The Micropalaeontological Society

http://www.tmsoc.org

Annual General Meeting 2012

A coccolithophore bloom off Newfoundland, courtesy of NASA

PLEASE NOTE THAT DELEGATES MAY REGISTER AND SUBMIT POSTERS THROUGHOUT OCTOBER AND EARLY NOVEMBER.

1. The **conference field trip** will be to Bradgate Park, Charnwood Forest, led by Jim Riding. Cost is £15. Depart central Nottingham at 09.30 h, return by 18.00 h. Details will be sent direct to delegates who register for this excursion.

2. The **conference hotel** is the Rutland Square Hotel, St James Street, Nottingham NG1 6FJ, tel: +44 (0)115 9411 114, fax: +44 (0)115 9410 014, email: rutland.square@forestdale.com web: www.rutlandsquarehotel.co.uk
We have been allocated rooms at a special rate of £60 for a single room and £70 for a double room per night and this includes breakfast. To book a room please ring or email the hotel direct and quote 'TMS 12'; you will be given this special rate.

3. The **conference dinner** will be held at Merchants Restaurant, Nottingham at 19.30 h for 20.00 h on Monday 12th November 2012. Cost to delegates £15.

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NATURAL ENVIRONMENT RESEARCH COUNCIL

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FOREWORD

The Annual General Meeting of TMS has traditionally been held in London and over one day. A glance at the Society Handbook tells us that the only time this event was not held in the capital was 25th October 1972, when it was held at the University of Leicester on the theme of 'The Electron Microscope on Micropalaeontology'! Last year, the committee decided to ring the changes and have a longer, two-day, meeting, and to hold this event in other centres. Inevitably, London will be used again, but other cities will be given the chance to host this meeting in future provided the new format is a success. This decision may force some members to travel more than they would have, but of course many more members will have shorter journeys to make. It makes perfect sense to use different centres and to vary the format. We would like to take this opportunity to thank those members of the Society at University College London, both now and in the past, for the incredible contribution this group has made to the TMS and micropalaeontology in general over the past 40 years.

After several proposals were considered for the new meeting location and theme, the Committee voted to hold the 2012 AGM at the British Geological Survey in the newly refurbished headquarters at Keyworth, Nottingham, with the symposium theme of 'Warm Worlds' for the first day. This reflects the plethora of research into global change during greenhouse phases of Earth history. We have a superb array of invited talks by individuals who are at the cutting edge of this research, namely Alan Haywood, Emanuela Mattioli, Jenny Pike, Jörg Pross and Andy Purvis. Emanuela and Jörg will be travelling from France and Germany to present their lectures on Monday 12th November. On the next day, Martine Hardy of ExxonMobil will present a keynote lecture on an important shale gas operation in Poland. This will be followed by an open session of talks on all aspects of micropalaeontology. Other notable events are a pre-conference field excursion to Charnwood Forest, a tour of the new 'geological walk' and the core store at BGS, posters, society business, a post society business reception (some things will never change!) and a conference dinner. We sincerely hope that all the participants will enjoy all aspects of the programme we have designed and put together. In particular, we hope that students of our subject will appreciate the opportunity to meet experienced practitioners and to learn from the many presentations.

We welcome you to the 2012 AGM at Keyworth, and hope you like the new format. Thank you very much for participating!

Jim Riding and Sev Kender

(Convenors)

LOGISTICS

The TMS AGM will be held at the headquarters of the British Geological Survey at Keyworth, Nottingham. The Keyworth campus is located on Nicker Hill, Keyworth. Keyworth is a large village around 10 km south of Nottingham city centre. Geographical details are on: http://www.bgs.ac.uk/contacts/sites/keyworth/home.html.

The address is:
British Geological Survey
Environmental Science Centre
Nicker Hill
Keyworth
Nottingham NG12 5GG

It is the responsibility of the delegates to arrive at BGS Keyworth during the morning of Monday 12th November (see below). However, a bus will be provided to transport delegates to the conference dinner after the proceedings, departing at around 19.00 h. A bus will depart from the conference hotel (The Rutland Square Hotel) in central Nottingham at 08.00 h on Tuesday 13th November. This will get you to the BGS campus well in time for proceedings.

POSTERS

Posters must be portrait oriented, up to a maximum of A0 (119 x 84 cm, 47 x 33 inches)

ARRIVALS BY RAIL/BUS/TAXI

The nearest rail link is Nottingham Station. Take a taxi or a bus to Keyworth from central Nottingham. The best bus service to use is Keyworth Connection (https://www.trentbarton.co.uk/services/keyworthconnection/maps-and-times). Keyworth Connection buses depart from the Broadmarsh Bus station immediately north of Nottingham Station, or from specified bus stops en route. The best bus stop from the station is just outside the station on the right. Delegates can also arrive at East Midlands Parkway or Loughborough stations. Delegates can, of course, also travel to central Nottingham by coach.

ARRIVALS BY ROAD

Delegates can drive to BGS. Put NG12 5GG into your sat nav. There is adequate car parking on campus. Arrive at the main entrance on Nicker Hill. Access at the back gate on Platt Lane is security pass-controlled. Delegates should go to the main reception on arrival and register for the meeting.

PROGRAMME

Monday 12th November

10.00 h onwards	Registration. All delegates must collect their name badge/pass and conference pack from the main BGS reception.
10.00 h-12.00 h	TMS committee meeting at BGS; details of the room will be sent to committee members.
10.30 h-12.00 h	Optional tour around the new(!) BGS 'Geological Walk' and National Core Store.
12.00 h-13.00 h	LUNCH (in the BGS reception foyer area).
13.00 h-16.25 h	**Guest keynote lectures on 'Warm Worlds'**
13:00 h-13.10 h	Welcome and Introduction, Prof. J. Ludden, Director BGS, and Dr. M. Ellis, Head of Science for Climate Change
13.10 h-13.40 h	*Uncertainty and modelling climates in deep time* by A.M. Haywood, A.M. Dolan, D.J. Hill, F.W. Howell, J.O. Pope, C.L. Prescott, J.C. Tindall
13.40 h-14.10 h	*Environmentally driven evolutionary patterns in the size of marine calcareous nannoplankton throughout the Jurassic* by E. Mattioli, B. Pittet, G. Suan, B. Suchéras-Marx
14.10 h-14.40 h	*The Holocene interglacial: a view from Antarctica* by J. Pike, G.E.A. Swann, M.J. Leng, A.M. Snelling
14.40 h-15.10 h	*Macroevolution and macroecology of planktonic foraminifera in a cooling world* by Andy Purvis, Isabel Fenton, Emilie Hall, Gavin H. Thomas, Thomas H. G. Ezard
15.10 h-15.40 h	TEA/COFFEE
15.40 h-16.10 h	*Warm Worlds down under: Deciphering Antarctica's Climate during the early Eocene Greenhouse Phase* by Jörg Pross
16.10-17.30	SOCIETY BUSINESS
17.30 h-19.00 h	POSTER SESSION AND DRINKS/NIBBLES IN THE BGS RECEPTION At this time, delegates can peruse the posters in the BGS foyer. Authors should be standing at their posters at least between 17.30 h and 18.00 h.
19.00 h	Travel by coach to Merchants Restaurant, central Nottingham for the conference dinner (19.30 h onwards)

Tuesday 13th November

Keynote Industrial Lecture (09.00 h-09.45 h)

Integrating palynology and geochemistry to support reservoir quality interpretation of an unconventional Shale Gas play (Silurian Podlasie and Lublin basins, Poland)

Martine J. Hardy, Cara Davis, Jon Kaufman, Kevin Bohacs, Pawel Lis, Stewart G. Molyneux

OPEN TALKS ON MICROPALAEONTOLOGY (09.45-13.00 h)

09.45 h-10.00 h	*Microfossils to Megabucks* by Haydon Bailey
10.00 h-10.15 h	*Palynological evidence for Antarctic sea ice and climate change during the latest Cretaceous* by V.C. Bowman, J.E. Francis, J.B. Riding, S.J. Hunter and A.M. Haywood
10.15 h-10.30 h	*Mesozoic Radiolarian biochronology applied to geodynamic reconstructions in the Lesser Caucasus (Armenia, Karabagh)* by T. Danelian, G. Asatryan, G. Galoyan, M. Seyler, M. Sosson, L. Sahakyan and A. Avagyan
10.30 h-10.45 h	*Testing the robustness of thecamoebians for quantitative limnological reconstruction* by X. Panades I Blas and G. Swindles
10.45 h-11.00 h	*Miocene vegetation and climate: from the Brassington Formation of Derbyshire to global distributions* by M.J. Pound, J.B. Riding, U. Salzmann, A.M. Haywood, T.H. Donders and J. Daskova
11.00 h-11.30 h	COFFEE/TEA/BISCUITS
11.30 h-11.45 h	*Toward an high-resolution stratigraphy for Antarctic Neogene radiolarians* by Johan Renaudie and David B. Lazarus

11.45 h-12.00 h *Foraminifera are sorted by size and taxon during post-mortem transport* by Mike Rogerson, Angela Kelham and Stuart McLelland

12.00 h-12.15 h *Early to Middle Miocene vegetation and climate at the Wilkes Land margin, East Antarctica* by Ulrich Salzmann, Francesca Sangiorgi, Sandra Passchier, Stefan Schouten, Joerg Pross, Peter Bijl, Lisa Tauxe, James Bendle, Carlota Escutia, Henk Brinkhuis and the IODP Expedition 318 Scientists

