonian stage boundary. A thorough biostratigraphic overview is necessary before consideration for adoption. The Santonian Working Group recommends the speciation of *Inoceramus (Cladoceramus) undulatoplicatus* as the diagnostic macrofossil bioevent for the base of the Santonian stage, however, studies are still needed to determine utility of micropaleontologic bioevents for this boundary. Calcareous nannofossils were examined from sediments of the Bruceville Marl within the proposed GSSP Ten Mile Creek area and from well-preserved sediments of the coeval Smoky Hill Member type area (western Kansas). Correlation of nannofossil bioevents with the lowest stratigraphic occurrence of *I. undulatoplicatus* provides a high resolution biostratigraphic framework and stratigraphic proxy necessary for the Coniacian/Santonian transition.

Six bioevents are useful for recognition of the Coniacian/Santonian transition within the Bruceville Marl and Smoky Hill Member. The first occurrences of *Amphizygus* n.sp. and *Prediscosphaera* cf. *P. grandis* as well as the first occurrences of two rare taxa, *Orastrum campanensis* and *Tortolithus* n. sp., are coincident with the

lowest stratigraphic occurrence of *I. undulatoplicatus*. In addition, two nannofloral acmes occur near the boundary, *Watznaueria quadriradiata* and *Zeugrhabdotus scutula* (the latter is only witnessed within Niobrara sediments). From their relative abundance data and stratigraphic proximity to *I. undulatoplicatus'* first occurrence, *Amphizygus* n.sp. and *Prediscosphera* cf. *P. grandis* bioevents have the most nannofossil biostratigraphic utility for the Coniacian/Santonian transition within Western Interior and northern Gulf of Mexico sediments.

Lateral and Vertical Distribution Patterns of Distinct Coccolithophore Morphotypes from a Transect through the South Atlantic Ocean

Babette Boeckel & Karl-Heinz Baumann

FB 5 Department of Geosciences, University of Bremen, P.O. Box 330440, Bremen, 28334, Germany
bboeckel@uni-bremen.de

Many coccolithophore species show a global distribution, seeming to be capable of tolerating a wide spectrum of ecological conditions. However, recent fine-scale morphological and genetic studies have revealed the presence of different subspecies within formerly regarded species entities (Sáez et al., 2003; Geisen et al., 2004).
This study aims at the detection of the ecological affinities of different morphotypes. We therefore examined coccolithophore plankton communities from various photic zone depth profiles (0-220 m) collected throughout the South Atlantic Ocean. The species complexes in focus include *Calcidiscus leptoporus*, *Emiliania huxleyi*, and *Umbellosphaera tenuis*. In order to identify possibly different ecological preferences of the various types, their cell concentrations were related to the hydrographic conditions of the water-column.

Distinct distribution patterns can be observed for the several types that appear to be related to certain ecological conditions. For example, among the three subspecies *C. leptoporus* small is associated with highest nutrient levels, whereas *C. leptoporus* ssp. *leptoporus* exhibits rather broad ecological tolerances. *E. huxleyi* var. *corona* is the dominant variant in the Subtropical Gyre waters. Within the Subtropical Frontal Zone Type II of *U. tenuis* reaches high percentages (Fig. 1). To check whether the plankton distribution patterns can be tracked in the sediment, underlying surface sediments were examined. In large part the distribution patterns are also observed in the sediment (Fig. 1) implying further palecological potential that lies in the separation of the morphotypes.

References:

Geisen, M., Young, J.R., Probert, I., Sáez, A.G., Baumann, K.-H., Sprengel, C., Bollmann, J., Cros, L., de Vargas, C., Medlin, L.K., 2004. Species level variation in coccolithophores. In: Thierstein, H.R. and Young, J.R. (eds.), Coccolithophores – From molecular processes to global impact, 327-366, Berlin (Springer).

Sáez, A.G., Probert, I., Geisen, M., Quinn, P., Young, J.R., Medlin, L.K., 2003. Pseudo-cryptic speciation in coccolithophores. Proceedings of the National Academy of Sciences of the United States of America, 100 (12), 7163-7168.

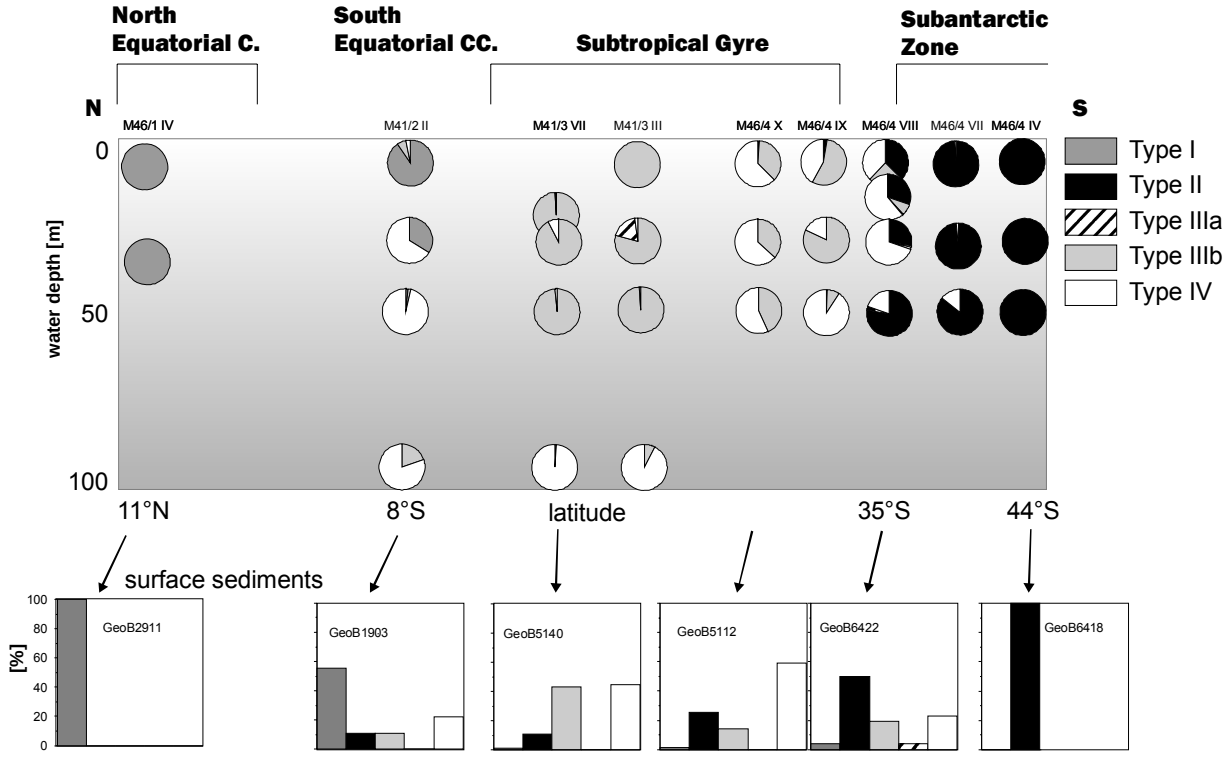


Fig. 1 Relative percentage of *U. tenuis* types

Response of Calcareous Nannofossil Assemblages to Regression of the Niobrara Sea

Todd M. Boesiger[1] *& David K. Watkins*[2]

[1]BP America, Inc, 501 Westlake Park Blvd, Houston, TX 77079, U.S.A.
[2]Department of Geosciences, University of Nebraska, Lincoln, NE 68588 U.S.A.
Todd.Boesiger@bp.com

A section of the lower Campanian Niobrara Formation was sampled for calcareous nannofossils in order to characterize water-mass conditions that influenced phytoplankton productivity during the regression of an epeiric sea at the transition from the calcareous Smoky Hill Member of the Niobrara Formation to the overlying, non-calcareous, Sharon Springs Member of the Pierre Shale. This transition reflects the departure of a productive water-mass during the regression of the longest second-order cycle in the Western Interior Seaway during the Late Cretaceous. Alternating limestone and marlstone beds in this uppermost portion of the Smoky Hill Member record the variation between sediments with high calcium carbonate content and those of increased terrigenous components, respectively. Bulk sediment is compared statistically with assemblage counts of calcareous nannofossils. The behaviors of two species, *Biscutum*

constans and *Prediscosphaera cretacea*, influence assemblage variance over the section examined. In the lower interval these species indicate subtle changes in productivity in a well-preserved, diverse assemblage. In the upper interval, an excursion toward increased magnetic susceptibility correlates with decreased surface water fertility and temperature in the upper interval as inferred from nannofossil assemblages. It is interpreted that the underlying stable assemblage was interrupted not by the culmination of a prolonged decline of productivity in the surface waters, but the sudden decrease in fertility coincident with the departure of the productive water-mass and a cooling climate. These changes occurred before the conformable contact with the overlying Sharon Springs Member of the Pierre Shale.

A Statistically-derived Microfossil Biozonation of the Miocene and its Application to a Deepwater Gulf of Mexico Field

Andrew R Bowman[1], Roger J Witmer[1], Felix M Gradstein[2], & Anthony Gary[3]

[1] Chevron Energy Technology Company, 1500 Louisiana Street, Houston, 77002, USA
[2] Geological Museum, University of Oslo, N-o318 Oslo, Norway
[3] Energy & Geoscience Institute, University of Utah, 423 Wakara Way, Salt Lake City, 84105, USA
Andy.Bowman@chevron.com

In an attempt to refine Chevron's Gulf of Mexico deepwater Miocene biozonation, a statistically rigorous methodology was applied to the extensive micropaleontological database of wells penetrating the Miocene. Over a two year period, we analyzed, in an integrated manner, the stratigraphic distribution of calcareous nannofossil and foraminiferal species that resulted in improvements in age-dating and correlation for both exploration and development scale projects. Our approach was to first begin with a detailed evaluation and validation of bioevents of many hundreds of Miocene age taxa using hardcopies of species distribution charts (BugCAD plots), followed by analysis of results processed through specialized computer software (IPS and BioSlot). This process yielded the placement of the more common types of bioevents (species range tops and bases), and in addition aided in the discernment of new, useful, subordinate bioevents. All bioevents were then analyzed using the ranking and scaling probabilistic sequencing method (RASC), and the correlation and scaling in time method (CASC). The RASC/CASC methods resulted in the most probable order, termed the "optimum sequence" for the Miocene age biostratigraphic events. This optimum sequence has been empirically validated by its successful application to correlations during drilling wells and in multiple-well projects on a development scale in a deepwater Gulf of Mexico field.

The Kilwa Group (Cretaceous-Paleogene) Sedimentary Succession from the Kilwa and Lindi areas of Coastal Tanzania (Tanzania Drilling Project): a Nannofossil Konservat-lagerstätte

Paul R. Bown, Tom Dunkley Jones & Jackie A. Lees

Department of Earth Sciences, University College London, Gower Street, London, WC1E 6BT; UK.
p.bown@ucl.ac.uk

Calcareous microfossils from Paleogene hemipelagic clays of Tanzania were first described in the foraminiferal work of Blow and Banner (1962), who described new species of planktonic foraminifers and several biozones from the Lindi area. The Tanzanian Drilling Project (TDP) has returned to this area, with the primary aim of recovering pristinely preserved foraminifera and organic biomarkers for geochemical analysis in order to improve records of late Mesozoic-Paleogene tropical sea-surface temperatures and pCO_2 (Pearson et al., 2004). In addition to glassy foraminifera, the material also yields spectacularly diverse and well-preserved calcareous nannofossil assemblages that essentially constitute a long time-series Konservat-Lagerstätte. Using light microscopy we have so far described 86 new species from the Paleogene and more are in preparation from the Upper Cretaceous (Bown, 2005; Bown and Dunkley Jones, 2006). In many cases these new taxa significantly add to existing diversity estimates for many nannofossil families, and provide fascinating insights into the deep-time history and originations of extant groups. The data also demonstrate the dramatic diversity gradient that existed between Eocene shelf and ocean assemblages, arguably the most striking in the group's history, and representing, for the middle Eocene, a difference of three to four times. This contrast appears to be partly taphonomic and partly paleoecologic, but in any case provides fascinating additional information for critical intervals such as the Paleocene-Eocene and Eocene-Oligocene boundaries. Although hampered by the clay-rich nature of the sediments, preliminary scanning electron microscope study is revealing the exquisite nature of the preservation. In many well-known taxa additional grills and bars are present, but most striking is the presence of abundant holococcolith material, very small coccoliths (<2 μm) and coccoliths with delicate and intricate central area structures which have not been previously documented.

References:

Blow, W.H. & Banner, F.T., 1962. The Mid-Tertiary (Upper Eocene to Aquitanian) Globigerinacea. *In*: Eames, F.T. et al. (Eds). *Fundamentals of mid-Tertiary Stratigraphic Correlation*. Cambridge University Press, Cambridge, 61–151.

Bown, P.R. 2005., Paleogene calcareous nannofossils from the Kilwa and Lindi areas of coastal Tanzania: Tanzania Drilling Project Sites 1 to 10. *Journal of Nannoplankton Research,* 27, 21-95.

Bown, P.R. & Dunkley Jones, T., 2006. New Paleogene calcareous nannofossil taxa from coastal Tanzania: Tanzania Drilling Project Sites 11 to 14. *Journal of Nannoplankton Research,* 28, 17-34.

Pearson, P.N. et al., 2004. Paleogene and Cretaceous sediments cores from from the Kilwa and Lindi areas of coastal Tanzania: Tanzania Drilling Project Sites 1 to 5. *Journal of African Earth Sciences*, 39, 25-62.

Quantification of Plankton Size and Flux Changes across the Cretaceous/Paleogene Extinction

Timothy J. Bralower, Sara Geleskie, Michael A. Arthur, & Laurie Eccles

Department of Geosciences, Pennsylvania State University, University Park, PA 16802
bralower@geosc.psu.edu

The K/P extinction involved the loss of more than 90% of nannoplankton and planktonic foraminiferal species. The recovery of both groups included the appearance of dwarf taxa that existed along with opportunistic disaster taxa such as the nannoplankton *Braarudosphaera* and *Thoracosphaera*. Investigation of the ecology of the earliest Danian plankton, especially nannoplankton, is made difficult by their small size, and by the labor-intensiveness of high-resolution assemblage counts. Moreover, there have been no attempts to quantify the flux of the different groups. We use a Malvern Mastersizer, an instrument that optically measures particles between 0.1 and 1000 micron in size to obtain grain size data from the earliest Danian. We have investigated a detailed series of samples taken at intervals between 5 and 20 kyr from Ocean Drilling Program Sites 1212 (Shatsky Rise, Pacific Ocean) and 1262 (Walvis Ridge, South Atlantic Ocean). Orbital time scales at both sites provide precise time control and the paleontological record of the early Danian recovery is expanded and complete at both sites. The dominant earliest Paleocene nannoplankton taxa are highly differentiated in terms of size ranging from miniscule (*Neobiscutum* and early *Prinsius* are mostly 1-2 microns), to intermediate (*Ericsonia, Cruciplacolithus*, 4-8 microns) to very large (whole specimens of *Thoracosphaera* are >20 microns). Data from both sites clearly show the dominance of disaster forms and the dwarf planktonic foraminiferal taxa (20-40 microns) for 30 kyr after the boundary followed by the progressive appearance of the miniscule Danian nannofloras, then of intermediate nannoplankton taxa at ~200 kyr post K/P. Grain size distributions suggest a dramatic increase in the flux of planktonic foraminifera relative to nannoplankton at the K/P boundary followed by sequential, short-term phases of dominance of the two groups. Similarity between the two sites suggests that the evolutionary trends are global as are ecological factors that controlled the relative dominance of nannoplankton and planktonic foraminifera. We speculate that the successive intervals of dominance of the two groups were driven by short-term experimentation with new ecological strategies during the recovery interval.

Normalized (Paleo)biogeography: A New Tool for (Paleo)oceanography and (Paleo)ecology

Mário Cachão

Centro and Departamento de Geologia, Fac. Sciences Univ. Lisbon, Campo Grande, Edif, C6, 1749-016 Lisboa, Portugal.
mcachao@fc.ul.pt

Studies on coastal facies are still an exception among calcareous nannoplankton specialists and even fewer works relate species abundance between neritic and oceanic sample sets. In this sense, a method able to provide overall comparisons while yielding a typical signature for oceanic and neritic lith assemblages would be helpful.

Here we propose a new application for an already old geochemical method, the normalized multi-element diagrams or normalized spider diagrams (Rollinson, 1994), in which chemical elements are replaced by *taxa*. A key element for such diagrams is the definition/selection of a standard, in our case, mean Coccolithophore abundances, for example, for the Atlantic Ocean; on another words, the type abundances of calcareous nannoplankton (liths per gr.) on Atlantic surface sediments (or their fluxes along the water column; a seasonal depending and thus more complex task). Such oceanic standard can subsequently be used to analyze and interpret calcareous nannoplankton abundances in sediments from the surrounding shelf areas. Recent work on nannolith *s.l.* abundances from present day and Holocene shallow (paleo)environments along Western Iberia Atlantic coasts (Alday et al., 2006; Cearreta et al., 2004; Ferreira & Cachão, 2005; Guerreiro, 2005; Guerreiro et al., 2005) will be used to illustrate this approach (Fig. 1).

Once standards for the Atlantic, Indian, Pacific Oceans or for other particular areas (e.g. the Mediterranean) are defined and obtained this method have the potential to become a powerful tool in calcareous nannoplankton (paleo)biogeography (Fig. 2).

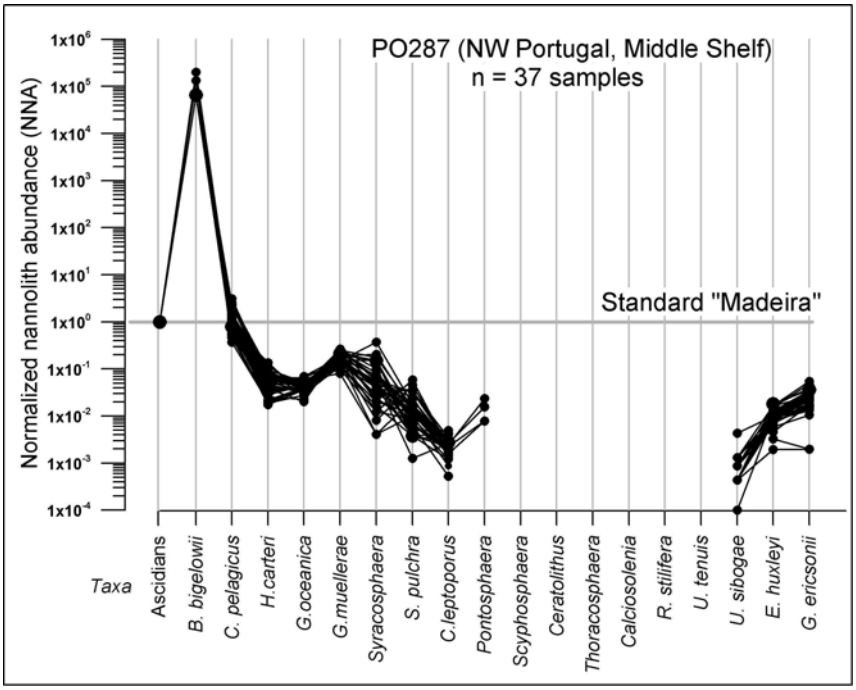


Fig. 1 Example of a normalized diagram of calcareous nannoplankton assemblages retrieved from the neritic core PO287 (data from Guerreiro, 2005) using as oceanic standard mean calcareous nannoplankton abundances from 5 surface samples off Madeira island (Eastern Atlantic). Values on the horizontal line (normalized abundance of 1) indicate species with similar to the standard abundances (in the ascidians case this indicates that in both PO287 and Madeira sample sets no spicules of this group were found). Typical neritic species disclose values above the standard line (in this case *B. bigelowii* was found five orders of magnitude higher than the standard). Values below are indicative of a neritic deficit on their respective *taxa* when compared to the oceanic domain. Species with no values indicate absence from NW Portuguese

middle shelf . After plotting the 37 samples a coherent picture (spider diagram) is obtained defining the neritic signal for this particular data set.

References:
Alday, M.; Cearreta, A.; Cachão, M. Freitas, M.C.; Andrade, C. & Gama, C. (2006) Micropaleontological record of the Holocene estuarine and marine stages in the Corgo do Porto rivulet (Mira River, SW Portugal), *Estuarine Coastal and Shelf Science*, 66: 532–543.
Cearreta, A.; Cachão, M.; Cabral, M.C.; Bao, R. & Ramalho (2004) Lateglacial and Holocene environmental changes in Portuguese coastal lagoons 2: microfossil multiproxy reconstruction of the Santo André coastal área. *Holocene* 13 (3): 447–458.
Ferreira, J. & Cachão, M. (2005) Calcareous nannoplankton from the Guadiana estuary and Algarve continental shelf (Southern Portugal): An ecological model, *Thalassas* 21 (1): 35-44.
Guerreiro, C. (2005) Nanoplâncton calcário como traçador da sedimentação marinha em domínio nerítico e parálico (NW de Portugal). *Master thesis Dep. Geology Fac. Sciences Univ. Lisbon*: 192 p.
Guerreiro, C., Cachão, M. & Drago, T. (2005) Calcareous nannoplankton as a tracer of the marine influence on the NW coast of Portugal, over the last 14000 years. *J. Nannoplankton Res*. 27(2): 59–172.
Rollinson, H. (1994) Using geochemical data: evaluation, presentation, interpretation. *Longman Group UK Ltd.*, 352 p.

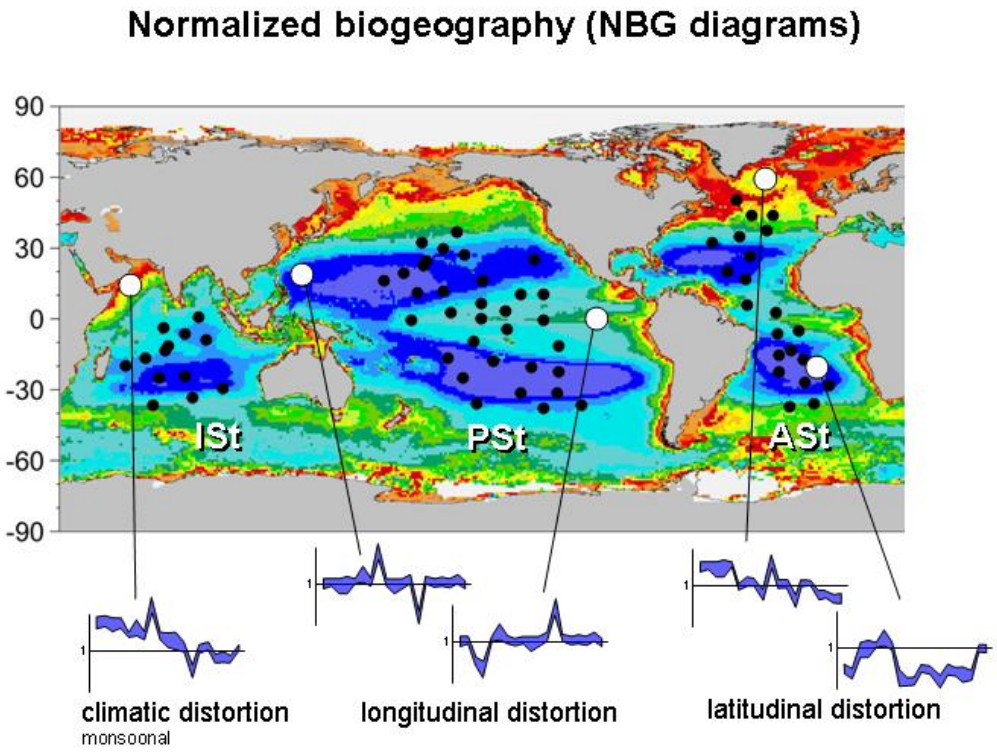


Fig. 2 Examples of hypothetical normalized biogeography (NBG) diagrams. If similar sequences of taxa are used on all cases (see Fig. 1), each diagram will disclose a unique signature (relative to a specific oceanic standard) that become characteristic of a particular climatic and/or oceanographical setting. Base picture from SEAWIFS chlorophyll (www.rutgers.edu). ISt, PSt, ASt – hypothetical sample sets used to compute the Indian, Pacific and Atlantic standards, respectively.

Holocene Calcareous Nannofossils from the Mira Core (SW Portugal): A Sunspot Proxy on a Coastal Paleo-Ria?

Mário Cachão & M. Conceição Freitas

Centro and Departamento de Geologia, Fac. Sciences Univ. Lisbon, Campo Grande, Edifício C6, 1749-016 Lisboa, Portugal.
mcachao@fc.ul.pt

The MIRA CP1 core was retrieved from a present day flat-floored small fluvial valley, tributary of the Mira River (SW Portugal; Fig. 1) approx. 5km upstream of its mouth. A 27-m-long bore-hole recovered a continuous and almost complete Holocene sedimentary sequence directly overlaying Paleozoic schists and greywackes allowing a high resolution study of its micropaleontological content (Alday *et al.*, 2006). From this study it was possible with a single core to confirm the post-glacial paleoenvironmental model for the Portuguese coast based on 5 stages: i) a coccolith-barren lower fluvial stage; ii) a coccolith intermittent lower estuarine stage; iii) a coccolith rich marine (ria) stage; iv) a coccolith intermittent upper estuarine/lagoonal stage and v) a coccolith-barren upper fluvial stage (Freitas *et al.,* 2003; Cearreta *et al.*, 2003; Guerreiro *et al.*, 2005). 192 5-cm equal spaced samples were taken from the interpreted marine (ria) section of the core, between -4 and -16m depths, and prepared according to Flores & Sierro (1997) technique adapted to neritic facies (Ferreira & Cachão, 2003).

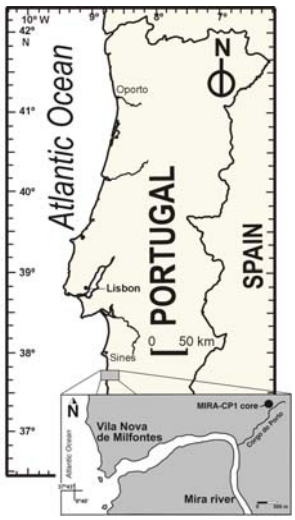


Fig. 1 – Location map of the studied core MIRA CP1.

Factor Analysis retrieved two major factors from the coccolith assemblages. Factor 1 (24% var.) is more strongly influenced by oceanic dwelling taxa (*e.g. G. muellerae* and *U. sibogae*) while Factor 2 (23% var.) is related to coastal neritic taxa (*e.g.* Ascidian spicules, *C. pelagicus braarudii*, *H. carteri* and *B. bigelowii*). Their scores tend to dominate during a lower and an upper sector, respectively, confirming the existence of two episodes of marine colonization inside the Holocene paleo-ria (Alday *et al.,* 2006).

Cyclicity on calcareous nannoplankton time series was subsequently investigated by performing spectral analysis on F1 and F2 scores. F1 score periodogram discloses three significant periodicities (450, 350 and 236-yrs) and a less significant fourth

periodicity (140-yrs) while F2 score periodogram discloses only one significant periodicity (228-yrs) and a less important one (119-yrs) (Fig. 2).

Such centennial periodicities are not commonly registered in geological time series, being quite below sub-Milankovitch frequencies but too long to allow direct comparisons with instrumental records of Climate. Some authors have explored possible links between solar influence on the Climate (Bond *et al.*, 2001) giving clues to find possible causes for millennial and centennial cycles. To further investigate this question, our frequencies are compared to sunspot (observed + estimated by cosmogenic nuclides; Vaquero *et al.*, 2002; Solanki *et al.*, 2005, Fig. 2), NAO monthly indexes (Luterbacher *et al.*, 1999, 2002) and North Atlantic storm records (Hickey, 2005).

Results from comparing these time series will be presented and discussed.

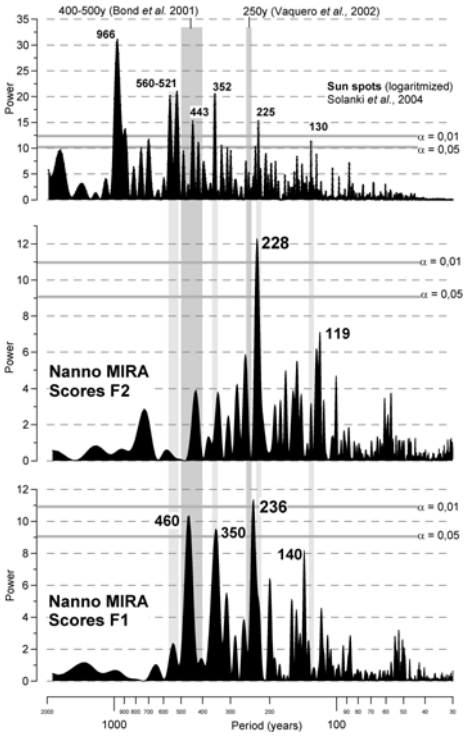


Fig. 2 – Periodogram of sunspot time series (data from Solanki *et al.*, 2005) compared to periodograms obtained from F1 and F2 scores for calcareous nannoplankton time series, from the marine (ria) sector of the MIRA CP1 core.

References:

Alday, M.; Cearreta, A.; Cachão, M. Freitas, M.C.; Andrade, C. & Gama, C. (2006) Micropaleontological record of the Holocene estuarine and marine stages in the Corgo do Porto rivulet (Mira River, SW Portugal), *Estuarine Coastal and Shelf Science*, 66: 532–543.

Bond, G.; Kromer, B.; Beer, J.; Muscheler, R.; Evans, M.N.; Showers, W.; Hoffmann, S.; Lotti-Bond R.; Hajdas, I. & Bonani, G. (2001) Persistent solar influence on North Atlantic Climate during the Holocene, *Science* 294: 2130–2136.

Cearreta, A.; Cachão, M.; Cabral, M.C.; Bao, R. & Ramalho (2004) Lateglacial and Holocene environmental changes in Portuguese coastal lagoons 2: microfossil multiproxy reconstruction of the Santo André coastal area. *The Holocene* 13 (3): 447–458.

Ferreira, J. & Cachão, M. (2003) Nanofósseis calcários em fácies costeiras: revisão de técnicas de estudo. *Ciências da Terra (UNL), Lisboa, nº esp. V*: pp. A76–A78.

Flores, J.A. & Sierro, F.J. (1997) revised techniques for calculation of calcareous nannofossil accumulation rates. *Micropaleontology*, 43 (3): pp. 321–324.

Freitas, M.C.; Andrade, C.; Rocha, F.; Tassinari, C.; Munhá, J.M.; Cruces, A.; Vidinha, J. & Silva, C.M. (2003) – Lateglacial and Holocene environmental changes in Portuguese coastal lagoons 1. The

sedimentological and geochemical records of the Santo André coastal area. *The Holocene* 13 (3): 433-446.
Guerreiro, C., Cachão, M. & Drago, T. (2005) Calcareous nannoplankton as a tracer of the marine influence on the NW coast of Portugal, over the last 14000 years. *J. Nannoplankton Res*. 27(2): pp.159–172.
Hickey, K.R. (2005) - Meteorological data record at Armagh Observatory. Volume 5 - The storm and Gale chronology 1796-2002. Armagh Observatory Scientific publications. Data available at www.arm.ac.uk.
Luterbacher, J., C. Schmutz, D. Gyalistras, E. Xoplaki, and H. Wanner (1999) - Reconstruction of monthly NAO and EU indices back to AD 1675, Geophys. Res. Lett., 26, 2745-2748.
Luterbacher, J., Xoplaki, E., Dietrich, D., Jones, P.D., Davies, T.D., Portis, D., Gonzalez-Rouco, J.F., von Storch, H., Gyalistras, D., Casty, C., and Wanner, H. (2002) - Extending North Atlantic Oscillation Reconstructions Back to 1500. Atmos. Sci. Lett., doi:10.1006/asle.2001.0044.
Solanki, S.K.; Usoskin, I.G.; Kromer, B.; Schussler, M. & Beer, J. (2005) - 11,000 year sunspot number reconstruction. IGBP PAGES/World Data Centre for Paleoclimatology, Data contribution series #2005-015. NOAA/NGDC Paleoclimatology Program USA.
Vaquero, J. M., Gallego, M. C. y García, J. A. (2002) A 250-year cycle in naked eye observations of sunspots. *Geophy. Res. Lett.* **29**, 1997, doi:10.1029/2002GL014782.

The Use of Triangular Coordinate Diagrams for Paleoenvironmental Interpretation of the Northeastern Brazilian Continental Margin

Edmundo Camillo, Juliana Quadros, Felipe Toledo, & Karen Costa

Paleoceanography Laboratory of South Atlantic (LaPAS)-Oceanographic Institute of University of São Paulo, Praça do Oceanográfico, 191. Cidade Universitária. São Paulo/SP - Cep: 05508-120 - Brazil
jupq@usp.br

Okada (1983; 1992) proposed an analytical method for the environmental characters of recent nannofossil flora by plotting the three floral components into a triangular coordinate diagram that illustrates the provincialism in calcareous nannoflora related to dominant species abundance. It is useful since few taxa dominate the Quaternary calcareous nannofossil assemblage.

Calcareous nannofossil assemblages of the Brazilian continental margin are scarcely studied. The present work was carried out in order to improve our understanding of short-term variations of the calcareous nannofossil assemblages and their relation to the paleoenvironmental history. This study attempts to present Holocene and Last Glacial Maximum (LGM) paleoenvironmental interpretations by using the triangular co-ordinate diagram for calcareous nannofossil in two western South Atlantic piston cores: CMU-14 (14°24,847 S / 38°49,307W; 965m depth) and PAR-40(07°29,617S / 34°20,451W; 1261m depth). Percentage abundance variations between final member taxa were employed to reconstruct the marine paleoenvironment during the last 20 kyr.

The resulting data indicate small depth variation as expected for deep sea cores. It is possible to observe differences between LGM and Holocene, but the magnitudes of the fluctuations are different to each core (Figure 1). PAR-40 has presented more stable conditions during the last 20 kyr compared to CMU-14, what can be explained by their

geographic positions. According to the triangular co-ordinate diagram the general productivity has decreased from the LGM conditions to the Holocene ones.

References:
Okada, H. 1983. Modern nannofossil assemblages in sediments of coastal and marginal seas along the western Pacific ocean. *Utrecht Micropaleontology Bulletin*, 30, 171-187.
Okada, H. 1992. Biogeographic control of modern nannofossil assemblages in surface sediments of Ise Bay, Mikawa Bay e Kumano-Nada, off coast of central Japan. *Memorie Di Scienze Geologiche*, 43, 431-449.

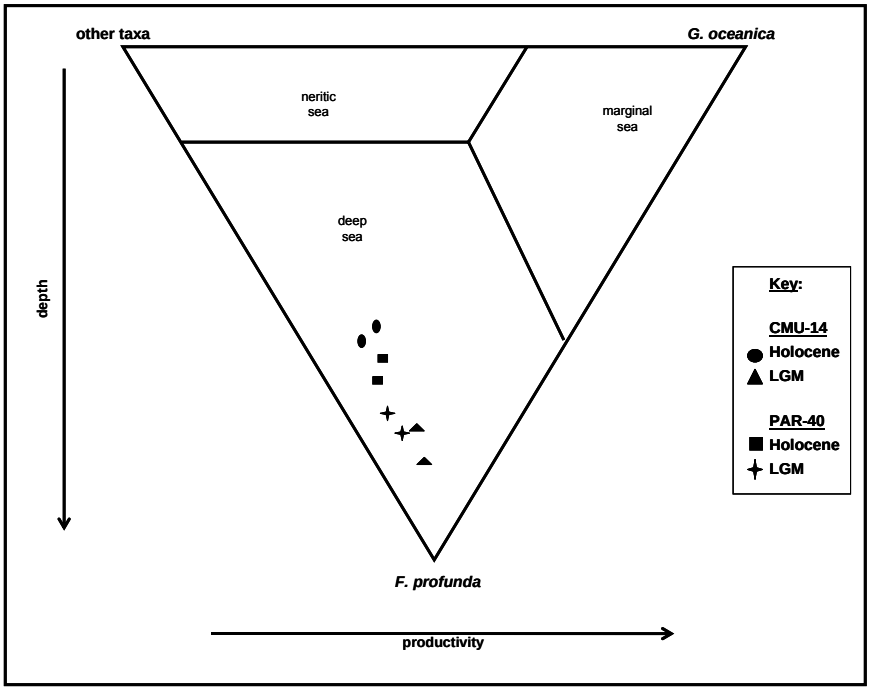


Figure 1: Triangular co-ordinate diagram to two deep-sea cores at NE Brazilian continental margin.

Biostratigraphic events in Upper Jurassic and Cretaceous outcrops of Cuba

Ana Marina Escobar Castro

Edgar Gerson Barbosa 223, São Bernardo do Campo. São Paulo. Brazil.
aescobar67@yahoo.com

Cuba is usually considered to have formed the western end of the Tethys during Late Jurassic and Early Cretaceous. Upper Jurassic and Cretaceous carbonate rocks and associated marls and shales crop out in central and western Cuba. This paper presents an analysis of the vertical distribution of calcareous nannofossils throughout the Jurassic-Cretaceous of twenty-six outcrops. The calcareous nannoplankton has been little studied in Cuba, it has established for the first time a sequences of calcareous nannofossil events

for this period. Generally the sections have a poor nannofossil content. Assemblages are dominated by Tethyan taxa. The biostratigraphic analysis identified 79 species contained in 42 genera.

The Late Jurassic section has a poor nannofossil content, badly preserved due to the strong limestone recrystallization or to shale oxidation, which obscures the biostratigraphic zonation. However, through the combination of nannofossil and previous paleontologic data (calpionelids, calcispheres and crinoids of the Saccocomidae family), it was possible to recognize the occurrence of four Mesothitonian and four Neotithonian outcrops. Such Upper Jurassic sections were accumulated in a deep, anoxic marine environment (outer ramp to bathyal), as suggested by the dominant pelagic microfacies

In the Early Cretaceous outcrops the nannoflora is poor and badly preserved, but with sporadic occurrence of some species in the interval. However, nine bioevents of nannofossil first or last occurrences were detected, and when integrated to certain nannofossiliferous associations permit recognition of the Upper Berriasian, Upper Hauterivian, Upper Aptian and Upper Albian.

Shales and mudstones of the six Campanian-Maastrichtian outcrops have furnished a characteristic, diversified nannofossiliferous association. Nannofossil studies indicate three hiatuses within the Cretaceous, namely in Early Hauterivian, Early Aptian and Aptian-Albian boundary.

Upper Miocene Calcareous Nannofossils from Transylvania, Romania

Carmen Chira

Babeş-Bolyai University, Faculty of Biology and Geology, Department of Geology, 1 Kogălniceanu St., Cluj-Napoca, 400084, Romania
mcchira@bioge.ubbcluj.ro

The study is focused on the biostratigraphy, evolution and diversity of the Upper Miocene, respectively Pannonian calcareous nannofossils from the Transylvanian Basin. The current data concerning the Pannonian calcareous nannofossils from Romania, and the particular data referring to the Transylvanian Basin are presented.

The Pannonian deposits studied until know from the Transylvanian Basin are located in the southern part of the basin, especially in the Lopadea – Garbova – Geoagiu area. These deposits contain endemic calcareous nannofossils, represented by two species belonging to the genus *Isolithus*: *Isolithus semenenko* and *Isolithus pavelici*, and *Noelaerhabdus* species. The presence of the genus *Isolithus* - Pannonian calcareous nannofossil – was only recently evidenced in Romania (Chira, in press).

The genus *Isolithus* was described by Luljeva (1989) from the Eastern Paratethys (Ukraine - Euxinic Basin). The form with three rays, *Isolithus semenenko* Luljeva, was described from the Lower Kimmerian, which corresponds to the Dacian (Pliocene). This genus was recently described also from the Central Paratethys, by Coric, (2004), which investigated Pannonian sediments from several occurrences from Croatia, Serbia and Montenegro, and Austria.

