programme for ACE to operate as a sanctioned, international research initiative, operating under the SCAR umbrella. Additional information on ACE can be found at http://www.geo.umass.edu/ace.

PP21A-0304 0830h POSTER

Trough-mouth-fan Evolution on the Pacific-Margin of the Antarctic Peninsula Outer Continental Shelf and its Relation to Sediment Drifts on the Adjacent Continental Rise

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Rebesco et al. (1998) propose a general depositional model that relates sediment drift evolution on the Antarctic Peninsula Pacific-margin abyssal plain to glacial processes on the continental shelf. In their model, the terrigenous sediment were directly delivered to the rise and contributed to the construction of large sediment drifts when grounded ice sheets extended to the shelf edge. In this scenario, large volumes of sediment by-passed the margin at the mouth of ice streams (i.e., fast flowing ice), whereas prograding slopes were constructed on those portions of the shelf margin between major ice streams. This model relies heavily on the modern geomorphology of the margin. In contrast, an evaluation of the subsurface stratigraphy suggested that there may have been significant lateral shifts of ice-stream locations and associated trough-mouth-fan depositional systems through time (Bart and Anderson, 1995). New seismic data acquired along the strike of the Antarctic Peninsula shelf during the 2002 season aboard the NBP R/VIB confirm that slope progradation between the modern troughs was indeed associated with large ice streams. Moreover, the data illustrate that the last several glacial cycles did not produce significant slope progradation anywhere along the margin which signifies a major change in the stratal-stacking pattern on the outer continental shelf. This change in stacking pattern is roughly coincident with a major reduction in sedimentation rates on at least two of the drifts (i.e., those drilled at ODP Sites 1095 and 1101).

PP21A-0305 0830h POSTER

Sediment Texture as a Recorder of Past Sea Level Changes - Examples from the Pliocene of New Zealand and the Oligocene of Antarctica

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Variations in sediment texture off prograding wave-graded coasts often follow the same pattern - a progressive change from well-sorted sand on the beach face to moderately-sorted muddy sand around fairweather wave base and finally to poorly-sorted mud beyond storm wave base. We attribute this offshore fining pattern to a decrease in wave-induced bed shear stress with increasing water depth, whereby sand introduced to the coast by rivers is transported primarily across the bed and accumulates nearshore whilst mud remains in suspension nearshore but settles out offshore. The resulting systematic increase in percent mud offshore comes from the mixing of these two populations and relates directly to water depth for a particular wave climate. Because bed shear stress can be estimated from wave statistics it should be possible to predict the depth at which mud will begin to accumulate on open coasts. Furthermore, where the paleogeography of inner shelf sedimentary sequences is known, percent mud becomes a reasonable proxy for estimating paleo water depth.

We collected samples from a shore-normal transect off the coast of Manawatu, New Zealand (moderate waves, H = 0.5 m, T = 7 s) and used the percent mud as a basis for estimating past water depth from Pliocene cyclic inner-shelf sediments from the nearby Rangitikei Basin. We also estimated past water depth for Oligocene cycles cored by the Cape Roberts Project off the Victoria Land coast of Antarctica (when the coast was largely ice-free). In both cases we have made detailed measurements through several lithological cycles, each thought to represent relative sea level change due to obliquity (41 ky period) forcing.

The Rangitikei cycles, which are tens of m thick, range from muddy sand through fine mud and back to sand. The CRP cycles are similar in scale, recording relative sea level changes of the order of tens of metres but most cycles begin with a glacial diamict resting on an erosion surface, representing retreat of the ice and the start of a new cycle. Using the Manawatu coast as an analogue, we suggest the sandy sediments were deposited in water depths of less than 20 m, whilst sediments with more than 85 % mud were deposited at depths greater than 50 m. Thus the total relative sea level change in each cycle, as recorded by sediment texture, is at least 30 m.

URL: http://geo.vuw.ac.nz/croberts

PP21B MCC: Hall D Tuesday 0830h

Middle to High-Latitude Paleoceanography and Paleoclimatology Posters *(joint with A, OS, GC)*

Presiding: **E Levac,** St. Francis Xavier University**; P deMenocal,** Lamont-Doherty Earth Observatory of Columbia University

PP21B-0306 0830h POSTER

Differences Between Labrador Sea and North Atlantic Heinrich Layers:Implications for Iceberg Supply and Meltwater Discharge

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Further study of fifty cores from the Labrador Sea reveals the presence of eight Heinrich events, i.e., H0-H6, including H5a. Heinrich layers in the Labrador Sea are identified by their high detrital carbonate concentration, increased coarse-fraction content, and lighter 18O values in Neogloboquadrina pachyderma (sinistral). Heinrich layers in ice-proximal regions of the Labrador Sea are dominated by nepheloid-flow deposits that are recognized in X-radiographs as thin graded mud layers with floating coarser grains of ice-rafted detritus (IRD) as opposed to those in the North Atlantic which consist of pelagic sediments rich in IRD. The concentration of IRD within Heinrich layers H1 and H2 in the upper slope of the northwestern Labrador Sea cores shows a double peak dominated by detrital carbonate grains, whereas the lower-slope and deep Labrador-basin cores show a single peak. These findings are in contrast with North Atlantic Heinrich layers that are characterized by a double peak of IRD; a peak of quartz and volcanic grains followed by a carbonate peak. There are light dO18 peaks observed immediately prior to H2 and H1 which are neither associated with an increase in IRD nor with the concentration of detrital carbonate. The distribution and thickness of Heinrich layers suggest that iceberg discharge during different Heinrich events in the Labrador Sea followed different drift routes. Heinrich-like event H0 is present only in the upper slope cores of the northwestern Labrador Sea close to Hudson Strait but absent in the lower slope and deep-basin cores. During or prior to H0, the Laurentide Ice Sheet may have retreated to the inner shelf (or more landward), hence the glaciomarine sediments delivered to the inner shelf and icebergs were transported by the already established Labrador Current. On the other hand, during the deposition of earlier Heinrich events, iceberg discharge was so massive that it overwhelmed the Labrador Current and swamped the open Labrador Sea with icebergs. A narrow light dO18-Npl peak at the end of H2 and H4 preceded by heavier values during these events in all proximal cores suggests that the iceberg supply was predominant over meltwater discharge. This might indicate that ocean surface temperatures were too low to allow major iceberg melting toward the end of those Heinrich events when warming started. It is proposed that H3 and H5a in the Labrador Sea, on the other hand, may have been associated with major melt-water discharge.

PP21B-0307 0830h POSTER

Sub Millennial-Scale Climate Variability off the Western Iberian Margin During the Penultimate Glacial Period (MIS 6)

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High-resolution palaeoclimate records of planktonic foraminiferal fauna, stable isotopes and ice-rafted debris counts obtained from the Portuguese margin (40°N, 9°W) exhibit large fluctuations during the penultimate glacial period (MIS 6). This study focuses on four main points: 1) the distinction between cooling episodes related to Heinrich-type ice-rafting events and those related to increased regional upwelling, 2) the magnitude and apparent similarity in the frequency of climate change associated with ice-rafting events to those described during the last glaciation, 3) the effect on the ventilation of North Atlantic Deep water during the most important cold events, and 4) the variability of the Portuguese benthic *delta* ^{18}O and the Vostok methane record seemingly in phase.