12.15 h-12.30 h *Phytoplankton cysts turn crazy: abnormal acritarchs announce isotope excursions in the Lower Palaeozoic* by T. Servais, A. Delabroye, A. Munnecke and T.R.A. Vandenbroucke

12.30 h-12.45 h *Late Pleistocene pteropods as a proxy for surface ocean carbonate concentrations* by Deborah Wall-Palmer, Christopher Smart, Malcolm Hart and Alessandra Conversi

12.45 h-13.00 h *Microfossil provenance of British lowland Iron Age artefacts* by Mark Williams, Jeremy Taylor, Ian Wilkinson, Ian Whitbread, Ian Boomer, Rebecca Stamp and Emma Yates

BUFFET LUNCH FROM 13.00 H

POSTERS

Bering Sea intermediate water changes: 0 – 300 ka by A. Aturamu, S. Kender, M. Williams, J. Zalasiewicz

Palynological evidence for Antarctic sea ice and climate change during the latest Cretaceous by V.C. Bowman, J.E. Francis, J.B. Riding, S.J. Hunter, A.M. Haywood

Are Ice Sheet Reconstructions of the mid-Pliocene Warm Period Model Dependent? by A.M. Dolan, D.J. Hill, A.M. Haywood, S.J. Koenig and the PlioMIP Participants

Upper Cretaceous Radiolaria reworked in the Eocene London Clay Formation by T. Fer, T. Danelian, H. W. Bailey

Biostratigraphy and paleoecology of the Miocene sequence from the Qabilt Ash Shurfah to Wadi Zaqlum sections, Sirte Basin, Libya by Mostafa M. Hamad

What caused mid-Piacenzian warming? Results from the PlioMIP experiments by D.J. Hill, A.M. Haywood and PlioMIP participants

The Former BP Micropalaeontology Collection by T. Hill, S. Stukins, G. Miller

Holocene water mass changes in Marguerite Bay, Antarctic Peninsula, from benthic foraminiferal assemblages by Sev Kender, Victoria Peck, Claire Allen

Diversity history of Cenozoic planktic marine diatoms by David B. Lazarus, John Barron, Andreas Türke, Patrick Diver, Johan Renaudie

Building global infrastructure for 21st Century marine micropalaeontology by David B. Lazarus, Patrick Diver, Fumio Akiba, Paul Bown, Dave Harwood, Kris Hooks, Brian Huber, Masao Iwai, Jackie Lees, Itsuki Suto, Noritoshi Suzuki, Woody Wise, Jeremy Young

Recent advances in calcareous nannofossil biostratigraphy across the Pliensbachian/Toarcian boundary in the Peniche section, the GSSP candidate by Emanuela Mattioli and the Toarcian working group

The onshore Miocene of the UK: The last unknown stratum and its implications for Pennine development by M.J. Pound , J.B. Riding, U. Salzmann, A.M. Haywood

Late Pliocene lakes and soils: A global data set for the analysis of climate feedbacks in a warmer world by M. J. Pound, U. Salzmann, A.M. Haywood

The macroevolutionary history of Antarctic Neogene radiolarians by Johan Renaudie and David B. Lazarus

A model for the evolution and infill of coastal tidal creek systems in the Holocene of English Fenland by D.M. Smith, J.A. Zalasiewicz, M. Williams, I.P. Wilkinson, J.J.Scarborough, M. Redding

Age, environment and paleoclimate of the Yorktown Formation, US Atlantic Coast by Stephanie Strother, Marci Robinson, Harry Dowsett

The John Williams Index of Palaeopalynology by S. Stukins

Oxygen isotope variability in Ordovician and Silurian conodonts by J.R. Wheeley, M.P. Smith, I. Boomer

ABSTRACTS

Bering Sea intermediate water changes: 0 – 300 ka

Adeyinka Aturamu[1], Sev Kender[2], Mark Williams[1], Jan Zalasiewicz[1]

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The Bering Sea is a semi-enclosed marginal sea in the North Pacific, whose surface circulation is dominated by the Bering Sea Gyre. A large continental shelf of less than 200 m water depth is present in the northern and eastern areas, while the deep basin in the west lies in more than 3500 m water depth. Sea-ice is present over the northern continental shelf during winter and this lasts for over 6 months in the year. The Kamchatka Pass and several passages and straits between the Aleutian Islands serve as the primary passages of North Pacific surface (Alaskan Stream), intermediate and deep waters into the Aleutian Basin, which dominate the Bering Sea. The Bering Sea is a source of Western Subarctic Pacific water, and plays an important role in the circulation of the western subarctic Pacific Ocean. It is characterised by a cold surface layer during winter and a dichothermal layer at around 100 m water depth during summer. The Bering Sea is a transition region between the cold dry Arctic air mass to the north, and the moist, relatively warm maritime air mass to the south. North Pacific Intermediate Water (NPIW) is currently partly formed through brine rejection during wintertime sea-ice production in the Okhotsk Sea, producing dense shelf water. There is currently no deep or intermediate water forming in the Bering Sea, but studies have suggested there may have been a significant component of NPIW formed in the Bering Sea during the last glacial.

Our study aims to understand the oxygenation of intermediate waters over the Bowers Ridge (central Bering Sea) from benthic foraminiferal assemblages, in order to understand the evolution of Bering Sea intermediate water ventilation over the last ~300 kyr. A total of 100 samples have been analysed at 13 cm intervals from Site U1342 (Bower Ridge,), where 41.35 metres of succession was cored during IODP Expedition 323. The samples are rich in calcareous benthic foraminifera with medium to good preservation, from which a minimum of 300 individuals were picked from the majority of samples except where there were fewer specimens available. We use correspondence analysis to determine changes in the assemblages, and interpret these changes in relation to ecology and water properties in the form of productivity, ventilation and oxygenation of the sea during glacial and interglacial periods of the Pleistocene.

The results are compared with the results of analyses of oxygen and carbon isotopes from the foraminifera and the sedimentology of the core undertaken by co-workers in California for reconstructing changes in palaeoceanography and palaeoecology through glacial and interglacial periods. Benthic foraminifera are common to abundant, with over 50

species identified. Almost all species are calcareous, (e.g. *Islandiella*, *Bulimina exilis*, *Ehrenbergina*, *Cassidulina*, *Uvigerina bifurcata*) which indicate variable bottom water properties over the last ~300 ka. Foraminiferal BFOI (benthic foraminiferal oxygen index) analysis shows oxygen levels generally ranged from ~0.2 – >3 ml/l (dysoxic to oxic), and generally correlate with laminated intervals. Generally, there are higher proportions of phytodetritivores (*Alabaminella* aff. *weddellensis*, *Islandiella norcrossi* and *Cassidulina laevigata*), during glacials MIS 4, 6 and 8, possibly due to the proximity of the sea ice margin. It is possible that enhanced sea ice over Bowers Ridge during MIS 2-3 reduced seasonality of productivity, and that bottom waters became better oxygenated due to intermediate water formation.

Keywords: Bering Sea, benthic foraminifera, oxygenation, ventilation, productivity.

Microfossils to Megabucks

Haydon Bailey

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At the British Association for the Advancement of Science meeting this year I was asked to make a short presentation on the use of micropalaeontology during a Palaeontological Association session entitled "Our fossil fuelled future".

After a short discussion regarding horizontal drilling using micropalaeontology at the wellsite, which will be familiar to all, I then moved a step further. I took the following statement from Jones (2006); "*In terms of value added, 30% of the current production (on the Valhall Field) is attributed to optimal reservoir placement enabled by biosteering and associated technologies*" and followed it through to its logical conclusion regarding the value added by commercial biostratigraphers. Even after giving a good slice of the pie to the "associated technologies" the results are still quite interesting.

Palynological evidence for Antarctic sea ice and climate change during the latest Cretaceous

V.C. Bowman[1], J.E. Francis[1], J.B. Riding[2], S.J. Hunter[1] and A.M. Haywood[1]

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Understanding the sensitivity of polar ice sheet growth and decay to climate change is critical for mitigating future anthropogenically-influenced changes to the global hydrological cycle. Current global levels of atmospheric carbon dioxide (*p*CO2) are approximately 1.4 times pre-industrial and are predicted up to 2.8 times by 2100. During the Late Cretaceous *p*CO2 was up to four times pre-industrial levels making it an ideal comparative scenario to study earth system responses to atmospheric change.

A new palaeoclimate proxy is being developed for the high southern palaeolatitudes using small chorate dinoflagellate cysts that are ubiquitous in Late Cretaceous to Neogene sediments around the Antarctic margin. These cysts (*Impletosphaeridium*) have previously been interpreted as an indicator of seasonal sea ice development and decay.

In conjunction with global climate modelling of sea ice extent, these acmes suggest the possibility of drifted seasonal sea ice reaching the tip of the Antarctic Peninsula during particularly cold late Maastrichtian orbits. The formation of significant sea ice in the Southern Ocean has previously been modelled to post-date the initiation of ice sheets in the Antarctic interior.

Keywords: Antarctic Peninsula; Seymour Island; sea ice; *Impletosphaeridium*; Maastrichtian; Cretaceous; dinoflagellate cysts.