Pannonian calcareous nannofossils belonging to the genera *Noelaerhabdus* and *Bekelithella* were mentioned also from Romania, by Marunteanu (1995, 1998), Chira & Marunteanu (2000), a.o. In the Intra-Carpathian area, the calcareous nannofossils identified in the Middle-Late Pannonian deposits (C, D, E Pannonian – corresponding to the Meotian stage - Marunteanu, 1998) have an endemic character being widespread especially in the Pannonian Basin. The species of *Noelaerhabdus* and *Bekelithella* are dominant; subordinately *Coccolithus pelagicus, Calcidiscus leptoporus, Braarudosphaera bigelowii,* and *Reticulofenestra pseudoumbilicus* are also present. The nannofossil assemblages of the "*Congeria banatica* Beds" (Middle Pannonian), are dominated by the presence of *Noelaerhabdus bekei, N. bozinovicae, N. jerkovici.* The same species and *Noelaerhabdus bonagali, N. mehadicus*, were recorded in the "*Congeria czjeky* Beds" (Late Pannonian). New species of *Noelaerhabdus* were described: *Noelaerhabdus bonagali* Marunteanu and *Noelaerhabdus mehadicus* Marunteanu (Late Pannonian). Starting from the *Noelaerhabdus* evolution, two nannoplankton biozones were defined for the Middle and Late Pannonian: *Noelaerhabdus bozinovicae* Zone, and *Noelaerhabdus bonagali* Zone (Marunteanu, 1998). *Noelaerhabdus bozinovicae* Zone was defined from the first occurrence of *Noelaerhabdus bozinovicae* Jerkovici to the first occurrence of *Noelaerhabdus bonagali* Mărunțeanu (Middle Pannonian – C, D). This zone was correlated with the upper part of the NN10 zone (Martini, 1971), and the debut of the NN11 zone. The nannofossil assemblage is dominated by *Noelaerhabdus* species, with various morphostructures. *Noelaerhabdus bonagali* Zone was defined from the first to last occurrence of *Noelaerhabdus bonagali* Marunteanu and correspond to the Late Pannonian (E). This zone was correlated with the lower part of NN11 zone. It was remarked that the zone contains only *Noelaerhabdus* and *Bekelithella* species.

The Pannonian deposits from Lopadea Veche contain two species of the genus *Isolithus: Isolithus semenenko* and *Isolithus pavelici.* Among these, *Isolithus semeneko* dominates. The nannoplankton assemblage consists almost exclusively of these two species. In the analysed samples from Lopadea Veche, the following forms were also remarked: *Noelaerhabdus* cf. bozinovicae, *Noelaerhabdus* sp., *Braarudosphaera bigelowii, Coccolithus pelagicus*, *Coccolithus* cf. *miopelagicus*, *Calcidiscus* cf. *macintyrei*, *Helicosphaera walbersdorfensis, Reticulofenestra* cf. *minuta*, *Reticulofenestra* cf. *haqii*, *Sphenolithus abies, Syracosphaera* cf. *histrica*, and *Triquetrorhabdulus* aff. *rugosus*. Excepting the genus *Noelaerhabdus*, the other species are probably reworked from the Middle Miocene. Sometimes reworked species from Cretaceous (*Microrhabdulus decoratus* a. o.) are present, too. Frequently ascidian spicules occur. In general, the analysed samples from Garbova – Garbovita area and Geoagiu de Sus contain larger forms of *Isolithus semenenko* and *Isolithus pavelici,* as compared to those from Lopadea Veche. The assemblages contain also: *Coccolithus pelagicus*, *Coccolithus miopelagicus, Braarudosphaera bigelowii,* a. o.

In conclusion, two species of the genera *Isolithus* were described from the Pannonian deposits between Lopadea Veche, Garbova – Garbovita area, Geoagiu de Sus and other areas in southern Transylvania: *Isolithus semenenko* and *Isolithus pavelici*. *Noelaerhabdus* genus is also present sometimes in the nannofossil assemblage. These nannofossils are generally considered to be endemic for the Pannonian of the Central and Eastern Parathethys.

References
Chira, C.: The presence of genus *Isolithus* Luljeva, 1989 (calcareous nannofossil) in the Pannonian from Lopadea Veche, Transylvania (Romania). Studia Universitatis Babeş-Bolyai, Geol. (in press).
Chira, C., Marunteanu, M., 2000: Calcareous nannofossils and dinoflagelates from the Middle Miocene of the Transylvanian Basin, Romania. – 8th International Nannoplankton Association Conference, Abstract volume, p. 3, Bremen.
Coric, S., 2004: Occurences of endemical Pannonian calcareous nannoplankton genus *Isolithus* Luljeva, 1989 in the Central Paratethys. *Scripta Fac. Sci. Nat. Univ. Masaryk. Brunensis.*, 31 - 32, (2001 - 2002), Geology, p. 19 – 22, Brno.
Martini, E., 1971: Standard Tertiary and Quaternary Calcareous Nannoplankton Zonation. *Proceedings of the II Planktonic Conference*, Roma , 1970, A. Farinacci, ed., Ed. Tecnoscienza, p. 739 - 785, Rome.
Marunteanu, M., 1995: *Noelaerhabdus bonagali* n. sp. (Calcareous Nannoplankton) in the Upper Malvensian – Romanian Banat. Rom. J. Paleontology, 76, p. 99 – 100, Bucharest.
Marunteanu, M., 1998: Pannonian nannoplankton zonation. Intern. Symp.Geol. in the Danube gorges, p. 263 – 265, Beograd.

Upper Cretaceous Calcareous Nannofossils from the Northeastern Trascau Massif – Southern Apuseni Mountains, Romania

Carmen Chira, Ramona Balc, & Igriţan Alin

Babeş-Bolyai University, Faculty of Biology and Geology, Department of Geology, 1 Kogălniceanu St., Cluj-Napoca, 400084, Romania
mcchira@bioge.ubbcluj.ro

The Trascau Massif is part of the Southern Apuseni Mts. (Romania) and is located in their north-eastern part. Our study is focused especially on some representative profiles from Iara – Surduc – Ocolisel area and Buru – Rimet – Geoagiu de Sus area. The Upper Cretaceous deposits belong to the Rimetea Nappe. The Rimeti Formation constitutes the post-tectonic cover of this nappe. It is represented by polymictic conglomerates followed by flysch sequences in which the alternation between sandstones and marls or marly clays is characteristic (Bleahu et al., 1981). According to the micropaleontological (Lupu in Bleahu et al., 1981) and palynological data (Antonescu, 1974), the age of the Rimeti Formation is Uppermost Albian – Lower Senonian. The Vraconian – Coniacian age of the Rimeti Formation was established based on foraminifera (Ianovici et al., 1976).

A study concerning the calcareous nannofossils from the Rimeti Formation was performed in the southern part of the investigated area (Balc et al., in prep.). The presence of *Broinsonia parca* Biozone (CC18 zone after Sissingh, 1977) was remarked. The age of the deposits was considered early Campanian. The assemblage is dominated by *Watznaueria barnesae, Cribrosphaerella ehrenbergii, Retecapsa crenulata, Tranolithus orionatus* and *Eiffelithus eximius*, but common are also *Arkhangelskiella cymbiformis, Zeugrhabdotus* spp*., Broinsonia* spp. and *Prediscosphaera* spp.

The studied calcareous nannofossils from Iara - Surduc area indicate the presence of Upper Cretaceous calcareous nannofossils assemblages (Chira et al., in press). The flyschoid facies from this area is represented by limy sandstones, and polygeneous

conglomerates. The Cretaceous deposits belong only to the uper Coniacian (*Micula staurophora* Biozone). About 70 species have been identified The preservation status is moderate to good and in several samples the partial dissolution of some taxa can be observed.The calcareous nannofossils assemblages are dominated by *Watznaueria barnaese.* Other common taxa are represented by the species: *Cribrosphaerella ehrenbergii, Retecapsa crenulata, Tranolithus orionatus, Eiffelithus eximius, Prediscosphaera cretacea.* Distinctive components of the assemblages are: *Lucianorhabdus* spp*., Micula* spp*., Calculites* spp*., Zeugrhabdotus* spp.Rarely, *Eprolithus floralis, Lithastrinus septenarius, Quadrum gartneri, Amphizygus brooksii, Loxolithus armilla, Placozygus fibuliformis, Retecapsa angustiforata, Biscutum* spp. are also present. The character of the assemblage is cosmopolitan and tethyan.

At Ocolisel, 42 species have been identified belonging to the upper part of the *Calculites obscurus* Zone (CC17) (lower Campanian). The assemblage is dominated by *Watznaueria barnaese, Micula staurophora, Retecapsa crenulata, Tranolithus orionatus,* and *Helicolithus trabeculatus.* The calcareous assemblages from the Rimeti Formation point to an upper Coniacian – lower Campanian age.

References:

Antonescu, E., 1974: Palynostratigraphic data on Cretaceous Deposits in the Galda de Sus – Poiana Aiudului Region, Metaliferi Mountains. Dari de seama ale sedintelor, LX (1972 – 1973), 4. Stratigrafie, p. 25 – 49, Bucharest.

Balc, R., Suciu-Krausz, E., Borbei, F.: Biostratigraphy of the Cretaceous deposits in the western Transylvanides from Ampoi Valley (Southern Apuseni Mountains, Romania) (in prep.).

Bleahu, M., Lupu, M., Patrulius, D., Bordea, S., Stefan, A., Panin, S., 1981: The Structure of the Apuseni Mountains. Guide to Excursion B3. Carpatho-Balkan Geological Association, XII Congress, Bucharest. Guide book Series, Nr. 23, 107 p.

Chira, C., Balc, R., Vulc, A.M., Igritan, A., Cretaceous calcareous nannofossils from Petresti – Iara area (Apuseni Mountains): Biostratigraphical and paleoecological significance. Studia Universitatis Babes-Bolyai, Cluj-Napoca (in press).

Ianovici, V., Borcos, M, Bleahu, M., Patrulius, D., Lupu, M., Dimitrescu, R., Savu, H., 1976: Geologia Muntilor Apuseni. Ed. Acad. RSR, Bucuresti, 631 p.

Sissingh, W., 1977: Biostratigraphy of Cretaceous calcareous nannoplankton. Geol. Mijnbouw, Den. Haag, 56, p. 37 – 65.

Floral changes in calcareous nannofossils and their paleoceanographic significance in the equatorial Pacific Ocean during the last 500,000 years

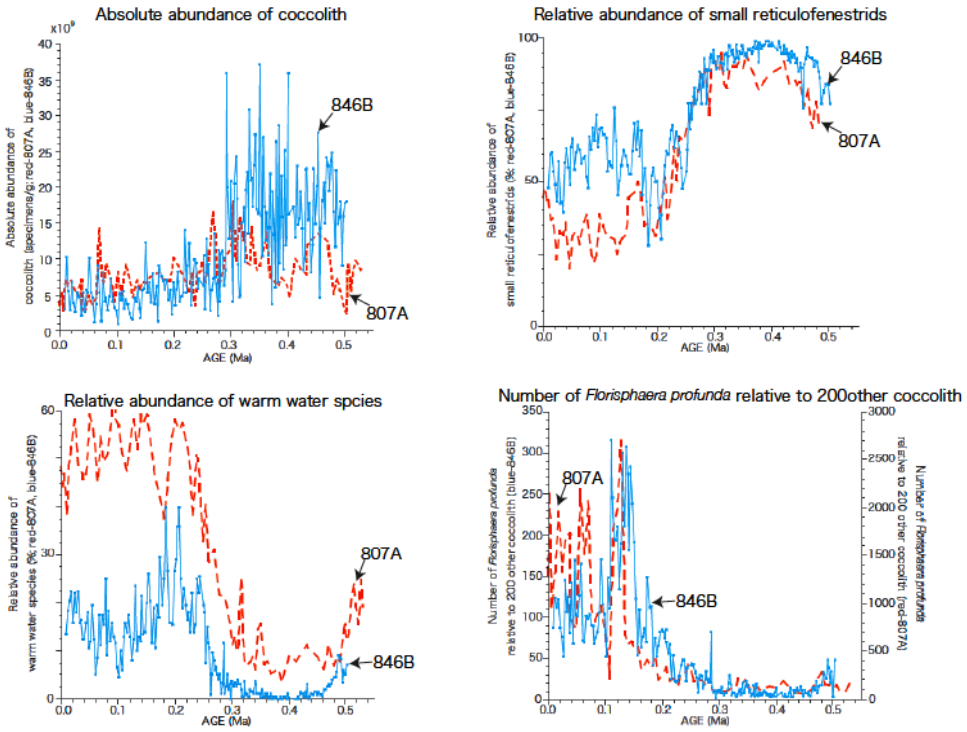
Shun Chiyonobu[1], Tokiyuki Sato[2], Reika Narikiyo[2], and Makoto Yamasaki[2]

[1] Institute of Geoloogy and Paleontology, Graduate School of Science, Tohoku University, 6-3, Atamaki Aoba, Sendai, 980-8758, Japan.

[2] Institute of Applied earth Sciences, Faculty of Engineering and Resource Science, Akita University, 1-1, Tegatagakuentyo, Akita, 010-0851, Japan.;

chiyonobu@mail.tains.tohoku.ac.jp

The late Quaternary calcareous nannofossil assemblages from ODP Holes 807A and 846B, located in the western and eastern equatorial Pacific Ocean, respectively, were analyzed to clarify changes in surface water conditions during the last 500,000 years. The uppermost Quaternary sediments in both holes contain abundant nannofossils, and their assemblages are characterized by high species diversity. The absolute abundances of coccoliths (specimens/g) and relative numbers of small reticulofenestrids decreased drastically in both holes between 0.3 - 0.2 Ma, whereas the relative abundance of warm water species and *Florisphaera profunda* increased suddenly at this time. These data indicate that upwelling around the western and eastern equatorial Pacific regions weakened after 0.2 Ma, which was causes by a decrease in trade winds strength.



Calcareous Nannofossils and Planktonic Foraminifers of the Last 1.07 Ma from Chatham Rise (East New Zealand Pacific Ocean): Paleoecological and Paleoceanographic Implications

Miriam Cobianchi[1], *Valeria Luciani*[2], *& Claudia Lupi*[1]

[1] Dipartimento di Scienze della Terra, Università di Pavia, Via Ferrata 1, 27100 Pavia (Italy)
[2] Dipartimento di Scienze della Terra, Polo Scientifico Tecnologico, Università degli Studi di Ferrara, via Saragat 1, 44100 Ferrara (Italy)
miriam@unipv.it

The study of the Pleistocene calcareous nannofossil and planktonic foraminiferal distribution patterns from the Core MD 97-2114 (east New Zealand Pacific Ocean) provides a good opportunity to trace the position of the oceanic fronts and currents of this region in order to improve the knowledge about the oceanic thermohaline circulation during the Quaternary climatic phases. The location of the studied core lies on the north-eastern part of the Chatham Rise, which is a major E-W trending submarine high, extended about 300 km eastward from the New Zealand. The depositional rise coincides with the subtropical front (STF) separating the subantarctic and subtropical surface water masses. This plateau is placed above the calcium carbonate compensation depth (CCD) and therefore calcareous nannofossils and foraminifers are well preserved. The integrated calcareous nannofossil and planktonic foraminifer biostratigraphy provides a resolution of about 66,87 ky and documents that the core records the last 1.07 Ma. Moreover, core were sampled at 10 cm spacing which corresponds to a resolution of 3,85 ky being the main sedimentation rate of about 2,6 cm/ky. The percent abundance curves of the calcareous nannofossil and foraminiferal paleoclimatic indices are in phase with the $\delta^{18}O$ curve (Cobianchi et al., 2005; Venuti et al., in press) and display relative increase of cool water taxa during glacial periods whereas warm species rise during interglacials. In spite of that, the composition and species richness of the calcareous planktonic assemblages maintain throughout the core subtropical characters suggesting that the STF was located to Chatham Rise through glacial/interglacial periods at least since the Early Pleistocene. Calcareous plankton assemblages indicate stratified water column characterised predominantly by mesotrophic conditions; high abundances of the opportunist *Globigerina bulloides* and *Coccolithus pelagicus* suggest increased upwelling and nutrient levels generally corresponding to glacial intervals. Further information about circulation patterns during Quaternary are inferred correlating paleoecological with sedimentological and mineralogical proxies.

References

Cobianchi M., Lupi C., Luciani V., Florindo F., Venuti A., Zerba, P. (2005) – Upper Quaternary bio-magnetostratigraphy from Chatham Rise (SW Pacific Ocean): a framework for palaeoceanographic interpretation. EUG 05-A- 06474

Venuti A., Florindo F., Michel E. and Hall I.R (in press). - Variability of the Deep (Pacific) Western Boundary Current across the Mid-Pleistocene climate revolution – Geology

Middle/Upper Miocene (Sarmatian/Pannonian) Endemical Calcareous Nannoplankton from the Central Paratethys

Stjepan Ćorić

Geological Survey of Austria, Neulinggasse 38, A-1030 Vienna, Austria
stjepan.coric@geologie.ac.at

Endemical calcareous nannoplankton from the Upper Sarmatian (corresponding to the Uppermost Serravallian; Middle Miocene) laminated marine sediments formed under hypersaline conditions (PILLER & HARZHAUSER, 2004) was investigated. Laminated

Sarmatian marls from the Našice quarry (Croatia, section Vranović) contain the endemical Sarmatian nannoplankton *Rhabdosphaera prijedorensis* JERKOVIC, *Acanthoica beogradiensis* (JERKOVIC) AUBRY, *A. coheinii* (JERKOVIC) AUBRY, and *Acanthoica* spp. in association with *Calciosolenia brasiliensis* (LOHMANN) YOUNG, *C. murrayi* GRAN and *Syracosphaera* spp. Monospecifical calcareous nannoplankton assemblages with *Sphenolithus moriformis* (BRÖNNIMANN & STRADNER) BRAMLETTE & WILCOXON) and *Perforocalcinella fusiformis* BONA were observed too. *Perforocalcinella fusiformis*, calcareous particles with longitudinal ridges ocurring isolated or arranged in a rosette (Fig. 1), is a useful stratigraphical marker in the Central Paratethys with the first occurrence in the Sarmatian (upper NN6).

The Upper Miocene Pannonian Lake was formed by separation of the Central from the Eastern Paratethys. Generally, temperature decreases from the Serravallian, and the new palaeogeographical circumstances resulted in changing of the palaeoecological conditions (such as strongly reduced salinity) within this bioprovince. Molluscs and dinoflagellates are used for the biostratigraphic subdivision of the Pannonian Lake deposits. Occurrences of the Pannonian calcareous nannoplankton were reported from many localities in the Central Paratethys. LULJEVA (ЛЮЛЬЕВА, 1989) investigated Miocene-Pliocene calcareous nannofossil assemblages from some cores and outcrops in the Southern Ukraine (the Eastern Paratethys bioprovince) and described two new endemical nannofossil genera: *Lacunolithus menneri* (found in the Meotian) and the three-rays form *Isolithus semenenko* from the Lower Kimmerian.

During recent investigations on Pannonian sediments from the Central Paratethys, *I. semenenko* was recorded for the first time in this bioprovince (Croatia: Slapno quarry, Našice quarry; Serbia: Beočin).

Marls and silty marls from the Slapno quarry (Croatia, Mt. Žumberak near Karlovac) contain *I. semenenko, Braarudosphaera bigelowii* (GRAN & BRAARUD) DEFLANDRE, *Coccolithus pelagicus* (WALLICH) SCHILLER, *Cyclicargolithus floridanus* (ROTH & HAY) BUKRY, *Reticulofenestra haqii* BACKMAN, *R. minuta* ROTH, *R. pseudoumbilica* (GARTNER) GARTNER, and *Triquetrorhabdulus* sp. *Isolithus semenenko* is well-preserved and abundant in the entire nannoplankton assemblages (>90%) at this section. A new four-rays form *Isolithus pavelici* was described (Ćorić & Vrsaljko subm.) from this locality.

Pannonian marly limestones and massive marls from the 70 m long section Vranović (Croatia) were investigated. Based on quantitative investigations, three assemblages can be distinguished: 1) *Noelaerhabdus*-assemblage characterised by the abundant occurrences of *Noelaerhabdus bozinovicae* (Fig. 2), *N. jerkovici* (Fig. 3), *N. bekei,* and *Noelaerhabdus* sp.; 2) *Perforocalcinella*-assemblage (with abundant *Perforocalcinella fusiformis*) and 3) *Isolithus*-assemblage (with *I. semenenko* and *I. pavelici*). Pannonian fossil associations with the molluscs *Radix croatica* GORJANOVIC-KRAMBERGER and *Gyraulus praeponticus* GORJANOVIC-KRAMBERGER ("Croatica beds") in the lower part, and *Congeria banatica* HOERNES and the dynocyst *Spiniferites bentori pannonicus* ("Banatica beds") in the upper part of this section indicate oligohaline paleoconditions (PAVELIĆ et al. 2003).

The light marl from the quarry of the cement factory Beočin was sampled in 1885 and kept in the collection of the NHM Vienna. Sediments with the mollusc fauna

Valenciennius reussi NEUMAYR contain a well-preserved and very abundant nannoflora with *Isolithus semenenko* and *I. pavelici*.

The Sarmatian and the Pannonian - regional stages of the Central Paratethys - span 6 nannoplankton zones (NN6-NN11), but only NN6 and NN7? were yet documented. Recent research has indicated that some endemical calcareous nannoplankton forms are very useful for the stratigraphical analysis of Middle/Upper Miocene sediments of the Central Paratethys.

References:

LULJEVA S.A. (ЛЮЛЬЕВА, С.А.) 1989: New occurrences of Miocene and Pliocene calcareous nannoplankton from Ukraine (Новьие Миоценовые и Плиоценовые известковые наннофоссилии юога Украины). - Доклады Академии наук Украинскои ССР, 1, В, 10-14.

PAVELIĆ, D., KOVAČIĆ, M., MIKNIĆ, M., AVANIĆ, R., VRSALJKO, D., BAKRAČ, K., TIŠLJAR, J., GALOVIĆ, I. & BORTEK, Ž. 2003: The evolution of the Miocene Environments in the Slavonian Mts. Area (Northern Croatia). – 22nd IAS Meeting of Sedimentology, Evolution of Depositional Environments from the Palaeozoic to the Quaternary in the Karst Dinarides and the Pannonian Basin, Opatija 2003, Field Trip Guidebook, 173-181.

PILLER, W. E. & HARZHAUSER, M. 2004: The Myth of the Brackish Sarmatian Sea. - Terra Nova, 17 (5), 450-455.

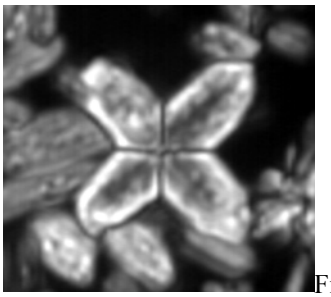


Fig. 1

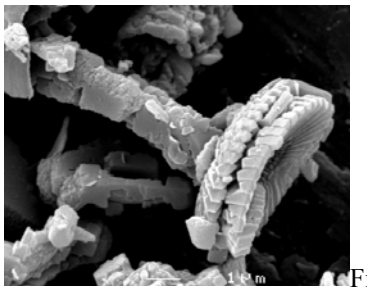


Fig.2

Coccolithophore Flux in the Alfonso Basin: Seasonal Variation and Species Composition

Mara Y. Cortés [1], Francisco Javier Urcádiz-Cázares [1], Norman Silverberg [2], Fernando Aguirre-Bahena [2] & Jörg Bollmann[3].

[1]Dep. Geología Marina, Univ. Autónoma de Baja California Sur. Apdo. Postal 19-B, CP 23080, La Paz, BCS, México
[2]Centro Interdisciplinario de Ciencias Marinas, Inst. Politécnico Nacional, México.
[3]Geology Department, University of Toronto, Canada.
mycortes@uabcs.mx

The production of organic and inorganic carbon by coccolithohores is anticipated to play a significant role in the global carbon cycle. Therefore, detailed knowledge of coccolithohores related carbon flux is needed. Here we present a time-series record of vertical coccolith flux and coccolithophore assemblage composition in the Alfonso basin, Gulf of California, near the coast of the Baja California Peninsula. This location is

of particular interest as it is very sensitive to changes of the environmental conditions that may be preserved in laminated sediments.

A moored sediment trap was deployed at 360 m water depth from January 2002 to October 2003 with sampling interval of 7 to 14 days. Samples were subdivided in 10 aliquots for the analysis of total carbon, C_{org}, carbonate, and other parameters such as diatoms. For coccolith analysis an aliquot was subdivided in a fraction of 1/30 using a wet rotary splitter and 1/4500 of the original sample was processed according to Bairbakhish et al. (1999). About 1500 images were captured with a fully automated SEM at the Geological Institute ETH Zurich, archived on CDs and subsequently manually processed on a PC at the UABCS (Bollmann et al 2002, 2004).

The total coccolith flux varied considerably between individual sampling periods, and in general, a seasonal pattern with low fluxes in spring – summer and maximal values in autumn-winter were found. During 2002 the lowest flux in the trap (0.02×10^8 coccoliths/m^2) was registered in summer and the highest (64.66×10^8 coccoliths/m^2) in autumn. During 2003 the overall values were considerably increased. The lowest flux was registered in spring (52.35×10^8 coccoliths/m^2) and the highest in autumn (128.8×10^8 coccoliths/m^2). The highest values in 2003 are related to the hurricanes that occurred during the sampling period.

In total 47 taxa were identified but only three species, *Gephyrocapsa oceanica* (43.6%), *Emiliania huxleyi* (28%) and *Florisphera profunda* (15.7%), constituted 88 percent of the total flux of coccoliths. This corresponds to the species composition observed in the water column for the same period of observation. *G. oceanica* was always present and its flux pattern is similar to the total flux. The flux of *E. huxleyi* remains almost constant during the observed time period whereas *F. profunda* shows peak fluxes in autumn. Although the cosmopolitan species *E. huxleyi* has been considered the most important coccolithophore species on a global scale, *G. oceanica* is the most abundant species in the Alfonso Basin and maybe another marginal seas.

References:

Bairbakhish, A. N., J. Bollmann, et al. (1999). Disintegration of aggregates and coccospheres in sediment trap samples. *Marine Micropaleontology* **37**: 219-223.

Bollmann, J., M. Y. Cortés, et al. (2002). Techniques for quantitative analyses of calcareous marine phytoplankton. *Marine Micropaleontology* **44**: 163-185.

Bollmann J., Quinn P., Vela M., Brabec B., Brechner B., Cortés M.Y., Hilbrecht H., Schmidt, D.N., Schiebel, R., and Thierstein, HR. (2004). Automated particle analysis: Calcareous microfossils. In: Francus P. (Editor). Image Analysis, Sediments and Paleoenvironments. Springer Verlag: 229-251.

Long-distance correlation across the Paleocene-Eocene boundary: an integrated study using calcareous nannofossil and carbon-isotope stratigraphy

Armando A. Scarparo Cunha & Simone de Oliveira Costa

PETROBRAS Research Center (PDEXP-BPA), Cidade Universitária, Quadra 7, Ilha do Fundão, Rio de Janeiro, RJ – Brazil, CEP 21949-900
scarparo@petrobras.com.br

Carbon isotope measurements ($\delta^{13}C$) on bulk carbonate samples and calcareous nannofossil semi-quantitative analyses were made in two marine sections across the Paleocene-Eocene boundary. The integrated calcareous nannoplankton / carbon isotope stratigraphic study supports the correlation between two wells located in different basins of the Atlantic Ocean (DSDP site 366 - Serra Leone Rise, in northwestern Africa, and Well A – Jequitinhonha Basin, in northeastern Brazil).

The $\delta^{13}C$ curve of well DSDP-366 (cores 43, 44, 45, 47 and 48) and the calcareous nannofossil biozonation suggest that the Paleocene-Eocene boundary occurs at 740 m. Here, a positive to negative inversion of the $\delta^{13}C$ trend is interpreted to correspond to the well-known negative carbon isotope excursion (CIE) related to the Paleocene-Eocene Thermal Maximum (PETM). The abundance and diversity of the genus *Fasciculithus* decrease markedly at 741.6 m, just below the change in the $\delta^{13}C$ curve and a level characterized by intense carbonate dissolution (at 740 m). The lowermost occurrence of *Discoaster multiradiatus* at 768 m and the absence of the genera *Rhomboaster* and *Tribrachiatus* below 728.4 m are used as additional biostratigraphic markers.

In Well A of the Brazilian Continental Margin, semi-quantitative analyses based on calcareous nannofossils and carbon isotope studies were carried out in cuttings samples. Although these not always provide high biostratigraphic and chemostratigraphic resolutions, the integration of the two methods made it possible to establish a reliable stratigraphic subdivision of the Paleocene-Eocene section. Following standard oil-industry procedures related to cuttings, only the first downhole occurrences (FDOs) of diagnostic species can be used for the biochronostratigraphic zonation. Thus, the uppermost decline in diversity and abundance of the genus *Fasciculithus*, together with a decrease in $\delta^{13}C$ values, permit to estimate the stratigraphic position of the Paleocene-Eocene boundary. The FDOs of *Rhomboaster cupis* and *Heliolithus kleinpellii* were used as accessory events.

The profile of the carbon isotopic curves of well DSDP-366 and Well A permits their correlation with other curves based on data compiled from several DSDP and ODP well sites. Even taking into account the different $\delta^{13}C$ values of Well A and DSDP-366 in comparison to other published curves, the information obtained from both wells supports long-distance correlations of the CIE, and confirms that integrated biostratigraphic / isotope stratigraphic studies constitute a powerful tool for the global correlation of Paleocene-Eocene sections.

High Resolution Calcareous Nannofossil Bioevents: An Example from the Basal Middle Miocene of the Gulf of Mexico

Richard A. Denne

Applied Biostratigraphix, 51 Midday Sun Pl., The Woodlands, TX, 77382, USA
richdenne@aol.com

Although the standard global calcareous nannofossil zonation schemes (e.g. Martini, 1971) are usually adequate for the condensed sections generally found in deep-sea coreholes, they often lack the resolution needed in expanded continental margin deposits where a single zone can be thousands of meters thick. This can be especially problematic if the zone of interest contains significant hydrocarbon reservoirs. In these thick sections, fossil occurrences are typically rare outside of discrete horizons known as Maximum Flooding Surfaces (MFS). Using a technique outlined by Denne (2003), bioevents were established for eight MFS's found in the highly expanded, reservoir-prone, lower Middle Miocene section of the Gulf of Mexico, which contains only a single global nannofossil zone boundary (NN6 / NN5). These bioevents are based on last occurrences (LO) of standard markers, secondary markers, and local markers, consistent last occurrences (minor abundance increases) (CLO), downhole abundance increases, and acme tops (zones of highest abundance) of a number of different species, including some forms that have yet to be formally described. Dominance shifts and morphometric changes can also be utilized, although none were used in this study. As this bioevent scheme was formulated for use in oil-field drilling, species' bases were not used due to the potential of downhole contamination.

These eight biohorizons are defined as follows:

Event 66 is found in the lower part of global nannofossil zone NN6, and is defined by the LO of a variety of *Discoaster sanmiguelensis* colloquially known as "*Catinaster* sp. A". "*Catinaster* sp. A" is typified by extremely small arms causing it to appear to be a form of *Catinaster* (see Aubry, 1993, plate 3).

Event 67 is marked by a downhole increase of "*Cyclicargolithus floridanus neogammation*", a small, circular to subcircular reticulofenestrid with a bicyclic central area, and a downhole increase of typical *D. sanmiguelensis*. Although "*C. floridanus neogammation*" does not look like the specimen figured by Bramlette and Wilcoxon (1967) in their description of *Cyclococcolithus neogammation*, it does fit their written description in that it has a central area similar to that of the Eocene form *Toweius gammation*.

Event 68 marks the top of global nannofossil zone NN5 based on the last, albeit rare, occurrence of *Sphenolithus heteromorphus*. Due to the rarity of *S. heteromorphus* at this level, this event is usually identified by the acme of *D. sanmiguelensis*.

Event 68a is defined by a small downhole increase of *Calcidiscus premacintyrei*. This event is often not identified due to the weak expression (low fossil abundances) of the MFS.

Event 69 is defined by LO of *Discoaster petaliformis* and the CLO of *Sphenolithus heteromorphus*, as well as the very rare LO of a small reticulofenestrid called

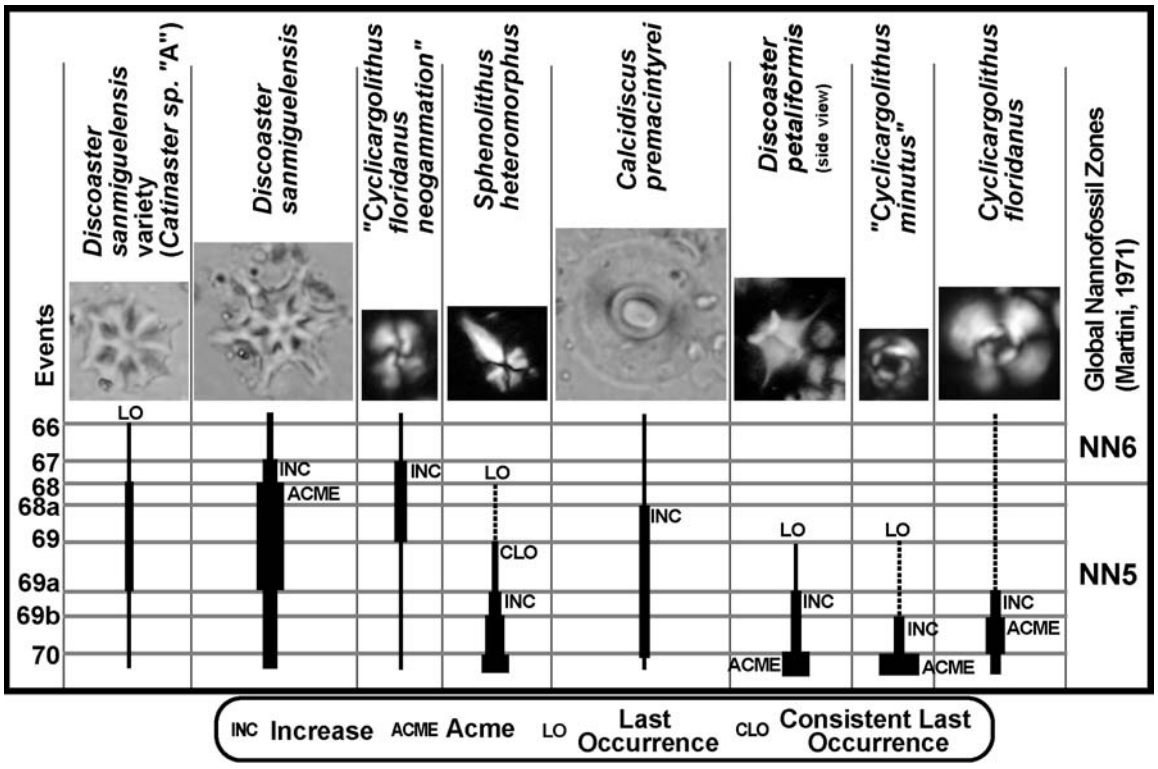
"*Cyclicargolithus minutus*". This form is smaller than the typical *C. floridanus*, and has a larger central opening / shield ratio than *C. floridanus*.

Event 69a is marked by downhole increases of both *D. petaliformis* and *C. floridanus.*

Event 69b is defined by a downhole increase of "*C. minutus*" and the initial acme of *C. floridanus*.

Event 70 is identified by the acmes of *D. petaliformis* and "*C. minutus*", and typically also contains higher abundances of *S. heteromorphus* than were seen above this horizon.

This bioevent scheme has been used to subdivide reservoir intervals in a number of wells, and has been effective in biostratigraphic correlations at both the field and regional level.



References:

Aubry, M.-P., 1993, Neogene allostratigraphy and depositional history of the DeSoto Canyon area, northern Gulf of Mexico: Micropaleontology, v. 39, p. 327-366.

Bramlette, M.N., and Wilocoxon, J.A., 1967, Middle Tertiary calcareous nannoplankton of the Cipero section, Trinidad: Tulane Studies in Geology, v. 5, p. 93 – 131.

Denne, R.A., 2003, Sequence biostratigraphy and a new nannofossil zonation of the Pleistocene Gulf of Mexico: Transactions - Gulf Coast Association of Geological Societies, v. 53, p. 256 – 265.

Martini, E., 1971, Standard Tertiary and Quaternary calcareous Nannoplankton zonation: in Farinacci, A., ed., Proceedings of the Second Planktonic Conference Roma 1970, Edizioni Tecnoscienza, Roma, v. 2, p. 739-785.

Distribution and Ecological Behavior of Living Coccolithophores off the Southeastern Coast of Andros Island (Middle Aegean Sea)

Margarita Dimiza, Maria V. Triantaphyllou, & Michael D. Dermitzakis

University of Athens, Faculty of Geology & Geoenvironment, Dept. of Hist. Geology-Paleontology, Panepistimiopolis 15784, Athens, Greece
mtriant@geol.uoa.gr

This study determines the species composition and the seasonal quantitative analysis of living coccolithophore distribution in coastal environments (Andros island, middle Aegean Sea, Eastern Mediterranean).

Water samples were collected during six cruises carried out from 2001 through 2004, from recent marine environments (gulfs of Korthi and Kastro, southeastern coast of Andros Island).

High coccolithophore species richness (62 heterococcolithophores and 40 holococcolithophores) has been determined; the most dominant of these being *Emiliania huxleyi*. Also, highly abundant were the holococcolithophore species, Rhabdosphaeraceae and *Syracosphaera* spp.

The ecological study verified seasonal differentiation by using the ecological indices. High species diversities, in terms of Shannon's, Simpson's and Pielou indices, associated with dominant K-selected taxa Rhabdosphaeraceae and holococcolithophores, were recorded during the warm period (August, September) whereas low diversities coupled with maximum concentration of cells/l and predominant R-selected species *Emiliania huxleyi,* were observed during late autumn-early spring (November, March). Additionally the applied hierarchical cluster analysis has divided the coccolithophores of upper photic zone into four distinct assemblages (*Emiliania huxleyi* assemblage, *Palusphaera vandellii* assemblage, *Rhabdosphaera clavigera* assemblage and *Helladosphaera cornifera* assemblage). These assemblages show a clear relation to the seasonal differentiation. The principal components analysis indicated two factors for seasonal variability. The first factor characterizes the warm, oligotrophic season, while the second focuses on the eutrophic conditions of colder periods.

The possibility of using coccolithophores as environmental proxies, in regions with potential impact of human activities, is based on the application of the one way analysis of variance, multiple discriminant analysis, estimation of ecological indices, and on the presence of malformed coccoliths in the assemblages. The study pointed to the existence of two ecotopes (Kastro and Korthi gulfs) during the summer period

Calcareous Nannoplankton Dynamics through the Eocene-Oligocene Boundary – a New Record from the Western Equatorial Indian Ocean

Tom Dunkley Jones[1], Paul R. Bown[1], Paul N. Pearson[2], Bridget S. Wade[3], Ian K. McMillan[2], Chris J. Nicholas[4], Caroline H. Lear[2] & Helen K. Coxall[2]

[1]Department of Earth Sciences, University College London, Gower Street, London, WC1E 6BT; UK.
[2]School of Earth, Ocean and Planetary Sciences, Cardiff University, Main Building, Park Place, Cardiff, CF10 3YE; UK.
[3]Department of Geological Sciences, Rutgers, The State University of New Jersey, Wright Laboratory, Busch Campus, 610 Taylor Road, Piscataway, NJ 08954-8066, USA.
[4]Department of Geology, Trinity College, University of Dublin, Dublin 2, Ireland.
tom.dunkleyjones@ucl.ac.uk

The Eocene-Oligocene transition period witnessed the most significant climatic change in the Cenozoic with a fundamental reordering of the planet's oceanic and atmospheric circulation, rapid cooling of deep and high-latitude waters and the formation of continental scale ice sheets on Antarctica (Zachos et al., 1992). It is considered to be the largest "mass extinction" event of the Cenozoic (Raup & Sepkoski, 1986) and both the global ocean-atmosphere system and the biota established in the early Oligocene are those of the modern world (Prothero et al., 2003), yet this fundamental change from the Paleogene "greenhouse" world occurred in less than 300kyr and is still poorly understood (Coxall et al., 2005).

