

Paleoceanography and Paleoclimatology

PP11A MCC: Level 1 Monday 0830h

Marine Records of Past Climate

Posters (joint with OS, GC)

Presiding: P A Martin, University of Chicago; M S Cook, MIT-WHOI
Joint Program in Marine Geology and Geophysics

PP11A-0194 0830h POSTER

Geochemistry of the Deep Water Bamboo Coral *Isidella*; Intermediate Depth and Surface Ocean Chemical Recorder

Howard J Spero¹ (5307523307; spero@geology.ucdavis.edu)

Nicholas A Jang¹ (najang@ucdavis.edu)

Jess F Adkins² (jess@gps.caltech.edu)

¹University of California Davis, Department of Geology, Davis, CA 95616, United States

²Caltech, Department of Geological and Planetary Sciences, Pasadena, CA 91125, United States

Geochemical analyses of deep water corals have provided a wealth of data on past ocean circulation and chemical changes. Information obtained from these carbonate precipitating organisms generally reflects ambient conditions at the depth of growth. The bamboo coral, *Isidella* sp., belongs to a group of deep water Octocorals that live at intermediate ocean depths (~200 – 1500m) and produce a calcite skeleton that is divided by proteinaceous gorgonin internodes. Because, the calcite and organic regions of the skeleton are precipitated simultaneously, their chemistries are temporally coupled. Stable isotope, radiocarbon and ²¹⁰Pb data were obtained from several specimens of *Isidella* sp. that were collected in fishing dredges from the outer continental shelf near Pt. Reyes, CA (38°N 123.4°W ~220 m). ²¹⁰Pb analyses on one of the specimens suggests the coral was 15-80 years old. ^δ¹³C and ^δ¹⁸O data from the calcite skeleton display the typical nonequilibrium covariation that has been described previously, thereby limiting the use of these data in reconstructing environmental temperatures. Although ^δ¹³C analyses of the organic internodes produced typical marine values of -16.9±0.1‰ (n=17). ^δ¹⁵N values were unusually high, 13.8±0.4‰. Because the internode geochemistry records the organic chemistry of sinking particulate matter ingested by the coral, the enriched ^δ¹⁵N data reflect the chemistry of local upwelled NO₃ that was strongly influenced by subsurface denitrification. AMS analyses of the center and outer edge of the skeleton (branch diameter = 2.2 cm) and adjacent organic internodes (growth proceeds from center outwards) yield ¹⁴C ages of 2065 and 2000±35 years for the calcite (Δ¹⁴C = -226.4 and -220.3‰) and 785 and 765±35 years for the organic node (Δ¹⁴C = -93.1 and -90.7‰) respectively. The calcite AMS ages record the ¹⁴C reservoir age of upper N. Pacific thermocline waters whereas the organic data record the surface ocean reservoir age during the corals growth. The reservoir age difference is ~1250 years. Comparison of these ages with data from a mussel collected along the Pt. Reyes coast in 1913 (¹⁴C age = 710 years; M. Solomon unpub. data) suggest our coral specimen died is ~80 years ago in agreement with the ²¹⁰Pb data. These results demonstrate that the bamboo corals are a valuable archive of intermediate and surface ocean chemistry and could prove invaluable for reconstructing combined near surface circulation and intermediate ocean chemistry changes in the past.

PP11A-0195 0830h POSTER

Deep-Sea Corals: a New Tool to Track Intermediate Water Masses Variability

Audrey Lutringer¹ (33-1-69-82-43-57; lutringer@lsce.cnrs-gif.fr)

Dominique Blamart¹ (33-1-69-82-43-25; blamart@lsce.cnrs-gif.fr)

Norbert Frank¹ (33-1-69-82-43-58; Norbert.Frank@lsce.cnrs-gif.fr)

Laurent Labeyrie¹ (33-1-69-82-35-36; labeyrie@lsce.cnrs-gif.fr)

¹Laboratoire des Sciences du Climat et de l'Environnement, Campus du CNRS Avenue de la Terrasse, Gif sur Yvette 91 198 ced, France

Intermediate water masses in the North Atlantic Ocean are affected by strong seasonal mixings but their variability during climate change is still to be explored. One of the more suitable tools to record this variability are deep-sea corals, because they record continuously sea water parameters in their aragonitic skeleton. Unfortunately they do not precipitate their skeleton at isotopic equilibrium with sea-water. The positive linear regression existing between ^δ¹⁸O and ^δ¹³C is not easily interpretable in terms of environmental parameters. We have used Smith et al. 2000 calibration combined with Shackleton 1974 paleo-temperature equation to interpret the isotopic signal (C and O) contained in deep-sea corals. Knowing the value of ^δ¹³C in seawater we can determine the corresponding value of ^δ¹⁸O along the regression line for each coral. This value is then corrected for the fractionation between aragonite and calcite and it can be used in the equation established by Epstein et al. 1953 and later rewritten by Shackleton 1974 to find a temperature. The method has then been applied to corals (*Lophelia pertusa*) coming from different cores collected in the Porcupine and Rockall banks at about 750m depth. The sampling was made with a micro-sampler to take into account the distribution of isotopes in the different aragonite crystal forms. These isotopic analysis lead us to a relationship between the ^δ¹⁸O value of the coral, the ^δ¹⁸O of seawater and the temperature. As the corals have been dated with the ²³⁰Th/U method, the different isotopic values can be placed in a Temperature/Salinity diagram in order to estimate the relative contribution of the various water masses in the Porcupine and Rockall banks along time. This new approach offers the possibility to track intermediate water masses variability.

PP11A-0196 0830h POSTER

Reproducibility of Geochemical and Climate Signatures in *Montastrea annularis*

Jennifer M Smith¹ (727 553 1017; jsmith@marine.usf.edu)

Terrence M Quinn¹ (727 553 1658; quinn@marine.usf.edu)

Robert B Halley² (727 803 8747 x3020; rhalley@usgs.gov)

¹University of South Florida, College of Marine Science, 140 Seventh Ave South, St. Petersburg, FL 33701, United States

²US Geological Survey, 600 4th Street South, St. Petersburg, FL 33701, United States

Geochemical variations in modern and fossil coral skeletons (Sr/Ca, Mg/Ca, ^δ¹⁸O, ^δ¹³C) are increasingly being used to reconstruct climate variability in tropical ocean-atmosphere system on interannual to centennial timescales. Coral-based climate studies are usually carried out using a single coral core from a reef, or a collection of cores covering different time intervals from the same reef site. Cross checking or replication - the generation of multiple climate time series from a single locality - is not a standard operating procedure in coral paleoclimatology because of the expense of generating additional geochemical time series. Quantitative assessment of intra-reef geochemical variability in multiple coral cores from the same reef is needed to verify the fidelity of climate reconstructions based on geochemical variations from a single coral. We perform such an assessment using the geochemical signals derived from two *Montastrea annularis* corals (LK1 and LK23) recovered in 2002 from Looe Key reef, Florida USA (24.5° N, 81.4° W). Looe Key is located in the central portion of the Florida Keys and has an hourly *in situ* seawater temperature record extending back to 1990. We extended this *in situ* SST record further back in time by splicing in HadISST 1.1 data extracted from the appropriate 1° by 1° grid point. Paired geochemical measurements of Sr/Ca, ^δ¹⁸O and ^δ¹³C were made by sampling coral LK1 and LK23 along their respective major growth axes. Geochemical variations versus depth were converted to monthly resolved time series extending from 2002-1966. The two ~37 year coral time series replicate well in terms of both phasing and mean perspective: (^δ¹⁸O LK1, -3.90±0.28 ‰; LK23, -3.93±0.31 ‰), (^δ¹³C LK1, -0.80±0.68 ‰; LK23, -0.72±0.59 ‰), and Sr/Ca (LK1, 9.208±0.080 mmol/mol; LK23, 9.226±0.082 mmol/mol). Coral Sr/Ca-SST estimates of mean SST over the period 2002-1966 for LK1 (27.25±2.00°C) and LK23 (26.71±1.80°C) agree to within 0.3°C of observed mean SST in the instrumental record (26.94±2.12°C). Coral ^δ¹⁸O-SST estimates of mean SST (cf. LK1, 26.83±1.33; LK23, 27.05±1.79) also match well the mean SST of the instrumental record. Stacking or averaging the LK1 and LK23 records to create composite Sr/Ca-SST and ^δ¹⁸O-SST records improves the estimate of the proxy-based mean SST relative to the instrumental record.

Month-to-month comparisons between predicted and observed SST indicate that the maximum misfit for coral ^δ¹⁸O-SST of ~1°C occurs in March-April and Aug-Oct; whereas for coral Sr/Ca-SST the maximum misfit of ~0.5°C peaks in September. In summary, Sr/Ca and ^δ¹⁸O records from two *M. annularis* coral heads from Looe Key, Florida replicate quite well, which provides confidence that accurate records of climate variability in the tropical Atlantic can be reconstructed from this scleractinian coral.