Mesozoic Radiolarian biochronology applied to geodynamic reconstructions in the Lesser Caucasus (Armenia, Karabagh)

T. Danelian[1], G. Asatryan[2], G. Galoyan[2], M. Seyler[1], M. Sosson[3], L. Sahakyan[2], A. Avagyan[2]

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Biochronological constraints on the sedimentary cover of ophiolites preserved in the Lesser Caucasus are of great significance for the palaeogeographic and geodynamic reconstruction of the area and for lateral correlations of ophiolitic belts between Turkey and the Middle East. Since most of the Tethyan submarine extrusive events (i.e. lava flows) are covered by or intercalated with radiolarites, radiolarian biochronology is one of the main tools available for the investigation of their geologic history.

Two main ophiolitic zones are recognized in the Lesser Caucasus and they are linked to the evolution of Tethys: 1) the Sevan-Akera zone, situated in the East and SE of Lake Sevan, constitutes the main suture of the Neo-Tethys ocean in the area; we also include in this zone the Amassia-Stepanavan ophiolites, situated in the north-western part of Armenia; 2) the Vedi ophiolite (in the SE of Yerevan), is considered as a folded klippe sequence thrusted on the South-Armenian Block. The latter was probably part of the Taurides-Anatolides micro-continent; it was detached from Gondwana during the Late Palaeozoic – Early Mesozoic time.

This is one of the key areas of the Alpine-Himalayan mountain belt, since it is situated at the junction of suture zones between Turkey and Iran. However, lateral correlation of ophiolites is difficult, mainly because of the absence of detailed age constraints for most of them. While the extension of Caucasian ophiolites into the Izmir-Ankara-Erzinçan suture zone (Turkey) is a realistic possibility, their extension into Iran is still very questionable.

We focus here on biochronologic results obtained recently from the sedimentary cover of the Sevan-Akera ophiolites in Armenia and Karabagh, as well as their northward extension in Amassia.

Our results from the Sarinar section (east of Lake Sevan) suggest that Bajocian radiolarites overly ophiolitic lavas and that during the upper Bathonian to lower Oxfordian subaerial volcanism resulted to tuffite intercalations between radiolarites. Further to the north, in the Dali section of the Sevan ophiolite we establish that submarine volcanism was still active during the late Tithonian-Hauterivian interval. The same interval is also established in a huge olistholithe of radiolarian cherts present in the Dzkgnaget outcrop situated in the north of the lake Sevan.

A number of radiolarian chert samples from the Amassia ophiolite have yielded only Lower Cretaceous ages so far. The most interesting of these samples has yielded an

assemblage with *Archaeodictyomitra montisserei*, *A. undata*, *Pseudodictyomitra pseudomacrocephala* and *P. tiara* suggests a Cenomanian-Turonian age. This radiolarian dating provides important time constraint to one of the youngest submarine volcanic events that occurred in the Tethyan realm of the Lesser Caucasus.

Very little is known about the age of the sedimentary cover of ophiolites in the mountainous region of Karabagh. A number of previous studies led in the seventies and early eighties (Zhamoida et al., 1976; Kazintsova and Abbasov, 1981; Gazanov, 1985) mention the presence of Jurassic and Cretaceous Radiolaria in the region; however, most of these studies were conducted at a very early stage development of modern Mesozoic Radiolarian taxonomy and biostratigraphy. In addition, they are relatively difficult to be integrated into the geological/geodynamic analyses because little information is provided about the outcrops and stratigraphic position of studied samples. One remarkable exception is the study of Vishnevskaya (1995) who, in addition to a number of clearly indicated radiolarian assemblages from the Mt Karawul section, found also Bajocian-early Bathonian radiolarian in cherts overlying stratigraphically basaltic lavas. We discovered a new Late Barremian – Eraly Aptian radiolarian assemblage from a volcano-sedimentary sequence situated in the southeastern part of Sevan-Akera suture zone, west of the village Vank in the mountainous region of Karabagh. The presence of the easily recognisable subspecies *Aurisaturnalis carinatus perforatus* is of particular significance because it is the end member of a well studied lineage that went extinct in the early Aptian. Indeed, the middle late Barremian – early early Aptian age range of this subspecies allows to suggest that submarine volcanic activity took place during this interval in the Tethyan oceanic realm preserved in Karabagh. A rather diverse assemblage yielded by radiolarian cherts overlying stratigraphically ophiolitic lavas at Ghegamassar (east of Lake Sevan) point to a late Hauterivian-early Aptian age.

Given that these submarine volcanic events are more or less contemporaneous to the Aptian alkaline OIB-type lavas from the Vedi ophiolite established by Rolland et al. (2009), it is likely that these lavas are also the expression of a volcanic activity associated to the emplacement of the same oceanic volcanic plateau.

Are Ice Sheet Reconstructions of the mid-Pliocene Warm Period Model Dependent?

A.M. Dolan[1], D.J. Hill[1,2], A.M. Haywood[1], S.J. Koenig[3] and the PlioMIP Participants

[1]School of Earth and Environment, University of Leeds, Leeds, UK; [2]British Geological Survey, Keyworth, UK, [3]Department of Geosciences, University of Massachusetts, Amherst, USA.

During the mid-Pliocene Warm Period (3.264 to 3.025 Ma ago), global mean temperature was similar to that predicted for the next century, and atmospheric carbon dioxide concentrations were slightly higher than pre-industrial levels. Sea level was also higher than today, implying a reduction in the extent of the ice sheets. Thus, the mid-Pliocene Warm Period provides a natural laboratory in which to investigate the long-term response of the Earth's ice sheets and sea level in a warmer-than-modern world.

A combination of climate and ice sheet models can be used to enhance our understanding of ice sheet stability. At present, our understanding of the Greenland and Antarctic ice sheets during the warmest intervals of the mid-Pliocene is based upon predictions using generally only one climate model and one ice sheet model (see Figure 1). Therefore, it is essential that the model dependency of these results is assessed.

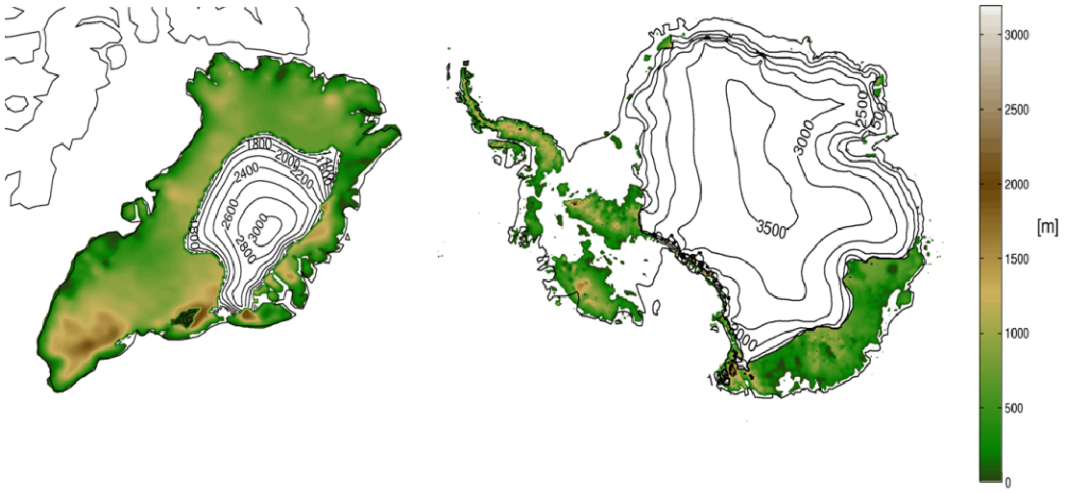

Figure 1: Greenland (left) and Antarctic (right) ice sheet reconstructions for the mid-Pliocene Warm Period. These ice sheet reconstructions are based on climate modelling using the Hadley Centre atmosphere-only climate model and the British Antarctic Survey Ice Sheet Model (BASISM; Hill, 2009; Dowsett *et al.*, 2010).

The Pliocene Model Intercomparison Project (PlioMIP) has brought together 14 international modelling groups to simulate the warm climate of the Pliocene. Here we use the climatological fields derived from the results of both the atmosphere-only climate models (Experiment 1) and the coupled atmosphere-ocean climate models (Experiment 2) to force an offline shallow ice approximation ice sheet model (BASISM). This will test the climate model dependency of ice sheet simulations over Greenland and East Antarctica.

We show that climate model dependency is high over Greenland, with Pliocene reconstructions ranging from an ice-free state to a near modern Greenland ice sheet. Over East Antarctica, there is less discrepancy between the different models and only one reconstruction exhibits significant ice sheet retreat in the sensitive Wilkes Land and Aurora subglacial basin regions.

Although these results are not able to shed light upon the reasons for inter-model discrepancies, they do serve to highlight the differences between model predictions of climate over the ice sheet regions during the mid-Pliocene Warm Period.

References

Dowsett, H. et al. (2010) The PRISM3D palaeoenvironmental reconstruction. *Stratigraphy*, **7**: 123-139.

Hill, D.J. (2009) *Modelling Earth's cryosphere during Peak Pliocene Warmth*. PhD Thesis. University of Bristol/BAS

Keywords: mid-Pliocene; ice sheets; climate models; ice sheet models; Greenland; Antarctica.

