OS22B-1164 1330h POSTER

International Centre for Geohazards (ICG) Established at the Norwegian Geotechnical Institute in Oslo, Norway.

Anders Solheim[1] (47-22023059; as@ngi.no)

Farrokh Nadim[1] (47-22023047; fna@ngi.no)

[1]Norwegian Geotechnical Institute, P.O.Box 3930 Ullevaal Stadion, Oslo N-0806, Norway

As one of 13 new Centres of Excellence' awarded by the Norwegian Research Council with a 10-year funding schedule, the International Centre for Geohazards (ICG) was established at the Norwegian Geotechnical Institute (NGI), in January 2003. The Centre is formed through a co-operation between several institutions, which in addition to NGI are the Gelogical Survey of Norway (NGU), Norwegian Seismic Array (NORSAR), University of Oslo (UiO) and the Norwegian University for Science and Technology (NTNU). The Centre is located in the NGI building in Oslo, Norway. Funding is for 10 years, and the centre is staffed by researchers from the partner institutions, visiting scientists, postdoctoral fellows and Ph.D. students. With the ultimate goal of geohazard mitigation and preventing the loss of lives and damage to infrastructure and environment, key research topics of the Centre are: Unsaturated soils and mechanisms for precipitation-induced slides in steep slopes; Risk and vulnerability analysis for geohazards; Earthquake hazard, vulnerability and risk evaluation; Rock slope failures - models and risks; Landslides in soft clay slopes (quick clay), fjord margins and coastal zones; GIS applications to geohazards; SAR applications to geohazards; Slide dynamics and mechanics of disintegration; Tsunami modelling and prediction; and Offshore Geohazards. As prospecting for hydrocarbons move into increasingly deeper waters of the world's continental margins, research on offshore geohazard forms an important activity of the new centre. Main offshore geohazards include slope instability, effects of shallow gas and gas hydrates on the behaviour of seafloor sediments, mud volcanism and diapirism. Of these, slope instability is considered to be the major hazard, because of the potentially serious third party impact. The current offshore geohazards project within ICG consists of three main themes: Assessment of offshore geohazards (site surveys); Geophysical methods for offshore geohazard studies, including improved modelling; and Pore pressures in offshore sediments: prediction and measurements. Education is a highly prioritised task of the Centre, and new courses are being offered at NTNU and UiO. These courses aim at giving graduate level education in geohazards, with thesis work carried out on ICG projects.

URL: http://www.geohazards.no

OS22C MCC: 3000 Tuesday 1340h

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

Presiding: **L Beaufort,** Centre Europëen de Recherche et d'Enseignement de l'Environnement, CNRS**; T F Pedersen,** University of Victoria

OS22C-01 1340h

Late Quaternary History of the Northeast Pacific Ocean off Vancouver Island, Canada

Jennifer Lynn McKay[1] (514-987-4080; mckay.jennifer@uqam.ca)

Tom Pedersen[2] (250-721-6120; tfp@uvic.ca)

[1]GEOTOP, University of Quebec at Montreal, C.P. 8888, succursale Centre-Ville, Montreal, QC H3C 3P8, Canada

[2]School of Earth and Ocean Sciences, University of Victoria, Petch Building 168, 3800 Finnerty Road, Victoria, BC V8P 5C2, Canada

