OS31B MCC: Level 1 Wednesday 0830h

Late Pleistocene and Holocene Paleoceanographic Variability Along the Pacific Margin of North America II Posters *(joint with B, PP)*

Presiding: **L Beaufort,** Centre Européen de Recherche et d'Enseignement de l'Environnement, CNRS**; M Machin-Castillo,** Universidad Nacional Autónoma de México

OS31B-0208 0830h POSTER

A High Resolution Climatic Transect Across the Coastal Margin of Northernmost California During the Past 3,500 Years

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A diatom proxy for SST from two offshore cores, ODP 1019 (41.7 deg. N, 124.9 deg. W, 980 m water depth) and TN062 0550 (40.9 deg. N,124.6 deg. W, 570 m water depth), and a pollen proxy for summer moisture from terrestrial bog core SB70-1 (40.3 deg. N, 123.4 deg. W, 910 m altitude), together reveal a detailed record of climate change in the Eel River basin area of northernmost California during the past 3,500 years. Age models for all three cores are well constrained by AMS dates, with sample spacing varying from ca. 150 years at ODP 1019 to between 30 and 50 years in both TN062 0550 and SB70-1. As indicated by the diatom proxy for the warm waters of the Central Gyre, Pseudoeunotia doliolus, a late Holocene trend toward warmer fall SST's began approximately 1,000 years earlier at the more offshore (60 km offshore) ODP Site 1019 (ca. 3.4 ka), than it did in the more coastal (33 km offshore) piston core TN062 0550 (ca. 2.4 ka). This diatom proxy suggests that a pronounced offshore-coastal SST gradient existed during the fall between the two sites until ca. 1.4 ka (or AD 600), when this climatic gradient abruptly collapsed. During the past 1,400 years, diatom data at both sites argue for cooling of SST's between ca. AD 600 and AD 900, followed by pronounced warming between ca. AD 950 and AD 1200, and then followed by cooling between ca. AD 1350 and AD 1800. The ages of these intervals are suggestive of local expression of the Dark Ages Cold period, Medieval Warm period, and the Little Ice Age. Pollen in the core SB70-1 is derived from the local montane communities of mixed evergreen forest, forests that are dominated by Douglas fir (Pseudotsuga menziesii), and include hardleafed oaks (Quercus chrysolepis), as well as incense cedar (Calocedrus decurrens), Ponderosa pine (Pinus ponderosa), and fir (Abies grandis). We interpret increased oak, which is associated with increased herbs, as indicative of warm dry conditions, whereas increased Douglas fir would suggest a more closed forest with increased summer moisture. Prior to ca. AD 500 AD, oak pollen dominates over Douglas fir pollen, suggesting that comparatively warm, dry summers prevailed in the North Coast Range. Between ca. AD 500 and AD 600, Douglas fir pollen increased from roughly 15% to nearly 40% of the pollen assemblage, evidence of an abrupt increase in summer moisture that was coincident with the collapse in the offshore-coastal climatic gradient suggested by diatoms. Presumably, regional cooling between AD 600 and AD 500 may have shifted the summer position of the Subtropical High further to the south, causing changes in both the diatom and pollen proxies. After ca. AD 600, fluctuations in the relative percentages of Douglas fir and oak pollen compare well with the generalized climate trends suggested by the diatoms in the offshore cores.

OS31B-0209 0830h POSTER

Variability of Precipitation in Southern California During the Late Quaternary: Inferences From Clay Mineral Assemblages of the Santa Barbara Basin (Images Core MD02-2503)