Upper Cretaceous Radiolaria reworked in the Eocene London Clay Formation

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Radiolarians were recently found in the Lower Eocene London Clay Formation of the London Basin. They were retrieved from six samples from a borehole drilled as part of the Thames Tideway Project, operated by the Thames Water Utilities Ltd. on the River Thames, near Barnes in the Richmond district. The Radiolaria recovered are in general rather poorly preserved, with nearly half of the specimens found to be non-identifiable. Some samples yielded though a number of moderately to fairly well-preserved specimens for which previously described species could be identified. They all come from a ca. 10 m-thick sequence of silty shales, situated in the lower part of the Formation. Seventeen taxa are identified in total, including 8 species. All Radiolaria observed are of Upper Cretaceous age and they are therefore reworked in the lower part of the Eocene London Clay Formation. The best preserved sample records a fauna composed of fourteen species, including *Theocapsomma amphora* and *Amphipyndax stocki*, tknown from the Santonian to Palaeocene interval. The presence of *Theocapsomma* sp.aff. *T. amphora* in our material, a species described initially by Popova-Goll et al. (2005) from the southern Russian platform, suggests a Santonian to early Campanian age. Given the stratigraphy of the London Basin sequences, the age of radiolarians points to their origin in the Seaford Chalk Formation (upper Coniacian-lower Santonian), which contains numerous chert levels and could be coeval with a lower Santonian transgressive event. However, no in-situ radiolarian have to date been recorded from Santonian chalks of the London Basin. Their provenance therefore remains unknown. Other identified species in the same most diverse sample include *Archaeodictyomitra simplex, Diacanthocapsa ovoidea, Dictyomitra multicostata* and *Stichomitra communis*.

Biostratigraphy and paleoecology of the Miocene sequence from the Qabilt Ash Shurfah to Wadi Zaqlum sections, Sirte Basin, Libya

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The Miocene carbonate-siliciclastic deposits are widely exposed along the stretch of Qabilt Ash Shurfah to Wadi Zaqlum sections, Sirte Basin, NW Libya. These deposits overlie unconformably the Late Cretaceous Sidi As Sid Formation and are overlain unconformably by Quaternary clastic deposits. Three stratigraphic sections were investigated namely, from north to south: Qabilat Ash Shurfah, Ras Al Shaqqah and Wadi Zaqlum sections. Lithostratigraphically, the Miocene sequence can be differentiated into two main units representing shallow marine deposits with relatively intermittent deep marine incursions. These are from base to top as follows: 1- the Al Faidiyah Formation and 2- the Al Khums Formation (represented in the lower part by the An Naggazah Member, followed upwards with the Ras Al Mannubiyah Member). Detailed foraminiferal investigations led to the recognition of three zones from base to top: *Elphidium macellum/Miogypsina intermedia* and *Globigerinoiedes trilobus* zones covering the Al Faidiyah Formation and assigned an early Miocene (Burdigalian) age and the *Borelis melo melo* zone which includes the Al Khums Formation and dates it as Middle Miocene (Langhian to Early Serravallian) age. Detailed microfacies analysis of the rock units led to the recognition of eleven microfacies types indicating that the Miocene sequence was deposited in transgressive-regressive cycles ranging from nearshore, warm shallow inner to middle shelf marine environments with development of reefal facies with slightly deep marine incursions. Such environments reflect the eustatic sea level changes related to the latter minor tectonic pluses which accompanied the main Upper Cretaceous tectonic event.

Keywords: Qabilat Ash Shurfah, Al Faidiyah Formation, Miocene, foraminifera, Sirte Basin, Libya.

Integrating Palynology and Geochemistry to Support Reservoir Quality Interpretation of an Unconventional Shale Gas Play (Silurian Podlasie and Lublin Basins, Poland)

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Poland has experienced increased exploration activity associated with an emerging shale gas/oil play developed in Ordovician to Lower Silurian shales. The prospective section is part of the southwestern margin of Baltica (East European Platform). ExxonMobil had acquired a large acreage position to test the potential of the Lower Silurian play. As part of this evaluation, reservoir and source studies were performed on samples from an extensive collection of conventional core archived in Poland.

Eighty samples were analysed for palynology, bulk organic and inorganic geochemistry (total organic carbon, Rock Eval pyrolysis, XRD mineralogy, elemental analyses), and GRI porosity / matrix permeability. A subset of samples were selected for advanced biomarkers characterization and nanometre-scale pore imaging using SEM on BIB-(Broad Ion Beam milling) prepared samples.

Relative distance to shore, expressed as paleo-water depths, were interpreted from palynological assemblages. Integrating palynological results with organic geochemistry allowed classification of source facies from restricted inner ramp (excellent oil-prone) to mid ramp (good gas-prone and poor oil-prone) to outer ramp (poor gas-prone). Molecular signatures of solvent extracts and pyrolyzates contribute to interpreting character of generated hydrocarbons. These were consistent with deposition of primitive marine algae in dysoxic conditions, either as algal bloom or dispersed organic matter.

Shale matrix porosity and permeability have thus far not been linked directly to source facies, but rather to level of thermal maturation and kerogen types. SEM imaging revealed nanometer-scale pore architecture comprising voids in select kerogen types as well as intercrystalline and intracrystalline pore networks in the mineral matrix.

The integration of palynology with modern rock characterization techniques is a significant advance in the resource evaluation of early Paleozoic source. Despite paucity of land plants in the Ordovician / Silurian, marine source rocks have the hydrocarbon potential of being either oil-prone, as expected for such rocks, or gas-prone of primary generation. Areal and stratigraphic variations in source rock quality may exert a major control over "sweetspot" development in the play.

Uncertainty and modelling climates in deep time

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Interest in modelling and in determining how well models reproduce warm climate states in Earth History is steadily increasing. In part this interest is sustained by parallels between proxy reconstructions of atmospheric carbon dioxide (CO_2) levels, and current/projected concentrations of CO_2 (the analogue concept). Hundreds of simulations are now available, providing many plausible realisations of past climate; but why do simulations differ, what are the sources of uncertainty? In this presentation I will discuss the main sources of uncertainty in modelling climates of the past, and in data/model comparison, as well as ways in which these can be quantified and then reduced.

In climate models uncertainty is introduced through (1) incomplete knowledge of required initial conditions and boundary conditions (e.g. the starting state of the ocean and greenhouse gas concentrations), (2) structural uncertainty (i.e. models will not necessarily provide the same answers given the same starting conditions), and finally (3) physical parameter uncertainty (components of climate that occur at a resolution higher than that of the model itself must be parameterised based on incomplete observations of such components in the modern climate system). In terms of data/model comparison sources of uncertainty are (1) the different integration times of models versus geological proxies, (2) differences in spatial scales, (3) the interpretation of climate signals from proxies and (4) the incomplete and time averaged nature of geological data.

The quantification of uncertainty in models can be achieved through running climate ensembles with one model, as well as multiple models. At the same time reconstructions of past climate can be improved by progressively moving towards ever more tightly and thoughtfully defined windows in time. This has the added benefit of reducing uncertainty in boundary conditions required by the models themselves (e.g. orbital forcing). In narrower time windows it will be computationally possible to perform transient-style climate experiments with the objective of reproducing trends in climate variability rather than equilibrium states, which arguably never existed because climate is never in equilibrium. This may prove to be a more meaningful/reliable measure of model performance than attempting to compare absolute temperatures from proxies and models.

Whilst progress can and will be made, the signal to uncertainty ratio in deep time will remain unsatisfactory for the foreseeable future. This means that patterns of data/model discord, and their relevance to model predictions of the future, should be viewed with considerable scepticism. Ultimately, since the sensitivity of climate is not a constant, to a first order, data/model discrepancies tell us more about what we do not know about the past then they do about how well models perform for future climate scenarios.

Until uncertainties are reduced, it may be more beneficial to concentrate combined data/model studies towards the examination and testing of geological hypotheses, rather than as a means to directly evaluate the performance of models.

Keywords: Uncertainty; modelling; climates; environments; deep time.

What caused mid-Piacenzian warming? Results from the PlioMIP experiments

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The Pliocene model intercomparison project (PlioMIP) was initiated to assess the ability of climate models to reproduce a warmer, higher CO_2 climate of the recent geological past. The model boundary conditions were specified, so each of the models in both the atmosphere only Experiment 1 and the coupled ocean-atmosphere Experiment 2 were running equivalent experiments. Here we present a new analysis of the energy balance of each of these models, elucidating the causes and important features of the warm mid-Piacenzian climate.

Experiment 1 energy balances from each of the different models are very similar. Tropical warming is equivalent to that from greenhouse gases alone, although cloud albedo and implied heat transport impacts generally cancel out. At the poles the warming is primarily driven by a reduction in the cloud free albedo, which originates from the reduction in the ice sheets and Arctic sea ice in the boundary conditions and snow albedo feedbacks. Experiment 2 shows similar patterns to a lesser degree, but with a much more dynamic response from the ocean-atmosphere system. Surface albedo is still a dominant factor, as is greenhouse gas warming, but each of the models respond in a different way to the prescribed forcing, especially in the North Atlantic.

Comparison of the multi-model means from PlioMIP Experiment 2 and micropalaeontological reconstructions of sea surface temperature (SST) show a generally good fit, apart from the North Atlantic and Nordic Seas. However, taking into account the variation between the models and the uncertainties in the techniques used to reconstruct SSTs the majority of the signal is lost in the noise. An alternative timeslice approach for reconstructing the mid-Piacenzian is presented as an alternative way forward for data-model comparison.