PP11A-0197 0830h POSTER

Microanalysis of O-C-B Stable Isotopes in Deep Sea Corals by SIMS

Dominique Blamart¹ (dominique.blamart@lsce.cnrs-gif.fr)

Claire Rollion-Bard²

Anne Juillet-Leclerc¹

Jean-Pierre Cui³

¹Laboratoire des Sciences du Climat et de l'Environnement, CEA-CNRS, Domaine du CNRS, Bat 12, 4, Avenue de la Terrasse, Gif sur Yvette 91198, France

²CRPG-CNRS, BP 20, 15, rue Notre-Dame des Pavres, Vandoeuvre les Nancy 54500, France

³Université de Paris XI, Faculté des Sciences., Bat 504 Géologie, ORSAY 91405, France

We measured the O-C and B isotope composition of deep sea coral (DSC) (*Lophelia pertusa*) at a micrometre scale by ion microprobe (SIMS - Secondary Ion Mass Spectrometry). Coral skeletons are composed of two different microstructures: (1) centres of calcification and (2) surrounding fibers. In (*Lophelia pertusa*) centres of calcification are arranged in lines of centres of calcification (LCC), large enough (50 microns) to be measured using the SIMS technique. Our results show clear patterns between the LCC and the surrounding fibers. LCC have a restricted range of variation in ^δ¹⁸O (-2.8 ± 0.3‰ (PDB)), a larger range in ^δ¹³C (-14.3 to -10.9‰ (PDB)) and ^δ¹¹B (24.8 to 35.8‰) with most of the values at 30‰ (NBS951). The ^δ¹¹B variation corresponds to a pH variation of 1 unit from 8.4 to 9.4. Surrounding skeletal fibres exhibit large isotopic variation both for O and C and (up to 12‰), and B (up to 17‰). ^δ¹³C and ^δ¹⁸O are positively correlated. At the lightest ^δ¹⁸O values of the surrounding fibers, the C and O isotopic composition of the centres of calcification deviate from this linear trend. The variation of ^δ¹⁸O at a micrometre scale is probably the result of two processes: (1) an isotopic equilibrium calcification with at least 1 pH unit variation in the calcification fluid at the site of LCC and (2) a kinetic fractionation. The δ¹³C apparent disequilibrium in *Lophelia pertusa* may be the result of mixing between depleted δ¹³C metabolic CO₂ (respiration) and DIC coming directly from seawater.

PP11A-0198 0830h POSTER

Pre-treatment Effects on Coral Skeletal ^δ¹³C and ^δ¹⁸O

Andrea G Grottolli¹ (215-898-9269; grottolli@sas.upenn.edu)

Olivia Gibb¹ (215-573-0279; gibb@sas.upenn.edu)

Gerard M Wellington² (713-743-2649; wellington@uh.edu)

¹University of Pennsylvania, 240 South 33rd Department of Earth and Environmental Science, Philadelphia, PA 19104-6316, United States

²University of Houston, 3400 Calhoun Rd. Department of Biology and Biochemistry, Houston, TX 77240, United States

Pre-treatment protocols for coral skeletal stable carbon (^δ¹³C) and oxygen (^δ¹⁸O) isotope analyses include no treatment, bleach (NaOH), hydrogen peroxide (H₂O₂), or vacuum roasting prior to analysis. Such pre-treatments are used to remove organic material prior to isotopic analyses. Researchers that do not pre-treat samples argue that such treatments result in non-linear shifts in coral skeletal ^δ¹³C and ^δ¹⁸O thus increasing the analytical error in the ^δ¹³C and ^δ¹⁸O values. Vacuum roasting does cause isotopic shifts and is no longer practiced. However, both no pre-treatment and pre-treatment (with either NaOH or H₂O₂) coral ^δ¹³C and ^δ¹⁸O values continue to be published in the literature. In all previous studies of the effects of NaOH and H₂O₂ pre-treatments on coral ^δ¹³C and ^δ¹⁸O, the samples sizes were typically small and the exact time interval being sampled and compared was not specifically controlled. Here, we evaluated the effects of NaOH and H₂O₂ pre-treatments on coral skeletal ^δ¹³C and ^δ¹⁸O in *Pavona clavus* and *Pavona gigantea* from

Panama, and *Porites compressa* from Hawaii. In Panama, at least five coral fragments from five different colonies of each species were stained on November 1978 and April 1979 then collected in November 1979. In Hawaii, at least five coral fragments from five different colonies at 1.7 and 7 m depths were stained on 1 September and 21 November 1996 then collected 2 March 1997. For each fragment, a bulk skeletal sample was extracted representing the entire growth interval of between the two stain lines yielding at least 24 mg of material. Sampling between the stain lines ensured that all of the fragments from a given site and species were sampled over the same time interval and avoided any potential contamination from the tissue layer. Eight milligram subsamples from each fragment were subjected to 24 hours of the following treatments: NaOH, H₂O₂, Milli-Q filtered water (control), or no pre-treatment (control). Each subsample was then rinsed with distilled water ten times and dried at 60°C for 48 hours prior to isotopic analysis. In all cases, NaOH pre-treatment resulted in a statistically significant decrease in coral skeletal $\delta^{13}\text{C}$ compared to the controls. The decreases in $\delta^{13}\text{C}$ in *P. clavus* and *P. gigantea* were twice as large as in *P. compressa*. These results did not change with depth in *P. compressa*. Thus NaOH pre-treatment makes coral skeletal $\delta^{13}\text{C}$ values less reliable and compromises any comparisons among species. In all cases H₂O₂ pre-treatment resulted in decrease in $\delta^{13}\text{C}$ compared to the controls, though this decrease was not statistically significant. Caution should be taken to avoid pre-treating corals with H₂O₂ in order to minimize any additional variability in the $\delta^{13}\text{C}$ values of coral samples. In all cases, NaOH and H₂O₂ pre-treatments did not have any significant effect on coral skeletal $\delta^{18}\text{O}$ values relative to the controls and does not compromise the interpretation of $\delta^{18}\text{O}$ values from pre-treated coral samples.

PP11A-0199 0830h POSTER

The Interpretation of Geochemical Data from Coral Skeleton Need to Be Revisited

Anne Juillet-Leclerc¹ ((33)169824348;
Anne.Juillet@lsce.cnrs-gif.fr)

Stéphanie Reynaud²

Claire Rollion-Bard³

¹LSCE, Domaine du CNRS, Gif sur Yvette 91198, France

²CSM, Avenue Saint Martin, Monaco 98000, Monaco

³CRPG, 15 rue Notre-Dame des Pauvres, Vandoeuvres-lès-Nancy 54501, France

The aragonite skeleton of the long-live massive corals, developed all around the tropical belt, are unique archives to supplement the instrumental records. It is generally admitted that the oxygen isotopic composition is governed by the classical isotopic thermometer. Recently ion microprobe investigations proved that at micrometre scale, during a year, the signal is not linear relative to time and the isotopic fractionation is mainly due to a kinetic process. Nevertheless, a quasi-equilibrium formula is derived from the mean annual oxygen isotopic composition for two coral genera, from annual data series published by Weber and Woodhead (1972). The kinetic process, revealed by ion probe data, is confirmed by analysing corals cultured in 5 controlled temperature conditions: it affects both oxygen and carbon isotopic partition, the oxygen showing also the quasi-equilibrium fractionation. By performing a statistical treatment (an empirical orthogonal function analysis), on annual oxygen and carbon isotope time series over at least one hundred years, we separate the two fractionations from the oxygen signal. The trend showed by the quasi-equilibrium signal from the beginning of the XXth century is mainly due SST increase and it appears that when the SST changes linked with an El Niño event are reduced, the interannual fluctuations are essentially related to precipitation changes, revealing an unexpected abrupt shift of El Niño consequence between 1924 and 1931.

PP11A-0200 0830h POSTER

Alkenone Temperature Record for the last 500 kyr in the Eastern Equatorial Pacific Ocean

Antonio Mendoza¹ ((831)459-5061;
amendoza@cats.ucsc.edu)

Christina Ravelo (acr@cats.ucsc.edu)

The global climate system has varied much over geological time with continuous oscillations between glacial (cool) and interglacial (warm) states. The focus of our work is on the Ocean Drilling Program (ODP) Site 847 (0° 11.593'N, 95° 19.227'W, water depth: 3334 m) located in the eastern equatorial Pacific Ocean west of the Galapagos Islands. Sea surface temperature at this site is influenced by the westward-flowing South Equatorial Current and equatorial divergent

upwelling. Previous work has shown that the tropics may play a direct role in triggering changes in the global climate system. Changes in the solar energy budget due to orbital parameter changes have an influence on glacial/interglacial cycles, but paleorecords have shown that other processes and feedbacks in the atmosphere-ocean system play a large role as well. We use the alkenone proxy to reconstruct a high-resolution record (at 2000 years between samples) of past SST and compare it with other proxies ($\delta^{18}\text{O}$, CaCO₃ accumulation, organic matter accumulation) to better understand the changes in climate and ocean conditions on sub-Milankovitch to Milankovitch timescales from 0-500 kyr in the eastern tropical Pacific. Over the last 500 kyr, SSTs have varied from 21.2 °C to 26.5 °C reflecting changes in climate related to the glacial/interglacial states. Glacial/interglacial cycles in the record occur with 100,000 year periodicity as seen in other records such as the benthic $\delta^{18}\text{O}$ record from ODP Site 846 (3° 5.696'S, 90° 49.078'W, water depth: 3295 m). Comparing the SST changes with measurements from other proxies helps to discriminate between changes in the upwelling conditions that affect productivity and changes in advection of water to this site. The ODP Site 847 SST and the $\delta^{18}\text{O}$ benthic record covary with each other indicating a strong teleconnection between climate changes across the globe. Some events in the $\delta^{18}\text{O}$ record are not observed in the alkenone record. Clearly there are cases when changes in ice volume occur independently from tropical temperature changes, although characterizing the circumstances under which high and low latitudes become independent from each other still needs further study. Further data analysis will need to be done to rigorously compare our SST record with other more distant records to have a better understanding of how the tropics affect changes in higher latitudes and global climate.

