OS42C-06 1715h

Hydrocarbon Seepage and Gas Hydrate Deposits in the Southern Gulf of Mexico - Results From R/V Sonne Cruise 174.

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During October and November 2003, the German ship R/V Sonne visited the Campeche Escarpment in the southern Gulf of Mexico. The primary objectives of the cruise were the following: 1) extend our knowledge of gas hydrates buried just below the seafloor in the deep ocean; 2) determine whether natural hydrocarbon seeps in the southern Gulf of Mexico support chemosynthetic fauna, and 3) pinpoint sites for future exploration with deep-diving submersibles. Recent findings indicate that marine deposits of gas hydrate represent an important contribution to the global carbon cycle. Methane released from the gas hydrate reservoir may interact with other components of the Earth system influencing climate and is a potential source of energy. Although most gas hydrate is buried under hundreds of meters of marine sediment, the Gulf of Mexico is one place where it exists at or near the seafloor, where it can be sampled and studied. Gas hydrate is one component of the natural hydrocarbon system of the Gulf of Mexico; other components - known primarily from the northern Gulf - include oil seeps that produce natural oil "spills" visible from space and lush communities of chemosynthetic tubeworms and mussels. Natural oil seeps also occur in the southern Gulf of Mexico on the Campeche Escarpment and were expected to harbor chemosynthetic fauna and possibly gas hydrates. Recently, satellite remote sensing has been successfully used to pinpoint active seeps based on the unusual synthetic aperture radar signature generated by oil slicks on the sea surface in the northern Gulf of Mexico. Using a combination of satellite image analyses, acoustic profiling techniques, detailed bathymetric mapping, and interpretation of seafloor reflectivity data, we were able to identify and study such areas of active seafloor seepage of hydrocarbons in the previously unexplored southern Gulf of Mexico.

URL: http://www.gashydrate.de/projekte/omega/otega2/

OS42C-07 1730h

Mud volcanoes and gas Hydrates in the Black Sea - new Data From Dvurechenskii mud Volcano

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METEOR cruise M52/1 revealed the presence of gas hydrates in sediments of mud volcanoes in the Sorokin Trough of the Black Sea. Methane Hydrates were sampled from Dvurechenskii MV, Odessa MV, Yalta MV, and an unnamed mud volcano. Dvurechenskii mud volcano (DMV), a flat topped "mud pie"-type structure, seems to be presently active. Pore water in the sediments of DMV is enriched in several constituents such as ammonium and chloride. These elements can only have come from deeper sediments. High sediment temperatures of up to 16.5°C in close contact to the ambient bottom water of 9°C also suggest a strong activity. Steep gradients in temperature indicate a high fluid and/or mud flux in DMV which is independently deduced by the shape of pore water profiles. Active fluid expulsion sites are also evidenced by TV-sled observation, and a potential methane flux from the sediment to the bottom water was traced by measurements.

OS42C-08 1745h

ULTRADEEP LARGE SCALE POCKMARKS OFF CONGO - EXAMPLES FOR MASSIVE OCCURRENCE OF GAS HYDRATE, FLUID AND GAS SEEPAGE

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Deep sea pockmarks belong to the large scale features on the sea floor, where major fluxes of fluids and gases can be observed. They are also among the rare places, where gas hydrates are found near the sea floor in the reach of sampling. The southwest African continental margin off Gabon and Congo has revealed numerous such structures during recent surveys using high resolution seismic and acoustic systems , and 3 pockmark structures had been subsequently selected to be studied within the framework of the German geotechnologien gas hydrate initiative. Main objectives were the occurrence, evolution and properties of gas hydrate, fluid and gas seepage and its physical appearance within the hemipelagic sediment cover. Deep Tow Side Scan Sonar and sea floor video observations confirmed the widespread distribution of shallow carbonate precipitates and gas hydrates, contributing to high backscatter as well as very high reflection amplitudes in sediment echosounder data. Only parts of these a few to 30 meters deep sea floor depressions are affected by fluid escape on sub-circular areas of a few hundred meters diameter. Numerous samples of gas hydrates had been recovered from the vicinity of all 3 surveyed pockmarks, indicating a close relationship between fluid pathways, chemosynthetic communities as clam fields or tube worms, gas hydrate growth and carbonate precipitation. 3D seismic data collected at high to very high resolution, using seismic sources up to 1 kHz source frequency, reveal a complex nature of the fluid upflow zone and their relationship to deeper shallow gas pockets. It is assumed that they allow the spatial reconstruction of gas hydrate occurrence, gas distribution and the sediment volume, contributing to the overall fluid flow, as well as the quantification of gas hydrates stored in the vicinity of the pockmarks in the upper 200 meters of the sediment column.

