[2]Nordic Volcanological Institute, Grensasvegur 50, Reykjavik 108, Iceland

[3]Massachusetts Institute of Technology, 77 Massachusetts Ave., E34-254, Cambridge, MA 02139, United States

We present the first detailed record of Holocene climate variation from Icelandic eolian soil deposits. Seven cold and windy episodes occurred in Iceland during the last 10,000 years, including the well-documented Little Ice Age (0.6-0.1 ka) and "8.2 kyr Event". Each of these events is associated with cold and windy climate in central Greenland, enhanced drift ice discharge into the North Atlantic, and a diminution of deep convection in the North Atlantic. Whereas these conditions are consistent with an expansion of the polar cell, they cannot be attributed to a persistent negative phase of the NAO/AO.

PP42A-0872 1330h POSTER

Noble Gas Thermometry and Hydrologic Ages: Evidence for Late Holocene Warming in Southwest Texas

Maria Clara Castro[1] (734-615-3812; mccastro@umich.edu)

Patrick Goblet[2] (33-1-64-69-47-49; patrick.goblet@ensmp.fr)

[1]University of Michigan, Department of Geological Sciences C.C. Little Building 425 E. University Ave., Ann Arbor, MI 48109, United States

[2]Ecole des Mines de Paris, Centre d´Informatique Géologique 35, rue Saint Honoré, Fontainebleau 77305, France

Paleoclimatic reconstruction through the use of noble gases dissolved in groundwater has been the object of numerous studies in recent years. Unlike many other continental temperature proxies, noble gases have the advantage of providing direct information on atmospheric temperatures at the time rainwater penetrated the ground and joined a particular groundwater reservoir. In recent years, new methods for determination of noble gas temperatures have been developed, which provide a high level of accuracy on such temperature estimations. The issue of paleoclimatic reconstruction through noble gases however, is not only one of accurate temperature determination, but also one of accurate water age estimation so that a correct correspondence between noble gas temperatures and groundwater age can be established and proper paleoclimatic reconstruction attempted. The typical approach to estimate groundwater ages has been based on computing water travel times along streamlines from the recharge to the observation point taking into account only advection. This approach is limited because, like any other tracer, the movement of water in porous media is also affected by cinematic dispersion and molecular diffusion. We have therefore undertaken the formulation of hydrologic models that yield significantly better constraints on groundwater ages in the Carrizo aquifer and surrounding formations of south Texas, where noble gas temperatures have already been determined. To account for groundwater mixing we treat age as one would treat a solute concentration. In order to simulate groundwater ages we used a finite element model of groundwater flow that has been validated by ^{4}He and ^{3}He. The finite model spans a 120.6 Km cross-section between altitudes of +220m and -2210 m, and comprises 58,968 elements and 31,949 nodes. Combination of these newly calculated water ages and previously reported noble gas temperatures reveals new aspects of late Pleistocene and Holocene climate in southwestern Texas, in particular, an abrupt late Holocene temperature increase previously unidentified through ^{14}C dating. Temperature increased by up to 3.4°C in the first half of the last millennium and by 1.5°C between ∼5.6 and 3.7 kyrs BP. More important than the resolution of individual paleoclimate episodes is the identification of a slow cooling trend between ∼1,200 kyrs and ∼200 kyrs, a trend that accelerates during the late Pleistocene and early Holocene. This cooling trend gives way to an extremely rapid increase in temperature in the late Holocene. Such abrupt warming seems to have accelerated in the last millennium and seems to continue at present. This temperature increase is the most striking feature arising from the determination of new groundwater ages.

PP42B MCC: Level 2 Thursday 1330h

Old World Social Responses to Holocene Abrupt Climate Change Events II Posters *(joint with B, GC, PA, HG)*

Presiding: **H Weiss,** Yale University**; D M Anderson,** NOAA Paleoclimatology Program

PP42B-0873 1330h POSTER

Drastic Aridification Caused the Decline of Oasis Civilizations on the Silk Route during the Eighth Century

Kuo-Yen Wei[1] (886-2-23691143; weiky@ntu.edu.tw)

Sheng-Rong Song[1] (886-2-23630231X2671; srsong@ntu.edu.tw)

Chi-Yue Huang[2] (huangcy@mail.ncku.edu.tw)

[1]Dept. of Geosciences, National Taiwan University, Post Box 13-318, Taipei 106, Taiwan

[2]Dept. of Earth Sciences, National Chengkung University, 1, University Road, Tainan 701, Taiwan

