European Science Foundation

Standing Committee for Life, Earth and Environmental Sciences (LESC)

ESF LESC EXPLORATORY WORKSHOP

Evolution of carbonate Systems during the Oligocene-Miocene climatic Transition

- Scientific Report -

Postdam, Germany, 22-26 February 2005

Convened by:

Maria Mutti[1], Werner Piller[2] and Christian Betzler[3]

Scientific Coodination: Andrea Knoerich[1]

[1] Institut für Geowissenschaften, Potsdam University

[2] Institute for Geology and Palaeontology, University of Graz

[3] Geologisch-Palaeontologisches Institut, Universität Hamburg

February 2005

1. Executive Summary

Long-term, step-wise global cooling leads during the Cenozoic from a greenhouse to an icehouse Earth. The Oligocene and Miocene comprise the most important phases in this evolution. This workshop was designed to address the dynamic evolution of carbonate systems deposited during the Oligocene and Miocene in the context on climatic and earth surfaces process changes and to provide a forum for discussion, cooperation and expertise echange among the high number of European researchers active in this research field. The main disciplines represented at the workshop were carbonate sedimentology (outcrop and subsurface), paleontology (paleocology and taxonomy), seismic stratigraphy, paleoceanography (stable isotopes and elemental ratios), large data management, forward modelling.

The most important outcome of this workshop has been to bring together people with different expertises, but who work on interdependant topics, who would not normally attend the same conferences. Furthermore, meeting in a dedicated facilty for three full days also has helped to overcome many personal and cultural diffidences which have hindered communication in the past.

The specific contents of the presentations given at the workshop are summarized in section 4.2. The discussion has identified the following research lines for future activities, summarized in section 4.3: (1) recognizing sealevel changes in carbonate platforms, (2) integrating paleocological information into facies models, (3) use of terminology to describe the carbonates, (4) paleoenvironmental controls, (5) correlation tools.

Three major outcomes are foreseen as the direct result of this workshop :

(1) Preparation of a proposal for ESF for a programme to enable development /promotion of a culture of exchange and to ensure that regular meetings can take place.
(2) Publication of a book with articles presented at the workshop. This will be in the form of a Special Publication of IAS (International Association of Sedimentologists), published by Blackwell. The IAS Bureau has approved our proposal on the 24th of April 2005, and we will hope to send the articles to the publisher in approximately one year from now.
(3) The discussion of joint research initiatives that will lead to the preparation of projects to be sumbitted as joint, collaborative proposals with national agencies.

2. Scientific Content of the Wokshop

2.1. The Scientific Problem

Long-term, step-wise global cooling leads during the Cenozoic from a greenhouse to an icehouse Earth. The Oligocene and Miocene comprise the most important phases in this evolution. We wish to address the dynamic evolution of carbonate systems deposited during the Oligocene and Miocene in the context on climatic and earth surfaces process changes. A high number of European researchers are active in this research field, and this workshop shall provide a forum for discussion, cooperation and expertise echange and eventually lead to the development of a scientific programme for a European project on carbonate platform and climate variability during a major climatic transition.

Recent, major advances in the understanding and time-resolution of climate event taking place at this time, as well as the proliferation of studies on Oligocene and Miocene carbonate systems, invites us to reevaluate the significance of these carbonate systems in the context of changes in climate and earth surface processes. These changes can be traced by paleoecology and paleobiogeography of neritic and pelagic biota. Additionally, the skeletons of these biota represent archives for proxy data, such as stable isotopes. Stable isotopes can be used to trace steps of climate change and track associated changes in earth surface processes such as continental weathering and runoff, sea-level, current circulation patterns, and surface water temperatures. Carbonate systems, as has been demonstrated during the past decades, by widely depending on the ecological requirements of organisms producing the sediment are sensitive recorders of changes in environmental conditions on the earth surface.

Carbonate systems of this age are well exposed throughout the Mediterranean and the Middle East regions, as well as in the surface and subsurface of South East Asia, Australia and New Zealand and have been the object of many studies throughout the years. They carry economic relevance as many host signioficant amounts of hydrocarbons. The high number of previous studies, ranging from broad geological investigations to more specific aspects of sedimentology, stratigraphy and paleontogy, provide an excellent basis to develop synthesis for specific stratigraphic intervals for each region.

A major compilation at the Mediterranean scale published in 1996 (SEPM Concepts Books), mainly focused on reefal (scleratinian) carbonate systems, also brought attention to the existence of distinct systems referred to as “non-tropical or “cool” water carbonates. More recently, some debate has been generated regarding the nature of these carbonates, in terms of how tropical versus “cool-water” they are, or how much they record the effects of temperature changes versus nutrients or other environmental changes. This issue is of relevance with regard to how changes in carbonate facies can be related to the climatic changes specific to the time ineterval. To address this point, it is necessary “to put some order” into the spatial and temporal distribution of these carbonate systems, to develop maps for different time slices, and to recognize spatial changes with latitude as well as temporal changes associated to climatic evolution. Because different terminologies and study approaches in use hinder the possibility of a direct comparison of existing data, before such maps can be compiled, it is necessary to bring some order in the terminology used. Also, studies on neritic carbonates should be better compared to basinal, pelagic records, where complementary information on climate and oceanographic parameters is recorded.