PP11A-0201 0830h POSTER

Variation of the Path and Intensity of the Kuroshio During the Past 30 Kyr based on Alkenone Sea Surface Temperatures

Ikehara Minoru¹ (81-88-864-6719;
ikehara@cc.kochi-u.ac.jp)

Matsuda Ayuri¹ (ayuri@cc.kochi-u.ac.jp)

Murayama Masafumi¹ (murayama@cc.kochi-u.ac.jp)

Kawamura Kimitaka²
(kawamura@lowtem.hokudai.ac.jp)

¹Center for Advanced Marine Core Research, Kochi University, B200 Monobe, Nankoku 783-8502, Japan

²Institute of Low Temperature Science, Hokkaido University, W8N19, Kita-ku, Sapporo 060-0819, Japan

The Kuroshio Current is a greatest and important warm surface current in the North Pacific. The Kuroshio plays a role of main heat transport from the tropical ocean to the North Pacific. Therefore, it is seemed that the historical changes of the path and intensity of the Kuroshio influenced the climate changes in the Northwest Pacific and the surrounding land area. Three sediment cores, MD01-2422, TSK-1PC, and OTK-2PC were collected from off Shikoku, Tokara Strait, and southern Okinawa Trough to reveal the paleoceanographic changes in the Kuroshio flow region. Age models of the cores are established by AMS 14C dates (calendar ages) of planktonic foraminifera. At the site of off Shikoku (MD01-2422), alkenone sea surface temperatures (SSTs) fluctuated between 21 and 25 degrees C with amplitude of about 4 degrees C during the past 30 kyr. Alkenone SSTs were abruptly increased by about 3.5 degrees C at 17 kyr B.P. The rapid warming corresponded to a sharp decrease of alkenone production. These results indicate that the surface water at core site was significantly influenced by the warm and nutrient-poor Kuroshio at 17 kyr B.P. The SST differences between the off Shikoku and the Nishishichitō Ridge (Sawada and Handa, 1998) were very small during the last glacial maximum (LGM) and middle Holocene (2-4 kyr). Lowered SSTs for these periods in off central Japan and off SW Japan may have been influenced by a northern-origin cold water mass. Middle Holocene cooling at off Shikoku may correspond to the so-called Pulleniatina minimum event (PME) in the East China Sea. On the other hand, SSTs in off Shikoku were much warmer than eastern Kuroshio region (Nishishichitō Ridge) during the last deglaciation, early Holocene, and latest Holocene. The path of the Kuroshio main flow at the LGM was shifted southward due to the global cooling based on the distribution patterns in alkenone SSTs. The intensity of the Kuroshio was significantly enhanced at the early Holocene (7-9 kyr) because the warm surface water was distributed in the entire area of off central and SW Japan.

PP11A-0202 0830h POSTER

Alkenone Paleotemperatures in the Eastern Tropical Pacific Since the LGM: Magnitude and Timing of Deglacial Warming

Deborah J. Dryer¹ (ddryer@mit.edu)

Athanasios Koutavas¹ (617-324-6106;
koutavas@mit.edu)

Julian P. Sachs¹ (617-253-0474; jsachs@mit.edu)

¹Massachusetts Institute of Technology, 77 Massachusetts Avenue, Cambridge, MA 02139, United States

High productivity and relatively cool tropical temperatures in the upwelling environment of the eastern equatorial Pacific make alkenone paleothermometry an attractive method for reconstructing past sea surface temperatures. However, because of the complex temporal and spatial ocean dynamics in this region, interpretation of alkenone unsaturation data requires careful consideration of production and sedimentation processes affecting alkenone delivery and burial in seafloor sediments. Here we report new results from application of this method in four equatorial cores spanning the last 30,000 years. Results indicate a range of Last Glacial Maximum cooling between 1 and 3 °C relative to present, while the timing of deglacial warming is generally in phase with planktonic $\delta^{18}\text{O}$ within the resolution of the records. A warming trend through the Holocene is evident in a site offshore Ecuador, which supports the idea of a cooler middle Holocene due to more persistent upwelling and weaker ENSO. Core-top alkenone SST values are in general warmer than annual mean modern temperatures, possibly indicating a seasonal production bias or lateral delivery of alkenones from warmer waters north of the equator. While attesting to the essential robustness of alkenone paleothermometry in this region, these results also underscore the need for more systematic study and evaluation of this method as a monitor of regional paleoceanographic change.

PP11A-0203 0830h POSTER

Core-Top Calibration of Temperature Dependent Calcium Isotope Fractionation for ten Species of Planktonic Foraminifera

Neil G. Sime¹ (44-1223-333400;
ngs20@esc.cam.ac.uk)

Christina L. De La Rocha¹
(christina00@esc.cam.ac.uk)

Albert Galy¹ (albert00@esc.cam.ac.uk)

¹Department of Earth Sciences, University of Cambridge, Downing Street, Cambridge CB2 3EQ, United Kingdom

Previous work has demonstrated the variable temperature dependence of calcium isotope fractionation ($\delta^{44}\text{Ca}$) in planktonic foraminifera up to 0.24‰ °C⁻¹. While the majority of this work has focused on cultured samples and plankton tows, there have been no detailed studies of core-top sediments. Here we present the results of $\delta^{44}\text{Ca}$ ($^{44}\text{Ca}/^{42}\text{Ca}$) measurements made via MC-ICP-MS on ten species of planktonic foraminifera (spinose and non-spinose) from a suite of marine box-core surface samples, taken from sites between 61°S and 29°N with SST from 8 to 28°C. The $\delta^{44}\text{Ca}$ -temperature relationship seen for all but three of the species was parallel to, but offset from, inorganic aragonite equilibrium by +0.15 to +0.20‰, and was assumed to represent calcite equilibrium. In contrast to the results of previous studies, which found a much greater degree of temperature dependence on Ca isotope fractionation by *Globigerinella sacculifer*, *Neogloboquadrina pachyderma* (d) and *Globigerinoides ruber* than for other species, the core-top specimens of these three species showed the same $\delta^{44}\text{Ca}$ -temperature relationship as the other foraminifera. In general, values for *Globorotalia inflata*, *Globorotalia truncatulinoides* and *Globigerina bulloides*, were offset from calcite equilibrium to more positive $\delta^{44}\text{Ca}$. The magnitude of this disequilibrium in some species may be as high as +0.70‰, e.g. *G. bulloides*. Disequilibrium seems to be limited to deep-dwelling species and cold-water sites (<~12°C), and this may be tied to an increase in calcification rate at lower depths, initiated by the increasing [CO₂²⁻], and causing further depletion of Ca in a closed Ca pool. Alternatively, it may be due to the addition of a later calcite crust. No difference in the magnitude of Ca isotope fractionation was observed between species bearing photosymbionts and those without them.

PP11A-0204 0830h POSTER

Variability of Shell Mass, $\delta^{18}\text{O}$ and Mg/Ca in Planktonic Foraminifera: From Production to Preservation

Pallavi Anand¹ (palj@geo.vu.nl); Gerald Ganssen¹ (gang@geo.vu.nl); Henry Elderfield² (he101@esc.cam.ac.uk); Frank Peeters¹ (peef@geo.vu.nl); Dick Kroon¹ (kroo@geo.vu.nl); Simon Jung¹ (jung@geo.vu.nl)

¹Paleoecology and Paleoclimatology, Vrije Universiteit, De Boelelaan 1085, Amsterdam 1081 HV, Netherlands

²Department of Earth Sciences, Downing Street, University of Cambridge, Cambridge CB2 3EQ, United Kingdom

Mg/Ca in planktonic foraminifera tests is now well established as a temperature proxy for surface and near-surface waters. Yet work remains to be carried out to define the post-depositional processes affecting foraminiferal Mg/Ca after water-column production. The advantage of Mg/Ca over other paleotemperature proxies is that it can be coupled with $\delta^{18}\text{O}$ measured on the same foraminiferal sample so as to determine seawater $\delta^{18}\text{O}$. We present results of a study of the effect of dissolution on both Mg/Ca and $\delta^{18}\text{O}$ of several planktonic foraminiferal species along a depth transect (~450-4000 m) off Somalia, spanning the lysocline at ~2000 m. The planktonic foraminiferal species, *Globigerinoides ruber*, *Globigerina bulloides*, *Globigerinoides sacculifer* and *Neogloboquadrina dutertrei* were analysed for average shell mass, Mg/Ca, Sr/Ca, $\delta^{18}\text{O}$ and $\delta^{13}\text{C}$ from core-top samples from 250-300 μm size fraction from a depth transect off Somalia (water depth range for samples: ~450-4000 m). The average shell mass decreases by 10% in *G. ruber*, 19% in *N. dutertrei*, 29% in *G. bulloides* and 37% in *G. sacculifer* below the lysocline. *N. dutertrei* is the only species which shows a significant decrease in both $\delta^{18}\text{O}$ (from -0.61 to -0.25 ‰) and Mg/Ca (from 2.57 ± 0.47 to 1.10 mmol/mol). Only a small decrease in Mg/Ca is found in *G. sacculifer* (from 3.50 ± 0.07 to 3.08 mmol/mol), *G. bulloides* (from 4.84 ± 0.20 to 4.39 mmol/mol) and *G. ruber* (from 4.49 ± 0.24 to 4.17 mmol/mol) below the lysocline. The $\delta^{18}\text{O}$ and Mg/Ca of *G. ruber* are least affected by dissolution and hence is the most useful species for surface water temperature reconstructions at this site. Data from the water column and the sediment record for *G. ruber* and *N. dutertrei* will serve to quantify the fate of shell mass, $\delta^{18}\text{O}$ and Mg/Ca proxies from production to preservation.

