OS52A MCC: Level 2 Friday 1330h

Sedimentation on European Margins III Posters *(joint with C)*

Presiding: **J P Syvitski,** Institute of Arctic and Alpine Research**; C A Nittrouer,** University of Washington**; P Weaver,** Southampton Oceanography Centre**; F Trincardi,** CNR-Istituto di Geologia Marina

OS52A-0886 1330h POSTER

The Neogene Evolution of the Mid-Norwegian Continental Margin: Mineralogical and Stratigraphic Aspects

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The mid Norwegian continental margin lies along the path of the North Atlantic Drift, an extension of the Gulf Stream, and therefore experiences changes in the ocean circulation that are reflected in the sedimentary record. Coupled with this is the climatic deterioration that triggered the growth and oscillations of the Quaternary ice sheets in the northern hemisphere. We will here present the depositional evolution of the mid Norwegian margin as witnessed by the mineralogy of Neogene sediments recovered as part of the site investigations performed for the Ormen Lange gas field. The results will be put into the context of the seismic and sedimentary stratigraphy that has been established for the area that shows a Neogene development from pelagic through contouritic sedimentation to the deposits left by Quaternary glacial/interglacial fluctuations and which has provided the backdrop for the Storegga submarine slide.

OS52A-0887 1330h POSTER

Headspace Gas Analysis from the Po Delta and Adriatic Sea: Abundant Deltaic Gas and Associated Anomalous Sub-bottom Profiler Records

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During a EuroSTRATAFORM cruise onboard the RV Seaward Johnson II' the Adriatic Sea was sampled in order to evaluate the presence and distribution of shallow gas in the area, and its association with anomalous seafloor and sub-bottom acoustic data. The productivity of the Northern Adriatic is one of the highest in the Mediterranean Sea and high-resolution seismic data showed areas with anomalous sub-bottom profiler data suggestive of shallow gas. As part of a multi-PI program, we sampled 61 cores from the western Adriatic coast by capturing the basal portion of slow cores, gravity cores, kasten cores and box cores (the cores were, in a large part, collected to address other questions in the EuroSTRATAFORM program). Samples were preserved at sea, and analyzed in the lab for C1-C6, CO2, H2S, and H2. Preliminary results show that the highest values of CH4 and CO2 are associated with anomalous sub-bottom profiler data (suggestive of shallow gas) and the shallow, high sediment accumulation rate sediments of the Po delta. 14 sites had more than 70 uL/L of CH4 and of those, 5 sites had more than 20000 uL/L. The highest gas values were found in the kasten and gravity cores, whilst the box cores gave high results only where the gas was very shallow, like in front of the Po discharge area. Due to the high methane content in 8 of the samples, these were sent for isotopic analysis. These results may tell us about the nature of shallow gas in the Adriatic Sea and its association with shallow and seafloor acoustic properties, as well as recent sediment accumulation rates and TOC.

OS52A-0888 1330h POSTER

Numerical Experiments to Investigate how Processes Form Strata.

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sedflux$_{2D}$ is a numerical model that is able to simulate the deposition and erosion of sediment within a basin over geologic time scales. For this paper, we use an upgraded *sedflux*$_{2D}$ to examine the importance of physical processes on both the evolving stratigraphy as well as the final stratigraphy. We have upgraded *sedflux*$_{2D}$ by including a near-shore shelf reworking module (Storms, 2003), and a fluvial erosion/deposition module (Paola, 1992). We are able to analyze the output of this numerical model to precisely reconstruct the basin evolution. That is, we know where and when specific processes lay down strata. Furthermore, we can reconstruct strata that were eroded and so are no longer present at the end of the simulation. For this paper we have performed a series of numerical experiments using *sedflux*$_{2D}$ that examine the effects of various processes. We begin with first order processes such as sea level variations and subsidence. We then begin adding complexity to the simulations by varying sediment supply, and introducing smaller scale processes such as debris flows, turbidity currents, and waves. We note that certain facies are consistently eroded and so do not appear in the final deposit. Specifically, we see that much of the shore-face sediments are missing from the stratigraphic record. Also, we note that these shore-face sands are more likely to be preserved during a transgression. Principally, this is due to increased erosion by the river during falling sea level. On the other hand, ocean storms are efficient at eroding shallow marine sediment during either rising or falling sea level. It is the combination of these two processes that conspire to remove much of the stratigraphic signature of the shore-face.