An integrated compilation of existing case studies focused on specific geographical areas worldwide will also allow us to recognize patterns in the sedimentary facies distribution and develop diversified facies models for a range of carbonate systems ranging from reefal (scleratinian) to "different degrees" of non-tropical. Because different biotic and facies associations respond differently to sea-level chages, the differential response of these systems to sealevel changes should be better documented. This is particularly significant in the context of existing controversies regarding frequencies and amplitudies of sealevel fluctuations during this time interval.

2.2. Specific Workshop Goals

To achieve these goals, it was deemed necessary to bring together a number of people actively working in these research topics to provide a forum for discussion, cooperation and expertise exchange. Specific goals of this workshop will be to:

- coordinate the use of terminology used to describe the carbonates, to enable comparison of different areas and time slices
- integrate sound paleontological data
- develop facies maps using an integrated and coordinated terminology for different time slices and selected geographical areas and order case studies along "latitudinal transects"
- carbonate facies and frequency/amplitude of sealevel change
- integrate information from neritic with slope and pelagic records
- identify gaps in our knowledge of these systems both in space and time
- analyse the patterns emerging from these data compilation
- attempt a first correlation of patterns with climatic phases and tectonic events

The worshop will contribute to increase European collaboration and set the foundations for the development of future collaborative initiatives. Furthermore, it will outline the main questions and themes for a scientific programme for a European project on carbonate platform and climate variability during a major climatic transition.

3. Scientific Programme

Tuesday 22 February 2005

18:00-19:00	Registration at Kongress Hotel
19:00	Ice breaker with light dinner

Wednesday 23 February 2005

08:00 - 08:30	Registration
08:30 - 08:45	Welcome remarks, Overview of the Agenda and Workshop Motivations (Mutti, Piller, Betzler)
08:45 - 09:00	Overview of ESF structure and funding opportunities (Mutti, Piller, Betzler)
	Miocene platforms and climate
09:00 - 09:30	Miocene carbonate systems, global events (Mutti)
09:30 - 10:00	Late Oligocene through Miocene Paleotemperatures (K. Billups)
	coffee break and posters (10:00-11:00)
11:00 - 12:30	Miocene sea-level changes and platforms: Middle - Late Miocene Sea-Level Changes: Frequencies and Amplitudes (C. Betzler) Maldives Miocene Carbonate Sequence Stratigraphy Pattern and Oxygen Isotope Records as Sea Level Proxy (A. Droxler) The Marion Plateau Carbonate System (ODP Leg 194) - An Archive of Middle Miocene Sea-Level Changes (C. John)
12:30-13:00	Discussion on sea-level changes
	Lunch (13:00-14:00)
	Facies and carbonate producers
14:00 - 14:30	Impact of Carbonate Producing Biota on Platform Architecture. Insights from Miocene Examples of the Peri-Mediterranean Areas (L.Pomar)
14:30 - 15:00	The Reef-Climate Paradox in the Cenozoic (W.Kiessling)
15:00 - 16:00	Who is producing in the factories: Advantages and Limitations of Using Molluscs for Paleoecological Analysis in Oligo/Miocene Carbonate Systems (M. Harzhauser) Latitudinal Trends in Oligo-Miocene Reef Patterns and their Relationship to Climate (C. Perrin)
	coffee break (16:00-16:15)
16:15 - 17:15	Larger Foraminifera in the Berau-Delta: Indicators of Environmental Change? (W. Renema) Freak Show or Useful Tools on Palaeoecological Reconstruction - the Role of Echinoderms in Oligo-Miocene Carbonate System (A. Kroh)
17:15 - 18:00	Posters
18:00- 23:00	Optional evening program Visit to the Berlin Wall Museum

Thursday 24 February 2005

Spatial and Temporal Variability

08:30 - 08:45	Templates for correlation (W.Piller)
08:45 – 09:15	A Genetic Classification of Carbonate Platforms Based on their Basinal and Tectonic Settings in the Cenozoic (D. Bosence)
09:15 - 10:15	Discussion on (1) carbonate producers, factories and setting (2) carbonate facies and frequency/amplitude of sealevel changes Break up into groups
	coffee break (10:15-10:30)
10:30 - 11:30	Mediterranean and Paratethys Upper Miocene Carbonates in Southern Spain (J.C. Braga) Depositional Dynamics in Foramol (Temperate-Type) Carbonate Systems: Examples from the Sardinia Region (Italy) (L. Simone)
11:30 - 12:00	Oligocene-Miocene Carbonates of the Western Central Paratethys (W.Piller)
12:00 - 13:00	Indopacific Equatorial Carbonate Development during the Cenozoic (M. Wilson) Oligocene to Pliocene Coral Reef Formation on Kita-Daito-Jima, Northern Philippine Sea (Y. Iryu)
	Lunch (13:00-14:00)
14:00-15:00	*Poster presentations*
	Discussion Session
15:00-17:00	*Discussion session on regional patterns* *Break up into groups according to geographical location* *(1) analyse patterns emerging from data presented* *(2) identitfy gaps in our knowledge of these systems both in space and time* *(3) are there new target areas , which could help to resolve some of the key questions?*
	coffee break (16:00-16:15)
17:00-18:00	*Presentation of Discussion Groups*
19:30	*Workshop Dinner at Cecilienhof Castle*