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Clay mineral assemblages have been investigated in a late Quaternary sequence cored in the deepest (569m) part of the semi-enclosed Santa Barbara Basin, off Southern California. Core MD02-2503 consists of 45.27m of silty clay, nannofossil silty clay, and nannofossil clay, ranging from dark olive and dark olive grey to dark grey and very dark grey. The sediment is mostly laminated from top to 15.50m and from 18.00m to 21.00m, and massive to slightly bioturbated in other parts with rare laminated intervals below 32.00m. The distribution of laminated intervals in MD 02-2503 and ODP Site 893 nearby is very comparable and suggests an age of approximately 32ka at the bottom of the core. Smectite dominates the clay assemblages and is associated with abundant illite, kaolinite and chlorite being present in low contents. Smectite is especially abundant in the terrigenous load of the Santa Clara river, which drains the semi-arid continental interior of the Transverse Range. Illite is more abundant in the terrigenous load of the Ventura river and short intermittent rivers, as well as in the suspended load of the Santa Ynez river Northwest of the Santa Barbara Basin. The Santa Clara river is the largest source of terrigenous sediment of Southern California and by far the major contributor to the sedimentation of the Santa Barbara Basin, especially during intervals of intense precipitation. The content of smectite in Core MD 02-2503 is used as a tracer of the terrigenous discharges of the Santa Clara river, and related regional precipitation. Their variations are better expressed through relative abundances of smectite and illite (S/I index). Maximum values of the S/I index express intervals of intense precipitation and river discharge, whereas low values of the S/I index express more arid conditions. The S/I index increased from 28ka to 26.5ka and after 21.5ka, suggesting that precipitation intensified in Southern California during an interval marked by a warming of Pacific surface waters, increased lake level in Death Valley and the Mojave area, and glacier advances in the Sierra Nevada. Peak values of the S/I index interpreted as short intervals of maximum precipitation between 19.5ka and 12.5-13ka occurred during the Tioga Glaciation of the Sierra Nevada, and finished in coincidence with the end of Mojave lacustrine episodes and with vegetational changes (decline of pine and stabilization of oak) in the Santa Barbara area. A further interval of intermittently high S/I and intensified precipitation from 10ka to 6.5ka coincides with lacustrine development and oscillations in the California hinterland. Low values of the S/I index after 6.5ka, suggest little precipitation in Southern California as lakes dessicated in the continental interior. A further decrease of S/I and inferred precipitation at 2.8ka to 3.0ka marked the onset of modern conditions in the Santa Barbara area. Major increases of precipitation in the Santa Barbara area coincide with important climatic events: increase of West Pacific surface temperature at 26-28ka, peak of the last glaciation at 21ka, early Holocene moisture and formation of Mediterranean sapropel S1 from 10ka to 6.5ka. The decrease of precipitation after 6.5ka coincides with the development of aridity in the thirties of latitude worldwide.

OS31B-0210 0830h POSTER

Abrupt Climatic Transitions: Surface to Intermediate-Water Response From High-Resolution Sediment Records, Santa Barbara, California

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Exceptionally high sedimentation rates in Santa Barbara Basin provide an opportunity to closely examine the character of the abrupt warming at the end of the last glacial episode. Two new piston cores collected as part of the IMAGES/MONA program span the intermediate water depths of Santa Barbara Basin, allowing us to determine the timing and amplitude of deglacial warming through the entire water column. Site MD02-2503 was drilled at 569 m water depth, recovering 47 m, providing intermittently laminated sediments to Interstadial event 6 (32ka). Site MD02-2504 was drilled at 440m water depth, just below the modern basin sill depth and recovered 37 meters of sediment, to 22ka. Sedimentation rates for both cores average 140 cm/ka, comparable to ODP Site 893. Preliminary results indicate a two-step warming (Termination IA and IB) recorded by oxygen isotopic values and Mg/Ca ratios of planktonic foraminifera. Planktonic foraminiferal Mg/Ca records a 9 degree (C) temperature change from the last glacial to Holocene, consistent with records from Pt. Conception (ODP 1017). A 3 per mil oxygen isotopic shift is recorded by planktonic foraminifera over this same time period. Thus, warming recorded by Mg/Ca ratios and stable isotopic values appear similar in terms of both magnitude and phasing. Benthic foraminiferal assemblages at both sites indicate changes in intermediate water characteristics on stadial/interstadial and glacial/interglacial timescales. While laminations are absent for most of MD02-2504, they are present in both cores during the Bolling-Allerod. This implies an expansion of the oxygen minimum zone (OMZ) during the Bolling-Allerod that is vertically more significant than the Holocene. Further work on these cores, combined with data from previously described ODP Sites on the California margin (893 and 1017), will allow us to determine 1) if the deglacial termination on the California margin appears synchronous with global climate change, 2) the relative timing of surface to intermediate water warming across the Termination, and 3) the strength and depth of the OMZ during abrupt climate change.