Data for marine sediment cores collected from the continental margin off Western Canada indicate that dramatic changes in productivity and oxygen minimum zone intensity occurred during the last 16 kyr B.P. During the late glacial marine organic matter accumulation in sediments was greatly reduced off Vancouver Island. This reflected low primary and export production because glacial-mode atmospheric circulation (i.e., the dominance of the Aleutian Low) did not drive upwelling in the region. At start of the Bolling warm period (14.3 kyr B.P.), and coincident with the retreat of glaciers from the continental shelf, there was a substantial increase in the burial of organic matter. Much of this organic material was old terrestrial organic matter derived from the erosion of shelf sediments. However, the accumulation of marine organic matter also increased in the Bolling and peaked in the Allerod (13.5 to 12.6 kyr B.P.). At this time the marine organic carbon accumulation rate was an order of magnitude higher than in the late glacial and Holocene. Other paleoproductivity proxies (i.e., bio-barium, opal and alkenone abundances) also indicate increased marine productivity during the Allerod. Since productivity in the region is controlled by the upwelling of nutrient-rich subsurface waters the data suggest enhanced upwelling, which is also alluded to by radiocarbon data (i.e., a decrease in benthic-planktonic age differences). Redox-sensitive trace metal and benthic foraminifera data suggest that the intensity (i.e., degree of oxygen-depletion) of the oxygen minimum zone (OMZ) also fluctuated during the deglacial. Notably, there is a prominent increase in OMZ intensity during the Allerod. The corresponding increase in marine organic carbon accumulation at this time and lack of any evidence of decreased ventilation suggests that OMZ intensification was a response to increased primary productivity and carbon export. Intensification of the OMZ during the deglacial is documented along the length of the entire California Current System, but it appears to have been delayed by approximately 1500 years off Vancouver Island.

OS22C-02 1355h

The Pacific Decadal Oscillation and the Growth and Decay of the Cordilleran Ice Sheet During the Last Glacial

Timothy N Cosma[1] (tcosma@uymich.edu)

Ingrid Hendy[1] (734-936-8458; ihendy@umich.edu)

[1]The University of Michigan, Department of Geological Sciences, Ann Arbor, MI 48109, United States

Late Quaternary growth and decay of the Cordilleran Ice Sheet left substantial terrestrial sedimentary deposits in the American Northwest and although this ice sheet has been the subject of numerous studies, the interaction between global climate and local ice sheet growth and decay is not fully understood. MD02-2496, drilled off the coast of Vancouver Island, Canada, (48°58'N; 127°02'W; 1190m water depth; 38.38m core length) provides the first high resolution Late Quaternary record of northeast Pacific ocean response to climate change that can be precisely correlated with Cordilleran Ice Sheet dynamics. Preliminary results indicate MD02-2496 contains a significant record of climate variability that shares many similarities with Greenland δ^{18}O records. From the base of the core to 31.5m terrigenous sediments dominate. Numerous drop stones, high magnetic susceptibility and δ^{18}O values suggest glacial conditions From 25-31.5m, higher Corg/terrigenous ratios are suggested by color reflectivity and low magnetic susceptibility similar to that of the core top. δ^{18}O values decrease during this interval and demonstrate unprecedented variability similar to the widely documented MIS 3 interstadial events. Magnetic susceptibility increases at 25m prior to an interstadial event (possibly IS 2). The sudden occurrence of bedded turbidite layers at 19.5m appears co-incident with high δ^{18}O values suggesting the Last Glacial Maximum. The incidence of turbidites decreases upcore to 7m. A dramatic shift in δ^{18}O toward lower values occurs at 9.5m marking the Bølling. The upper 7m of the core contains sediments with the same distinct color reflectivity shift and low magnetic susceptibility seen between 25 and 31.5m. Tentative interpretation of these early results suggests the core bottom (31.5 m +) preserves the first record of a possible MIS 4 glacial advance in the Juan de Fuca lobe. The interstadial events recorded in MIS 3 (25-31.5m) suggest glacial retreat and a return to a high sedimentary Corg/terrigenous ratio. The increase in magnetic susceptibility at 25m appears coincident with regional ice sheet growth, while the turbidite sequence beginning at 19.5m possibly signifies the maximum ice extent (20 ka) with the engulfing of Vancouver Island and ice expansion on the continental shelf. The sudden shift of δ^{18}O at 9.5m probably correlates with the Bϕlling and subsequent rapid decay of the Cordilleran Ice Sheet with modern oceanic conditions returning at 7m.