Availability of water, and response to shortage of it, plays an important role in shaping human history. Near a century ago, Ellsworth Huntington (1907) suggested that the developments of ancient civilizations in Inner Asian and their invasions into China and Europe were pulsed by climatic changes. In revisiting this proposition, here we present a paleoclimatic record of the past 5000 years deduced from carbon isotopic ratio of organic carbon and percentage of aragonite in bulk sediments of a radiometrically dated sedimentary core of Lake Bosten, Xinjiang, China. Together the two proxies of aridity provide a detailed record of climatic fluctuation of the Inner Asia. The arid periods are well characterized by high content of authigenic aragonite and heavier values of carbon isotopic ratio of organic carbon in the bulk sediments (implying dominance of C4 plants which thrived under arid condition). Conversely, the humid/wet periods are marked by lighter carbon isotopic values (indicating presence of C3 plants of humid climate and absence of aragonite. The Western Region (Xi-Y) area of China enjoyed a long period of stable and humid condition from 2nd century B.C. to the 8th century when many oasis city-states were established and Buddhism spread from India. A drastic deterioration of climate during the eighth century appears to cause the decline of those once strived ancient civilizations in the eastern side of the Tarim Basin along the Silk Routes.

PP42B-0874 1330h POSTER

Dating, definition, and impacts of Holocene short-term climate change episodes: issues and prospects with an Aegean area focus

Sturt W Manning (+44 118 9318132; s.w.manning@reading.ac.uk)

Department of Archaeology, University of Reading, PO Box 217 Whiteknights, Reading RG6 6AB, United Kingdom

Much attention currently focuses on the identification and role of significant short-term (century-scale) climate change episodes, with instances of such episodes in the past offering analogues for possible present and future scenarios. Archaeology has so far been under-used as a relevant data source. It has a great deal to contribute with rich datasets pertaining to the impacts on humans and their habitats from such events. The Aegean region - the case study considered in this paper - has a rich database from the Neolithic period (9th millennium BC) onwards. But a key issue must first be addressed: the ability to establish tight chronological resolution for all data types to be considered. This is critical to ensure that only genuinely coeval and associated phenomena as observed in various records are considered together. There is otherwise a danger that researchers suck in a variety of un-linked data and smear them together inappropriately. The problem centres particularly on radiocarbon dating, since this is the main basis to prehistoric archaeological dating, and also the dating of most pollen records, sediment records, and so on. For example, significant short-term global climate change episodes have been recognised at 8.2, 5.2 and 4.2 ka BP. However, is it a coincidence that each of these dates lie in periods when radiocarbon levels effectively plateau - that is real calendar dates over 100-200+ year periods yield essentially very similar radiocarbon ages? Are disassociated data being associated through similar radiocarbon ages rather than their true calendar dates? This problem, and potential strategies to a solution through radiocarbon wiggle-matching, will be explored for the above episodes. Concentrating then on the 4.2 ka BP episode, data from one particular case - the Aegean region - will be assessed in terms of our ability to define the 4.2 ka BP event. Current limitations will be highlighted. The differing impacts of the episode in the region will then be surveyed to highlight the variety of responses such episodes can promote contingent on local circumstances and evolutionary trajectories.

PP42B-0875 1330h POSTER

Abrupt Changes in the Asian Summer Monsoon Winds During the Holocene

David M Anderson[1] (303-497-6237; david.m.anderson@noaa.gov)

Anil K Gupta[2] (anilg@gg.iitkgp.ernet.in)

Jonathan T Overpeck[3] (jto@u.arizona.edu)

Deep N Pandey[4] (dnpandey@ethnoforestry.org)

[1]NOAA Paleoclimatology Program, 325 Broadway, E/CC23, Boulder, CO 80305, United States

[2]Department of Geology and Geophysics, Indian Institute of Technology, Kharagpur 721302, India

[3]Department of Geosciences and Institute for the Study of Planet Earth, University of Arizona, Tuscon, AZ 85721, United States

[4]Indian Institute of Forest Management, India and Forest Department, Van Bhawan, Tilak Nagar, Jaipur, Bhopal 462003, India