Friday 25 February 2005

08:30 - 09:00	ESF presentation and discussion of plans for a ESF project **Discussion Session**
09:00 – 10:30	Separation into smaller groups to discuss (1) terminology used to describe the carbonates (2) integration of paleontological data into facies models
	coffee break (10:30-10:45)
10:45 – 13:00	Presentation of Discussion Groups and general discussion
	Lunch (13:00-14:00)
14:00 – 16:00	Separation into smaller groups to discuss (1) how to achieve better time resolution (2) effect of climate change of facies patterms
	coffee break (16:00-16:30)
16:30-17:15	Presentation of group discussions
17:15-18:00	Concluding remarks

4. Results and future directions

4.1 General considerations

The most important achievement of this workshop was to bring together people with different expertises who would not normally attend the same conferences. However, their research topics are interdependant. This workshop helped the different groups to become acquainted with one another, to be informed about the research of the others, and to evaluate its effect on the own topic. The main disciplines represented at the workshop were : carbonate sedimentology (outcrop and subsurface), paleontology (paleocology and taxonomy), seismic stratigraphy, paleoceanography (stable isotopes and elemental ratios), large data management, forward modelling.
Meeting in a dedicated facilty for three full days also helped to overcome many personal and cultural diffidences which have hindered communication in the past. This is particularly relevant at the European scale. New collaboration plans and perspectives have been opened now. This was the first step towards developing a culture of communication. All participants have cleary identified this as a major outcome, and look forward to meeting again regularly in the future.

4.2 Contents of the presentations and discussion

The first presentation by Mutti outlined the main controls over Oligocene and Miocene carbonate environments and biotic assemblages. Comparison with modern examples was used to highlight the complexities in reconstructing controls in ancient settings. Environmental parameters to be considered comprise changes in temperature, nutrient concentration, salinity and mineral saturation state. A fundamental problem in reconstructing these parameters is that the time resolution in shallow water carbonates is often inadequate to capture the temporal variability at which these parameters evolve. It was noted how the temporal correspondance between episodes of platform drowning and positive excursions in the marine carbon isotope record suggests that carbonate facies are closely tied to the carbon cycle. However, the main climatic changes as recorded by the oxygen isotope record seem to show controversial correspondance to times of facies changes.

Billups in the second talk outlined research of the past 5 years focused on the application of Ca/Mg in foraminifera for separating the effect of temperature versus ice volume on oxygen isotope records. She illustrated examples from the O/M boundary and the middle Miocene. Of great relevance to the workshop goals, her results indicate that times of oxygen isotope excursions are mostly out of phase with the reconstructed paleotemperatuee changes. This implies that a simple correlation between carbonate facies changes and the oxygen isotope curve is a flawed approach. Second, the temperature fluctuations recorded by Ca/Mg variations at one single location are higher than previously assumed, and can reach several degree C in amplitude. This is sufficient to trigger significant faunal turn-overs and moving an environment from the tropical to the temperate domain.

The next block of talks was focused on Oligocene and Miocene sealevel changes, with particular emphasis on their timing, amplitude and effects on platform geometries. Oxygen isotope records are commonly used to track sealevel changes, but can be controversial as they carry a mixed signature (see above, presentation by Billups).

Betzler in the first presentation outlined how different Oligocene and Miocene sedimentary systems drilled by ODP (Bahamas, Queensland Plateau, New Jersey) have yielded different records with regard to timing and amplitude. He provided possible explanation for how to reconcile the results. The differential capturing by the coring program of lowstand versus highstand systems may justify differences in amplitude. Explaining the disparate timing of sealevel changes at this time in Earth History is more puzzling and requires further investigation.

One ideal location which has the highest potential to further investigate this issue was presented by Droxler, who outlined plans for a IODP drilling campaign in the Maldives. Preliminary studies based on seismic surveys indicate marked stratigraphic signatures in Oligocene and Miocene carbonate platforms which are supposedly related to sealevel

changes. He outlined a plan to approach the mixed paleotemperature and ice volume signature on oxygen isotope curves, in order to extract the sealevel signature.

John presented recent results from a former ODP Leg (194), which drilled the Marion Plateau. His approach was to integrate stratigraphic geometries, stable isotope records and lithosphere flexure to analyze the range of sealevel amplitude values at the late middle Miocene sealevel fall. His results indicate a higher amplitude than recognized by previous datasets.