OS22C-03 1410h

Millennial and Centennial Variability of the California Current System During the Holocene Recorded in Santa Barbara Basin

Kevin G. Cannariato[1] (1-213-740-6733; cannaria@usc.edu)

James P. Kennett[2] (kennett@geol.ucsb.edu)

Douglas J. Kennett[3] (dkennett@oregon.uoregon.edu)

Justin S. Revenaugh[4] (justinr@umn.edu)

Bjorn A. Malmgren[5] (bjorn.malmgren@marine-geology.gu.se)

[1]University of Southern California, Department of Earth Sciences, Los Angeles, CA 90089, United States

[2]University of California, Department of Geological Sciences, Santa Barbara, CA 93106, United States

[3]University of Oregon, Department of Anthropology, Eugene, OR 97403, United States

[4]University of Minnesota, Department of Geology and Geophysics, Minneapolis, MN 55455, United States

[5]Goteborg University, Department of Earth Sciences-Marine Geology, Goteborg SE-405 30, Sweden

Understanding natural climate variability on millennial and centennial time-scales is necessary for predicting future climate change. Here we present planktonic foraminiferal oxygen and carbon stable isotope records at decadal resolution from Santa Barbara Basin documenting California Current system variability through the Holocene. Threshold mean-climate changes in SSTs and upper-water column structure occurred as well as significant millennial- and centennial-scale variability. A transition from warmer SSTs and a more stratified water column to cooler SSTs and a less stratified water column occurred between 4 and 3 ka and is associated with a global climate transition exhibited in records from the tropics to the poles. Millennial and centennial oscillations in SST and water column structure are associated with inferred atmospheric variability in the tropics, North Atlantic and Antarctic. These results suggest that interdecadal-like teleconnections may have been active on centennial and millennial time-scales. Furthermore, centennial periodicities imbedded in the records suggest possible forcing through variations in solar output.

OS22C-04 1425h

Regime Shifts in Productivity off Baja California During the Late Pleistocene?

Joseph D Ortiz[1] (330-672-2225; jortiz@kent.edu)

Suzanne E. O'Connell[2] (soconnell@wesleyan.edu)

Jeffery DelViscio[3] (jdelviscio@cspinet.org)

Alexander van Geen[4] (avangeen@ldeo.columbia.edu)

Luc Beaufort[5] (beaufort@cerege.fr)

[1]Department of Geology, Kent State University, Kent, OH 44242, United States

[2]Department of Earth and Environmental Sciences, Wesleyan University, Middletown, CT 06459, United States

[3]Center for Science in the Public Interest, 1875 Connecticut Ave. N.W.,Suite 300, Washington, DC 20009, United States

[4]Lamont-Doherty Earth Observatory, Columbia University, Palisades, NY 10964, United States

[5]CNRS - CEREGE, Univ. Aix-Marseille III Technopole de l' Arbois - BP 80, Aix-en-Provence 13545, France

The eastern subtropical Pacific is a region of the surface ocean influenced strongly by ENSO but characterized by generally low sedimentation rates. Core MD02-2508 raised from 700m depth on the Magdelana Margin near the southern tip of Baja California during the IMAGES VIII MONA cruise exhibits high sedimentation rates and appears to extend beyond 100 ka based on a preliminary age model. Work on a piston core collected during a prior cruise to the same location (MV99-PC08) demonstrates a clear correlation between the GISP-2 d18O record, and sedimentary records of diffuse spectral reflectance, organic carbon, calcium carbonate, and benthic foraminifers per gram sediment during the past 52 kyrs. Peaks in organic carbon content, which occur during warm interstadial events, correspond to maxima in benthic foraminiferal absolute abundance that are as much as two order of magnitude greater than those observed during cool stadial events. Although the age model of the core MD02-2508 is preliminary, data from this new core appears to extend this correlation back beyond 100 ka. From 2400 cm to 0 cm, sediment in core MD02-2508, is only laminated during the strongest of the interstadial events and exhibits an inverse linear correlation between calcium carbonate content and organic carbon content. Sediment deposited below 2400 cm are radically different. The base of core MD02-2508 is more distinctly and continuously laminated, exhibiting greater variance in organic carbon and calcium carbonate content. Of perhaps greater significance, there is a positive, exponential relationship between calcium carbonate and organic carbon content off Baja California during this interval, except for brief periods of lower organic carbon and calcium carbonate that exhibit the negative correlation which

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dominates at the site from 2400-0 cm. These results suggest greatly enhanced marine productivity prior to 100 ka off Baja California than at any time in the past 100 kyrs. One potential way to explain this result is to invoke stronger La Nina-like conditions in response to the enhanced northern hemisphere solar forcing at that time.