OS31B-0211 0830h POSTER

Paloceanographic Changes in the Eastern Equatorial Pacific During the Late Pleistocene: Preliminary Results of Core MD02-2529 From the IMAGES VIII MONA Cruise

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We applied principal component analysis and the modern analog method to study the relationship between species in planktic foraminiferal assemblages in the Late Pleistocene (upper 4 m) of core MD02-2529. Four main factors responsible for 54% of the total variability were extracted by principle component analysis. The first factor (dominated by G. bulloides and G. glutinata) mainly records mixed layer conditions whereas the second factor (dominated by N. dutertrei) is associated with thermocline variability. The interpretation of the other factors is as yet obscure. Visual correlation of each factor with the relative abundance of whole planktic foraminiferal tests clearly demonstrates that the distribution of factor loadings throughout the upper 4 m of the core is not significantly affected by dissolution. This is confirmed by comparison with sedimentary carbonate content inferred from diffuse spectral reflectance. Although the foraminiferal factors are uncorrelated with the sedimentary carbonate content, whole planktic foraminiferal tests are positively correlated with carbonate content, while the >150 um carbonate fraction is inversely related to carbonate content. Factor 1 decreases in importance from 4 m to the top of the core. In contrast, Factor 2 increases in important around 3.6 m at a transition associated with a sharp decrease in sediment carbonate content. Using the Brown University database of core-top foraminiferal assemblages and modern seasonal and mean annual sea-surface temperatures, we applied the modern analog method to reconstruct paleotemperature variations in core MD02-2529. Values of the sample dissimilarity index generally range between 0.15-0.25 throughout the record, indicating the presence of reasonable analogs. The results demonstrate rather small but consistent temporal variations of seasonal and mean annual temperature. Whereas SST variations are generally within 2°C (between 26 and 28°C) in the upper part of the record, lower winter and summer values are found during and below the transition at 3.6 m. These lower paleotemperatures are associated with higher values of Factor 1 and appear to indicate a cooling of the upper photic zone and enhanced productivity. The transition near 3.6 m depth in core is associated with an increase in Factor 2 and probably indicates a shoaling of the thermocline across a stadial to interstadial transition. The suggestion that the thermocline likely shoals at stadial/interstadial boundaries is consistent with observed variations in the S(H) diversity index. Further work on the core will provide improved age control and test whether the observed faunal patterns are persistent features of climate transitions in this part of the Eastern Equatorial Pacific.

OS31B-0212 0830h POSTER

Climatic and Environmental Controls of Organic Carbon Accumulation on the California Continental Margin: a Comparison of Deep and Shallow Sites in the Late Quaternary Santa Barbara Basin

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The Quaternary sedimentary sequence of the Santa Barbara Basin presents a unique opportunity for testing the relative importance of different environmental criteria for the preservation of organic carbon. New piston cores obtained during the IMAGES MONA Cruise (2002) from a central/ deep (569 m) and marginal/ shallow (481 m) location in the Santa Barbara Basin lie within and above the intermediate water mass and have been deposited within more consistently dysoxic (deep core) and consistently oxygenated (shallow core) settings. This study correlates total organic carbon (TOC) with C/N ratios, carbonate and grain size. Our results will help evaluate the relative significance of local environmental versus regional oceanographic/climatic variation in the preservation of organic matter. Initial sample spacing analyses were acquired at 40 cm (∼275 y). TOC ranges from 3.4 to 1.0 wt.% (shallow) and 4.1 to 1.3 wt.%(deep). C/N ratios vary from 10.5 to 8.4 (shallow) and from 13.3 to 8.7 (deep). Gross trends in TOC and C/N are well correlated between core MD 2503 (deep) and core MD 2504 (shallow). The TOC profile in both has a typical "burned-down" pattern decreasing downcore from 4.1 and 3.4 wt.% respectively to ∼1.5 wt.% at 12 - 14 mbsf at the base of the Holocene. The C/N ratios show an inverse relationship to TOC suggesting a downcore decrease in the preservation of marine organic matter. Below the most dramatic effects of burial diagenesis C/N ratios in both cores are highly correlated with TOC, suggesting that the relative contribution of organic matter is controlling TOC. In cores MD 2503 and MD 2504, mean $CaCO_3$ sharply drops from higher values during the glacial (3.7 and 6.3 wt.%, respectively) to lower values during the Younger Dryas and Bolling Allerod (2.0 and 4.5 wt.%). After initially increasing at the base of the Holocene, both locations record a gradual decrease in $CaCO_3$ to the present. Higher (20 cm, 130 y) resolution TOC and C/N data is being produced to strengthen correlations with other proxy data. Grain size analysis for both cores is being completed to determine the role of fine-grained material. From data provided by co-workers stable isotopes of planktonic and benthic foraminifera, Mg/Ca ratios, faunal and floral (nannoplankton and pollen) assemblages, and clay mineralogy are also being correlated with TOC to determine the relative significance of provenance productivity, ventilation and substrate composition in the accumulated preservation of organic matter.

