OS71C-0312 0830h POSTER

Use of High-Resolution Sidescan Sonar in the Study of Near-Surface Marine Gas Hydrates and Associated Features

Ingo Klaucke[1] (+49-431-600-2335; iklaucke@geomar.de)

Wilhelm Weinrebe[1] (+49-431-600-2281; wweinrebe@geomar.de)

Gerhard Bohrmann[1] (gbohrmann@geomar.de)

[1]GEOMAR Research Centre for Marine Geosciences, Wischhofstr. 1-3, KIEL 24148, Germany

Near surface gas hydrates and associated features such as carbonate crusts, mud volcanoes, clam fields and bacterial mats in the Black Sea and on Hydrate Ridge have been the target of detailed studies using high-resolution sidescan sonar. The main target of the studies is to distinguish and quantify the extent of the individual features. Our recently acquired dual-frequency sidescan sonar system uses 75 kHz (for up to 1500 m swath width) and 410 kHz (up to 200 m swath width) Chirp sidescan signals together with a 2-16 kHz Chirp subbottom profiler in order to image up to 1500 and 200 m wide swaths of the seafloor, and to provide up to 30 m of subbottom penetration, respectively. Yet unsolved problems with the stability of the towfish resulted in relatively high towing speeds around 3 kn, which give along-track resolutions of 1.5 and 0.25 m for the 75 and 410 kHz sidescan sonar, respectively. Vertical resolution of the subbottom profiler is up to 6 cm, and underwater navigation of the towfish was carried out with a portable USBL system providing a resolution of about 1% of the range.

Initial processing of the data clearly indicate a strong improvement over previously available mid-range sidescan sonar imagery (30-36 kHz) with better distinction between individual features. However, only the most recently active features are imaged with this system while older features are buried under a thin sediment cover and remain 'invisible' for high-resolution sidescan sonar. An exception to this rule are carbonate crusts and chemoherms that are widely associated with near-surface gas hydrates and represent the remnants of former fluid venting structures. Such carbonate crusts are widely distributed on the summits and flanks of Hydrate Ridge (offshore Oregon) and on the top of mud volcanoes in the Sorokin Trough (SE of Crimea, Black Sea). Mudflows and clam fields are also clearly imaged, especially with 410 kHz sidescan sonar. However, whether the extent of near-surface gas-hydrates and bacterial mats can be quantified on the basis of high-resolution sidescan sonar is not yet clear and requires further integration of sidescan sonar data, subbottom profiler records and ground-truthing from video observations and coring.

URL: http://www.gashydrate.de

OS71C-0313 0830h POSTER

A new Perspective of the Tectonics of the Tjörnes Fracture Zone, Offshore Northern Iceland, from EM300 Multibeam Bathymetry, High Resolution MCS and CHIRP Sonar Profiles

Bryndís Brandsdóttir[1] (bryndis@raunvis.hi.is); Robert Detrick[2] (rdetrick@whoi.edu); Gudrún Helgadóttir[3] (gudrun@hafro.is); Einar Kjartansson[3] (eik@hafro.is); Bjarni Richter[4] (br@os.is); Karl Gunnarsson[4] (kg@os.is); Steinar Thór Gudlaugsson[4] (stg@os.is); Neal Driscoll[5] (ndriscoll@ucsd.edu); Graham Kent[5] (gkent@ucsd.edu)

[1]Science Institute, University of Iceland, Hagi, Hofsvallagata 53, Reykjavík 107, Iceland

[2]Woods Hole Oceanographic Institution, Woods Hole Road, Woods Hole, MA 02543, United States

[3]Marine Research Institute, Skulagata 4, Reykjavík 101, Iceland

[4]National Energy Authority, Grensásvegur 9, Reykjavík 108, Iceland

[5]Scripps Institution of Oceanography, Univ. of California, San Diego, CA 92037, United States

The Tjörnes Fracture Zone (TFZ) separates the North Iceland Rift Zone (NIRZ) from the Kolbeinsey Ridge (KR), the segment of the Mid-Atlantic Ridge immediately north of Iceland. The TFZ lacks the clear topographic expression typical of oceanic fracture zones and consists of broad zone of deformation roughly 150 km long (E-W) by 75 km wide (N-S) defined by 3 major extensional basins (Eyjafjardaráll, Skjálfandadjúp, Öxarfjördur) and two WNW-trending seismic zones - the Grímsey seismic lineament (GSL) on the north and the Húsavík-Flatey fault (HFF) on the south. Newly collected high-resolution multibeam bathymetry data, multichannel seismic and chirp profiling data provide a new perspective on the structure and neotectonics of the TFZ. The sediment-filled basins are bounded by numerous NS-trending faults, some of which extend to the seafloor, suggesting they are actively extending. The HFF can be traced offshore from Húsavík village across Skjálfandi Bay as two WNW-trending, south-facing fault scarps and northwest of Flatey Island into the southern Eyjarfjardaráll basin as a WNW-trending, north-facing scarp. Reflection records indicate an increased dip-slip component of motion westwards along these faults, on which severe earthquakes occurred in 1755 and 1872. In contrast, the GSL consists of numerous NS-trending, left-stepping, en-echelon rift valleys, akin to the fissure swarms observed on land. These are volcanically and hydrothermally active. The KR emerges from the Eyjafjardaráll basin as a narrow, well-defined rift zone north of ~66°50'N. As the NIRZ has propagated northward over the past 2 my, deformation within the TFZ shifted from predominately strike-slip motion along the HFF to extension along en-echelon rift zones. Tectonically, the GSL thus resembles the northernmost Reykjanes Ridge and Reykjanes Peninsula in southwestern Iceland rather than a conventional oceanic transform with narrow zones of predominately strike-slip motion.

OS71C-0314 0830h POSTER

Multi-system Acoustic Survey in Hecate Basin for Geohazard Assessment

Stephen F Bloomer[1] (250-472-4685; sbloomer@uvic.ca)

Kristin M. M. Rohr[1] (250-272-4342; krohr@sharks.seos.uvic.ca)

N. Ross Chapman[1] (250-472-4340; chapman@uvic.ca)

Francois Beaudet[1] (250-472-4343; fbeaudet@uvic.ca)

Graig Sutherland[1] (250-472-4342; graigs@uvic.ca)

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

In May and June of 2002, a geophysical survey was performed in southern Hecate Strait to assess sea floor and subsurface geohazards. The survey comprises a portion of a research program to study the impact of potential hydrocarbon exploration and production in Hecate Basin as part of the multidisciplinary NSERC/SSHRC funded Coast Under Stress project.