Recent attention has focused on the rapid and near-coincident increase in the deep-ocean record of oxygen and carbon isotopes, a drop in Calcium Carbonate Compensation Depth (CCD) of over a kilometer (Coxall et al., 2005) and increase in paleoproductivity indices in the earliest Oligocene (Diester-Haass & Zahn, 2001). This event, the "Oligocene Isotopic Event 1" or Oi1, is estimated to occur 400kyr after the Eocene-Oligocene Boundary (EOB), as defined by the last occurrence of the planktonic foraminifera genus, *Hantkenina* (Coxall et al., 2005). However the relationship between the two events has not been adequately resolved due to the poor preservation of carbonate sediments in low-latitude deep-sea records or the absence of the *Hantkenina* spp in high-latitude sections.

We present results from two on-shore boreholes in southern Tanzania that recovered a 200m sequence of hemi-pelagic clays through both the *Hantkenina* extinction and the Oi1 event. Preservation of both foraminifera and calcareous nannofossils is exceptional with the preservation of a remarkably diverse hetero- and holococcolith assemblage (Bown, 2005; Bown & Dunkley Jones, 2006). Such preservation provides a rare opportunity to study the ecological dynamics of a "deep-time" phytoplankton community through a period of severe global change and here we present high-resolution assemblage counts through this interval in combination with a number of additional palaeoceanographic proxies. These records suggest increased climate variability immediately prior to the EOB that correlates with the decline in abundance of *Discoaster* species, *Calcidiscus? protoannulus*, and *Reticulofenestra dictyoda*, as well as the last occurrences of *Discoaster saipanensis*, *Pemma papillatum* and the *Turborotalia cerroazulensis* group of planktonic foraminifera. The simultaneous extinction of the foraminifera genera *Hantkenina* and *Cribrohantkenina* clearly marks the EOB and is

followed by a marked and rapid drop in nannofossil community diversity. Lower diversity assemblages continue into the Oligocene and may represent a more eutrophic community dominated by *Cyclicargolithus* and *Sphenolithus* species. Stable isotope stratigraphy reveals the two-step shift in oxygen isotopes characteristic of the onset of Oi1 (Coxall et al., 2005) and allows the relationship between the various biotic events at the EOB and the climatic change at Oi1 to be adequately resolved for the first time.

References:

Bown, P.R. 2005. Paleogene calcareous nannofossils from the Kilwa and Lindi areas of coastal Tanzania (Tanzania Drilling Project 2003-4). *Journal of Nannoplankton Research*, **27**: 21-95.

Bown, P.R. & Dunkley Jones, T. 2006. New Paleogene calcareous nannofossil taxa from coastal Tanzania: Tanzania Drilling Project Sites 11 to 14. *Journal of Nannoplankton Research*, **28**: 17-34.

Coxall, H. K., Wilson, P. A., Palike, H., Lear, C. H. and Backman, J. (2005). Rapid stepwise onset of Antarctic glaciation and deeper calcite compensation in the Pacific Ocean. *Nature* **433**: 53-57.

Diester-Haass, L. and Zahn, R. (2001). Paleoproductivity increase at the Eocene-Oligocene climatic transition: ODP/DSDP site 763 and 592. *Palaeogeography, Palaeoclimatology, Palaeoecology* **172**: 153-170.

Prothero, D. R., Ivany, L. C. and Nesbitt, E. A. (2003). *From Greenhouse to Icehouse: The Marine Eocene-Oligocene Transition*. New York, Columbia University Press.

Raup, D. M. and Sepkoski, J. J. (1986). Periodic Extinction of Families and Genera. *Science* **231**(4740): 833-836.

Zachos, J. C., Breza, J. R. and Wise, S. W. (1992). Early Oligocene ice sheet expansion on Antarctica: Stable isotope and sedimentological evidence from Kerguelen Plateau, southern Indian Ocean. *Geology* **20**: 569-573.

Nannofossils as paleothermometers of the mid-Cretaceous Greenhouse

Elisabetta Erba & Daniele Tiraboschi

Dipartimento di Scienze della Terra "Ardito Desio", via Mangiagalli 34, 20133 Milan, Italy
Elisabetta.Erba@unimi.it

The mid-Cretaceous greenhouse climate represents the most extreme warmth of the past 300 my. It was accompanied by major perturbations in biogeochemical cycling, preserved in the geological record as long- and short- term, abrupt and transitional changes. In pelagic environments, calcareous nannoplankton were sensitive to major changes in temperature, fertility, and chemistry of surface waters. Consequently, abundance and composition of nannofossil assemblages are used to reconstruct paleoclimatic fluctuations and the functioning of the ocean/atmosphere system. During the early phase of the mid-Cretaceous greenhouse, in the Aptian to Albian interval, peculiar paleoceanographic/paleoclimatic conditions led to black shale deposition during oceanic anoxic events and subevents. While nannofloral assemblages as well as isotopic, sedimentological, paleontological, geochemical data testify a very warm climate, cooling episodes are not obvious, especially at low paleolatitudes. In the Tethys and Atlantic oceans, cooling events are evidenced by incursions and/or increases in abundance of nannofossil taxa typical of high latitudes and, therefore, considered adapted to cooler surface waters.

During the mid-Cretaceous major changes in abundance and composition of calcareous nannofossils as well as large variations in their biogenic fluxes seem correlatable with large magmatic events (LIP formation) and presumably with major increases in atmospheric CO_2, changes in climatic conditions, seawater composition and structure, and oceanic fertilization.

Excess pCO_2 is usually identified as the cause of increased global temperature, however, high levels of volcanogenic carbon dioxide and other volatiles such as S and particulate material in the atmosphere and stratosphere can induce global cooling (volcanic winter).

Quantitative analyses of nannofossils revealed climate variability during what has been identified as an equably hot world. The sequence of warmings and coolings in the Aptian-Albian might result from individual volcanic episodes leading to emplacement of different LIPs. Alternatively or concomitantly, cooling episodes and trends could represent reversed greenhouse conditions resulting from a drawdown of atmospheric carbon dioxide after weathering of basalts exposed on land and burial of organic carbon-rich sediments in the oceans.

Paleoecological signals in nannofossil assemblages of the Monte Petrano section, Italy

Andrea Fiorentino

Dipartimento Difesa del Suolo – Servizio Geologico d'Italia, APAT, Via Curtatone, 3 Roma 00185, Italy
andrea.fiorentino@apat.it

A section, approximately 5 m thick, was sampled in the Scaglia Bianca Formation at Monte Petrano, near Cagli in the Marche Region; its range extends within the *Rotalipora appenninica* planktonic foraminifer biozone and *Eiffellithus turriseiffelii* nannofossil biozone. The succession is represented mainly by limestones with rare chert, interbedded with a few marly layers and five layers of black mudstones and shales, rich in organic matter, marking the Pialli Level (OAE1d). The study was aimed at the recovery of paleoenvironmental signals accompanying changes of lithology.

A quantitative analysis of nannofossil assemblages has been carried out on smear slides prepared from 72 samples (4 of which barren) collected throughout the section. *Watznaueria barnesae* turned out to represent most of the assemblage in every sample (ranging from around 80% to approximately 40% in a few samples). Consequently, a hundred specimens were counted not considering *W. barnesae*, which was counted separately in order to enhance variation of abundance in other taxa.

A 40% abundance of *W. barnesae* was considered the limit of reliability of nannofossil assemblages as regards paleoenvironmental information (Roth & Krumbach, 1986); above this value, assemblages were considered too much affected by preservation to provide paleoecological signals of any meaning. However, in some cases particular conditions allow to raise this value and to retain the high abundance of *W. barnesae* as an indicator of low productivity.

In the Monte Petrano section there is no direct relationship between the abundance of *W. barnesae* and preservation; furthermore, the lowest values of *W. barnesae* abundance are reached in correspondence of the black layers which are associated with an increase in productivity. Therefore, the results obtained have been considered reliable as far as paleoenvironmental signals are concerned.

Biscutum constans is the species considered in direct connection with high productivity; its abundance has been observed to change with a trend opposite to that of *W. barnesae*. In the Monte Petrano section an increase of *B. constans* occurs in correspondence of the black layers, even though with a small shift. The most pronounced increase is located, however, in the lower part of the section, where no black layers are present. This occurrence could be interpreted as an indication that additional events of enrichment in organic matter might have taken place, but no lithological record of such events was preserved.

Parhabdolithus swinnertonii has been associated with *Rhagodiscus* as a productivity indicator. *Discorhabdus* has also been considered among them, despite its delicate structure strongly influenced by preservation. In the Monte Petrano section all of them peak in correspondence with the black layers.

Some changes of abundance are not very marked; however, particularly regarding level V, variations could be clearly observed.

Zygodiscus, a taxon associated to moderate productivity, could not be used due to problems of preservation.

Manivitella pemmatoidea, a warm water indicator, is commonly present in assemblages from the Mediterranean. No direct relationships with lithological changes were detected in the Monte Petrano section, but additional studies are needed to find out possible links with climatic changes.

The examination of the diagrams of Diversity, Shannon Index and Equitability does not provide clear trends in the nannofossil assemblages; poor preservation could play a role, negatively affecting data. However, results obtained by the analysis of variation in the abundances of nannofossils, considered as productivity indicators, shows that increases occurred in connection with the black layers, even though they cannot be detected directly in the levels themselves.

References

Roth, P.H. and Krumbach, K.R. (1986) - Middle Cretaceous calcareous nannofossil biogeography and preservation in the Atlantic and Indian Oceans: implications for paleoceanography. Mar. Micropaleontol., vol.10(1-3), pp.235-266.

Spatial and Temporal Changes in Calcareous Nannofossil Assemblages during the Late Callovian-Middle Oxfordian in Southeastern France

Fabienne Giraud

UMR CNRS 5125 - PEPS, Université Lyon 1, 2 rue Raphaël Dubois, 69622 Villeurbanne cedex, France
Fabienne.Giraud@univ-lyon1.fr

The Late Callovian-Early Oxfordian interval is characterized by a cool climatic phase characterized by an abrupt temperature fall and a long-term stepwise recovery (Dromart *et al*., 2003). During the lower Oxfordian, the general absence of limestone sediments and the lack of reefal formations reflect a crisis in the carbonate production (Cecca *et al*., 2005). The presence of numerous stratigraphic hiatus around the Callovian-Oxfordian boundary could be the result of an abrupt sea-level fall in the late Callovian (*lamberti* ammonite Zone), followed by a sea-level rise starting at the Callovian-Oxfordian boundary (Dromart *et al*., 2003; Cecca *et al*., 2005). A very recent study realized on calcareous nannofossil assemblages at the Callovian-Oxfordian transition in the East Paris Basin documents an increase in primary productivity in relation to the cooling phase (Tremolada *et al*., 2006). Coral-reef distribution, ammonite biogeographical patterns, paleofloral assemblages and geochemical data (synthesis in Cecca *et al*., 2005) are evidence that a progressive warming began in the middle Oxfordian.

In this work, we have analysed the distribution pattern of calcareous nannofossils in lower latitudinal localities (south-eastern France) in order to see 1) the response of nannofossils to the climatic cool phase in different sedimentary settings; 2) the response of nannofossils to climatic changes (transition from cold phase to progressive warming). Three sections, two from Ardèche area and corresponding to a slope paleoenvironment, and one located in the center of the Dauphinois basin were analysed and compared for their calcareous nannofossil assemblages on a restricted temporal interval: the Callovian-Oxfordian boundary. One section from Ardèche was analysed for calcareous nannofossil abundance, assemblage composition and biometry, and calcium carbonate content from the late Callovian to middle Oxfordian.

In all the sections and during all the considered time interval, calcareous nannofossil assemblages are dominated by *Watznaueria britannica*. The different morphotypes described by Giraud *et al*. (in press) are present in south-eastern France but their contribution and those of other taxa changed from one section to another and through time. The calcareous nannofossil assemblages of Ardèche sections are characterized by a greater contribution of small morphotypes within *W. britannica* coccoliths, more abundant *Watznaueria barnesiae*/*fossacincta*, *Watznaueria manivitiae*, large and *Schizosphaerella punctulata* compared to the central basin section. In the basin section large morphotypes of *W. britannica* and the taxa *Biscutum* spp., *Zeugrhabdotus erectus* and *Stephanolithion bigoti bigoti* are more abundant than in the slope sections. We also recognized a great number of large *Watznaueria* (> 8 µm) with a large external cycle, a small central area occupied by a small button, highly birefringent, which are closer on morphology of *W. manivitiae* than *W. britannica*. These *Watznaueria* are more abundant in the slope sections.

Variations through time of the calcareous nannofossil abundance and assemblages, and *W. britannica* sizes, evidenced successive steps.

From the Late Callovian (*lamberti* Zone) towards the Callovian-Oxfordian boundary, representing transition from sea-level minimum to transgressive deposits, the calcium carbonate content decreases whilst the calcareous nannofossil abundance and species richness increase in marls, but stay low in limestone beds. The nannofossil assemblage composition also changes with a decrease in the relative abundance of the taxa *Watznaueria barnesiae*/*fossacincta*, *Watznaueria manivitiae*, large and yellow*Watznaueria* whereas the relative proportion of *W. britannica*, *Discorhabdus*, *Biscutum* and *Z. erectus* increases. *Cyclagelosphaera* presents its highest percentage during this interval before slightly decreased around the boundary.

During the early Oxfordian (*scarburgense* Subzone, *mariae* Zone), abundances and species richness increase but calcium carbonate content stays low (< 30%). Successive peaks are observed: first, the group (*Biscutum*, *Z. erectus*, and *Discorhabdus*), then large-sized of *W. britannica* (Morphotype D and E). Mesotrophic conditions in surface-waters prevailed in this interval and the peak in abundance of Morphotype E, possibly favored by low salinity (Giraud *et al*., in press) could be indicative of more climatic humid conditions.

In the lower part of the *praecordatum* Subzone (*mariae* Zone), carbonate content starts to increase and highest abundances and species richness are reached. A sharp increase of small-sized *W. britannica* is observed in this interval, Increasing sizes of the largest coccoliths of *W. britannica* are also observed. *Axopodorhabdus* spp. which is very minor in the assemblage (less than 5%) presents its maximum in this interval. Highest surface-water fertility are recorded in this interval but higher species richness also suggests a more open-marine environment compared to the preceeding interval.

The middle part of the early Oxfordian (*mariae* - *cordatum* ammonite Zones transition) is characterized by a progressive decrease 1) in nannofossil abundance and species richness, 2) of the size of the largest *W. britannica* coccoliths, whilst the calcium carbonate content increases. Almost all the taxa decrease during this interval and *Discorhabdus* and *W. manivitiae* became very scarce. The percentage of *Watznaueria barnesiae* slightly increases. The assemblages are dominated by small-sized *W. britannica* but the large and yellow *Watznaueria* also presents its highest percentage at the top of this interval. Unstable paleoenvironmental conditions (cooler surface waters ?, more proximal setting ?) prevailed during this interval.

The end of the *cordatum* Zone and the early middle Oxfordian are characterized by an increase in abundance and species richness whereas the contribution of small-sized *W. britannica* decreases. The relative abundance of *Watznaueria manivitiae* and *Discorhabdus* spp. increases, with maximum recorded for this latter. An increase in the relative abundance of Morphotype F is also observed. All these observations suggest warmer mesotrophic surface-waters under warmer and humid climatic conditions during this interval.

The comparison of distribution patterns of calcareous nannofossils between the south-eastern France and East Paris Basin led to the following results. The dominance of *W. britannica* in south-eastern France could be indicative of higher surface-water fertility in this setting than in Paris Basin where the group *W. barnesiae/fossacincta* is dominant (Tremolada *et al*., 2006). *Discorhabdus* spp. and both *Biscutum* spp. and the

representatives of the family Axopodorhabdaceae (which could be more adapted to cooler surface-waters; Tremolada *et al*., 2006) are respectively more and less abundant in south-eastern France compared to the Paris Basin. Very few numbers of *Discorhabdus* are observed in higher latitude settings during the Callovian-Oxfordian. This suggests warm surface waters affinity for *Discorhabdus*, and warmer surface-waters in south-eastern France than in Paris Basin.

References:

Cecca, F., Martin Garin, B., Marchand, D., Lathuilière, B., Bartolini, A., 2005. Paleoclimatic control of biogeographic and sedimentary events in Tethyan and peri-Tethyan areas during the Oxfordian (Late Jurassic). Palaeogeogr., Palaeoclimatol., Palaeoecol., 222, 10-32.

Dromart, G., Garcia, J.-P., Picard, S., Atrops, F., Lécuyer, C., Sheppard, S.M.F., 2003. Ice age at the Middle-Late Jurassic transition ? Earth and Planet. Sci. Lett., 213, 205-220.

Giraud, F., Pittet, B., Mattioli, E., Audouin, V., in press. Paleoenvironmental controls on the morphology and abundance of the coccolith *Watznaueria britannica* (Late Jurassic, southern Germany). Mar. Micropaleontol.

Tremolada, F., Erba, E., van de Schootbrugge, B., Mattioli, E., 2006. Calcareous nannofossil changes during the late Callovian-early Oxfordian cooling phase. Mar. Micropaleontol., 59, 197-209.

Calcareous Nannoplankton as a Proxy of Sedimentary Dynamics in Nazaré Submarine Canyon (West off Portugal)

C. Guerreiro[1,2], M. Cachão[2,3], A. Oliveira[1], & A. Rodrigues[1]

[1] Instituto Hidrográfico, Rua das Trinas, 49, 1200 Lisboa.
[2] Centro de Geologia da Univ. de Lisboa, Edifício C6, 6.4.67, Campo Grande, Lisboa.
[3] Dep. Geologia da Faculdade de Ciências da Univ. de Lisboa, Edifício C6, 6.4.55, Campo Grande, Lisboa.
catarina.guerreiro@hidrografico.pt

Calcareous nannoplankton fossil record from coastal environments has been proven to be an innovative proxy for studies of coastal paleoenvironments. The peculiar nature of the *post-mortem* processes that act on the nannoliths (*sensu lato*) allows us to use them as natural tracers of (1) marine influence variations inside paralic systems (estuaries and coastal lagoons) and (2) oceanic influence variations inside neritic domains (continental shelf) (Guerreiro *et al*., 2005)

The present work aims to study calcareous nannoplankton on a peculiar neritic environment of the Portuguese Continental Shelf: the Nazaré Submarine Canyon (W off Portugal) (Fig.1). This canyon is the longest active submarine valley in Europe and one of the larger and deeper canyons in the world, with 170km of total length, between -60m, at about 500m from the coast, and the Iberian Abyssal Plain (Oliveira *et al*., 2003). It is a typical "gouf" canyon, because of its large dimension, low longitudinal slope (10 to 20%) and its headband deeply carved on the coastal rim (Vanney & Mougenot, 1981). Such deep shelf incision and its location near the coast promotes and intensifies certain hydrodynamic conditions (*e.g.* upwelling; stationary internal wave, Quaresma *et al*. in press) and the mixing of distinct water masses (Oliveira *et al*., 2003). The present study intends to test nannoliths as tracers of the marine influence (neritic *versus* oceanic) in the

Nazaré Submarine Canyon region, and evaluate the impact of its particular hydrological, hydrodynamic and sedimentary processes on the ecological and taphonomical signal registered by this group of organisms.

The (paleo)ecologic and (paleo)geographic study of this sector of the Portuguese Continental Shelf was performed by determining the absolute abundances of calcareous nannoplankton from 69 surface sediment samples collected in May, 2004, during the EUROSTRATAFORM campaign (Fig.1). Slides were prepared according to the random settling procedure (Flores & Sierro, 1997) and observed under optical polarizing microscopy at 1250x magnification.

Results indicate that this submarine canyon is not acting as a preferential entrance of calcareous nannoplankton from the oceanic domain into the neritic domain, since its assemblages/abundances have typical neritic concentration values (max. 5.6×10^6 nanno/g).

High amounts of temperate (*Gephyrocapsa muellerae*) and subtropical (*Gephyrocapsa oceanica* and *Calcidiscus leptoporus*) species is concordant with the Portuguese Continental Shelf location at the oriental margin of Atlantic Ocean, at the transition from the Temperate to the Subtropical Biogeographic Zone (Guerreiro *et al*., 2005). Mapping the marine sedimentation in the Nazaré Submarine Canyon, inferred from surface samples' spatial interpolation maps, allowed to define domains where littoral dynamics and hydrodynamic processes are more active (Fig. 2). The presence of high nannolith abundances in certain sectors of the inner shelf, characterized by high hydrodynamic conditions, suggests *in loco* productivity of calcareous nannoplankton, probably related with particular oceanographical conditions of this region (*e.g*. upwelling, stationary internal wave). The analysis of nannoliths *versus* silty-clay fraction (%) also demonstrates that the majority of the samples register a signal, in general, more ecological than taphonomical (Fig. 3). High values of the smaller species (*e.g. E. huxleyi* and *G. ericsonii*, with max. $1{,}8\times10^8$ nanno/g) dominating the assemblages in the majority of the samples, are also clearly indicator of this productivity.

The particular dynamic of the Nazaré Submarine Canyon and its vicinity to the coast are probably playing an important conditioner/impeditive role on nannolith sedimentation. However, results suggest that calcareous nannoplankton are, effectively, proliferating in this sector of the shelf, far from the stratified and oligotrophic water conditions that are normally recognized as the *modus vivendi* of these organisms. Nannoliths can be sufficiently resistant to be preserved in coastal sediments and certain energetic marine environments such as the Nazaré Submarine Canyon and thus, can be used as a proxy for (paleo)environmental and oceanographical interpretations, allowing to delimitate the domains where the littoral and the mechanisms intrinsic to the canyon are more intense.

References:

Flores, J.A. & Sierro, F.J. (1997) – Revised technique for calculation of calcareous nannofossil accumulations rates. *Micropaleontology*, 43 (3): pp. 321 – 324

Guerreiro, C., Cachão, M. & Drago, T. (2005) – Calcareous nannoplankton as a tracer of the marine influence on the NW coast of Portugal, over the last 14000 years. *J. Nannoplankton Res*. 27(2): pp.159–172

Oliveira, A., Vitorino, J., & Rodrigues, A. (2003) – Turbidez das massas de água do canhão submarino da Nazaré (Portugal). *Ciências da Terra (U.N.L.)*, Lisboa, n.º esp. V, CD-ROM, pp. L32 – L36.

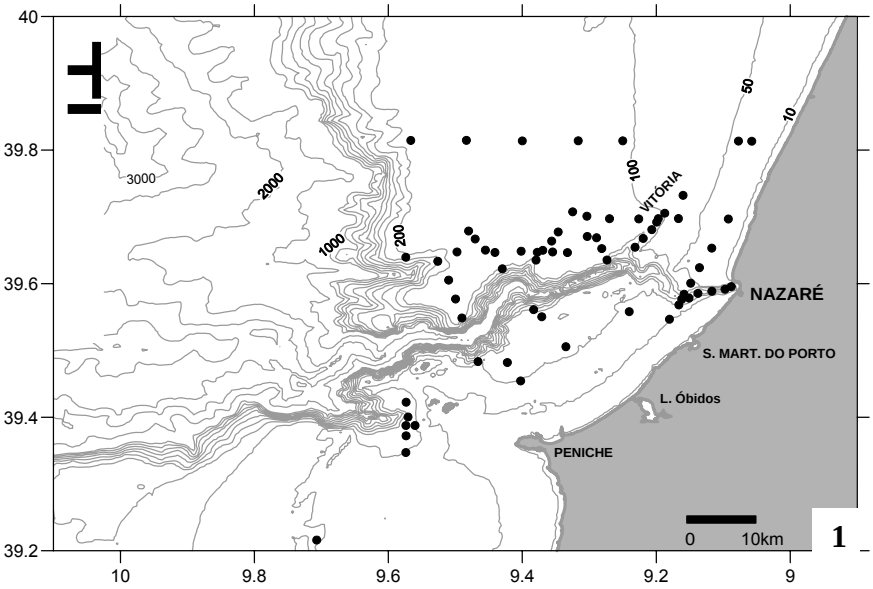


Figure 1 – Nazaré Submarine Canyon location (W off Portugal). EUROSTRATAFORM surface sediment sampling (May, 2004).

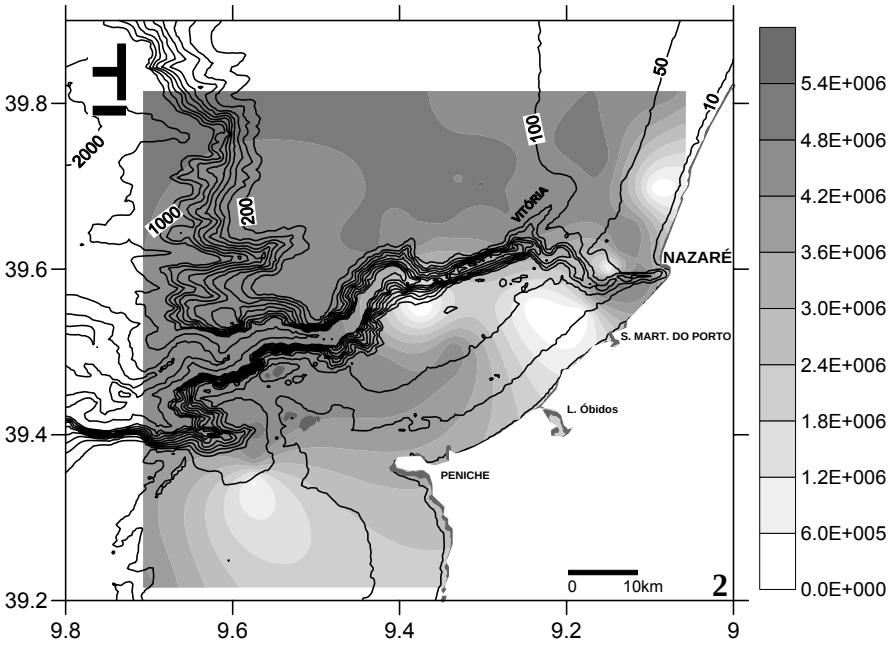


Figure 2 -Calcareous nannoplankton absolute abundance (nanno/g >3µm) distribution (EUROSTRATAFORM) in the Nazaré Submarine Canyon region.

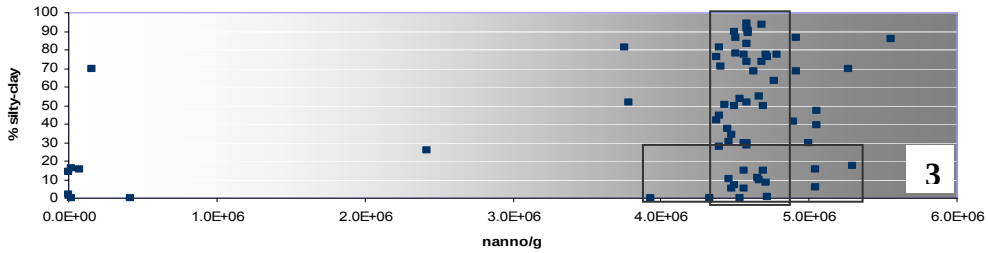


Figure 3 – Silty-Clay percentage *versus* Calcareous nannoplankton (nanno/g >3µm). Vertical band: constant nanno/g values, independently of the sample silty-clay fraction (%). Horizontal band: high nanno/g values in low to absent silty-clay fraction (%) samples.

Quaresma L.S., Vitorino J., Oliveira A. (in press) – "Evidence of sediment resuspension by nonlinear internal waves on the western Portuguese mid shelf". *Marine Geology*.

Vanney, J-R. & Mougenot, D. (1981) – La Plate-Forme Continentale du Portugal et les provinces adjacentes: Analyse Geomorphologique. *Mem. Serv. Geo. Port.*, 28: 86pp.

Calcareous nannoplankton from the Sarcheshmeh Formation in the Kopet-Dogh Range, Northeast Iran

Fatemeh Hadavi & Maryam Shokri

Geology Department, Faculty of Sciences, Ferdowsi University of Mashhad, Mashhad. Iran
fhadavi@ferdowsi.um.ac.ir

The kopet-Dogh range, which stretches for>7000km in WNW-ESE direction, from the Caspian Sea, through the FSU, Iran and into Afghanistan consists of gently folded rock sequences of Late Jurassic, Cretaceous and Tertiary age. The base of sequence is only exposed in the eastern part of the mountain range in Iranian territory. The Sarcheshmeh Formation comprises grey marls and pencil-shales, with subordinate *Orbitolina* – bearing limestone intercalations, developed as a conformable cover of Tirgan Formation throughout the Kopet-Dogh Ranges (Stocklin, 1971). Lateral interfingering between the upper and lower Sarcheshmeh has been observed in some places. The Sarcheshmeh is everywhere overlain by the Sanganeh Formation, the contact bearing marked by a persistent keybed of coquina limestone. The thickness increases from 100m in southeastern most Kopet-Dogh to more than 500m in the central Kopet-Dogh. The age of this formation according to Ammonites and Microfauna was reported Lower Aptian to middle-Albian.

The studied section was located in Western Kopet-Dogh and comprise of abundant well preserved nannofossill. According to this study the age of Sarcheshmeh Formation is Albian to late Albian-Early-Cenomanian corresponding to CC8-CC9 of the Sissingh Zonation (1977).

References:
Sissingh, W. 1977. Biostratigraphy of cretaceous calcareous nannoplankton. *Geol. Mijnbouw,56:37-65.*
Stocklin, 1971. Stratigraphic Lexicon of Iran. Geological Survey of Iran, Report No.18.

Morphological and Morphometric variations of *Braarudosphaera bigelowii*

Kyoko Hagino[1], Yoshihito Takano[2], Yuichiro Tanaka[3], Takeo Horiguchi[1] & Hisatake Okada[1]

[1] Department of Natural History Sciences, Faculty of Science, Hokkaido University, N10W8, Kita-ku, Sapporo, 060-0810 Japan.
[2] Harmful Algal Bloom Division, National Research Institute of Fisheries and Environment of Inland Sea, Fisheries Research Agency of Japan, 2-17-5 Maruishi, Hatsukaichi, Hiroshima 739-0452, JAPAN
[3] Geological Survey of Japan, National Institute of Advanced Industrial Science and Technology (AIST), Higashi 1-1-1, Tsukuba, Ibaraki, 305-8567, Japan
hagino@nature.sci.hokudai.ac.jp

Living *Braarudosphaera bigelowii* can be subdivided into three morphometric groups; small form (<2.4μm in side length of pentalith), intermediate form A (4.0-5.3μm

in side length of pentalith) and intermediate form B (5.3-7.2μm in side length of pentalith) with a quasi-continuous distribution between intermediate forms A and B (Hagino et al., 2005; Takano et al., in press). Since 16 base pare differences, including indels, were found between the SSU rDNA of intermediate forms -A and –B specimens, size variations observed in living *B. bigelowii* can be considered as a result of pseudo-cryptic speciation, although the forms still have been treated as morphotypes of *B. bigelowii* due to their quasi-continuous size variation (Takano et al., in press). When did *B. bigelowii* diverse in size? The answer to this question is unknown because there is no information on size of Paleogene and Neogene *B. bigelowii*. To study the size variation of *B. bigelowii* in the Cenozoic, we have measured side length of pentaliths of *B. bigelowii* fossils, contained in the Neogene and early Quaternary cores from Blake Ridge, NW Atlantic Ocean (Hole 994C, ODP Leg 164).

Size range of *B. bigelowii* populations in the late Neogene and early Quaternary periods were wider than those of living population. In the late Neogene (c.a. 6Ma), *B. bigelowii* consists of three morphometric groups; small (c.a. 2.0μm), intermediate (3.5-8.0μm) and very large (12-13μm). In the early Quaternary (1.65Ma), *B. bigelowii* is composed of three morphometric groups; intermediate (3.5-6.0μm), large (8.5-11μm) and very large (11-13μm) forms, with a quasi-continuous distribution between large and very large forms. All late Neogene and most early Quaternaly specimens are composed of flat trapezoidal elements similar to the pentaliths of living specimens, however, one third of very large pentaliths from the early Quaternary consist of convex trapezoidal elements.

The data on size variation of *B. bielowii* in the geological time is still scarce, and we revealed only a fraction of evidence. However, we can say that *B. bigelowii* likely had a size reduction event in the last 1.65 million years, since large *B. bigelowii* (> 8μm in side length of pentalith) has never been reported from the previous studies on living cocolithophores.

References:

Hagino, K., Okada, H. and Matsuoka, H., 2005. Coccolithophore assemblages and morphotypes of *Emiliania huxleyi* in the boundary zone between the cold Oyashio and warm Kuroshio currents off the coast of Japan, *Marine Micropaleontology*, 55. 19-47.

Takano, Y., Hagino, K., Tanaka, Y., Horiguchi, T. and Okada, H., in press. Phylogenetic affinities of an enigmatic nannoplankton, *Braarudosphaera bigelowii* based on the SSU rDNA sequences, *Marine Micropaleontology*

Calcareous Nannofossil Biostratigraphy and Paleoecology of the Cenomanian-Turonian Boundary Interval of ODP Leg 207 at the Demerara Rise (Equatorial Atlantic)

Petros Hardas & Jörg Mutterlose

Ruhr-University Bochum, Universitätsstr. 150, Bochum, 44801, Germany.
petros.hardas@rub.de

During ODP Leg 207 at the Demerara Rise (western equatorial Atlantic) a thick black shale succession was drilled, covering the late Albian to late Santonian. We have

studied the biostratigraphy and palaeoecology of the black shales of the Cenomanian-Turonian boundary interval (CTBI), where the Oceanic Anoxic Event 2 (OAE2) occurred (e.g., Schlanger et al., 1987), with respect to its content in calcareous nannofossils.

The biostratigraphy of four sites (1258, 1259, 1260, and 1261) has been studied; 147 samples have been analyzed. We have identified the following eight calcareous nannofossil bioevents (first occurrences, FOs and last occurrences, LOs, Fig.1): LO of *Corollithion kennedyi,* FO of *Cylindralithus biarcus,* LO of *Axopodorhabdus albianus* and FO of *Quadrum gartneri,* FO of *Quadrum intermedium,* FO of *Eprolithus octopetalus*, FO of *Eprolithus eptapetalus*, and FO of *Eiffellithus eximius*. These bioevents have been correlated with the stable carbon isotope curves of Erbacher et al. (2005). The FO of *Q. gartneri* was observed in the lower part of the $\delta^{13}C_{org}$ excursion, which is earlier than in the sections of Eastbourne (England), Pueblo (USA) and Oued Mellegue (Tunisia), where its FO falls very close to the onset of decreasing $\delta^{13}C$ values in the upper part of the excursion interval (Nederbragt & Fiorentino, 1999; Tsikos et al., 2004).

Sixty samples from Sites 1258 and 1260 have been analyzed quantitatively. Settling slides have been prepared by using the technique of Geisen et al. (1999). During the $\delta^{13}C_{org}$ excursion calcareous nannofossil assemblages show a reaction. The high fertility indicator *Zeugrhabdotus erectus* shows a significant increase of its relative abundance, whilst the oligotrophic taxa *Watznaueria* spp. (including *W. barnesae* and *W. fossacincta*) decrease strongly (Fig.2). This indicates enhanced nutrient input during OAE2. The suggested cooler water species *Eprolithus floralis* decreases, which may indicate warmer surface water temperatures during this event (Fig. 2).

Other species increasing their relative abundances during the OAE2 and therefore thought to be indicative of high productive or/and warmer surface waters include *Prediscosphaera* spp. (*Prediscosphaera cretacea* and *Prediscosphaera columnata*), *Sollasites horticus*, *Retecapsa ficula*, and *Zeugrhabdotus diplogrammus* (Fig. 2). The following species show a decrease of their relative abundance during OAE2, indicating a preference for low productivity or/and cooler surface waters: *Amphizygus brooksii, Broinsonia* spp. (including *Broinsonia enormis* and *Broinsonia matalosa*), *Gartnerago segmentatum*, *Watznaueria biporta*, and *Zeugrhabdothus noeliae* (Fig. 2).

References:

Erbacher, J., Friedrich, O., Wilson, P.A., Birch, H., Mutterlose, J., 2005. Stable organic carbon isotope stratigraphy across Oceanic Anoxic Event 2 of Demerara Rise, western tropical Atlantic. Geochemistry, Geophysics, Geosystems 6, Q06010, DOI 10.1029/2004GC000850.

Geisen, M., Bollmann, J., Herrle, J., Mutterlose, J., Young, J., 1999. Calibration of the random settling technigue for calculation of absolute abundances of calcareous nannoplankton. Micropaleontology, 45, 437-442.

Nederbragt, A., Fiorentino, A., 1999. Stratigraphy and palaeoceanography of the Cenomanian – Turonian Boundary Event in Oued Mellegue, north-western Tunisia. Cretaceous Research 20, 47-62.

Schlanger, S.O., Arthur, M.A., Jenkyns, H.C., Scholle, P.A., 1987. The Cenomanian – Turonian Oceanic Anoxic Event, I. Stratigraphy and distribution of organic carbon-rich beds and the marine 13C excursion. Geological Society, London, Special Publication 26, 371-399.

Tsikos, H., Jenkyns, H.C., Walsworth-Bell, B., Petrizzo, M.R., Forster, A., Kolonic, S., Erba, E., Premoli Silva, I., Baas, M., Wagner, T., Sinninghe Damste, J.S., 2004. Carbon – isotope stratigraphy recorded by the Cenomanian – Turonian Oceanic Anoxic Event: correlation and implications based on three localities. Journal of the Geological Society, London 161, 711-719.

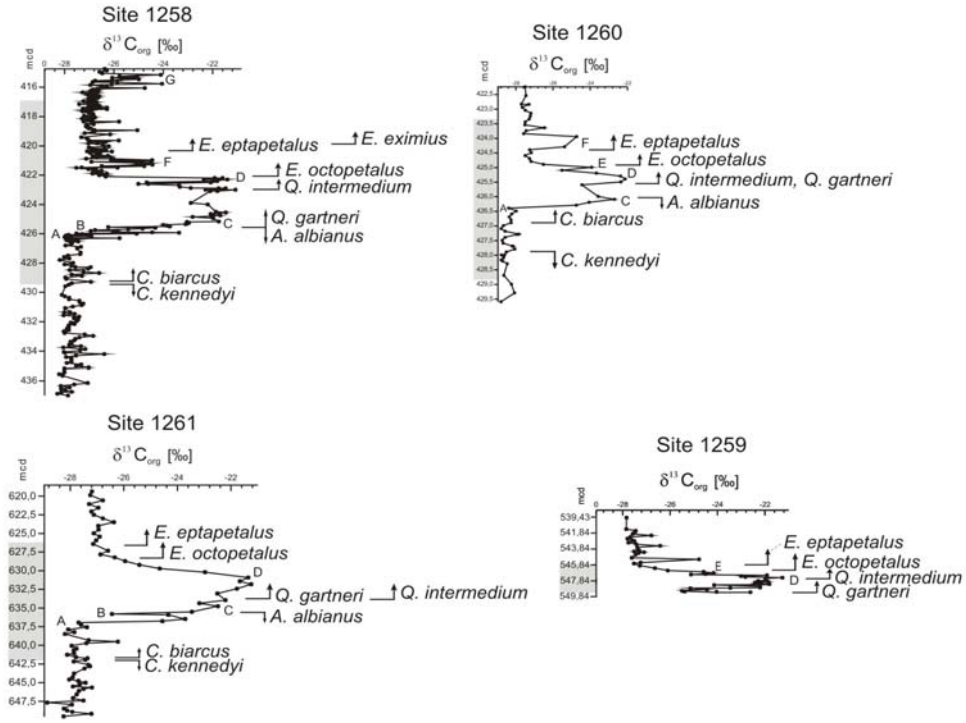


Fig. 1. Chemo- and biostratigraphic correlation of the CTBI of Sites 1258, 1260, 1261 and 1259. Stable carbon isotope curves modified after Erbacher et al. (2005). Shaded parts of the mcd (meters composite depth) refer to the studied interval.