OS31B-0213 0830h POSTER

Late Quaternary intermediate water oxygenation history in Santa Barbara Basin from benthic foraminiferal assemblages

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The Southern California margin adjacent to Santa Barbara Basin (SBB) experienced dramatic changes in bottom water oxygenation and related strength of the oxygen minimum zone (OMZ) on millennial through orbital scales during the late Quaternary. These are clearly recorded by quantitative changes in benthic foraminiferal assemblages and/or strength of sediment laminations in SBB. The basin was well oxygenated during cool episodes and poorly oxygenated during warm episodes, in response to changes in intermediate water ventilation and surface ocean productivity. Previous work has shown that benthic foraminiferal assemblages exhibit high sensitivity to changing oxygenation state and groups of taxa can be ranked accordingly. The history of basin oxygenation change during the late Quaternary (last 25 to 33 ka) is now extended over greater depth range through studies of two new IMAGES cores in SBB (569 m at deep basin and 440 m at sill depth). During cool episodes (LGM; Younger Dryas) the assemblages indicate that the water column was well mixed and oxygenated. No evidence exists of significant water mass stratification or presence of the OMZ. Faunal changes are remarkably similar and correlated between the two water depths. In contrast, the assemblages during warm episodes (Bolling/Allerod; and Holocene) indicate strong vertical water mass stratification in oxygenation. The deep basin is much more poorly oxygenated than that at sill depth. Yet, changes in assemblages at sill depth, although often taxonomically different, clearly record oscillations in strength of the OMZ. One benthic foraminiferal species (Bolivina tumida) appears, from earlier works, to be indicative of high concentration of dissolved methane and/or maximum deficiency of oxygen concentration in the basin floor. If so, changing pattern in this species would suggested broad methane expulsions during the early Holocene and during the three episodes in the B/A. The early Holocene was poorly oxygenated compared with the late Holocene.

OS31C MCC: Level 1 Wednesday 0830h

General Ocean Sciences: Geochemistry and Ocean Circulation Posters *(joint with A, B)*

Presiding: **W Cai,** University of Georgia**; E A Laws,** University of Hawaii**; E Y ZENG,** Southern California Coastal Water Research Project

OS31C-0214 0830h POSTER

Seasonal and Interannual Variability of the Carbon Exchange Coefficient Between the Ocean and the Atmosphere

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We use wind speed data from the Special Sensing Microwave Imager (SSM/I), sea-surface temperature (SST) and salinity, to compute the carbon exchange coefficient (K) between the ocean and the atmosphere. The computation is performed on the finest spatial and temporal available grid, i.e., weekly on a 1/4 degree grid, between 1992 and 2002 and over the entire ocean. On average, the Pacific basin is the area with the least seasonal variability, whereas the Indian basin shows the highest variability, with peaks at 0.095 (in moles CO2 kg-1 microatm-1 cm hour-1) around week 30-31 (end of July).The Atlantic basin shows the lowest value (about 0.058) around week 32 (mid-august). The interannual variability shows a slight increase in the exchange coefficient, probably related to an increase in wind speed. The carbon flux is also computed using K and the air-sea CO2 pressure difference and shows that the uptake by the ocean is mostly concentrated in the south eastern part of South America, in the south western part of the Indian Ocean and south of Greenland, whereas the Equatorial region, especially in the west part of the Pacific, releases up to 10 Gt C per year (for an area of 4x5 degrees). This release is also observed in the north western part of the Indian Ocean (around the Oman Sea).