Sea-surface temperature off Portugal in Stage 6 was in general warmer than during the last glacial, pointing towards a weaker southward influence of polar water masses. Ice-rafting occurred mainly in mid-MIS 6 (between 163 and 143 kyrs) as a group of poorly differentiated, short duration quasi-continuous events, mainly marked by the high abundance of sinistral *N. pachyderma*. Differences exist in IRD composition relative to the last glacial, with a reduced Canadian-derived detrital carbonate component, combined with an important contribution of volcanic particles originating from northern Britain and Icelandic ice-sheets. The lower magnitude and higher frequency of these events suggests that the warmer temperatures would have induced iceberg waning closer to the source areas.

Centennial periodicity similar to that observed in Stage 3 (700 years) is also a persistent feature of the penultimate glacial, although the group of mechanisms behind this variation is not fully understood. Solar radiation changes may exert some control, and it is reasonable to surmise that a diverse combination of forcing factors and reaction times of the different components of the complex ocean-atmosphere-ice-sheet system would have produced a record with the same cyclicity in the deep-sea sediments.

PP21B-0308 0830h POSTER

Pleistocene Changes in Sea of Okhotsk Hydrography and Productivity

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The Sea of Okhotsk (SOk), a marginal sea of the North Pacific, is characterized by a unique climatic situation that leads to a specific hydrography and productivity regime that makes this ocean area to one of the most productive areas of the world ocean. Because the specific environmental conditions are strongly influenced by the Siberian climate at one side and the global oceanic circulation on the other, the SOk represents a key area to investigate the interaction of land and ocean governed climate processes. The other important hydrographic feature of the SOk is the Sea of Okhotsk Intermediate Water, which is considered to be an important source for the North Pacific Intermediate Water and therefore to play a key role in ventilating the North Pacific. Thus the reconstruction of the paleoceanographic conditions in the SOk might give further

information needed for the understanding of the paleo-ocean circulation and chemistry of the North Pacific.

In the frame of the German/Russian cooperation KOMEX (Kurile Okhotsk Sea Marine Experiment) we studied the spatial distribution pattern of radiolarians in the upper 1000 m of the water column in the SOk and compared these data to surface sediment and down-core data. We used the obtained ecological information of radiolarians in combination with isotope data and paleochemical information to reconstruct the Pleistocene oceanography of the SOk with specific emphasis on changes of the hydrographic structure and productivity regime in comparison to the North Pacific for the last 340 kyrs.

PP21B-0309 0830h POSTER

Sedimentation Rates in the Central North Pacific Pelagic Clay Province Using Strontium Isotope Stratigraphy

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In this study, we present an age-depth profile for a large diameter piston core collected by the R/V Ewing in 1997 sampled at 8.8 °N, 135.4 °W in the central North Pacific Ocean. Most of this core (EW9709-PC07) is not datable by conventional biostratigraphic methods. Fish teeth ichthyoliths are abundant throughout the core, while radiolarians are present in the bottom portion. Downcore evaluation of sedimentation rates and sources for the pelagic clay component is hindered by inability to obtain accurate stratigraphic ages. To generate an age-depth profile, strontium isotopic compositions were determined on ichthyoliths previously cleaned of contaminants using a newly improved reductive cleaning procedure. Ages were determined by reference to the recently refined Sr isotope curve for Neogene seawater. Red clays dominate the uppermost portion (top 350 cm) of this 16 m core. Lower in the core, silicious clays and carbonate-rich intervals occur. This lower section includes datable radiolarians, allowing some cross-calibration with the Sr isotope method. Our data suggests a very good correlation between the radiolarian biostratigraphy and the Sr isotope technique employed here. Most of the scatter in the data can be attributed to either analytical error or diagenesis. ICP analysis of selected intervals showed high Ca/P ratios indicating some ichthyoliths have undergone diagenetic alteration. The age-depth curve for PC-07 indicates two distinct sedimentation rates for this site with a transition period in between due to a change in lithology. From 1500 cm to approximately 650 cm (early to mid-Miocene) there is a high sedimentation rate of 1.35 mm/ky. The rate appears to decrease abruptly around 650 cm (15 Ma), increase around 550 cm (11 Ma) and decrease again during the uppermost 350 cm pelagic clay interval (10 Ma). The average sedimentation rate for the red clay interval (mid-Miocene to present) is an order of magnitude lower (0.25 mm/ky), reflecting northward movement of the site away from the equatorial high productivity zone. Obtaining precise time calibration on cores from this large oceanographic province is critical to the evaluation of flux rates of hydrogenous components and terrestrial eolian dust in global paleoclimate and paleoceanographic reconstructions.

PP21B-0310 0830h POSTER

Preliminary ^{10}Be Chronology for the Last Deglaciation of the Southern Scandinavian Ice Sheet

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Prominent moraines crossing the Baltic region mark the late Pleistocene maximum extent and recessional phases of the southern margin of the Scandinavian Ice Sheet (SIS). Five moraines present between the advance during the Last Glacial Maximum (LGM) and the Younger-Dryas Salpausselkä Moraines in Finland dated at 11.6 ± 0.5 ^{10}Be ka (Tschudi et al., 2000) suggest a millennial-scale signal for this sector of the ice sheet. However, dating control constraining the age of the LGM and retreat phases of the southern SIS margin in the region is all but lacking. We have sampled boulders for surface exposure dating with the cosmogenic nuclide ^{10}Be from moraines along a broad south-to-north transect spanning Poland, Lithuania, Latvia, Belarus, Estonia, and Finland. Here we report ^{10}Be concentrations on 63 boulders measured by accelerator mass spectrometry at the Tandetron facility, Gif-sur-Yvette, France. We used a production rate of 5.1 ± 0.3 atoms g^{-1} yr^{-1} scaled for latitude and altitude according to Stones factors. No corrections for snow cover or erosion have been applied. Six boulders from the LGM have a weighted mean age of 18.5 ± 0.6 ^{10}Be ka. Twenty four samples from the Pomeranian Moraine have a weighted mean age of 14.6 ± 0.2 ^{10}Be ka. Eight samples from the Middle Lithuanian Moraine have a weighted mean age of 14.3 ± 0.4 ^{10}Be ka. Ten samples from the North Lithuanian Moraine have a weighted mean age of 13.1 ± 0.3 ^{10}Be ka. A single boulder on the Pandivere Moraine was dated at 14.4 ± 1.3 ^{10}Be ka. These results define a preliminary time frame for the deglaciation of SIS southern margin in this region. The chronology will be further refined based on ^{10}Be results from an additional 97 samples.