The next group of talks was on facies and carbonate production. The first presentation, by Pomar, discussed the impact of carbonate producing biota on Miocene platform architecture using examples from the Mediterranean. In carbonate systems, a wide spectrum of depositional profiles (from homoclinal ramp to rimmed shelves) can develop as a response from the interdependence between sediment supply and accommodation. He showed how ecological changes may affect accomodation, thus impacting architecture. Differences in shallow water carbonate production can be attributed to the euphotic, oligophotic and the deeper aphotic zones.

The second presentation in this thematic group, by Kiessling, presented the apparent paradox of expanding reef habitats during the Cenozoic at a time of longer term cooling. He constructed his arguments on a data base built on literature compilation. The greatest increase in recorded reef sites was from the Late Oligocene to the early Miocene, whereas preserved reef volumes increased strongest from the early to middle Miocene. Average reef diversity peaked in the Late Oligocene and then declined towards the late Miocene, whereas the global diversity of scleractinian corals steadily increased through the Oligocene and Miocene and there were almost no extinctions at the genus level across the Oligocene-Miocene boundary. He argued that neither climatic data nor any other quantified physico-chemical parameter is able to explain the large expansion of reefs across the Oligocene-Miocene boundary, thus implying a predominantly biological control.

Perrin showed that most Tertiary buildups occur within a latitudinal belt broadly centred on the tropical regions and slightly shifted to the North. During the Tertiary, the reef belt show both gradual latitudinal shifts and latitudinal contraction / expansion. In particular, the latitudinal width of the reef belt seems to have been reduced near the Eocene – Oligocene boundary and increased again after the Rupelian. It was wider than today during most of the Miocene, its widest extension occurring during the middle Miocene.

Harzhauser pointed out how molluscs are generally strongly underrated when interpreting carbonate systems in the circum-Mediterranean area, because of taphonomic loss and difficult taxonomic interpretation in thin-sections. He argued that this affects mostly small-sized gastropod species, which however, display a high diversity within modern carbonate systems. Mollusc shells may contribute up to 80% of the sediment within nearshore settings and especially around Miocene oolite shoals. Nevertheless, in most micro-facies studies this highly indicative and extremely species-rich group is just referred to as “gastropod”, “bivalve” or, to reach the top of accuracy, as “oyster” or “pectinid”. Obviously, such identifications are meaningless in terms of ecology or biogeography. He emphasized the importance of a classical, taxonomy-oriented paleontology in any facies-analysis.

Renema presented data on modern larger benthic foraminifera in Borneo. He discussed the shallow to deep water zonation.

Kroh showed how echinoderm debris can account for up to 45 % of the biogenics in Oligo-Miocene carbonates. The composition of the echinoderm fauna in carbonate environments and their abundance is among else controlled by climate. Many groups are currently restricted to certain climate zones, and in particular the shallow water forms are sensitive to temperature changes. Thus employing an actualistic approach these forms and their fossil relatives may be used in palaeotemperature estimation of Oligo-Miocene sediments. Additionally, echinoderms are useful tools for palaeoenvironmental reconstruction. They are sensitive to water agitation, currents, depth and substrate. Some Miocene echinoids for example are useful indicators of reef proximity, sea grass presence or high energy settings.

The next block of presentations focused on the spatial and temporal variability of Oligocene and Miocene carbonate systems, illustrating controls and case studies. Piller opened this

block making remarks on the newest developments on biostratigraphic schemes. He presented a stratigraphic scheme and template for facilitating comparison and correlation among different case studies and workers.

Bosence, from a review of well-exposed outcropping and seismically imaged Cenozoic platforms, proposed that eight carbonate platform types can currently be recognised and characterised based on their basinal and tectonic setting. This reassessment of Cenozoic carbonate platforms indicates that their basinal and tectonic setting can be used to establish a first-order, genetic classification of carbonate platforms. The basinal and tectonic setting of carbonate platforms is shown to control their occurrence, the overall 3-D platform morphology, the large-scale stratigraphic features and depositional sequences. Climate, ocean chemistry and biological evolution control grain types, facies and some elements of platform margins but not the larger-scale features.

Braga gave an overview of Miocene carbonate platforms in the Western Mediterranean. Lithofacies changes of carbonate rocks in the stratigraphic record at the margins of the Neogene basins in southern Spain were mainly the result of temperature variations during the Late Neogene. These variations promoted the alternation of non-tropical and tropical carbonate deposition during the last 10 Ma in the region.

Simone discussed two examples of middle Miocene carbonate complexes from Sardinia, where foramol/rhodalgal carbonate factories were recognized. In order to achieve more informations about the dynamic evolution of the related carbonate systems, the biotically controlled sediment characterization (e.g.: coralline algal assemblages vs. bryozoan assemblages dominance, primary vs. hydraulic oyster shell concentrations) and the differentiation between the in situ and the parautochthonous/allochonous deposits have been performed.