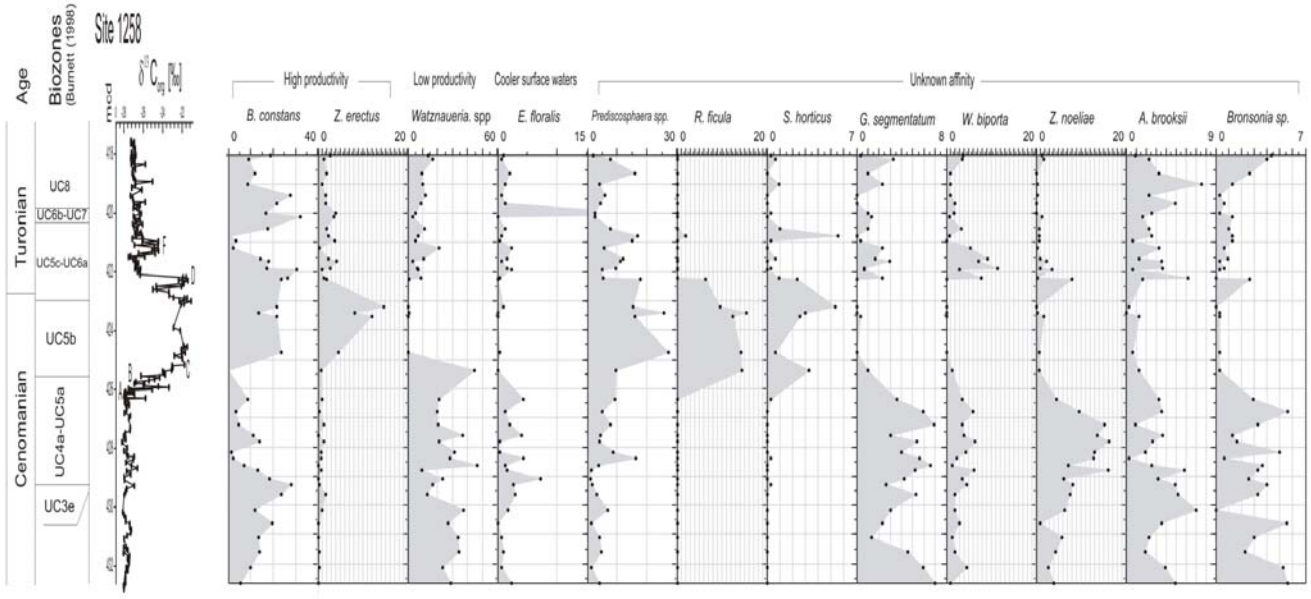


Fig. 2. Vertical distribution of the calcareous nannofossil taxa of the CTBI of Sites 1258 and 1260. Stable carbon isotope curves after Erbacher et al. (2005).

Middle Miocene (Badenian/Sarmatian) Calcareous Nannoplankton from the Southern Margin of the Central Paratethys (Northern Bosnia)

Lazar Jerković[1] *& Stjepan Ćorić*[2]

[1]202-440 Rue Poudriere, H4G 3L9, Verdun, Quebec, Canada (Faculty of Natural Sciences, University of Podgorica, Montenegro)
[2]Geological Survey of Austria, Neulinggasse 38, A-1030 Vienna, Austria
teslich@estart.com

During oil prospection at the southern margin of the Central Paratethys (Northern Bosnia) in the 1970's, calcareous nannofossils and foraminifers were investigated for the stratigraphical framework. These results are reinterpreted in the light of the newest stratigraphical and paleoecological results. Micropaleontological investigations were performed on Miocene sediments collected in 10 areas of Northern Bosnia: Bosanski Novi, northern and northeastern part of Potkozarje, Hrvaćani, Prnjavor, Derventa and Doboj, Mt. Vučjak, Gradačac, Gračanica, Tuzla basin, and Zvornik.

Strong tectonic movements of the Styrian phase at the Early/Middle Miocene boundary opened the sea-connection between the Central Paratethys and the Mediterranean, resulting in the Middle Miocene transgression. The Middle Miocene of the Central Paratethys is subdivided into the Badenian (corresponding to the Langhian and the Early Serravallian) and the Sarmatian (the Late Serravallian) regional stages. They span the nannoplankton zones NN5, NN6, and the lower part of NN7.

Based on calcareous nannoplankton, the Badenian sediments from Northern Bosnia can be attributed to the nannoplankton zones NN5 and NN6. Sediments with *Helicosphaera ampliaperta* (the marker for nannoplankton zone NN4) were not recorded in the investigated area. Calcareous nannoplankton assemblages of the *Sphenolithus heteromorphus* zone NN5 (the zone between LO of *Helicosphaera ampliaperta* and LO of *Sphenolithus heteromorphus*) are abundant and well preserved. They are characterized by high percentages of small reticulofenestrids (*Reticulofenestra minuta* and *R. haqii*) accompanied by *Coccolithus pelagicus, C. miopelagicus, Cyclicargolithus floridanus, Geminilithella rotula, Helicosphaera carteri, H. walbersdorfensis, Holodiscolithus macroporus, Pontosphaera multipora, Reticulofenestra gelida, R. pseudoumbilica* (5-7μm)*, Rhabdosphaera sicca, Sphenolithus heteromorphus, S. moriformis, Syracophaera pulchra* and *Umbilicosphaera jafari.*

In contrast to the sediments of the nannoplankton Zone NN5, sediments of the *Discoaster exilis* zone NN6 contain high percentages of medium-sized reticulofenestrids: *Reticulofenestra gelida* and *R. pseudoumbilica* (5-7μm). *Coccolithus pelagicus, C. miopelagicus, Cyclicargolithus floridanus, Geminilithella rotula, Helicosphaera carteri, H. walbersdorfensis, H. wallichii, Holodiscolithus macroporus, Pontosphaera discopora, P. multipora, Reticulofenestra haqii, R. minuta, Rhabdosphaera sicca, Sphenolithus abies, S. moriformis, Syracophaera pulchra* and *Umbilicosphaera jafari* consistently occur. Discoasterids (*Discoaster musicus, D. exilis* and *D. variabilis*) occur very rarely in the studied material from the northern margin of the Central Paratethys.

Sarmatian sediments (upper NN6) are characterized by occurrences of the endemical calcareous nannoplankton *Perforocalcinella fusiformis, Micrascidites latens,* and *Reticulofenestra splendida* n. sp.

Surface-Water Chemistry and Fertility Variations in the Tropical Atlantic across the Paleocene/Eocene Thermal Maximum as Evidenced by Calcareous Nannoplankton from ODP Leg 207, Hole 1259B

Shijun Jiang & Sherwood W. Wise, Jr.

Department of Geological Sciences, Florida State University, 108 Carraway Building, Tallahassee, FL 32306, USA.
jiang@gly.fsu.edu

Calcareous nannoplankton assemblages at Ocean Drilling Program Site 1259 at mid-bathyal depths on Demerara Rise (western equatorial Atlantic) underwent an abrupt and fundamental turnover across the Paleocene/Eocene Thermal Maximum (PETM) ~55.5 m.y. ago. The P/E boundary event is marked by a dissolution interval barren or nearly-barren of nannofossils due to the rapid acidification of the world oceans. *Toweius*, *Fasciculithus*, and *Chiasmolithus* sharply decrease at the onset, whereas *Chiasmolithus*, *Markalius* cf. *M. apertus*, and *Neochiasmolithus* thrive immediately after the event, which also signals the successive first appearances of *Discoaster araneus*, *Rhomboaster*, and *Tribrachiatus*. The environmental indications of these changes were further investigated by correspondence analysis on quantitative nannofossil counts based on two main factors extracted.

The PETM event has been attributed to CO_2-forced greenhouse effects. At Site 1259, the elevated pCO_2 and subsequent lowered surface-water pH values at the onset of the PETM caused intensive carbonate dissolution, producing the nannofossil-barren interval. The chemically stressed habitats may well have also induced the evolution of ephemeral nannofossil "excursion taxa", such as *Rhomboaster* and malformed discoasters (*Discoaster araneus* and *Discoaster anartios*). Based on its sudden increase, *Markalius* cf. *M. apertus* is considered to have been a local opportunistic species that took advantage of the surface-water changes. At the same time, a presumably higher runoff from continental areas fertilized the western equatorial Atlantic as indicated by an increase in the abundance of r-mode specialists preferring high-nutrient conditions, such as *Chiasmolithus*, *Coccolithus pelagicus* and *Hornibrookina arca*. Contrasts between the results of this study and previous work at ODP Site 690 in the Southern Ocean, the New Jersey continental margin, and the central paleoequatorial Pacific further demonstrate that the response to the PETM can be influenced by local differences in geologic setting and oceanographic conditions.

Intraspecific variability in Coccospheres in the Deep Photic Zone

Alicia Kahn & Marie-Pierre Aubry

Department of Geological Sciences, Rutgers University, 610 Taylor Road, Piscataway, NJ 08854
kahn@rci.rutgers.edu

The modern deep photic zone is inhabited by a specific coccolithophore community. In an attempt to better understand the ecological dynamics of this community we have conducted a quantitative analysis of 5 taxa, *Algirosphaera robusta*, *Gladiolithus striatus*, *G. flabellatus*, *Florisphaera profunda sensu lato*, and *Solisphaera* spp. Our sample is from station VANC10MV07 (33^{o}S 45 ^{o}E) at 120 m depth on the Eastern Side of the HV Melville Hydroacoustic and Biological Sampling Cruise transect across the southern Indian Ocean. We have measured the diameters of the coccospheres and the lengths and widths of the coccoliths and their various features. This reveals that these species have low intraspecific variability. In addition, we observe very little interspecific variability as well. This distinguishes the species in the deep photic zone from species in the shallow photic zone, in which intraspecific variability is marked. For instance, the diameter of the coccosphere of *A. robusta* varies by 20%, whereas that of *D. tubifera* varies by 45%. The amplitude of intraspecific variability in fossil taxa may constitute a direct indicator of the depth (upper/lower photic zone) at which the taxa lived.

Paleogene Synchrony between Nannofossil Evolutionary Events and Environmental Change

Andrea L. Kalb & Timothy J. Bralower

Department of Geosciences, Pennsylvania State University, University Park, PA 16802 USA
akalb@geosc.psu.edu

A preliminary study on the synchrony of calcareous nannofossil assemblages and environmental change will provide a greater resolution of nannofossil evolutionary events in the Paleocene and Eocene. If environmental change is the dominant driver of nannofossil evolutionary events, then one would expect the times of maximum environmental changes to be synchronous with the timing of the nannofossil record as a result of the widespread rapid dispersal of taxa. Using a random settling technique based on Beaufort (1991), abundance data can be used to determine the number of nannofossils per gram of sediment. A more detailed study of the changes in the assemblages using this data will determine if there is synchrony in the Paleogene, similar to Neogene records, or if the Paleogene was fundamentally different from the Neogene. This data shows that first occurrences of chosen datums appear during periods of biotic turnover as shown by corresponding changes in the overall assemblage at the same depth as the first occurrence. This study will help us understand major intervals of biotic upheaval and environmental stresses in the oceans.

Reference:
Beaufort, L., 1991. Adaptation of the random settling method for quantitative studies of calcareous nannofossils. *Micropaleontology* 37, 415-418.

Difference of Crystallographic Growth Patterns between Neogene and Paleogene Discoasters

Koji Kameo & Noboru Furukawa

Department of Earth Sciences, Faculty of Science, Chiba University, 1-33, Yayoi, Inage, Chiba, CHIBA, 263-8522, JAPAN
kameo@faculty.chiba-u.jp

Selected area electron diffraction (SEAD), high-resolution transmission electron microscopic and scanning electron microscopic analyses of nannoliths were performed to determine crystal habit of *Discoaster* spp. Determination of crystallographic direction of elements were based on calcite decoration method of Okazaki and Inoue (1976). Examined species are *Discoaster brouweri*, *Discoaster variabilis*, *Discoaster barbadiensis*, and *Discoaster saipanensis*. Neogene Discoasters are composed of a frame structure like spreading umbrella that bent ray radially combined. There are five-rayed and six-rayed specimens and the latter type has two kinds of tip shapes, the linear tip (*D brouweri*) and the Y-shaped tip (*D. variabilis*). Each ray seems to be composed of a single crystal. Moreover, the [0001] direction of a ray is identical both on five-rayed and six-rayed specimens and its direction is perpendicular to the tangential plane of the central area of a specimen. Therefore, the basal part of rays is almost perpendicular to the extension of the [0001]. Also, each ray is being joined together in the plane that is parallel to [0001].

On the other hand, Paleogene Discoasters (*Discoaster barbadiensis* and *Discoaster saipanensis)* have more number of rays than those of Neogene species. Although the direction of a ray is seemingly similar to the Neogene type, the ray extension of a Paleogene species is an inverse direction to that of the Neogene species and a ray corresponds to the development of $(10\bar{1}4)$ face. Thus, the mechanism of the crystal growth between Neogene and Paleogene Discoasters should be different and generic division of discoasters must be re-considered.

Reference:
Okazaki, K, and Inoué, S., 1976 *Development, Growth and Differentiation* 18: 413,434

Application of Graphic Correlation in Nannofossil Biostratigraphy

Sudeep Kanungo & Emil Platon

Energy & Geoscience Institute, University of Utah, 423 Wakara Way, Suite 300, Salt Lake City, Utah 84108, USA
skanungo@egi.utah.edu

The fossil record of calcareous nannoplankton is one of the most abundant and stratigraphically complete of any fossil group. Nannofossils are exceptionally useful for biostratigraphy because of their small size, planktonic habit, rapid evolution and largely cosmopolitan distribution. In the last three decades, nannofossils have lend themselves to high-resolution zonation schemes, which are based on a series of well-established primary markers and a host of secondary markers whose biostratigraphic utility has not been fully explored yet. Determining the maximum range (inception to extinction) of such secondary markers would be the best way of enhancing their utility in biostratigraphy. This study aims to improve the stratigraphic resolution of secondary markers. For this purpose we are applying the graphic correlation methodology on analyzed data from a suite of coeval mid-Cretaceous Ocean Drilling Program (ODP) sections in the western North Atlantic region.

The Graphic Correlation method was developed by Shaw in the 1960's as a means to establish the total ranges of fossil taxa and to correlate among stratigraphic sections by placing all sections in a standardized framework. Generally, data from a large number of analyzed sections (wells and outcrops) in a given area define a composite standard. When graphing a new section, this composite standard is used to retrieve stratigraphic events, i.e., first and last occurrences of fossil datums. Once interpreted, the new section becomes a part of the composite standard and increases its resolution by establishing more accurate fossil ranges, i.e., stratigraphic tops and bases. A Windows-based graphic correlation software application, StrataPlot, developed at the Energy and Geoscience Institute, was used for the purpose of this study.

Trial and Error, Environmental Forcing or Mere Chance – what controls coccolithophore evolution?

Hanno Kinkel, Daniela Crudeli & Jeannette Lezius

Institut für Geowissenschaften, Christian-Albrechts-Universität zu Kiel, Germany
hki@gpiuni-kiel.de

Although coccolithophores possibly provide the most complete fossil record of any organism group, there is still little knowledge on the driving forces of nannoplankton evolution. Potential external forcing mechanisms are thought to be climatic or geochemical changes in the oceans. However there is still a lack of interdisciplinary studies, in which physical parameters and evolutionary studies are combined and even

where they are combined the resolution of such studies is often too coarse to decipher linkages between environmental forcing mechanisms and evolutionary response.
We have carried out studies on a number of high-resolution sedimentary sequences with available paleoceanographic datasets to test whether or not there is an external forcing on coccolithophore evolution. These studies take into account stratigraphic occurrences and disappearances of marker species, relative and absolute abundances of coccolihophore assemblages, biometric analysis of selected species, as well as stable isotopes of coccolithophore fine fractions. We have mainly focused on the evolution of the genus *Gephyrocapsa*, which radiated in the Early Pliocene and underwent a number of evolutionary events since then. .

In general it appears that speciation events seem to follow a rather arbitrary pattern, with no clear linkage to external forcing mechanisms. However in several cases evolutionary patterns and coccolithophore assemblages clearly follow environmental gradients or changes, demonstrating an external forcing on plankton evolution. Thus it appears that external factors function as shapers of the overall community structure and the reason for speciation still remain unknown, and could be totally intrinsic or be cased by an environmental forcing so far unconsidered.

Quaternary Nannofossil Biostratigraphy and Diachrony, Correlation to Oxygen Isotope Events

Craig Koch [1,2] *& Jeremy Young*[1]

[1] Palaeontology Department, The Natural History Museum, London, UK
[2] School of Ocean Sciences, University of Wales, Bangor, UK.
c.koch@nhm.ac.uk

Quaternary nannofossils have been carefully and intensively studied over the past thirty years resulting in a zonation scheme which is remarkable in at least three ways. First, it has very fine resolution, around 200,000 years. Second, the zonation appears to be very reliable throughout low latitudes. This is indicated both by consistency of sequence of events and by correlations with oxygen isotopes and magnetostratigraphy. Third, it is based on rather subtle events; there is no great change in nannofloras during the Pleistocene.

As part of a project on Quaternary nannofossils we have reviewed the literature to assess the degree of diachrony shown by the events and provide a new synthesis of correlations with marine isotope stages for biostratigraphers and Quaternary researchers. The objectives are first to provide an improved correlation of events with oxygen isotope stages and second to investigate patterns of diachrony in events and so constrain the possible causes of diachrony. Our analysis is based on all available good quality correlations of Quaternary nannofossil events with oxygen isotope stratigraphy.

Sea Surface Temperature during Heinrich Events in the NE Atlantic, Evidence from Coccolithophore-based Proxies

Craig Koch [1,2], Jeremy Young[1], Vicky Peck[3], & Antoni Rosell[4]

[1] Palaeontology Department, Natural History Museum, London, UK.
[2] School of Ocean Sciences, University of Wales, Bangor, UK.
[3] Cardiff University, Wales, UK (currently at BAS, Cambridge, UK)
[4] ICREA, Universitat Autonoma de Barcelona, Spain
c.koch@nhm.ac.uk

Recent research into Heinrich Events of the last glacial provide conflicting records of sea surface temperature (SST), questioning the true climatic conditions under which the periodic collapse of the Laurentide ice sheet occurred. High resolution planktonic foraminifer Mg/Ca SST records appear to oppose those based on faunal assemblage composition, suggesting elevated summer SSTs immediately preceded and persisted through each of the last five Heinrich Events. It is possible that these discrepancies may be related to anomalous salinity conditions or to variable seasonal conditions having differential effects on the various proxies To constrain our understanding of these records we present coccolithophore based SST records in parallel with Mg/Ca and faunal assemblage investigations of planktonic foraminifera. We have used two independent coccolithophore-based approaches: the well established alkenone paleothermometry technique and two methods based on the relative abundance of different morphotypes of *Emiliania huxleyi* and *Coccolithus pelagicus*.

Three piston cores from the Porcupine Bight area of the NE Atlantic (MD04 2819, MD01 2461 and OMEX 2K) provide high resolution records of the late Quaternary. These cores are made up of distinct glacial interglacial cycles, marked by nannofossil ooze / clay rich layers, the earliest of which is MIS 10. Coccolith abundances vary greatly, with highest numbers during MIS 5e ($3.5x10^{11}$) and the lowest during Heinrich Events ($2.6x10^{7}$).

Morphological analyses on *E. huxleyi* and *C. pelagicus* coccoliths show that large *E. huxleyi* (>4um) first appears during MIS 6, and becomes common during MIS 2-4, making up between 5-30% of the total assemblage, peaking during Heinrich Events. Two morphotypes of *C. pelagicus* size are distinguishable, *Coccolithus pelagicus pelagicus* (small) and *Coccolithus pelagicus braarudii* (large). The larger form dominates throughout most of the core, especially during interglacials, the smaller form only dominates during the coldest parts of the glacials, especially during Heinrich Events.

Both of these changes have been interpreted as cold water indicators by several authors and the fact that the size trends go in different directions makes it difficult to interpret the patterns as preservational artifacts. So the coccolithophore data strongly supports the classic model that Heinrich Events were characterized by cold surface water conditions. Hence recent anomalous indications of warm conditions during Heinrich events probably require special explanations rather than indicating that the basic model is flawed.

Maastrichtian Calcareous Nannofossils from Clasts in Pleistocene Glaciomarine Muds from the Northern James Ross Basin, Western Weddell Sea, Antarctica

Denise K. Kulhanek and the SHALDRIL II Shipboard Scientific Party

Florida State University, Dept. of Geological Sciences, 108 Carraway Building, Tallahassee, FL 32306-4100, USA
kulhanek@gly.fsu.edu

Site NBP0602A-9, drilled during the SHALDRIL II cruise of the RV/IB *Nathaniel B. Palmer*, includes two holes located in the Northern James Ross Basin in the western Weddell Sea. Neither hole reached the lower Oligocene target interval due to floes of multiyear sea ice that forced abandonment of the holes while drilling through the glaciomarine overburden. Hole NBP0602A-9A reached 4.23 meters below the seafloor (mbsf), whereas Hole NBP0602A-9B penetrated to 10 mbsf. Sediment from both holes consists of very dark gray, pebbly, sandy mud, grading to very dark greenish gray, pebbly, silty mud in the lower 2.5 m of Hole 9B. In addition to abundant pebbles found throughout the cores, both holes contain numerous sedimentary clasts interpreted as rip-up clasts. Biostratigraphic analysis of diatom assemblages from the glaciomarine muds yielded rare to few, poorly preserved diatoms. The mixed assemblage consists mostly of extant species with ranges extending back to the Pliocene, but also includes reworked taxa that range to the Miocene. The absence of *Rouxia* spp., however, suggests the sediment is late Pleistocene in age.

The sedimentary clasts were either barren of diatoms, or included very rare fragments of Plio-Pleistocene taxa that likely resulted from contamination by the surrounding mud matrix. On the other hand, the clasts contain common (1 specimen/2-10 fields of view), moderately to well-preserved calcareous nannofossils. The assemblage consists of typical Late Cretaceous species, such as *Biscutum constans*, *Eiffellithus turriseiffelii*, *Cyclagelosphaera margerelii*, *Kamptnerius magnificus, Prediscosphaera* spp., *Cribrosphaerella* spp., and *Arkhangelskiella* spp. Species typical of Maastrichtian austral high-latitude deposits also occur, including *Nephrolithus frequens* and *N. corystus*. The presence of *N. frequens* dates the age of the clast material as Maastrichtian. The clasts are believed to derive from fossiliferous Mesozoic strata from nearby localities along the northern Antarctic Peninsula, such as those described on Seymour and James Ross Islands; however, these clasts represent the most diverse and richest Maastrichtian nannoflora known to date from similar lithologies in this region.

Albian-Cenomanian Calcareous Nannofossil Biostratigraphy and Paleoceanography from ODP Site 1258, Demerara Rise

Denise K. Kulhanek & Sherwood W. Wise, Jr.

Florida State University, Dept. of Geological Sciences, 108 Carraway Building, Tallahassee, FL 32306-4100, USA
kulhanek@gly.fsu.edu

Ocean Drilling Program Site 1258, drilled during Leg 207 on Demerara Rise off the northern coast of South America, recovered organic-rich Albian and Cenomanian sediments that yield abundant, moderately to well-preserved calcareous nannofossils. Biostratigraphic analysis shows that most of the Albian section spans Roth's (1978) middle to late Albian *Axopodorhabdus albianus* Zone (NC9). A disconformity separates these sediments from overlying uppermost Albian and Cenomanian laminated shales from the *Eiffellithus turriseiffelii* Zone (NC10). The high-fertility indicators *Biscutum constans* and *Zeugrhabdotus erectus* are typically abundant throughout the section, although there are intervals where these species are less predominant. The low-fertility, eutrophic indicator *Watznaueria barnesae* is also present throughout the section, but usually less abundant than the high-fertility indicators. Abundance changes amongst these species indicate changes in surface-water fertility conditions at Demerara Rise during the mid-Cretaceous. In addition, the presence of *Seribiscutum primitivum* within the Albian section represents the first known occurrences of this species at such low latitudes, as Demerara Rise was located within 15º of the equator during the mid-Cretaceous. This species exhibits a bipolar distribution and is considered a cool-water, high-latitude species. Its presence on Demerara Rise indicates cooler water incursions either through changes in surface circulation or upwelling conditions during the opening of the Equatorial Atlantic.

Reference:
Roth, P.H., 1978. Cretaceous nannoplankton biostratigraphy and oceanography of the northwester Atlantic Ocean. *In* Benson, W.E., Sheridan, R.E., et al. (Eds.) Init. Repts. DSDP 44. U.S. Government Printing Office, Washington, D.C., pp. 731-760.

Emiliania huxleyi Morphotypes: Expression of Seawater Carbonate Chemistry?

Kristina Larsson & Jorijntje Henderiks

Department of Geology and Geochemistry, Stockholm University, SE-106 91 Stockholm, Sweden
jorijntje.henderiks@geo.su.se

Three NE Atlantic deep-sea cores, BOFS 8K (52°N 22°W), BOFS 5K (50°N 21°W) and NEAP 8K (59°N 23°W), were used to reconstruct the carbonate sedimentation history over the past 30,000 years. Climatic change over the last glacial-interglacial cycle is associated with dramatic changes in ocean circulation, the global

carbonate system and the nature of the sediments deposited in the deep-sea. In the investigated cores, glacial and deglacial sediments are dominated by terrigenous IRD, whereas during the Holocene biogenous carbonate contributions, as well as their mass accumulation rates, increase significantly. This results from increased biological productivity as well as increased sediment focussing at the sites. Fine fraction (<38 μm) carbonate, and thus coccolith production and dissolution, drives most of the bulk carbonate changes and is the focus of this study. The proportion of foraminifera is increased during the LGM, whereas detrital carbonate dominates during Heinrich events. Distinct glacial-interglacial variability in carbonate preservation was revealed by a dissolution index using the ratio between *Emiliania huxleyi*, the dominating species, and that of etched or unidentifiable small placoliths under polarised light microscopy. Overall, placoliths are better preserved in the glacial sediments. Differences in carbonate dissolution are likely due to changes in deep water circulation as well as increased primary productivity during the Holocene.

A biometric study of *E. huxleyi* reveals increased coccolith sizes, a more circular coccolith shape and a bimodal distribution during the glacial period, especially during the LGM. This points to the existence of two *E. huxleyi* morphotypes (Type A and Type B; cf. Young and Westbroek, 1991), with a larger form dominating glacial sediments. This is consistent with previous results from the central Atlantic and Mediterranean Sea (Colmenero-Hidalgo et al., 2002; Fig. 1). The abundance of either morphotype appears to be primarily controlled by sea surface temperature (SST), as previously suggested (Colmenero-Hidalgo et al., 2002; Hagino et al., 2005). The smaller Type A is depicted as a 'warm' water genotype, whereas the larger Type B characterises cooler SST, which is consistent with its dominance during the LGM.

However, a strikingly similar pattern between calculated *E. huxleyi* placolith weights (cf. Young & Ziveri, 2000) and foraminifera shell weights (Barker et al., 2004) suggests that the carbonate chemistry of the surface ocean may also play a role (Fig. 2). In NEAP 8K, increased foraminiferal shell weights during the LGM are believed to reflect elevated $[CO_3^{2-}]$ of surface waters due to lowered glacial atmospheric pCO_2 (Barker et al., 2004). However, a comparison of the latter data with measurements of *E. huxleyi* carbonate weights within a narrow size range are required to further test our hypothesis.

References:

Barker, S., Elderfield, H. & Kiefer, T. 2004. Temporal changes in North Atlantic circulation constrained by planktonic foraminiferal shell weights, *Paleoceanography*, **19**, doi:10.1029/2004PA001004.

Colmenero-Hidalgo, E., Flores, J-A. & Sierro, F.J., 2002. Biometry of *Emiliania huxleyi* and its biostratigraphic significance in the Eastern North Atlantic Ocean and Western Mediterranean Sea in the last 20 000 years, *Mar. Micropaleontol*., **46**, 247-263.

Hagino, K., Okada, H. & Matsuoka, H., 2005. Coccolithophore assemblages and morphotypes of *Emiliana huxleyi* in the boundary zone between the cold Oyashio and warm Kuroshio currents off the coast of Japan, *Mar. Micropaleontol*., **55**, 19-47.

Young, J. & Westbroek, P., 1991. Genotypic variation in the coccolithophorid species *Emiliania huxleyi*, *Mar. Micropaleontology*, **18**, 5-23.

Young, J.R. & Ziveri, P., 2000. Calculation of coccolith volume and its use in calibration of carbonate flux estimates, *Deep-sea Res. II*, **47**, 1679-1700.

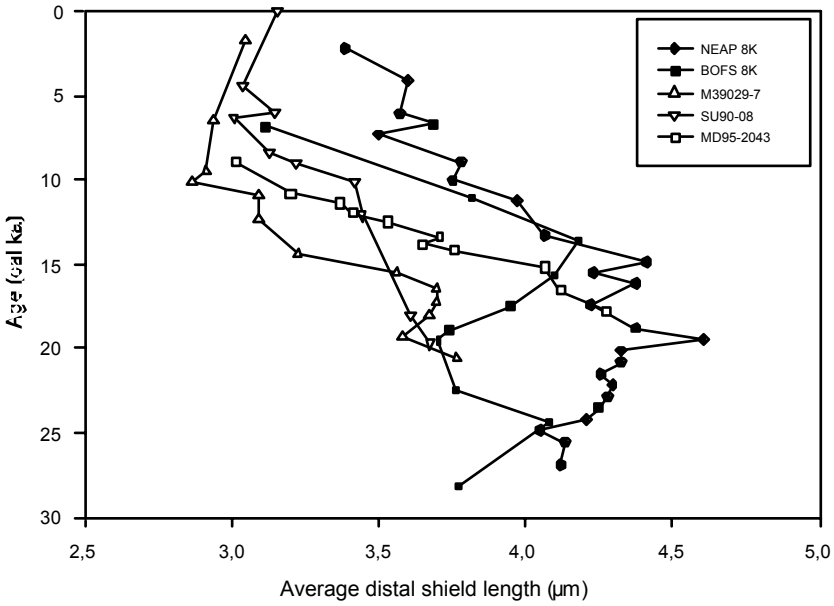


Fig.1: Average distal shield lengths of 100 *E. huxleyi* specimens from cores NEAP 8N and BOFS 8K (this study), as well as data from Colmenero-Hidalgo et al. (2002). Although overall patterns are similar, average coccolith lengths in the North Atlantic appear larger than in the Central Atlantic and Mediterranean Sea.

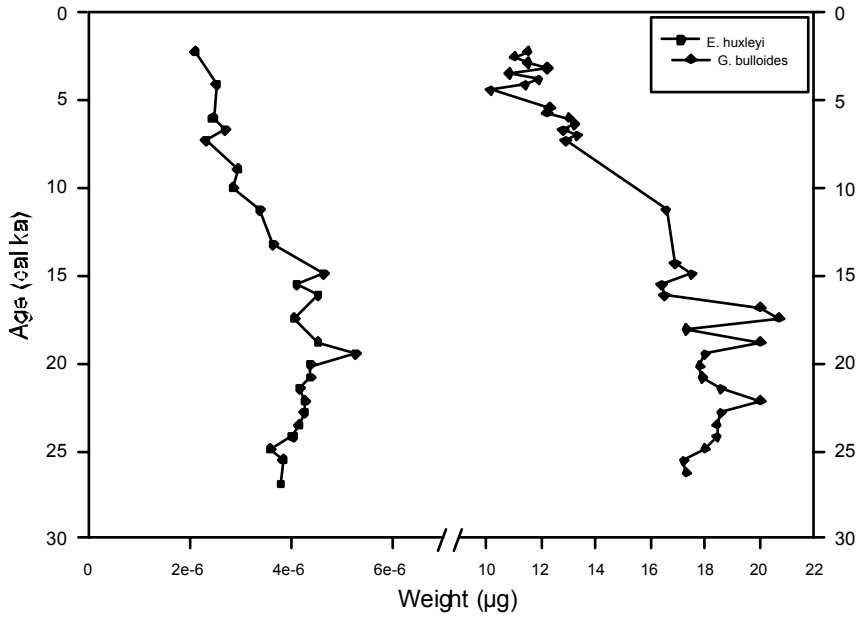


Fig.2: Comparison between the average weights of 100 *E. huxleyi* coccoliths (cf. Young & Ziveri, 2000) and foraminifera shell weights of Barker et al. (2004) in North Atlantic core NEAP 8K.

Separation of nannofossil Size Fractions by Microfiltration: Innovations, Modifications, and Results

Jackie A. Lees [1] *& Fabrice Minoletti*[2]

[1] Department of Earth Sciences, University College London, Gower Street, London WC1E 6BT, UK
[2] Laboratoire Biominéralisations et Paléoenvironnements (JE2477), Université Pierre et Marie Curie (Paris 6), 4 Place Jussieu, 75252 Paris, cedex 05, France
j.lees@ucl.ac.uk

We will illustrate and expand on the microfiltration method first described by Minoletti et al. (2001). This technique is being used to produce fractionated nannofossil assemblages for refined palaeoceanographic analysis (e.g. Minoletti et al., 2005), to concentrate particularly small-sized taxa (<3μm) for re-evaluation of biodiversity estimates, and to provide information on the significance of size in nannofossil carbonate flux from the Late Cretaceous through Present Day.

Innovations in, for example, how to keep the nannofossils from clogging the filter, and modifications to the procedure, for instance to allow for separation of differing lithologies, will be described and illustrated. We will then demonstrate the effectiveness of the technique using illustrations of separated samples and presenting new geochemical results.

References

Minoletti, F., Gardin, S., Nicot, E., Renard, M. & Spezzaferri, S. 2001. Mise au point d'un protocole expérimental de séparation granulométrique d'assemblages de nannofossiles calcaires: applications paléoécologiques et géochimiques. *Bull. Soc. Géol. Fr.*, **172**: 437-446.

Minoletti, F., de Rafelis, M., Renard, M., Gardin, S. & Young, J.R. 2005. Changes in the pelagic fine fraction carbonate sedimentation during the Cretaceous-Paleocene transition: contribution of the separation technique to the study of the Bidart section. *Palaeogeogr., Palaeoclimatol., Palaeoecol.*, **216**: 119-137.

Nannofossil Preservation and Paleoenvironmental Analysis

Jackie A. Lees [1]*, Stuart Robinson*[1]*, Paul R. Bown*[1]*, & Jeremy R. Young*[2]

[1] Department of Earth Sciences, University College London, Gower Street, London WC1E 6BT, UK
[2] Palaeontology Department, The Natural History Museum, Cromwell Road, London SW7 5BD, UK
j.lees@ucl.ac.uk

Bearing in mind recent documentation of significant recrystallisation of planktonic foraminiferal tests and the associated modifications to their geochemical signals (Pearson et al., 2001), and concerns over preservational integrity of some nannofloras in stored samples (Self-Trail & Seefeld, 2005; Dunkley Jones & Bown, in revision), we should be striving to better categorize differences in nannofossil preservation, particularly with respect to paleoenvironmental studies. Whilst there is tacit acknowledgement that nannofossil central structures are compromised by poor preservation, are we overlooking the significance of this in paleoceanographic terms?

We attempt to address this by presenting results of a comparison between the preservational features of the nannofossils and planktonic foraminifera, and values from the carbon and oxygen isotope analyses of both groups, using two disparate samples from the Middle Eocene (Nannofossil Zone NP16/17, Planktonic Foraminifera Zone P13/E12). Tanzania Drilling Project sample TDP18/18-2, 16cm, from coastal Tanzania, is clay-rich and contains glassy foraminifers and nannofossils that display features such as intact, delicate central-area structures and intact delicate taxa, with minor etching on some rims and all specimens identifiable to species level. Ocean Drilling Project sample ODP143-865C-5H-5, 112-113cm, from the tropical mid-Pacific, is a typical deep-sea ooze, containing foraminifers in which the tests have become milky through recrystallisation, and in which the nannofossils exhibit empty central areas, ragged rims and calcite overgrowth, but with the specimens generally identifiable to species level.

Based on our observations and analyses, we will address what constitutes good nannofossil preservation, and will identify a set of criteria that might be adopted when assessing this especially for particular palaeoenvironmental analyses, i.e. absolute proxies for sea-surface temperature or productivity. The current system of light microscope estimation of overgrowth versus etching is too subjective and heavily biased by the breadth of experience of the worker (as we will demonstrate).

References

Dunkley Jones, T. & Bown, P.R. In revision. Post-sampling dissolution and the consistency of nannofossil diversity measures: a case study from freshly cored sediments of coastal Tamzania. *Marine Micropaleontology*.

Pearson, P.N. et al. 2001. Warm tropical sea surface temperatures in the Late Cretaceous and Eocene epochs. *Nature*, **413**: 481-487.

Self-Trail, J.M. & Seefelt, E.L. 2005. Rapid dissolution of calcareous nannofossils: a case study from freshly cored sediments of the south-eastern Atlantic Coastal Plain. *Journal of Nannoplankton Research*, **27**: 149-159.

Paleoceanographic Significance of Calcareous Nannofossils in Sediments of the Shaban Deep (northern Red Sea)

Heiko-Lars Legge & Jörg Mutterlose

Institut für Geologie, Mineralogie und Geophysik, Ruhr-Universität Bochum, Universitätsstr. 150, 44801 Bochum, Germany
joerg.mutterlose@rub.de

We present a high-resolution record of calcareous nannofossils from the Red Sea for the last 2000 years. The investigated core GeoB 7805-1 was recovered during Meteor-cruise M 52/3 in 2002 from the Shaban Deep, a brine filled basin in the northern Red Sea. A total of 96 samples was analysed under the SEM in order to obtain qualitative and quantitative data of the distribution pattern of calcareous nannofossils.

The Red Sea is characterized by a restricted, desert-surrounded environment, connected to the Indian Ocean by the shallow (137 m) and narrow (30 km) Strait of Bab-el-Mandeb. The climate is arid, with low precipitation (10- max. 200 mm/year) and high

rates of evaporation (2.000 mm/year). Present environmental conditions in the northern Red Sea are dominated by the strong stratification of the water column. The limited nutrient-renewal from the deeper waters promotes an oligotrophic nannoplankton community dominated by *E. huxleyi* in the upper-photic zone. Recent results (core GeoB 5844-2) indicate, however, that during the two cold periods of the Last Glacial Maximum (LGM; 22-19 kyrs) and the Younger Dryas (YD; 13.1-11.7 kyrs) different paleogeographic conditions prevailed (Legge et al., 2006). High abundances of *Gephyrocapsa* (*G. ericsonii* and *G. oceanica*) reflect an increased productivity as a result of an enhanced winter mixing of the surface waters. These findings are confirmed by independent evidence from the isotope trend. The strongly reduced gradients in oxygen isotopes, particularly during the YD, suggest a deep convection of the water column (Arz et al., 2003).

For the last 2000 years the strong stratification of the water column favored in general high abundances of *E. huxleyi*. These conditions were, however, modified during the Dark Ages Cold Period (DACP; ~100-700 AD) and the Little Ice Age (LIA; ~1300-1800 AD) in the northern Red Sea. High absolute abundances of *Gephyrocapsa* spp. seem to mark stronger and cooler winter conditions in the northern Red Sea region during the DACP and the LIA. Our findings provide evidence of an enhanced winter mixing of the waters initiated by lower air temperatures during both of these cool periods during the last 2000 years. Our nannofossil findings therefore suggest that not only northern and central Europe were effected by the two cooling periods of the DACP and the LIA, but also the northern Red Sea area.