Data were collected on 100 miles of survey lines over a grid consisting of 10 north-south lines crossed by 10 east-west lines with a line separation of 0.5 mile. Water depths were relatively uniform, ranging from 230-260 m over the area. 64-channel multichannel seismic data using a 120 cu in airgun source were collected for deep subsurface structural mapping. The shallow subsurface was imaged using the Huntec high-resolution seismic system with a boomer source. 50 KHz Simrad echosounder data suitable for seafloor classification were collected using Quester Tangent Corporations QTC-V system.

A standard geophysical seismic facies interpretation of the Huntec data suggested the shallow subsurface is composed of 3 units: (a) The lowest unit is composed of Tertiary siltstones/sandstones. This unit is highly folded/faulted, due to Miocene/Pliocene tectonism, and often is incised by paleochannels. (b) Overlying these sediments is a unit that has a relatively transparent acoustic facies. This unit likely represents Pleistocene glacial till. Its upper surface often outcrops at the seafloor, forming prominent moraine-like features at the seafloor. When overlain by the uppermost unit, it forms a strong reflector at that interface, though its continuity is often disrupted by gas that is present near that contact (c) The uppermost acoustic unit is relatively transparent and infills topographic lows and reaches a maximum thickness of 15 meters. It is likely composed of silts/sands.

Seafloor classification of the echosounder data using feature extraction and cluster analysis indicates that this unit is somewhat acoustically distinct from the glacial till unit, suggesting different sediment properties for these two units. Pockmarks occasionally form at the sea floor, but cannot be distinguished by the seabed classification algorithms.

The origin of the shallow gas is unknown: it may be a result of biogenic degradation of organic matter, or gas diffusing upward along faults or bedding planes from the Tertiary sediments, as suggested by the multichannel seismic sections. The answer to this question awaits analysis of cores to be collected on future surveys.

OS71C-0315 0830h POSTER

Plunge Pools in Submarine Canyons

David W Caress[1] (831-775-1775; caress@mbari.org)

H Gary Greene[1,2] (greene@mlml.calstate.edu)

Charles K Paull[1] (paull@mbari.org)

[1]Monterey Bay Aquarium Research Institute, 7700 Sandholdt Rd., Moss Landing, CA 95039, United States

[2]Moss Landing Marine Laboratories, 8272 Moss Landing Rd., Moss Landing, CA 95039, United States

Many submarine canyon systems include well-defined intra-canyon depressions. Often, these depressions are found at the base of scarps along the canyon thalweg, with morphologic characteristics similar to subarial plunge pools formed at waterfalls. One plausible mechanism for the origin of these features is scouring during submarine debris flows. Other processes which can plausibly contribute to the formation of re-entrants and depressions in submarine canyons include erosion by spring sapping, slumping, collapse following gas expulsion or subsurface dissolution, and channel damming by mass wasting of canyon walls.

We have examined multibeam bathymetry surveys of a number of submarine canyons, and identified more than fifteen apparent plunge pools within submarine canyon systems offshore of Australia, Hawaii, and North America. These features range in scale from 2 km long, 6 km across, and 300 m deep (the largest plunge pool in Perth Canyon, offshore Australia) down to as small as 10 m deep and 150 m across (the smallest plunge pool identified offshore Kohala, Hawaii). Although these features vary considerably in scale, they share common characteristics. Each basin is located at the base of a headwall scarp within the canyon, and is bounded on the down-canyon side by a sill. Measurements of the characteristic dimensions of the plunge pools show that the basin depth (defined relative to the down-canyon sill) increases with the headwall scarp height,. However, the across and down canyon basin widths do not strongly correlate with the scarp height, and seem to be more closely related to the width of the overall canyon channel.

The Monterey Bay Aquarium Research Institute investigated three apparent plunge pools using ROV Tiburon during a spring 2001 expedition to the Hawaiian Islands. These basins are located in submarine canyons on the north side of Molokai and the Kohala coast of Hawaii. Our ROV observations support the hypothesis that these intra-canyon depressions are formed through scouring during submarine debris flows. In all cases the down-canyon depression sills are dams composed of debris piles, with angular rubble exposed on the depression side and sand covering the down-canyon side. The Molokai plunge pool is draped with mud and silt, suggesting no recent activity. However, the Kohala plunge pools show clear signs of recent scour and no sediment cover. The headwalls above the plunge pools expose layered volcanoclastic and lava flow units, with more resistant layers frequently forming vertical or overhanging walls. We interpret these canyons as being largely formed through retrogressive (headward) erosion and slope failure. Periodic rockfalls and debris flows following undercutting of the headwalls scours the depressions, builds the pool dams, and both lengthens and deepens the canyons.

Modern bathymetric surveys indicate that plunge pools occur in many, but not most submarine canyons. Our ROV observations suggest that stratigraphic variability is a key prerequisite for plunge pool formation. Headwall scarps can persist within active canyons when the existence of more and less resistive layers allows for differential erosion. In turn, plunge pools form when headwall scarps are persistent features.

URL: http://www.mbari.org/education/cruises/Hawaii/

O
S

OS71D MCC: Hall D Sunday 0830h

The Yin and Yang of Quaternary Climatic and Sea Level Fluctuations During the Past Two MA and How Does This Bear Upon Predictions for Future Climatic and Sea Level Changes? Posters *(joint with A, B, GC)*

Presiding: **S Eittreim,** U.S. Geological Survey**; J Collen,** Victoria University of Wellington**; D W Edsall,** Office of Naval Research

OS71D-0316 0830h INVITED POSTER

Stepwise Rise of Post-glacial Sea Level and some Geological Implications

John D. Milliman[1] (804-684-7112; milliman@vims.edu)

J. Paul Liu[1] (804-684-7739; jpliu@vims.edu)

[1]Virginia Institute of Marine Science, The College of William and Mary, Gloucester Point, VA 23062, United States