The Asian summer monsoon affects climate and society throughout a large part of the tropics. Abrupt changes in the monsoon had potentially dramatic effect on human societies during the Holocene. Using fossil evidence of Globigerina bulloides abundance in the Arabian Sea, we reconstructed the history of the Asian summer monsoon winds during the past 10,000 years. G. bulloides provides a reliable index of the monsoon, its abundance correlated with the cool upwelling conditions produced each summer by the monsoon winds. The Arabian Sea sediments are nannofossil-rich foraminifer oozes, and the low oxygen content of the Arabian Sea minimizes the bioturbation that would otherwise smooth the fossil record. In addition to the well-known decrease in the monsoon winds since a maximum in the early Holocene, we found a series of smaller, millennial-scale oscillations between strong and weak monsoon intervals throughout the Holocene. Periods of weaker monsoon winds correlate with cool conditions in the circum-north Atlantic during the Holocene, just as they did during the larger Dansgaard-Oeschger events of the last glacial, evidence of a link between low and mid-latitude climate. The changes in the monsoon winds were probably accompanied by changes in rainfall over India, and we hypothesize that rain harvesting structures built in India since 5000 year BP were societal adaptations to climate change. Widespread evidence exists for the construction of ponds, tanks, and artificial reservoirs during the late Holocene when the monsoon reached its Holocene minimum, and we also find correlation between heightened historical human efforts for adaptation and the most recent minima in the monsoon winds that occurred 1600 AD. The monsoon record supports an emerging paradigm that at least in the tropics, the most societally-important climate changes were driven by changes in precipitation rather than surface temperature. The cause of the monsoon oscillations, and their links to other aspects of the tropical circulation and higher latitude climate are still poorly understood and require improved and more extensive quantitative records of the tropical circulation.

PP42C MCC: 3004 Thursday 1340h

Mesozoic Black Shales: Fresh Looks at an Old Problem II *(joint with OS)*

Presiding: **K G MacLeod,** University of Missouri**; P A Meyers,** University of Michigan

PP42C-01 1345h INVITED

On the Origin of Mesozoic Oceanic Anoxic Events (OAEs): An Overview

Michael A Arthur (814 863 6054; arthur@geosc.psu.edu)

Pennsylvania State University, Department of Geosciences, University Park, PA 16802, United States

The search for commonality in the nature and origin of "black shale" units that characterize Jurassic-Cretaceous "Oceanic Anoxic Events" has not come to fruition. Indeed, it would appear that OAEs differ from one another in duration, distribution, organic carbon contents, and carbon isotope signatures. In addition, they differ in origin as interpreted from faunal, floral and stable isotope data. Considerable uncertainty remains regarding the relative roles of productivity (carbon flux) and mechanisms of preservation (low dissolved oxygen at the sediment/water interface, high sedimentation rate, or high mineral surface area) during OAEs in general. For example, it is difficult to separate anoxia from high surface-water productivity as a cause for enhanced organic matter preservation, in part because oxygen depletion in deeper water masses is a response to high fertility and organic carbon flux. Mineral surface area recently has been proposed as the only control on organic carbon contents, but this seems doubtful. There are, however, interesting patterns that bear further examination. OAEs, and black shales in general, typically form during transgressive episodes. For epicontinental black shales, transgression creates conditions that favor nutrient trapping in relatively isolated basins; these nutrients originate either from fluvial sources or are transported into epicontinental seas from adjacent ocean basins with well-developed, nutrient-rich oxygen minimum zones. It is not clear how transgression induces more global, open-ocean OAEs. They may be a response to several factors related to the cause(s) of the transgressions, including changes in deepwater overturn rates induced by increasing expanse of shallow shelf regions or opening of oceanic gateways, and/or by overall higher nutrient fluxes from weathering brought about by warmer, wetter climates related to times of greater outgassing resulting from increased volcanism. In some cases, enhanced oceanic stratification may have result in anoxia and a preservational OAE (e.g., OAE 1d), whereas most OAEs appear to involve enhanced mixing and nutrient fluxes (e.g., OAE 1b and OAE 2). There has been more excitement recently regarding decomposition of methane hydrates as a possible trigger for OAEs producing sudden warming and consumption of deep-water oxygen. Although significant negative carbon isotope excursions accompany the Toarcian and Aptian (OAE 1a) OAEs, the isotopic patterns can be explained by volcanic events. There is evidence that increased volcanism precedes or accompanies some OAEs. It is clear that more high-quality, globally distributed geochemical and biotic records are required to resolve the OAE problem.