PP21B-0311 0830h POSTER

Land/Ocean Interactions NW Iceland: Sediment and Sediment Magnetic Characteristics on Decadal to Millennial time-scales in the Isafjardardjup/Djupall/Blosseville Basin Tansect 36 to 0 cal BP

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Twenty piston and gravity cores have been raised along a 450 km transect from the glaciated terrain of the NW Peninsula of Iceland, along the 250 m deep Djupall trough, and down the slope to the Blosseville Basin north of the Denmark Strait sill. Three of these cores include giant calypso cores collected as part of the IMAGES V Nordic Seas campaign. Shipboard derived whole core magnetic susceptibility on all cores, and u-channel derived natural remanent magnetization (NRM) and laboratory magnetization, anhysteretic remanent magnetization (ARM) and isothermal remanent magnetization (IRM), were studied through progressive alternating field (AF demagnetization) on eight of the cores. This provides an exhaustive set of magnetic data with which to assess the environmental variability captured by the sediments of this region. Chronologies are based on AMS 14C dates and the occurrence of the Saksunarvatn (10.18 cal ka) and Vedde (11.98 cal ka) tephras with well established ages. The cores extend from ca 36 cal ka to the present, although the last 11 cal ka has the most complete coverage. The u-channel samples were measured at 1-cm intervals, however, such measurements are not independent and integrate approximately 4.5 cm of stratigraphic depth. Based on the sedimentation rates, the temporal resolution of the u-channel sample ranges from 16 to 250 yr/sample. The results from this study indicate that the geometry of the late Quaternary sediment bodies along Isafjardardjup/ Djupall/ Blosseville transect represent a complex architecture with evidence for units being cut-out on the flanks of Djupall trough. Late glacial ice lingered on the NW Peninsula of Iceland until 10 -11 cal ka as evident in the very high mass magnetic susceptibilities (70-100 x 10-7 m3/kg). A regional isochron, the Saksunarvatn tephra, is observed in most cores as an interval of low magnetic susceptibility (15 x 10-7 m3/kg) and a higher coercivity magnetic mineralogy, than observed in the background sediments. Within individual cores, variations in magnetic remanence ratios closely match variations in mean grain size. In B997 338PC for example (13-36 cal ka, 50-yr sample resolution) these environmental magnetic parameters document recurring periodicities at 2000 and 500 yrs whereas the kARM/kMS ratio shows dramatic power in three discrete periods between 700 and 400 yr These striking periodicities are retained in the very high resolution IRM data from MD99-2266 with a sampling interval of 20 yr/sample..

PP21B-0312 0830h POSTER

Periodic Regime Shifts of ENSO Behavior Appeared in Alkenone SST Changes in Mid-latitude North Pacific During the Last 150,000 Years.

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In order to examine the response of mid-latitude North Pacific to glacial-interglacial changes, we have generated the late Quaternary records of alkenone SST in California (ODP 1014 and 1016) and Japan (MD01-2421) margins during the last 150,000 years.

SST changed from 9 degrees to 18 degrees centigrade at ODP 1016 and from 12 degrees to 19 degrees centigrade at ODP 1014, and the profiles are similar to SPECMAP oxygen isotope profile, although early warmings were observed at terminations I and II. At MD01-2421, SST changed from 13 degrees to 23 degrees centigrade. The lowest SST (6 degrees lower than Holocene) was observed during the late LGM, while SST during the early LGM is almost as same as that of Holocene.

A comparison between California and Japan margins showed that the periods with high SST in California margin are the periods with low SST in Japan margin, and the reverse is also true. The out of phase change repeated with precession cycle, and it reflects the latitudinal displacement of the subarctic boundary in reverse between the eastern and western margins of N. Pacific like a seesaw. Such a seesaw-like displacement is attributed to the regime shift of ENSO behavior. In more El Nino-like conditions, subtropical circulation was weaker, and the subarctic boundary shifted southwards in the western margin. The timing and cyclicity of the change agree with the result of Zebiak-Cane ENSO model (Clement et al., 1999, Paleoceanogr., 14, 441). The SST change in mid-latitude North Pacific is an amplified signal of the climatic changes induced by the regime shift of ENSO behavior.

PP21B-0313 0830h POSTER

Sr/Ca and Mg/Ca Heterogeneity Across Individual Foram Tests as Revealed by Ion Microprobe Analysis

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Many benthic foraminifera live for $\geq$ 1 year and the chemistry of individual tests may preserve information on seawater temperature changes over this time. Microanalysis of individual tests is complicated by the combination of thin test walls and the presence of surface contaminants, not held within the carbonate structure. We optimised conditions for the analysis of Mg and Sr in the benthic foraminifera *Ammonia batavus*, by ion microprobe. The use of field and contrast apertures restricted the size of the analysed area to $\sim$10 μm and reduced the effects of sample contamination.

Sr concentrations were unaffected by any contamination encountered and Mg could be determined provided checks were made for silicate contamination using Al, Si and K intensities. Measured Mg and Sr concentrations were in reasonable agreement with previously reported values. Mn was present at a level too low to permit clean analysis, even at very low levels of contamination.

Significant variations in Sr concentrations occurred within individual test chambers and may reflect the juxtapositioning of calcite of different ages as the test is deposited. Significant variations in Mg and Sr concentrations occurred between test chambers. Sr increased in concentration in the outermost (most recently deposited) parts of the test. This may reflect an increase in test calcification rate coincident with increases in bottom water temperature or food availability. The development of this method provides a valuable tool for investigating geochemical variations across individual foraminifera tests.

PP21B-0314 0830h POSTER

Bottom Water Hydrography of the Kara Sea (Siberia) Revealed From Stable Isotopes of Water Samples and Bivalve Shells

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In shallow water of the Kara Sea (Siberia) oxygen isotope ratios of Arctic bivalves oscillate in phase with stable carbon isotopes. These variations mirror annual hydrological variations in the bottom water. A first order δ^{18}O to salinity calibration for the bivalves allows the determination of salinity variations during growth season. These variations mainly arise due to changing contents of Atlantic derived marine water from the outer shelf and freshwater from the extremly high early summer river run-off from Ob and Yenisei. Also contributing is sea-ice meltwater during summer and brine water originating from enhanced sea-ice formation in a reoccurring flaw polynya during winter. The hydrological conditions are typical for all Arctic shelf seas and bivalve δ^{18}O records are suitable to reconstruct salinity changes of times technically not accessible for direct sampling like the yearly river break up or the geological past.

The δ^{18}O composition of water in conjunction with salinity is a good measure for the fractions of river runoff, sea-ice meltwater, and marine water contained in the water column. Data of water samples from summer 1999 and 2000 reveal net-sea-ice formation in the bottom waters, i.e. brine water, despite sampling during a period of local sea-ice melting. Model results indicate that remains of this brine enriched bottom water are transported from the polynya region southward in a bottom "counter current" to the sampling sites. Comparison of the bivalve data with the hydrological data indicates, that the bivalves record times when the counter current is active. Thus, a remnant of brine enriched winter water is recorded by the bivalves during summer. Periodically occurring low salinity events are evidence that part of the extreme river discharge during early summer is mixed down to the bottom at least to 30 m water depth. The riverine signal is not observed in bivalve records at 70 m water depth. Salinity changes at this depth are more likely induced by interannual variations of the bottom water provenance and long term developments, which are due to changes of the atmospheric pressure field on up to decadal time scales.

PP21B-0315 0830h POSTER

Multi-proxy Characterization of the Feni and Gardar Drifts

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Sediments from two North Atlantic drift deposits the Feni Drift (DSDP Leg 94, Site 610) and the Gardar Drift (DSDP Leg 94, Site 611) provide a monitor for water flowing over the Iceland-Faero Ridge and through the Rockall Trough and Maury Channel. The Feni Drift was sampled at holes 610 and 610A (53^{o}13.297N, 18^{o}53.213W, 2417 m), east of Rockall Bank and west of the Rockall Trough. The Gardar Drift was sampled at hole 611C (52^{o}50.15N, 30^{o}19.10W, 3230 m), near the Charlie-Gibbs Fracture Zone. The sediments were light-colored nannofossil oozes and chalks.