Sub-tidal, inter-tidal, and terrestrial data from the East China Sea (ECS) and Yellow Sea (YS), augmented by data from the Sunda shelf as well as Fairbanks's Barbados coral reef data, show a pattern of episodic post-glacial sea level transgression: a series of short, rapid flooding events (some faster than 90-100 mm/y), separated by a series of long, slow rises (2-6 mm/y). During two short, early post-LGM rapid rises sea level rose by about 7- to 9-m, so that by about 15 ka BP it had reached -100 m. A rapid flooding event (Fairbanks's MWP-1A) occurred between 14.3 -14.1 ka BP, when sea level jumped from -95 to -75 m (100 mm/yr). For the next 2.5 ky sea level rose slowly 6 mm/yr), with a possible still-stand or slight regression during the Younger Dryas. Between 11.6 and 11.4 ka BP, sea level rose about 18 m, to -60 m (MWP-1B), after which it again stagnated until another rapid rise 9.5 ka-9.2 ka BP (MWP-1C), when it rose to 19 m to -16 m. The last flooding occurred between 8.0 and 7.0 ka (MWP-1D), resulting in a +2 to +4 m highstand along the western Pacific. Close correlation with ice-core proxies confirms this step-like pattern, reflecting periods of rapid deglaciation interspersed with long intervals of little or no change in global ice volume. One important geological implication of this stepwise rise of sea level is the presence of flooding surfaces in Holocene sedimentary sequences, one example of which is given in this presentation.

OS71D-0317 0830h INVITED POSTER

Roles of Sea Level and Climate Change in the Development of Holocene Deltaic Sequences in the Yellow Sea

J. Paul Liu[1] (804-684-7739; jpliu@vims.edu)

John D. Milliman[1] (804-684-7112; milliman@vims.edu)

[1]Virginia Institute of Marine Science, The College of William and Mary, Gloucester Point, VA 23062, United States

Both post-glacial sea-level and climatic changes are preserved in the the shallow, low gradient, sediment-dominated Yellow Sea. As a result of rapid flooding during melt-water pulse (MWP) 1A, 14.3-14.1 ka BP, sea level reached the southern edge of the North Yellow Sea (NYS), and after MWP-1B (11.6-11.4 ka BP) sea level entered the Bohai Sea. The first major Yellow River-derived deltaic deposit formed in the NYS during decelerated transgression following MWP-1B and increased river discharge in response to re-intensification of the summer monsoon about 11 ka cal BP. A second subaqueous delta formed in the South Yellow Sea about 9-7 ka BP during decelerated transgression after MWP-1C flooding and in response to the southern shift of the Yellow River mouth. The modern subaqueous and subaerial deltas in the west Bahai Gulf and (to a lesser extent) along the Jiangus coast have formed during the modern sea-level highstand. These changing Holocene patterns are most clearly illustrated by a short film clip.

OS71D-0318 0830h POSTER

Mid-Shelf mud Deposition During the Holocene Transgression on the Monterey Bay, California Shelf

Eric E Grossman[1] (831-427-4725; egrossman@usgs.gov)

Steve L Eittreim[2] (650-329-5272; seittreim@usgs.gov)

Michael E Field[1] (831-459-3428; mfield@usgs.gov)

Brian D Edwards[2] (650-329-5488; bedwards@usgs.gov)

[1]U.S. Geological Survey Pacific Science Center, 1156 High St., Santa Cruz, CA 95064, United States

[2]U.S. Geological Survey, 345 Middlefield Road, Menlo Park, CA 94025, United States

High-resolution seismic reflection profiles and geochronological analyses of vibracore samples of the Monterey Bay shelf reveal that a 420 km^2 mudbelt lying unconformably on a wave-abraded terrace is entirely of Holocene age and may record evidence of Meltwater Pulse 1B (MWP-1B). The deposit has a maximum thickness of ~32 m between the -30 and -90 m isobaths and buries a prominent slope-break (paleoseacliff) carved into the underlying terrace between -35 and ~-55 m. Sedimentological and faunal analyses of 9 vibracores indicate an upward-fining sequence with a basal shallow-shelf facies consisting of coarse, marine carbonate-rich sands and gravels with abundant intertidal to subtidal molluscs underlying a deep-shelf mud facies composed of massive terrigenous silts and clays devoid of molluscs. A sharp contact separates these two characteristic units in all cores and represents a sudden shift in depositional environment or a widespread erosional event. Ten calibrated ^{14}C AMS ages of in situ molluscs and detrital wood from the base of the deposit (-88 m) in 4 of the 9 cores show that deposition of the basal unit began ~14-15 ka and accreted at rates of 0.12-0.35 mm/yr. Based on these rates, the age of the biolithologic contact is 11.0±0.3 ka, immediately following meltwater pulse 1B. A plausible mechanism explaining the simultaneous biolithological transition along 14 km of the outer shelf mudbelt is an abrupt shift in depositional setting associated with a relatively rapid transgression of the shoreline. In addition to rapid drowning associated with MWP-1B, flooding of the stepped Monterey Bay shelf circa 11 ka, would have moved the shoreline above the -35 to -55 m paleoseacliff and translated the focus of shallow-water deposition more than 5 km landward in a short time. Further investigation of the internal structure and accumulation history utilizing seismic reflection and radiometric analyses will test this hypothesis across a larger area and help to refine our understanding of the modes and rates of midshelf mudbelt development.

OS71D-0319 0830h POSTER

A 11.5 ka paleo-seacliff left behind by Melt Water Pulse 1B sea-level rise

Stephen L. Eittreim[1] (6503295272; seittreim@usgs.gov)

Eric E. Grossman[1] (8314274725; egrossman@usgs.gov)

Roberto J. Anima[1] (6503295212; ranima@usgs.gov)

[1]U.S. Geological Survey, 345 Middlefield Rd, Menlo Park, CA 94025, United States