PP42C-02 1405h INVITED

The Dissolved Oxygen Controversy: Reconciling Oceanographic Versus Geological Perspectives

Richard V Tyson (44-191-222-6605; r.v.tyson@ncl.ac.uk)

School of Civil Engineering and Geosciences, University of Newcastle, Newcastle NE1 7RU, United Kingdom

Geological models for the origin of black shales have invoked a preservative effect of dysoxia-anoxia for nearly a century, yet during the last 30 years some oceanographers have used modern sediment data to question and even deny the importance of dissolved oxygen. This schism over the origin of organic-rich sediments must be addressed and healed. With regard to modern sediment observations the problem appears to be how representative the data are, how and where oxygen hypotheses are tested (and against what expectations), and how the findings may have been extrapolated and generalised. It is increasingly clear that the total organic carbon (TOC) content of sediments is a classic multivariate problem where input (productivity), preservation, and inorganic dilution must all be considered simultaneously. The most common low oxygen environments in the modern ocean are oxygen minimum zones (OMZ), but these are also characterised by high productivities, high sedimentation rates, and generally high preservation, and are thus a very poor place to isolate the role of oxygen. Furthermore, OMZ studies have used a comparative analysis of TOC above, within, and below the OMZ, where the latter is defined only by local minima, not oxygen values considered likely to have a significant effect on benthos or geochemical preservation. Sometimes hypotheses have been constructed based on data from only a narrow (suboxic-dysoxic) oxygen range, fully oxic regimes, or areas too strongly influenced by grain size. The organic-rich nature of modern deep Black Sea sediments has also been denied, but seems indisputable relative to similar oxic regimes. A critique and analysis of the available modern data (increasing all the time, but still limited) suggest that the oceanographic view that oxygen is not important is impossible to sustain as a generality, indeed a statistical non-linear effect can be identified by multiple regression analysis. In many modern settings other factors are definitely dominant, but in the slowly deposited ancient basinal facies, the role of oxygen appears to be a critical control on preservation. Important issues remain to be resolved, but the old bipolar arguments about productivity versus preservation must be cast aside in favour of more complex multivariate approaches.

PP42C-03 1425h

Planktic Foraminiferal Turnover and Stable Isotope Stratigraphy Across OAE1B in the Subtropical North Atlantic

Brian T. Huber[1] (202-786-2658; huber.brian@nmnh.si.edu)

Nancy A. Price[2] (small_fzzy_mamml@yahoo.com)

Kenneth G. MacLeod[3] (macleodk@missouri.edu)

[1]Smithsonian Museum of Natural History, Department of Paleobiology, MRC-121, Washington, DC 20560, United States

[2]Richard Stockton College of New Jersey, Jimmie Leeds Road, Pomona, NJ 08240, United States

[3]University of Missouri, Columbia, Department of Geological Sciences, Columbia, MO 65211, United States

Stable isotope data generated from glassy (diagenetically unaltered) foraminifera from the subtropical North Atlantic (ODP Site 1049) reveal abrupt paleoceanographic and faunal changes that coincide with the Aptian/Albian boundary and the onset of Oceanic Anoxic Event (OAE) 1b. At least three planktic and one benthic species per sample, selected at closely spaced intervals from the *Globigerinelloides algerianus* Zone (mid-Aptian) through uppermost *Ticinella bejaouaensis* Zone (uppermost Aptian), reveal a consistently low ($<1.1^o/_{oo}$) vertical $\delta^{18}O$ gradient, suggesting that the thermocline was weakly developed throughout this time. Benthic $\delta^{18}O$ values show a slight positive increase from $+0.5\ ^o/_{oo}$ during the mid-Aptian to $+1.1^o/_{oo}$ during the latest Aptian, then decrease to $-0.2^o/_{oo}$ during peak Corg deposition in OAE 1b (*Hedbergella rischi* Zone, lowermost Albian). Assuming that the $\delta^{18}O$ composition of Cretaceous seawater averaged $-1.2^o/_{oo}$ and polar ice sheets were absent or very small, we estimate that middle bathyal waters at this site ranged from 7-9°C during the mid-late Aptian and warmed to 12°C during OAE 1b peak Corg deposition. Mid-late Aptian upper surface waters ranged from 11-12°C, then warmed to 20°C during OAE 1b. The simultaneous change in planktic foraminifer assemblages and stable isotope values indicates that the onset of OAE 1b involved major changes in the North Atlantic climate and oceanography.