OS22C-05 1440h

A 35,000 years record of the Oceanic Primary production variability in the Santa Barbara basin

Luc Beaufort[1] (33 442 97 15 71; beaufort@cerege.fr)

Stephanie Cuven[1] (phanie.cuven@infonie.fr)

Noelle Buchet[1] (nbuchet@cerege.fr)

[1]CNRS CEREGE, Europole de l'Arbois BP 80, Aix-en-Provence 13545 C04, France

The high sedimentation rate of the Santa Barbara Basin has attracted many paleoclimatic studies since drilling of ODP Site 893. In particular the occurrence of laminated sediments during each Dansgaard-Oeschger (D/O) event is particularly intriguing. The reason of these anoxic events can be related either to higher primary production or to change in the chemistry of the intermediate water that fill the deep part of the basin. Here we present a record of primary production (PP) estimations based on coccolith assemblages. It is based on the relative abundance of deep photic zone flora (Florisphaera profunda) versus the upper photic zone flora. This record has been established on Core MD02-2103 in the vicinity of ODP Site 893 during the IMAGES-VIII cruise (2003). The PP record shows higher PP during the Holocene and Boelling Allerod (250 g C/m2/year) than during the Youger Dryas, MIS 2 and MIS 3 (150 g C/m2/year). This record therefore confirms the importance of Glacial/Interglacial influence on strength and path of the California current. During the D/O events no significant increase of primary production is observed, implying that the preservation of laminations during these events is controlled more by the chemistry of the intermediate water rather than by primary production. In order to check the variability of El Nino Southern Oscillation through time and how ENSO influence PP in that contest, we sampled lamina in some intervals (Holocene, Boelling Allerod and D/0 5). Preliminary analysis of a 20 years record from the upper Holocene indicates that the ratio between two Emiliania huxleyi morphotypes show small but significant seasonal variability and a 5-6 year period which may correspond to ENSO cycle.

OS22C-06 1455h

Climate-Related Changes in Particle Flux and Export Production During the Last 40 ka from the Pacific Margin of Baja, Mexico

Robert F. Anderson[1] (845-365-8508; boba@ldeo.columbia.edu)

Martin Q. Fleisher[1] (martyq@ldeo.columbia.edu)

Joseph Ortiz[2] (jortiz@kent.edu)

Yan Zheng[1,3] (yan_zheng@qc.edu)

Alexander van Geen[1] (avangeen@ldeo.columbia.edu)

[1]Lamont-Doherty Earth Observatory, P. O. Box 1000, Palisades, NY 10964, United States

[2]Geology Dept. Kent State University, 336 McGilvrey Hall P.O. Box 5190, Kent, OH 44242, United States

[3]Queens College, City University of New York, Flushing, NY 11367, United States