The 30-m thick mid-shelf mudbelt of the Santa Cruz continental shelf covers a notch in the underlying eroded bedrock that appears to be the remnant of a 11.5 ka seacliff. This paleo-seacliff is located midway between the present coastline and the shelf break, about 7 km offshore from Santa Cruz. Calcareous shell and wood debris that occur in the coarse material at the base of the muds on the outer shelf are dated at 14-15 ka Cal yr BP and confirm the mud deposit as Holocene. The depth range of the hypothesized paleo-seacliff, reflecting the former height of the cliff, is from 40 m at top to 70 m at base. Meltwater Pulse (MWP) 1B has been documented as quickly raising sea level to the -43 m level at 11.5 ka. We believe this sea-level event caused a 12-ka seacliff to be left behind and subsequently buried. The seismically-discernable gradient of the cliff face is 0.04, which is greatly diminished from its presumed original vertical slope. The implied cliff-retreat rate, from 11.5 ka to the present, for the area east of Santa Cruz where the bedrock consists of the relatively soft Purisima Formation is 600 mm/yr. West of Santa Cruz where the bedrock is the more resistant silica-rich Santa Cruz Mudstone, the paleo-seacliff is closer to shore and the implied retreat rate is 130 mm/yr. Today's cliff-retreat rates in the Santa Cruz area average about 200 mm/yr. In the simplest model, if the sea-level rise rate were equal to the cliff retreat rate during transgression of the cliff, the resulting cliff would be attenuated from vertical to 45°. The transgressive sea-level event that left the paleo-seacliff behind probably proceeded at a rate significantly less than the cliff retreat rate to account for the greatly attenuated slope. We therefore estimate a rate on the order of 100 mm/yr or less for the sea-level rise associated with MWP 1B. High-resolution seismic surveys of the world's shelves will undoubtedly reveal similar evidence of sea-level stands beneath today's high-stand muds, and these sea-level stands may reveal much about climate for the mid-late Holocene by showing shoreline configurations at locations seaward of present coastlines.

OS71D-0320 0830h POSTER

Evidence for Rapid Postglacial Sea-Level Changes off the Northern Ireland Coast

Jasper Knight[1] (+44 28 7032 3179; j.knight@ulster.ac.uk)

Rory Quinn[1] (+44 28 7032 4884; rj.quinn@ulster.ac.uk)

[1]University of Ulster, School of Biological and Environmental Sciences, Coleraine BT52 1SA, United Kingdom

Marine geophysical surveys off the paraglacial coast of Northern Ireland show a range of geological evidence for changes in relative sea-level (RSL) during the late-glacial and early Holocene periods (c. 14-8 kyr BP). Geological evidence was interpreted from Chirp sub-bottom geophysical profiles, side-scan sonar data, and echo-sounded bathymetry. Evidence observed includes submerged notches and shore platforms, and tabular or wedge-like acoustic units which have variously sharp, graded, draped and unconformable contacts. Submerged notches and shore platforms, interpreted to represent sea-level stillstands, are present at -30 m, -24 m and -15 m OD. These are cut into, variously, acoustic units interpreted as subglacial and glaciomarine diamicts (tills), indicating a close relationship between glacial and marine sediment deposition and RSL stage. Separating these stillstand features spatially and stratigraphically are sandy and muddy sediment units which record periods of sediment infilling (reduction of accommodation space) under more slowly rising RSL. Interpretation of acoustic units using a systems tract approach identifies periods of sediment deposition associated with late-glacial (14-12 kyr BP) and early Holocene (10-8 kyr BP) transgressive RSL phases, which are separated by a deep RSL lowstand. Transgression between c. 11-9.5 kyr was up to 16 mm yr. The rapid changes in RSL, associated with changes in marine sedimentation patterns, are similar to those observed in the tropical coral (global eustatic) record, but those in Ireland have a different timing because of the interplay between glacio-isostatic and eustatic effects. The presence of short periods of eustatic RSL change along the Ireland coast - which are out of tempo with global eustatic patterns - may support evidence for varying strength of glacio-isostatic RSL rise over time, perhaps associated with reactivation of pre-existing regional faults.

OS71D-0321 0830h POSTER

Holocene land- and sea-level changes in Great Britain

Benjamin P Horton[1] (+44 (0) 191 374 2486; b.p.horton@durham.ac.uk)

Ian Shennan[1] (+44 (0) 191 374 2484)

[1]University of Durham, Department of Geography University of Durham, Durham DH1 3LE, United Kingdom

Over the last decade there has been a significant increase in the number and distribution, spatially and through time, of reliable observations of past relative sea level in Great Britain. These have contributed to better models of the glacial isostatic adjustment (GIA) processes at both the national and global scales. Despite significant improvements in the agreement between predicted RSL changes derived from different GIA models and observations from dated sediments there remain important discrepancies. Until the reasons for these are solved, the best estimates of current relative land- and sea-level change come from analysis of the observations, supplemented with estimates from models where there is a good fit.

Analysis of more than 1200 sea level index points and 180 limiting dates for 52 locations in Great Britain over the last 16kyr provides estimates of late Holocene land-level changes (negative of relative sea-level change). Maximum relative land uplift occurs in central and western Scotland, 1.6mm/yr, and maximum subsidence in southwest England, 1.2mm/yr. Sediment consolidation, arising from autocompaction as the sediment accumulates and from land drainage, increases the subsidence in areas with thick sequences of Holocene sediments, with an average effect equivalent to an extra 0.2mm/yr land subsidence, but more in parts of southeast England, 0.5 to 1.1mm/yr. Modelled changes in tidal range during the mid to late Holocene in eastern England suggest that the calculated rate of land subsidence is overestimated unless such changes are quantified. The effect is most significant, equivalent to 0.4 to 0.6mm/yr, for large coastal lowlands, the Humber and Fenland, that were tidal embayments during the mid to late Holocene.

OS71D-0322 0830h POSTER

Time Slice Reconstruction of Bathymetry and Shoreline, Santa Barbara Channel Area, Southern California, Past 20 k.y.

Julia M Frazier[1] (jfrazier@es.ucsc.edu)

Richard Behl[1] (1-562-985-5850; behl@csulb.edu)

[1]California State University, Long Beach, Department of Geological Sciences 1250 Bellflower Blvd., Long Beach, CA 90840

The Santa Barbara Channel area has been the focus of numerous marine geology, paleoceanography and tectonic studies. The coastal area also hosts important archeological resources. This study creates a series of incremental maps for every 2,000 years of the region to present a stepped view of how sea level, sedimentary and tectonic processes governed the position and shape of the coastline over the last 20,000 years. This data lends insight into the potential locations of ancient archeological sites along the coast, as well as geological processes operating in margin-proximal basins and shorelines. Bathymetric data compiled by the Monterey Bay Aquarium Research Institute were integrated with digitized, published sedimentary and tectonic data in a GIS database. Faults with a significantly high slip rate were considered in the reconstruction, along with many sedimentation rates distributed across the basin, slopes and shelves. Over the last 20,000 years, sedimentation rates of 1.2-1.73 m/k.y. have been recorded within the basin center and 0-3 m/k.y. recorded on the slopes and shelf areas. The Oak Ridge and Pitas Point reverse faults experience a relatively high average slip

rate of 6 m/k.y. and 3 m/k.y., respectively. This reconstruction indicates that the Montalvo Ridge area may have been more of a promontory than an island, as previously proposed considering only change in sea level. The geomorphic evolution of the basin is determined by the combined effect of sedimentation (supply and current distribution), tectonics and eustatic sea level. Additional sedimentation and uplift rate data along the slopes and shelves, specifically west of Ventura, within the submarine fan south of Point Conception, and along the shelves surrounding the Channel Islands, would assist in a more complete reconstruction of the study area.