OS52A-0889 1330h POSTER

Efficacy of two Measures of Relative Sea Level in Predicting Stratal Geometry and Surface Morphology in an Experiment with Varying Base Level

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Using experimental data, we compare two methods of measuring relative sea level as predictors of stratal and surface morphology. The first method is the “local” relative sea level (LRSL), defined as the sum of rate of eustatic sea level change and local subsidence rate. The second is the shoreline-following RSL (SFRSL), which is the local RSL evaluated at the shoreline as the shoreline moves across the depositional surface. The two methods are compared using data from an experiment conducted in the eXperimental EarthScape (XES) facility at St. Anthony Falls Laboratory, University of Minnesota, Minneapolis. The experiment was designed to investigate morphodynamic and stratigraphic response to both isolated and superimposed slow and rapid base-level cycles, in a fluvial deltaic system. The experimental system was subject to steady, nonuniform passive-margin style subsidence and constant rates of sediment and water supply. The experimental conditions were ideal for evaluating and comparing these two measures of relative sea level. We find that the LRSL variation does a good job predicting overall stratal preservation of sea level cycles as a function of downstream position in the basin: preserved cycle thickness is predicted well using the relative vertical distances between successive diminishing minima in the LRSL curve at each position. On the other hand, the SFRSL correlates well to the temporal history of incised valley initiation and development.

OS52A-0890 1330h POSTER

Submarine Geomorphology of Incised Valleys on the Northern English Channel Shelf

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Late Quaternary sea-level fluctuations exposed large expanses of the English Channel shelf during glacial periods leading to the development of complex incised fluvial valley systems carved into the bedrock. These submerged remnants of the formerly extensive English Channel River provide a critical interface between the onshore fluvial systems of NW Europe and sediment sinks at the Celtic Sea shelf margin. Here we investigate the detailed morphology of the submerged River Arun, a tributary of the English Channel River, with a view to understanding the processes governing valley evolution. We conducted a high-resolution swath bathymetry survey of the Arun palaeovalley using a portable Reson 8101 240 kHz Multibeam Echosounder owned by the UK Universities High-Resolution Geophysics Consortium. An 8km x 17km area was surveyed in water depths ranging from 18m to 55m. The Reson 8101 was mobilised on a vessel of opportunity using an over-the-side pole mounting. Narrow focused beams (1.5° x 1.5°) produced a footprint $0.5m^2$ to $3.5m^2$ and coverage over a 150° angular sector of seafloor. The sonar range resolution of 5cm combined with 2cm accuracy tidal measurements meant a very high vertical accuracy was achieved. DGPS positioning using a POS MV 220 was accurate to within 1m, and the system also provided satellite aided inertial heading and motion data. Co-registered acoustic backscatter data was merged with a Digital Elevation Model to aid in classifying the seabed. A dense grid of complementary commercial boomer profiles together with extensive cores have been used to constrain the subsurface stratigraphy. Our newly defined shelf morphology reveals a topographically complex submarine landscape comprising bedrock-incised valleys and embayments. The main Palaeo-Arun valley axis trends northwest to southeast and is bounded by bedrock on one margin and fluvial gravels on the other. The width of the valley narrows downstream from a maximum of 2km to 300m and the depth of incision increases from 2m to 20m. Integration of multibeam data with boomer seismic profiles permits a geological interpretation of the bathymetry data to be drawn. Upstream of the topographic valley, the valley form can be correlated into a buried valley system that is observed in seismic data. The geometry of the valley is controlled partly by the presence of a monocline formed of resistant bedrock lithologies and partly by incision into older fluvial gravels that now form submerged terrace remnants. Downstream valley narrowing is the result of incision of the river through a resistant sandstone cuesta. At this point we have identified a prominent knickpoint and plungepool where the gorge opens out into the northern branch of the English Channel River. Preliminary interpretation of the submarine geomorphology suggests that initial valley formation was governed by enhanced fluvial erosion of weaker lithologies between resistant sandstone cuestas. Fluvial aggradation in these topographic lows may have occurred partly due to ponding behind structural barriers. Subsequent incision to produce the observed valley form was probably a consequence of baselevel fall coupled with breaching of the resistant barrier prior to shelf drowning during the Holocene transgression. Our analysis indicates that bedrock structure can significantly influence the morphology of incised shelf valley systems.