Keywords: palaeoclimate; modelling; Pliocene; energy balance; temperatures; timeslice.

The Former BP Micropalaeontology Collection

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The Natural History Museum (NHM) curates the former British Petroleum (BP) Micropalaeontology Collection, which contains micropalaeontology samples from over 3,800 wells and several hundred outcrop sequence from over 120 countries and oceans. The collection includes material dating back to explorations undertaken in the late 1950s and was acquired by the NHM in 1992. The museum has since catalogued and databased this unique resource. The collection includes wet and dry residues, calcareous/silicious microfossils, palynological preparations and nannofossil slides that derive from core, sidewall core and cutting samples, in addition to associated material from many outcrop localities. Due to the commercial sensitivity of the collection, initial access to the collection was restricted. However, it is now possible to obtain access to the resource and the potential value of this collection to micropalaeontological research is very high.

An online museum database and Google Earth layer provides micropalaeontologists with the opportunity to undertake rapid evaluations of whether the collection may contain material beneficial to their research. Similarly, considering the vast spatial and temporal variation of the material encountered, combined with the lack of published research associated with the well run and outcrop microfossil assemblages, there are numerous potential opportunities to develop collaborative projects with the museum to utilise this valuable resource to its full potential.

Keywords: Biostratigraphy; palynology; foraminifera; ostracoda

Holocene water mass changes in Marguerite Bay, Antarctic Peninsula, from benthic foraminiferal assemblages

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Enhanced upwelling of warm, nutrient and CO_2 rich Upper Circumpolar Deep Water (UCDW), driven largely by Southern Westerly Winds (SWW), is believed to account for the deglacial rise in atmospheric CO_2 and retreat of West Antarctic ice shelves and glaciers. Measured increases in Antarctic windiness in past decades has caused concern that UCDW upwelling may become reinvigorated, releasing CO_2 and causing further destabilisation of West Antarctic ice shelves. However, the evolution of Holocene UCDW upwelling is largely unknown, limiting our ability to evaluate upwelling sensitivity to changing windiness. Here we present a unique record of bottom water conditions in Marguerite Bay, West Antarctic Peninsula, from benthic foraminiferal assemblages, showing that reductions in UCDW upwelling occurred throughout the Holocene. We link upwelling strength with changing windiness through the Holocene.

The typical CDW marker species *Bulimina aculeata* is present throughout, although rare in the early Holocene probably due to low oxygen. The early Holocene is associated with high productivity (diatoms and planktonic foraminifera), and indicates strong UCDW influence on the inner continental shelf. UCDW upwelling during the mid-Holocene is restricted to subsurface waters. During the late Holocene UCDW upwelling becomes cyclic, episodically replaced with saline shelf water as indicated by agglutinated foraminiferal horizons (e.g. *Miliammina, Trochammina*).

Greater UCDW upwelling in Marguerite Bay in the early Holocene is consistent with previous benthic foraminiferal studies from Palmer Deep, and increased opal production south of the Polar Front in the SE Atlantic and SW Pacific. We propose that the northward migrating core of the SWW through the Holocene, coincident with Antarctic cooling (Taylor Dome ice core), drove reduced Marguerite Bay upwelling via a less vigorous ACC. The records presented here form part of a comprehensive and high resolution proxy record of UCDW influence on the West Antarctic Peninsula through the Holocene. Simultaneous shifts in UCDW influence within Marguerite Bay and other southern hemisphere marine and climate records support a common driving force for Holocene climate change around Antarctica, which may well be the SWWs.

Keywords: Antarctica; Holocene; benthic foraminifera; Circum Polar Deep Water

Diversity history of Cenozoic planktic marine diatoms

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Diatoms are a dominant component of the global plankton, and it is important to understand their evolutionary response to past and future climate change. Their Cenozoic diversity history can indicate their climatic sensitivity by comparison to Cenozoic climate cooling. While reasonably comprehensive catalogs of species have been used to calculate the diversity history of planktonic foraminifera, coccolithophores and dinoflagellates, no comparable catalogs have yet been published for marine planktonic diatoms, and only two (contrasting) modern diversity curves have been published.

Cenozoic diatom diversity was calculated from species first and last occurrences ('range-through' method) extracted from the Neptune database of marine microfossil occurrences (Lazarus 1994) by Spencer-Cervato (1999) (SC99). Her results showed a major increase in diversity throughout the Cenozoic, with an initial Eocene increase, and much higher diversity from further increase beginning in the mid Miocene. Rabosky and Sorhannus (2009) (RS09) used the same database and standard paleobiologic subsampling methods to obtain a different result, wherein diatom diversity peaked in the Eocene and declined to lower levels that increased only modestly throughout the rest of the Cenozoic. We use both a new, as yet unpublished catalog of diatom species, and a new version of the Neptune database (NSB, based at the MfN in Berlin) to calculate new diversity estimates for Cenozoic diatoms. Unlike the earlier studies with Neptune, in our analyses of NSB occurrence data we combine subsampling with additional analyses to compensate for biases in subsampled estimates due to changing patterns of dominance, and the development of largely endemic polar floras during the Cenozoic. We also calculate that nearly 80% of living species, and nearly half of modern genera originated in the Neogene, and thus this interval is most relevant to understanding future diatom response to climate change.

Our results from analysing both the catalog data and NSB are similar. They show a temporary Eocene diversity peak/decline, followed by strong renewed diversity increase beginning in the lower Miocene, resulting in much higher modern diversity than in the basal Cenozoic, and a 2X-3X increase over the Neogene. Our own results are still underestimates of the extent of diatom diversification, in that we have not included the effects of systematic changes in preservation and style of data recording over the Cenozoic, both of which have probably biased the data against detecting diversity increase over time.

Modern diatom diversity increase developed in parallel to global cooling and the development of endemic cold-water polar biotas during the Neogene. Expected equilibrium diversity in a future warmer world thus might possibly be lower than that of today.

Building global infrastructure for 21st Century marine micropalaeontology

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Marine micropaleontologic research addresses problems that are global in scope and increasingly needs tools to access and synthesise data on a global scale. Current data systems are inadequate: ocean drilling program databases contain only a subset of raw primary data; archives e.g. Pangea hold fragmentary, non-standardised literature results. Two databases are being developed that help address these needs -the most recent version (NSB) of the Neptune database of microfossil occurrences, and the IODP supported master Taxonomic Name Lists of marine microfossil species (TNLs).

Neptune originated at the ETH, Zürich in the 1990s (Lazarus, 1994); was improved by porting to standard internet capable database software, and by addition of many data records, by the NSF supported Chronos project in the 2000's. Neptune Sandbox Berlin (NSB), with financial support from CEES, Oslo, has now been created by Lazarus and Diver to insure Neptune's continued development. NSB, like the earlier version of Neptune, holds >500,000 occurrence records for several thousand marine microfossil species; age models for sections; and taxonomy with synonyms. NSB is stable, internet accessible, and available for cooperative research use. NSB allows lower-level access for much more sophisticated data analyses than was possible with Chronos. Improved community access to NSB via a website is planned for the coming months.

The TNL database of IODP has recently been created by members of IODP's Paleontology Coordination Group (PCG) to allow integration and exchange of paleontology data throughout the multi-agency IODP effort. It contains over 18,000 evaluated species names for planktonic foraminifera, radiolaria, coccolithophores, diatoms and dinoflagellates. The TNL is based on IODP's own databases, the Neptune taxonomy tables and several large community databases, but with extensive editing and harmonisation of content. It will be hosted at IODP and maintained under supervision of the PCG, and is expected to provide a standard online source of taxonomic names for use by IODP, community databases such as NSB, and other science users.

With convergence of data content, data technologies (both systems use a common sql software - Postgres) and growth of internet exchange standards, these, and other databases are becoming more closely linked to each other, forming a global federated structure for use in 21st century marine micropaleontologic research.

Environmentally driven evolutionary patterns in the size of marine calcareous nannoplankton throughout the Jurassic

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In modern oceans, the size structure of marine phytoplankton communities greatly affects food web structure and organic/inorganic carbon export into the ocean interior. This last mechanism plays a fundamental role in the transfer of carbon from the surface oceanic reservoir to the carbonate sediments that belong to the lithospheric reservoir. Yet evolutionary patterns through time in the size structure of calcareous nannoplankton have been poorly investigated, especially in Jurassic time.

Here we present size structure evolution of *Schizosphaerella* (a probable calcareous dinoflagellate) in the interval comprised between the Late Sinemurian and the Toarcian (~192 to 180 Ma, Early Jurassic). *Schizosphaerella* was the main pelagic carbonate producer in the time interval considered and was dominating the calcareous nannoplankton community both in quantity and in size. *Schizosphaerella* size was explored in samples coming from two sections sampled in the Jurassic Lusitanian basin (Portugal), namely Saõ Pedro de Moel and Peniche. Size pattern data from Peniche have been in part published (Suan et al., 2008). We investigated: (a) long-term size evolution patterns and (b) for a short interval (~200 kyr) within the Early Pliensbachian, size changes in marlstone-limestone alternations that correspond to precession cycles (Suchéras-Marx et al., 2010).