OS71D-0323 0830h POSTER

Sea Level Rise in Long Island Sound Over the Last Millennium

Ellen Thomas[1] (1-860-685-2238; ethomas@wesleyan.edu)

Johan C. Varekamp[1] (1-860-685-2248; jvarekamp@wesleyan.edu)

[1]Department of EES, Wesleyan University, 265 Church Street, Middletown, CT 06459, United States

Salt marshes along the north coast of Long Island Sound carry a detailed paleoenvironmental record, with information on relative sea level rise, climate and anthropogenic impacts (e.g., metal pollution). We studied fourteen salt marsh cores along the Sound, and here present data on cores from marsh islands in the mouth of the Connecticut River (Great Island) and the Housatonic River (Knells Island). Both are largely high-marsh environments, with a tidal range of 1.7 m at Great Island, 2 m at Knells Island. Cores are sliced in 2 cm intervals, dated with ^{210}Pb, ^{137}Cs and ^{14}C, and benthic foraminifera are used as paleo sea level indicators. The records go back 600 years (Great Island) and 1500 years (Knells Island). Both locations show evidence for enhanced fresh water discharge around 1900 and 1950 AD, well-documented wet periods in the climate history of Connecticut. The relative sea level rise (RSLR) curve from Knells Island shows little change between 500 and 1000 AD, then the rate of RSLR accelerates until 1600 AD to about 2.5 mm/year. From 1600 to 1700 AD, the curve is flat, then rises to about 1.7 mm/year, with an acceleration to 3 mm/year in the last 100 years. The Great Island RSLR curve shows a rate of 1.7 mm/year from 1400 AD on, with a short slow-down at 1700 AD, and a slightly faster rate of 2.3 mm/year in the last 300 years. These data are similar to those in our other RSLR curves from the Long Island Sound marshes: RSLR rates are variable over the last 1000 years (1 mm/year on average), and accelerate in the last 200-300 years to about 2.5-3 mm/year. The exact date of the beginning of the recent acceleration remains to be determined because it falls in the dating gap between viable ^{210}Pb and ^{14}C ages. Many curves show a slight decrease in rate of relative sea level rise around 1500-1600 AD, which we correlate with the coldest stretch of the Little Ice Age. The Knells Island core appears to show an acceleration around 1000 AD, which may correlate with the onset of the Medieval Warm period, but this signal is hard to discern in many other cores. A pronounced, short slow-down in the rate of relative sea level rise occurred around 600 AD in several cores. We tentatively correlate this episode with a coeval cold snap recorded in the GISP2 ice core record. The data thus suggest a direct link (no significant lag time) between climate change and rates of RSLR on the northeastern US seaboard.

OS71D-0324 0830h POSTER

Rapid Sea-Level Rise at 8.0-7.5 ka and Antarctic Ice Sheet Thinning

Thomas M Cronin[1] (703-648-6363; tcronin@usgs.gov)

Peter R Vogt[2] (vogt@qur.nrl.navy.mil)

Debra A Willard[1] (dwillard@usgs.gov)

[1]U.S. Geologic Survey, 926A National Center, Reston, VA 20192, United States

[2]Naval Research Laboratory, Code 7420, Washington, DC 20375, United States

Global deglaciation following the last glacial maximum (LGM) involved a series of millennial-scale climate reversals related to glacial meltwater pulses (MWP) from glacial lake drainage and shrinking ice sheets, resulting in reduced North Atlantic deep water formation, and global sea level (GSL) rise. The final stages of deglaciation between 9 and 7 ka are still poorly understood in terms of the rate, the relation to meltwater and climate events, and the source of ice sheet melting. We present geochronological, micropaleontological and geophysical evidence from from Chesapeake Bay which indicate a period of relatively stable sea level prior to and during the 8 ka cool event (9.2-7.9 ka), followed by a rapid (~500 yr) global sea level rise from 24 $\pm$ 1 to 4 $\pm$ 1 mbsl (subsidence-corrected) between about 7.9 to 7.6 ka. This rapid sea-level event followed a large Laurentide Ice Sheet (LIS) meltwater discharge and glacial lake drainage dated at ~8.4 ka. It was at least as rapid (36 to 200 mm yr^{-1}) and as large (18-20 m) as sea-level events associated with earlier MWP 1A (13.8 ka) and 1B (11.5-11 ka). Because the timing of Laurentide Ice Sheet (LIS) melting was nearly complete by 8 ka, LIS probably contributed no more than a few meters to the 7.8 ka sea-level event, though LIS meltwater influenced global climate and thus may have affected West Antarctic Ice Sheet (WAIS) thinning. It is hypothesized that Antarctic Ice Sheet melting is a likely candidate as the source of sea-level rise. Studies from the Ross Sea Embayment indicate that the West Antarctic Ice Sheet experienced grounding line recession between ~8 and 6 ka and modeling studies indicate that parts of the WAIS thinned up to 200 m since 8 ka. The Holocene contribution of Ross Sea area WAIS ice may have been as much as 6-7 m. Ice from other parts of the WAIS, East Antarctic Ice Sheet drawn down into the Ross Sea Embayment through the Transantarctic Mountains, and/or margins of the East Antarctic Ice may account for the remaining 8-10 m of ice volume.