URL: http://www.ese.ic.ac.uk/general.php?GenID=292

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OS52A-0891 1330h POSTER

Modeling the Impact of Flood Sedimentation on the Acoustic Response of the Seabed

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While seldom resolved in seismic reflection data, flood deposits have the potential to modify the seismic response of the seabed offshore of rivers by altering the physical properties of the surface such as grain size distribution, bulk density and porosity. We are assessing the acoustic significance of such changes by simulating the evolution of flood-derived strata offshore of the Po and Pescara Rivers, and the variation in the seabed reflectivity and attenuation of these strata over time. The simulations are being carried out by coupling the sediment discharge model HYDROTREND with the sedimentary-process/stratigraphic model SEDFLUX2D, and the acoustic velocity and attenuation models of Biot and Buckingham. At this writing, only the flood-sedimentation simulations have been completed. Two one-hundred year long simulations have been generated for each river. The Po simulations, which are for the last glacial maximum (LGM) versus the present environment, examine the impact of varying drainage basin area on flood sedimentation (in this case due to differences in sea level). The Pescara simulations are for the pre- and post-emplacement of dams on the river, and address the impact of flow regulation on sedimentation offshore of such rivers. As expected, the simulations for both rivers predict thicker, coarser-grained flood deposits that extend farther offshore of the rivers as their sediment discharge increases. Flood deposits offshore of the Po are predicted to be more substantial during the LGM when lowered sea level increased the drainage basin area of the river to roughly twice its present size. The Pescara simulations suggest that dam emplacement has significantly reduced the coarseness and total amount of sediment being deposited offshore of the river, and that the change is marked by an abrupt upwards transition from coarser, more heterogeneous pre-dam strata to finer, homogeneous post-dam strata. The impacts of these sedimentologic changes on the acoustic character of the seabed are now being modeled.

OS52A-0892 1330h POSTER

Morphodynamic Modeling of Response of River Deltas to Sea Level Rise

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River deltas have shown a variety of responses to Holocene sea level rise. The mouths of the Thames, Humber and Severn Rivers display deep embayments similar to those of Delaware River and Chesapeake Bay. The mouths of the Maas/Schelde River System show an intermediate degree of embayment, whereas the mouths of the Po and Ebro Rivers show actively prograding deltas similar to that of the Mississippi River. To date most attempts at morphodynamic modeling of the response of a river mouth to sea level rise have relied on the normal flow assumption; that is, the effect of backwater has not been considered in treating river flow. When the rate of sea level rise is sufficiently large compared to sediment supply to the delta, such models predict the autoretreat of a sediment-starved delta. It is suggested here that such an analysis is strictly valid only for rivers with relatively large Froude numbers ($>$ 0.5) in their deltaic zones. Most large rivers have much lower Froude numbers near their mouths, implying that backwater effects cannot in general be neglected. Here a 1D morphodynamic model of delta response including backwater effects is compared with one that does not include them. The former model predicts that when the rate of sea level rise is sufficiently high and the sediment supply sufficiently low, the response is a modified form of autoretreat characterized by the formation of a deep embayment. This feature cannot be predicted with the latter type of model.

OS52A-0893 1330h POSTER

Form of Submarine Erosion From Confluences in mid-Atlantic USA Continental Slope Canyons

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In models for fluvial incision, channel bed erosion rates (E) depend on rainfall catchment area A and channel gradient S: $E \sim A^m S^n$. Canyons of the continental slope were incised by turbidity currents, debris flows and other sedimentary mass movements. If such flows are initiated by failure of over-steepened hemipelagic deposits in canyon walls, the frequency of flows experienced by the channel could depend on canyon upstream area, leading to erosion rate also depending on area. Considering that channel gradient additionally affects erosion-relevant flow properties, there may be analogous erosional relationships to those of subaerial geomorphology. To address this possibility, a database of hemipelagic catchment area and channel gradient was created for dendritic canyons in the upper continental slope. At a river confluence, the long-term erosion rates of the two branches are equal so that their contrast in areas and gradients can reveal the ratio of exponents m/n (Seidl and Dietrich, 1992). Such data for these submarine canyons show significant scatter, but they suggest on average $E \sim A^m S^n$ with m/n=0.2-0.3. Interestingly, gradient and area are related by a power-law relationship ($S \sim A^{-0.3}$) that is consistent with the erosion law if the landscape is in a steady state. This relationship is similar to that found for debris flow erosion in subaerial colluvial channels. Furthermore, gradient-area graphs are similar whether the canyons head at the shelf break or away from it, so there is little evidence to suggest that shelf spillover has contributed greatly to canyon incision here. Seidl, M., and Dietrich, W. E., 1992, The problem of channel erosion into bedrock: Catena Suppl., v. 23, p. 101-124.