URL: <http://www.geo.vu.nl/users/pal/staff/palj.htm>

PP11A-0205 0830h POSTER

Glacial-Interglacial Change in Seawater Carbonate Chemistry Inferred From Foraminiferal Mg/Ca

Mary Jane Coombs¹ (coombs@umail.ucsb.edu)

Jennifer S Fehrenbacher² (jsf1@uchicago.edu)

David W Lea¹ (lea@geol.ucsb.edu)

Pamela A Martin² (pmartin@uchicago.edu)

¹University of California, Department of Geological Sciences, Santa Barbara, CA 93106, United States

²The University of Chicago, Department of Geophysical Sciences 5734 S. Ellis Avenue, HGS 421, Chicago, IL 60637, United States

Carbonate ion concentration, which is associated with both the concentration of dissolved CO_2 in and pH of seawater, can be used to infer changes in the carbon cycle and ocean circulation over time. Recent studies have presented reconstructions of glacial-interglacial deep-water carbonate chemistry changes using shell thickness (Broecker and Clark; 2001, 2003) and foraminiferal assemblages (Anderson and Archer, 2002); however, these independent proxies yield conflicting views of glacial seawater chemistry. We explore an alternative method of quantifying variation in carbonate ion concentration of seawater over time using changes in planktonic foraminiferal shell chemistry. Many studies have shown the utility of planktonic foraminiferal Mg/Ca analysis as a paleotemperature indicator; detailed core-top studies demonstrate that Mg/Ca is also sensitive to shell dissolution. Dekens *et al.* (2002) have quantified the relation between Mg/Ca, water depth, and dissolution for several species of planktonic foraminifera. Here, we use new Mg/Ca data from a set of cores from the Ontong Java Plateau, western equatorial Pacific Ocean (1.6 - 4.0 km), a set of cores from Ceara Rise, western equatorial Atlantic Ocean (2.8 - 4.0 km), and core-top calibrations defined by Dekens *et al.* (2002) to quantify temporal changes in carbonate ion concentration of seawater. By applying Mg/Ca calibrations to the shallowest core from each region, we infer sea surface temperature. Differences in Mg/Ca between the shallowest and deeper cores in

each region should reflect differences in preservation, indicating differences in deep-water carbonate chemistry. Preliminary Mg/Ca results from the Pacific reveal changes in both sea-surface temperature and dissolution between the Last Glacial Maximum (LGM) and the Holocene. Mg/Ca temperatures reconstructed from *G. ruber* reveal ~3 °C lower temperature during the LGM, consistent with previous results from the region (Lea *et al.*, 2000). Smaller planktonic Mg/Ca differences between the shallow (1.6 km) and deep (3.4 km) Pacific cores during the LGM imply better preservation and therefore higher deep-water carbonate ion concentration (~20 $\mu\text{mol/kg}$ higher). These preliminary *G. ruber* results are consistent with the results of Broecker and Clark (2001); however, reconstructions of the carbonate ion gradient using a second species, *G. sacculifer*, imply opposite changes. These differences may reflect the different depth habitats of the two species.

PP11A-0206 0830h POSTER

Core-top Evaluation of Planktonic Foraminiferal Mg/Ca and Leaf wax n-alkanoic Acids as Proxies for the Indian Monsoon

Kristina A. Dahl¹ (508-289-2853; kdahl@whoi.edu)

Delia W Oppo² (508-289-2681; doppo@whoi.edu)

William B Curry² (508-289-2591; wcurry@whoi.edu)

Frank Sirocko³ (+49 6131 39 22714; sirocko@mail.uni-mainz.de)

¹MIT/WHOI Joint Program, Woods Hole Oceanographic Institution, MS #22, Woods Hole, MA 02543, United States

²Woods Hole Oceanographic Institution, MS #23, Woods Hole, MA 02543, United States

³Institut für Geowissenschaften, Johannes Gutenberg-Universität Mainz, Mainz 55099, Germany

Reconstructions of the strength of the Indian Monsoon using marine sediments have historically relied on the percentage of the planktonic foraminifer *Globigerina bulloides*, which ideally records the strength of monsoon-induced upwelling in the Arabian Sea. While extremely useful, it is unclear whether subtle variations in *G. bulloides* abundance can be quantitatively linked to subtle changes in the monsoon. For example, *G. bulloides* abundances saturate above ~35-40%, which suggests potential problems with quantitative interpretations of this proxy. In this study, we use 22 core-top sediment samples geographically distributed throughout the Arabian Sea to assess the paleoceanographic potential of three alternative proxies for monsoon strength: planktonic foraminiferal Mg/Ca, leaf wax n-alkanoic acid concentrations and leaf wax $\delta^{13}\text{C}$. Strong upwelling along the Oman Margin during the Indian summer monsoon cools sea surface temperatures (SSTs) along the coast of Oman by several degrees relative to the non-upwelling season and to non-upwelling areas. Because the Mg/Ca ratio of foraminiferal shells is temperature dependent, this proxy may provide a more rigorous estimate of the strength of upwelling than the abundance of *G. bulloides*. We also assess the potential use of long-chain ($\text{C}_{24}\text{-C}_{32}$) leaf wax n-alkanoic acids, derived from terrestrial plants, as indicators of monsoon wind strength and direction. Winter and summer Indian monsoon winds have the potential to deliver leaf wax n-alkanoic acids to the Arabian Sea from Asia and Africa, respectively. During the summer monsoon, leaf waxes should be largely derived from Ethiopia, where desert grasslands and C4 plants dominate the vegetation. During the winter monsoon, leaf waxes should be derived from Asia, where C3 plants are dominant. Thus, both the concentration of leaf waxes and their carbon isotopic composition should yield information regarding the sources of these compounds to sediments. In addition to presenting modern (i.e. core-top) data, we will discuss the utility of planktonic foraminiferal Mg/Ca and leaf wax n-alkanoic acids as potential indicators of monsoon strength in the past.

PP11A-0207 0830h POSTER

Mg Isotopic Compositions of Modern Marine Carbonates

Eirik Krogstad¹ ((0045) 38142643; ejk@dlc.ku.dk)

Martin Bizzarro¹

N Gary Hemming²

¹Danish Lithosphere Centre, Østervoldgade 10 L, Copenhagen K DK-1350, Denmark

²School of Earth and Environmental Sci., Queens College, Flushing, NY 11367, United States

We have used a MC-ICP-MS to measure the isotopic composition of magnesium in a number of samples of modern marine carbonate. Due to the large mass difference between ^{26}Mg and ^{24}Mg (similar to that between ^{13}C and ^{12}C), there is potential for mass fractionation during geologic and biologic processes that

may make this isotope system useful for geochemical studies. These samples are from the study of Hemming and Hanson (1992, GCA 56: 537-543). The carbonate minerals analyzed include aragonite, low-Mg calcite, and high-Mg calcite. The samples include corals, echinoderms, ooids, etc., from subtropical to Antarctic settings. Mg purification was accomplished by ion-exchange chromatography, using Bio-Rad AG50W-X12 resin on which greater than 99 percent recovery of Mg is achieved. Samples were introduced into the MC-ICP-MS (VG Axiom) using a Cetac MCN-6000 nebuliser. We use a standard-sample-standard bracketing technique, and samples are analysed at least three times. For lab standards we find that the reproducibility on the $^{26}\text{Mg}/^{24}\text{Mg}$ to be about ± 0.12 permil (2 s.d.). We monitored our separated samples for Na and Ca, as we have found that high Ca/Mg and Na/Mg produce variable magnesium isotopic fractionation during mass spectrometry due to as yet unclear matrix effects. We have normalized our results to our measured values for seawater. We observed a $\text{d}^{26}\text{Mg}(\text{s.w.})$ range of -1.4 to +2.4 permil in our modern carbonate samples relative to present day seawater. Due to the long residence time of Mg in the oceans (ca. 50 my), this must be due to kinetic or biologic effects. Our $\text{d}^{25}\text{Mg}(\text{s.w.})$ variations as a function of $\text{d}^{26}\text{Mg}(\text{s.w.})$ plot along the terrestrial fractionation trend. With an average $\text{d}^{26}\text{Mg}(\text{s.w.})$ of ca. +0.5 permil in all samples of mantle lithologies and mantle-derived igneous rocks (Bizzarro *et al.*, Goldschmidt abs., 2003), we can assume that the Mg isotopic composition of Earth's river water lies between ca. -2.4 and +0.5 permil (relative to seawater). The actual value will vary according to the ^{26}Mg of provenance carbonates and silicic crust, and the relative rates of chemical weathering and physical denudation. It is unlikely therefore that the Mg isotopic composition of seawater has remained constant through time.

PP11A-0208 0830h POSTER

Testing Three new Mg/Ca-Temperature Calibrations for Arctic, Benthic Foraminifera: A High Resolution Study of the Last Two Millennia.

Greta Bjork Kristjansdottir¹ (303-492-7641; gbk@colorado.edu)

Anne E Jennings¹ (jennings@spot.colorado.edu)

David W Lea² (lea@geol.ucsb.edu)

¹INSTAAR and Dept. of Geol. Sciences, University of Colorado, Boulder, CO 80303, United States

²Dept. of Geol. Sciences, University of California, Santa Barbara, CA 93106, United States

Since the mid-1990s foraminiferal Mg/Ca studies have been growing more important for paleo-seawater reconstructions. A distinct advantage of the Mg/Ca method is the opportunity to reconstruct temperature and salinity of seawater from the same medium, by paired measurements of Mg/Ca and $\delta^{18}\text{O}$. Calibrations of Mg/Ca ratio against temperature are reasonably well-constrained for temperatures above 10°C but are less well developed for cooler temperatures, thus limiting the methods applicability to high-latitude studies. We have developed preliminary calibrations for three common, arctic, benthic foraminifera (*Melonis barleeanus*, *Cassidulina neoteretis*, and *Islandiella norcrossi/helenae*) by using modern, sediment-surface samples from the Iceland and Greenland margins (spatial bottom-temperature gradient of $0 - 9^\circ\text{C}$). We use a set of surface grab-samples collected from the Iceland margin (cruise B997) and the Greenland margin (cruise BS1191). All samples were stained with Rose Bengal upon collection. Both stained and unstained individuals were used due to a limited number of stained individuals in the samples. Before analysis each Mg/Ca sample (60-100 individuals) went through rigorous cleaning (Boyle and Keigwin, 1985/1986; Boyle and Rosenthal, 1996).