Paleomagnetic sample cubes were taken for rock- and paleo-magnetic studies and standard scoop samples for geochemical and textural analyses. The non-terrigenous fraction of the sample was removed prior to geochemical and partical-size analysis.

Bulk magnetic susceptibility was determined using a KLY-2 Kappa Bridge. In general, the bulk magnetic susceptibility for samples from hole 611C is higher than for hole 610. Hole 610 has a downcore decrease in susceptibility at 2.5 Ma, which reflects a decline in the terrigenous mineral component. A peak in the susceptibility and in the % terrigenous mineral component occurs ∼1.0 Ma. Hole 611C has two sharp upcore increases in bulk susceptibility, one at 3.5 Ma and another at 4.5 Ma. Two pronounced peaks occur at about 1.5 Ma and 2.6 Ma in both the bulk susceptibility and % terrigenous component; a second, lower peak occurs ∼4 Ma in both data sets.

The terrigenous grain size and sorting are similar at each site (ϕ50 = 6.35 for hole 610 and 6.41 for hole 611C; IGSD, a measure of sorting, = 1.17 for hole 610 and 1.27 for hole 611C). However, between 4 Ma and 5 Ma, the particle distribution pattern is flatter and the grain size is coarser for hole 610, implying a higher energy flow. In this same time frame, the ϕ50 and distribution patterns for hole 611C are more variable.

The δ^{13}C and δ^{18}O values of benthic foraminifera were determined at UC Santa Cruz. The δ^{18}O becomes more enriched upcore for both sites, starting around 4 Ma, consistent with the development of Northern Hemisphere glaciation. However, at 6 Ma, there is an interesting divergence older values remain constant at site 610, whereas δ^{18}O values at site 611, the deeper site, decline 1.2 $^o/_{oo}$in about 1.5 Ma. Younger samples from both sites become gradually more depleted in δ^{13}C. Hole 611C has a very sharp negative peak at 4Ma.

Geochemical analysis of the terrigenous component shows that fraction to be dominantly continental at Feni Drift. However, at Gardar Drift, sediments younger than 3 Ma are largely oceanic.

PP21B-0316 0830h POSTER

Vedde Ash Time Slice Maps for the Northern North Atlantic: Preliminary Results

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The Vedde Ash Bed has been identified in several marine sediment cores and represents an important time-marker for the mid/upper Younger Dryas cooling. The age of the Vedde Ash Bed is dated to 10,310 radiocarbon years and 11,980 ice core years. In the present paper we present Vedde Ash time slice maps based on published and unpublished data from 40 sediment cores in the northern North Atlantic. Identification of the Vedde Ash Bed in the cores is based on peak abundance of glass shards estimated by quantitative or semi-quantitative grain counts of basaltic and rhyolitic grains and geochemical characterisation at most of the sites. The maps represent various palaeoclimatic proxies including,delta O-18 and delta C-13 of Neogloboquadrina pachyderma, and distribution of planktic and benthic foraminifera, diatom - and planktic foraminferal sea surface temperature reconstructions. Percentage of N. pachyderma sinistral (s) reveals cold sea-surface conditions more or less throughout the whole area. Delta O-18 N. pachyderma (s) however, shows marked gradients with depleted values along the continental margins and an area of higher values north-east of Iceland. The results are preliminary and additional data will be added to these maps.

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Evidence for a Change in Iceberg-Drift Patterns in the Nordic Seas During the Mid-Pleistocene Revolution

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We used sediment proxy records from a continuous, 1.5 million year long deep-sea sediment core from a site in the western Norwegian Sea to obtain new insights into the nature of palaeoceanographic change in the northern North Atlantic (Nordic seas) during the climatic shift of the Mid-Pleistocene Revolution (MPR). Data of red-green sediment color and magnetic susceptibility both reveal significant differences in their mean values when comparing the intervals older than 700 ka with those from the last 500 ka. Between 700 ka and 500 ka the values of both records change constantly pointing at a gradual transition of the climatic conditions in the course of the MPR. Together with further sedimentological evidence the records suggest that the mid-Pleistocene climate shift was accompanied by a general change in iceberg drift pattern. It is proposed that prior to the onset of the major late-Pleistocene glaciations in the Northern Hemisphere a main contribution to the iceberg drift in the eastern Nordic seas originated from a more southerly provenance via the North Sea area whereas later icebergs derived dominantly from the surrounding landmasses, i.e., from Fennocscandia.

PP21B-0318 0830h POSTER

Abrupt Climatic Changes During Younger Dryas in the NE Nordic Seas

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New, detailed stratigraphical analyses, from sediment core JM99-1200, based on the planktic foraminiferal fauna, oxygen isotopic measurements, the content of ice rafted debris and the relative proportions of marine organic carbon and biogenic carbonate have been carried out. The aim is to reconstruct abrupt climatic variability during the Younger Dryas (YD) and during the Allerd (AL)/YD and YD/Preboreal (PBO) transitions to discuss the causes of the abrupt climatic changes. The core is located in a glacial trough,

Andfjorden, northern Norway at 476m water depth. This is an open marine location, which can provide us with a high resolution of climate records due to high sedimentation rates. The core site is influenced by two watermasses. The relatively warm Atlantic Water from the North Atlantic Current and the less saline coastal water from the Norwegian Coastal Current. The chronology of the core is based on seven AMS 14C datings performed on macrofossils. The AMS datings have been calibrated to calendar years by using INTCAL 98. The sedimentationrate in YD is calculated by linear interpolation between the dated levels. This is implying an average of eight years/centimeter. Sea surface temperatures (SST) were calculated by using the SIMMAX method developed by Plaumann et al., (1996) based on the modern analogue technique.

The estimated SST varies from 1.5 to 10 degrees celcius and the duration of a production low during Younger Dryas is about 1200 years, which correlates very good with the chronology of the Greenland icecores. It is cold during YD except in two levels in the early part of the period which shows warming peaks of 8 degrees celcius. The AL/YD transition last about 30 yr. with a temperature change of 3.5 degrees celcius. The transition YD/PBO is decadal with a temperature change of 2 degrees celcius. The planktic foraminiferas correlates also well to variations in temperatures from Greenland ice core. Variable inflow of Atlantic water masses can be a controlling mechanism in changes of the climate in the investigated area.