OS52A-0894 1330h POSTER

Three-dimensional modelling of thrust-controlled foreland basin stratigraphy

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In this study we present a 3D forward stratigraphic model, which aids in the interpretation of alluvial successions in foreland basins filled by axial-deltaic and alluvial fan systems, under conditions of variable tectonism and eustatic sea-level change. The first set of model experiments indicate that the onset of tectonic activity is reflected by rapid retrogradation of both depositional systems, widespread flooding and onlap of marine sediments. Syntectonic fluvial patterns on the axial-delta plain are dominated by bifurcating channels, swiftly relocating in response to the general rise of relative sea level induced by flexural subsidence. The resulting surface morphology of the axial delta is conical. Syntectonic eustatic sea-level fluctuations result in parasequence-scale packages of retrograding and prograding fan and deltaic sediments bounded by minor flooding surfaces and Type-2 unconformities. Incised channels are rare within the syntectonic parasequences and are formed only during phases of tectonic quiescence when eustatic falls are not longer compensated by the subsidence component in the rise of relative sea level. Suites of amalgamating axial channels corresponding to multiple eustatic falls delineate the resulting Type-1 unconformities. Coarse-grained, incised channel fills are found in the zone between the alluvial fan fringes and the conical body of the axial delta, as the axial streams tend to migrate towards this zone of maximum accommodation. Similar suites of amalgamating axial channel belts are created when the foreland basin is detached from its substratum by a hinterland-dipping sole thrust and transformed into a thrust-sheet top basin. This is shown in the second set of experiments. Here, the competition between rates of regional flexural subsidence, and local detachment-induced uplift controls the accommodation space evolution and the stratigraphic patterns in the marine-influenced thrust-sheet top basin. Model experiments show that displacement over low-angle faults (2 6 degr.) with moderate rates (5.0 m/kyr) results in a vertical uplift component sufficient to counteract the background flexural subsidence rate. Consequently, the basin-wide accommodation space is reduced, fluvio-deltaic systems carried by the thrust sheet prograde and part of the sediment supply is spilled over towards adjacent basins. The intensity of the forced regression and the interconnectedness of fluvial sheet sandstones increases with the dip angle of the detachment fault.

URL: http://www.library.uu.nl/digiarchief/dip/diss/2003-0708-104559/inhoud.htm

OS52A-0895 1330h POSTER

Comparison of Floc Sizes From a LISST-100 and a Digital Floc Camera

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A LISST-100 in situ laser particle sizer was deployed together with a digital floc camera (DFC) in estuarine and continental shelf settings on several occasions. The LISST-100 can measure particle sizes in the range 2.5-500μm, whereas the DFC can detect particles larger than 125μm; the two instruments thus overlap in the 125-500μm size range. The particle sizes from the two instruments are compared. At a first glance, the LISST-100 underestimates the floc median diameter (D_{50}) by a factor of 2-4 when compared to the DFC. However, when the data from the two instruments are "trimmed", so that only particles in the overlapping size ranges are considered, the two instruments yield nearly identical values for D_{50}. Thus, the LISST-100 and the DFC both appear to detect particles in their overlapping size ranges correctly. Since the DFC only detects particles larger than 125μm, it will usually overestimate D_{50}, whereas the LISST-100 will usually underestimate D_{50}. Using the two instruments in conjunction, floc size spectra from 2.5μm and up can be measured, hence better estimates of the D_{50} can be obtained.

OS52A-0896 1330h POSTER

Experimental Investigation of Microventing in Kaolinite

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The present research focuses on the causes of microventing, a phenomenon generally occurring in cohesive sediments during their deposition and consolidation. Microvents are characterized by volcano–like formations, remnants of the expulsion of fluid and sediment along a vertical channel through the sediment layer. The size of these vent formations ranges from the order of millimeters to several centimeters, hence the term "microvent." Several causes proposed for microvents may be generally grouped as biological processes and mechanical processes. An example of a biological process is the production of subsurface gas due to organic decomposition; rising bubbles can produce microvents. The present study is concerned only with mechanical processes, which are hypothesized to be:

- Pressure fluctuations in pore fluid
- Solids concentration perturbations near sediment–suspension interface
- Gas expulsion by sediment compression

The objectives of the study are to examine microventing through direct and indirect means, in order to examine these hypotheses. Sedimentation tests have been performed in the laboratory using kaolin clay in water; a natural microventing has been observed to occur at sediment concentrations similar to that of a lutocline. A series of controlled experiments are presently underway to force microventing by means of water or gas injection into the sedimentation column, in order to approximate the natural microventing. It is believed that analysis of pore water pressure and total (solid and water) pressure time series will lead to better understanding of the causes of microventing, and allow discrimination between those causes. Pressure gradients and solids concentration gradients will also be examined in these tests, and image analysis will be used to compare the visible characteristics of the microvents which are formed.