The Uplift of Panama – The Coccolith Side of the Story

Jeannette Lezius[1]*, Hanno Kinkel*[1]*, Daniela Crudeli*[1]*, Nils Andersen*[2] *& José-Abel Flores*[3]

[1]Research Unit Ocean Gateways, Institute for Geosciences, University of Kiel, Ludewig-Meyn-Straße 10, 24118 Kiel, Germany
[2]Leibniz-Laboratory for Radiometric Dating and Stable Isotope Research, Max-Eyth-Str. 11-13, 24118 Kiel, Germany
[3]Grupo Geociencias Oceánicas, Departamento de Geología, Universidad de Salamanca, 37008 Salamanca, España
lezius@gpi.uni-kiel.de

The late Miocene to Pliocene closing history of the Panamanian Gateway is a turning point in earth climate, ocean circulation patterns and plankton evolution. In order to reconstruct these fundamental changes coccolithophorid assemblages on both sides of the Isthmus, from OPD Site 1241 (tropical eastern Pacific) and ODP Site 1000 (central Caribbean) were investigated with respect to their biostratigraphy, morphometry, ecology, and geochemistry. Possible relations of floral changes to biodiversity, biogeography, ecology, carbonate fluxes and stable isotope geochemistry are analysed. We determine the influence of these ecological and/or evolutionary induced changes within the coccolithophorid assemblages on paleoproductivity and it´s relations to paleoceanography.

Data are presented from a combined quantitative biostratigraphic study of calcareous nannoplankton with Scanning Electron Microscopy and Light Microscopy. Detailed focus is taken on nannofossil evolutionary events like the paracme of *Reticulofenestra pseudoumbilicus*, the short range of *Reticulofenestra rotaria* the first occurence of the genus *Gephyrocapsa* and the extinctions of *Sphenolithus abies* and *Reticulofenestra pseudoumbilicus*. We investigate synchrony or diachrony of these events based on orbital tuned high-resolution records to identify temporal and spatial schemes, as well as the varieties between several taxa.

Absolute and relative abundances were determined to qualify the biodiversity of the coccolithophorid assemblages, resulting in the disposition of diffenrences in biogeography and ecology. Absolut abundances afford as well the calculation of species specific carbonate fluxes (after Young and Ziveri, 2000) and accumulation rates (in combination with biometric data, see Baumann, 2004). To reinforce the resultant calculated contribution of coccoliths to bulk carbonate and it´s large variabilities, measurements were made with a laser grain size analyser to trace the distribution of size classes in the bulk samples. Biometry is used to qualify intragenetic species variations, such as patterns of evolution and differences between taxa. This tends to link evolutionary changes and carbonate acculmmulation rates, thus to scrutinise wether there is an increase in size or in productivity, and allows a linkage towards the Panamanian Isthmus closing history.

Although the coccolithophorid assemblages on both sides of the Isthmus show a predominance of *Reticulofenestra* before and after the closure, the contribution of the reticulofenstrids to the coccolith carbonate is considerably small. The changes in abundance of *Reticulofenestra* are correlated with a pronounced shift in the bulk stable carbon isotope record. Are these variations within the coccolith assemblage solely responsible for the diversion in stable carbon isotope values due to a large range of interspecific vital effects or does it record changes in the surface water carbon chemistry? Thus, the influence of evolutionary and/or ecological induced changes in coccolithophorid assemblages on stable isotope signals as well as the contribution of species-dependent isotope fractionation is tested. Since coccoliths hold a large potential as recorders of geochemical signals from surface waters, stable carbon and oxygen isotope values were measured on both, bulk fine fraction (<20µm), and quasi-monospecific coccolith samples. The latter were obtained by developing a new technique of size class separation basing on Stoke´s Law. The bulk values of the investigated ODP cores 1241 and 1000 reveal a coinciding general trend of both, the stable carbon and oxygen isotope records of bulk fine fraction from ODP Leg 138 (Shackleton and Hall, 1995), DSDP Site 590 (Grant and Dickens, 2002) and ODP Site 926 (Shackleton and Hall, 1997). Besides the general trends, the use of polyspecific assemblages is problematic, since monospecific coccolithophorids grown in culture experiments exhibit a vital effect in stable isotope ratios of up to 5‰ relative to equilibrium fractionation (Ziveri et al. 2003; Dudley et al., 1986). To qualify the influence of species specific vital effects on bulk isotopes, it is necessary to isolate carbonate from single species (enriched assemblages, where the dominant species comprises 50-60%, Stoll and Ziveri, 2002) assuming that this biogical fractionation in a given species is constant and does not vary through time (Ziveri et al., 2003). Our presented results clearly indicate that the

separation of monospecific coccolith subfractions is necessary for a better understanding and interpretation of bulk fine fraction stable carbon and oxygen isotope records.

References:
Baumann, K.-H., 2004. Importance of size measurements for coccolith carbonate flux estimates. Micropaleontology, 50. Suppl. 1: 35-43
Dudley, W.C., Blackwelder, P., Brand, L., Duplessy, J.C. and Haq, B.U., 1986. Stable isotopic composition of coccoliths, Marine Micropaleontology 10; 1-3, Pages 1-8.
Grant, K.M. and Dickens, G.R., 2002. Coupled productivity and carbon isotope records in the Southwest Pacific Ocean during the late Miocene-early Pliocene biogenic bloom. Palaeo3, 187; 1-2, Pages 61-82.
Shackleton, N.J. and Hall, M.A., 1995. Stable isotope records in bulk sediments (Leg 138). Proceedings of the Ocean Drilling Program, Scientific Results 138, Pages 797-805.
Shackleton, N.J. and Hall, M.A., 1997. The late Miocene stable isotope record, Site 926. Proceedings of the Ocean Drilling Program, Scientific Results, 154, Pages 367-372.
Stoll, H.M. and Ziveri, P., 2002. Separation of monospecific and restricted coccolith assemblages from sediments using differential settling velocity. Marine Micropaleontology 46; 1-2, Pages 209-221.
Young, J.R. and Ziveri, P., 2000. Calculation of coccolith volume and its use in calibration of carbonate flux estimates, Deep-Sea Research Part II: Topical Studies in Oceanography 47; 9-11, Pages 1679-1700.
Ziveri, P. et al., 2003. Stable isotope 'vital effects' in coccolith calcite. Earth and Planetary Science Letters, 210(1-2). Pages 137-149.

Calcareous Nannofossil Biostratigraphy of the Gramame Formation, Pernambuco-Paraíba Basin, Northeast Brazil

Francisco Henrique De Olivera Lima

PETROBRAS - CENPES; Cidade Universitária, Quadra 7, Prédio 20, Sala 1106, Rio de Janeiro - RJ - Brazil 21941-598
henriquel@petrobras.com.br

The Pernambuco-Paraíba Basin is located on the northeastern Brazilian coast. Almost all the geological knowledge about the basin derives from the investigation of outcrops along the coast. The scarce subsurface studies indicate that the basin has a sedimentary column over 3,000 m thick, comprising rocks of Aptian through Holocene age. The Gramame Formation consists mainly of alternating mudstones and argillaceous mudstones. Sedimentological analyses point out to a quiet, warm water depositional environment with moderate (below wave-base) depth. There are over two dozen known outcrops of the Gramame Formation in the Pernambuco-Paraíba Basin. Of these, four have been selected for this study, namely the CIMEPAR, CIPASA, NASSAU and POTY quarries, which are considered the most suitable to the proposed work. Exposures in these quarries result from active exploration fronts for cement factories, which yield fresh, unweathered rock sections. Calcareous nannofossils provide the best stratigraphic control in the area, resulting in a high-resolution biochronostratigraphic framework.

Based on the results obtained, the section was divided into two biozones, *Arkhangelskiella cymbiformis* (CC25, with three subzones) and *Nephrolithus frequens* (CC26, comprising two subzones), all of Maastrichtian age (Perch-Nielsen, 1985).

During this time, the Pernambuco-Paraíba Basin was subject to hot and dry climatic conditions with very low siliciclastic input, giving rise to the development of carbonate platforms. The nannofossil assemblage is rich and diversified, composed of typical Cretaceous genera such as *Ahmuellerella*, *Ceratolithoides*, *Cretarhabdus*, *Cribrosphaerella*, *Eiffellithus*, *Gartnerago*, *Helicolithus*, *Kamptnerius*, *Lithraphidites*, *Loxolithus*, *Manivitella*, *Microrhabdulus*, *Micula*, *Prediscosphaera*, *Retecapsa*, *Rhagodiscus*, *Staurolithites*, *Tegumentum*, *Tetrapodorhabdus*, *Watznaueria* and *Zeugrhabdotus.*

The oldest biozone recognized in the outcrops, Subzone CC25A, is characterized by common *Lithraphidites praequadratus* and *Arkhangelskiella cymbiformis.* The presence of *L. praequadratus* was used because the last occurrence of *Reinhardtites levis* (bioevent that marks the base of this subzone), has not been observed. The top is marked by the first occurrence of *L. quadratus.* Subzone CC15A occurs in the CIMEPAR, CIPASA and NASSAU quarries with thicknesses varying from 13.1 to 30.4m. The calcareous nannofossil richness oscillates from 8 to 56 *taxa* per sample. Additionally, the last occurrence of *Gartnerago segmentatum* is recorded in three quarries. This bioevent has been used by Mortimer (1987) and Antunes (1998) as a biostratigraphic *datum*.

Subzone CC 25B is recognized between the successive first occurrences of *Lithraphidites quadratus* and *Micula murus.* This subzone is 3.7 to 6.4m thick in the CIPASA and NASSAU quarries. Correlation of both sections suggests that this subzone spans to the upper part of CIMEPAR quarry (Fig. 1).

Subzone CC 25C extends from the first occurrence of *Micula murus* to that of *Nephrolithus frequens.* It occurs in the CIPASA and NASSAU and POTY quarries, with thicknesses of 2.0 to 5.9m.

The base of Subzone CC 26A is recognized by the first occurrence of *Nephrolithus frequens.* The presence of *N. frequens* was used because the last occurrence of *Ceratolithoides kamptneri* (event that defines the base of this subzone) has not been observed. The top is marked by the first occurrence of *Micula prinsii*. Subzone CC26A occurs in the NASSAU and POTY quarries, with thicknesses of 2.5 to 6.1m.

The highest subdivision recognized in the outcrops is Subzone CC26B, the base of which is marked by the first occurrence of *Micula prinsii*. The top is defined by the last occurrence of the Cretaceous assemblage. This subzone is 4.7 to 5.3m thick in the NASSAU and POTY quarries.

On the top of Subzone CC26B, there occurs a biostratigraphic and lithologic unconformity related to the Cretaceous-Paleogene boundary. Across this surface, Maasthichtian rocks of the Gramame Formation are directly overlain by Paleogene strata of the Maria Farinha Formation. The entire section corresponds to a third order sequence, organized into a Transgressive System Tract succeeded by a Highstand System Tract, with thicknesses up to 55 m and an inferred duration over 4.6 million years.

References

Antunes, R.L. 1998. Nanofósseis calcários e sua bioestratigrafia no Cretáceo da margem continental brasileira: bacias do Ceará e Potiguar. PhD thesis, Universidade Federal do Rio de Janeiro, Brazil.

Mortimer, C.P. 1987. Upper Cretaceous calcareous nannofossil biostratigraphy of the Southern Norwegian and Danish North Sea area. *Abhandlungen der Geologisches Bundesanstalt*, 39:143-175.

Perch-Nielsen, K. 1985b. Cenozoic calcareous nannofossil. *In*: Bolli. H.M.; Saunders, J.B. & Perch-Nielsen, K. (Eds.), Plankton Stratigraphy. Cambridge University Press, pp. 427-554.

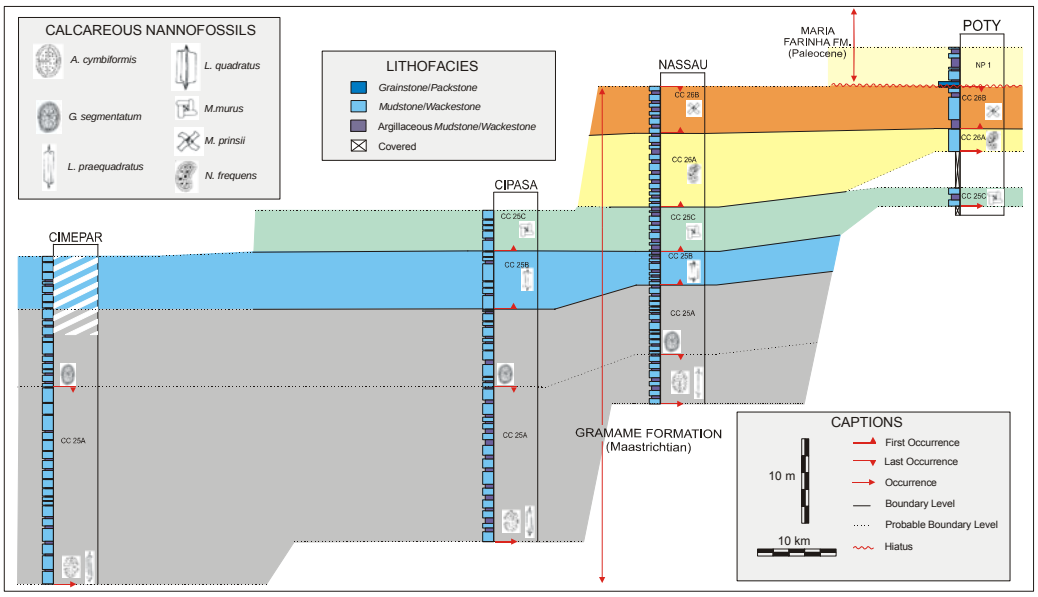


Figure 1. Biostratigraphical correlation section between CIMEPAR, CIPASA, NASSAU and POTY quarries, Northeastern Brazil. The POTY Quarry presents well preserved outcrop of the biostratigraphic and lithologic unconformity related to the Cretaceous-Paleogene boundary. Across this surface, Maasthichtian rocks of the Gramame Formation are directly overlain by Paleogene strata of the Maria Farinha Formation.

Carbon Isotopes of Calcareous Nannofossils as a Paleoproductivity Indicator

Chuanlian Liu

State Key Laboratory of Marine Geology, Tongji University, Shanghai 200092, P.R.China
clliu@online.sh.cn

Carbon isotopic analyses have been carried out on calcareous nannofossils from the ODP Site 1143 in the southern South China Sea and the ODP Site 807 in the Western Pacific Warm Pool. We use 4~25μm size sediments as nannofossils fraction for isotope analysis after the methods of Nelson et al.(1985) and Dudley et al.(1989). At the same time, we also counted the percentage of *Florisphaera profunda* and calculated the primary productivity according to the equation of Beaufort et al. (1997). The results demonstrated that the trends of the $\delta^{13}C$ records of nannofossils are similar to primary productivity variations at both ODP Site 807 and ODP Site 1143. Cross-spectral analysis also reveals that the $\delta^{13}C$ records of nannofossils was coherent and in phase with the primary productivity. These imply that the $\delta^{13}C$ of nannofossils can be used as an indicator of sea-water surface paleoproductivity.

References

Nelson, C. S., Hendy, C. H., Dudley, W. C., 1985, Quaternary isotope stratigraphy of Hole 593, Challenger Plateau, south Tasman Sea: preliminary observations based on foraminifers and calcareous nannofossils. In: Kennett, J.P., von der Borch, C. C., et al.(Ed.), Initial Reports of the Deep Sea Drilling Project, Volume XC, Washington,.1413~1424

Dudley, W. C., Nelson, C. S., 1989, Quaternary surface-water stable isotope signal from calcareous nannofossils at DSDP Site 593, southern Tasman Sea. Marine Micropaleontology, 13: 353~373
Beaufort L, Lancelot Y, Camberlin, P., et al., 1997, Insolation cycles as a major control of equatorial Indian Ocean primary production. Science, 278:1451~1454

Calcareous Nannofossil Productivity and Climate Interactions during Pleistocene in a S-N Transect from Antarctic Basin to Chatham Rise

Claudia Lupi & Miriam Cobianchi

Dipartimento di Scienze della Terra, Università di Pavia, Via Ferrata 1, 27100 Pavia (Italy)
clupi@manhattan.unipv.it

The comparison among three cores cored along a transect from Prydz Bay - Antarctica to Chatham Rise - New Zealand (ODP Leg 188; Site 1165B 64°22'S; 67°13'E; PRNA ANTA 95-157, 62°05.95'S; 175°17.34'E; IMAGES MD 97-2114, 42°22.32'S; 171°20.42'W) allowed us to describe the abundance and taxonomic compositional variations of calcareous nannoplankton associations during the Pleistocene climate phases from polar to subtropical regions.

Quantitative analyses have been carried out on calcareous nannofossils in order to recognise the biostratigraphic events and abundance variation of the different species. The correlation of the abundance curves of selected species with paleomagnetic, geochemical and mineralogical data (Cobianchi et al., 2005; Giglio et al, 2002; Venuti and Florindo, 2004; Venuti et al., in press; Villa et al., in press) documents that they fluctuate in phase with the glacial/interglacial cycles.

Although South to North latitudinal gradient of calcareous nannofossil distribution results in a marked drop in abundance toward the high latitudes, our data permitted some paleoceanographic and paleogeographic considerations. During the Early Pleistocene (Jaramillo subchron) while the calcareous nannofossils experienced their maxima abundance in the subtropical region of the Chatham Rise, they occurred also in the Prydz Bay area, documenting a warm event at about 1 Ma (Villa et al, in press). From this interval upwards, the site 1165B of Prydz Bay shows a calcareous nannofossil decrease related with more stable conditions of the East Antarctic Ice Sheet (EIAS). The climate evolution of the EIAS influenced the whole Southern Ocean and leaded, since 1 Ma, to the disappearance of calcareous nannofossils near the Antarctic Divergence (site 1165-Prydz Bay), to a sporadic occurrence of calcareous nannofossils near the polar front (Anta 95-157), and to a slight decrease in abundance in the subtropical region (MD 97-2114) testifying the climate relationship among the different areas.

References:

Cobianchi M., Lupi C., Luciani V., Florindo F., Venuti A., Zerba, P. (2005). – Upper Quaternary biomagnetostratigraphy from Chatham Rise (SW Pacific Ocean): a framework for palaeoceanographic interpretation. EUG 05-A- 06474
Giglio F., Langone L., Morigi C., Frignani M. and Ravaioli M., 2002. – Biogenic silica and organic carbon in sediments from the Pacific sector of the Southern Ocean. Royal Society of New Zealand Bulletin, 35, 443-449

Venuti A and Florindo F., 2004. – Magnetostratigraphy and environmental magnetism of two Quaternary deep-sea gravity cores from the west Pacific Southern Ocean. Geochemistry, Geophysics, Geosystems, 5, Q12011, doi: 10.1029/2004GC000810
Venuti A., Florindo F., Michel E. and Hall I.R (in press). - Variability of the Deep (Pacific) Western Boundary Current across the Mid-Pleistocene climate revolution – Geology
Villa G., Lupi C., Cobianchi M., Florindo F. and Pekar S.F (in press). – A Pleistocene Warming Event at 1 Ma in Prydz Bay, East Antarctica: Evidence from ODP Site 1165. Palaeogeography, Palaeoclimatology, Palaeoecology

Refining Calcareous Nannofossil and Planktonic Foraminiferal Integrated Biostratigraphy of the Last 1.07 Ma: New High-resolution Data from the East New Zealand Pacific Ocean (Chatham Rise IMAGES Core MD97-2114)

Claudia Lupi[1], *Valeria Luciani*[2], *Miriam Cobianchi*[1], *& Stefano Fabbri*[2]

[1]Dipartimento di Scienze della Terra, Università di Pavia, Via Ferrata 1, 27100 Pavia (Italy)
[2] Dipartimento di Scienze della Terra, Polo Scientifico Tecnologico, Università degli Studi di Ferrara, via Saragat 1, 44100 Ferrara (Italy)
clupi@manhattan.unipv.it

This study is aimed to improve the resolution of the Pleistocene calcareous nannofossil and planktonic foraminiferal integrated biostratigraphy in order to constrain chronologically the history of the east New Zealand Pacific Ocean water masses, fronts and currents that are a crucial part of global ocean circulation system.

Core MD97-2114 (42°22.32'S; 171°20.42'W) was cored during an IMAGES cruise on the northern slope of Chatham Rise, a submarine ridge east of New Zealand, at 1935 m water depth. Quantitative data of calcareous nannofossils and planktonic foraminifers, calibrated with magnetostratigraphy and oxygen isotope stratigraphy (Cobianchi et al., 2005; Venuti et al., in press), indicate that the studied core contains a sedimentary record of the past c.1.07 Ma. The nannofossil assemblages are abundant and well preserved as well as the foraminifers, documenting a significant biogenic carbonate production throughout the interval. Several standard nannofossil events, as the FO of *Emiliania huxleyi*, the LO of *Pseudoemiliania lacunosa*, the LO of *Crenalithus asanoi,* the re-entry of "medium sized" *Gephyrocapsa,* and the LCO of "small sized" *Gephyrocapsa* were documented and their correlation with the Marine Isotope Stages is consistent with the previous calibrations. Other subsidiary events, particularly the acme intervals of different *Gephyrocapsa* morphotypes, improved the biostratigraphic resolution. They are omotaxic with those documented by de Kaenel (2000) for the Mediterranean region. Beside the last appearance of *Globorotalia tosaensis*, proposed by Berggren et al. (1995) to subdivide the Pt 1 planktonic foraminiferal zone in Pt 1a and b, the identification of additional bioevents have been achieved by using climatically/ecologically controlled entries/exits or variations in abundance such as: first entry of *Globigerinoides tenellus*, last exit of *Hastigerina aequilateralis,* LCO of *H. siphonifera,* LCO of *Globorotalia crassaformis*, FCO of *G. truncatulinoides,* LCO of *Neogloboquadrina dutertrei* and FCO of *Neogloboquadrina pachiderma*. Because these planktonic foraminfer events mainly

reflect regional biogeographies, further investigation is needed to estimate how widely is applicable the improved biostratigraphic subdivision.

The biostratigraphic analyses allowed us to propose an integrated high-resolution scheme for the Pleistocene interval showing 16 bioevents, calibrated with magneto-isotope stratigraphy, and providing a biostratigraphic resolution of c. 66,87 ky.

References:

Berggren W. A., Kent, D. V., Swisher C. C. III. Aubry M-P., 1995. A revised Geochronology and chronostratigraphy. In Geochronology, time scales and global stratigraphic correlation Berggren W. A, Kent, D. V., Swisher C (Eds). Special Publication - SEPM (Society for Sedimentary Geology). 54; 129-212

Cobianchi M., Lupi C., Luciani V., Florindo F., Venuti A., Zerba, P. (2005) – Upper Quaternary bio-magnetostratigraphy from Chatham Rise (SW Pacific Ocean): a framework for palaeoceanographic interpretation. EUG 05-A- 06474

de Kaenel E., 2000. – Mediterranean Pleistocene calcareous nannofossil biochronology. 8th INA Meeting-Bremen

Venuti A., Florindo F., Michel E. and Hall I.R (in press). - Variability of the Deep (Pacific) Western Boundary Current across the Mid-Pleistocene climate revolution – Geology

Pelagic Carbonate Production by Nannoplankton across the Early Toarcian Anoxic Event

Emanuela Mattioli[1], Bernard Pittet[1], Ivan Bour[1], Samuel Mailliot[1], Laurent Petitpierre[1], Letizia Reggiani[2], Guillaume Suan[1]

[1]UMR5125-CNRS PaléoEnvironnements & PaléobioSphère, UFR Sciences de la Terre, Université Claude Bernard Lyon1, 2 rue R. Dubois, 69622 Villeurbanne Cedex, France

[2]Dipartimento di Scienze della Terra, Università degli Studi di Perugia, Piazza Università 1, 06123 Perugia, Italia

mattioli@univ-lyon1.fr

The Early Toarcian anoxic event (ETAE; Jenkyns, 1988) was characterized by a major biologic crisis of marine ecosystems (Harries & Little, 1999) and a perturbation of the carbon cycle testified by an important negative excursion of the carbon stable isotopes, recorded in the carbonates of bulk rock, in the organic matter, organic biomarkers, and fossil wood. The organic matter-rich deposits that were formed during the ETAE have been interpreted as the result of an enhanced primary production, issued either from an intensification of upwelling (Jenkyns, 1988), or from increased continental weathering and runoff under greenhouse conditions (Cohen et al., 2004). Both these mechanisms might have produced nutrification of surface waters. However, enhanced primary production during the ETAE is questionable, because the photosynthetic incorporation of light carbon in biomass production likely produces a depletion of ^{12}C in surface waters, which should result in a positive $\delta^{13}C$ excursion (Arthur et al., 1990), very negative values are observed during the ETAE instead, when organic matter accumulation and preservation was important. Furthermore, a quantification of the abundance of primary producers of that period (dinoflagellates and coccolithophorids) indicates a significant decrease in primary production, until a temporary disappearance of

phytoplankton during the crisis acme (Bucefalo Palliani et al., 2002; Mattioli et al., 2004). Primary productivity was probably solely sustained by phototrophic bacteria (Chlorobiaceae; van de Schootbrugge et al., 2005) or by green algae (*Tasmanites*, Bucefalo Palliani et al., 2002; Mattioli et al., 2004).

The quantification of spatial distribution of coccolithophorid productivity in the Tethys Ocean during the different phases of the ETAE is therefore crucial for the understanding of the role of primary production in the mechanisms of carbon sequestration from surface waters and its eventual export to the sedimentary reservoirs. Furthermore, Toarcian coccolithophorids being in a phase of diversification (Bown et al., 2004) did not experience the mass extinction that affected most of benthic and nekto-benthic organisms during the ETAE.

Coccolith and *Schizosphaerella* absolute abundance were quantified in five sections and boreholes located within the Jurassic western Tethys. Nannofossil abundance was then corrected by the accumulation rate calculated for each studied site. The size of *Schizosphaerella,* the major carbonate producer in the study interval, was measured in two sections. The results of this work show that nannofossil abundance and size significantly decrease during the ETAE. Absolute abundance of nannofossils significantly varies from a site to another suggesting a variable nannoplankton production in different areas within the western Tethys. *Schizosphaerella* size stays, however, in the same range in the two studied sites. The highest absolute abundance measured in this study corresponds to the low productivity areas in modern Oceans (Baumann et al., 1999). This is consistent with the fact that nannoplankton was in the early stage of its evolution during the Early Jurassic; abundance seems to increase exponentially though Mesozoic (Mattioli & Pittet, 2002).

References:

Arthur, M.A., Brumsack, H.J., Jenkyns, H.C., Schlanger, S.O., 1990. Stratigraphy, geochemistry, and paleoceanography of organic carbon-rich Cretaceous sequences. In: Ginsburg, R.N., Beaudoin, B. (Eds.), Cretaceous Resources, Events, and Rhythms. Kluwer Acad. Publ., Netherlands, pp. 75-119.

Baumann, K.-H., Cepek, M., Kinkel, H., 2004. Coccolithophores as indicators of ocean water masses, surface-water temperture, and paleoproductivity - Examples from the South Atlantic.Use of proxies in paleoceanography, Springer, 117-144.

Bown, P.R., Lees, J.A., Young, J.R., 2004. Calcareous nannoplankton evolution and diversity through time. Coccolithophores, from molecular processes to global impact, Springer, 481-508.

Bucefalo Palliani, R., Mattioli, E., Riding, J., 2002. The response of marine phytoplankton and sedimentary organic matter to the early Toarcian (Lower Jurassic) oceanic anoxic event in northern England. Marine Micropaleontology, 46, 223-245.

Jenkyns, H.C., 1988. The early Toarcian (Jurassic) anoxic event: Stratigraphic, sedimentary, and geochemical evidences. Am. Journ. Sci., 288, 101-151.

Harries, P.J. & Little, C.T.S. 1999. The early Toarcian (Early Jurassic) and the Cenomanian–Turonian (Late Cretaceous) mass extinctions: similarities and contrasts. Palaeogeography, Palaeoclimatology, Palaeoecology, 154, 39–66.

Mattioli, E., Pittet, B., 2002. The contribution of calcareous nannoplankton to the carbonate production in the Early Jurassic. Marine Micropal., 45, 175-190.

Mattioli, E., Pittet, B., Bucefalo Palliani, R., Röhl, H.J., Schmid-Röhl, A., Morettini, E.. 2004. Phytoplankton evidence for the timing and correlation of palaeoceanographical changes during the early Toarcian oceanic anoxic event (Early Jurassic). Journal of the Geological Society of London, 161, 685-693.

van de Schootbrugge, B., McArthur, J.M., Bailey, T.R., Rosenthal, Y., Wright, J.D., Miller, K.G., 2005. Toarcian anoxic event: An assessment of global causes using belemnite C isotope records. Paleoceanography, 20, PA30008.

Seasonal and Interannual Dynamics of Coccolith Carbonate Production in the Gulf of Lions (NW Mediterranean Sea)

K.J. Sebastian Meier[1], Luc Beaufort[1] & Serge Heussner[2]

[1]CEREGE, Europôle Méditerranéen de l'Arbois - BP 80 -, 13545 Aix en Provence cedex 04, France
[2]CEFREM, Université de Perpignan, 52 av. de Villeneuve, 66860 Perpignan cedex, France
meier@cerege.fr

Although biogenic carbonate production is largely dominated by coccolithophores, there is only limited information on seasonal and interannual patterns of coccolithophore production in the Mediterranean Sea. The Gulf of Lions (NW Mediterranean Sea) is one of the most productive regions of the Mediterranean characterised by relatively high interannual and seasonal variability (Bosc et al. 2004), and therefore ideally suited for investigating coccolithophore production patterns. In order to determine coccolithophore carbonate fluxes, we investigated two 12-yr (1993-2005) sediment trap series from the Gulf of Lions located at 500 m water depth and about 500 m above bottom of the shelf break south of Marseille (43°02'N, 5°11'E) and east of Perpignan (42°25'N, 3°32'E). Thirteen coccolith species were distinguished using the SYRACO automatic recognition system, and image analysis was applied for morphometric measurements and weight calculations of the individual liths. *Emiliania huxleyi*, *Florisphaera profunda* and *Gephyrocapsa ericsonii* are the dominant species. A clear annual signal is observed in the Marseille trap with maximum coccolith fluxes during February to May. In the Perpignan trap, coccolith fluxes are much more variable, reaching highest values in autumn and winter. As particle fluxes to the deeper slope in the Gulf of Lions originate to a large extent from resuspended shelf and/or upper slope sediments (Heussner et al. in press), coccolithophore fluxes represent a mixture of the primary production signal and resuspension. Due to the general E-W transport of the Liguro-Provencal current, resuspension dominates in the Perpignan trap, whereas the Marseille trap, although also influenced by resuspension, shows a clear productivity signal. In the Marseille trap, *E. huxleyi* carbonate fluxes are generally better correlated with primary productivity of the surface waters than with the total carbonate flux. During highest *E. huxleyi* fluxes, the mean length and weight of the liths are smaller than during low fluxes. This indicates that coccolithophores are not just a component of the total carbonate flux, but show a distinct temporal distribution pattern in response to environmental changes. Several major depositional events occurred during the twelve years that are probably related to dense water formation in response to increased wind stress, cooling and reduced precipitation. They are often correlated with peaks in productivity, which might indicate increased nutrient levels due to compensatory upwelling processes.

References:
Bosc, E., A. Bricaud, and D. Antoine (2004), Seasonal and interannual variability in algal biomass and primary production in the Mediterranean Sea, as derived from 4 years of SeaWiFS observations. Global Biogeochem. Cycles, 18, GB1005, doi:10.1029/2003GB002034.
Heussner, S., Durrieu de Madron, X.,Calafat, A., Canals, M., Carbonne, J., Delsaut, N. and Saragoni, G. in press. Spatial and temporal variability of downward particle fluxes on a continental slope: lessons from an 8-yr experiment in the Gulf of Lions (NW Mediterranean). Marine Geology.

Coccoliths, dinoflagellates, foraminifers and diatoms in the Late Quaternary Cariaco Basin: the importance of taphonomical overprinting

Kenneth Mertens & Stephen Louwye

Research Unit Palaeonology. Krijgslaan 281 / S8, Ghent University, Belgium
Kenneth.Mertens@ugent.be

The Cariaco Basin is an anoxic pull-apart basin on the continental shelf of Venezuela. The region is under the influence of the migrating intertropical convergence zone (ITCZ), reflected in the light-dark coloured cycles in the sediment (varves). The question arose, whether these migrations are observable on a stadial/interstadial scale. The aim of this study is to establish a reconstruction of the palaeoclimate in the Cariaco Basin during the last 20 kyr, using coccoliths, dinoflagellate cysts, foraminifers and diatoms as paleoecological proxies.

An integrated study of the four phytoplankton groups reveals the importance of taking taphonomy into account in palaeoecological studies. Periods of stronger dissolution result in increases of the more resistant species (*Gephyrocapsa oceanica*, *Spiniferites ramosus*, *Cyclotella littoralis* and *G. bulloides*) and lower diversity, whereas better preservation is indicated by more fragile species (*Emiliania huxleyi*, *Brigantedinium* sp*., Thalassionema nitzschioides* and *G. ruber*) and higher diversity. By slicing up the sediment on a 100 µm scale, we were able to observe this taphonomical overprinting on a seasonal scale. To what extent these fluctuations can also be explained by palaeoecology, and fluctuations of the ITCZ, will be discussed.

The taphonomical imprint left by *G. oceanica* vs. *E. huxleyi* will be highlighted further by discussing experimental data and a dataset collected from numerous publications. Most interestingly, there seems to be a time lag between the planktonic and terrigenous (Ti) proxies, which indicates the planktonic signal to be autochtonous, and thus a better representative to study climate fluctuations over the Cariaco Basin.

Multivariate Morphon Analysis Updated

Áurea Narciso[1], *Mário Cachão* [1,2], *& Rui Taborda* [2,3]

[1]Centre Geology, Univ. Lisbon, Building C6, Campo Grande, 1749-016 Lisboa, Portugal, PhD scholarship SFRH/BD/8944/2002;
[2]Dep. Geology, Fac. Sciences, Univ. Lisbon, Building C6, Campo Grande, 1749-016 Lisboa, Portugal
[3]LATTEX/IDL, Fac. Sciences, Univ. Lisbon, Building C6, Campo Grande, 1749-016 Lisboa
acnarciso@fc.ul.pt

A morphometric study of the species *Coccolithus pelagicus* in the Eastern margin of the North Atlantic led to the recognition and subsequent characterization of three morphotypes / subspecies (*C. pelagicus pelagicus*, *C. pelagicus braarudii* and *C. pelagicus azorinus*; in Parente *et al.*, 2004). This study, performed on a sample set of a core recovered off Iberia (MD95-2040), implicated the initial tabulation of 100 measurements per sample into 1 μm size intervals, each named a morphon. For example, morphon 12 includes all measurements above or equal to 12 μm and less than 13 μm ([12; 13[ ). A morphometric matrix with samples as rows and morphons as columns was then computed to test which contiguous morphons showed high positive correlation and thus could define a specific morphotype. To perform this task R-mode Factorial Analysis was applied. The entire procedure was denominated as Multivariate Morphon Analysis (MMA) (Parente *et al.,* 2004).

However, an obvious constraint to this method is the arbitrary selection of the limits attributed to each morphon as stated above. Since morphotypes are defined by a specific size range determined from a group of correlative morphons, their lower and upper size borders have major implications if one wants to disclose and follow possible size changes in time and/or space of the morphotypes. In order to overcame this limitation and obtain an objective tool to define morphotypes size ranges, MMA was improved through the development of an additional MATLAB module (ver. 7.0.1). In this module factorial loadings for the first two major factors were used to select the most meaningful (with higher variance) combination of morphons of all possible combinations of 1 μm dimensional classes, thus eliminating the initial arbitrary factor. This procedure was tested against theoretical populations of placoliths with size attributes determined by the user with good results.

References:

Parente, A., Cachão, M., Baumman, K.-H., de Abreu, L. and Ferreira, J. (2004). Morphometry of *Coccolithus pelagicus s.l.* (Coccolithophore, Haptophyta) from offshore Portugal, during the last 200 kyr. *Micropaleontology* 50(1): 107-120.

The Pleistocene-Holocene Calcareous Nannoplankton Record off the Coast of Vietnam

Alyssa M. Peleo-Alampay [1], Rikki Pamela Pineda[1] & Martin G. Wiesner[2]

[1] National Institute of Geological Sciences, University of the Philippines, Diliman, Quezon City, Philippines
[2] Institute of Biogeochemistry and Marine Chemistry, University of Hamburg, Germany
ampanigs@yahoo.com

Today, seasonal upwelling off Vietnam is more prevalent in the summer months when southwesterly winds blow through the South China Sea. This study systematically investigates the upwelling history of this area in the recent past by examining the distribution of calcareous nannoplankton. A gravity core, SO148-50, located 11º55.23'N and 110º01.03'E at 1908 meters water depth is used in this study. Station 58 is located on the lower continental shelf extending out from Nha Trang Bay. General results from the upper 100 cm of the core reveal a diverse assemblage of calcareous nannoplankton dominated by a few species. The dominant species are *Gephyrocapsa oceanica, G. ericsonii* and *Florisphaera profunda*. The overwhelming dominance of gephyrocapsids is consistent with its known affinity to warmer nearshore areas. Correlation with sea surface temperatures (SST; based on foraminiferal data, de Silva et al., 2006) show lower *Gephyrocapsa* abundance during lower SST. The cooling trend, beginning at 70 cm below seafloor is also supported by sudden increase in abundance of *Rhabdosphaera claviger* and *Discosphaera tubifera*, known cool water species. *F. profunda*, an upwelling indicator, shows an increasing trend downcore in the upper 100 cm analyzed. Moreover, reported oligotrophic species, *Umbellosphaera irregularis* and *Umbilicosphaera sibogae* likewise show a sudden increase beginning at 70 cms. These suggest that during the Pleistocene, upwelling off Vietnam may have been weaker or absent.

Reference:

De Silva, L.P., Hipol, K.A. and Wiesner, M.G. 2006. Late Pleistocene-Holocene upwelling history off the coast of Vietnam: the planktonic foraminiferal record- Part I. *Programs and Abstracts of the NIGS Research Symposium 2005*. National Institute of Geological Sciences, University of the Philippines.

Response of Eocene-Oligocene Nannofossils to Southern Ocean Temperature Variations

Davide Persico [1], G. Villa [1], C. Fioroni [2], & L. Pea [1]

[1]Università degli Studi di Parma Dipartimento di Scienze della Terra, Parco Area delle Scienze 157A, 43100 Parma, Italy.
[2]Università degli Studi di Modena e di Reggio Emilia Dipartimento di Scienze della Terra - Largo S. Eufemia, 19 - 41100 Modena, Italy.
davide.persico@unipr.it

Modern coccolithophorids as a group at different latitude have a broad temperature range tolerance, from 0°C and 30°C (Brand, 1994). However, a minimum temperature of approximately 2°-3°C in surface-sub-surface waters is required for coccolithophores to reproduce (Burckle and Pokras, 1991, Findlay and Giraudeau, 2000), in fact nannoplankton is not present in the Southern Ocean, south of the Antarctic Divergence, where summer sea surface temperature (SST) are < +1°C (Olbers et al., 1992). The highest species diversity index, is detected in sub-tropical areas, with a temperature range between 15° and 25°C (Mcintyre and Bé, 1967; McIntyre et al., 1970), thus representing the optimum temperature range for calcareous nannoplankton.

Observations from this project have underlined that little changes within this optimum temperature range do not cause evident changes in the population density and in the species diversity index. In contrast, more evident responses in the distribution and abundances of some species are recorded when temperature changes occur around the lower temperature limit (2° C).