PP21B-0319 0830h POSTER

Multi-disciplinary Analysis of IMAGES Core (MD012421) off the Central Japan

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The northwest Pacific, where the cold Oyashio and the warm Kuroshio Currents meet each other today, is the most sensitive region in the North Pacific for monitoring the migration of the western boundary currents in response to the past climatic change. A long core (45.82 m length) was recovered from 2,2240m water depths off the central Japan during the IMAGES cruise in 2001. A multi-disciplinary study was carried out on this core by analyzing the following: color, grain size, mineral composition, paleomagnetism, d18O, d13C, Opal, CaCO3, species of diatoms, coccolithophorids, radiolaria, planktonic foraminifera, and benthic foraminifera, CaCO3 preservation, Uk37?, TOC, C/N, d13CTOC, d15NTOC, biomarkers and pollen. The following main results were obtained. The d18O curve of G. bulloides is very similar to the standard oxygen isotope curve, suggesting continuous deposition over the last 150ka. All warm water indices yielded by the four microfossil assemblages (diatoms, coccoliths, radiolaria and planktonic foraminifera) show temperature decreases during the MIS 2 and 6, and increases during the MIS 5, although their correlation coefficients with each other are not always high (between 0.5 and 0.6). The Alkenone-derived temperature (19?C) at the core top agrees with the mean annual SST at present time in this region. The SST at the end of the MIS 2 was 13?C, which is seen today about 4.5 degree latitude north than the core site. Similar migrations in SST are inferred from the coiling ratio of N. pachyderma. The C/N ratio, d13CTOC and d15NTOC indicate that the TOC is mainly of marine origin, although terrestrial origin slightly increases during the MIS 6. The curve of the warm pollen index is similar to the d18O curve of G. bulloides, except for the MIS 6 and 5e when temperature changes inferred from the pollen curve precede the d18O curve.

PP21B-0320 0830h POSTER

Aspects of Termination II and MIS 5 as Recorded at the West Spitsbergen Margin

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IMAGES V cores MD99-2303 (77°31.18N, 08°23.98W: 2277m water depth) and MD99-2304 ((77°37.26N, 09°56.90W: 1315m water depth) provide high resolution information about high latitude climate variability during Termination II and MIS 5. Here we report a study of stable isotopes, ice rafted debris and magnetic properties in these cores with a detailed focus on Termination II and MIS 5. The cores are located underneath the west Spitsbergen current, thereby reflecting changes in the distribution and strength of Atlantic Water flowing into the northern part of the Nordic Seas. During Termination II, flickering conditions occur as the insolation starts to increase, before a final abrupt response is seen as the insolation reaches interglacial values. The new glacial inception is seen as an almost instantaneous response to the large insolation fall during MIS 5.5, with an extremely rapid transition from full interglacial to glacial conditions. Throughout the rest of MIS 5 we observe somewhat less expressed but still clear responses to the subsequent insolation changes. The sites are under main influence of the Svalbard-Barents Sea Ice Sheet, but the Scandinavian Ice Sheet does to some extent also affect the observed variability. Relatively large-scale ice dynamical changes of short duration occur repeatedly. These are particularly well expressed in ice rafted debris records, indicating frequent instability of the surrounding ice sheets, superimposed on the insolation induced variability. This high frequency variability indicates that feedback mechanisms with a shorter response time than the orbital forcing is of major importance at driving high latitude paleoclimate variability.

PP21B-0321 0830h POSTER

High Resolution Climatic Variations Recorded by Mollusk Fauna at Nussloch (Rhine Valley, Germany) During the Last Glaciation

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During the last 31 and 19 kyr interval important eolian sediment deposited in Western Europe at Nussloch (Rhine Valley, Germany) favored by the enhanced atmospheric circulation at mid-latitudes and large areas of deflation providing quantities of material such as the English Channel, the North Sea or the dry Rhine valley.

The 10m-high studied sequence is composed of an alternation of nine gley-loess cycles. Except for few adjoining assemblages, the composition of the malacofauna is almost constant all along the sequence and typical of a humid loess facies and a steppe environment. Each cycle is composed of three parts. The first is the deposit of loess in windy, dry and cold climate, with associated malacofauna in equilibrium with these conditions. The second is the development of a gley in a colder and more humid context, with a very reduced particle deposition and, in the first half of the sequence, the presence of a permafrost. The associated malacofauna are characterized by a more or less important decrease in the diversity and equitability indicating the influence of a climatic drop. The third part is not characterized by any particular deposit, but by the thaw of the permafrost, when it is present, and by a demographic explosion of the mollusk fauna if the climate is not too dry. Such lithological alternations have been evidenced in all the Late Pleistocene deposits in Western Europe. They suggest that global climatic variations had a strong influence on the continental domain in Europe during this interval.

Precedent results obtained from this site have shown that the variations in a grain size index can be correlated with those of the dust content recorded in the GRIP ice-core, both being influenced by the eolian dynamics. Thus, the timescale of the GRIP ice-core has been applied to the loess sequence of Nussloch, and allowed us the comparison of our mollusk index with the d18O of the GRIP core. From this correlation it appears that the abundance in terrestrial mollusks fits the d18O variations in the ice-core supporting that the high biological abundance regularly occurring in the sequence would due to climate ameliorations and not related to sedimentological artifacts. Nevertheless the strong dryness occurring in the upper part of the sequence, and indicated by both the mollusk species richness and the d13C of the organic matter of the soil, seems to have restrained the development of the malacofauna, preventing the malacofauna to record any climatic improvement during this period.

PP21B-0322 0830h POSTER

A Comparison of Holocene Paleoceanographic Records Along a Scotian Shelf-Baffin Bay Transect: Differences in the Evolution of Sea Surface Conditions

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Records of paleoceanographic conditions were compared for 5 locations along the Eastern Canadian Margin. These high resolution records are from the North Water Polynya (northern Baffin Bay), Cartwright Saddle (Labrador Shelf), La Have and St. Anne's Basins (western and northeast Scotian Shelf) and Bay of Islands (western Newfoundland). The cores provide a resolution of about 100 years and have multiple radiocarbon ages. Reconstructions of sea surface temperature (SST), salinity (SSS) and sea ice cover duration were based on proxydata from dinoflagellate cysts and on paleobioclimatic transfer functions.

The transect can be divided latitudinally into three regions, each exhibiting a different Holocene paleoceanographic story: the western Scotian Shelf (La Have Basin), the Gulf of St. Lawrence influence zone (including St. Anne's Basin and Bay of Islands), and the Baffin Bay-Labrador Shelf zone, which includes Cartwright Saddle and NW Polynya.

The differences in paleoceanography are most likely due to the location of each region relative to the remaining ice sheet and sources of meltwater, and are best illustrated by the timing of the SST optimum. The SST optimum occurred earlier in La Have Basin (before 8500 BP), because it is more remote from the remaining ice sheet. The minimal changes in salinity during the Holocene suggest only a limited influence of meltwater influx on the western Scotian Shelf. At sites under the influence of the Gulf of St. Lawrence, the SST optimum was delayed until 8500 or 7500 BP, probably because of meltwater influx through the St. Lawrence River. In Cartwright Saddle and NW Polynya, the SST optimum occurred after the influence from meltwater and the remaining ice sheet disappeared (from 6000-4000 BP).

nt oscillations in SST are superimposed on the main paleoceanographic events. They have a cyclicity of 1500 years. The amplitude of SST variations is greater at the northern sites (Cartwright Saddle and NW Polynya). At the southern sites, it diminish after 8000 BP. This would suggest a control by the meltwater, however, these changes in SST are not always accompanied by changes in salinity.

The role of sedimentation rates was also explored as it appears critical when attempting to correlate short duration paleoceanographic events between different sites. At the present, three conclusions could be drawn from this study: 1- some short duration events are localized and the oceanographic conditions might have evolved differently in each region; 2- the time resolution is not sufficient to track events along the transect (for example meltwater events); 3- because of their lower resolution, paleoceanographic studies based on deep-sea cores could present a simplified story of changes in surface circulation.