PP42C-04 1440h

Stable Isotopic Values of Fish Remains and Inoceramids in Late Cretaceous Black Shales on Demerara Rise

Ken MacLeod[1] ((573) 884-3118; macleodk@missouri.edu)

Patrick Stanley[1] (qmmplanck@hotmail.com)

Silke Voigt[2] (silke.voigt@uni-koeln.de)

Anne Zacke[2] (anne.zacke@uni-koeln.de)

[1]University of Missouri, Department of Geological Sciences, Columbia, MO 65211-1380, United States

[2]Universitat zu Koln, Geologisches Institut Zulpicher Str. 49a, Koln D-50674, Germany

Stable isotopic measurements of exquisitely preserved foraminifera (those with radial hyaline microstructure preserved and no shell infilling) have galvanized investigation of ancient sea surface temperatures. Intervals within the black shale' facies on Demerara Rise exhibit such preservation and suggest contemporary tropical sea surface temperatures at least as warm, if not several degrees warmer, than modern tropical surface waters. Further, these data indicate a 5-10 degrees C temperature range across the planktic realm. Unfortunately, exquisite preservation is present in only some intervals on Demerara Rise and benthic taxa are rare to absent throughout. To try to generate a more complete stratigraphic record of paleotemperatures and a fuller characterization of conditions through the water column, we are measuring stable isotopic values of phosphate oxygen in fish remains, carbonate carbon and oxygen in inoceramids, and organic carbon in organic material within inoceramids shells. Preliminary results for the fish debris range from 19.5 to 21.0 per mil V-SMOW suggesting paleotemperatures of 20 degrees C. The estimated temperature range overlaps the cooler planktic foraminifera estimates suggesting the Demerara Rise fish analyzed lived at or near the thermocline. The taxonomic resolution possible with fish remains is limited, but the relative resistance of phosphate oxygen to diagenetic alteration should allow us to track temperature changes across intervals where foraminifera preservation deteriorates. Inoceramid values, on the other hand, yield problematically warm benthic temperature estimates. Inoceramid oxygen isotopic values average -2.9 per mil V-PDB and are as low as -3.3 per mil. Paleotemperatures estimated from these values are 4-6 degrees C warmer than estimated thermocline temperatures (but 6-8 degrees C cooler than the warmest surface temperature estimates). Stratigraphic coverage is currently too sparse to critically evaluate this observation. Finally, inoceramid carbonate-carbon values are comparable to values in planktic foraminifera (1 per mil V-PDB) but shell organic carbon values (-25 per mil V-PDB) provide no indication of unusual metabolism in these bivalves.

PP42C-05 1455h

The Role of Paleogeography on the Evolution of Mesozoic Ocean Circulation: Sensitivity Experiments Using a Fully Coupled Ocean-Atmosphere Model

Tran T Huynh[1] (1-734-764-3362; tranhu@umich.edu)

Christopher J Poulsen[1] (1-734-615-2236; poulsen@umich.edu)

[1]Department of Geological Sciences, University of Michigan, 425 E. University Ave., Ann Arbor, MI 48109-1063, United States

Geography has long been recognized as one of the primary controls on climate. Many studies have assessed the response of paleoclimate to paleogeography by examining the impact of continental configuration, land area, and the opening/closing of gateways on oceanic circulation patterns in the past. Most of these modeling studies have employed ocean-only general circulation models (GCMs) using restoring boundary conditions derived from atmosphere-only GCM experiments. The lack of ocean-atmosphere feedbacks may have serious consequences for the predicted circulation, and would tend to prohibit changes in ocean heat transport and water-mass formation. In this study, we use a fully coupled ocean-atmosphere GCM, the Fast Ocean Atmosphere Model (FOAM), to examine the role of geography on Mesozoic ocean dynamics. Triassic and Cretaceous paleogeographic reconstructions were chosen because these time slices represent the extremes of geographic evolution during the Mesozoic. All experiments include identical boundary conditions (e.g. land surface characteristics, solar luminosity, atmospheric pCO_2) except for paleogeography. All simulations were integrated until the ocean component of FOAM reached equilibrium. In addition, we compared the relative impact of geography to atmospheric CO_2 on ocean circulation by running experiments with high and low pCO_2 values for the Triassic and Cretaceous. Initial results demonstrate that changes in the continental configuration during the Mesozoic will affect the location, as well as the number of sites, of water-mass formation. More sites of deep and intermediate water formation existed during the Triassic than Cretaceous. The simulations suggest that while the sites of water-mass formation are determined by continental configuration, it is atmospheric CO_2 that controls the strength of oceanic overturning. The simulations also show that ocean heat transport is higher during the Mesozoic than the modern day, and that the total heat transported poleward by the oceans decreases between the Triassic to Cretaceous experiments. Thus it appears that paleogeography exhibits primary control in the patterns of oceanic circulation during the Mesozoic by determining the sites of water-mass formation and ocean heat transport. However, other factors (such as atmospheric CO_2) can also have significant impact on ocean dynamics of the time.