Piller gave a review on the newest results oof the Austrian researchers active in the Paratethys area. Oligocene carbonate sediments are rare in the western Central Paratethys and represent mixed carbonate-siliciclastic regimes. During the Early Oligocene carbonates of the Lower Inn Valley are predominated by coralline algal- and bryozoan-dominated facies and reflect a shore-basin gradient. In the Late Oligocene of the Upper Austrian Molasse Zone carbonate-siliciclastic ramp deposits are also characterized by coralline algae but also by mass occurrences of miogypsinid foraminifers. During the Miocene, three carbonate factories can be differentiated: (1) The late Eggenburgian/Ottnangian locally and very restricted warm-temperate Zogelsdorf carbonate factory; (2) The middle Miocene (Badenian) Leitha Limestone subtropical to tropical carbonate factory; (3) The Sarmatian factory, with Persian Gulf-type oolites and frequently small build-ups of nubeculariid foraminifers. This combination clearly points to carbonate supersaturated, marine or even hypersaline waters and require tropical-subtropical conditions. The occurrence of pedogenic carbonate (*Microcodium*, caliche) points to a semi-arid climate on land.

Wilson outlined that the most extensive, diverse and near complete Cenozoic global record of humid equatorial carbonates occurs in SE Asia. She stated that understanding equatorial carbonate development is of importance given recent recognition of their role in global cycles, evaluating climate change and understanding marine biodiversity patterns. SE Asian carbonates, in common with those from other humid, equatorial regions, differ from their more intensively studied counterparts from arid, subtropical regions. Equatorial carbonates are dominated by bioclasts, with coated grains and aggregates almost entirely absent since biological and physical processes dominate over chemical ones. SE Asian carbonates are not associated with evaporites, and were often affected by coeval clastic and nutrient influx or tectonism. Individual formations formed in a wide range of settings and there is considerable variability in depositional facies and platform types related to local conditions. In comparison, a major change in dominant biota around the Paleogene-Neogene boundary strongly affected rates of carbonate production, carbonate sedimentology and platform development. Paleogene carbonates are dominated by calcitic, non-framework building biota forming large-scale platforms, or shoals, whereas Neogene carbonates often form buildups with abundant aragonitic reefal corals and a pervasive meteoric diagenetic overprint. The reasons for the change in carbonate producers are currently being evaluated, but may include a combination of biogeographic, plate-tectonic, oceanographic, climatic and ecological factors.

Iryu presented the results of the investigations on a drill hole on Kita-daito-jima, a carbonate island, lying ~350 km east of Okinawa-jima (southwestern Japan). The reconstructed Oligocene to Pliocene age-depth section of Kita-daito-jima shows (1) that reef formation on Kita-daito-jima was controlled by combined effects of sea-level changes and tectonic movements (subsidence and uplift); and (2) that two types of reef formation were recognized: the growth keeping up with the subsidence of the island and the rapid reef formation which commenced at sea-level falls.

Kenter offered an unplanned presentation regarding a Web-based Outcrop Digital Analog Database (WODAD), which is an attempt to make outcrop information more readily available to the earth scientists. This relational database will 1) cover the Phanerozoic, 2) include carbonates, clastics as well as mixed systems and, 3) maximize the searchable parameters. The database is currently under construction at the Vrije Univeristeit in Amsterdam and partly funded by the petroleum industry. The web-based database will be operational by the end of June and contributions from academia and industry are invited. The first of three databases will concentrate on carbonate outcrops and publication as a digital manuscript from AAPG (American Association of Petroleum Geologists) is planned for 2007. This case was presented to provide an example which could help to facilitate the comparison of Oligocene and Miocene carbonate platforms across the world.

Although not planned in the original program, it was considered important to present the poster contents to the entire group. Therefore, the entire group moved from poster to poster, where 5 minutes presentations were given by the authors.

4.3 Discussions and research lines

During the workshop, several discussion rounds took place, both formally and informally. The discussions were focused on identifying research lines for future activities.
Topics discussed included : (1) recognizing sealevel changes in carbonate platforms, (2) integrating paleocological information into facies models, (3) use of terminology to describe the carbonates, (4) paleoenvironmental controls, (5) correlation tools.

Sea-level : The discussion on sealevel changes was centered on the concerns of having such disparate records from different locations. Reasons discussed to explain this were a) different sedimentary systems react differently to sealevel fluctuations, b) some of the records lack crucial data (e.g. lowestand packages). Key areas should be designated where future research is centered. It was discussed whether it is valid to consider only marine sections which were subsiding since the Oligo-Miocene or also uplifted land, so that also outcrops could be used. From that two possible areas were designated the Maldives and the Neogene basin in Turkey (Mut Basin, Ermenek Basin).

Paleoecology : The participation of a wide range of specialists from different expertises and professional backgrounds provided a unique perspective into approaching the significance of carbonate facies into a broader, paleoecological and paleoclimatic context. First, it is clear that the paleoecological information that can be extracted from biotic assemblages, is too often ignored by physical sedimentologists. For example, in addition to corals, also molluscs, red algae, larger benthic foraminifera and echinoids have a very clear paleocological signal, providing information on water depth, temperature and salinity, which are critical for sedimentologic interpretations. However, this information is available only if the taxonomic identifications are made. Acquiring this information calls for very close cooperation across expertise boundaries. It was also noticed that bryozoa are the group of biocalcifiers least understood for what regards paleoecological requirements.
The discussion, however, also showed that paleoecological reconstruction of carbonate sedimentary systems based on taxonomy also has its limits. Whereas Miocene and younger assemblages are very similar to Recent associations, Oligocene and older assemblages have different compositions on the generic and species level.