OS31C-0215 0830h POSTER

An Idealized Model of Organic Carbon Dynamics on the Continental Margin of the Eastern United States

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Continental margins play a significant role in the production and burial of organic carbon in the ocean, bur these areas are poorly resolved global circulation models. In this study, a high-resolution three-dimensional, nonhydrostatic model of an idealized eastern coastal United States after Mahadevan and Archer, 1998, was modified to simulate organic carbon production and export off the shelf. The model assumes a periodic north and south boundary, and an offshore boundary at the shelf-break density front determined by bathymetry. The model uses a free surface and a sigma grid in the vertical. The model is initialized with a vertical nutrient profile taken from the open Atlantic Ocean. As the winds are given time to influence the region, upwelling conditions can result in the vertical movement of water. Vertical diffusion also carries nutrients into the euphotic zone. Excess nutrients in the euphotic zone are converted to particles that advect with the flow while sinking with a velocity of 10^{-5} m/s. Remineralization is treated as a first-order decay. We will vary the alongshore wind stress, shelf width, and vertical diffusivity to determine their respective impacts on organic carbon export. Eventually, we hope to parameterize the impact of coastal circulation on the carbon cycle with global circulation and carbon models. Mahadevan, A., Archer, D., Modeling a Limited Region of the Ocean, Journal of Computational Physics 145, 555-574, 1998.

OS31C-0216 0830h POSTER

Hydrothermal Reduction of Carbon Dioxide at 250°C and 500 bar

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Fischer-Tropsch type catalysis reactions are believed to play important roles in abiotic synthesis of organic compounds in mid-ocean ridge vent fluids. However, little is known about the mechanisms of these processes, especially the reaction intermediates in the formation of abiotic hydrocarbons from reduction of CO_2. To better understand abiotic synthesis of hydrocarbons, an experiment involving CO_2 reduction was carried out in a flexible-Au/Ti-cell hydrothermal solution apparatus at 250°C, 500 bar. To limit sources of contamination and simplify the pathway of this reduction process, this experiment was conducted by injecting CO_2 and then H_2 into the reaction cell, instead of using organic acids as surrogate sources. Magnetite was used as a catalyst for organic synthesis. To exclude organic contaminants on the catalyst and their potential effects on this reduction process, however, the magnetite was reacted with hydrogen peroxide prior to the experiment. Subsequently, H_2 was injected into the reaction cell to restore the magnetite structure. Dissolved CO_2 (aq) (35 mmol/kg) was then injected into the reaction cell. This was followed by systematic addition of dissolved H_2. With the addition of H_2 into the system, trace amounts of dissolved CO and CH_4 were produced. 7 μmol/kg formate ($HCOO^-$) and 8 μmol/kg acetate (CH_3COO^-) were also detected by ion chromatography. More formate was produced with adding more H_2. When injecting H_2 to a final concentration of 11 mmol/kg, the concentration of formate increased to 0.16 mmol/kg, CO and CH_4 remain constant, while CO_2 decreased to 4 mmol/kg, and no acetate was observed. Surface compositional analysis of magnetite was conducted using X-ray Photoelectron Spectroscopy (XPS). The concentration of carbon increased following reaction. The prominent C_{1s} peak from the reacted magnetite occurred at 284.5 eV, which corresponds to graphite. The subsidiary peak was consistent with that expected for trace carbon on metal surfaces, which also can be seen in the unreacted magnetite. Results suggest that at 250°C, 500 bar, graphite and formate exist as two primary reduced carbon phases in the system, while the amount of CH_4 and CO were much less than predicted from theoretical data. We speculate that the coating of graphite on the magnetite surface and concomitant loss of magnetite catalytic activity prevent the formation of methane. A similar experiment with temperature stepping scheme (from 250 to 400°C) is in progress. It will allow us to assess the potential contribution of reduced carbon phase formation to the abiotic synthesis of organic compounds under seafloor hydrothermal conditions.

OS31C-0217 0830h POSTER

Helium isotopes and heavier noble gas abundances of water in adjacent sea of Japan

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We have measured helium isotopic ratios of water samples collected with various depths in adjacent sea of Japan. The $^3He/^4He$ ratios vary significantly from