PP42C-06 1510h

Hydrothermal Links Between the Caribbean Plateau and OAE2

Robert A Duncan[1] (541 737 5206; rduncan@coas.oregonstate.edu)

Laura J Snow[1] (541 737 5206; lsnow@coas.oregonstate.edu)

[1]College of Oceanic and Atmopsheric Sciences, Oregon State University, Corvallis, OR 97331, United States

A popular current model for the sporadic occurrence of ocean anoxic events (OAEs) in the Cretaceous ties hydrothermally-induced changes in ocean chemistry (bio-limiting trace metals) during ocean plateau (LIP) volcanism to increased surface productivity, followed by mid-to-deep water oxygen depletion and accumulation of organic-rich sediments. This proposed connection is far from accepted, and important unresolved aspects include the timing of events and yet-to-be-proved synchroneity of volcanism and OAEs, the sensitivity of phytoplankton to bio-limiting (and toxic) trace metals, the difference in biotic responses at various OAEs, and the source of the hydrothermal inputs (sea floor spreading centers or ocean plateaus). To test this hypothesis we have measured the distribution of major, minor and trace element abundances in five pelagic carbonate and black shale sequences that bracket the OAE2, defined by a prominent positive

excursion in the global seawater d13C record. Sedimentary sections at Rock Creek Canyon (Pueblo, CO), ODP Site 1138 (Kerguelen Plateau), Bass River (NJ), Totuma well (Venezuela) and Baranca el Canyon (Mexico) were chosen to examine potential trace metal patterns and gradients around the proposed source of hydrothermal inputs - the Caribbean Plateau, whose initial volcanic activity has been dated at 93-89 Ma. ICP-AES and ICP-MS elemental abundances from whole rock samples are normalized to Zr to remove the effect of terrestrial inputs. We find prominent trace metal "spikes" (up to 50 times background) for elements known to be concentrated in volatile degassing of magmas and in hydrothermal plumes resulting from seawater-rock reactions. These anomalies begin at the onset and continue well into the d13C excusion at all five sites. Furthermore, the magnitude of the anomalies decreases with distance from the Caribbean region, and the pattern of elements shifts from a wide range of metals near-source to predominantly long residence time metals far "downstream".

PP42C-07 1525h INVITED

Last ODP Legs Expand Black Shale Legacy of Scientific Ocean Drilling

Philip A Meyers[1] (734-764-0597; pameyers@umich.edu)

. Scientific Party Leg 207[2]

. Scientific Party Leg 210[2]

[1]Department of Geological Sciences, The University of Michigan, 425 East University Avenue, Ann Arbor, MI 48109-1063, United States

[2]Ocean Drilling Program, Texas A&M University, College Station, TX 77845, United States

Scientific ocean drilling has been central to our basic knowledge about Cretaceous black shales and to our growing understanding of the paleoceanographic and paleoclimatic processes that participated in their deposition. Spot-coring during early DSDP legs charted the geographical and temporal occurrence of black shales in the ocean basins. The concept of Oceanic Anoxic Events (OAE) is part of this legacy. Subsequent drilling recovered continuous sequences that have identified patterns of geographical and temporal differences in black shale sequences and have encouraged reconstructions of the paleoceanographic histories recorded by these differences. Sequences recovered by the last few ODP Legs have expanded this legacy and have opened new opportunities for improved understandings about black shales. Leg 198 recovered a classic section of TOC-rich (35 percent) early Aptian black shale from the Shatsky Rise that corresponds to OAE1a. Leg 207 recovered Cenomanian-Turonian (OAE2) and Coniacian-Santonian (OAE3) black shales, some containing nearly 30 percent TOC, from five sites on the Demerara Rise. Leg 210 recovered TOC-rich (4 percent) laminated black shales from the deep Newfoundland Margin that correspond to OAE1d and OAE2. The Demerara Rise sequences are particularly impressive in ranging in thickness from 56m to 93m and in having well-developed laminations and shale-limestone cycles. The five sites constitute a 1km paleodepth transect and record both high surface productivity and enhanced organic matter preservation under an intensified oxygen-minimum layer impinging on the Demerara Rise.