Of the three species, *M. barleeanus* showed the greatest temperature sensitivity and was fitted with an exponential relationship between Mg/Ca and temperature, while both *C. neoteretis* and *I. norcrossi/helenae* showed a lower temperature sensitivity and were fitted with a linear relationship in the range of $0 - 7^\circ\text{C}$. To test our new calibrations we have reconstructed a 2000-yr temperature record from a well studied and dated core (MD99-2269) from the NW-Iceland shelf. Where available all three benthic species were analyzed. We compare our reconstructions to carbonate content, oxygen isotope, diatom and coccolith temperature and environmental reconstructions from the same core. During this interval in the core we expect to see climate signals from the Little Ice Age and the Medieval Warm Period.

PP11A-0209 0830h POSTER

Unraveling primary and diagenetic controls over U/Ca in planktonic foraminifera

Ann D. Russell¹ (530-752-3311; russell@geology.ucdavis.edu)Matthew Schmidt¹ (530-752-3311; schmidt@geology.ucdavis.edu)¹Department of Geology, University of California, One Shields Avenue, Davis, CA 95616, United States

The quest to understand the marine controls over atmospheric carbon dioxide has led paleoceanographers to seek reliable reconstructions of past seawater carbonate chemistry. Laboratory culture experiments have shown that the uranium/calcium ratio of planktonic foraminifera (*O. universa* and *G. bulloides*) is sensitive to changes in seawater carbonate ion concentration, decreasing by 28% per 100 $\mu\text{mol kg}^{-1}$ increase in $[\text{CO}_3^{2-}]$. However, the application of U/Ca as a proxy for carbonate ion has been limited by its apparent association with a diagenetic manganese-rich phase in many cores. Here we present a U/Ca profile from ODP999A in the Caribbean over the last 140 kyr, showing that U/Ca in *G. ruber* covaries with pCO_2 from the Vostok ice core, consistent with a primary signal controlled by variations in surface-water $[\text{CO}_3^{2-}]$. The U/Ca record from ODP999A is similar to shorter records from two other Caribbean cores (*G. ruber* VM28-122 and *G. sacculifer* in CP6001-4), in spite of striking differences in their Mn/Ca records, suggesting that Mn-rich phases are not the dominant control over U/Ca in these cores. When U/Ca from ODP999A is corrected for covariation with Mn/Ca, its correspondence with the Vostok CO_2 record improves. We estimated surface-water pCO_2 using the ODP999A U/Ca record and SST and the Vostok pCO_2 record is consistent with a strong influence of surface-water $[\text{CO}_3^{2-}]$ over foraminiferal U/Ca in this core.

PP11A-0210 0830h POSTER

Calibration of Mg/Ca, Sr/Ca and Ba/Ca in Sediment Trap Planktonic Foraminiferal Shells and Seawater

Kuo-Fang Huang¹ (14890107@ccmail.ncku.edu.tw)Chen-Feng You¹ (cfy20@mail.ncku.edu.tw)Hui-Ling Lin² (hllin@mail.nsysu.edu.tw)Ying-Tzung Shieh³ (ytshieh@eden.tpm.gov.tw)Mung-Dar Li¹ (mdli20@mail.ncku.edu.tw)¹Department of Earth Sciences, National Cheng Kung University, 1, Ta-Hsueh Road, Tainan 701, Taiwan²Institute of Marine Geology and Chemistry, National Sun Yat-Sen University, 70, Lien-Hai Road, Kaohsiung 804, Taiwan³Taiwan Museum, 2, Xiang-Yang Road, Taipei 100, Taiwan

Mg/Ca, Sr/Ca and Ba/Ca in foraminiferal calcite are important proxies for reconstructing the past hydrological properties in the ocean. Paired Mg/Ca and $\delta^{18}\text{O}$ measurements on single foraminiferal species are especially of great merit in estimating both temperature and $\delta^{18}\text{O}$ in seawater. However, only a paucity of data is available for the purpose of direct calibration between seawater and foraminiferal shells compositions. Several species of planktonic foraminifera (250-350 μm) obtained from the plankton tow and sediment trap (between 14 Oct. 2000 and 20 Mar. 2002) near the central ocean basin of the South China Sea (SCS) were hand picked and cleaned thoroughly for high precision trace element/calcium ratios determination using a HR-ICP-MS (Element II, Thermo-Finnigan) installed at NCKU. The SCS located between Southeast Asia Continent and Western Pacific Ocean is an ideal place for assessing the relationships between foraminiferal shells chemistry and properties of ambient seawater, because of its distinctive intra-annual variability in T and S in terms of both the spatial and temporal distributions. Seawater profile samples were collected using CTD rosette sampler over the plankton tow and trap deployment periods. This allows us to examine if calcite shells reached isotopic equilibrium with surrounding seawater and to calibrate precisely of Mg/Ca thermometry in foraminiferal shells and other climatic proxies. The preliminary results indicate: (1) Mg/Ca of all species show a significant relationship with instrumental T calculated from habitat depths of each

species, $\text{Mg/Ca} = 0.43 \exp 0.075 T$ ($r = 0.76$). (2) The Sr/Ca ratios display gradual decreasing trends with dwelling depth, which are similar to the distributions in seawater profiles. (3) The Ba/Ca of thermocline-dwelling species show large variations compared with other depth dwellers.

PP11A-0211 0830h POSTER

Paired Mg/Ca and $\delta^{18}\text{O}$ in Planktonic Foraminifers from Caribbean and (Sub-)Tropical South Atlantic Core-Top Sediments - Assessing the Dissolution EffectMarcus Regenberg¹ (+49-431-600-2311;mregenberg@geomar.de); Dirk Nuernberg¹ (+49-431-600-2313; dnuernberg@geomar.de); Silke Steph¹ (+49-431-600-2310; ssteph@geomar.de);Jeroen Groeneveld¹ (+49-431-600-2251;jgroeneveld@geomar.de); Ralf Tiedemann¹ (+49-431-600-2309; rtiedemann@geomar.de);Stefan Mulitza² (+49-421-218-7110; smul@palmmod.uni-bremen.de)¹GEOMAR Research Center for Marine Geosciences, Wischhofstr. 1-3, Kiel D-24148, Germany²University of Bremen, Klagenfurterstr., Bremen D-28359, Germany

Reliable sea surface temperatures (SST) are crucial to any reconstruction and modeling of past ocean salinity and density, water column stratification, thermohaline circulation, and ice volume. Currently, foraminiferal Mg/Ca paleothermometry is widely used for reconstructing past SST, although modern species-specific Mg/Ca vs. SST calibrations still suffer from inconsistencies, and the impact of calcite dissolution needs still to be better defined. Here, we present paired Mg/Ca and $\delta^{18}\text{O}$ data of the spinose mixed layer dwelling foraminiferal species *Globigerinoides ruber* and *Globigerinoides sacculifer*, and the nonspinose thermocline dwelling *Neoglobobulimina dutertrei* gathered from Caribbean and South Atlantic core-top sediments. Samples cover a wide range of water depths from 1000-4600 m, thus extending existing data sets to more shallow water depths. In particular, the Caribbean study allows to assess dissolution effects since spatial temperature variations are minimal. Caribbean specimens of *G. ruber* have highest Mg/Ca ratios, while Mg/Ca in *G. sacculifer* is lower by 10-12%, and *N. dutertrei* is even lower by ca. 50%. *G. ruber* shows a wide range in Mg/Ca concentrations from 3.6-5.8 mmol/mol, while the Mg/Ca range in *G. sacculifer* and *N. dutertrei* is smaller (1.4 and 1.5 mmol/mol, respectively). $\delta^{18}\text{O}$ values of the deep-dwelling *N. dutertrei* are consistently more positive than those of the shallow-living *G. sacculifer* and *G. ruber*. All species exhibit stable Mg/Ca ratios down to species-specific water depth levels. *N. dutertrei* and *G. sacculifer* start losing Mg below ca. 3-3.5 km water depth, whereas for *G. ruber*, Mg is being removed from the tests far above 3 km water depth. The according $\delta^{18}\text{O}$ data of all species consistently become more positive with increasing water depth, although the strongest change is seen in tests of *G. ruber*. From these data it can be noted that *G. ruber* is most sensitive to dissolution (up to 15-20% decrease in foraminiferal test Mg/Ca per km), whereas *N. dutertrei* is the most resistant (25-30% decrease in Mg/Ca per km water depth). Our results, therefore, are in contrast to previously published data from other ocean areas. Based on these results we develop species-specific Mg/Ca vs. SST calibrations for the Caribbean and the (sub-)tropical Atlantic, which consider the effect of increased dissolution with increased water depth.