OS52A-0897 1330h POSTER

The Sand-Mud Transition: Observations and Environmental Controls on two Italian Mudlines

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The textural and geochemical properties of surficial sediment were characterized on nearshore cross-shelf transects spanning the sand-mud transition (SMT) off the Tronto and Pescara rivers, Apennine Margin (Adriatic Sea), Italy. Measured parameters were geometric mean diameter (GMD), specific surface area (SSA), mud fraction (<63μm), heavy metals concentrations (Cu, Pb, Zn), calcium carbonate content and clay mineralogy. The SMT on the Tronto River is identified between 15 20 m and parallels the coastline while the SMT associated with the Pescara River undulates between 20 25 m. GMD, SSA, and mud fraction were found to be highly correlated with depth. Depositional dynamics were examined with a recently developed parameter to describe the amount of material in sediments deposited as flocs, floc fraction in sediments, f_S, which also correlated significantly with depth and the sediment properties. A spatial analysis of the Pescara SMT during 35 years of reduced suspended sediment supply showed only slight changes to the depth of the SMT. This observation and the strength of the correlations suggest that wave-generated shear stress is the primary control on the depth of the SMT. The three metals clearly indicate sharp increases across the Apennine SMTs but do not show anthropogenic enrichment. The metals also correlated significantly with f_S, which confirms deposition of contaminants by flocs and suggests energy levels influence seabed metal distributions. Investigation of the relationship between wave energy and SMT depth in 10 diverse coastal environments showed the depth of the SMT scales linearly with significant wave height.

OS52A-0898 1330h POSTER

The Upper Cretaceous Gosau Basins Of The Apuseni Mts./Romania; Basin Analysis, Provenance Analysis And Thermal History

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The remnants of the Upper Cretaceous Gosau basins of the Apuseni Mts. record a similar sedimentary succession as the Gosau basins of the Eastern Alps: the Lower Gosau subgroup, represented by shallow marine sediments, and the Upper Gosau subgroup (turbiditic flysch and pelagic sediments). The controlling tectonic process of the Austroalpine Gosau basins is proposed to be subduction tectonic erosion, which led to the strong subsidence within these basins. Investigations on heavy minerals and the maturation of organic matter can help to understand the sudden subsidence which took place in Campanian/Maastrichtian time. The Lower Gosau subgroup reflects a predominantly metamorphic clastic source. In the Upper Gosau subgroup the metamorphic influence becomes less important. In some samples Chrome Spinel and Glaucophane has been identified. Both minerals in one assemblage show that a former accretional wedge with high-pressure rocks and obducted oceanic crust was eroded. The vitrinite reflectance data show a range of 0,8 to 1,8 % Rr within the Upper Cretaceous sequence. Increased coalification was measured close to large Banatitic and Neogene intrusions (up to 5.0 % Rr). For basin modeling, an erosion of 1600 m of Late Cretaceous sediments has been computed. Together with the measured and interpreted field data, the entire Gosau succession had a max. thickness of 2800 m. This thickness values are also reported from the Eastern Alps. Fission track dating was used to determine the age of the dedritic Zirkons. With this age-population-method a dynamic evolution of the hinterland concerning its exhumation and erosion can be modeled. Combined with models based on Apatit fission track length, a rapid uplift of the crystalline basement can be shown. All these results prove the similarity to the Gosau Basins of the Eastern Alps and the assumption that a direct connection to the Basins in the Apuseni Mts. existed during the Upper Cretaceous time. The main mechanism for the generating of the basins is inferred to be subduction errosion caused by a low-angle Benioff plane, an isostatic imbalance caused by the nappe stack produced during the collisional process and a simultaneous uplift of the crystalline basement.

OS52A-0899 1330h POSTER

Terminal Distributary Channel Deposits in the Modern-Age Po Delta lobes, Adriatic Sea

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River dominated deltas are characterised by a high degree of river channel and mouth switching, which tends to form several coeval or slightly diachronous delta lobes. An open question is weather the distinct spatial organization of distributary channels and their subaqueous counterparts affect the geometry of subaqueous delta lobes. We took advantage of the extremely high sediment supply of the Modern-Age Po delta system and of the good chronological control on its evolution to analyze in detail the delta lobe geometry and the presence of multiple terminal distributary channels. The very rapid outbuilding of the Modern-Age Po delta (up to 129 m/yr) occurred since the onset of Little Ice Age (ca. 1450 - 1850 AD) under anthropogenic forcing on the river regime and increasing supply driven by colder climatic conditions. A detailed reconstruction of the delta lobe evolution compiled using a dense grid of VHR Chirp-sonar profiles and historical maps allowed to identify two different types of depositional styles in the prodelta: a) shingled depositional delta lobes characterised by laterally-continuous seismic reflectors and showing evidence of variably-preserved flood deposits; and b) lobes with more pronounced mound shape on shore-parallel sections, and bi-directional downlap of internal reflectors, hosting a network of terminal distributary channels filled by massive sediment. The Po delle Tolle lobe outbuilding in the late XIX Century provides the best example of a network of partially preserved shallow-water terminal distributary channels extending to water depths of as much as 25 m. The channel-like features have erosional base, acoustically-transparent and lithologically homogenous fill and likely reflect multiple stages of reactivation. These features occur isolated or in clusters with individual channel widths ranging from 100-300 m and depths up to 4 m. The short-lived episodes of cut-and-fill are hypothetically attributed to episodic events of catastrophic reactivation of distinctive Po river branches driven by sudden increases in river discharge of natural or artificial origin.