OS71D-0325 0830h POSTER

Extending the Instrumental Record of Sea-Level Change: A 1300-Year Sea-Level Record From Eastern Connecticut

Jeffrey P Donnelly[1,2] (508-289-2994; jdonnelly@whoi.edu)

Peter Cleary[2] (pjc7h@cms.mail.virginia.edu)

[1]Woods Hole Oceanographic Institution, Geology and Geophysics Department, Woods Hole, MA 02543, United States

[2]Brown University, Department of Geological Sciences, Providence, RI 02912, United States

The instrumental record of sea-level change in the northeastern United States extends back to the early 20th century and at New York City (NYC) extends back to 1856. These tide gauge records indicate that sea level has risen at a rate of 2.5 to 4 mm/year over the last 100-150 years. Geologic evidence of sea-level change in the region over the last 2,000 years indicates rates of sea-level rise of about 1 mm/year or less. The discordance between the instrumental and geologic records is frequently cited as potentially providing evidence that anthropogenic warming of the climate system has resulted in an increase in the rate of sea-level rise. In order to begin to test the hypothesis that acceleration in the rate of sea-level rise has occurred in the last 150 years due to anthropogenic climate warming, accurate and precise information on the timing of the apparent acceleration in sea-level rise are needed.

Here we construct a high-resolution relative sea-level record for the past 1350 years by dating basal salt marsh peat samples above a glacial erratic in a western Connecticut salt marsh. Preservation of marsh vegetation remains in the sediment record that has a narrow vertical habitat range at the upper end of the tidal range provides information on past sea levels. *Spartina patens* (marsh hay) and *Juncus gerardi* (black rush) dominate both the modern marsh and their remains are the major constituent of the marsh sediments and occur in the modern marsh between mean high water (MHW) and mean highest high water. We use the elevation distribution of modern plant communities to estimate the relationship of sediment samples to paleo-mean high water. The chronology is based on 15 radiocarbon ages, supplemented by age estimates derived from the horizons of industrial Pb pollution and pollen indicative of European land clearance. Thirteen of the radiocarbon ages and the Pb and pollen data come from samples taken along a contact between marsh peat and a glacial erratic located in the marsh. Two additional radiocarbon ages were obtained from the basal contacts of two cores taken 600m northwest of the erratic in the same marsh. Because we based our record entirely on basal samples, the samples were not displaced vertically by autocompaction of the peat column.

The data show a sea-level rise rate of 1.0 $\pm$ 0.3 mm/year from 700 to 1650 AD. From the middle of the 17th century to the middle of the 19th century the rate of sea-level rise was 0.4 $\pm$ 1 mm/year indicating that the rate of sea-level rise may have slowed during the Little Ice Age. The tide gauge record from New London, CT indicates a rate of 4.1 mm/year between 1939 and present. Data from the Battery tide gauge at NYC indicates a rate of sea-level rise of about 2.8 mm/year from 1856 to present. The NYC tide gauge record indicates that MHW was about 32 cm below modern MHW (as defined by the National Oceanic and Atmospheric Administration) and matches well with the proxy record of past MHW derived from the marsh sediments. The increase in the rate of sea-level rise to modern levels occurs in the 19th century and most likely in the later half of the 19th century. The timing of the observed sea-level rise rate increase is coincident with the onset of atmospheric warming in the late 19th century and indicates that a link between increases in the rate of sea-level rise and anthropogenic climate warming is possible and even likely.

OS71D-0326 0830h POSTER

Insolation Gradient Reconciling Early Warming Relative to d18O Terminations

Zhonghui Liu[1] (4018632810; Zhonghui_Liu@brown.edu)

Timothy D Herbert[1] (4018631207; Timothy_Herbert@brown.edu)

[1]Brown University, Department of Geological Sciences, Providence, RI 02912, United States

Milankovitch theory that ice-volume is controlled by the insolation at critical latitudes and seasons (65*N) has been favored for its ability to account for some key features of Pleistocene glaciations. However, one of perplexing mysteries unresolved by this theory is that, about 3 to 1 million years ago, ice sheets varied at almost metronomic 41-ka obliquity cycles, while the 21-ka precessional period is dominant in insolation. Another related problem but not addressed by this theory is that some of climatic proxies suggest an early transition relative to the insolation, resulting in a causality problem if insolation is claimed as the external forcing. For example, U-Th dating of some coral reefs, d18O of calcite vein, and sea surface temperature (SST) records have shown that the penultimate transition occurred as early as 135-142 ka ago, whereas the June insolation was below the average before 133 ka ago. These two puzzles (41-ka variability and timing of transitions) can be resolved if one uses insolation gradients between high and low latitudes, in addition to 65*N insolation alone, as the external driving force of ice ages. The insolation gradient has a strikingly similar distribution of frequency variances to paleoclimatic records (SST and d18O) before the late Pleistocene. One of the insolation gradient minimum, occurring at 149 ka ago, 10 ka earlier than the insolation minimum, could well explain the early penultimate transition (e.g. SSTs and sea levels). We argue that Pleistocene glaciations are controlled by insolation gradients. Interglacials correspond to stronger insolation gradients, caused by either increasing high-latitude insolation, as Milankovitch theory states, or a reduction in low-latitude insolation which provides less northward atmospheric heat (moisture) transport, as some climate models suggest.

OS71D-0327 0830h POSTER

Modeling the influence of sea-level fluctuations on fluvial morphology in tectonically active coastal regions

Noah P Snyder[1,2] (nsnyder@usgs.gov)

Kelin X Whipple[2] (kxw@mit.edu)

Gregory E Tucker[3] (gtucker@nimbus.geog.ox.ac.uk)

Dorothy J Merritts[4] (dorothy.merritts@fandm.edu)

[1]USGS Pacific Science Center, 1156 High Street, Santa Cruz, CA 95064, United States

[2]Dept. of EAPS, Massachusetts Institute of Technology, Cambridge, MA 02139, United States

[3]School of Geography and the Environment, University of Oxford, Oxford OX1 3TB, United Kingdom

[4]Dept. of Geosciences, Franklin and Marshall College, Lancaster, PA 17604, United States

We explore the response of bedrock-floored coastal streams to eustatic and tectonically induced fluctuations in base level. A numerical model coupling onshore fluvial erosion with offshore wave-base erosion is developed. The results of a series of simulations for simple transgressions with constant rate of sea-level change (SLR) show that response depends on the relative rates of rock uplift (U) and wave-base erosion (ϵ_w). Simple regression runs highlight the importance of nearshore bathymetry. Shoreline position during sea-level fall is set by the relative rate of base-level fall (U-SLR) and ϵ_w, and is constant horizontally when these two quantities are equal. The results of models forced by a realistic late Quaternary sea-level curve are presented. These runs show that a stable shoreline position cannot be obtained if offshore uplift rates exceed ϵ_w. Only in the presence of a relatively stable shoreline position can fluvial profiles begin to approximate a steady-state condition, with U balanced by fluvial erosion rate (ϵ_f). In the presence of a rapid offshore decrease in rock-uplift rate (U), short (5 km) fluvial channels respond to significant changes in rock-uplift rate in just a few eustatic cycles. The results of the model are compared to real onshore and offshore profile data from the Mendocino triple junction region of northern California. The late Holocene sea-level stillstand response exhibited by the simulated channels is consistent with various features seen in the California streams, including low-gradient channel mouths with alluvial deposits, and uplifted marine platforms.