Here we present a synthesis of studies on Eocene and Oligocene sediments from the Southern Ocean ODP Sites 690, 689, 744, 738 and 748 that were studied in detail to determine the calcareous nannofossil biostratigraphy and paleoecology. Age estimates for the nannofossil biohorizons recognized in the section were obtained through direct correlation to magnetostratigraphy (Roberts, et al., 2003; Florindo and Roberts, 2005).

Quantitative analyses data allowed subdivision of the calcareous nannofossil assemblages into groups with different paleoecological behaviour, especially with respect to sea surface temperature. The following paleoecological groups were recognized: warm-water taxa, temperate-water taxa, cool-water taxa, and no temperature affinity taxa. A temperate-water taxa index (Twt) was constructed using a ratio between ((T/T+C)*100) (Persico and Villa, 2004; Villa and Persico, 2006) and was compared to the oxygen stable isotope curves obtained on the same sites (Salamy and Zachos, 1999; Wilson et al., 2001; Bohaty and Zachos, 2003).

In the time-frame obtained, on the basis of the interpretation of the paleoecological groups as climate proxy, we have recognized at least 3 temperate phases during the late Eocene(36 to 34 Ma), a cooling event in the earliest Oligocene (33.5 Ma), a cold phase for most of the Oligocene, and a warming trend in the late Oligocene (26.5 to about 25Ma).

This research has evidenced in phase correlation between (Twt) and the $\delta^{18}O$, when the latter values encompass an interval included between 0,9 and 2,4 ‰ which corresponds to an SST comprised between 2° and 8° C, named here "Nannofossil Critical

Temperature range". Vice versa, the correlation is not evident when isotopic values imply temperatures higher than 8° C.

In the early-Middle Eocene at Sites 748 and 738 the isotopic values reveal SST higher than 8°C, and the response of c.n is probably more influenced by other factors, for example by nutrient availability.

References:

Bohaty, S. M., and Zachos J. C. 2003, Significant Southern Ocean warming event in the late middle Eocene, Geology, 31, 1017–1020.

Burckle L.H. and Pokras E.M., 1991 Implications of a Pliocene stand of *Nothofagus* (southern beech) within 500 kilometers of the South Pole, *Antarct. Sci.* 3 (4), 389–403.

Findlay C.S. and Giraudeau J., 2000 Extant calcareous nannoplankton in the Australian sector of the Southern Ocean (austral summers 1994 and 1995), *Mar. Micropaleontol.* 40, 417–439.

Florindo F. and Roberts A. P., 2005. Eocene-Oligocene magnetobiochronology of ODP Sites 689 and 690, Maud Rise, Weddell Sea, Antarctica *Geol Soc Am Bull.* 117, 46-66

Harland R. and Pudsey C., 1999 Dinoflagellate cysts from sediments traps deployed in the Bellingshausen, Weddell and Scotia Seas, Antarctica, *Mar. Micropaleontol. Deep-Sea Res.* 37**,** 77–99.

McIntyre A. and Be' A.W.H., 1967 Modern coccolithophoridae of the Atlantic Ocean: I. Placoliths and critholiths, *Deep-Sea Res.* 14, 561–597.

McIntyre A., Be' A.W.H. and Roche M.B., 1970 Modern Pacific coccolithophorida: a paleontological thermometer, *N.Y. Acad. Sci. Trans. Ser. II* 32 (6), 720–731.

D. Olbers, V. Gouretsky, G. Seiss and J. Schroter, 1992 *Hydrographic atlas of the Southern Ocean*, Alfred Wegener Institute, Bremerhaven (1992) 18 pp. and 82 plates.

Persico D. and Villa G., 2004 Eocene-Oligocene calcareous nannofossils from Maud Rise and Kerguelen Plateau (Antarctica): paleoecological and paleoceanographic implications. *Marine Micropaleontol.* 52, Issue 1-4, 153-179.

Roberts, A. P., Bicknell S. J., Byatt J., Bohaty S. M., Florindo F., and Harwood D. M., 2003 Magnetostratigraphic calibration of Southern Ocean diatom datums from the Eocene-Oligocene of Kerguelen Plateau (Ocean Drilling Program Sites 744 and 748), *Palaeogeogr. Palaeoclimatol. Palaeoecol.*, 198, 145– 168.

Villa, G. and Persico, D., 2006 Late Oligocene climatic changes: Evidence from calcareous nannofossils at Kerguelen Plateau Site 748 (Southern Ocean). *Palaeogeography, Palaeoclimatology, Palaeoecology,* 231, 110–119.

Salamy, K. A. and. Zachos, J. C., 1999, Late Eocene-Early Oligocene Climate Change on Southern Ocean Fertility: Inferences from Sediment Accumulation and Stable Isotope Data. *Palaeogeog., Palaeoclimat., Palaeoecol.,* 145, 79-93.

Wilson G. S., Roberts A. P., Morgans H. E.G., Verosub K. L. and Sagnotti L. 2001. Eocene-Oligocene Antarctic and Southern Ocean Climatic Deterioration: Phase Relationships between Climatic Oceanic Cooling. *Quaderni di geofisica*, 16, 199-200.

Contribution to Paleoceanographic Studies of the Western South Atlantic: Preliminary Results of a Nannofossil Survey

Juliana Quadros, Felip Toledo, Edmundo Camillo, & Karen Costa

Paleoceanography Laboratory of South Atlantic (LaPAS)-Oceanographic Institute of University of São Paulo, Praça do Oceanográfico, 191. Cidade Universitária. São Paulo/SP - Cep: 05508-120 - Brazil

jupq@usp.br

The sensitivity of the tropics to climate change has been one of the greatest unsolved issues in paleoclimatologic and paleoceanographic studies. In special, it has been highlighted the essential role of the South Atlantic on the ocean circulation and heat budget between the Southern Ocean and the North Atlantic. However marine microfossil assemblages of the South Atlantic are scarcely studied and the most of the works have been focused at the eastern South Atlantic and Equatorial Atlantic.

Since little information has been available on the nannofossil assemblages especially at Brazilian continental margin, this study aims to contribute to more comprehensive paleoceanographic data for the western part of the South Atlantic. The northeastern Brazilian continental shelf is almost entirely covered by biogenic carbonate sediments (Vital *et al.*, 2005), as it is narrow and shallow due to the poor terrigenous sediment supply one could suppose it had been influenced by the latest climate changes.

In order to establish a general view of the study area two deep-sea sediment cores recovered from two distinct marginal basins have been studied – CMU-14 (14°24,847 S / 38°49,307W) at Camamu Basin and PAR-40 (07°29,617S / 34°20,451W) at Pernambuco-Paraiba Basin. The data sets comprise 47 sediment samples in which quantitative investigations of calcareous nannofossil assemblages were performed across the last 20 kyr. All the samples used for this study include isotopic analysis of oxygen and carbon in tests of planktonic foraminifera (Toledo, 2000; Costa, 2000), what made possible to identify the marine isotopic stages for the late-Pleistocene-Holocene.

The goal of this study is to summarize the observed temporal fluctuations in composition of the calcareous nannofossil assemblages and to provide information in terms of changes in ocean surface conditions. One useful tool will be the changes in abundance of the coccolithophorid species *Florisphaera profunda* which shows closely relationship with long-term variations in thermocline and nutricline depth (Molfino & McIntyre, 1990; Okada, 1992).

The initial findings indicate variations in calcareous nannofossil assemblages, both CMU-14 and PAR-40 show similar trends, but the magnitudes of the fluctuations are slightly different (Figure 1). The dominant taxa were *F. profunda* (50-82%), *G. oceanica* (4-16%), small Gephyrocapsas (2-14%), *E. huxleyi* (1-13%) and Rhabdosphaera spp. (2-7%). The floral variations suggest that the oceanographic conditions in the northwestern South Atlantic were not stable in the last 20 kyr. We are currently exploring the potential changes in the position of the Intertropical Convergence Zone as a possible cause for these variations.

References:

Costa, K. B. Variações Paleoceanográficas na porção oeste do Atlântico Sul entre o Último Máximo Glacial e o Holoceno:isótopos estáveis de oxigênio e carbono e razão Cd/Ca em foraminíferos bentônicos. Porto Alegre, 2000. 236p.Tese de Doutorado – Instituto de Geociências, UFRS.

Molfino, B & McIntyre, A. 1990. Precessional forcing of nutricline dynamics in the Equatorial Atlantic. *Science*, 249, 766-769.

Okada, H. 1992. Biogeographic control of modern nannofossil assemblages in surface sediments of Ise Bay, Mikawa Bay e Kumano-Nada, off coast of central Japan. *Memorie Di Scienze Geologiche*, 43, 431-449.

Toledo, F. A. L. Variações Paleoceanográficas nos últimos 30.000 anos no oeste do Atlântico Sul: Isótopos de oxigênio, assembléias de foraminíferos planctônicos e nanofósseis calcários. Porto Alegre, 2000. 245p.Tese de Doutorado – Instituto de Geociências, UFRS.

Vital, H.; Esteves, L. S.; Araujo, T. C. M. & Patchineelam, S. M. Oceanografia geológica e geofísica da plataforma continental brasileira. In: Souze, C. R. G.; Suguio, K.; Olivera, A. M. S.; Olivera, P. E. (Eds.) Quaternário do Brasil. Ribeirão Preto: Holos, 2005. p.153-175.

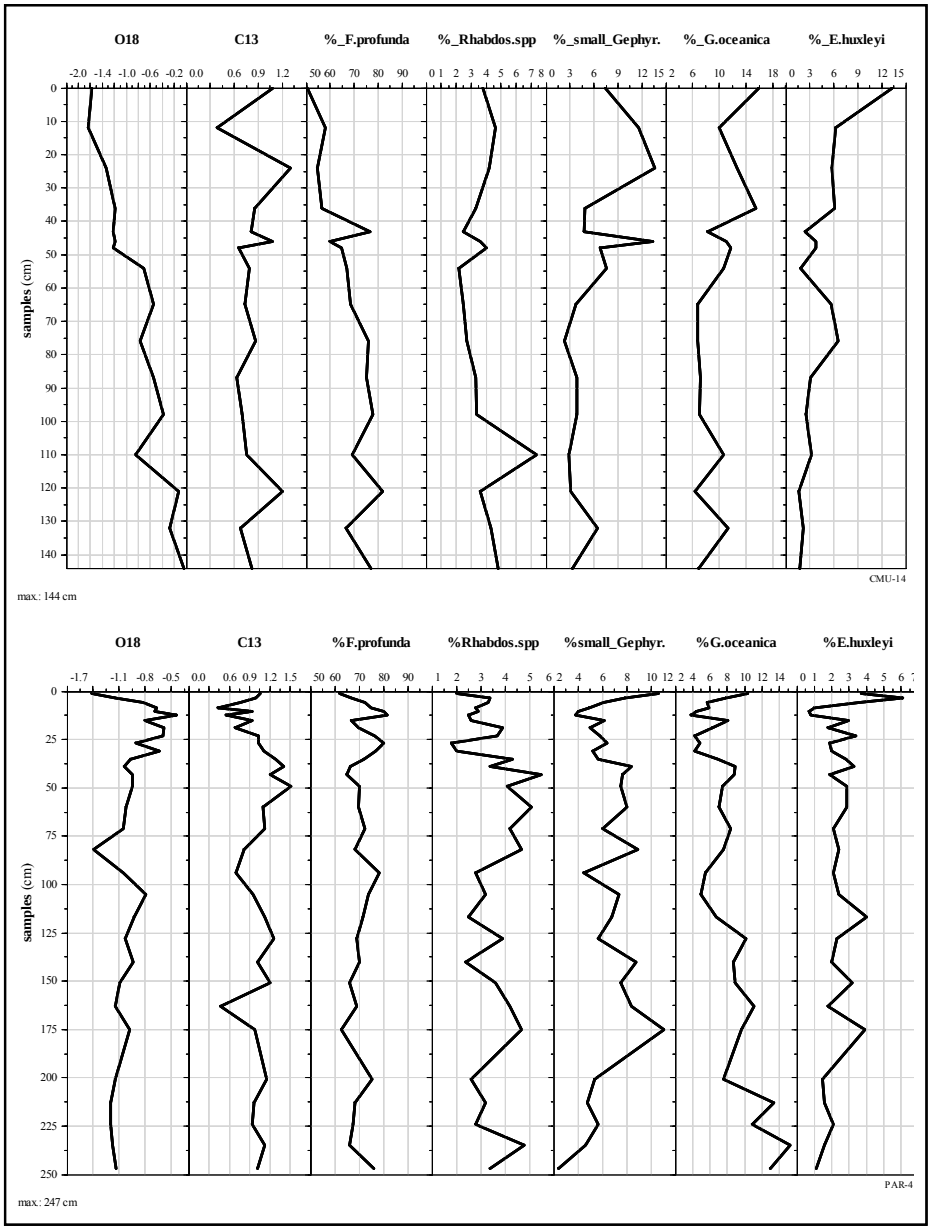


Figure 1: Percentage abundance of the dominant taxa and isotopic data.

Late Cretaceous Nannoplankton Zones of South Caucasus

Azer Rahimli

Caspian Business Center 4 floor, 40 J. Jabbarly Street, Baku AZ 1065, Azerbaijan.
arahimli@encotec.az

The Late Cretaceous deposits are widely spread in the Lesser Caucasus (Azerbaijan). They constitute main structural-facial zones of the region: Somkhit-Agdam, Geokcha-Garabagh and Araksian. Lithologically they consist of terrigenous, carbonaceous and volcanogenic facies spanning a stratigraphic interval from Cenomanian to Maastrichtian. With the help of electron and light microscopes there have been studied nannofossils from the sections in the Araksian (Negram, Paiz, Gyulistan, Kermechetah, Badamly, Tirkesh), Geokchai-Garabagh (Sheilanly, Saraly-Khashtab, Lyapakheiranly , Dolanlar, Chovdar, Bulanlyg, Agdaban) and Somkhit-Agdam (Kyurakchai, Agdag, Dzegam) structural – facial zones. There have been also studied samples from prospecting wells in the field Muradkhanly and Kyurdakhany of Apsheron peninsula. Detailed investigations of nannofossils allowed to determine regularities of their vertical spread in the upper Cretaceous and Danian deposits as well as to identify nannoplankton zones (1).

The Upper Cretaceous calcareous nannoplankton has been also studied from sections of the Trialetian Ridge (2) in the Eastern Georgia. As a result we performed correlation of the identified Upper Cretaceous nannoplankton zones in the both regions (see Table 1).

Table 1

Stage	**Substage**	**The Lesser Caucasus (Azerbaijan) Rahimli, 1980**	**The Trialetian Ridge (Georgia) Kilasonia, 1986**
Danian	Upper Lower	Chiasmothus danicus Cruciplacolithus tenuis	*Chiasmothus danicus* *Cruciplacolithus tenuis*
Maastrichtian	Upper Lower	Tetralithus murus- Nephrolithus frequens Lithraphidites quadratus	Tetralithus murus Layers with Zygodisci spiralis
Campanian	Upper Lower	Broinsonia parka Arkhangelskiella Specillata	Tetralithus trifidus Tetralithus aculeus
Santonian	Upper Lower	Cribrosphaerella arkhangelskii Ahmuellerella mirabilis	Layers with Arkhangelskiella cymbiformis
Coniacian	Upper Lower	Marthasterites furcatus Rucinolithus hayi	Layers with Arkhangelskiella cymbiformis
Turonian	Upper Lower	Lithastrinus grilli Microrhabdulus Decoratus	Tetralithus pyramidus M.decoratus
Cenomanian	Upper Lower	Gartnerago obliquum Lithraphidites alatus	

In the Cenomanian deposits in the Lesser Caucasus composed of terrigenous deposits, there have been identified two nannoplankton zones: the lower – *Lithraphidites alatus* and upper – *Gartnerago obliquum*. The Cenomanian deposits in the Trialetian Ridge are represented mainly by a volcanogenic facies. In rare interlayers of marls there occur single *Watznaueria barnesiae*. Turonian deposits are not widely spread in the Lesser Caucasus. Most completely they are represented in the Araksian zone. They are conglomerates, sandstones, tuff-sandstones, gritstones and calcareous clays. There have been recorded rich complexes of foraminifers and nannoplankton there (3). Two zones have been identified in Turonian: *Microrhabdulus decoratus* and *Lithastrinus grillii*. Composition of nannoflora from these zones is very well correlated with coeval complexes of nannofossils in Trialetia. There has been identified coeval zone of *Microrhabdulus decoratus* in the lower Turonian there, whereas in the upper Turonian there has been identified *Tetralithus pyramidus* zone. Coniacian and Santonian deposits are widely spread in the Lesser Caucasus. The Conaician transgression covered nearly the whole territory of the Lesser Caucasus. In the Araksian zone these deposits are exposed in the basins of rivers East Arpachai and Djagrychai as well as in the Ordubad and Julfa regions. They are represented by the alternation of limestones and marls with interlayers of clays. In Coniacian we traced two zones *Rucinolithus hayi* and *Marthasterites furcatus*. Santonian rocks represented mainly by limestones and marls with interlayers of clays, contain different amount of nannoplankton. Single accumulation of nannoplankton have been recorded in pelitomorphic and dense limestones. Probably, processe of re-crystallization limestones and dissolution of nannoflora therein took place there, whereas in the calcareous clays, there occur rich accumulations of nannoplankton. In Santonian there has been determined one nannoplankton zone *Cribrosphaerella arkhangelskii-Ahmuellerella mirabilis*. If we compare this zone with Trialetia, then in the Coniacian-Santonian deposits one can identify layers with *Arkhangelskiella cymbiformis*. Species-index *Marthasterites furcatus*, which are nearly world-wide,unfortunately has not been determined there. Representatives of genera *Arkangelskiella*, *Ahmuellerella*, *Broinsonia*, *Tetralithus* have been recorded in both regions. Campanian and Maastrichtian deposits are widely spread in the Somkhit-Agdam and Araksian zones. They occur mainly in the carbonaceous facies there. In the Lesser Caucasus Campanian there have been traced two zones, i.e., the lower zone *Arkhangelskiella specillata* and the upper zone *Broinsonia parka*. In Trialetia one can identify *Tetralithus aculeus* and *Tetralithus trifidus* respective. In Campanian there occurred flourish of such genera like *Tetralithus*, *Cribrosphaerella*, *Arkhangelskiella*, *Broinsonia*. Both regions are characterized by a significant amount of common species. In the Lesser Caucasus Maastrichtian one can identify the lower zone *Lithraphidites quadratus* and the upper zone *Tetralithus murus-Nephrolithus frequens*. The species *T. murus* is typical for south regions, whereas *N. frequens* mainly occurs in the north areas. Presence both species in the upper Maastrichtian demonstrates that both chimatic belts existed in the region. In the Trialetian Maastrichtian there has been identified zone of *Tetralithus murus* for the upper parts. In the lower parts there have been traced layers with *Tetralithus murus*. World-wide species *Zygodiscus spiralis* have not been determined in Trialetia. In the overlapping Danian deposits represented by limestones, marls, clays and conglomerates there occurs disappearance of the upper Cretaceous species and there appear nannofossils

with Paleogene habit. Two zones have been identified there: the lower – *Cruciplacolithus tenuis* and the upper *Chiasmolithus danicus*. They are typical for both regions.

Thus, comparing calcareous nannoplankton from the Azerbaijan part of the Lesser Caucasus and the Trialetian Ridge of the Eastern Georgia, one can observe great specific and generic similarity of compositions of the identified subdivisions . At the same time, absence of some species–indices in the upper Cretaceous deposits in Trialetia which occur both in the Lesser Caucasus and in many regions of the world (4), probably, is linked with volcanic activity and re-crystallization in dense pelitomorphic limestones.

Reference

Rahimli A.A., 1980, Zonation of Upper Cretaceous Deposits of Minor Caucasus (Azerbaijan) based on Planktonis Foraminifers and Calcareous Nannoplankton (cahiers de micropaleontology – 2-9-14).

Kilasoniya, E.D.. Late Cretaceous kokkolitophorides in the Trialetia Ridge and their stratigraphic importance. Author's abstract of candidate's thesis, 1986

Reworked Pliensbachian-Aalenian Nannofossils from Jara Dome, Kutch: Early Jurassic Paleobiogeography of Western India

Jyotsana Rai

Birbal Sahni Institute of Palaeobotany, 53, University Road, P.O. Box – 106, Lucknow, INDIA
jyotsana_rai@yahoo.com

The Jara Dome, situated on the northwestern extremity of mainland group of islands in the Kutch basin, exposes the upper part of the Chari Formation. It has yielded well preserved, diverse and datable nannofossil assemblage comprising over twenty species. This part of the Chari Formation is exposed in a stratigraphic section (GPS value 23˚43' 38" N : 68˚ 59' 42" E) and is divisible into the basal gypsiferous shales of ca. 1m in thickness overlain by a non-gypsiferous shaly unit followed by the marker Dhosa oolitic limestone bands. The gypsiferous and non-gypsiferous shales are separated by a thin microammonite -bearing horizon. Ammonites help to date the sequence as late Callovian – early middle Oxfordian. It is only the non-gypsiferous shale unit, which has yielded the nannofossil flora while the other two units are practically devoid of nannofossils due to unsuitable facies of the gypsiferous shales and recrystallization of nannofossils in hard Dhosa Oooite.

The recovered nannofossil assemblage includes *Ansulasphaera helvetica, Biscutum constans, Cyclagelosphaera margerelii, Ethmorhabdus gallicus, Lotharinguis crucicentralis, L. sigillatus, Podorhabdus grassei, Stephanolithion bigotii bigotii, S. bigotii maximum, S. hexum, S. speciosum, Thoracosphaera saxea, Watznaueria barnesae, W. britannica, W. manivitae, W. ovata, Watznaueria* spp., *Zegrhabdotus erectus,* Amongst the above cited taxa, the age of the sampled stratigraphic level of the basal non-gypsiferous shaly unit is constrained by the FAD of *S. bigotii bigotii* in the European late early Callovian *calloviense* zone and the LAD of *A. helvetica* in the late late Callovian *lamberti* zone. This interval corresponds to the NJ 13 *Stephanolithion bigotii bigotii* zone.

Record of *Crepidolithus granulatus, C. pliensbachiansis, Stradnerlithus clatriatus, Scizosphaerella punctulata* in the assemblage indicates reworked elements from older Chari and the oldest Patcham formation which is exposed in the Patcham Island. The Patcham Formation is dated as Bajocian – Bathonian on rare records of ammonites evidences. The earliest transgressive event in the region is postulated during Bajocian by several workers. Record of reworked nannofossils strongly suggest an earlier trangressive event, possibly during Pliensbachian – Torcian time in the Kutch basin. Coeval records of nannofossils containing (*C. granulatus* and *C. pliensbachiansis*) from Queen Charlotte Island, British Columbia (Bown, 1992) and (*C. granulatus, S. punctulata*) from Masirah Island, Sultonate of Oman (Perch – Nielsen, 1997) suggests existence of a seaway in the form of an arm of the Tethyan sea between Arabia - Africa and in the western part of India. The present nannofossil find, thus has much wider implications not only in dating of early Jurassic sediments but also on the paleogeographical position of India during this time.

High Resolution Biostratigraphy of a Well in Campeche Bay

Ma. Antonieta Sánchez-Rios [1], Daniel García-Urbano[1], Patricia Padilla-Avila[1], Bruno A. Reyna-Tellez[1], Janett Sánchez-Durán[1], Mónica Ayala-Nieto[1], Aaron del Valle-Reyes[1], Antonio Reyes-Vázquez[1], José Vicente Ortega González[2], José Robles Nolasco[2], Elia Pliego Vidal[2], Carlos Medina[2], & Rocio Noriega Nieto[2].

[1]Instituto Mexicano del Petróleo, Eje Central Lázaro Cárdenas Norte 152, Col. San Bartolo Atepehuacan, C.P. 07730, México, D. F.
[2]Petróleos Mexicanos, Calle 33, No.9, Col. Burocratas, Edificio 1, Ala poniente, C.P. 24180, Cd. del Carmen, Campeche
masrios@imp.mx

High resolution biostratigraphy of a well located in Campeche Bay suggests a late Pliocene to early Paleocene age. Paleobathymetry shows a range from the Outer Neritic to the Upper Bathyal – Middle Bathyal.

Abundant calcareous nannofossils, foraminifera and key palynomorphs bioevents were identified in the sediments of the well; *D. pentaradiatus* (2.30, 2.45 My), *G. miocenica* (2.30, 2.40 My), *S. abies* (3.58 My), *G. margaritae* (3.4, 3.58 My), *C. acutus* (5.05, 5.34 Ma), *D. quinqueramus* (5.6 My*), D. hamatus* (9.4 Ma), *D. sanmiguelenses* (11.8 My), *G. fohsi peripheroronda* (14.6 My), *S. heteromorphus* (13.6 My), *D. saundersi* (21.10 Ma), *S delphix* (23.8 My), *G. opima opima* (27.10 My ?), *Ch. cubensis* (28.5My), *G. ampliapertura* (30.3 My), *E. formosa* (32.80 My), *Ch. gigas* (44.5 My), *D. kuepperi* (47.3 My), *T. orthostylus* (50.6 My), *S. anarrhophus* (53.6 My), *F. tympaniformis* (55.33 My), *M. velascoensis* (54.7My), *P. pseudomenardii* (55.9 My), *M. conicotruncana* (58.8 My), *G eugubina* (64.70 My), Globotruncanas (65.50 My) y el Bloom de *Thoracosphaera* sp y *Braarudosphaera* sp. (aprox. 65.00 Ma).

Several stratigraphic discontinuities were detected. The most significant could be those of the Early Miocene, Middle Oligocene, Oligocene/Eocene boundary, Late

Eocene/Middle Eocene boundary, Middle Eocene/Early Eocene boundary. These stratigraphic discontinuities should be correlated with the seismic analysis.

The Neogene sediments are 1765m thick. While the Paleogene sediments are 485m thick. During the Neogene, the Outer Neritic-Upper Bathyal is steady. During the Paleogene, the deposit turned into a deeper environment; Middle-Upper Bathyal. The calcareous nannofossils, planktic foraminifers, and dinoflagellates were abundant during the Paleogene, which points to deeper environments compared to the Neogene, where those microfossils are less abundant. Benthic foraminifera, pollen and spores are scarce throughout most of the sedimentary column. This suggests that they were deposited in a deep environement.

On the other hand, various microfossil abundance peaks were observed mainly in the Paleogene and to a lesser extent in the Neogene. Some of these peaks could be interpreted as condensed sections. This implies that the biostratigraphic data obtained in this study could be used for sequence stratigraphic interpretation.

High Resolution Biostratigraphy in Sediments of Two Wells in the Western Gulf of Mexico

Ma. Antonieta Sánchez-Rios [1], Mónica L. Ayala-Nieto[1], Julio C. González-Lara [1], Aarón del Valle-Reyes[1], Janett Sánchez-Durán [1], Patricia Padilla-Avila [1], Daniel García-Urbano[1], Cristina Pérez-Castillo[1], Bruno A. Reyna-Téllez[1], Antonio Reyes-Vázquez[1], Paula A. Fuentes-Franco[1], Guillermo Quintanilla-Rodríguez[2], Juan Rico-Pérez[2], & Lidia Aguirre-Meza[2]

[1]Instituto Mexicano del Petróleo, Eje Central Lázaro Cárdenas Norte 152, Col. San Bartolo Atepehuacan, C.P. 07730, México, D. F.
[2]Petróleos Mexicanos, Cesár López de Lara 202 Sur, Edificio Aguila, 2° piso, Zona Central, C.P. 89000, Tampico, Tamps.
masrios@imp.mx

An integrated high-resolution biostratigraphic study was carried out using calcareous nannofossils, planktic and benthic foraminifera, and palynomorphs from two wells in the western Gulf of Mexico. The age for these sediments ranges is from early Pleistocene to Middle Miocene.

Early Pleistocene is represented by nannoflora and microfauna of Biozone NN19 and Biozone of *Globorotalia truncatulinoides truncatulinoides* respectively, and by dinocysts species: *Spiniferites delicatus, Spiniferites membranaceous, Multispinula quanta* and *Hystrichokolpoma rigaudiae.* These sediments were deposited under Inner to Middle Neritic bathymetric conditions.

Pliocene is characterized by a nannofossil biozones NN18, NN17, NN16, NN15 and NN14-NN12 interval; foraminifera biozones of *Globorotalia miocenica, G. tosaensis tosaensi*s, *G. margaritae*, and by dinoflagellates cysts species: *Polysphaeridium zoharyi, Lingulodinium machaerophorum, Melitasphaeridium choanophorum* y *Operculodinium crassum*. Paleobathimetry corresponded to Inner Neritic-Upper Bathyal during that age.

Late Miocene sediments have microfossils of biozones NN11, NN10, NN9 and biozones of *G. humerosa* and *G. acostaensis*. Dinoflagellate cysts found in these sediments are: *Spiniferites mirabilis, Dapsilidinium pastielsii, Sumatradinium hispidum*, and *Achomosphaera andalusiensis*. Paleobathimetry where the sediments were deposited, occurred under Outer Neritic-Upper Bathyal conditions.

Middle Miocene strata are represented by: calcareous nannofossils biozones NN9, NN8, NN6, NN5; biozones of *G. mayeri*, *Globigerinoides rubber*, *G. fohsi lobata-G. robusta*, *G. fohsi fohsi*; and probably by one part of Biozone of *G. fohsi peripheroronda*. These strata were deposited mainly in Outer Neritic-Upper Bathyal.

Nannofossil diversity and abundance shows notable variations throughout the two wells. A strong predominance of calcareous nannofossils and the marine palynomorphs is noticed in Outer Neritic setting and a planktic foraminifera increase is observed mainly in Upper Bathyal, in Well A. A continental palynomorphs abundance is observed towards Inner Neritic-Middle Neritic, and a reduction is representative in the Outer Neritic-Upper Bathyal in Well B.

Differential Interoceanic Surface Water Cooling during the late Campanian as Indicated by Calcareous Nannofossil Assemblage Changes

Leah J .Schneider [1,2] *& David K. Watkins*[1]

[1]University of Nebraska-Lincoln, Department of Geosciences 214 Bessey Hall Lincoln, NE 68588-0340
[2]present address: The Pennsylvania State University, Department of Geosciences 503 Deike Building University Park, PA 16802
leahjschneider@hotmail.com

Climate change during the late Campanian to Maastrichtian (Late Cretaceous) led to marked alterations in ocean circulation and in the biogeography of calcareous plankton. Temperature decrease in surface waters, most notably at higher latitudes, caused increased provinciality of nannofossil assemblages.

Previous studies have documented the predictable nature of changes in species abundance corresponding to changes in paleolatitude, leading to the use of certain taxa as paleotemperature indicators. Stratigraphic changes in the abundance of these temperature-sensitive species can be used as a proxy for changes in the thermal regime of the upper surface waters of the oceans during the Late Cretaceous.

Nannofossil assemblages were analyzed from 3 sites (one from the North Atlantic, central Pacific, and southern Indian Ocean) to ascertain the relationship between surface water cooling and ocean circulation changes in major ocean basins, especially in terms of the relative magnitudes and degree of synchroneity of these changes. Statistical analysis demonstrates that the composition of the fossil assemblages from Exmouth Plateau, a high latitude, Indian Ocean site, steadily diverge from those of the low to mid latitude localities in the Atlantic and Pacific oceans. The Exmouth Plateau assemblages exhibit a marked increase in the abundance of cool water species during the late Campanian that is attributed to progressive surface water cooling. The cooling trend

evident at Exmouth Plateau occurs just prior to a regional hiatus found throughout the Indian and Southern oceans that correlates to thermohaline circulation changes proposed by Barrera et al. (1997) at the Campanian/Maastrichtian boundary. The low to mid-latitude Atlantic and Pacific sites, on the other hand, show no appreciable change in assemblage composition relative to the paleotemperature indicators, suggesting that little thermal change occurred in the surface water masses at this time.

References:
Barrera, E., Savin, S.M., Thomas, E., Jones, C.E., 1997, Evidence for thermohaline-circulation reversals controlled by sea-level change in the latest Cretaceous, Geology, v.25, p.715-718.

Correlation between Late Cretaceous Calcareous Nannofossil and Strontium Isotope Data from the North Carolina Coastal Plain, USA

Jean M. Self-Trail [1] & W. Burleigh Harris[2]

[1]U.S. Geological Survey, 926A National Center, Reston, VA 20192, USA;
[2] Department of Earth Sciences, University of North Carolina at Wilmington, Wilmington, NC 28405, USA
jstrail@usgs.gov

Calcareous nannofossil and strontium isotope data were analyzed from three coreholes at Elizabethtown, Hope Plantation and Kure Beach, located in the North Carolina Coastal Plain, USA. Dates of sediment samples and corresponding calcareous nannofossil marker species were obtained using $^{87}Sr/^{86}Sr$ ratios correlated to the LOWESS (Locally Weighted Regression Scatterplot Smoother) Table Version 3 of McArthur et al. (2001) and from equations for the Campanian-Maastrichtian provided by Miller et al. (2004). Marker species strontium dates were then correlated to the geochronologic timescale of Ogg et al. (2004).

The Cenomanian Clubhouse Formation typically is marked by the first occurrence (FO) of *Microrhabdulus decoratus*, which occurs in the basal sample of the Hope Plantation core. This species is assigned an age of 97.2Ma, which is slightly older than previously recorded (Norris et al., 1998). Other first and last occurrences (LO) identified from the Clubhouse Formation include the FO of *Metadoga*? sp. and the LO's of *Radiolithus planus* and *Eiffellithus parvus*. Strontium ages from this interval range from 97.2 - 94.4Ma, with an average 95.6Ma, corroborating a calcareous nannofossil Zone CC10 placement for these sediments.

The FO of *Marthasterites furcatus* occurs in an unnamed unit from the Kure Beach core and is assigned an age of 88.9Ma (late Coniacian), only slightly younger than previously recorded (Norris et al., 1998). Additional Coniacian marker species include the FO of *Micula decussata*, which was identified from both the Kure Beach and Elizabethtown cores and assigned dates of 87.1Ma and 87.6Ma, respectively, and the LO of *Munarius marszalekii* (86.8Ma), which has proven to be a useful local biostratigraphic marker.

Santonian marker species include *Calculites obscurus* and *Aspidolithus parcus parcus*, both from the Kure Beach core. The FO's of these two species occur at 83.9Ma and 83.8Ma, respectively, and are consistent with previously published dates. Additional $^{87}Sr/^{86}Sr$ samples taken throughout the Santonian/Coniacian section in the Kure Beach core supply age dates consistent with Ogg et al. (2004) and show a progressive increase in age downcore.

The FO of the late Campanian marker species *Aspidolithus parcus constrictus* and the LO of *Marthasterites furcatus* are documented from the Kure Beach core. Strontium isotope data assigns an age of 83.0Ma to *A. p. constrictus*, which is within the margin of error for the age quoted by Norris et al. (1998). The LO of *M. furcatus* is dated at 81.5Ma, placing this event in the latest late Campanian.

The middle to upper Campanian Cane Acre, Coachman, and Bladen Formations provided abundant calcareous nannofossil marker and background species for comparison with strontium isotope data. The LO of *Bukryaster hayi* at 78.5Ma, and the FO's of *Ceratolithoides aculeus*, *Quadrum sissinghii*, *Quadrum trifidum*, and *Reinhardtites levis* at 77.5Ma, 76.8Ma, 73.6Ma, and 72.8Ma, respectively, provide Sr dates that are significantly younger than the limits placed on zonal correlations by Ogg et al. (2004), but coincide with dates reported by Miller et al. (2004) for the same nannoflora assemblages in New Jersey. The LO's of background nannofossils such as *Broinsonia verecundia* (78.6Ma), *Stoverius asymmetricus* (73.6Ma), and *Prediscosphaera arkhangelskyi* (71.6Ma) are stratigraphically synchronous with Ogg et al. (2004); additional Sr isotope dates record a progressive increase in age of sediments downcore.

The upper Maastrichtian Peedee Formation is widespread throughout the coastal Carolinas, and samples from the Kure Beach core provided dates for the FO's of *Lithraphidites quadratus* (69.1Ma) and *Ceratolithoides kampnerii* (66.4Ma), which are coincident with previously published dates (Norris et al., 1998). Additionally, the FO of *Lithraphidites grossopectinatus* (66.8Ma) and the LO's of *Cribrocorona gallica* (66.8Ma), *Lithraphidites? charactozorro* (66.4Ma), and *Podorhabdus? elkefensis* (66.2Ma) are useful local occurrences.

References:

McArthur, J.M., Howarth, R.J., and Bailey, T.R., 2001, Strontium isotopic stratigraphy: LOWESS version 3: Best fit to the marine Sr-isotopic curve for 0-509 Ma and accompanying look-up table for deriving numerical age: The Journal of Geology, v. 109, p. 155-170.

Miller, K.G., Sugarman, P.J., Browning, J.V., Kominz, M.A., Olsson, R.K., Feigenson, M.D., and Hernandez, J.C., 2004, Upper Cretaceous sequences and sea-level history, New Jersey Coastal Plain: Geological Society of America Bulletin, v. 116, p. 368-393.

Norris, R.D., et al., 1998, Proceedings of the Ocean Drilling Program Initial Reports, v. 171B, Ocean Drilling Program, College Station, Tex., p. 93-319.

Ogg, J., Agterberg, F.P., and Gradstein, F.M., 2004, The Cretaceous Period, *in* Gradstein, F.M., Ogg, J., and Smith, A., eds., A geologic time scale 2004: Cambridge University Press, Cambridge, p. 344-383.

Age Range of *Heterolepa* (*Cibicides*) *salensis* Zone of the Northern Caucasus and its Correlation According to Nannofossils

Andreyeva-Grigorovich Aida Sergeivna & Daniel Odhiambo Waga Dennis

Institute of Geosciences, Academy of sciences of Ukraine, Kiev-54, 01054, Gonchara street 55b, Kiev, Ukraine
aida.a@rambler.ru

The *Heterolepa* (*Cibicides*) *salensis* zone was first established by Yul.P. Nikitina (1958, 1963) in the lower part of Chadumian Stage in the Salo-Manich interstream on the basis of the appearance of new anomalinids, including *Heterolepa salensis* (Nikit.), *H. sulzenensis* (Herr.), *H. kiliani* (And.) *almaensis*, *Bolivina ex.gr. mississipensis* Cushm. and others. The zone is widely geographically distributed from the Crimea Peninsula (in the west) to the Prearal area (in the east). The facies composition of the zone varies along its extension and due to this several names for this interval have been proposed (*Plectofrondicularia volgensis*, *Amphimorphina haueriana*, *Caucasina shischkinskyae* and *Haplophragmoides fidelis*). The Rupelian age of this zone was dominating and widely accepted among most of micropaleontologists of the former Soviet Union (Nikitina, Morozova, Shutzkaya, Ter-Grigoryanz and others).

In its stratotype section (borehole Dubovskaya-5, interval 423-373 m) the *Heterolepa* (*Cibicides*) *salensis* zone comprises green, gray-green marly sandy clays. The lower boundary is gradual, the upper one is set on a lithological change, where the zone is overlayed by typical maikopian sediments presented by dark, light brown-grey clays of 20 meters of thickness and characterized by *Haplophragmoides deformabilis* zone (Nikitina, 1972).

We studied nannofossils from the intervals assigned to the *Heterolepa* (*Cibicides*) *salensis* zone from five boreholes: Kanelovskaya-7 (int. 569-582.0m), Mechetkinskaya-20 (385.0 m) Salskaya-27 (int. 281-244.0 m), Zavetninskaya-17k (299.0 m), Nikolaevskaya-2 (135.0 m). According to the tectonic-structural division of the Precaucasus (Ahmetyev, Beniamovski, 2003) the first two boreholes are located in the Esko-Armavir subzone area, Salskaya-27 in Rostov subzone, Zavetninska-17k - Kalmyksk zone and Nicolaevskaya-2 in eastern Donbas, respectively.