Terminology : It became clear that people with different research directions and expertises tend to use different terminology to describe carbonate sediment. Everybody agrees that this is a problem affecting communication and identification of the real scientific problems. Furthermore, using different terminology considerably reduces the possibility to compare different study areas. Currently, there are two major terminologies in use for description of

neritic carbonate. A system which is based on the observation which are the most important sediment-forming components, and a system which takes into account the feeding priorities of the carbonate-producing biota. None of the systems ultimately allows reconstruction of controlling factors, such as e.g. water temperature or nutrient content. It was agreed that descriptive terns should be used and an interpretative terminology should be avoided. It was also encouraged to develop this issue actively by developing a new, adequate terminology.

Paleoenvironmental controls : The main controls over carbonate assemblages are on shorter time scales temperature, nutrients, salinity of the water masses in which the biota live and on longer time scales biologic evolution, geodynamics and changes in paleogeography. Paleotemperature reconstructions, based on integrated oxygen isotope records and Mg/Ca ratio on foraminifera show that important temperature variations took place during this time, and some are out of phase with main glaciation events; their magnitude is large enough to cause shifts in benthic communities. However, time resolution in shallow water carbonates is too poor to be compared with the paleoceanographic records.
In addition, it was observed that local parameters can play an overryiding role that can mask the glohbal signal. Therefore it is necessary to understand regional settings before making global implications. Topography and geomorphology of an area are important prerequiite that may strongly affect depositional systems.
Many possible research topics have been discussed. One very interesting idea was to compare the role of nutrients and light adaptation to evolutionary patterns. This could be applied to to the average depth of coral growth (e.g. Luis Pomar) and to how the size of larger foraminifera (Lepidociclina) changes with respect to depth of the photic zone (small-shallow, large-deeper).

Age resolution : The time resolution available in most shallow-water carbonate records is not adequate to be compared with climatic events as recorded by deep-sea records. In part, there is an intrinsic limitation regarding achievable age resolution of shallow water strata. However, additional efforts should be made to achieve the best possible resolution, by integrating different dating schemes. This is necessary to resolve the entire climatic transition and its details.

4.4. Proposed activities

- As a result of this workshop, the convenors plan the preparation of a proposal for ESF for a programme to enable development /promotion of a culture of exchange and to ensure that regular meetings for exchange can take place.
- It was consdered important to publish a book that would outline the state of knowledge as presented during the workshop. To adequately reach the carbonate community a Special Publication of IAS (International Association of Sedimentologists), published by Blackwell, was generally agreed by the workshop participants. The IAS Board has met in Vienna on the 24th of April 2005, and has approved our proposal. We will hope to send the articles to the publisher in approximately one year from now.
- Last, but not least, the workshop has promoted the discussion of joint research initiatives that will lead to the preparation of projects to be sumbitted as joint, collaborative proposals with national agencies.
- It was also recommended that the community of carbonate workers expand to other platforms (IODP and ICDP) to gain additional data.

5. List of participants

Name	Affiliation	E-mail
Bassi, Davide	University Ferrara, Dip. Delle Risorse Naturali e Culturali, Corso Ercole I d'Este 32, I-44100 Ferrara Phone: +39-0532-293726; Fax: +39-0532-206468	bsd@unife.it
Betzler, Christian	University Hamburg, Geologisch Paläontologisches Institut und Museum Bundesstraße 55, D-20146 Hamburg, Germany Phone: +49 40 42838 5011, Fax: +49 40 42838 5007	betzler@geowiss.uni-hamburg.de
Billups, Katharina	University of Delaware 700 Pilottown Road, Lewes, DE, 19958, U.S.A. Phone: 302 645 4249, Fax: 302 645 4007	kbillups@udel.edu
Bosellini, Francesca	University Modena, Department of the Palaeobiology Museum and Botanic Garden Via Universita 4, 4100 Modena, Italy Phone: +39 532 205 6522, Fax: +39 532 205 5887	frabos@unimore.it
Bosence, Dan	University of London, Department of Geology Egham, Surrey TW20 0EX, UK Phone: +44 (0) 1784 443612, Fax: +44 (0)1784 471780,	d.bosence@gl.rhul.ac.uk
Brachert, Thomas	University Mainz, Institute of Geosciences Becherweg 21, D-55099 Mainz, Germany Phone: +49 6131 3924 281, Fax: +49 6131 3924 768	t.brachert@geo.uni-mainz.de
Braga, Juan Carlos	University Granada, Department of Stratigraphy and Palaeontology Facultad de Ciencias, Campus Fuentenueva, 18002 Granada, Spain Phone: +34 958 24 83 32, Fax: +34 958 24 85 28	jbraga@ugr.es
Brandano, Marco	University Rome "La Sapienza", Department of Earth Sciences Piazzale Aldo Moro 5, I-00185 Roma, Italy Phone: +39 649914547, Fax: +39 64454729	marco.brandano@uniroma1.it
Corda, Laura	University Rome "La Sapienzia", Department of Earth Sciences Piazzale Aldo Moro 5, I-00185 Roma, Italy Phone: +39 6 49914859; Fax: +39 6 4454729	laura.corda@uniroma1.it
Droxler, André	Rice University, Department of Earth Science MS-126, P.O. Box 1892, Houston, TX 77251-1892, U.S.A. Phone: 713-348-4885, Fax: 713 348-5214	andre@rice.edu
Harzhauser, Mathias	Natural History Museum Vienna, Burgring 7, A-1010 Vienna, Austria Phone: +43 1 52177 250, Fax: +43 1 52177 459	mathias.harzhauser@nhm-wien.ac.at
Iryu, Yasufumi	University Tohoku, Institute of Geology	iryu@dges.tohoku.ac.jp