OS52A-0900 1330h POSTER

Dispersal of Sediment in the Western Adriatic during Energetic Wintertime Forcing

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EuroSTRATAFORM aims to relate sediment delivery and reworking to seabed morphology and stratigraphy through observations and modeling of water column transport. The Po River dominates buoyancy and sediment input into the Adriatic Sea, but small Apeninne rivers (the Chienti, Pescara, etc.) may produce locally important signals. Sedimentation is influenced by fluvial supply, resuspension by waves and currents, and transport by oceanographic currents forced by winds and buoyancy. Transport is likely highest during times of energetic forcing; including Bora events with northeasterly winds and Sirocco events with southeasterly winds. It is difficult, from field measurements alone, to characterize dispersal and convergence patterns over the relevant spatial scales. We applied a three-dimensional hydrodynamic model that includes fluvial delivery, transport, resuspension, and deposition of sediment to quantify sediment dispersal with a 2-km resolution over the entire Adriatic. Circulation calculations were driven by spatially- and temporally-varying wind fields for the Fall / Winter of 2002 / 2003 and realistic Po and Apennine river discharges. Waves were hindcast with the SWAN model. Dispersion of both resuspended and river-derived sediment was estimated for periods that contained intense Bora and Sirocco winds. Predicted sediment dispersal rates and patterns are sensitive to forcing winds, buoyancy flux, and wave patterns. Higher sediment flux was predicted during Bora conditions than during Sirocco conditions. Sirocco winds weaken the Western Adriatic Coastal Current (WACC), and because they tend to concentrate over the Eastern Adriatic, they often fail to create especially energetic waves in the Western Adriatic. Bora wind conditions, on the other hand, intensify the WACC and can build high wave energies over the northwestern Adriatic. Most of the sediment transport occurs during Bora, with a net southward flux. These predictions will be compared to field observations made as part of the EuroSTRATAFORM experiment.

OS52A-0901 1330h POSTER

Stratigraphic Variability Due To Uncertainty In Model Boundary Conditions

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Uncertain boundary conditions influence the predictions of numerical sedimentary models, especially over geological timescales. This study explores the effects of uncertainty in a number of complex climatological boundary conditions on the stratigraphic prediction. Two high-resolution models are sequentially run: the climate-driven hydrological model, HydroTrend, generates time series of daily discharge and sediment loads at the river mouth, which are then ingested in the process-based stratigraphic model, 2D-SedFlux. Focus is on shallow shelf evolution over the last 21kyr; both for the East Coast US and for two Italian margins sites at Sicily and Elba respectively. Considerable uncertainty is associated with the input parameters. Drainage basin characteristics are strongly controlled by the hard to define details in the timing of Ice Sheet retreat. Temperature and precipitation at 21kBP estimates differ significantly between different Community Climate Model (CCM) realizations. The translation of a proxy for ocean storm conditions to storm diffusivity in SedFlux is a tuning process and thus requires a wide range of values. A first case-study showed that the SedFlux prediction for the sedimentary architecture of the New Jersey shelf is consistent with the acoustically observed thickness distributions and facies. Sensitivity tests that explore the ranges in the input parameters show local deviations in the thickness distribution of up to 46%, considerable depth variation (>10m) in the prediction of certain facies shifts and up to 1.5ö difference in the mean grain size prediction. We propose to associate a standard deviation, as well as a data-sparse PDF based on a series of sensitivity experiments to a predicted base-case' value. In that way the stratigraphic variability caused by ranges in the boundary conditions is evident for later users.