PP42D MCC: 3004 Thursday 1600h

Nature and Causes of Cyclicity in Triassic Through Miocene Paleoclimate Records II *(joint with OS)*

Presiding: **K L Bice,** Woods Hole Oceanographic Institution**; T Wagner,** University Bremen

PP42D-01 1600h INVITED

Milankovitch Forcing in Equatorial, Late Triassic Pangea: (Deep River; Dan River, and Richmond Basins, Southeastern USA)

Paul E Olsen[1] (845-365-8491; polsen@ldeo.columbia.edu)

Dennis V Kent[1,2] (845-365-8544; dvk@ldeo.columbia.edu)

Peter M LeTourneau[1] (845-365-8621; letour@ldeo.columbia.edu)

[1]Lamont-Doherty Earth Observatory, 61 Route 9W, Palisades, NY 10964, United States

[2]Dept. of Geological Sciences, Rutgers University, Piscataway, NJ 08854, United States

The Milankovitch character of lake level fluctuations in the tropics of central Pangea has been well established since the pioneering work of Van Houten in the 1960's (1) that laid the foundation for quantitative analysis of core and outcrops in the 1990's (2,3). In the region from about 3° to 10° N latitude giant rift lakes fluctuated to the classic Milankovitch frequencies of precessional forcing of 20, 96, 128, and 404 ky, as well as the less well known 1.75 and 3.5 m.y. cycles. The latter are the Triassic values for the periods of g4-g3 of eccentricity related precessional forcing and the secular resonance, theta (2(g4- g3) - (s4-s3)), of precessional and obliquity related forcing. We attribute the forcing of lake depth largely to modulation of the strength of tropical convergence. Late Triassic rifts located from 0° to 3° N latitude show similar patterns, except with a strong tendency towards a doubling of the climatic precessional frequency and a lack of evaporites as previously reported from the Dan River basin (4,5,6). Here we report on new analyses of coal-bearing cores and drill holes from the Deep River, Dan River, and Richmond basin of older Late Triassic lacustrine strata that reinforce this pattern but show that the doubling of the precessional frequency is not ubiquitous at the equator and also show that very strong climatic transitions appear related to the 1.75 and 3.5 m.y. cycles juxtaposing coals and caliches in vertical sequence and sometimes coinciding with major faunal and floral transitions. (1) Van Houten FB. 1964. Kansas Geol. Surv. Bull. 169:497. (2) Olsen PE & Kent DV. 1996. Palaeogeo. Palaeoclim. Palaeoecol. 122:1-26. (3) Olsen PE & Kent DV. 1999. Phil. Trans. Roy. Soc. Lond. (A) 357:1761-1787. (4) Olsen PE & Kent DV.1996. Eos, Trans., AGU 77(46), Suppl.:301. (5) Olsen PE. 1997. Ann. Rev. Earth Planet. Sci. 25:337-401. (6) Olsen PE & Kent DV. 2000. in Bachmann G. and Lerche I. (eds.), Epicontinental Triassic, Vol. 3, Zent. Geol. Palaont. VIII:1475-1496.

PP42D-02 1620h INVITED

Organic Carbon Cyclicity in the Kimmeridge Clay (Dorset, UK)

Richard V Tyson[1] (44-191-222-6605; r.v.tyson@ncl.ac.uk)

Graham Weedon[2] (graham.weedon@luton.ac.uk)

[1]School of Civil Engineering and Geosciences, University of Newcastle, Newcastle NE17RU, United Kingdom

[2]Centre for Environmental Change, University of Luton, Luton LU13JU, United Kingdom

The type section of the Late Jurassic Kimmeridge Clay Formation (KCF) of Dorset (UK) has recently been completely cored and studied during the NERC RGGE project. The middle 250m of the formation is characterized by conspicuous metre-scale Milankovitch cyclicity, expressed primarily by marine total organic carbon (MTOC) content, and thought to record 38ka obliquity and 19ka precession cycles. The cyclicity is clearest where mean compacted sedimentation rates are <80m/Ma, the low dilution amplifying the effect of productivity and redox cycles on MTOC content. Overall the dominant first MTOC mode varies symmetrically from 0.5% at the top and base of the KCF, to 4-5% in the central eudoxus-wheatleyensis interval, reflecting the long term relative sea level trend and its effects on clastic dilution and bottom water oxygenation. Superimposed third order cycles also influence the cyclicity. Algorithms relating sedimentation rate, carbon delivery flux, bottom water oxygen, burial efficiency and TOC in modern marine sediments yield low to moderate mean paleoproductivity estimates of 40-150 gC/m2/a. Given low dilution and good preservation high absolute paleoproductivity is not required to explain typical MTOC values, but MTOC variation is influenced by the interaction of input, preservation and dilution (IPD) factors in a complex multivariate fashion. In this distal facies phytoclast and palynomorph concentration data (No. per mg rock) are primarily controlled by inorganic sediment dilution, not organic matter supply, which forces positive correlations between genetically unrelated particles; the concentration of refractory phytoclasts may thus provide an intra-cycle proxy for relative mineral dilution. Using this approach, comparison of different cycles suggests that the MTOC is also influenced by dilution at this scale, but changes in all the IPD variiables are probably important. Excess organic-walled plankton concentrations are sometimes correlated with heavier d13Com values, suggestive of short-term productivity spikes (calculated palaeoproductivities of up to 400 gC/m2/a), while other d13Com anomalies are apparently associated with higher contents of isotopically heavy sulphurised organic matter.