The identified assemblage is presented by the following species: *Cyclicargolithus floridanus*, *Coccolithus subdistichus*, *Cribrocentrum reticulatum*, *Chiasmolithus oamaruensis*, *Coronocyclus nitescens*, *Coronocyclus serratus*, *Discoaster barbadiensis*, *Discoaster tani nodifer*, *Discoaster tani tani*, *Discoaster deflandrei*, *D. saipanensis*, *Dictyococcites bisectus*, *Lanternithus minutus*, *Isthmolithus recurvus*, *Pontosphaera multipora*, *Tranversopontis pulcher*, *Sphenolithus moriformis*, *Reticulofenestra umbilica*, *Reticulofenestra insignita*, *Reticulofenestra dictyoda*, and *Zygrhablithus bijugatus*.
The presence of such species as *Discoaster saipanensis* and *Discoaster barbadiensis* in the lower part of the *Heterolepa* (*Cibicides*) *salensis* zone of good preservation and without signs of reworking suggests that the age range of the foraminifera zone can be extended at least to the upper part of the Bartonian Stage of Late Eocene. This indicates that the sediments of the *Heterolepa* (*Cibicides*) *salensis* zone are diachronous in age from Late Eocene to Early Oligocene. Both *Discoaster* species disappear upwards in the

middle part of the *Cibicides salensis* Zone and thus mark the boundary between Eocene/Oligocene.

The *Heterolepa* (*Cibicides*) *salensis* zone in the Global Stratigraphic scale (2004) can therefore be correlated with the upper half of P16 to the lower part of P18. The lower boundary is set above the appearance of *Turborotalia cerroazulensis cunialensis*, and upper boundary – near the last occurrence of the same species). Thus coincides with the biozone of *Turborotalia cerroazulensis cunialensis* and has a duration of roughly 800Ka to 1 million years. In the interregional zonal scale of southern Russia (Ahmetiev, Beniamovski, 2003) it correlates with upper part of *Bolivina antegressa* Zone and *Haplophragmoides* subzone of *Lenticulina hermanni* Zone.

References:

Ahmetiev M.A., Beniamovski V.N. Regional (unificated) stratigraphic scheme of marine paleogene of the southern European part of Russia. Bull. MOIP. Ser. Geolog.2003, vol.78, issue 5 , pp. (in Russian).

Nikitina Yu.P. Microfauna of Maikopian sediments of the Lower Don basin. In Maikopian sediments and their age analogues in Ukraine and Middle Asia. Kiev, Naukova dumka. pp. 52-67. (in Russian).

Nikitina Yu.P. Biostratigraphy of Paleogene sediments of south-easr part of Russian platform and Skifian Plate. Thesis of Post Doctoral Degree of geological-mineralogical sciences. Leningrad, 1972, 47 p. (in Russian).

A Geologic Time Scale, eds. Felix M. Gradstein, James G.Ogg and Alan G. Smith. The Paleogene Period. Cambridge University Press. 2004.p.384-408.

Latest Quaternary High-resolution Nannofossil Biostratigraphy from the Ursa and Brazos-Trinity Minibasins, Gulf of Mexico: Preliminary Results from IODP Expedition 308

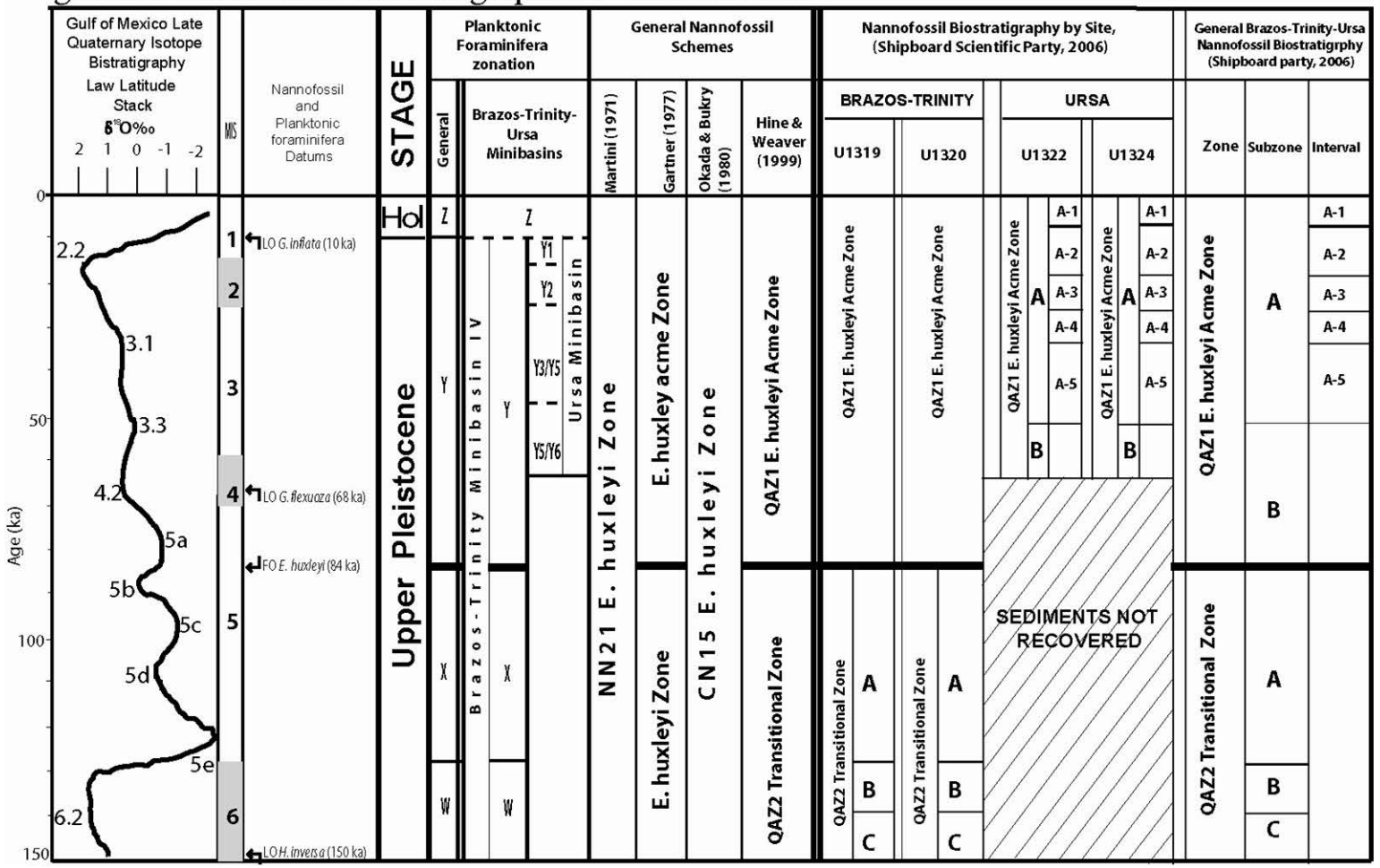
A. Shumnyk[1], P.B. Flemings[2], J. Behrmann[3], C. John[4], and the Expedition 308 Shipboard Scientific Party

[1] Department of Geological Sciences, Carraway Building: Antarctic Circle, Florida State University, 4100 FSU, Tallahassee FL 32306-4100, USA,.
[2] Department of Geosciences, Pennsylvania State University, 307 Deike Building, University Park PA 16802-2714, USA.
[3] Albert-Ludwigs-Universität Freiburg, Geologisches Institut, Albertstrasse 23B, 79104 Freiburg, Germany.
[4] Integrated Ocean Drilling Program, Texas A&M University, 1000 Discovery Drive, College Station TX 77845-9547
anatoliy.shumnyk@bugware.com

Preliminary analyses show that distinctive cyclical patterns are present in the distributions of some twenty upper Quaternary calcareous nannofossils recovered from the Ursa and Brazos-Trinity Minibasins during IODP Expedition 308 to the Gulf of Mexico. The well preserved nannofossils are rare in sandy deposits and abundant in pelagic and hemipelagic sediments. Reworked Neogene to Cretaceous taxa are present throughout the sections drilled. Reworked assemblages are usually more abundant than the in-situ assemblages except in the hemipelagic sections. The cyclic patterns indicate periodic influxes of sediments associated with mass-transport events, particularly turbidity currents. These cyclic patterns are more evident in the Ursa Minibasin.
The oldest sediment drilled in the Brazos-Trinity Minibasin IV was dated at ~150 Ka based on the absence of *Helicosphaera inversa*, which spans the Holocene-upper Pleistocene interval from marine-isotope stages (MIS) 1 to 6. The oldest deposits recovered from the Ursa Minibasin span MIS 1-4 within the *Emiliania huxleyi* Acme Zone (QAZ1), and are younger than ~60 Ka.

Quantitative analysis of the assemblage distributions has provided the basis for a high-resolution nannofossil stratigraphy. As a result, the *Emiliania huxleyi* Acme Zone and the Transitional Nannofossil Zone (QAZ2) with its two A and B subzones were identified in Brazos-Trinity Minibasin IV. On the other hand, the *Emiliania huxleyi* Acme Zone (QAZ1) with its two A and B subzones are distinguished in the Ursa section. Five nannofossil intervals from A-1 throughout A-5 were resolved within Subzone A at the Ursa sites. A number of stratigraphic units can be correlated within the minibasins using this high-resolution nannofossil stratigraphy (Figure 1).

Figure 1. Conclusive Uppermost Pleistocene-Holocene nannofossil biostratigraphy for Ursa and Brazos-Trinity Minibasins. General nannofossil biostritigraphies by different authors; Foraminifera biostratigraphy and stable isotope stratigraphy are shown against distinguished nannofossil biostratigraphical subdivisions.



Calcidiscus leptoporus as a Proxy for Summer Warm Subtropical Waters in Lisbon Bay

Alexandra Silva, Sofia Palma, Teresa Moita, & Paulo Oliveira

IPIMAR/INIAP, Avenida de Brasília, 1449-006 Lisboa, Portugal
amsilva@ipimar.pt

On the Portuguese coast, *Calcidiscus leptoporus* is a common winter/spring coccolithophore that never reaches high abundances in coastal waters. During August/September 2005, a survey carried out on Lisbon Bay, revealed the presence of different *C. leptoporus* morphotypes, distributed by two size classes based both on morphological criteria (Baumann and Sprengel, 2000) and size (Knappertsbusch *et al*, 1997; Baumann and Sprengel, 2000). At surface, the large form of *C. leptoporus* was observed inshore, along a thermal upwelling front and was spatially separated from an intermediate form that was observed off-shore on warm and saltier waters. Satellite-derived sea level anomaly maps revealed that during the cruise, and for at least three weeks before, the off-shelf surface circulation was dominated by the presence of two counter rotating mesoscale eddies, responsible for an unusual strong northeastward flow of warm oceanic waters into the Bay. The large form only represents less than 3% of total coccolithophore assemblage, and occurred in surface temperatures between 15.5-17.5ºC, while the intermediate form reached more than 40% of the coccolithophore community, with temperatures and salinities higher than 20ºC and 36, respectively. The different morphotypes occurred simultaneously in space and time and thus can function as proxies of water bodies with different oceanographic conditions.

References:

Knappertsbusch, M., Cortes, M.Y. and Thierstein, H.R. (1997). Morphologic variability of the coccolithophorid *Calcidiscus leptoporus* in the plankton, surface sediments and from the Early Pleistocene. *Marine Micropaleontology*, 30, 293-317.

Baumann,K.-H and Sprengel, C., (2000). Morphological variations of selected coccolith species in a sediment trap north of the Canary Islands. *Journal Nannoplankton Research*, 22, 185-193.

Calcareous Nannofossils from the Upper Cretaceous and Paleogene of the Eastern Azov Region (Ukraine)

Eugene Solyanik

Institute of Geological Sciences of NASU, 55-b O. Gonchara Str., Kiev, 01601, Ukraine
solyanik2002@yahoo.com

As part of a Ukrainian Geological Survey mapping program, calcareous nannofossils were examined from coreholes 97 and 98 drilled in the Gruzskoy Yelanchik valley (Eastern Azov region, southern slope of the Ukrainian Shield). It provided new information concerning distribution of nannoplankton in Upper Cretaceous and

Paleogene sediments of the region. Data on nannofossils were supported by foraminiferal studies (Zosimovich *et. al.,* 2006).

Carbonaceous sediments from corehole 97 yielded the Upper Cretaceous nannofossil assemblage of more than 60 species. The assemblage includes *Broinsonia parca constricta, B. p. parca, Lucianorhabdus cayeuxii, Reinhardites anthophorus, R. levis, Calculites obscurus, Eiffellithus eximius* and gives evidence for the UC14d-UC15 zonal interval sensu Burnett (1998). It was not possible to conduct more detailed zonation of the interval due to the absence of marker-species. Similar nannofossil assemblage was identified by Shumnyk (2002) in the upper part of limestone with *C. temirensis* and lower part of Aleksandrovka formation in the territory west of the Gruzskoy Yelanchik valley. In the Black Sea northwestern shelf and Crimean continental slope the assemblage was identified at the top of Pavlovka formation, at the top of Novaya Mayachka strata and at the lower part of Djankoy formation (Shumnyk, 2002). Foraminifers from this interval refer to *Globorotalites emdyensis* Zone of the Late Campanian, which corresponds to macrofaunal *Belemnitella langei* Zone. The foraminiferal assemblage is characteristic of Aleksandrovka formation in the Eastern Azov region.

The following Upper Cretaceous nannofossil assemblages of about 50 species were recognized in carbonaceous sediments from corehole 98**.**

1. Assemblage with *Calculites obscurus, Ceratolithoides aculeus, Eiffellithus eximius, Lucianorhabdus cayeuxii, Reinhardites anthophorus* that gives evidence for the UC15b,c interval.
2. Assemblage with *Broinsonia parca parca, Lucianorhabdus cayeuxii, Uniplanarius gothicus, Uniplanarius trifidus, Reinhardites levis* evidencing UC15d,e interval.

Foraminifers found in the lower part of UC15d,e interval are characteristic of *Globorotalites emdyensis* Zone). In the upper part of UC15d,e interval, along with the typical Late Campanian species, there are present Early Maastrichtian species, which possibly point to the transitional from Campanian to Maastrichtian age of studied deposits (middle part of Aleksandrovka formation).

Two Paleogene nannofossil assemblages of more than 50 species were identified in corehole 98.

1. Assemblage with *Discoaster tanii, D. martini, D. bifax, Rhabdosphaera gladius, Chiasmolithus solitus, Nannotetrina fulgens* evidencing the upper part of Zone NP15-lower part of Zone NP16 of Martini's standard zonation (1971). It is *Acarinina rotundimarginata-Hantkenina alabamensis* Zone according to planktonic foraminifers and *Uvigerina costellata* Zone by benthic foraminifers. Nannofossils and foraminifers from the interval are characteristic of Novopavlian regional stage of the Southern Ukraine.
2. Assemblage with *Cyclicargolithus floridanus, Helicosphaera bramlettei, H. dinesenii, H. reticulata, H. euphratis, Rhabdosphaera vitrea, R. crebra, Pemma basquensis, Transversopontis pulcher, Pontosphaera multipora,* and frequent *Sphenolithus* spp. evidencing Zone NP16 identified in the Novopavlian deposits in the south of Ukraine. Foraminifers refer to Hantkenina alabamensis-Subbotina turkmenica zonal interval being typical for the upper Novopavlian-lower Kumian deposits of the Middle Eocene of the Southern Ukraine.

As a result of a study of Upper Cretaceous nannofossils and foraminifers from coreholes 97 and 98 drilled in the Gruzskoy Yelanchik valley, there were identified upper Campanian and Maastrichtian deposits of Aleksandrovka formation. Earlier, according to the legend of the Donets Basin map series, these deposits were considered to be upper Campanian only and referred to Sidorovka formation.

Paleogene nannofossils and foraminifers studied from corehole 98 are characteristic of the Novopavlian-lower Kumian deposits of the Middle Eocene of the Southern Ukraine. Earlier, according to the legend of the Donets Basin map series; these deposits were referred to Obukhov formation.

The obtained data allowed correcting the boundary between Yelanchik and Primorye structural-facial zones (SFZ). The Upper Cretaceous and Paleogene deposits uncovered by coreholes 97 and 98 should be referred to Primorye SFZ and not to Yelanchik SFZ, as it has been done earlier during geological mapping.

Thus while mapping Cretaceous and Paleogene deposits in the Gruzskoy Yelanchik valley the legend of the Central Ukrainian and Prichernomorye map series should be used instead of the legend of the Donets Basin map series.

References:

Burnett, J. A. 1998. Upper Cretaceous. *In*: P.R. Bown (Ed.). *Calcareous Nannofossil Biostratigraphy*. Chapman & Hall/Kluwer Academic Publishers: 132-199.

Martini, E. 1971. Standard Tertiary and Quaternary calcareous nannoplankton zonation. *In:* A. Farinacci (Ed.). *Proceedings of the Second Planktonic Conference Roma 1970. Edizioni Tecnoscienza, Rome*, **2**: 739-785.

Shumnyk, A.V. 2002. Upper Cretaceous nannofossils of the Southern Ukraine. *Abstract of a Ph.D. thesis.* Kiev: 20 pp.

Zosimovish, V.Yu., Knyazkova, I.L., Lyulyeva, S.A., Plotnikova, L.F., Solyanik, E.A., Strekozov, S.N., Chubar, Zh.V., Shevchenko, T.V. & Shevchuk, Ye.A. 2006. New data on the stratigraphy of Upper Cretaceous and Paleogene sediments in the Gruzskoy Yelanchik basin of the Eastern Azov region. *In:* P.F. Gozhyk (Ed.). *Contemporary trends of Ukrainian geological science.* Kiev: 198-222.

Short-term Climatic Changes in the North Atlantic (ODP Site 980) during the Last 150,000 years as Revealed by Coccolithophore Assemblages

Katharina Stolz, Karl-Heinz Baumann, & Katharina Janke

Fachbereich 5 Geowissenschaften, University of Bremen, Postfach 330 440, 28334 Bremen, Germany
kstolz@uni-bremen.de

This study uses mainly coccolithophore assemblages to reconstruct environmental conditions and their forcing factors in the North Atlantic region in the last 150,000 years. The investigation is carried out on a late Pleistocene sediment record from the Rockall Plateau (ODP Leg 162 Site 980), providing a highly resolved succession from the late Marine Isotope Stage (MIS) 6 up to MIS 1.

Studies from Mc Manus et al. (2001) show that this record clearly reflects the climatic and palaeoceanographic changes within the last 150,000 years. Those changes can mainly be seen in variations of the carbonate content and changes in the $\delta^{18}O$ signal which is characterised by positive and negative excursions as signs for cooling and warming events in the late Pleistocene. The sea surface temperatures (SST) derived from alkenone data show those changes as well. Furthermore the analysis of lithics indicates that large amounts of Ice Rafted Debris (IRD) have been released and deposited in the North Atlantic. Therefore, this study wants to investigate those events in a high resolution using mainly the primary producers coccolithophores as a palaeoclimatic tool.

The coccolithophore assemblage (see fig. 1) shows drastic changes in numbers throughout the whole core. The assemblage is dominated by occurrences of *Gephyrocapsa muellerae* in the lower part and *Emiliania huxleyi* in the upper part. This change in dominance occurs in MIS 4 and has been described by Thierstein et al. (1977) as a worldwide event.

With the beginning of MIS 5e the contents of coccolithophores increase rapidly and remain at relatively high contents during MIS 5, being dominated by the species *E. huxleyi* and *G. muellerae*. In addition this interglacial is characterised by species that are adapted to warmer conditions, such as *Syracosphaera pulchra*, and *Calcidiscus leptoporus*. Not surprising, *Coccolithus pelagicus ssp. braarudii* is not present during MIS 5e but increases in numbers at c. 105,000, and 75,000 years.

The last glacial cycle spanning MISs 4 to 2 is distinguished by lower contents of coccoliths, but still shows significant changes in the assemblage. This is mainly indicated by fluctuations in the occurrence of *C. leptoporus* and the subtropical form *S. pulchra*. Their high abundances indicate an enhanced influence and inflow from the North Atlantic Current (NAC). Being connected with Heinrich Events, decreases in the coccolith assemblages point to a weakened influence of the NAC and therewith a climatic and ecologic deterioration. Furthermore there are some peaks of reworked Cretaceous nannofossils which partly occur in correlation with IRD peaks.

References:

McManus, J.F., Oppo, D.W., and Cullen, J.L., 2001, ODP 980 Isotope and IRD Data, IGBP PAGES/World Data Center for Paleoclimatology Data Contribution Series #2001-065. NOAA/NGDC Paleoclimatology Program, Boulder CO. USA.

Thierstein, H.R., Geitzenauer, K.R., Molfino, B. & Shackleton, N.J., 1977, Global synchronity of Quaternary coccolith datum levels: Validation by oxygen isotopes, Geology, 5, 400-404.

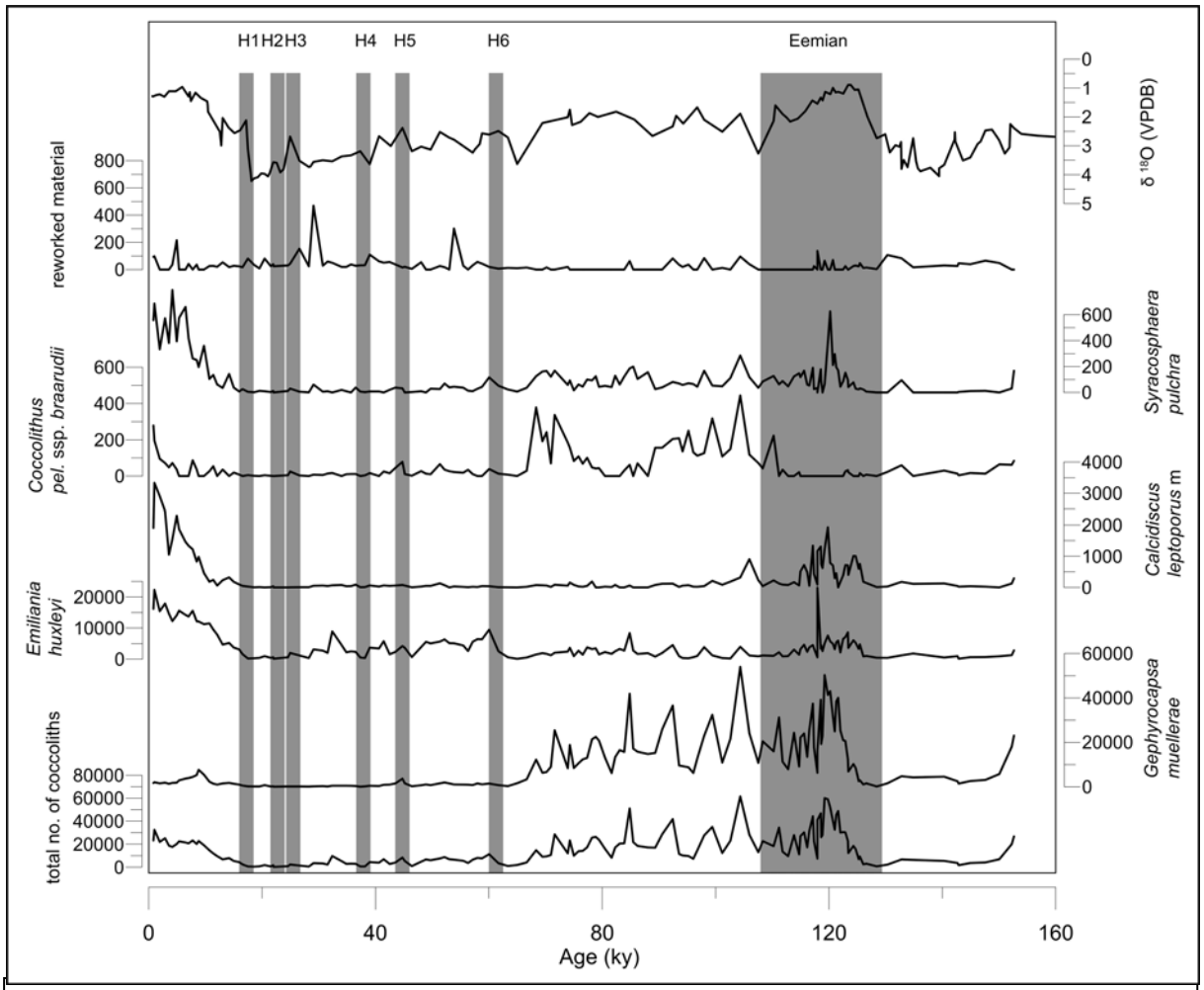


Fig. 1: Coccolith assemblages of ODP Leg 162 Site 980, the coccolith abundances are given as absolute contents *10^6/g Sediment; $\delta^{18}O$ values are taken from McManus et al. (2001).

Nannofloral Expansion during the Middle Miocene Transgression, Carpathian Foredeep, Czech Republic

Lilian Švábenická

Czech Geological Survey, Klárov 131/3. P.O.Box 85, Praha, CZ-118 21, Czech Republic
svab@cgu.cz

Classification of the Middle Miocene deposits in the western part of Central Paratethys, explicitly in the Carpathian Foredeep and adjacent area of Molasse Basin is under discussion for a long time. Specific development of these strata reflects an

important phase in the genesis of Neoalpine molasse in the Lower and Middle Miocene situated in the foreland of the Alpine-Carpathian front and on the SE slopes of North European Plate, Bohemian Massif.

Generally, subsequent nannofossil assemblages have been recognized in the Carpathian Foredeep, Czech Republic reflecting Middle Miocene transgression (Lower Badenian in regional stages of Central Paratethys):

- Rare, strongly damaged nannofossils. Reworked specimens reach up to 90%. The autochthonous component is represented by *Helicosphaera ampliaperta, H. carteri, Sphenolithus heteromorphus*, rare specimens of genera *Umbilicosphaera* and *Calcidiscus*, zone NN4, horizon with Helicosphaera ampliaperta (Švábenická 2002). Small placoliths of *Reticulofenestra* sp. are mostly absent. *Helicosphaera waltrans* is scarcely present in association with *H. ampliaperta* and evidences zone NN5, horizon with Helicosphaera waltrans (Ćorić and Švábenická 2004). Assemblage is usually found in intraclasts (product of the Lower Badenian transgression).
- Poor and poorly preserved nannofossils with *H. waltrans* accompanied by rare *H. ampliaperta* and sporadic *S. heteromorphus,* dominance of *Coccolithus pelagicus* (70–90%). Helicosphers form about 15-20 %, *Reticulofenestra minuta* and discoasters (including 5-rayed symmetrical specimens) are present on rare occasions. Miocene component varies between 25–40%, the rest is formed by reworked nannofossils.
- Nannofossils abundant, proportion of reworked specimens rapidly decreases and percentage of autochthonous component fluctuates between 70–95%. *H. waltrans* and rare *S. heteromorphus* occur continuously. *Helicosphaera walbersdorfensis* appears for the first time. *R. minuta* quantitatively prevails over *C. pelagicus*. Helicosphers form up to 20%, discoasters present occasionally. Interval with higher numbers of *Micrantholithus* sp. accompanied by *Braarudosphaera bigelowii* has been delimited.
- Nannofossils abundant with *H. walbersdorfensis, H. waltrans* absent. Alternately, higher numbers of *Discoaster exilis, Umbilicosphaera* sp., and dominance of *R. minuta* are observed. Higher up, oval specimens of *Coronocylclus nitescens* appear. Zone NN5, horizon with *Sphenolithus heteromorphus* (Švábenická 2002).

Rather problematic is the correlation with the Langhian stratotype section, Mediterranean (Fornaciari et al. 1997) because of the following phenomena: 1. joint occurrence of relative common *Helicosphaera waltrans* and *H. walbersdorfensis*, 2. first common occurrence of *H. walbersdorfensis* precedes appearance of foraminifer species *Orbulina suturalis* (Petrová and Švábenická in print). On the other hand this correlation corresponds with the results presented from the Roggendorf -1 borehole, Molasse Basin (Ćorić & Rögl 2004) where *H. waltrans* is mentioned together with *H. walbersdorfensis* whereas the first occurrence of foraminifers *Orbulina suturalis* and *Praeorbulina glomerosa circularis* in the overlying strata.

Nannofossil assemblages of zone NN6 have not been found here.

Shallow epicontinetal sea of normal salinity with nutrient supply is supported by coastal nannoflora with higher numbers of *R. minuta, C. pelagicus,,* and helicosphers. Low abundances of sphenoliths and scarce occurrence of discoasters in the strata above intraclasts may imply input of cool surface waters. The increasing percentage of *R. minuta* probably reflects deepening of depositional area.

Biostratigraphy and paleoecology of the Middle Miocene (Lower Badenian) sediments of Carpathian Foredeep is under the study of project “Evaluation of sediments

on the Karpatian-Badenian boundary in the southern part of the Carpathian Foredeep" supported by the Grant Agency of the Czech Republic (No. 205/04/2142).

References

Ćorić S., Rögl F. 2004: Roggendorf-1 borehole, a key-section for Lower Badenian transgressions and the stratigraphic position of the Grund Formation (Molasse Basin, Lower Austria). *Geol. Carpathica* 55, 2, 165–178.

Ćorić S., Švábenická L. 2004: Calcareous nannofossil biostratigraphy of the Grund Formation (Molasse Basin, Lower Austria). *Geol. Carpathica* 55, 2, 147–153.

Fornaciari E., Rio D., Ghibaudo G., Massari F., Iaccarino S. 1997: Calcareous plankton biostratigraphy of the Serravallian (Middle Miocene) stratotype section (Piedmont Tertiary Basin, NW Italy). *Mem. Sci. Geol*. 49, 127–144.

Petrová P., Švábenická L. (in print): Biostratigraphy and paleoecology of the Middle Miocene sediments in the Carpathian Foredeep, Czech Republic. *Geol. Carpathica.*

Švábenická L. 2002: Calcareous nannofossils of the Upper Karpatian and Lower Badenian deposits in the Carpathian Foredeep, Moravia (Czech Republic). *Geol. Carpathica* 53, 3, 197–210.

Nannofossil Biostratigraphy and Paleoecological Reconstruction of the Turonian-Santonian Interval at ODP Site 1261 (Leg 207): Preliminary Results

Paola Tamagnini

Dipartimento di Scienze della Terra "Ardito Desio", via Mangiagalli 34, 20133 Milano, Italy.
paola.tamagnini@unimi.it

During ODP Leg 207 five sites were drilled on the northern margin of Demerara Rise in a depth transect from 3200 to 1900 meters below sea level (modern water depth). They recovered multiple sequences of Cenomanian-Turonian black shales, Campanian-Maastrichtian chalk, and Paleocene to lower-middle Eocene chalk. Site 1261 is located in a water depth of 1899 mbsl on the dipping northwest-facing slope of Demerara Rise and it's the shallowest site of the depth transect. Sediments document a 370 m-thick sequence of Pleistocene-late Miocene sediments overlying 300 m of middle Eocene-Cenomanian marine deposits that generally contain calcareous nannofossils.
I have studied nannofossil assemblages in the Turonian-Santonian interval, consisting of 45 m of black shales (claystones with abundant organic matter) as dominant lithology, and few levels of clayey limestone and chalk.

A total of 153 samples were prepared following two different methodologies aimed at semiquantitative ananlyses for biostratigraphy (simple smear slides) and quantitatitative analyses for estimates of paleofluxes (settling boxes). All slides were studied under a light microscope with a magnification of 1250X. In the first phase, dissolution and overgrowth were carefully checked to , eventually, eliminate samples with poor preservation from the sample-set for quantitative investigation. The absolute abundance of total nannofloras and of individual taxa were calculated using counts of at least 300 specimens in each slide and adopting the mathematic formula for settling slides (Geisen 1999).

The occurrence of marker species allowed to attribute the studied interval to the NC14 through NC17* zones (Bralower 1995) of Late Turonian to Early Santonian age. Preservation and abundance of coccoliths change frequently, from poor to moderate and from common to abundant, respectively.

Nannofossil abundance starts to increase just at the base of the studied interval, showing an interval of high values between 602 and 596 mbsf (in the lower part of the NC14 zone); this interval is also underlined by higher abundance of several taxa reflecting an increase in the amount of nannoflora. The abundance decreases upward until the depth of 585 mbsf (upper part of NC14); a second increase follows this interval and underlines the final part of NC14 and the lower NC15 biozones (583 mbsf).

Comparison of relative and absolute abundances shows some differences; the most evident one is about the curve of *E. floralis*. While the absolute abundance of the taxon shows only one positive peak (602.4 mbsf), the relative abundance presents three different peaks (at 602.4; 597.4; 588.4 mbsf). It's important to note the scale of these fluctuations: for absolute abundances values change from 0.2E+05 to 2E+05 (n° of nannofossils/1g of sediment), while the relative abundance increases from 2% to 4%. The relative abundance of *B. constans* seems to decrease from the depth of 604.4 until 593.4 mbsf, but the absolute abundance doesn't show decreased values. A Temperature Index (TI) is calculated using the ratio between cool temperature-related taxa and warm temperature-related ones (Herrle 2002). It is generally low indicating warm surface temperature, but there is an interval of high values corresponding to a cooling episode correlative with the "high abundance zone" between 602 and 596 mbsf

Cool temperature-related taxa, such as *E. floralis*, *T. stradneri* and *T.orionatus* show different behaviours: an abundance peak is detected by *E. floralis* at 602.4 mbsf, while other taxa present high abundance between 605 and 597 mbsf. *T. orionatus* and *T. stradneri* also detect other two peaks in the upper part of the section (at 585 and 583 mbsf).

The warm temperature-related taxon *Z. diplogrammus* seems to be more abundant in the upper part of the section, while *R. splendens* is abundant in the lower part ("high abundance zone").

Also fertility-related species, like *B. constans* and *Z. erectus*, show high abundance between 602 and 596 mbsf and in the upper part of the section (585-583 mbsf). The Fertility Index (FI), calculated as the ratio between high fertility-related taxa and low fertility-related ones, underline these two mesotrophic episodes.
FI and TI seem to be correlated: in general higher fertility conditions correlate with cooler temperature.

The Turonian is characterized by climatic fluctuations: a long term temperature rise, starting in the Cenomanian and reaching maximum in the late Turonian. , is interrupted by short cooling episodes, such as in the middle-upper Turonian (Voigt & Wiese, 2000; Voigt et al 2004).The interval of higher values in the Temperature Index and the *E. floralis* abundance peak, recovered in the studied section, are correlatable with this cooling episode.

References

Bralower, T.J.; Leckie, R.M.; Sliter, W.V.; Thierstein, H.R.; 1995. "An integrated cretaceous microfossils biostratigraphy". *SEPM Special Publication 54,* 65-79.

Gale, A.S.; Smith, A.B.; Monks, N.E.A.; Yung, J.A.; Howard, A.; Wray, D.S.; Hugget, J.M.; 2000. "Marine biodiversity through the Late Cenomanian-Earlty Turonian: Palaeoceanographic controls and sequence stratigraphic biases". *Journ. Geol. Soc. London* ,157, 745-757.

Geisen, M. et al., 1999. "Calibration of the random settling technique for calculation of absolute abundances of calcareous nannoplankton". *Micropal. 45*, 437-442.

Herrle, J. O.; 2002. "Paleoceanographic and paleoclimatic implication on Mid- Cretaceous black shale formation in the Vocontian Basin and the Atlantic: evidence from Calcareous Nannofossils and Stable Isotopes". *Mikropalaontog. Mitteilungen* ,27, pp 114.

Lamolda, M.A.; Gorostidi, A.; Paul, C.R.C.; 1994. "Quantitative estimates of calcareous nannofossil changes across the Plenus Marls (latest Cenomanian), Dover, England: implication for the generation of the Cenomanian-Turonian Boundary Event". *Cret. Res*. ,14, 547-550.

Paul, C. R. C.; Lamolda, M. A.; Mitchell, S. F.; Vaziri, M. R.; Gorostidi, A.; Marshall J. D.; 1999. "The Cenomanian-Turonian boundary at Eastburne (Sussex, UK): a proposed European referente section". *Palaeogeogr., Palaeoclimatol., Palaeoecol*. 150, 83-121.

Voigt, S. & Wiese, F.; 2000. "Evidence for Late Cretaceous (Late Turonian) climate cooling from oxygen-isotope variations and palaeobiogeographic changes in Western and Central Europe". *Journ. Geol. Soc. London*, 157, 737-743.

Voigt, S.; Gale, A. S.; Flöger, S.; 2004. "Mildlatitude shelf seas in the Cenomanian_Turonian greenhose world: Temparature evolution and North Atlantic circulation". *Paleoceanography*, 19, PA4020.

Calcareous Nannofossil Biostratigraphy and Stable Isotope Stratigraphy (C and O) from the Middle Slope, Quaternary of the Northern Campos Basin, Brazil

Lucio Riogi Tokutake

PETROBRAS/UN-ES/ATEX/SE, P O Box 19010,Vitória-ES, Brazil 29075-973
tokutake@petrobras.com.br

The northern Campos Basin, in the south coast of Espírito Santo state, is almost unknown , especially in terms of the Quaternary in deep water. Two cores from the middle slope were chosen for study in this area. Samples were collected from these cores for calcareous nannofossil biostratigraphy and stable isotope stratigraphy (Carbon and Oxygen). Calcareous Nannofossils results shows an absolute predominance of *Emiliania huxleyi* and *Gephyrocapsa* spp. Stable Isotope Stratigraphy reveals an excellent correlation with models, allowing a good comparison with the oxygen isotopic stages (fig.1). The correlation between *E. huxleyi* relative abundance and $\delta^{18}O$ indicates paleotemperature affected the taxa abunndance (fig.1).

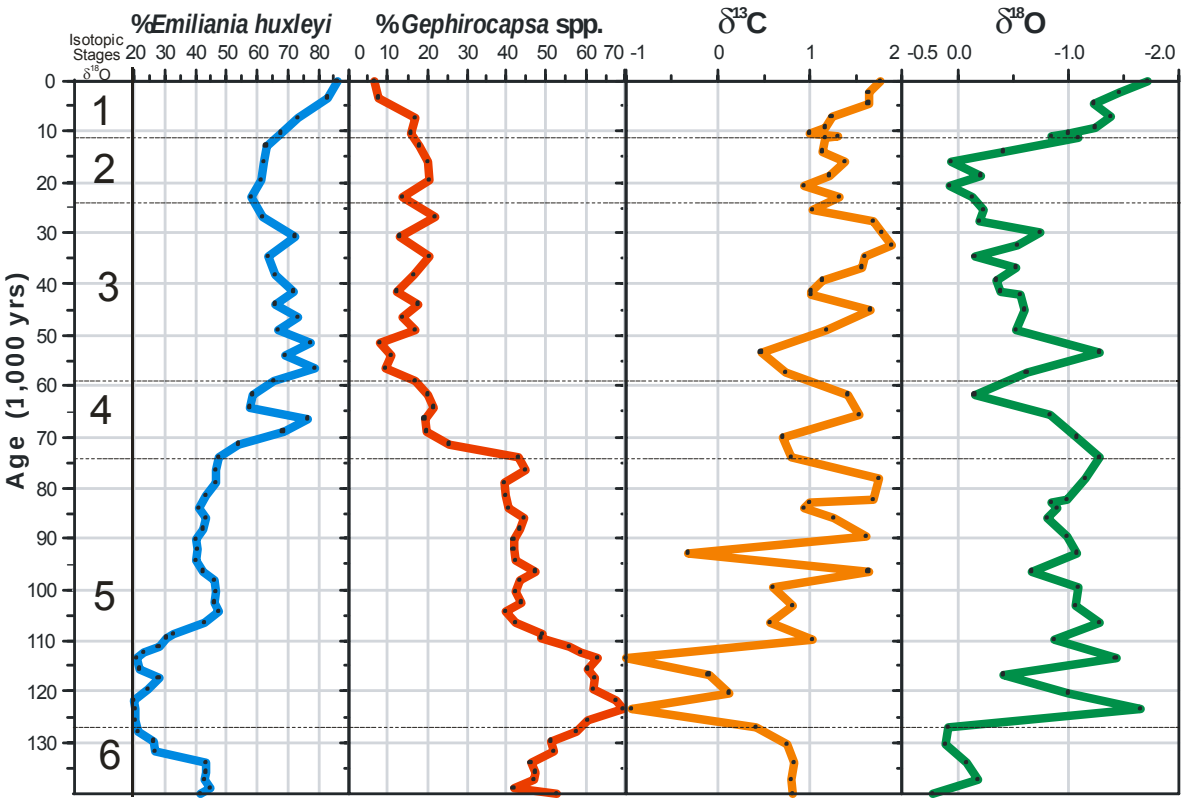


Fig.1 Comparison among % of E.huxleyi, Gephyrocapsa spp. and Isotopic reason of C_{13} O_{18}.