URL: http://instaar.colorado.edu/deltaforce/

OS52A-0902 1330h POSTER

Geotechnical and Microstructural Characterization of the Recent Delta Po River Flood Deposit, Adriatic Sea, Italy

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During Fall 2000, a flood occurred in the northern Adriatic Sea, which introduced large quantities of sediments in the Po delta area in particular. Twelve samples were taken during June 2003 to investigate their geotechnical and microstructural properties in order to trace the signature of the flood layer in a downstream direction. Most of the analyses involved CAT-scan profiling, coupled to some X-ray radiographs and basic geotechnical testing including water content, Atterberg's limits, along with intact and remolded undrained shear strength. The sediment consists of a very soft light brownish silty-clay to dark gray silty-clay with some sandy layer and a high amount of organic matter. Some shells and warm tubes are observed. The flood deposit is found between 8 to 15 centimeters depth depending on the station and is about 10 centimeters thick. Typically, the flood layer is recognized on geotechnical profiles by a water content (105%); higher than for layers above and below; it less bioturbated and starts at the base with a sandy layer which has a much higher sensitivity (15). On the other end, the shear strength is in line with other layers. The pre-flood deposit is characterized by a water content of (60%) which is controlled by the consolidation process, with a normal higher shear strength but with a higher remolded shear strength in some case, around 1.5 kPa compare to less than 1 in the post-flood and flood deposits. The post-flood deposit is characterized by an hemipelagic deposit with an high percentage of bioturbation, by a water content of (75%) and a very low near surface shear strength increasing with depth. CAT-scan and X-ray radiograph profiles are also quite similar for all layers. In addition, the CAT-scan provides a 3D view of the biogenic structures. CAT-scan analyses coupled with geotechnical testing are being used to develop a measure of bio-porosity which could be used eventually as an index to correct the shear strength measured on the sediment matrix.

OS52A-0903 1330h POSTER

Snorri Drift: A Comparison of Stadial 2 and Stadial 4 on the SW Iceland Slope

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Preliminary investigations of an 18 meter marine core collected from the southwest Iceland slope south of Denmark Strait reveal a coherent record reaching back to oxygen isotope stage 7. The core provides a rare opportunity to study the environmental and oceanographic conditions just south of Denmark Strait over the last 200k years. Oxygen isotope data, sedimentological analyses, grain counts, and radiogenic isotopic data enable interpretation of climatic shifts, sediment source, as well as changes in the strength and direction of the bottom currents. Core MD99-2323 was collected in 1062 meters water depth from Snorri Drift, which is one of the northern North Atlantic drifts. The chronology of the core is based on radiocarbon dates, tephrachronology and an oxygen isotope curve derived from the planktic foram, Neogloboquadrina pachyderma sinistral. The 18 meter core shows a widely varying lithology with the interglacial intervals consisting of mostly muddy sand with few clasts and some laminations. Within the interstadials are abrupt coolings, which are marked by darker gray, clast rich units. The stadial units are characterized by alternating layers of dark gray clast rich intervals with a coarser matrix and lighter gray layers which have a finer matrix and fewer clasts. Often these units are somewhat laminated. Darker units are coarse and represent coolings. Lighter units are finer and represent warmings. The sediments of Stage 2 and 4 stadials reveal very different climatic conditions, sediment source and depositional processes on the Iceland slope. The d18O, foraminifera abundances, and number of ice rafted grains suggest that stage 2 was colder, more variable and unstable than stage 4 which was warmer and more stable. The radiogenic isotopes and grain counts indicate distinct sediment sources for these two stadials. During stage 2 the source appears extremely variable, but with a distinct Icelandic component, while during stage 4 the source is also variable, but with a more distal signature, possibly a Greenland source. This core represents the varying contribution from iceberg rafting and contourite deposition. The sediment of stage 2 have more IRD and larger grain sizes suggesting a higher energy transport process such as icebergs rafting. Stage 2 is during the LGM with evidence for a migrating glacial front affecting marine sedimentation. This is in contrast to the East Greenland terrestrial records, which suggest a stable Flakkerhuk stade from 60-10 ky with little ice sheet movement. In contrast, the sediments of stage 4 are finer and contain less but more consistent IRD. The finer grain size, distal source, and less IRD all suggest increased contourite deposition at this SW Iceland slope site which indicates a shift in the bottom current's direction and/or source of icebergs.

OS52B MCC: Level 2 Friday 1330h

General Ocean Sciences: Marine Sediments Posters *(joint with PP)*

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OS52B-0904 1330h POSTER

Enigmatic Shallow Subsurface Stratigraphy on the New Jersey Mid-Outer Shelf: Catastrophic Erosion or Diagenesis?