PP21B-0323 0830h POSTER

Possible Solar-Linked Climate Controls on Recurring Dispersal of Sediment-Bearing Sea Ice During the Holocene

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Records of Holocene IRD (ice rafted debris) in the subpolar North Atlantic have recently been tied to variations in solar output. That finding underscores the importance of understanding how coarse (sand-sized) lithic sediment comprising the IRD is linked to ice in the ocean and to climate.

New data from sediment traps in the Greenland and Norwegian Seas suggests that the Holocene IRD is released from melting multiyear sea ice exiting the Arctic through Fram Strait. Analyses of over 50 sediment trap samples demonstrate that large numbers of sand

sized grains settle through the water column during all months of the year. Fluxes of those grains are higher by factors of 3 to 4 than those estimated at the sites of the Holocene records, consistent with those locations in warmer waters to the south. In addition, 15 to 20 percent of the sediment trap lithic grains have hematite staining, which is a robust petrologic tracer of the sea ice trajectories associated with the Holocene IRD.

New evidence from NCEP-NCAR reanalysis demonstrates that anomalous north to northwesterly winds in the eastern North Atlantic, which are required to explain the record of hematite-stained grains in that region during the Holocene, occurred at rather specific times during the last several decades. Those times correspond to increases in extreme drift ice sightings and to a 1 to 2 degree cooling of the ocean surface. Similar temperature changes during the Holocene IRD events are suggested by Mg/Ca measurements in planktic foraminifera from eastern North Atlantic coring sites.

The most persistent north to northwesterly winds occurred during spring and summer and at times when pressure increased in both the Azores and Hawaiian highs. A link therefore appears to exist between the Holocene shifts in North Atlantic drift ice and subtropical atmospheric circulation, which in turn, based on results of recent GCM models, may be influenced by solar variability.

PP21B-0324 0830h POSTER

Geochemical Variations in Late Cenozoic Glacial Sediments Deposited by the Laurentide Ice Sheet: Implications for the Middle Pleistocene Transition

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We use geochemical indices derived from midcontinent U.S. glacial deposits to evaluate the hypothesis that the middle Pleistocene transition (MPT) was caused by erosion of a regolith and subsequent exposure of underlying fresh bedrock by the Laurentide Ice Sheet. Late Pliocene-Pleistocene glacial sedimentary sequences were divided into three age groups: two older groups of reverse-polarity tills (Matuyama Chron) and one younger group of normal-polarity tills (Brunhes Chron). We used the bulk geochemistry of the silicate fraction of these till groups to derive indices that document the degree of weathering experienced by the bedrock source prior its erosion by ice sheets. When compared to the composition of the average upper continental crust, the three till groups are depleted in all major-element oxides, except SiO_2 and TiO_2. This suggests the erosion of a source where most feldspars and ferromagnesians were weathered from the parent rock, leaving quartz and other resistates as the main constituents of the residuum. Despite the complexities related to the different stages of chemical weathering of rocks and to incorporation of other sources during glacial transport, trends in the indices from oldest to youngest tills are consistent with a mixing line between regolith and fresh bedrock sources. When compared to the youngest till group, the oldest till group shows significant losses of CaO and MgO, whereas there is a large gain in TiO_2 and small enrichment in Fe_2O_3. The slight gain or no change in K_2O and SiO_2 in the younger till group may reflect the greater resistance to weathering of K-feldspars and quartz. Na_2O concentrations show erratic behavior that cannot be explained. Finally, the composition of last glacial maximum (LGM) tills contrast significantly with the three older till groups, whereby LGM tills appear to be derived from the erosion of a much fresher rock source. Our results thus suggest that the oldest till units were derived from the erosion of weathered rock source, the pre-LGM normal-polarity tills were derived from the erosion of a mixed fresh/weathered rock source, or record the recycling of older glacial units, and LGM tills originated from the erosion of a fresh crystalline bedrock source. Consequently, these changes in subglacial geology may have caused a shift in ice sheet dynamics and contributed to the mechanisms acting behind the MPT. The evolution of the marine $^{87}Sr/^{86}Sr$ signal is also consistent with our hypothesis of the unroofing of crystalline bedrock by glacial erosion of regolith. The initial increase in $^{87}Sr/^{86}Sr$ coincides with onset of Northern Hemisphere glaciation; we interpret this to reflect an increased flux of continental debris to the ocean. Beginning at 1.2 Ma, there is a sharp increase in $^{87}Sr/^{86}Sr$, which coincides with the first appearance of significant 100-kyr spectral power in the global ice volume signal. We interpret this increase to reflect the first unroofing of crystalline bedrock, which supplied more radiogenic Sr to the ocean. The exposure of fresh crystalline bedrock would have increased silicate weathering, thus potentially lowering atmospheric CO_2 and providing an additional feedback to the onset of the 100-kyr cycle.

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Paleoenvironmental Change During the Holocene and Last Interglacial in San Pablo Bay, Northern California

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The San Francisco Bay exists as an estuary during sea level highstands and during this time its salinity field reflects the runoff regime of its watershed. Since the latter comprises about 40% of the state of California, study of the changing state of the estuary can provide insight into the climate history of the region. Previous studies have demonstrated significant secular variation in runoff during the late Holocene. The goals of the current work were to extend the record of the estuary's Holocene history and to investigate corresponding variation during the previous interglacial period (ca 130 - 115 ka). Changes at our study site indicative of variation in sediment budgets or tectonic activity were also of interest. Two boreholes were drilled along the southernmost margin of San Pablo Bay, a northern reach of San Francisco Bay. Estuarine sediments were examined for organic constituents; foraminifers were counted and shifts in species assemblages noted; their tests were subjected to stable isotope analysis so that variations in their isotopic signature could be tracked.

Beneath recent fill and remnants of marsh deposits, each borehole showed a sequence of three stratigraphic units: Holocene bay mud; alluvial deposits; and estuarine mud. This stratigraphy resembles the typical south Bay sequence: Holocene mud; alluvium deposited during the last glacial period; estuarine mud deposited during the 5e highstand. Foraminifers recovered from the Holocene and older estuarine deposits support the correlation with south Bay deposits. On the basis of stratigraphic position and this correlation, we consider the older estuarine muds to date from the 5e highstand. Foraminiferal assemblages in both the Holocene and Last Interglacial sediments showed systematic variation indicative of environmental change at the site. The 5e samples document a shift in dominant species from *Trochammina inflata* in the lowermost sample to *Elphidium gunteri* in the middle of the section and to *E. excavatum* in the upper samples. This transition indicates a gradual change from shallow intertidal mudflat conditions to a subtidal environment, a shift similar to that indicated by the south Bay sediments. The Holocene interval shows two changes in dominant taxa. *T. inflata* predominates in the lowermost sample beneath a short non-estuarine interval. *E. excavatum* is dominant in the middle of the section but gives way abruptly to *T. inflata* in the upper samples. These shifts indicate sudden changes in water depth that produced rapid transitions from intertidal to subtidal and back to intertidal conditions at the site, likely a result of tectonic movements or changes in sediment input. Stable isotopic measurements of both foraminifers and mollusk shells are in progress. These results are expected to provide information about past salinity at this location, which reflects the volume of freshwater inflow to the estuary.