	and Paleontology Aobayama, Sendai 980-8578, Japan Phone: 81 22 217 6622, Fax: 81 22 217 6634	
John, Cedric	University of California, Department of Earth Sciences 1156 High Street, CA 95060, Santa Cruz, USA Phone: +001 831 459 3280, Fax: 001 831 459 3074	cjohn@pmc.ucsc.edu
Kenter, Jeroen	University Amsterdam, Department of Sedimentology De Boelelaan 1085, 1081 HV, Amsterdam, The Netherlands Phone: +31 20 4447360, Fax: +31 20 4449941	jeroen.kenter@falw.vu.nl
Kiessling, Wolfgang	Museum of Natural History, Humboldt University Berlin Invalidenstr. 43, D-10115 Berlin, Germany Phone: +49 30 2093 8576; Fax: +49 30 2093 8868	wolfgang.kiessling@museum.hu-berlin.de
Kindler, Pascal	University Geneva, Department of Geology and Paleontology 13, rue des Maraichers, 1205 Genèva 4, Switzerland Phone: +41 22 379 6649, Fax: +41 22 379 3210	pascal.kindler@terre.unige.ch
Knörich, Andrea	University Potsdam, Institute for Geosciences P.O. Box 601553, D-14415 Potsdam, Germany Phone: +49 331 977 2983; Fax: +49 331 977 5060	aknoerich@geo.uni-potsdam.de
Kroh, Andreas	Natural History Museum Vienna, Geological-Palaeontological Department Burgring 7, A-1014 Vienna, Austria Phone: +43 1 52177 576, Fax: +43 1 52177 459	andreas.kroh@nhm-wien.ac.at
Laursen Vestergaard, Gitte	Statoil ASA 4035 Stavanger, Norway Phone: +47 41 40 99 21; Fax: +47 51 99 65 50	gila@statoil.com
Matsuda, Hiroki	University Kumamoto, Department of Earth Sciences 2-39-1 Kurokami, Kumamoto, Kumamoto 860-8555, Japan Phone: + 81 96 342 3424, Fax: +81 96 342 3424	hmat@sci.kumamoto-u.ac.jp
Morsilli, Michele	University Ferrara, Department of Earth Sciences Corso Ercole l d´Este 32, 44100 Ferrara, Italy Phone: +39 0532293715	michele.morsilli@unife.it
Mutti, Maria	University Potsdam, Institute for Geosciences P.O. Box 601553, D-14415 Potsdam, Germany Phone: +49 331 977 5230; Fax: +49 331 977 5060	mmutti@geo.uni-potsdam.de
Nebelsick, James	University Tuebingen, Institute for Geosciences Sigwartstr. 7, D- 72076 Tübingen,	nebelsick@uni-tuebingen.de

	Germany Phone: +49 7071 29 77546, Fax.: +49 7071 29 5217	
Perrin, Christine	University Toulouse III and MNHN Paris France Laboratoire des Mecanismes de Transfert en Geologie Universite Paul Sabatier Toulouse III 14 avenue Edouard Belin, 31400 Toulouse, France Phone: +33 5 61 33 25 64, Fax: +33 5 61 33 25 60	christine.perrin@lmtg.obs-mip.fr
Pickard, Neil	Cambridge Carbonates Ltd. Gullvivevägen 5, 756-55 Uppsala, Sweden Phone: +46 18 321151; Mobile: +46 733 130495	neil.pickard@telia.com
Piller, Werner	University of Graz, Institute for Geosciences Heinrichstraße 26, A-8010 Graz, Austria Phone: +43 316 380 5582, Fax: +43 316 380 9871	werner.piller@uni-graz.at
Pomar, Luis	Universitat de les Illes Balears, Ctra de Valldemossa, km 7.5, E-07122 Palma de Mallorca, Spain Phone: +34 971 173160; Fax: +34 971 173184	lpomar@uib.es
Renema, Willem	Nationaal Natuurhistorisch Museum P.O. Box 9517, 2300 RA Leiden, The Netherlands Phone: 071 5687576, Fax: 071 5687666	renema@naturalis.nl
Simone, Lucia	University of Naples Federico II, Department of Earth Sciences Largo San Marcellino, 10, 80138 Napoli, Italy Phone: +39 081 253 81 18, Fax +39 081 552 56 11	lusimone@unina.it
Suzuki, Yuka	University Tohoku, Institute of Geology and Paleontology Aobayama, Sendai 980-8578, Japan Phone: 81 22 217 6622, Fax: 81 22 217 6634	y_suzuki@dges.tohoku.ac.jp
Westphal, Hildegard	University Erlangen, Institute of Palaeontology Loewenichstr. 28, D-91054 Erlangen, Germany Phone: +49 9131 85 22967, Fax: +49 9131 85 22690	hildegard.westphal@pal.uni-erlangen.de
Wilson, Moyra	Durham University, South Road, Durham, UK Phone: 001 44 (0)191 3342282, Fax: 001 44 (0)191 3342301	moyra.wilson@durham.ac.uk