Millenial-scale changes in the organic carbon content of sediments deposited within the oxygen minimum zone (OMZ) along the Pacific Coast of North America have been correlated with the global pattern of climate variability as manifest, for example, in ice cores recovered from Greenland. These and related features have been attributed by various investigators either 1) to changes in the supply of oxygen associated with the ventilation of intermediate water mass, or 2) to local changes in productivity, as a result of ocean-atmosphere reorganizations, such as is seen during El Nino events today. Whereas evidence for changes in the intensity of the OMZ is unequivocal, most sedimentary proxies cannot discriminate between the two proposed causes, because the impact of low bottom-water oxygen concentrations on the composition of marine sediments (organic carbon concentration; trace metal enrichment; etc.) is generally indistinguishable from that of high biological productivity and related organic rain rates. Th-230, Pa-231 and Be-10 were measured in samples from a core collected off the Pacific coast of Baja, Mexico, at a water depth of 700-m. Th-230 profiling was used to evaluate changes in bulk particle fluxes, as well as the fluxes of opal, C-org, and CaCO3. Pa/Th and Be/Th ratios are sensitive to changes in the flux of biogenic particles, but not to the concentration of dissolved oxygen. Hence, these ratios provide unambiguous evidence for changes in productivity. Th-normalized mass fluxes are systematically greater during warm periods (corresponding to high C-org content) than during cold periods, both throughout the last deglaciation and across Interstadials 5 through 8. Pa/Th ratios are also systematically greater during times of warmer climate (Be-10 results are not yet available). While these results do not rule out changes in the ventilation of intermediate waters, they do provide clear evidence for changes in biological productivity and the export flux of biogenic particles. Enhanced productivity during warm events reflect either a shoaling of the nutricline, or an increase in upwelling-favorable winds, or some combination thereof.

OS22C-07 1510h

Stagnation of the Eastern Tropical Pacific During Deglaciation?: Porewater Oxygen Concentration Shifts in the Gulf of Tehuantepec

Ingrid L Hendy[1] (734 615 6892; ihendy@umich.edu)

Robert C Thunell[2] (Thunell@geol.sc.edu)

Thomas F Pedersen[3] (tfp@uvic.ca)

[1]University of Michigan, 2534 C.C. Little Building, 425 E. University Ave,.University of Michigan, Ann Arbor, MI 48109-1063

[2]University of South Carolina, Department of Geological Sciences, 700 Sumter Street,University of South Carolina, Columbia, SC 29208

[3]University of Victoria, School of Earth and Ocean Sciences, P.O. Box 3055 STN CSC, University of Victoria, Victoria, BC V8W 3P6

The oxygen minimum zone (OMZ; 400 m water depth) is a significant oceanographic feature along the North American Margin. However, during the last glacial, large changes in porewater oxygen concentrations have been documented suggesting the waxing and waning of the OMZ in close concert with rapid climate change events. It has been suggested that changes in California Undercurrent flow along the North American Margin and/or increased ventilation of intermediate waters played a role in OMZ ventilation off California. However little is known about ventilation at the source of the California Undercurrent (intermediate water in the Eastern Tropical Pacific). A depth transect of cores (15.7^{o}N; 95.3^{o} E; 570 to 750 m water depth) through the OMZ collected in the Gulf of Tehuantepec has provided a unique opportunity to examine regional intermediate water mass ventilation and local productivity from the present to the last glacial maximum (24 ka). The resolution of the cores (sedimentation rates of 40 to 100 cmkyr^{-1}) is such that evidence of OMZ responses to rapid climate timescales should have been recorded through the transition from glacial to interglacial. The cores show surprisingly similar sedimentation rates, trace metal (Mo, Re, U, Cd and Ag) and organic carbon concentrations and δ^{15}N values suggesting that the water column between 570 and 750 m was relatively homogenous. A significant increase in trace metal concentration occurs during the deglacial interval coincident with increases in % organic carbon and δ^{15}N, decreases in bulk sediment Si and Al contents and distinct sediment laminations. Most significantly this time interval contains the lowest sedimentation rate in the cores and yields an organic carbon flux that was constant through the deglaciation. The invariant organic carbon flux implies that the increase in trace metal concentrations seen during deglaciation cannot be the result of an increase in productivity. Further, an increase in organic carbon flux during the Holocene is not matched by an enrichment in trace metal concentration. These observations together show that porewater oxygen concentrations are not primarily controlled by productivity in this area. The low deglacial sedimentation rate suggests that less detrital clay was delivered to the site during deglaciation. Disappearance of detrital clay may be due to a number of factors including flooding of the shelf during sea level rise, winnowing of bottom sediments by contour hugging bottom currents and reduced rainfall in the region. What, then, produced the observed trace-element enrichments? The most probable explanation is that very low oxygen contents in regional bottom waters coupled with ample time for downward diffusion of trace metals allowed the elements to accumulate in the deposits, most likely as authigenic sulphides. These results imply an intensification of the oxygen minimum in the Gulf of Tehuantepec region during the deglaciation. This cannot be attributed to increased export production (and thus subsurface oxidant demand) but instead requires a primary physical control.