OS71D-0328 0830h POSTER

Getting to the bottom of it: a paleoreconstruction of the − 400 m drowned carbonate platform off northwestern Hawaii

Stacy D Jupiter[1] ((831) 459-5063; jupiter@darwin.ucsc.edu)

David A Clague[2] ((831) 775-1781; clague@mbari.org)

Jody M Webster[3] ((831) 459-2830; jwebster@es.ucsc.edu)

[1]University of California, Santa Cruz, Department of Ecology and Evolutionary Biology A316 Earth Marine Sciences 1156 High Street, Santa Cruz, CA 95064, United States

[2]Monterey Bay Aquarium Research Institute, 7700 Sandholdt Road, Moss Landing, CA 95039-9644, United States

[3]University of California, Santa Cruz, Department of Earth Sciences 1156 High Street, Santa Cruz, CA 95064, United States

Pleistocene sea level oscillations superimposed on volcanic subsidence contributed to the formation and successive drowning of a series of six carbonate platforms off Kohala on the northwest coast of Hawaii. We are using a paleoreconstruction of the − 400 m Kohala platform, based on geomorphology, ecology (species assemblages) and petrology (grain size, dominant microfossils, recrystallization) to refine models of local sea level fluctuations, subsidence rates and volcano growth. A synthesis of analyses of bathymetric and acoustic backscatter data, whole carbonate samples, thin sections and push cores has provided a history of primary and secondary construction, subaerial exposure and drowning signatures. We then evaluate the data in the context of paleogeographic and oceanographic constraints on reef development around Hawaii. ROV video observations suggest that the geomorphic structure of the 400 m platform is predominantly secondary construction: (1) eroded gullies are pervasive throughout the seaward slope of platform; (2) extensive weathering exists along the platform crest and flat; and (3) fissures parallel and normal to the platform slope are prominent features. While coralline-algal bindstones dominate most parts of the platform, the majority of coral samples were restricted to loose talus on the lower seaward slope. These different distributions may reflect: paleoenvironmental determinants of reef growth; sampling biases; and/or preservational biases. Explaining these differences requires accurate determination during collection of the attitude and location of each coral sample, followed by precise dating, to accurately constrain sea level, subsidence and volcano growth models.

OS71D-0329 0830h POSTER

Global Sea-Level Versus Local Control of Middle-Miocene to Recent Sequences on a Current-Swept Divergent Margin: Offshore Canterbury Basin, New Zealand

Hongbo Lu[1,2] (1-512-471-0387; hongbo@ig.utexas.edu)

Craig S. Fulthorpe[1] (1-512-471-0459; craig@ig.utexas.edu)

Paul Mann[1] (1-512-471-0452; paulm@ig.utexas.edu)

[1]University of Texas Institute for Geophysics, John A. and Katherine G. Jackson School of Geosciences, 4412 Spicewood Springs Road, Building 600, Austin, TX 78759-8500, United States

[2]Department of Geological Sciences, John A. and Katherine G. Jackson School of Geosciences, The University of Texas at Austin, Austin, TX 78712-1101, United States

Upper Miocene to Recent sequences beneath the continental shelf and slope of the offshore Canterbury Basin, New Zealand, are mapped using closely spaced, high-resolution multichannel seismic data collected in January 2000. Sequence geometries and morphologies of unconformities reflect competing influences of eustasy, contour-currents, and rate of sediment supply.

Eighteen regional sequence-bounding unconformities form three seismic stratigraphic units: 1) Miocene unconformities U1-8 (>16-5 Ma; all ages are from ODP Site 1119 and Clipper exploration well) have smooth shelves. Onlap can occur on both shelf and slope. Most sequences are progradational and of relatively long duration (>1.4 m.y.). Six additional localized unconformities also occur; each onlaps the underlying regional unconformity and is either truncated basinward by sediment drifts or downlaps onto the underlying unconformity. 2) Pliocene to early Pleistocene unconformities U9-13 (3.6-1.25 Ma) define aggradational sequences with durations ranging from 0.11 to 1.4 m.y. Frequency of onlap decreases up section. Each sequence contains a downlap surface, which onlaps the underlying unconformity and is truncated basinward by the overlying unconformity. 3) Early Pleistocene (∼1.2 Ma) to Recent unconformities U14-18 display shelf channel incision and erosional truncation by currents on the slope. Sequences are progradational and of short duration (<0.4 m.y.). They are downlapped on the shelf and slope failure truncates reflections near their well-defined shelf edges. Five additional local unconformities are truncated to landward by the overlying regional unconformity; most are only preserved on the outer shelf and upper slope.

The most recent unconformities (17 and 18, plus three local unconformities) correlate well with 100 k.y. cycles in the oxygen isotope record (stages 6-14) over the last 500 k.y., suggesting that they are of eustatic origin. Older sequences are of longer duration and encompass multiple oxygen isotope cycles. This could imply local control of older sequences. Alternatively, the sequence stratigraphic record may selectively respond to a subset of the global cycles, or to bundles of Milankovitch-scale cycles.

Currents redistribute deposits, control depocenter locations, generate diachronous unconformities, and influence seismic stacking patterns and morphologies. Multistage sediment drifts contain several sequence boundaries. Drift moats may serve as conduits for downslope sediment transport during relative sea-level falls, reactivating as moats when sea level rises. Large sediment drifts in the north transition southward to conventional progradational geometries, in parallel with a north-to-south increase in slope inclination (from $<2^{\circ}$ to $>5^{\circ}$). Geometries transitional between drifts and clinoform sequences suggest criteria by which current deposition can be recognized on margins without well-defined drifts.