Two ^{14}C dates have been obtained on Holocene shell fragments. These samples, spaced 420 cm apart vertically, show (uncorrected) ages of 3545 and 1775 radiocarbon years, providing an estimated average accumulation rate at the site of about 2.4 mm/yr. If this rate applied throughout the Holocene at the site, the more recent shift noted above occurred about 2760 radiocarbon years (uncorrected for reservoir effect) ago, and the entire 12.8 m thick Holocene unit represents about a 5300 year record.

PP21B-0326 0830h POSTER

Record of Late Pleistocene Through Holocene Climate Change in a Regional Lake System: Flathead Lake Basin, Northwestern Montana.

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Flathead Lake is a large oligotrophic lake (510 km2) located west of the continental divide near the former terminus of the Cordilleran Ice Sheet. Over 270 km of unpublished 3.5 kHz seismic reflection data suggest that an intact sediment package over 60m thick exists in much of the lake. We are examining the record of climate change contained in 8 piston cores, 8 gravity cores, and 2 freeze cores recovered from the northern portion of the lake. Piston core FL-00-9P (7.05m) from a central lake position preserves the longest continuous record. This core contains the Mount Mazama ash (7,630 cal. yr. B.P.) and the Glacier Peak ash (GPA; 13,755 cal. yr. B.P.), demonstrating the presence of a complete uppermost Pleistocene to Holocene record. Holocene sediments consist of silt with abundant mm- to cm- thick sulfide laminae. Core FL-00-12P, also contains the Mount Mazama ash and about 3m of Pleistocene sediment. This core does not appear to contain the GPA probably because of a disconformity near the Pleistocene-Holocene boundary. Grain size within Holocene sediments of core #9 increase up-core, probably as a result of delta progradation. We estimate that the Holocene sedimentation rate for the northern half of the lake ranges between 0.05cm/yr (lake center) and 0.09cm/yr (delta proximal) +/-0.02cm, based upon chronostratigraphy derived from the tephras along with 137Cs and 210Pb dating of two gravity cores.

Analysis of the lowermost section of core #9 (5.30 to 7.05 cm depth) indicates abrupt and dramatic changes in sedimentary style, mineralogy, and carbon chemistry just prior to deposition of the GPA. Sediment below the GPA consists of a series of cm- to dm-scale upward-fining packages with median grain sizes ranging between 24 and 2 um. These packages contain high total carbon content (2-4 wt.%), comprised almost entirely of inorganic carbon. Three of these upward-fining packages contain basal peaks in the atomic ratio of OC/N (~25-50) indicative of terrestrial organic matter. Quantitative X-ray diffraction reveals dominance of calcite, dolomite, and quartz, probably all introduced as detrital components from weathering of local Proterozoic metasediments. We interpret these packages as recording underflow-dominated (turbidite) sedimentation in a proglacial setting. Sandwiched within the package of upward-fining sequences is an anomalous layer of continuously fine-grained sediment occurring at a depth of 6.85m to 6.70m. This interval is characterized by higher organic carbon content (0.1 to 0.4 wt%), a corresponding decrease in total and inorganic carbon (TIC=0.05-0.5 wt%), and a lower OC/N ratio (~5-10) typical of autochthonous organic matter. A similar interval occurs above the turbidite sequence, from a depth of 6.20m to 6.06m. We infer these anomalously fine-grained intervals to reflect an interruption (or termination) of heavy proglacial sedimentation and development of more productive conditions. These interruptions may represent temporary climate amelioration and its influence on ice lobe stability and lake level. Alternatively, they may represent establishment of an ephemeral sediment trap behind an ablating ice lobe. Above the GPA, TOC and median grain size gradually increases, reflecting the establishment of extant conditions in the lake. Concomitant mineralogic shifts to dominantly a 2:1 Al clay and quartz system with peak increases in kaolin and chlorites reflect more intense chemical weathering during the Holocene.

PP21B-0327 0830h POSTER

Record of Meltwater Discharge in the Lower Mississippi River: Insight into the Timing of Meltwater Diversion between the Mississippi River and Eastern Drainage Routes to the North Atlantic

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During the last glacial maximum the Mississippi River served as the primary conduit for meltwater discharged from the southern margin of the Laurentide ice sheet. As ice retreated, lower drainage routes were opened to the east causing rapid drainage of glacial lakes, such as Lake Agassiz, and diversion of meltwater into the North Atlantic. Ice margin fluctuations during deglaciation repeatedly opened and closed these drainage routes and forced diversion of meltwater between the Mississippi River and the North Atlantic.

Injection of freshwater into the North Atlantic has been modeled to reduce North Atlantic Deep Water (NADW) production (Rahmstorf, 1995, Nature v. 378, p. 145-149) and is proposed to have caused many rapid cooling events during deglaciation, including the Younger Dryas (Clark et al., 2001, Science v. 293, p. 283-287). Dating control for the timing of meltwater routing is based on bracketed radiocarbon age estimates on ice margin positions and glacial lake outlet occupation. No evidence from the Mississippi River has been used to constrain this chronology, primarily due to the lack of datable organic material in the channel belt sediments.

Optical luminescence samples were collected from three large braided channel belts in the lower Mississippi valley to develop a detailed chronology of river

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response to discharge variations. Ages of these channel belts are 19.7-17.8, 16.5-15.0 and 12.1-12.5 cal. kyr. These ages correlate with times of meltwater routing to the North Atlantic (Clark et al., 2001). At times of high discharge, when meltwater was routed to the Mississippi, the channel belts were abandoned as the river incised to the level of the next lower surface. The age of these channel belts and the time of channel belt abandonment provide greater detail in the timing of freshwater forcing events in the North Atlantic during deglaciation.

PP21B-0328 0830h POSTER

Topographic Effects of the Ice Sheets on their Self Maintenance and Shaping the Climate during the LGM

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Through several studies in the past, it is stated that the cooling at Last Glacial Maximum (LGM) over the NH is caused mainly by the ice sheet existence. It is natural to state a question why and how the ice sheets over Europe and north America have grown and disappeared. To explain the ice sheet growth and termination, there are debates whether the climate was driven by orbital forcing and/or CO2, or how much self-maintenance mechanism of ice sheet worked.

In this study, we try to evaluate the main ice sheet - atmosphere feedback, such as ice albedo feedback, elevation - mass balance feedback, stationary wave feedback (through temperature) and transient eddy feedback (through precipitation). Sensitivity experiments are performed using the CCSR/NIES AGCM (T106, 1x1 deg, L20). Additionally a three dimensional thermo-mechanical ice sheet model (Saito and Abe-Ouchi, 2002) is used to diagnose each effect. It is driven with a Degree Day mass balance model forced by AGCM (monthly mean temperature and precipitation).

The main conclusions are as following; (1) The ice sheet during the LGM is maintained mostly by albedo feedback and elevation-mass balance feedback. (→careful treatment of albedo parameters are needed). (2) Stationary wave effect on temperature is extracted. Its effect is important for the advance in the east part of Laurentide ice sheet and prevents the migration in the Alaska region. (3) Lapse rate is about 5 k/km. (4) Laurentide do help the Fennoscanavia ice sheet to grow in the western part through the transient eddy feedback. (5) Growth of Fennoscandinan ice sheet to the south in the western part is prevented by the stationary wave feedback of Laurentide ice sheet and the presence of itself.