Our results show that, in spite of generally opposite trends between *Schizosphaerella* absolute abundances and calcium carbonate contents measured in bulk rock, *Schizosphaerella* sizes fluctuate between average values of 8 to 15 μm and are globally higher in carbonate-rich samples. This pattern is verified both on the short- and long-terms. On the long-term, *Schizosphaerella* sizes also display an inverse correlation with marine temperatures inferred from the $\delta^{18}O$ of brachiopod calcite. Size changes seem also to be related to $\delta^{13}C$ positive and negative shifts observed in the Late Pliensbachian and Early Toarcian, although the relationships between these two parameters is not straightforward.

Climatically induced changes in oceanic mixing may have altered nutrient availability in the euphotic zone and driven evolutionary shifts in the size of calcareous nannoplankton through the Jurassic. Evolutionary patterns in the size distribution of calcareous nannoplankton can thus be a useful complement to geochemical or sedimentological proxies to improve the interpretation of the effects of climatic change on marine ecosystems.

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Recent advances in calcareous nannofossil biostratigraphy across the Pliensbachian/Toarcian boundary in the Peniche section, the GSSP candidate

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The main candidate for the Global Boundary Stratotype Section and Point for the base of the Toarcian Stage at the Peniche section (Lusitanian Basin, Portugal) satisfies most of the requirements recommended by the ICS. The Pliensbachian/Toarcian boundary at Peniche is included in a continuous section that encompasses over 450 m of carbonate-rich sediments. At the Pliensbachian/Toarcian boundary, observed in a marl/limestone alternation unit, no significant vertical facies changes, stratigraphic gaps or hiatuses have been recorded.

The palaeontological record shows abundant and diverse well-preserved macro- and microfossil assemblages. The excellent record of Toarcian sediments allows the identification of calcareous nannofossil events (mainly first occurrences) that were previously attributed to younger strata, because of a combined effect of (1) condensation or hiatuses in many classical areas of Western Tethys previously studied for nannofossil biostratigraphy, and (2) a Lazarus effect controlling the distribution of species routinely used in biostratigraphy. In fact, a temporary disappearance of some nannofossil species is recorded during the Early Toarcian anoxic event. These re-occur consistently in strata younger than the event.

A very tight correlation of Peniche to the magnetostratigraphy of Almonacid de la Cuba (Iberian, Range, Spain) allows us to discuss the magnetic record and to correlate it to the Karoo volcanic reversed/normal polarity succession, hence the possible projection of Karoo ages onto the Toarcian boundary interval.

Testing the robustness of thecamoebians for quantitative limnological reconstruction

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Lakes around the world are under pressure from rapid climatic changes, and direct and indirect anthropogenic pressures. Environmental indicators play a fundamental role in determining short and long-term responses to natural and anthropogenic forcings. However, environmental indicators used in lakes are biased by ecological and taphonomic factors, and more indicators are needed to dissect more precisely the natural ecological dynamics from the external impacts on lakes. Thecamoebians exhibit the potential to be a robust indicator of lake ecosystems health. Thecamoebians (testate amoebae) are cosmopolitan single-celled organisms (protists) that produce a test (shell). The group is diverse, and specimens are abundant in lake sediments, highly sensitive to environmental factors, and their tests (shells) are preserved in a wide range of environmental conditions. However, the utility of thecamoebians as environmental indicators in lakes is restricted by the limited knowledge of the ecology and taxonomy of the group. Therefore, the group's responses to environmental variations in lakes cannot be directly attributed to either ecological processes, or to climatic and anthropogenic impacts, or both. The main aim of this project is to establish the sensitivity of lake thecamoebians to environmental conditions by assessing their occurrence along nutrient and climatic gradients in the British Isles. This will assist in the development of a relatively new tool for pollution monitoring and ecological assessment of lakes, and for palaeoecological reconstruction.

Keywords: thecamoebians; linmology; climate

The Holocene interglacial: a view from Antarctica

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The Holocene epoch is our current Quaternary interglacial and represents a warm world within the predominantly cold Quaternary period. During this warm interglacial the polar regions have been the most sensitive to changes in climate, exemplified by the western Antarctic Peninsula region where modern mean annual surface temperatures have warmed some 3°C over the past 60 years or so. In the ocean around Antarctica, siliceous diatoms are abundant in the phytoplankton and have excellent preservation in the sediments providing a palaeoecological and geochemical archive of changing ocean-ice-atmosphere conditions. Diatom assemblages can be used as proxies for sea surface and sea ice conditions, whereas diatom silica oxygen isotope ratios can be used as a proxy for melting glacial ice, hence atmospheric conditions. This unique combination of diatom assemblage and diatom silica oxygen isotope records has been applied to a sediment record from ODP Site 1098, Palmer Deep, on the western Antarctic Peninsula permitting oceanic and atmospheric conditions to be reconstructed from the same signal carrier – the diatoms; and records will be presented to provide a Holocene context for the recent observed rapid warming and ice sheet melting along the Antarctic Peninsula.

The onshore Miocene of the UK: The last unknown stratum and its implications for Pennine development

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Onshore Miocene rocks in the UK are extremely rare. The Brassington Formation of Derbyshire and Staffordshire is an extensive succession of gravels, sands and clays preserved in around 60 karstic hollows. Originally studied in the 1970's a palynoflora was recovered from the lignite and clay beds of the Kenslow Member - the uppermost member of the Brassington Formation. Based on the state of the art at the time, the formation was assigned to the Late Miocene or Early Pliocene. The erosional surface that these sediments rest upon has been used to date the uplift of the Pennines mountain chain of central England. The uncertainties in the dating of the palynoflora has led to uncertainties in the estimated rate of uplift. As the age of the Brassington Formation is of some importance in understanding regional uplift patterns a new palynological study has been undertaken.

A new field campaign at Kenslow Top Pit, Derbyshire has produced a new palynoflora from the coloured clays of the Kenslow Member. This new palynoflora contains many taxa recorded in the original work but also some previously not reported. The palynoflora represents a warm - temperate mixed forest containing taxa common to this biome type such as *Abies*, *Cedrus*, *Icacinaceae*, *Keteleeria*, *Liquidambar*, *Symplocos* and *Tricolpopollenites microhenrici* (?*Quercus*). By comparison of the new palynoflora, and the original palynoflora, with floras from continental Europe, the age of the Kenslow Member can confidently be placed in the Tortonian Stage (11.61 - 7.25 Ma) of the Miocene. This means that the uplift rate of the Pennines has been more modest than previously reported.

Keywords: Miocene; Tortonian; Palynology; Pennines; UK.

Miocene vegetation and climate: from the Brassington Formation of Derbyshire to global distributions

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To produce geological stage maps of Miocene vegetation, a 634 site palaeobotanical database has been constructed from existing literature and new fieldwork on the Brassington Formation, UK. From the global palaeobotanical database it can be seen that during the Langhian (15.97 – 13.65 Ma) the world was considerably warmer than it has been since. Cool – temperate mixed forest occupied the high latitudes, warm – temperate mixed forest dominated the modern temperate latitudes and the tropics were characterised by extensive tropical evergreen broadleaf forest. Following the Langhian the biome distributions show a gradual cooling and drying of the global climate until the end of the studied period. Specifically there is a contraction of temperate and warm-temperate biomes from higher latitudes and a gradual expansion of drier more open biome types.

Onshore Miocene rocks in the UK are extremely rare. The Brassington Formation of Derbyshire is the most extensive deposit of Neogene sediments within the onshore UK rock record. Originally studied in the 1970's a palynoflora was recovered from the lignite and clay beds of the Kenslow Member, the uppermost portion of the Brassington Formation, and assigned to the Late Miocene or Early Pliocene. The erosional surface that these sediments rest upon has been used to date the uplift of the Pennines mountain chain of central England. The uncertainties in the dating of the palynoflora have led to uncertainties in the rate of uplift. To better resolve the age of the palynoflora and the evolution of the Pennine landscape, a new study of the Brassington Formation has been undertaken.

A new field campaign at Kenslow Top Pit, Derbyshire has produced a new palynoflora from the coloured clays of the Kenslow Member. This new palynoflora contains many taxa recorded in the original work but also some previously not reported. The palynoflora represents a warm - temperate mixed forest living under an ambient mean annual temperature of 16°C. By comparison of the new palynoflora, and the original palynoflora, with floras from continental Europe, the age of the Kenslow Member can confidently be placed in the Tortonian Stage (11.61 - 7.25 Ma) of the Miocene. This means that the uplift rate of the Pennines has been more modest than previously reported.

Keywords: Miocene; Palynology; UK; palaeobotany; global biomes; climate.

Late Pliocene lakes and soils: A global data set for the analysis of climate feedbacks in a warmer world

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Albedo-related soil and vegetation feedbacks are key uncertainties and climate models differ considerably in estimating their strength. For the terrestrial realm, large inland water bodies and wetlands have also been shown to significantly affect surface temperatures and energy balance in past and present climate systems.

In this project we will test the importance of soil feedbacks and lakes in a higher CO_2 warmer world. We will focus on the Late Pliocene (Piacenzian stage), 3.6 to 2.6 million (Ma) years ago. The project will build on existing vegetation reconstructions and add to the comprehensive Pliocene dataset TEVIS a new global map and database of palaeo-lakes and soils. The data will be implemented as an additional boundary condition in Pliocene GCMs in order to increase the robustness of our climate predictions. Previous data-model comparisons using the new PRISM vegetation data set revealed that many climate models tend to underestimate the Pliocene mean annual rainfall in tropical regions of Amazonia, Africa and Australia. For the late Quaternary, climate modelling experiments have demonstrated the importance of large water bodies and climate feedbacks from soil formation processes for the regional climate of the African continent.