6. Statistics on participants

Distribution by gender

Total participants	**32**
Female participants	12
Male participants	21

Distribution by nationality

National participation	
Austria	4
France	1
Germany	8
Italy	6
Japan	3
Netherlands	2
Norway	1
Spain	2
Sweden	1
Switzerland	1
UK	2
USA	3

Distribution by age groups is not available

7. Appendixes

Proposal for an IAS Special Publication

Possible Title: Carbonate systems during the Oligocene-Miocene climatic transition

Editors: M. Mutti (Potsdam), W. Piller (Graz), C. Betzler (Hamburg)

Suggested Book contents:

Note: all these papers have been committed by the authors during an ESF workshop held in Potsdam in February 2005-

1. Preface

Introduction and Overviews

2. Miocene carbonate systems: problems and perspectives- Open issues in the study of late Oligocene-Miocene carbonate systems (e.g. terminology, correation tempates) (Mutti, Piller, Betzler)

Climate and Sea-Level Changes

3. Billups, K.: Review and synthesis of Paleotemperature data.
4. Droxler, A.: Carbonate Sequence Signature and sea-level changes
5. Cuevas-Castell, J. M., Betzler, C. et al.: Analysing periodicities and amplitudes of high-frequency sea-level fluctuations in neritic carbonates.
6. John, C.: Summary of periplatform sedimentation on the Marion Plateau – implication for sea-level studies.

Facies Models and Carbonate Producers

7. Braga, J. C. et al.: Controls on carbonate types in the Upper Miocene of S Spain.
8. Bosellini, F. and Perrin, C.: Paleoenvironmental significance of Oligo-Miocene scleractinian corals
9. Braga, J.C., Bassi, D. and Piller, W. E.: Significance and utility of coralline algae in Oligo/Miocene carbonates for sediemetnological facies models.
10. Harzhauser, M.: Underrated contributors to the sediment budget: Importance of molluscs for Oligo-Miocene carbonate environments.
11. Berning, B. et al.: Bryozoans as their contribution to Cenozoic carbonate production.
12. Kroh, A.: Echinoderms as environmental tools in carbonate systems.
13. Westphal, H. and Wisshak, M.: Bioerosion as environmental indicator.

Spatial and Temporal variability

14. Bosence, D., A genetic classification of Cenozoic carbonate platforms based on their basinal and tectonic settings

15. Perrin, C. and Kiessling, W.: Latitudinal trends in Oligo-Miocene reef patterns

16. Corda, L.: Biota and isotope constrains.

17. Brachert, T. et al.: *Has to be decided*.

18. Piller, W.E.: Oligo-Miocene Carbonates in the western Central Paratethys – an overview.

19. Harzhauser, M. and Kroh, A.: The Mid-Miocene Leitha Platform – a small scale carbonate platform in the Central Paratethys.

20. Brandano, M. and Mateu-Vicens, G.: Comparative analysis of two Miocene carbonate platforms: a distally steepened ramp (Menorca, Spain) and a low-angle ramp (Latium-Abruzzi, Italy).

21. Brandano, M. and Piller, W.E.: Rhodolites and their paleoenvironmental implication – an example from the middle part of a low-angle ramp (Latium-Abruzzi, Italy).

22. Morsilli, et al.: The Oligo-Miocene of the Gargano Promontory: New insights on the paleoenvironemntal evolution of the Apulia Domain (southern Italy).

23. Simone, L. et al.: *Title to be delivered.*

24. Marcano, G. et al.: Diagenesis in transitional carbonates (northern Sardinia, Italy).

25. Ruchonnet, C. and Kindler, P.: Depositional models on the Ragusa Platform during the Middle – Late Miocene (Sicily, Italy).

26. Hagen, M. et al.: Rhodalgal bank margin geometries in northern Sardinia, Italy.

27. Picard, N. et al.: Carbonates of the Asmari Fm., Iran *(depends on Statoil approval)*.

28. Piller, W.E. et al.: Oligo-Miocene carbonates of Central Iran.

29. Wilson, M.: *Title will be delivered.*

30. Iryu, Y., Matsuda, H. et al.: Tropical to warm-temperate Miocene carbonates of Japan.