PP21B-0329 0830h POSTER

Potential of Leaf Wax Lipids for Synchronization of Marine Sediments and Polar Ice Cores

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The waxy coating of vascular plants contains a series of C27-C33 n-alkanes with a characteristic prevalence of odd over even-numbered carbon chains. These species are relatively abundant and well-preserved in the marine environment. In this study, the lipid components of sediments from the Bermuda Rise were extracted and the leaf wax n-alkanes were analyzed by GC-MS. A characteristic fragment (m/z 85) of the mass spectra was used to quantitate the presence of each n-alkane in the sediment. The sediments analyzed spanned the transition from cold stadial to warm interstadial conditions, and back to stadial conditions, 40-36 kyr ago (IS-8). The concentration of leaf wax n-alkanes had an inverse relationship with sea surface temperature during this transition. Total C27-C33 n-alkane levels ranged from 200 ng/g of sediment in the interstadial to 700 ng/g in the stadial periods. The results of these analyses are consistent with an increase in aeolian deposition or detrital load during colder periods.

Techniques were also developed for the clean extraction and analysis of trace levels of naturally occurring lipids in polar ice. Pilot samples from a glacial (MIS 3) section of the Greenland GISP2 ice core had very low abundances of total C27-C33 odd n-alkanes ranging from 80-700 ng/kg of ice after subtraction of a blank that represented 10-50% of the n-alkanes present. The pilot samples exhibited an unexpected distribution of C27-C33 n-alkanes, with approximately equal abundances of even and odd-numbered n-alkane chains (as opposed to the approximately 5-fold excess of odd over even chains expected for leaf wax). The peak of the n-alkane distribution was between C28-C31.

We will evaluate the prevalence and significance of the n-alkane distribution in additional ice samples spanning the same time interval we analyzed in the Bermuda Rise sediment to determine if leaf waxes can be used to synchronize the chronologies of marine sediment and polar ice cores.

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Precision Positioning for Shallow Water Drilling

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The science-driven requirement for sediment cores on continental shelves has led to the Active Heave Compensation (AHC) upgrade Global LAke Drilling (GLAD)-800 drilling system. The AHC-GLAD800 drill rig was developed for installation on the largest vessels in the UNOLS fleet and was tested in the November 2001 on the R/V Knorr. Evaluation of the results of that test cruise pointed out the need for a significant increase in the accuracy and repeatability of the real-time navigation input to the vessel?s dynamic positioning (DP) system.

An shore-based evaluation of different Global Positioning System (GPS) receivers including P-Code, US Coast Guard broadcast differential GPS (DGPS) and commercial satellite distributed DGPS was used to develop an approach for real-time system that flags and excludes outliers in order to maintain the tight input requirements for the DP system.

Analysis of the data collected from the shore-based experiments and the at-sea field program will be presented.

PP21B-0331 0830h POSTER

The Growth of Large Current-Controlled Deposits: Comparing Gardar and Eirik Sediment Drifts

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We report preliminary observations from a survey of Gardar and Eirik sediment drifts conducted in the N. Atlantic aboard the R/V Knorr in August, 2002. Multibeam bathymetry, 3.5 kHz sonograms, piston and gravity cores, and high-resolution MCS profiles provide information about the origin, internal structure, and modern processes that shape these deposits. Sediment drifts exhibit some of the highest accumulation rates in the deep sea, with the potential of providing climate records with resolution comparable to that of ice cores. Unlike the latter, drift records can span tens of millions of years. However, drift topography changes with time, and this dynamic character requires careful study for their long-term records to be exploited reliably. Our survey was designed to compare the evolution of two drifts, and to better understand the processes that govern their evolution.

We began with a working model to explain three seismic facies seen elsewhere in drift deposits: 1) a core of disorganized reflectors banked against pre-existing topography; 2) acoustically stratified waves ms to 100s m in amplitude and 1 to several kms in wavelength that account for most of the drift buildup; and 3) additional stratified sediments that thicken towards the drift crest and extend upwards to the seafloor. We found departures from this model that are not fully understood. Facies one is widespread within both drifts, but is not restricted to mounded occurrences banked against underlying topography. We believe variously oriented, current-induced bedforms are the cause, and that they have a modern analog in a large field of complex mudwaves we mapped at S. Gardar (see Manley et al., this session.) Mudwaves comprising facies two occur at two scales: one is several 10s to 100s of m in height that accounts for large, localized relief; these were observed at both N. Gardar and Eirik Drifts. The other scale is an order of magnitude smaller but comprises areally extensive (1000s of sq. kms), thick (100s of ms) and lengthy (millions of years) stacks of migrating waves. The latter is best developed at N. Gardar Drift. Facies three is a mantle of rapidly deposited sediment at both N. Gardar and Eirik Drifts, and is not yet developed at S. Gardar. Piston cores from this facies show sand-sized sediments at Gardar are predominantly biogenic; those at Eirik contain large amounts of terrestrial detritus we assume came from the Greenland margin. Both regions show secondary drifts developed west from the main drift axis, introducing a new level of complexity in understanding drift evolution. Core samples and 3.5 kHz data from the uppermost 20 m below seafloor indicate that on Eirik Drift: 1) deposition is occurring largely NW of the main drift, i.e., on the leeward side and distal end; 2) Holocene sedimentation rates are as high as 40 cm/kyr; 3) current-induced bedforms are small to non-existent; and 4) little to no sediment is accumulating on the SE face of the drift.

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Mudwave Morphology and Sedimentation on the South Gardar Drift: North Atlantic

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Regular and irregular mudwaves mantle the southern portion of the Gardar Drift (eastern N. Atlantic). Geophysical investigations (3.5 kHz, SeaBeam and high-resolution multi-channel seismics) elucidated the nature of these features during Kn166-14 cruise in August of this year. Manley and Caress (1994) suggested previously that these features showed evidence of migration. Using the lee-wave model of Flood (1988), they determined that in addition to the general contour-following bottom currents, currents crossed the drift crest and flowed down the eastern flank towards the Maury Channel. Bianchi and McCave (2000) argued for limited mudwave migration and that the mudwaves are oriented 20o anticlockwise to local contours regardless of location along the drift.

Swath mapping along the crest of the south Gardar Drift (14,391 km2) shows a highly complex nature to these mudwaves. West of the main drift, mudwave orientations are governed by the location of secondary crest spurs that trend roughly E-W. Individual mudwaves can be traced across the main drift crest, making an elongated S pattern with mudwave orientation predominantly perpendicular to the drift crest. At the southern extension of the main Gardar Drift, mudwaves make a spiral pattern in map view changing orientations from 35o to 280o. A secondary fabric is superimposed on the mudwaves south of the western spur that is aligned with the large migratory mudwaves to the north. The 3.5 kHz records show this fabric may be the result of intermittent fill between waves or ancillary, smaller mudwaves superimposed on the dominant mudwave field. This suggests either two flow regimes are sculpting the region, or a major reorganization of current flow is occurring in this vicinity.

Mudwaves are well developed and migrating north of the western spur and west of the main Gardar Drift crest. Jumbo piston cores taken on each side of a particularly well-imaged mudwave chosen for study show differential sedimentation rates that clearly indicating that the mudwave has migrated upslope for the last 150 kyr. Prior to that time preliminary data suggests a different migration history.