Here we present the initial results of a data synthesis and mapping project to improve our understanding of Piacenzian climate change.

Keywords: Pliocene; Lakes and soils; global reconstruction; warmer world.

Warm Worlds down under: deciphering Antarctica's climate during the early Eocene Greenhouse Phase

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The warmest global climates of the past 80 Million years (Myr) occurred during the early Eocene epoch (~55-48 Myr ago), with greatly reduced equator-to-pole temperature gradients and atmospheric CO_2 levels in excess of 1,000 ppmv. Recently, the early Eocene has received considerable interest because it may provide insight into the response of the Earth's climate and biosphere to high atmospheric CO_2 levels that are expected for the near future as a consequence of unabated anthropogenic carbon emissions. However, climatic conditions of the early Eocene greenhouse world are poorly constrained in critical regions, particularly the Antarctic continent. We present a unique, well-dated record of early Eocene climate on Antarctica from an ocean sediment core recovered off the Wilkes Land coast. The information from biotic (pollen and spores) and independent organic geochemical (MBT/CBT palaeothermometry) climate proxies yields quantitative, seasonal temperature reconstructions for the early Eocene greenhouse world on Antarctica. Our results show that the climate in lowland settings along the Wilkes Land coast (palaeolatitude ~70° S) supported the growth of highly diverse, near-tropical forests characterized by mesothermal to megathermal floral elements including palms and Bombacoideae. Notably, winters were extremely mild (>10 °C) and essentially frost-free despite polar darkness, which provides a critical new constraint for the validation of climate models and understanding the response of high-latitude terrestrial ecosystems to increased CO_2 forcing.

Keywords: Eocene; greenhouse world; Antarctica; pollen; MBT/CBT palaeothermometry; ocean drilling.

Macroevolution and macroecology of planktonic foraminifera in a cooling world

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The Cenozoic macroperforate planktonic foraminifera have probably the most complete and well-understood fossil record of any clade. Although the record is far from perfect – DNA sequence data indicate that many morphospecies contain multiple genetic species – the clade represents a possible model system for macroevolution and paleomacroecology. We compare the evolutionary dynamics of the clade between "greenhouse" and "icehouse" conditions, showing that both speciation and extinction have been phylogenetically non-random. Phylogenies also contain within them evidence of adaptive zones - ecological arenas within which multiple species compete, but between which there is little or no competition. We show how the clade's phylogeny suggests that a set of adaptive zones persisted stably through the Eocene but that the Eocene-Oligocene transition saw a radical overhaul. We relate these changes to temporal trends in community phylogenetic patterns and functional diversity within the clade.

The macroevolutionary history of Antarctic Neogene radiolarians

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Understanding how life diversity is affected by environmental changes, and more generally what are the driving events of macroevolutionary patterns, is at the heart of ecological and paleobiological research. The imperfection of most fossil records is the cause of a large array of biases preventing direct reconstruction of paleodiversity. Marine micropaleontology however does not have the limitations of most fossil records and therefore should constitute a unique resource for paleobiology and a reference standard for macroevolutionary research. Neogene radiolarians in particular have a rich (thanks to the DSDP/ ODP deep sea drilling campaigns) and complete record. They are furthermore abundant, diversified and consistently well-preserved in Antarctic sediments. However, studies to date have focussed only on a small subset of this fauna.

In this study, a quantitative, taxonomically-complete dataset have been collected in various sites of the Southern Ocean, using 98 samples and ca. 7000 specimens per sample. Ca. 500 species were uncovered in this fauna, including 120 new to science.

The study of the macroevolutionary history of this fauna reveals that a significant, extinctionless ecological turnover, linked to a decrease in the evenness of the species' abundances and the rise of genus *Antarctissa* to dominance, occurred at ca. 8 Ma, followed 3 My later by a significant diversity loss. Although the ecological event can be tentatively associated with a regional change in the composition of primary producers, the triggering event of the diversity loss is yet to be found.

Toward an high-resolution stratigraphy for Antarctic Neogene radiolarians

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Cenozoic climate evolution is directly linked to the paleoceanographical evolution of the Southern Ocean. However the current accuracy of the available geochronological framework hinders the understanding of this evolution. Because of the peculiar sedimentary conditions of the Neogene Southern Ocean that prevents the reliable use of calcareous microfossils for biostratigraphy and because of the widespread hiatuses and the poor paleomagnetic polarity record in many sections, the Antarctic Neogene stratigraphic framework relies heavily on siliceous microfossils.

Current radiolarian biostratigraphy for the Antarctic Neogene is based on a total of 40 species. However, ca. 500 species are present in the Neogene Southern Ocean: the radiolarian fossil record for this time interval and that region has a huge potential that previous studies didn't make use of. The aim of this preliminary study is to uncover this potential by using a full fauna dataset in the context of a quantitative biostratigraphic analysis.

After careful treatment of outliers (reworked or misidentified specimens, species with inconsistent ranges, ...), and a biostratigraphical analysis using the Constrained Optimization (CONOP) method (Kemple et al. 1995) on six Antarctic Neogene ODP sites, we show here that 94 bioevents seem reliable enough to be used to correlate our Southern Ocean sections. Although still preliminary, this study underlines the feasibility of improving biostratigraphic analysis using whole fauna data.

Reference

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Foraminifera are sorted by size and taxon during post-mortem transport

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Palaeoenvironmental reconstruction using foraminifera relies on the assumption that assemblages reflect the ecological conditions at the time of deposition. However, the distribution of taxa can be greatly affected by transport and reworking of tests, and although this issue is generic to all environments with active submarine currents this issue is particularly pronounced in the canyon and fan systems in which much of the worlds hydrocarbon reserves are found. Here, we provide critically important new empirical constraints on 1) the behaviour of empty foraminiferal tests compared to quartzose sediments and 2) the likelihood that different taxa will behave differently and thus may become sorted during transport. Measured settling velocities range from 0.01 to 0.06 ms-1 (with foraminifera 200-500 although larger specimens fall faster than smaller ones, differences between taxa are also significant. Of the five taxa investigated, *Elphidium crispum* exhibits the fastest average settling velocity of 0.03 ms-1 while *Planorbulina mediterranensis* falls with the lowest average settling velocity of 0.01 ms-1. As predicted by this result, we also report significant spatial separation of taxa within a single flow using a simple waning turbidity current experiment within a laboratory flume. These results are highly compatible with the results of settling experiments, indicating that slowly settling tests such. *P. mediterranensis* and *Cibicides lobatulus* remain suspended in the current for longer, and are thus transported further, than more rapidly settling taxa such as *E. cripsum* and *Ammonia spp.* Consequently, assemblages of foraminifera experiencing even moderate turbulent currents should be assumed to be sorted by shape (i.e. by taxon) in addition to being sorted by size, and that hydraulic rather than ecological parameters control the distribution of assemblages.

Keywords: foraminifera; taphonomy; sediment; turbulent flow.

Early to Middle Miocene vegetation and climate at the Wilkes Land margin, East Antarctica

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The question of whether continental Antarctic climate was warm enough to support a substantial vegetation cover during the Neogene is of great significance to the ongoing controversial debate on the behaviour of Antarctic land ice during the Miocene-Pliocene transition from dynamic to persistent ice sheets. Here we present palynological results from a Miocene sediment record provided by the Integrated Ocean Drilling Program (IODP) Expedition 318 to the Wilkes Land margin (East Antarctica). The reconstructed vegetation changes are compared with climate estimates derived from dinoflagellate cysts and MBT/CBT organic palaeotemperature proxies.

Analyses of pollen and spores indicate a low-diverse vegetation dominated by *Podocarpus*- and *Nothofagus*- trees and shrubs. Particular high *Podocarpus* percentages occur during the Middle Miocene Climatic Optimum (MMCO). For this time period MBT/CBT suggests a cool temperate climate with increased mean air temperatures (MAT). Dinoflagellate cyst assemblages, dominated by autotrophic species, are indicative of ice-free surface waters. After MMCO a subsequent decline in MAT is indicated by MBT and dinoflagellate cyst assemblages, though pollen percentages (e.g. *Podocarpus*/*Nothofagus* ratio) remain relatively stable. However, very high *Nothofagus* and low *Podocarpus* pollen percentages may suggest lower temperatures towards the end of the middle Miocene

Keywords: Miocene, Antarctica, Palynology, vegetation, climate, IODP

Phytoplankton cysts turn crazy: abnormal acritarchs announce isotope excursions in the Lower Palaeozoic

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The Late Ordovician and Silurian are characterised by several strong, global positive $\delta^{13}C_{carb}$ excursions. Some of them exceed + 5‰ and thus belong to the strongest perturbations of the carbon cycle in the Phanerozoic. The onset of the excursions is characterised by extinction and/or turnover events of several groups of marine invertebrates. The causal mechanisms of the carbon cycle perturbations, however, are still unknown and currently a matter of vigorous scientific debate. Our own investigations in the Hirnantian (latest Ordovician) have shown that the onset of the major $\delta^{13}C$ excursion (HICE) is characterised by very high abundances of acritarchs showing abnormal, teratological forms (Delabroye et al., 2011). A critical review of published reports of abnormal acritarchs from the Late Ordovician to Early Devonian, and a correlation of their occurrences with the global stable carbon isotope curve, show that high abundances of teratological forms of acritarchs are often coeval to the run-up of δ13C excursions (Munnecke et al., 2012).