PP11A-0212 0830h POSTER

Paleo-SST and Seawater $\delta^{18}\text{O}$ Reconstruction of the Kuroshio-Front Region since the Last Glacial MaximumTakuya Sagawa¹ (81-11-706-2253; sagawa@ees.hokudai.ac.jp)Kazuhiro Toyota¹Tadamichi Oba¹¹Graduate School of Environmental Earth Science, Hokkaido University, Kita-ku Kita10 Nishi5, Saporo 060-0810, Japan

In the northwest Pacific, the Oyashio Current (low-temperature, low-salinity) and the Kuroshio Current (high-temperature, high-salinity) meet each other today at the east coast of Japan, and the Kuroshio-Front is located offshore Kashima in central Japan. Latitudinal gradient of SST is extremely steep in this region, and variations of SST and hydrological structure offshore Kashima are closely related to the north-south migration of the Kuroshio-Front. $\delta^{18}\text{O}_{\text{calcite}}$ ($\delta^{18}\text{O}_{\text{C}}$) and Mg/Ca ratios of *Globigerina bulloides* were analyzed

from piston core MD012420 (36°04.05', 141°48.92', 2101 m), recovered during the IMAGES-WEPAMA cruise to reconstruct water mass structures offshore Kashima. Both $\delta^{18}\text{O}_{\text{C}}$ and Mg/Ca ratios were measured from the same samples. Then Mg/Ca-based SSTs were combined with $\delta^{18}\text{O}_{\text{C}}$ to estimate past seawater $\delta^{18}\text{O}$ ($\delta^{18}\text{O}_{\text{W}}$) using a $\delta^{18}\text{O}$ -temperature calibration. Estimated SSTs from the core-top and Last Glacial Maximum (LGM) are 15.8°C and 6.4°C, respectively. The calculated $\delta^{18}\text{O}$ are 0.10‰/‰ for the Holocene average and 0.66‰/‰ for the LGM average. The difference in calculated $\delta^{18}\text{O}_{\text{W}}$ between LGM and Holocene, 0.76‰/‰, includes both global continental ice volume change and local $\delta^{18}\text{O}_{\text{W}}$ (salinity) changes. Assuming the amplitude of $\delta^{18}\text{O}_{\text{W}}$ variation due to glacial ice volume was 1.0‰/‰, then the residual, -0.24‰/‰, must be due to local $\delta^{18}\text{O}_{\text{W}}$ (salinity) change. We suggest that the Kuroshio-Front was located further south and the influence of the Oyashio Current, constituting low salinity water, was dominant offshore Kashima during the LGM.

PP11A-0213 0830h POSTER

The precise and accurate isotopic measurement of sub-nanogram samples of foraminiferal hosted boron by Total Evaporation N-TIMS; applications to paleoceanography

Gavin L Foster¹ (44-117-954-5235; g.l.foster@bristol.ac.uk)Tim Elliott¹ (44-117-954-5426; Tim.Elliott@bristol.ac.uk)Paul Pearson² (44-29-2087-74579; PearsonP@cardiff.ac.uk)¹Department of Earth Sciences, The University of Bristol Wilks Memorial Building, Queens Road, Bristol BS8 1RJ, United Kingdom²School of Earth, Ocean and Planetary Sciences, Cardiff University Main Building Park Place, Cardiff CF10 3YE, United Kingdom

Several recent experiments have confirmed early hypotheses that seawater pH is the dominant factor in determining the boron isotopic composition of foraminiferal calcite. Such a proxy for the paleo-carbonate chemistry of the oceans is extremely useful as it can potentially provide information concerning the CO_2 content of the atmosphere in the past. However, despite several important studies, boron isotope measurements of foraminifera has yet to become a routine tool in paleoceanography. Previous foraminiferal studies have exclusively utilised negative ion thermal ionisation mass spectrometry (N-TIMS), due to the superior sensitivity of analysing boron as BO_2^- ions. However, because B has only two isotopes, mass bias effects have been minimised by analysing relatively large samples (5-100 ng; 30-300 forams tests) coupled with rejection of up to 30% of analyses. This relatively large sample size, the requirement of running in triplicate to achieve acceptable precision, and the necessary rejection of 1 in 3 analyses, has contributed to the limited application of this technique to paleoceanographic problems. In this contribution we present details of a novel Total Evaporation N-TIMS approach that allows the accurate analysis of sub-ng amounts of boron (equating to less than 10 foraminiferal tests) to a precision of c. 0.5 per mil (2 s.d.). Automatic analysis and a relatively short acquisition period (c.1-2 hours) enable a large sample through put (12-20 analyses per day). Application of the approach to a number of fundamental technical problems (e.g. inter- and intra-species isotope variation and the effect of test size), as well as an investigation into the isotopic composition of plankton tow and monospecific benthic foraminifera will also be presented.

PP11A-0214 0830h POSTER

The Lithium Isotope Composition of Planktonic Foraminifera

Ed C. Hathorne¹ (44-1908-653023; e.c.hathorne@open.ac.uk)Rachael H. James¹ (44-1908-654296; r.h.james@open.ac.uk)Nigel B.W. Harris¹ (44-1908-655171; n.b.w.harris@open.ac.uk)¹Department of Earth Sciences, The Open University, Walton Hall, Milton Keynes MK7 6AA, United Kingdom

The temporal record of the lithium isotopic composition of seawater has the potential to provide an important proxy of the relative rates of weathering and hydrothermal processes. One of the most powerful types of evidence for changes in ocean chemistry comes from analyses of foraminiferal calcium carbonate. Here, we explore the utility of foraminifera as recorders of the Li isotopic composition of seawater.

The Li isotopic composition of foraminifera tests has been determined by multicollector inductively coupled plasma mass spectrometry (Nu Instruments) using a sample-standard bracketing technique. The external precision of this technique is $\pm 0.3 \text{ ‰}$ (2σ), based on fifteen analyses of seawater over a period of 9 months. Planktonic foraminifera ($\sim 10 \text{ mg}$) have been picked from surface sediments of the equatorial Pacific and the North Atlantic. Samples from the equatorial Pacific are Holocene/Pleistocene in age; those from the North Atlantic are from the Holocene. The foraminifera were subject to; cleaning in methanol and water, oxidation (hydrogen peroxide and sodium hydroxide), and leaching in weak acid (0.001M nitric acid). Additional reductive and refractory-phase cleaning steps (respectively, hydrous hydrazine/ammonia and DTPA solutions) had no effect on $\delta^7\text{Li}$ or Li/Ca. The $\delta^7\text{Li}$ value of the foraminifera ranges from 27 to 31 ‰ ; slightly lighter than modern-day seawater (31.1 ‰). Different species have consistently different $\delta^7\text{Li}$ values; *O. universa* have $\delta^7\text{Li}$ values within error of seawater, while *Gr. truncatulinoides* record the lightest $\delta^7\text{Li}$ ($27.1 \pm 0.3 \text{ ‰}$). This indicates that there are species specific vital effects on foraminiferal $\delta^7\text{Li}$. Samples of the same species from different latitudes in the North Atlantic have the same $\delta^7\text{Li}$, suggesting that there is no temperature effect on foraminiferal $\delta^7\text{Li}$. Furthermore, with the exception of *G. sacculifer*, there appears to be no variability in foraminiferal $\delta^7\text{Li}$ with test size. Similarly to foraminiferal $\delta^7\text{Li}$, foraminiferal Li/Ca varies between different species. Foraminifera with lower Li/Ca generally have higher $\delta^7\text{Li}$, suggesting that species specific vital effects are due to differences in calcite precipitation rates; i.e. there is a kinetic control on foraminiferal Li/Ca and $\delta^7\text{Li}$. *O. universa* have lowest Li/Ca (and highest $\delta^7\text{Li}$), suggesting that the bulk of their calcite is laid down in a more open system.

PP11A-0215 0830h POSTER

Orbital and Sub-orbital Periodicities in East Greenland Ice-rafting Since 630 ka

Kristen St. John¹ (828-262-6739; stjohnke@appstate.edu)

Jill Richie² (richiejt@appstate.edu)

Benjamin Flower³ (bflower@seas.marine.usf.edu)

Larry Krissek⁴ (krissek@mps.ohio-state.edu)

¹Department of Geology, Appalachian State University, Boone, NC 28608, United States

²Department of Mathematical Sciences, Appalachian State University, Boone, NC 28608, United States

³College of Marine Sciences, University of South Florida, St. Petersburg, FL 33701, United States

⁴Department of Geological Sciences, Ohio State University, Columbus, OH 43210, United States

The presence of hematite-stained ice-rafted debris (IRD) in the Irminger Basin reflects the discharge of debris-laden icebergs from the east central coast of Greenland and possibly Svalbard. In a comprehensive paleoceanographic study of a 630-kyr Irminger Basin sediment record recovered from ODP site 919, it was found that typically 20-40 percent of all the lithic (non-volcanic) grains of the coarse sand fraction were hematite-stained. Modern values for this area do not exceed 15 percent hematite-stained grains, and nearly all modern values greater than 15 percent are in the Greenland-Iceland Sea. This indicates that the modern discharge of icebergs from northern reded regions to the Irminger Sea is anomalously low, compared to conditions during the last 630 kyr. Spectral and cross-spectral analyses of the site 919 sediment accumulation record were performed using the SPECTRUM program. Statistical results include recognition of 123, 91, 19 and 8-kyr dominant periodicities in the abundance record of hematite-stained IRD. These results indicate that both orbital and sub-orbital forces influenced east Greenland ice-rafting since 630 ka. The 19-kyr period of hematite-stained IRD accumulation lags the 19-kyr period in the Site 919 oxygen isotope record by 3.2 kyr (± 1.6 kyr), suggesting that there was a persistent delay in the response of east Greenland ice sheets to changing global climates in the Pleistocene. In addition, the presence of the 8-kyr period suggests that Heinrich-type events may have been a characteristic feature not only of the last glacial cycle but of the Pleistocene in general.

PP11A-0216 0830h POSTER

Late Pleistocene 100-kyr Problem Viewed from Sea Surface Temperature Records: A Connection to Obliquity Cycles?

Zhonghui Liu¹ (401)863-2810; Zhonghui.Liu@brown.edu

Timothy D. Herbert¹ ((401)863-1207; Timothy.Herbert@brown.edu)

Willie Soon² (wsoon@cfa.harvard.edu)

¹Brown University, Dept. of Geological Sciences, Providence, RI 02912, United States

²Harvard-Smithsonian Center for Astrophysics, 60 Garden Street, MS 16, Cambridge, MA 02138, United States

Predominant late Pleistocene (0-0.6 Ma) 100-kyr cycles occurring in paleoclimatic records has been a major challenge to the orbital theory of climate change. By applying wavelet analysis to two Pleistocene sea surface temperature (SST) records, the onset and dominance of 100-kyr cycles were found to coincide with the reduction in amplitude of the 41-kyr cycles in SST records at about 0.6 Ma. Also the late-Pleistocene 100-kyr cycles were evolving toward longer periods to the present, suggesting the nonexistence of direct orbital forcing from eccentricity. The occurrence of strong power at both 41 and 80-kyr bands at the transitional stage (1.2-0.8 Ma) indicates a nonlinear climatic response to the orbital obliquity forcing. The apparent trade-off between 100 and 41-kyr power and the absence of significant precession power lead us to speculate that the 100-kyr period could be regarded as a pseudo cycle, which actually could be a blending of two and three obliquity cycles. The spectral evolution of Pleistocene glacial and interglacial changes is thus interpreted as the development of nonlinearity in the climate system in the mid- and late Pleistocene, which acts on the primary obliquity response. This nonlinearity is associated with the climate responses to weak northern hemisphere summer insolation maxima, arising from the combined variations of all three orbital parameters.