OS71D-0330 0830h POSTER

Drowned Carbonate Platforms in the Huon Gulf, Papua New Guinea; Morphology, Composition and Implications for Reef Development on a Rapidly Subsiding Margin

Jody Webster[1] (jwebste@es.ucsc.edu); Eli Silver[1]; Donald Potts[1] (potts@biology.ucsc.edu); Laura Wallace[4] (L.Wallace@gns.cri.nz); Kristin Riker-Coleman[3] (rike0003@tc.umn.edu); Christina Gallup[3] (cgallup@D.UMN.edu); Bruce Applegate[2] (tba@hawaii.edu); Stacey Jupiter[1] (sjupiter@es.ucsc.edu)

[1]University of California, Earth and Marine Sciences Building, 1156 High Street, Santa Cruz, CA 95064, United States

[2]University of Hawaii, 1680 East-West Road, Honolulu, HI 96822

[3]University of Minnesota Duluth, 1114 Kirby Dr., 229 HH, Duluth, MN 55812, United States

[4]Institute of Geological and Nuclear Sciences, 69 Gracefield Rd, Lower Hutt 30-368, New Zealand

Collision between the South Bismarck Plate and the northern edge of the Australian Plate has produced an actively subsiding foreland basin in the western Huon Gulf. A series of drowned coral reef platforms and pinnacles are preserved on this margin as a result of this rapid subsidence. Previous data and models suggest that these platforms drowned due to the combined affects of rapid relative sea-level rise associated with glacial terminations and continual subsidence (up to 5.7 mm/year) over the last 400 ky. A multidisciplinary cruise on the R/V Melville (Aug-Sep 2001). mapped and sampled nine platforms and pinnacles using; (1) Seabeam 2000; (2) high-resolution side-scan mapping (DSL120) and (3) the ROV Jason for outcrop sampling. Two U-Th ages (348 ka at 1950 mbsl and 60 ka at 240 mbsl) confirm the platforms age and deepen progressively NE towards the Markham Fault. The bathymetric and sidescan data indicates the platforms are composite features, often recording multiple terrace levels and pinnacle structures that probably formed during less dramatic interstadial sea-level fluctuations. The edges of the platforms have experienced substantial lateral modification through fracturing and slumping, producing vertical outcrop exposures, slumped blocks and debris fields. However, the tops of each platform appear to preserve the signature and timing of platform drowning. Coral assemblages and microfacies data indicate there are significant differences in paleoenvironmental settings between the shallow, middle and deep platforms. Prior to drowning, the deeper platforms developed in significantly higher energy reefal conditions compared with the middle or shallow platforms. Thus the paleoenvironmentals conditions have changed substantially through time in the Huon Gulf. The changes may be related a re-organisation of the oceanographic/climatic conditions of the Huon Gulf as a result of; (1) the rotation and uplift of the Huon Peninsular and/or (2) variation in more regional factors such as the position of the Intertropical Convergence Zone (ITCZ) over the last 400 ka.

OS71D-0331 0830h POSTER

Erosional/Depositional History of the Pernambuco Seachannel, South Atlantic Ocean

Douglas W. Edsall[1] (+81 3 3401 8924; edsalld@onrasia.navy.mil)

Norman Z. Cherkis[2] (703-971-3141; fiveoceanscon@yahoo.com)

[1]US Naval Academy, Physics Dept., Annapolis MD 21402, (present address: Assoc Dir for OAS, ONRIFO ASIA, POB 449, UNIT 45002), APO, AP 96337-5002, United States

[2]Naval Research Laboratory, Code 7420, Washington DC 20375 , (present address: Five Oceans Consultants, 6300 Saddle Tree Drive, Alexandria, VA 22310-2915, United States

Multibeam bathymetry and single-channel seismic reflection profiling data collected in the Brazil Basin during Project CENTRATLAN project revealed the existence of a fully incised, meandering and bifurcating seachannel on the South Atlantic Ocean seafloor east of central Brazil. Our examination provides the first comprehensive study of the morphology of Pernambuco Seachannel, which in some ways is similar in appearance to features of terrestrial riverine systems.

Pernambuco Seachannel is the only known example of a geostrophic or contour current created and maintained seafloor channel. It extends northward through the Bahia Seamount Group and into the northern part of the Brazil Basin. Within the Bahia Seamount Group, the course of the channel is partially constrained on the west by eastward-facing slopes of the Brazilian continental margin and on the east by the Bahia Seamounts group. In the northern portion of the study area, just prior to exiting the Bahia Seamounts, a shallower and younger second channel is present.

Three major unconformities are identified on seismic reflection records. On these, older and younger channels occupy the same relative positions with respect to the unconformities which appear to be identical with two of the three unconformities present at DSDP Leg 39, site 355. Using the ages assigned to these unconformities at this DSDP site suggests that erosional activity creating the older Pernambuco Seachannel by northward flowing AABW began in upper Eocene - middle Oligocene times but not before 11.2 M.Y.B.P. The westward migration of the younger channel is associated with the sea level transgression of post middle Miocene time.

OS71D-0332 0830h POSTER

Numerical Investigation of the Effects of Delta Avulsion on Stratigraphy

J. Scott S. Stewart (scotts@colorado.edu)

INSTAAR/University of Colorado, 450 UCB, Boulder, CO 80309, United States

SedFlux3D is a three dimensional numerical basin fill model which simulates the development of stratigraphy over time periods of hundreds to tens of thousands of years. Processes such as distributary avulsion with high spacial heterogeneity are critical to understanding stratigraphic patterns. Recently, a subaerial module has been added to simulate overbanking and flood deposits on the delta plain in addition to sediment deposition in the marine environment. Here, the role of river mouth avulsion on the volume stratigraphic record is investigated, and the effects of different avulsion rates are explored on both the subaerial and marine depositional record.

OS71E MCC: 104 Sunday 0830h

Graduate Education in Ocean Science on the Occasion of the 60th Anniversary *(joint with ED, HG)*

Presiding: **K Hardy,** Scripps Institution of Oceanography**; M Hendershott,** Scripps Institution of Oceanography**; J Hildebrand,** Scripps Institution of Oceanography**; K Melville,** Scripps Institution of Oceanography

OS71E-01 0830h INVITED

The Early Influence of The Oceans on Oceanography Education

John A Knauss (401 874 6141; jknauss@gso.uri.edu)

Graduate School of Oceanography University of Rhode Island, South Ferry Road, Narragansett, RI 02874