PP42D-03 1640h

Orbital Cycles, Climate, and Diagenesis Mimic Methane Releases: Results from a High Resolution Study of OAE2, New Jersey Coastal Plain

James D Wright[1] (732 445-5722; jdwright@rci.rutgers.edu)

Benjamin S Cramer[2] (022-217-6625; benjamin@dges.tohoku.ac.jp)

Kenneth G Miller[1] (732 445-3622; kgmt@rci.rutgers.edu)

Miriam E Katz[1] (732 445-3445; mimikatz@rci.rutgers.edu)

[1]Rutgers University, Dept of Geological Sciences 610 Taylor Road, Piscataway, NJ 08854, United States

[2]Tohoku University, Aoba, Aramaki, Institute of Geology and Paleontology, Sendai, NJ 980-8578, Japan

The Cenomanian-Turonian (Upper Cretaceous) section from Bass River State Park, New Jersey contains a 15 m thick interval representing Ocean Anoxic Event (OAE2). Our high resolution (5cm) bulk sediment inorganic stable isotope record, can be used to define OAE2 at Bass River. The down-hole gamma log shows well-developed cycles throughout the OAE2 interval that we interpret as short eccentricity cycles, providing a chronology for the OAE2 event. Assuming a 95 kyr eccentricity cycle and that OAE2 at Bass River is defined the interval of high $\delta^{13}C$ values, the duration of this event was $\sim$700$\pm$100 kyr. The dominant eccentricity forcing in the Bass River OAE2 record suggests that a monsoonal circulation controlled the regional and global carbon cycles as evidenced by sedimentary organic carbon and $\delta^{13}C$, respectively. Our results show a series of negative $\delta^{13}C$ excursions, that are typically on the order of 3 to 5 per mil, but in two instances the excursions were >20 per mil. We initially interpreted these excursions as reflecting methane releases from gas hydrates. Closer examination shows that the $\delta^{13}C$ excursions were produced by seafloor diagenesis in the presence of elevated organic carbon levels. These transients are characterized by: 1) the lack of a corresponding decrease in organic carbon $\delta^{13}C$ values; 2) calcite infilling of foraminiferal shells; and 3) increased $\%CaCO_3$. The $\delta^{13}C$ value of the authigenic $CaCO_3$ is $\sim$-25 per mil, indicating that reducing organic-rich sediments supplied much of the CO_2. We argue that increases in organic carbon flux raised alkalinity (through sulfate reduction) and resulted in authigenic precipitation of $CaCO_3$ at Bass River. In our model, negative $\delta^{13}C$ excursions are the result of seafloor diagenesis that is forced by climate rather than from the dissociation of methane hydrate.

PP42D-04 1700h INVITED

African climate variability and organic carbon accumulation in the Coniacian-Satonian eastern tropical Atlantic: Insights how insolation-cycles in the Cretaceous were transformed to marine black shales

Peter Hofmann[1] (49-221-470-4008; adg03@uni-koeln.de)

Thomas Wagner[2] (49-421-218-8950; twagner@uni-bremen.de)

Britta Beckmann[2] (49-421-218-8938; bbeckman@uni-bremen.de)

Sascha Floegel[3] (49-431-600-2836; sfloegel@geomar.de)

[1]University of Cologne, Department of Geology, Zuelpicher Str. 49a, Cologne 50674, Germany

[2]University Bremen, Geosciences, PO Box 330440, Bremen 28334, Germany

[3]GEOMAR Research Centre, Wischofstr. 1-3, Kiel 24148, Germany

There is increasing evidence from marine proxy records that tropical regions during the late Cretaceous were hotter than previously reported and were by far exceeding modern average temperatures. Tropical sea surface temperatures in the range of 32-36°C apparently lasted from the latest Cenomanian to the early Campanian. A fundamental consequence of superheated Cretaceous tropics is a vigorous hydrological cycle operating in equatorial regions. Geological evidence supporting such an enhanced hydrological cycle and a direct link to the formation of marine black shale cycles was recently reported for ODP Site 959 from the Deep Ivorian Basin (DIB) off equatorial West-Africa. Millennial-scale marine and terrigenous proxy records from that site provide a unique opportunity to investigate short-term variability of the ocean-climate system, to discuss the role of orbital forcing and to