OS22C-08 1525h

Late Quaternary History of the Tropical Pacific: THe Gulf of Tehuantepec Foraminiferal Record

Maria Luisa Machain-Castillo[1] (525 622 5832; machain@mar.icmyl.unam.mx); Elsa Arellano-Torres[1] (525 622 5832; arellano@mar.icmyl.unam.mx); Robert Thunell[2] (Thunell@geol.sc.edu); Mitchell Lyle[3] (mlyle@cgiss.boisestate.edu); Alan C Mix[4] (mix@coas.oregonstate.edu); Nicklas G Pisias[4] (pisias@coas.oregonstate.esu)

[1]Instituto de Ciencias del Mar y Limnología, Universidad Nacional Autónoma de México, Ciudad Universitaria, A. P. 70-305, Mexico City 04510, Mexico

[2]Department of Geological Sciences, University of South Carolina, 700 Sumter Street, Columbia, SC 29208, United States

[3]Center for Geophysical Investigation of the Shallow Subsurface, Boise State University, Center for Geophysical Investigation of the Shallow Subsurface, Boise, ID 83725, United States

[4]College of Oceanic and Atmospheric Science, Oregon State University, 104 Ocean Admin Bldg, Corvalis, OR 97331-5503, United States

The geographic location of the Gulf of Tehuantepec makes it sensitive to climatic changes. It is influenced by latitudinal shifts of the Trade Wind System and the Intertropical Convergence Zone which make for a complex oceanographic pattern. Today, two prominent features in the region are: 1) wind induced upwelling during the winter, and 2) a well developed oxygen minimum zone (OMZ) resulting from low oxygen Pacific Intermediate Water and high biological productivity in surface waters. We present the variation of these two features during the Late Quaternary as indicated by planktic and benthic foraminiferal records in a core from the OMZ (740m water depth). The benthic foraminiferal record indicates bottom waters were more oxygenated during the last glacial and a progresive strengthening of the OMZ during the interglacial. Planktic foraminiferal records show the presence of warm stratified waters during late Pleistocene, and increased influence of upwelling during Holocene, probably due to a latitudinal shift of the Trade Wind System. The coupling of these records could suggest that during times of upwelling, increased productivity strenghtened the OMZ. In contrast, in the absence of upwelling, bottom waters would be more oxygenated. However, high biological productivity in the area today is due to both, fertilization induced by upwelling during winter, and the presence of high-nutrient surface water carried out by the Costa Rica Coastal Current (CRCC) during summer and fall. Planktic foraminifera suggests a stronger presence of tropical water (CRCC) in the Gulf of Tehunatepec during Pleistocene, but not necessarily a significant drop in biological productivity. This scenario would require the supply of higher oxygenated bottom waters to the Gulf during glacial times. Ongoing research with other cores and paleoceanographic proxys will aid to elucidate these questions.

OS22D MCC: 3000 Tuesday 1600h

General Ocean Sciences: Ocean Carbon *(joint with A, B)*

Presiding: **W Cai,** University of Georgia**; N M Levine,** Princeton University

OS22D-01 1600h

Dcadal Variation of the Surface Water pCO2 in the Western and Central Equatorial Pacific Ocean

Taro Takahashi[1] (1-845-365-8537; taka@ldeo.columbia.edu)

Stewart C. Sutherland[1] (1-845-365-8688; suth@ldeo.columbia.edu)

Richard A. Feely[2] (1-206-526-6214; feely@pmel.noaa.gov)

Catherine E. Cosca[2] (1-206-526-6183; cosca@pmel.noaa.gov)

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

[2]Pacific Marine Environmental Laboratory, NOAA, 7600 Sand Point Way, NE,, Seattle, WA 98115, United States

The equatorial Pacific Ocean is known to undergo significant changes on interannual (e. g. El Nino/La