High abundances of teratological forms in modern marine protists are commonly observed in environments with a high degree of environmental stress. In the fossil record, the challenge is to attribute abnormal forms of organisms to specific environmental circumstances. Our study implies that they are somehow related to the global carbon cycle, i.e., to carbon isotopic composition of the ambient sea water, and that they share a common extrinsic cause with the contemporaneous extinction and/or turnover events in other fossil groups.

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A model for the evolution and infill of coastal tidal creek systems in the Holocene of English Fenland

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A Holocene sand/silt filled tidal creek (locally called a roddon) excavated near Whittlesey, within the English Fenland, preserves an unprecedented record of Fenland tidal creek evolution, flagging intervals of stasis punctuated by rapid environmental change, and is a potential model for the evolution of the Fenland landscape through the Holocene. The tidal creek was formed sometime between ca 4735BP and ca 3645BP, was established for several hundred years, and its infill comprises cm-scale, laminated, tidal sand-mud couplets (some 600 in total) suggesting rapid sedimentation that choked the creek system, cutting off the influence of marine conditions and terminating a long period of environmental stasis. Microfaunas in the roddon silts show marine and brackish influence, despite the fact that published palaeogeographies place Must Farm at least 30 km from the palaeocoast. The later mud-filled channel atop the Roddon may have been originally incised by a single marine event (perhaps a catastrophic storm surge), but quickly transformed into a slowly flowing river of the proto-Nene. Infill of the later channel occurred between ~3250 and 2050 BP (~1300-100 cal BC) as shown by archaeological finds. Once established this channel heralded a further phase of stasis, lasting about 1200 years, before the freshwater channel finally silted up and peat formation blanketed the area. In contrast to the tidal creek system, the late phase channel at Must Farm yielded a microfauna dominated by freshwater ostracods.

Keywords: Fenland; Holocene, roddons, tidal creeks, microfauna; sea-level rise

Age, environment and paleoclimate of the Yorktown Formation, US Atlantic Coast

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The Yorktown Formation of southeastern Virginia has a stratigraphic record that documents the highest sea level stand in the mid-Pliocene (3.5 - 3.0 Ma) and the maximum landward extent of the Atlantic Ocean along the east coast. The age of the Yorktown Formation is constrained by reversed polarity at the Deep Creek locality in Virginia and by the stratigraphically significant foraminifera *Globorotalia puncticulata*, *Dentoglobigerina altispira* and *Sphaeroidenellopsis* spp. Quantitative analysis of the planktic foraminiferal assemblage suggests decreased seasonality compared to present day and sea surface temperatures of 24.4 ± 1.5 °C. Studying the paleoclimate of oceanographically sensitive regions of the North Atlantic can help to inform paleoclimate simulations in regions where climate models do not agree.

The John Williams Index of Palaeopalynology

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The John Williams Index of Palaeopalynology (JWIP) is a card catalogue stored at the Natural History Museum, London, and is based around a central index of over 23,650 references (as of August 2012). The card catalogue began in 1971 by John Williams who has been the sole contributor to this unique resource since its creation. The references included within the catalogue are a thorough collection of palaeopalynological journal articles, textbooks, selected conference abstract volumes, and MSc and PhD theses etc. available online, that have been reviewed by the author since creation of the catalogue some 40 years ago. The catalogue evolves around a central card index (labelled 'JWIP References'), from which each reference is then cross-referenced into separate card catalogues categorised by palynomorph group (spores/pollen, dinoflagellate cysts and acritarchs, chitinozoans and miscellaneous), taxa (spores/pollen, dinoflagellate cysts, acritarchs and chitinozoans), geological period (26 divisions) and geographical region (17 regions).

Due to this unique format, the card index enables a user to undertake a search based on the specific needs of their research, whether it is the investigation of individual taxa in a taxonomic study, or an evaluation of assemblage data in a specific time or region, for example, allowing the user to find all the relevant references. The number of references obtained during each card index search surpasses generic web searches and/or academic search engines in terms of accuracy and detail. In addition, whilst the entire card index has been compiled by John Williams, each publication is also assiduously checked by John prior to being inputted into the card index. This results in the reliability and consistency encountered in the card index surpassing that of Palynodata, the only known comparable compilation of palynological data.

The card index is still growing, with John Williams adding information to the index of some 1000 additional references each year. The NHM are in the process of evaluating potential avenues to convert this into a digital resource. This presentation will review the resource, its structure and provide examples of its application to existing and potential palynological research.

Keywords: card index; database; marine; terrestrial; Cenozoic; Mesozoic; Palaeozoic

Late Pleistocene pteropods as a proxy for surface ocean carbonate concentrations

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Recent concern over the effects of ocean acidification upon calcifying organisms in the modern ocean has highlighted the aragonitic shelled thecosomatous pteropods as being at a high risk. Laboratory studies have shown that increased pCO_2, leading to decreased pH and low carbonate concentrations, has a negative impact on the ability of pteropods to calcify and maintain their shells.

This study presents the micropalaeontological analysis of marine cores from sites in the Caribbean Sea, the Mediterranean Sea and the Indian Ocean. Pteropods, heteropods and planktic foraminifera were picked from samples to provide palaeotemperature, abundance, diversity and fragmentation data for each core. Determination of pteropod calcification was made using the *Limacina* Dissolution Index and by calculating the average shell size of *Limacina inflata* specimens. Pteropod calcification indices were compared to global ice volume (oxygen isotope analysis) and Vostok atmospheric CO_2 concentrations for each core to determine any relationship between climate (and $CaCO_3$ saturation) and calcification through the Late Pleistocene.

It was found that the calcification of thecosomatous pteropods was affected by changes in surface ocean carbonate concentrations throughout the Late Pleistocene. These affects can be detected in shells from marine sediments that are located well above the aragonite lysocline and have not undergone post depositional dissolution. The results of this study confirm the findings of laboratory studies, showing a decrease in calcification during interglacial periods, when atmospheric and surface ocean concentrations of CO_2 were higher, reducing the availability of carbonate for the production and maintenance of calcium carbonate shells. During glacial periods, calcification was enhanced due to the increased availability of carbonate. This trend was found in all sediments studied, which indicates that the response of pteropods to past climate change is of global significance.

Whilst the application of these results to the modern ocean is inappropriate, since the conditions influencing climate change throughout the Late Pleistocene are not comparable to those of today, this study demonstrates that, at oceanic pH levels relatively higher and changing at a lesser rate than those predicted for the 21st Century, pteropods have been noticeably negatively affected.

These results also demonstrate the use of pteropods in reconstructing surface ocean conditions. The application of the *Limacina* Dissolution Index has proved to be a fast and inexpensive methodology in the determination of surface water carbonate saturation.

Abundances of key pteropod and heteropod species were also found to constrain palaeotemperatures better than planktic foraminifera, a use which could be further developed.

Keywords: pteropod; *Limacina* Dissolution Index; ocean acidification; Pleistocene.

Oxygen isotope variability in Ordovician and Silurian conodonts (poster)

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Conodonts are potentially robust archives of climate. Previous ion microprobe conodont $\delta^{18}O$ studies have proceeded directly to palaeotemperature interpretation without consideration of variability. Here, ion microprobe analyses of Ordovician and Silurian conodonts establishes: intra-element crown tissue $\delta^{18}O$ typically varies by ≤1‰ is normally ≤2‰ and rarely varies by 2-4‰; $\delta^{18}O$ can vary across elements, suggesting a microstructural and/or diagenetic control; $\delta^{18}O$ can vary between species representatives by c.3‰; $\delta^{18}O$ of pelagic and nektobenthic taxa can vary by 2.3‰; processing and thermal alteration influences $\delta^{18}O$. Utilization of material with no consideration of geological context or processing history may introduce significant artefacts. A protocol for future conodont oxygen isotope ion microprobe studies is proposed.

Microfossil provenance of British lowland Iron Age artefacts

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Understanding ancient trade and cultural connections is a mainstay of modern archaeology. While high value or exotic items often defined major and early long-distance trade routes, more enigmatic are the sources of everyday objects used in the lives of ancient peoples, such as the cooking pots of households or the earthworks surrounding homesteads, settlements or forts. Here we use microfossils to provenance archaeological materials in a British Iron Age setting, taking Burrough Hill Iron Age hill fort, east Leicestershire as the case study. Burrough Hill is situated in a landscape of Mesozoic sedimentary rock deposits covered with Quaternary till and its study has wide implications for understanding the source of Iron Age building and manufactured materials across southeast and eastern Britain. The hill fort occupies a geographically central site in Britain, and in the Late Iron Age was a tribal centre of the Corieltauvi. Permanent occupation of the hill probably began in late Bronze Age or early Iron Age times and continued into the Roman period. Iron Age materials recovered at Burrough Hill include pottery of the La Tène and Scored ceramic styles, daub from roundhouses, and the clay linings of the entrance wall, storage pits and hearths. Microfossils can be recovered from the smallest of sedimentary rock samples at Burrough Hill, and coupled with a micropalaeontological study of the local Quaternary sedimentary deposits and the regional Mesozoic record, provide a clear indication of the provenance of materials for manufactured and building materials at the site.

Keywords: Iron Age; artefacts; provenance; microfossils