PP11A-0217 0830h POSTER

Contrasting Patterns of Climate Variability in the Mid-Latitude North Atlantic During the Last 3 Glacial-Interglacial Cycles

Mark R. Chapman¹ (m.chapman@uea.ac.uk)

Katie R. Miller¹ (Kate.Miller@uea.ac.uk)

Laura Sbaffi² (Laura.Sbaffi@ga.gov.au)

¹School of Environmental Sciences, University of East Anglia, Norwich NR4 7TJ, United Kingdom

²Geoscience Australia, Petroleum & Marine Division, Canberra ACT 2601, Australia

Numerous investigations suggest that the subpolar ocean has experienced considerable variability in sea surface temperature (SST) associated with iceberg discharge events during the last glacial-interglacial cycle but, at present, little is known about the significance or amplitude of SST climatic fluctuations in previous glacial-interglacial cycles. We have generated a suite of detailed palaeoenvironmental measurements spanning the last 3 glacial periods from cores SU90-03 and MD99-2253, recovered from the northern margin of the subtropical gyre and the subpolar gyre respectively. The chronology for the cores are derived from ¹⁴C dates and $\delta^{18}\text{O}$ measurements made on the foraminifers *Globigerina bulloides*, *Cibicides wuellerstorfi* and *Uvigerina* spp. Past SST conditions were estimated from compositional changes in the planktonic foraminiferal assemblages and compared to a history of ice rafted detritus (IRD) input provided by counts of lithic particles. The impact of the northward surface transfer of heat on the return flow of North Atlantic Deep Water are evaluated from benthic $\delta^{13}\text{C}$ measurements. A series of IRD depositional events are documented throughout the length of both cores, with most intervals of enhanced IRD input readily recognisable at both 40°N and 56°N . In general, short-term coolings appear to match the pattern of IRD variations. However, a major amplification of the IRD signal and an increase in the frequency of IRD events appears to have occurred during the last glacial period compared to the previous glacials. This pattern is matched to a large extent by the characteristics of the paleotemperature records through MIS 8, 6, and 4-2. Well-defined millennial-scale fluctuations in surface water temperatures are less frequent during MIS 6 and the amplitude of SST variability during MIS 8 appears to be of a lesser magnitude ($3 - 4^\circ\text{C}$) compared to the last glacial period ($6 - 8^\circ\text{C}$) at the southern site. Significant differences are also evident when comparing SST variability and patterns of IRD variation through MIS 7 and 5 and the last 3 deglacial transitions. Results from these North Atlantic cores reveal a complex pattern resulting from differences in the timing and the strength of mid latitude temperature gradients which accompanied the phases of ice sheet growth and decay over the last 300,000 years.

PP11A-0218 0830h POSTER

Otolith Chemistry During Deposition of Sapropel S5 in the Mediterranean

Gert-Jan Reichart^{1,2} (+49-471-4831-1852; greichart@awi-bremerhaven.de)

Frans Jorissen³ (jorissen@sciences.univ-angers.fr)

Dirk Nolf⁴ (Dirk.Nolf@naturalsciences.be)

Eelco Rohling⁵ (E.Rohling@soc.soton.ac.uk)

Paul Mason⁶ (mason@geo.uu.nl)

¹Carbon Group Alfred Wegener Institute for Polar and Marine Research, Am Handelshafen 12, Bremerhaven D-27570, Germany

²Department of Geochemistry Faculty of Geosciences Utrecht University, P.O. Box 80021, utrecht NL-3508TA, Netherlands

³Laboratory for the Study of Recent and Fossil Bio-Indicators, Angers University, 2 Boulevard Lavoisier, BruxellesAngers B-10004904, Belgium

⁴Institut royal des Sciences naturelles de Belgique, rue Vautier 29, Southampton Bruxelles B-1000, Belgium

⁵Southampton Oceanography Centre (SOC), European Way, Southampton SO14 3ZH, United Kingdom

⁶Department of Petrology Faculty of Geosciences Utrecht University, P.O. Box 80021, Utrecht NL-3508TA, Netherlands

Geological evidence for periodical low oxygen bottom water conditions in the Mediterranean is known since the early sixties. Sediment layers deposited during these conditions are enriched in organic matter and known as sapropels. After more than 40 years of intensive study, controversies still exist over the mechanisms of their formation. Whereas some authors believe the water column to have been anoxic, possibly even into the photic zone, others argue that only the sediment water interface may have been oxygen depleted. According to the latter theory the higher organic carbon content in sapropelic sediments is attributed primarily to increased sea surface productivity. The proponents of the water column disoxia argue that a lower organic matter degradation rate under oxygen depleted conditions caused the higher organic matter contents. One of the reasons for this long standing controversy is that non of the methods used to reconstruct the paleoenvironment during sapropel times gives direct information on what happened in the water column. Proxies used to reconstruct bottom water conditions are valid only at the sediment water interface and reconstructed low oxygen concentrations can also be explained by a dyoxic blanket covering the sea floor. To resolve this issue information concerning higher parts of the water column is needed. We present such data for sapropel S5 found in a core from the Ionian Sea. Ten centimeter from the base of the sapropel a remarkably well preserved fish specimen was discovered parallel to the lamination of the sapropel. The fish specimen was determined as *Myctophum punctatum*, a mesopelagic lantern fish, and still contained both its otoliths. Over the complete depth interval corresponding to sapropel S5 several other otoliths of mesopelagic fish species were found. To reconstruct water column properties before, during and after the deposition of sapropel S5, we quantified the trace metals incorporated in the fish otoliths, using depth resolved Laser Ablation Inductively Coupled Mass Spectrometry.

PP11A-0219 0830h POSTER

Carbon and Nitrogen Stable Isotope Systematics in Three Mid-Pleistocene Sapropels from ODP Site 974 in the Tyrrhenian Basin

Stefano Bernasconi¹ (stefano@erdw.ethz.ch)

Philip A. Meyers² (734-764-0597; pameyers@umich.edu)

Michela Arnaboldi² (marna@umich.edu)

¹Geologisches Institut, ETH-Zentrum, Zuerich 8092, Switzerland

²Department of Geological Sciences, University of Michigan, Ann Arbor, MI 48109-1063, United States

The modern Mediterranean Sea is oligotrophic, yet its sediment record contains layers of organic-carbon-rich sapropels at 21 ky (precessional) spacing that imply periods of elevated productivity in the past that were equivalent to the high rates of modern upwelling systems. This paradox is resolved by lines of evidence suggesting that the mode of primary productivity changed from one dominated by algae to one dominated by photosynthetic bacteria during times of sapropel deposition. We have made a high-resolution comparison of the organic carbon and nitrogen isotopic compositions of three sapropels and their background sediments in a 3-m sequence that covers 1001 to 946 ka. $\delta^{13}\text{C}$ values systematically increase from -25 to -22 per mil and $\delta^{15}\text{N}$ values systematically decrease from 5 to -1 per mil as organic carbon mass accumulation rates increase. The increase in carbon isotope values mirrors the increase in marine productivity indicated by

the increased mass accumulation rates. The decrease in nitrogen isotope values implies major contributions of nitrogen-fixing cyanobacteria to the total productivity. The precessional minima with which sapropels coincide were times of wetter climate, which stratified the surface Mediterranean Sea and increased delivery of soil-derived phosphorus. Cyanobacteria function best when an amplified oxygen minimum zone extends into the photic zone, which also enhances recycling of phosphorus from detrital organic matter and thereby sustains nutrient availability. Our high-resolution study reveals several relatively rapid excursions into and out of the high-productivity mode, which indicates that sapropel deposition was a surface-driven phenomenon that did not require basin-wide stagnation.

PP11A-0220 0830h POSTER

The Deglaciation in the Bering Sea: New Results From High Accumulation Rate Cores

Mea S. Cook¹ (meacock@mit.edu)

Lloyd D. Keigwin² (lkeigwin@whoi.edu)

¹MIT-WHOI Joint Program in Marine Geology & Geophysics, Mail Stop #24, Clark South 275B, Woods Hole Oceanographic Institution, Woods Hole, MA 02543, United States

²Department of Marine Geology & Geophysics, Woods Hole Oceanographic Institution, Mail Stop #8, McLean 207A, Woods Hole, MA 02543, United States

Previous work in the Bering Sea region is difficult to integrate with data from other parts of the world because of the low sediment accumulation rates and low carbonate preservation endemic to the Pacific. In summer, 2002, we collected new sediment cores from 3 regions of the Bering Sea from the USCGC Healy. Based on lithologic and isotopic correlation, preliminary data show that accumulation rates are high (10 to 100 cm/ky). These cores will provide a stratigraphic and chronologic framework for studying the extent and timing of climate events in the region over the past ~60 ky. The deglaciation in the Bering Sea was marked by an abrupt freshening of surface water, as recorded in planktonic foraminifer and diatom $\delta^{18}\text{O}$. The origin of this freshwater is unknown. One possible source is discharge from the Yukon River, though Alaska is not thought to have been highly glaciated during the last glacial maximum. Another possible source is the newly opened Bering Strait, though the timing of the submergence of the strait is poorly constrained. Today, flow through the strait is primarily northward, though in the past, with different boundary conditions, the flow could have been reversed. All of our Bering Sea cores contain this deglacial sequence, which is characterized by high %carbonate, low %opal, and high organic carbon, and can be correlated with other cores from the open North Pacific. In our oxygen minimum zone-depth cores, this sequence is often laminated, not just during the deglaciation, but in the early Holocene and episodically through marine isotope stage 3. This is analogous to the lamination found in Santa Barbara Basin and the Gulf of California cores.