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High-resolution (1-15 kHz), shallow-penetration (~50 m), deep-towed chirp seismic profiles on the New Jersey mid- and outer-shelf have been collected in support of ONR's Geoclutter program. Geoclutter goals are to understand and predict acoustic scattering from the seafloor and the shallow sub-seafloor in order to distinguish man-made objects from naturally occurring features ("geological clutter") on sonar returns. Area 2 of the chirp survey covers 8.6×10.2 km, mostly surveyed at 50 m line spacing. Three shallowly buried, dendritic and meandering channel systems, ~2-4 km apart, are oriented E to NE. Channel flanks are truncated by the seafloor and seismic stratigraphy suggests multiple stages of incision and filling. The northernmost channel system, which is best constrained, is mainly V-shaped, up to 350 m wide and 12 m deep. This scale is among the smallest in the entire Geoclutter survey area. Sampling using an active-heave-compensated AHC-800 rig supplied by DOSECC reveals a sand and mud channel fill with, at its base, a burrowed contact with underlying mud that correlates well with the seismic interpretation. A prominent, vertical, seismic facies change occurs throughout Area 2: stratified material is overlain by up to ~20 m of seismically transparent material, within which the younger, dendritic channels are incised. These two facies are separated by an irregular boundary. In places, the boundary resembles steep-sided (commonly 50°-90°) incisions which truncate underlying reflections. Mapping of the boundary reveals that its irregularities are not random. Some align to form predominantly NE- and E-trending "channels" that may converge to the SW. Rare "blocks" of stratified material within the transparent facies, along with more numerous smaller, isolated reflections, may correspond to clasts of stiff clay recovered in a 35-cm core. We suggest that the seismically transparent material contains such clasts, of a wide range of sizes, derived from the underlying, presumably clay-rich, stratified material. If the facies boundary represents an erosion surface, the steep flanks suggest that the stratified material was consolidated at the time its erosion. To preserve these flanks, burial must have immediately followed erosion, pointing to erosion and re-deposition during a single, perhaps catastrophic event. One possibility is that widespread erosion accompanied sheet flow across the shelf, following breaching of glacial lake dams in southern New England ~17-15 ka , perhaps partially confined by an outer-shelf flexural bulge which has since relaxed. However, chirp profiles off North Carolina image a similar seismic facies contrast which could preclude an origin related to the collapse of glacial lakes. A second possibility is some form of diagenetic front, but testing this hypothesis will require further sampling.

OS52B-0905 1330h POSTER

Mapping a Pre-Last Glacial Maximum Paleo-Seafloor and Shelf-Slope Sediment Wedges beneath the New Jersey shelf

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The New Jersey margin has been intensively investigated but attempts to gather geophysical ground truth through coring have seen limited success. In 2001 and 2002, cruises funded by ONR have resulted in a suite of ultra-high resolution chirp reflection lines and shallow drilling using the DOSECC AHC 800 system, placed on board the R/V Knorr. The purpose of these experiments is to determine the geologic history of the margin during the last eustatic sea-level cycle. A key marker for examining the late Pleistocene-Holocene history is a high-amplitude seismic reflector which has been called "R". Previous coring has shown "R" to lie atop sediments 47 ka; however, the surface is likely time-transgressive. "R" underlies the so-called mid-shelf corridor of the New Jersey margin from Cape May to the Hudson Paleo-Shelf Valley, and changes west to east from a sub-horizontal reflector lying on average <9 m beneath the modern seafloor to an eastward dipping reflector that forms the base of two sediment wedges. This transition occurs across three discrete changes in the dip (inflections) of the "R" reflector that can be traced for 10s of km along a trend of N35degE, differing from the modern isobaths in strike by 15 degrees. The first change in dip occurs across an erosional zone previously described as the "R" outcrop area. Sediments overlying "R" between the first and second inflection points thicken by a factor of two and in places display stratified lower layers. The second inflection in "R" marks the westernmost limit of the outer shelf wedge, which is characterized by a stratified lower unit that thins seaward, overlain by a non-reflective unit, which is in turn overlain by a series of eastward-dipping stratified units. AHC 800 drilling penetrated through one of these shallow stratified units, confirming that the contact of stratified to non-reflective sediments is a change from interbedded sands and clays downward to denser, massive clay. We infer the lower stratified unit of the outer shelf wedge to be a return to interbedded sands and clays. The third inflection (12 km east) is the western limit of a previously unmapped sediment wedge that post-dates the outer shelf wedge and consists of stratified reflectors. Based on the geometry of "R" and the pair of wedges deposited east of the inflections in "R", we interpret the reflector to be paleo-seafloor and the inflections to mark a succession of eastward-migrating shelf-edges during sea level fall. Existing ages and the stratified reflections within the wedges argue against rapid emplacement, but rather a process that involves continual shedding of sediments off the evolving paleo-shelf edge by reworking, preceding and possibly following the last glacial maximum.

URL: http://www.ig.utexas.edu/research/projects/geoclutter/geoclutter.htm