The carbon stable isotope stratigraphy shows a good correlation with abundance variations of the genus *Gephyrocapsa*. Both indicate variations of nutrients availability. It is possible to conclude that periods of eutrophy and oligotrophy occurred in that area, caused by the import of continental nutrient-rich sediment. It is possible to suppose that the Itabapoana Turbiditic System, which is now inactive, fed the area with continental nutrients in the past.

As this study is limited in area, it was not possible to confirm is the *Emiliania huxleyi* acme base delay is a regional event, or if is a local effect of continental nutrients carried by the Itabapoana Turbiditic System, which allowed the *Gephyrocapsa* abundance to be continued for a while in this area.

Evidence of Productivity Changes in the Western South Atlantic during the Last 20 kyr

Felip Toledo, Karen Badaraco Costa, Maria Gomez Pivel, & Juliana Quadros

Paleoceanography Laboratory of South Atlantic (LaPAS)-Oceanographic Institute of University of São Paulo, Praça do Oceanográfico, 191. Cidade Universitária. São Paulo/SP - Cep: 05508-120 - Brazil

felipe.toledo@io.usp.br

Stable isotope and planktonic foraminifera analyses of three cores taken along the Brazilian continental margin (between 21°S and 28°S) showed that during the last 20kyr the major oceanographic changes in this area occurred in the time interval between 8 and 13 kyr. Glacial sea surface temperature (SST) estimates agree with those from CLIMAP, suggesting low to moderate cooling during the Last Glacial Maximum. However, the three cores analyzed suggest a greater cooling for the 8-13kyr period, so the SST contrast between the Holocene and the 8-13kyr time interval was the largest for the last 20kyr.

In this study we present the distribution and latitudinal gradient of calcareous nannofossils for the last 20kyr along the Brazilian continental margin. The species were divided in three groups according to the Okada triangular diagram (Okada, 1992) adapted for this region (Toledo *et al*., 2005). The three groups are (1) *Florisphaera profunda*, (2) *Gephyrocapsas* + *Emiliania huxleyi*, and (3) all the remaining species. The plotting of the relative abundances of these three groups suggests a strong latitudinal control on the species distribution in the southwestern Atlantic (Fig. 1).

The species *Florisphaera profunda* presented a homogenous relative abundance distribution both during the Holocene and the LGM, but with much larger relative abundances during the Holocene. During the 8-13kyr interval the relative distribution is not homogeneous showing a peak in the northern area and low relative abundances to the south. In general terms, the group composed by *Gephyrocapsa* + *Emiliania huxleyi*, presents an opposite trend compared to *Florisphaera profunda*, with largest relative abundances during the LGM and lowest during the Holocene. The relative abundance of this group during the 8-13kyr interval closely resembles the LGM conditions, although with an even larger relative abundance during 8-13kyr period. The remaining species never exceeded 15% of the total nannofossil assemblages. The largest relative abundances of this group occurred in the central area (~24.5 °S) during the Holocene and mainly during the interval between 8-13kyr. During the LGM the largest abundances of these species were located farther north.

The results obtained here suggest that the observed changes in the stable isotopic composition and in the faunal changes of planktonic foraminifera are strongly related to productivity changes. The wind regime seems to have a crucial role in the observed changes, supplying either nutrient rich waters from the south or depleted waters from the north. A decrease in the strength of the SE trade winds would slowdown the South Equatorial Current (SEC) and consequently, the divergence and supply of nutrients for primry production in the euphotic zone. A strengthening of the NE trade winds and the winds from the west would intensify the flux from the convergence zone and consequently would intensify the flux from the convergence zone and thus, the supply of nutrients in the subtropical gyre.

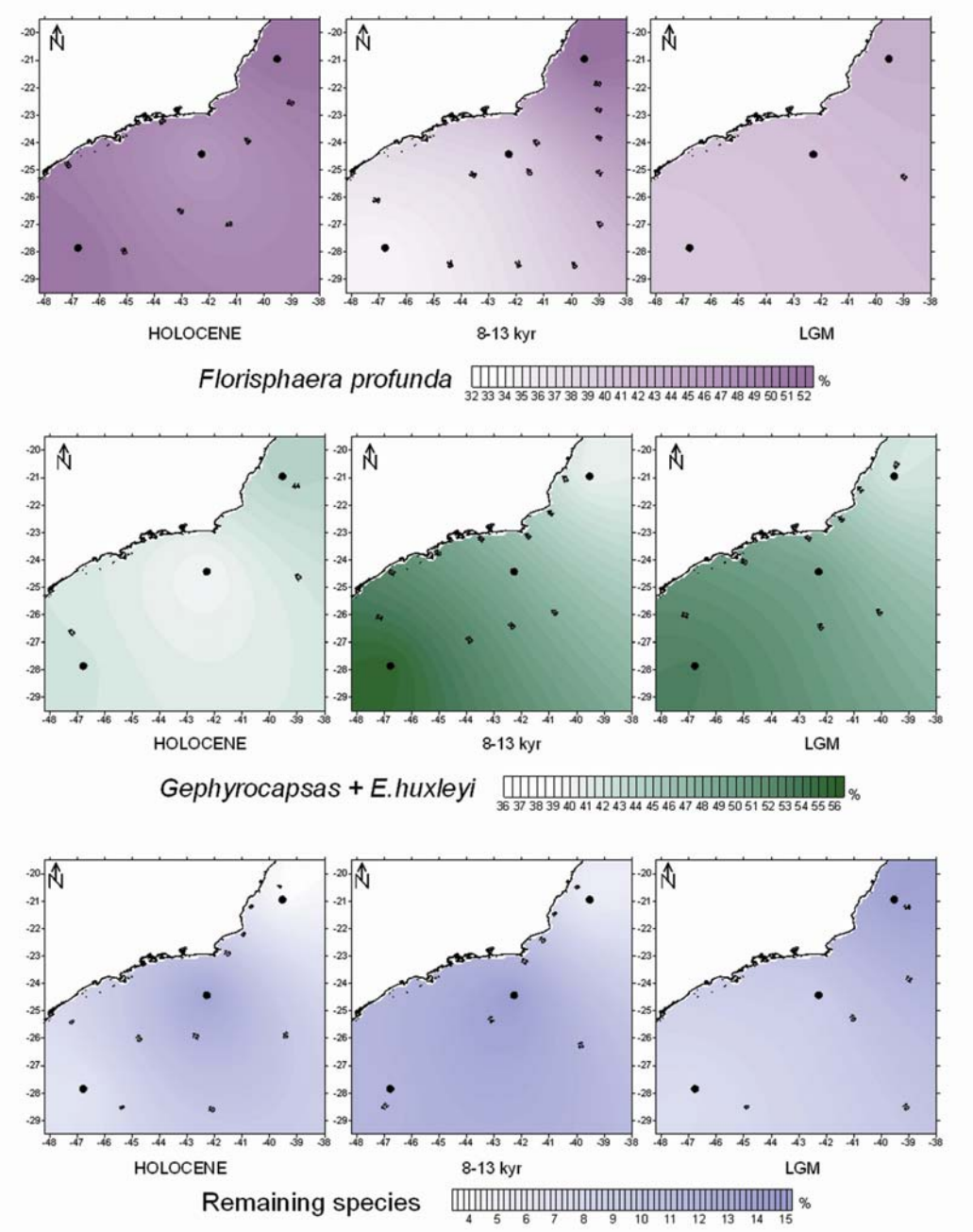


Figure 1. Relative abundances of calcareous nannofossils for the Holocene (left), the 8-13kyr period (middle) and the LGM (right) for the three groups of calcareous nannofossils as defined by Okada's triangular diagram modified for this region (Toledo *et al*., 2005).

References

Okada, H., 1992. Biogeographic control of modern nannofossil assemblages in surface sediments of Ise Bay, Mikawa Bay e Kumano-Nada, off coast of central Japan. Memorie Di Scienze Geologiche, 43: 431-449.

Toledo, F. A. L.; Juliana P. de Quadros; Edmundo Camillo Jr and Karen B. Costa., 2005. Análise Paleoambiental em Estudos Quantitativos de Nanofósseis Calcários: Aplicação do Diagrama Triangular de Coordenadas para o Sudoeste do Oceano Atlântico. Associação Brasileira de Estudos do Quaternário – ABEQUA, Guarapari, ES.

Calcareous Nannofossil and Planktonic Foraminiferal Assemblages and Paleoecological Reconstruction of Sapropel S1 in Southeast Aegean Sea

Maria V. Triantaphyllou[1], Assimina Antonarakou[1], George Kontakiotis[1], Margarita Dimiza[1], Patrizia Ziveri[2], Graham Mortyn[2], Alexandra Gogou[3], Vasilios Lykousis[4], Michael D. Dermitzakis[1]

[1]University of Athens, Faculty of Geology & Geoenvironment, Dept. of Hist. Geology-Paleontology, Panepistimiopolis 15784, Athens, Greece,
[2] ICTA Autonomous University of Barcelona (UAB) Edifici Cno-Campus UAB, 08193, Bellaterra, Spain
[3] University of the Aegean, Dept. of Marine Sciences, 81100 Lesvos, Greece
[4] Hellenic Centre for Marine Research, Inst. of Oceanography, 19013 Anavyssos, Greece
mtriant@geol.uoa.gr

Calcareous nannofossil and planktonic foraminiferal assemblages of two gravity cores, NS-14 and NS-40, were investigated and correlated. Both cores are located in the vicinity of Nisyros Island in SE Aegean Sea. Stratigraphic framework was based on radiocarbon dating. Additionally Z2 Santorini tephra layer and sapropel S1are both well represented. An interruption in S1 sapropelic sequence has been observed in both cores. Marine biogeochemical conditions and SSTs derived from alkenones, are well determined in core NS-14 (Triantaphyllou et al. 2006).

Warm and stratified conditions during S1a are characterized by high abundances of calcareous nannofossil *Florisphaera profunda* and planktonic foraminifer *Globigerinoides ruber* especially the *rosea* variety, suggesting the presence of a deep chlorophyll maximum (DCM). Towards the upper part of S1b the decrease of *F.profunda* followed by increase of *Braarudosphaera bigelowii* and *Globigerinoides trilobus-sacculiferus* imply severe reduction of stratification caused by great influx of less saline waters, most probably from the Black Sea. Above S1, at approximately 5-5.5 kyrsBP, calcareous nannofossils suggest an increase in productivity. A similar time interval of highly productive waters is observed just above the Santorini tephra layer.
The combined faunal and floral signals allow the refinement for the Aegean Sea area of the ecozonal scheme of Principato et al. (2003), during the last 9000 $BP_{nc.}$

References

Principato, M., Giunta, S., Corselli, C., Negri, A., 2003. Late Pleistocene-Holocene planktonik assemblages in three box-cores from the Mediterranean Ridge area (west-southwest of Crete): paleoecological and palaeoceanographic reconstruction of sapropel S1 interval. *Palaeogeogr. Palaeoclimatol. Palaeoecol*. 190, 61-77.

Triantaphyllou, M. V., Gogou, A., Lykousis, V., Bouloubassi, I., Ziveri, P., Rosell-Mele, A., Kouli, K., Dimiza, M., Papanikolaou, M., Gaitani, P., Katsouras, G., Dermitzakis, M.D., 2006. Primary production trends and response of terrestrial environments in SE Aegean core NS-14. A multiproxy approach. European Geosciences Union, Vienna, 2-7 April 2006.

Relation of Living Deformed *Distephanus speculum* (Silicoflagellate) and Environmental Indices in Southern Ocean

Hideto Tsutsui[1], Shiro Nishida[1], & Niichi Nishiwaki[2]

[1] Laboratory of Nannoplankton Technologies, 485-1-205, Takabatake, Nara City, Nara, 630-8301, JAPAN
[2] Nara University, 1500 Misasagicho, Nara City, Nara, 631-8502, JAPAN
blacksand@mail.goo.ne.jp

Distephanus speculum (Silicoflagellates) and its peculiar forms abundance are well known in the Southern Ocean. We observed 876 peculiar forms of *D. speculum*. As the result, the both forms' distribution and environmental indices suggests similar correlation patterns. Almost peculiar types are deformed at one or two side in basal ring and spine. The correlation patterns of major four peculiar forms and environmental indices are almost similar. Probably, deformed *Distephanus* occurs reproduction ratio of normal form, and two-temperature band: above 10 degree or below 5 degree while satisfies PO_4 and NO_3.

Silicoflagellates is classified unicellular marine phytoplankton of Eukaryota, and they have very simple and unique skeleton. Fig. 2 is the ideal skeletal form of *D.speculum*. Their reproduction system is asexual and 2-division schizogenesis. The parent and daughter skeleton is mirror image (Boney, 1973). However, McCartney (1987) suggests the possibility of sexual reproduction, their reproduction system does not understand well. Bohaty and Harwood (1998) recover paleo-temperature with fossil Silicoflagellates in Southern Ocean.

The appearances of peculiar forms are known (Kawabata and Nishida, 1992), but its fine details do not understand well. Therefore, we observed peculiar forms of *D.speculum* in shallow water than 150m depths in Southern Ocean (Fig. 1).

The appearance/abundance occasion for peculiar form does not understand well: 1) its distribution and relation of normal form, 2) relation to environmental indices including normal form, and 3) statistical characteristics and its trend.
However, there are many problems from observation work to statistics conversion, because its form suggests many variations and it is difficult to get common indices.

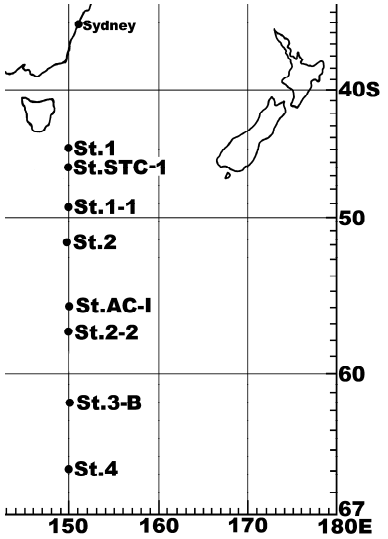
Therefore, we developed the original image conversion system for effectively observation. Peculiar form draw limited graphic area as CG image manually, but the numerical conversion is automatically. The observing specimens keep following conditions: 1) Basic skeletal parts lose or deform, or it has surplus structures. 2) It satisfies partially or fully basic skeletal part. 3) Observing form has overlap part/point including length to normal form, and 4) It is a skeleton while reproduction phase. Nishida (1985) collected Silicoflagellate specimens in this study area. Nemoto and Terazaki (1985) described some nutrition and other environmental indices in the same area.

Finally, we got 876 deforms. At first, 1) Error form counted every skeletal part, and 2) normal and peculiar forms collate its distribution. As the result, almost error occurs in basal ring and spine (Fig. 3). Fig. 4 is the correlation with deformed form and normal forms and environmental indices, but both forms suggest almost same patterns.

The correlation patterns of deformed/normal population and environmental indices are almost same. Therefore, the major 4 deformed forms (total 361 individuals)

compared with environmental indices as correlation profiles. As the result, 1) correlation profiles suggest same tendencies in spite of its type. 2) All type suggests weakly trends: the positive indices are Si, PO_4 and NO_3. Negatives are temperature and dissolved gas (delta s, t).

Probably, there is appearance possibility of deformed in basal ring and spine under following conditions: 1) Water temperature is above 10 degree centigrade or below 5 degree. 2) PO_4 is above about 1.5uM (micro Mol), NO_3 is above about 15uM, and Si is above 5uM, and 3) Dissolved gas density is above about $10^8 m^3\ k\ g^{-1}$.



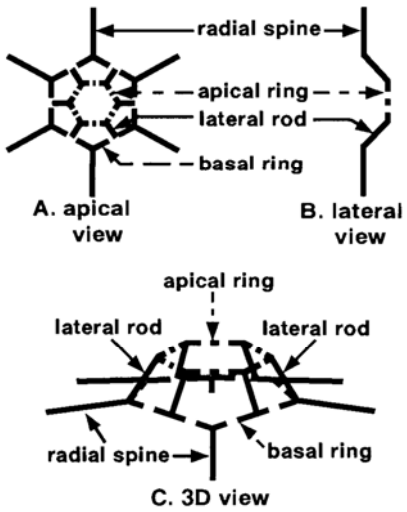
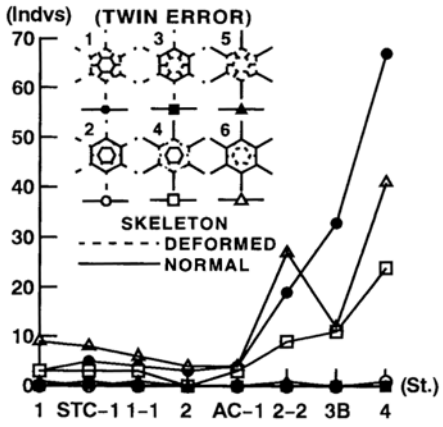


Fig. 1. Sampling stations of deformed specimens. Fig. 2. Ideal normal form of *D.speculum*, and its skeletal terminology. A: apical view, B: lateral view, C: 3D view. All sampling stations are along the Lat.150E.



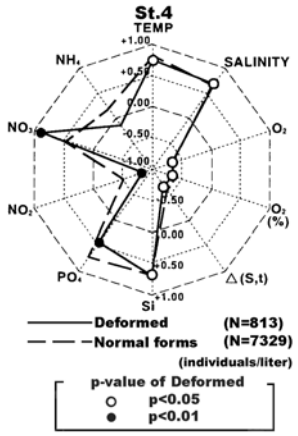


Fig. 3. Skeletal error counts at each sampling station.
Fig. 4. Radar chart of correlation with population of (1) to (6) corresponds to each error type. The solid line shows both forms and environmental indices at St. 4. normal and the broken line shows deformed (lost or modified) Solid line is deformed specimen, and broken line is parts. The horizontal axis is sampling station, and the vertical normal form. Number of individuals is adjusted for the axis is the number of individuals. value in a unit water volume (1 liter).

Tappan (1980) suggests that Genus *Distephanus* appeared Eocene. Probably, Silicoflagellates at that point were also influenced by rapid environmental transition like other life. As the result, they challenged reconstruction their form while rapidly reproduction and abundance. Finally, Genus *Distephanus* appeared as stable form at that point. That is, recent living *Distephanus* have possibility morphological transition and it is still proceeding, the deformed variations in this study suggest the minor transition of intra-species level.

References:

Bohaty S. and Harwood, D., 1998. Southern Ocean Pliocene paleotemperature variation from high-resolution silicoflagellate biostratigraphy. Marine Micropaleontology, 33:241-272.

Boney, A.D., 1973. Observations on the silicoflagellate *Dictyocha speculum* Ehrenb. Double skeletons and mirror-images. Mar.biol.ass.U.K.,56:263-266.

Kawabata, Y., and Nishida,S., 1992. Silicoflagellate flora in the Southern Ocean, with special emphasis on the skeleton morphology. INA newsletter 14 (3), p.92.

McCartney, K.,1987. Silicoflagellates, Ebridians, and Archaeomonads. In: Broadhead, T.W.(Ed.), Fossil Prokaryotes and Protists: Notes for a Short Course. University of Tenessee, Study of Geology 18,146-168.

Nemoto, T.,and Terazaki, M.,1985. Preliminary Report of The Hakuho-Maru Cruise KH83-4 (BIOMASS) Nov.,22, 1983-Feb., 24, 1984, The Southern Ocean and The Antarctica Sea. Ocean Research Institute, University of Tokyo, 85 pp.

Nishida, S., 1985. Taxonomy and ecology of nannoplankton. Preliminary Report of The Hakuho-Maru Cruise KH83-4(BIOMASS) Nov., 22, 1983-Feb., 24, 1984, The Southern Ocean and The Antarctica Sea. Ocean Research Institute,University of Tokyo, 37-38.

Tappan, H.,1980.The paleontology of plant protists. W.H.Freeman and Company, San Francisco, 1028

Middle-Late Eocene Environmental Changes and Biomagnetochronology as recognized by Calcareous Nannofossils at Kerguelen Plateau, Site 738

Giuliana Villa[1], Davide Persico[1], Fabio Florindo[2], Silvia Palandri[3], & Luigi Jovane[2]

[1] Dipartimento di Scienze della Terra, Università di Parma, Parco Area delle Scienze 157 - 43100 Parma, Italy.

[2] Istituto Nazionale di Geofisica e Vulcanologia, Via di Vigna Murata, 605 – 00143 Roma, Italy.

[3] Dipartimento di Scienze della Terra, Università di Pisa, Via S.Maria, 53 – 56121 Pisa, Italy.

giuliana.villa@unipr.it

ODP Site 738, which is located on the southern tip of the Kerguelen Plateau, is a critical site from the Southern Ocean for both stratigraphic and paleoclimatic studies. Hole 738B spans the entire Eocene, with particularly good core recovery (~97%) in the upper middle to upper Eocene.

Numerous studies have investigated the “greenhouse” to “icehouse” transition at this site using a variety of techniques, including clay mineral assemblages, stable isotopes, and microfossil assemblages, but a detailed calcareous nannofossil biostratigraphy and a reliable polarity stratigraphy are not currently available for the middle and late Eocene section in Hole 738B.

Problems were encountered during the initial shipboard work, and subsequent paleomagnetic work was not carried out. Given the importance of this site, we carried out a new calcareous nannofossils and paleomagnetic studies of middle and upper Eocene cores from Hole 738B.
Here we present:

- A detailed biostratigraphy, obtained through quantitative analysis, which allowed to identify the following bioevents in stratigraphic order: First Occurrence (FO) of *Reticulofenestra reticulata*, Last Occurrence (LO) of *Chiasmolithus solitus*, FO of *Chiasmolithus oamaruensis*, FO of *Dictyococcites bisectus*, LO of *R. reticulata*, FO of *Isthmolithus recurvus*, FO of *Reticulofenestra oamaruensis*, LO of *C. oamaruensis* and LO of *R. oamaruensis*. Biostratigraphic data underline the presence of hiatus coincident to *Discoaster saipanensis* Zone, in the middle Eocene, between about 37 and 40.4 Ma, which was recognized in others high latitude sites, then probably present at regional scale.
- A middle-upper Eocene magnetostratigraphic interpretation for Hole 738B, which is mainly constrained by new quantitative analyses of calcareous nannofossil assemblages.
- Preliminary analyses of variations in composition, concentration and grain-size of magnetic minerals throughout the sequence.

These results, permitted to identify selected taxa as indicators of sea surface temperature and nutrient changes through. the late middle Eocene to late Eocene interval in the Southern Ocean and compare them with the paleoecological results of Persico and Villa (2004) for this time interval. Also a detailed calibration of the biostratigraphic datums in the late middle Eocene interval allowed to recognize, within a reliable magnetostratigraphic framework, the paleoclimatic events. Environmental magnetic studies through the late middle Eocene to the late Eocene interval allowed to identify pulses in the flux of magnetic minerals to this site and their possible implications for Antarctic glacial history

References:

Persico D. and Villa G., 2004 Eocene-Oligocene calcareous nannofossils from Maud Rise and Kerguelen Plateau (Antarctica): paleoecological and paleoceanographic implications. *Mar. Micropaleontol.* 52, 1-4, 153-179.

Lower Cretaceous (Aptian-Albian) Calcareous Nannofossil Assemblages from the Southern Apuseni Mountains, Romania

Ana-Maria Vulc, Carmen Chira, & Alin Igriţan

Babeş-Bolyai University, Faculty of Biology and Geology, Department of Geology, 1 Kogălniceanu St., Cluj-Napoca, 400084, Romania
miana78@yahoo.co.uk

The aim of this study was to investigate the calcareous nannofossils assemblages from some representative profiles in the Lower Cretaceous deposits from the Southern

Apuseni Mountains, Romania. These assemblages are especially of Aptian–Albian age. The study improves the knowledge on the biostratigraphy of this region.

The Lower Cretaceous nannofossils from Romania have been investigated by Melinte (in Avram & Melinte 1998), in sites from the Carpathian flysch, Svinita, Resita and South Dobrogea areas. The presence of both Tethyan and Boreal species is worth to mention. The Berriasian–Valanginian nannofossils assemblages from the Romanian Carpathians and the Moesian Platform (Melinte, 1997) proved also the presence of cosmopolitan, tethysian and boreal taxa.

The following Lower Cretaceous lithostratigraphical units belong to the Austrian Transylvanides: Izvoarele Nappe, Fenes Nappe (comprising Fenes Formation, Valea Dosului Formation, and Metes Formation) and Cabesti nappe (comprising Cabesti Formation and Dumesti Formation). The Laramian Transylvanides contain the Cris Nappe (Ciuruleasa Formation, Valea Povernei Formation, and Soharu Formation). Among these, especially the Metes Formation and the Soharu Formation have been investigated. The Metes Formation has a typical wildflysch nature and is represented by sandstones, marls and clays. The Soharu Formation is also a flysch represented by sandstones, clays and conglomerates.

For the Metes Formation, the most representative profiles are located along the Metes and Fantanele Valleys (Chira et al., 2004). The assemblages contain: *Hayesites irregularis, Nannoconus steinmannii, N. pseudoseptentrionalis, Rotelapillus laffittei, Braarudosphaera stenorhetha, Prediscosphaera columnata, Conusphaera mexicana, Watznaueria barnesae, Prediscosphera columnata, Effellithus turriseiffelii, E. windii, Retecapsa crenulata, Zeugrhabdotus elegans, Z. diplogrammus, Z. scutula, Biscutum constans, Diazomatolithus lehmanii,* a.o. These assemblages, after Sissingh (1977) belong to the *Chiastozygus litterarius* (CC7), *Prediscosphera columnata* (CC8), and *Effellithus turriseiffelii* (CC9) Zones, which indicate an Aptian - Albian age.

The calcareous nannofossils assemblages from the Soharu Formation (Cerbu and Buninginea valleys) contain: *Watznaueria barnesae, W. britannica, W. fossacincta, W. ovata, Retecapsa surirella, Nannoconus steinmannii, N. inornatus*, *N. pseudoseptentrionalis, Eprolithus floralis, Hayesites irregularis, Zeugrhabdotus elegans, Z. diplogrammus, Diazomatolithus lehmanii, Pickelhaube furtiva,* a. o., assemblage, which corresponds to the *Chiastozygus litterarius* Zone (CC7), thus pointing to a Lower Aptian age of the corresponding deposits.

The investigated calcareous nannofossils lead us to the assignement of an Albian – Aptian age for the Metes Formation, and a Lower Aptian age for the Soharu Formation.

References:

Avram, E., Melinte, M. C., 1998: Barremian-Aptian boundary in the Dambovicioara area (Rumanian Carpathians). Zentralblatt fuer Geologie und Palaeontologie, Teil I, H. 11/12, p. 1117 – 1129, Stuttgart.

Chira, C., Balc, R., Vulc, A.-M., 2004: Cretaceous calcareous nannofossils from Ceru Bacainti area, Apuseni Mountains, Romania. Acta Palaeontologica Romaniae, v. 4, p. 89 – 96, Bucharest.

Melinte, M.C., 1997: Tethyan and boreal nannoflora around the Jurassic – Cretaceous boundary in Romania. Acta Palaeontologica Romaniae, v. 1, p. 234 – 240, Bucharest.

Sissingh, W., 1977: Biostratigraphy of Cretaceous calcareous nannoplankton. Geol. Mijnbouw, Den. Haag, 56, p. 37 – 65.

Timing of the Initiation of Antarctic Continental Glaciation based on Nannofossil Assemblages from Cores in the Ross Sea

David K. Watkins

Department of Geosciences, 214 Bessey Hall, University of Nebraska, Lincoln NE 68588-0340, USA
dwatkins1@unl.edu

Recent work on high resolution records of stable isotopes and carbonate sedimentation rates from the Pacific suggests a rapid (<200 ky) build-up of glacial ice in Antarctica occurred just subsequent to the Eocene-Oligocene boundary. This work is in harmony with recent climate modeling that suggests a rapid (ca. 40 ky) expansion of Antarctic ice from alpine growth centers to continental-scale glaciers that reached sea level. These studies suggest that no significant evidence of pre-Oligocene glaciation should be evident in the nearshore marine record of the Antarctic continent. Stratigraphic sequences from ice-proximal marine records in the Ross Sea, however, have been cited as prima facie evidence for substantial glacial calving at sea level throughout much of the Late Eocene. This discrepancy can be traced to the age assignment for the basal sequence in the CIROS-1 core in the McMurdo Sound region of the Ross Sea.

Re-examination of nannofossil assemblages from the CIROS-1 sequence indicates the high probability of reworking of the nannofossil assemblages that form the basis for magnetostratigraphic age framework. Nannofossils are very sparse throughout the sequence, with the richest sample yielding less than 120 specimens in a gravitationally-concentrated slide. Quantitative biostratigraphic analyses of nannofossil assemblage data from the CIROS-1 core indicate the presence of at least five distinct, and biostratigraphically exclusive, assemblages that occur intermixed through the section (out of predicted stratigraphic order). Re-evaluation of nannofossil data indicate an Early Oligocene age for the entire sequence, with reworked input from pre-existing Late Eocene, Middle Eocene, Paleocene, and Late Cretaceous sediments. The order of introduction of these reworked components suggests they represent a glacial unroofing sequence of a nearby coastal plain or embayment.

Calcareous Nannofossils from the Crow Creek Member (Pierre Shale): A Hypothesized Resuspension Event from the Late Cretaceous (Campanian) Western Interior Seaway

Ryan D. Weber & David K. Watkins

Department of Geosciences, University of Nebraska-Lincoln, 214 Bessy Hall, Lincoln, NE, 68588-0304
rweber7@gmail.com

The 1-3 m thick Crow Creek Member is a unique marl unit with rip-up clasts and a basal coarse layer in the Upper Cretaceous Pierre Shale in South Dakota and Nebraska. The Crow Creek Member was once thought to have been deposited by marine transgression on the eastern margin of the Western Interior Seaway. The discovery of distal impact

ejecta from the Manson impact within the Crow Creek Member, however, has suggested an impact-induced tsunami genesis. Recent investigation of core and outcrops along the Missouri River and tributaries reveals paleonotological evidence pertinent to an impact-induced sediment gravity flow hypothesis.

An upper Campanian autochthonous (*in situ*) nannofossil assemblage with a lower Campanian reworked nannofossil assemblage (presumably from the older Niobrara Chalk) occurs in the marl unit at most localities. The allochthonous assemblage decreases in abundance upward through the marl. This is more consistent with a gravitational settling depositional model rather than a marine transgression model. Marlstone chips in the basal coarse layer have nannofossil assemblage provenances from the underlying Gregory Member and Smokey Hill Member (Niobrara Chalk). The allochthonous assemblage decreases in abundance with greater distance from the Manson impact and the Sioux Ridge (a paleotopographic high). The non-uniform geographic distribution of the allochthonous assemblage suggests that reworking is linked to the Manson Impact. The autochthonous nannofossil assemblage within the Crow Creek marl does not exhibit any definitive paleoecologic trends, which does not support a transgression hypothesis.

These observations and the Crow Creek Member's fining upwards lithology, presence of distal impact ejecta, and coincidence with the Manson Impact suggest that it is an event deposit, involving some type of sediment gravity flow. While modern offshore impact-induced deposits are not well documented, the Crow Creek Member strongly resembles offshore tsunami deposits from the Holocene Mediterranean and submarine landslide deposits at the Cretaceous-Paleogene Boundary in the Gulf of Mexico.

Appendage -bearing Syracosphaeraceae - Function and Phylogeny

Jeremy R. Young[1], Karen Henriksen[2], & Markus Geisen[3]

[1]Palaeontology Department, The Natural History Museum, London, UK
[2]Maersk Oil, Copenhagen, Denmark
[3]Pelagic Ecosystem/Marine Bionics, Alfred Wegener Institute for Polar and Marine Research, Bremerhaven, Germany
j.young@nhm.ac.uk

The appendage bearing Syracosphaeraceae - *Ophiaster, Michaelsarsia* and *Calciopappus* are probably the most morphologically complex extant coccolithophores (Gaarder et al, 1954, Gaarder 1967, Manton & Oates 1975, 1983, Young et al. 2003). They have elongate appendages formed of highly modified asymmetric coccoliths which evidently represent extreme examples of modification of coccolith morphology for a specific function,. The nature of this function is still difficult to precisely identify in the absence of observation on live cells and particularly of cultures, however review of their morphology based on high resolution electron micrographs allows us to constrain the possible hypotheses. In particular we can show that: (1) The whorl coccoliths of *Michaelsarsia* and *Calciopappus* lie above rather than below the appendage coccoliths

and serve to hold the appendages in place. (2) In both *Calciopappus* and *Ophiaster* there are two different coccoosphere appearance modes - either with the appendages appressed to the body (wrapped around it in the case of *Ophiaster*) or with the appendages extended. (3) That in various other *Syracosphaera* species the exothecal coccoliths are produced in strings that appear homologous to the appendage coccoliths of *Michaelsarsia* and *Ophiaster*. These observations allow us to develop a number of hypotheses on the functional morphology and phylogeny of these extraordinary coccolithophores

References:

Gaarder, K.R., Markali, J. & Ramsfjell, E. 1954. Further observations on the coccolithophorid *Calciopappus caudatus*. *Avhandlinger utgitt av det Norske Videnskapsakademi i Oslo. Mat.-Naturvid. Klasse*, 1: 1-9.

Gaarder, K.R. 1967. Observations on the genus *Ophiaster* Gran (Coccolithineae). *Sarsia*, 29: 183-192.

Manton, I. & Oates, K. 1983. Nanoplankton from the Galapagos Islands: Two genera of spectacular coccolithophorids (*Ophiaster* and *Calciopappus*) with special emphasis on unmineralized periplast components. *Philosophical Transactions of the Royal Society of London (B)*, 300: 435-462.

Manton, I. & Oates, K. 1975. Fine-structural observations on *Papposphaera* Tangen from the Southern Hemisphere and on *Pappomonas* gen. nov. from South Africa and Greenland. *British Phycological Journal*, 10(1): 93-109.

Young, J.R., Geisen, M., Cros, L., Kleijne, A., Probert, I. & Ostergaard, J.B. 2003. A guide to extant coccolithophore taxonomy. *Journal of Nannoplankton Research, Special Issue*, 1: 1-132.

Gulf of Mexico Workshop

In the mid-1990's the Gulf Coast SEPM undertook an impressive project to document and illustrate the Cenozoic biostratigraphy used by industry in the Gulf of Mexico region. This project, dubbed "The Gulf of Mexico Taxonomic Equivalency Project," had the ambitious goal of producing a set of volumes that laid out complicated taxonomic concepts and jargon in order to allow geoscientists to successfully decipher and use paleo-reports from any local source. The intention was to obtain input from all the various industry groups, oil and gas companies, and consultants. Although the group working on foraminifera eventually succeeded in producing publications, the nanno group, despite holding a number of meetings, did not produce a coherent volume. Those who did not attend the meetings (foram workers) imagined that the participants argued bitterly and just could not agree. Nothing could be further from the truth: the discussions were cordial and informative. Most of us emerged with a better understanding of what taxa were being used, with great respect and warm feelings for our colleagues.

So, what happened? Why were the foram workers able to produce a publication while the nanno workers just had lively discussion? I think part of the answer is that although the foram workers had a complicated rat's nest of taxonomy to unravel, it was a mature rat's nest. The participants in the foram discussion had many decades of historical interaction. Though the terminology was complex, everyone used the same bugs.

Such was not the case with nannos. Our first meetings were gems of mutual revelation and discovery. We had different species concepts, species without formal names, and different ways of splitting useful taxa. Assumptions we had of what each other were up to were entirely at odds with actual practice. In order to produce a viable peer-reviewed publication, we needed species described, ranges documented, and much more discussion. Also, we weren't going to be able to just get permission to use some literature illustrations and say things like, "Oh yeah, I call that Discoaster 295."

There was also a cataclysm taking place in the oil industry. Those of us working for the oil companies found ourselves in the role of coordinators, not scientists. Drilling activity yo-yoed. In good times the consultants couldn't keep up with the work; in bad times they starved. Companies merged and customers were gained and lost. Bitter rivalries and hard feelings replaced those warm feelings of camaraderie we had during the meetings. . .

Now, nearly a decade has passed. The drilling has moved to deeper water. We're seeing more Paleogene and even some Mesozoic. In the '90s we worked around a biostratigraphic framework of forams. Now nannos are the dominant correlation tool. There are a lot fewer Majors in the business. Many smaller players rely exclusively on contractors for their biostratigraphy. Computers have provided us with tools to go beyond just using a few tops for correlation. My generation is turning grey; some of us are passing on.

The new generation has arrived. I think it's time we restart our dialog.

INA 11 Field Trip:
Western Interior Cretaceous Seaway

The field trip for INA 11 will feature visits to outcrops of the world famous Cretaceous rocks of Nebraska, including a stay overnight in cabins at Niobrara Nebraska State Park. The park supplies vistas of both the Niobrara Formation and the Missouri River, where Lewis and Clark passed by in their exploration of western America.

Some of the best-preserved Upper Cretaceous calcareous nannofossil assemblages in the world are located within a day's drive of Lincoln. The local sections contain more than 300 meters of Upper Cretaceous chalk and nannofossil marlstones with truly world class preservation. Formations highlighted during the field trips will include the Greenhorn Formation, the Niobrara Chalk, and the Pierre Shale, which all showcase the environment of deposition in the Western Interior Cretaceous Seaway.

The field trip will start with a tour through sections in northeastern Nebraska. Attendees will have a chance to view the Greenhorn Limestone which contains a complete section across the Cenomanian-Turonian boundary and preserves a detailed record of Oceanic Anoxic Event (OAE) 2. Correlative rocks to the west of Nebraska (Pueblo, Colorado) are a principle candidate for the Cenomanian-Turonian boundary stratotype. The nearby outcrops have had no tectonic disturbance and little overburden rock. As a result, they contain beautifully preserved nannofossil assemblages.

The Niobrara Chalk spans the Coniacian through lower Campanian with more than 200 meters of chalks and laminated marlstones. The excellent preservation and abundance of pelagic marine reptiles (mosasaurs, pleisiosaurs, giant turtles), pterosaurs, birds (the diving bird *Hesperornis*), fish (including the giant *Xiphactinus addax*), crinoids (*Uintacrinus*), and clams (including the 2-meter-wide *Platiceramus platinus*) have supplied the world's major natural history museums with some of their most impressive specimens. The calcareous nannofossils from the Niobrara are equally well-preserved, as can be seen in the excellent photo gallery of Mitch Covington at www.Bugware.com.

Participants will have a chance to explore three chalk members in the **Pierre Shale,** which includes nannofossils of **late Campanian to mid-Maastrichtian age**. The upper Campanian Gregory Member is dominated by Tethyan taxa, indicating the dominance of the oceanic connection with the south (Gulf of Mexico). The lower Maastrichtian Crow Creek Member is a chalk unit that was severely disturbed by a tsunami triggered by the impact of the nearby Manson bolide, as evidenced by its high content of shocked quartz and material (including nannofossils) reworked from older strata. The mid-Maastrichtian Mobridge Member contains only boreal assemblages of nannofossils, indicating the severing of the southern connection to the Gulf of Mexico and the complete dominance of the oceanic connection with the Arctic Ocean.

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"Underneath the prairie,
she felt the future stirring"

-Willa Cather