PP12A MCC: Level 1 Monday 1330h

Paleoceanography and Paleoclimatology Posters (joint with OS, GC)

Presiding: B L Otto-Bliesner,
National Center for Atmospheric
Research

PP12A-0221 1330h POSTER

Organic Matter Isotopic Analyses from Chukchi Sea Sediments: New Constraints on the Late Quaternary Sea Level History of Beringia

Zachary Lundeen¹ (zlundeen@geo.umass.edu); Julie Brigham-Grette¹ (juliebg@geo.umass.edu); Neal Driscoll² (ndriscoll@ucsd.edu); Lloyd Keigwin³ (lkeigwin@whoi.edu); Stephen Burns¹ (sburns@geo.umass.edu); Steven Petsch¹ (spetsch@geo.umass.edu)

¹University of Massachusetts-Amherst, Department of Geosciences, Amherst, MA 01003, United States

²Scripps Institution of Oceanography, Geosciences Research Division, La Jolla, CA 92093, United States

³Woods Hole Oceanographic Institution, 360 Woods Hole Rd., Woods Hole, MA 02543, United States

Accurately defining the sea level history of Beringia since the Last Glacial Maximum has important implications for understanding local paleoclimate data, paleoceanography of the Arctic Basin, and the timing of human migration from Asia into North America. However, few constraints exist on the timing of post-glacial sea level transgression across the former land bridge. To address this data gap, a new investigation into the sea level history of Beringia and its effects on regional paleoclimate and paleoceanography was launched in the summer of 2002 during a cruise on the USCGC Healy in the Bering and Chukchi Seas. A transect of cores were collected across the continental shelf to record the flooding history associated with glacial termination after the LGM. Cores from > 60m modern water depth lack lithologic changes expected from a marine transgressive sequence. Instead, these sediments consist primarily of clay and silt, with only minor amounts of coarser material, reflecting offshore marine burial. However, abrupt changes in downcore density suggest that unconformities may exist, with Holocene and Late-Glacial muds overlying older marine clays from an earlier sea level high-stand. To confirm this possibility, three cores were selected for elemental and isotopic analysis of bulk sedimentary organic matter. Downcore variations in $\delta^{13}\text{C}$, $\delta^{15}\text{N}$, TOC, and C/N are being used to determine the relative contributions of marine and terrigenous organic matter to the sediments. These geochemical data are useful as indicators of proximity to shoreline, riverine organic matter delivery and diagenetic alteration. Together with radiocarbon ages from fossil mollusks, these data place minimum limiting ages on the post-glacial transgression at multiple water depths on the Chukchi Shelf.

PP12A-0222 1330h POSTER

Climate Variability During the Last 1200 Years: Evidence From the North Icelandic Shelf

Jon Eiriksson¹ (354-5254475; jeir@rhi.hi.is)

Karen Luise Knudsen²

Hui Jiang³

¹Science Institute, University of Iceland, Dunhaga 3, Reykjavik IS-101, Iceland

²Department of Earth Sciences, University of Aarhus, Aarhus C DK-8000, Denmark

³Laboratory of Geographic Information Science, East China Normal University Shanghai, Shanghai 200062, China

Marine sediment cores from high resolution basins on the North Icelandic shelf provide reliably dated archives of Holocene paleoceanographic changes in the vicinity of the Polar Front. The present position of the Polar Front separates Arctic surface water of the East Greenland and the East Icelandic currents (Polar Water) from branches of the North Atlantic Current, the Irminger Current (Atlantic Water) to the west and north of Iceland. The area is also within the realm of the Arctic Front that delineates the maximum extent of the winter sea ice, which periodically extends from Greenland to Iceland. The Norwegian Sea Deep Water replaces the surface and intermediate water masses at a depth of 300-400 m off North Iceland. The modern salinity and temperature data from the area show that the deep water masses may be expected to encroach into topographic lows and basins on the shelf during periods of active deep water formation in the Nordic Seas. Another climatic boundary is represented by the North Atlantic Atmospheric low-depression track and the accompanying westerlies across Iceland. The strong gradients both in the ocean and in the atmosphere make this region extremely sensitive to climatic changes. The chronology for the North Icelandic shelf work is based on combined tephrochronology and AMS ¹⁴C datings. A marine reservoir correction of 400 years is generally applied for Holocene datings in the region. However, recent results from the North Icelandic shelf show that the reservoir age has not been constant in the area through Holocene time. Tephrochronology enables us to obtain independent control on radiocarbon datings from sedimentary records in an oceanographic boundary region between Atlantic and Arctic water masses. Icelandic tephra markers can be traced by the help of chemical analyses from volcanic source regions into the marine environment. The tephra are historically dated or dated on terrestrial material. A high-resolution record (200 cm/kyr), covering the last 1200 years, is dated by the help of nine well-known tephra marker horizons from volcanic eruptions in Iceland. A reconstruction of environmental changes, including the Medieval Warm Period (MWP) and the Little Ice Age (LIA), is based on sedimentological parameters, benthic and planktonic foraminiferal data, stable isotopes and diatom-based reconstructions of sea-surface temperatures. Both the summer (SSTs) and the winter (SSTw) sea-surface temperatures show multidecadal-to-centennial timescale fluctuations and the magnitude of fluctuations, from relatively warm to cold periods is about 1.0-1.5 degrees Celsius. There is a prominent drop in SSTs at AD 1300 and in both SSTs and SSTw at

AD 1600. Changes in the sea-surface and bottom water environments, including temperature fluctuations, on the North Icelandic shelf are correlated with the MWP and the LIA. The timing of the relatively warm MWP (AD 850-1300) and the cold LIA (AD 1300-1900) north of Iceland corresponds to that reported in historical sources from Iceland. It is also in accordance with climatic changes recorded in Greenland ice cores and in Europe, as well as the Northern Hemisphere temperature anomaly fluctuations. Paleoceanographic variations within the LIA on the North Icelandic shelf is also similar to the indication of the Iceland Sea Ice Index and other historical sources in Iceland.

PP12A-0223 1330h POSTER

Late Pleistocene environmental fluctuations in Taiwan southwestern plain with constraints of the analyses on organic carbon

Hung-Wei Chiang¹ (d91224004@ntu.edu.tw)

Yue-Gau Chen¹ (ygchen@ccms.ntu.edu.tw)

¹Dept. of Geosciences, National Taiwan Univ., P.O. Box 13-318, Taipei 106, Taiwan

Taiwan is located at the junction point between the Philippine Sea and Eurasian plate, where the Asian monsoon is supposed as the most important factor in controlling the regional climate. Due to the high subsidence rate caused by westerly moving thrust sheet, sedimentary sequences of late Quaternary overlying on the Tertiary basement in coastal plain are usually over 300 meters.

The isotopic composition of organic carbon has been reported to preserve the syn-depositional signals for source identification derived from two major sources, the terrestrial plants and marine organisms. Except for the extreme region, the terrestrial plants can be roughly divided into C₃ and C₄ plants in modern world. Since they adopt different photosynthesis processes, each of them shows specific $\delta^{13}\text{C}$ values. As literatures the $\delta^{13}\text{C}$ values of organic matters in marine sediments are relatively constant in a local area. On the other hand, the concentrations of total organic carbon (TOC) preserved in sediments can also reflect the experienced paleo-environment. For instance, an anoxic environment, such as a lagoon or marsh will usually preserve high TOC. Consequently, the elemental abundance and corresponding isotopes of organic carbon are widely used as proxies to retrieve sedimentary environment and vegetation changes. For the purpose of high resolution, i.e., every 3 to 4m, we sampled cores drilled in coastal plain of southwestern Taiwan and conducted carbon isotope analysis to diagnose the detailed environmental changes under the major framework-global change.

As our results, TOC values remain in a relatively stable and low level when the corresponding $\delta^{13}\text{C}$ data indicate marine organic source, while the terrestrial source usually causes undulated TOC. On the other hand, based on the isotopic data measured in the lower part of the core, the study area was inundated by sea-water as a result of the high sea-stand of MIS (marine isotope stage) 5. Subsequently, the climate turned to drier during MIS 2-4, even though there were different durations and extent from north to south. To the beginning of the Holocene transgression the northern study area was still a terrestrial environment dominated by C₄ plants when the southern was a shallow marine or lagoon. As a whole, our results can conclude that the coastal environments in southwestern Taiwan were consistent with major trend of global changes, but local characteristics were still locally influenced by neotectonics.

PP12A-0224 1330h POSTER

The Use Of Multiple Proxies From Subtropical Shallow-Water Carbonates In The Study Of Quaternary Environments: Core Analyses Of The Ryukyu Group, Southwest Japan

Saburo Sakai¹ (+81-852-32-9741; saburo@soc.shimane-u.ac.jp)

Natsume Sagawa² (+81-22-303-7678; na-sa@bj8.so-net.ne.jp)

¹Institute for Frontier Research on Earth Evolution, Japan Marine Science & Technology Center, 2-15 natsushima-cho, Yokosuka 237-0061, Japan

²Tohoku University, 2-14-27 sakuragaoka, aoba-ku, Sendai 981-0961, Japan

Quaternary shallow-water carbonates, which are often characterized by high sedimentation rates, can provide high-resolution records of sea-level fluctuation, climatic change, and oceanographic evolution for tropical