OS51A MCC: 3000 Friday 0800h

Sedimentation on European Margins I

(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

OS51A-01 0800h INVITED

Ravinement Surfaces And Deglacial Sediments On The Rhone Margin (France)

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The significance of key surfaces and parasequences on the Rhone margin is investigated by comparing high-, very high-, and ultra-high resolution seismic data to long Calypso cores. Each surface and deposit correspond to typical seismic facies, distinct lithologies and different faunal associations. Radiocarbon datings allow us to tie these surfaces and deposits to the deglacial history of the area. However, it is necessary to consider the Rhone subaqueous delta in three dimensions, in order to decipher the impact of global (sea-level), regional (climate, sediment flux), and local (hydrodynamics, avulsion) processes. The last deglacial sea-level rise is well recorded through surprisingly similar clinoform parasequences, that consist of sand and gravels progressively passing seaward to clayey silts. When these systems have a sufficient lateral extent, they can be utilized as a "dipstick" for sea-levels in the Western Mediterranean Sea. Cemented sands, that formed along the phreatic zone, are also observed at different depths and provide an independent way to constrain paleo-water depths.

OS51A-02 0815h

Continental-Margin Response to Sea Level: Theory and Experiment

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We present the results of theoretical and experimental studies on the stratigraphic response to high-amplitude eustatic sea-level cycles. Our theoretical work focused on the development of three-dimensional, integrated-morphodynamic models of shelf-clinoform response to eustatic cycling and the corresponding development of stratigraphic sequences. In our models, which treat the shoreline as a dynamic moving boundary, characteristic floods and coastal storms, of specified magnitude and intermittency, drive long-term evolution of the coupled fluvial and shallow-marine sediment surfaces. Clinoform behavior and overall margin morphology are sensitive to the relative efficacy of fluvial and shallow-marine sediment dynamics. The interplay of eustasy with large, frequent coastal storms generates compound clinoforms with broad, strongly interfering shelf environments and relatively small, highly three-dimensional fluvial systems. Such storm-dominated clinoforms develop significant phase shifts between the shoreline and the shelf edge (clinoform rollover) that affect the timing of sediment delivery to the deep marine and overall growth of the margin. Phase shifting decreases with increasing flood frequency and magnitude and, by extension, the transition to fluvio-deltaic sedimentation. In the experimental study, which we performed in a subsiding-floor basin at St. Anthony Falls Laboratory, we analyzed the stratigraphic response to both isolated and superimposed eustatic sea level cycles in a passive-margin setting. The interplay of subsidence and high-amplitude sea level cycling generated a complex stratigraphic architecture consisting of a series of stacked shelf-slope clinoforms. We measured the shoreline response, the partitioning of sediment between fluvial and marine environments, and the timing and nature of sequence-boundary formation.

OS51A-03 0830h

Gravity-Driven Sediment Transport on the Continental Shelf: Implications for Equilibrium Profiles Near River Mouths

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An analytical model is developed for equilibrium bathymetric profiles off river mouths associated with the shoreward, convex upward portion of subaqueous deltas and clinoforms. The model builds on recent field results demonstrating that gravity-driven flux of suspended mud is important on shelves provided that wave-induced suspension of sediment supports the requisite turbid hyperpycnal layer. Because the maximum sediment load is determined by the critical Richardson number, the results are independent of the properties of the suspended mud or the bed. The model assumes the equilibrium state to represent a balance between the supply of sediment by a river at the coast and the down-slope bypassing of sediment to deep water within wave-supported turbid near-bed layers. Progressive seaward increases in bed slope across the convex shelf profile allow the attenuation of wave agitation with depth to be compensated for by a down-slope increase in the contribution of gravity. The model is consistent with shelf profiles off the mouths of the Po (Italy), Rhone (France), Eel (California), Ganges-Brahmaputra (Bangladesh), and Waiapu (New Zealand) Rivers. The equilibrium profile is predicted to be a function of wave

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climate and riverine sediment supply only, with deeper and broader profiles associated with decreasing sediment supply, increasing wave height and/or increasing wave period.

URL: http://www.vims.edu/physical/projects/CHSD/projects/Euro

OS51A-04 0845h

On the Hydrological Routing of Water and Sediment into the Northern Adriatic

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The research focuses on long-term and short-term climate changes, and the perturbations from humans, which influence the Po and representative rivers along the Apennines. The modern Po is partly influenced by arge Alpine Lakes/reservoirs that condition the timing of source water release and the trapping of sediment. Runoff from the southern and western Alps flows more naturally to the Po valley. The 15 M inhabitants of the Po valley intersect this flow, and along with strong agricultural use and an extensive canal system, regulate the flow. Even the dispersal through the Po delta distributary system is regulated. As a result the flux of sediment into the coast is predicted to be 50% less that under pristine conditions. The Apennine Rivers are regulated to maintain stream flow during the dry season. The otherwise high inter annual variability is presently mitigated and flood discharges to the Adriatic are a rare occurrence. As a result sediment flux to the coastal zone has been reduced by at least 40%. This agrees with dated marine cores from the northern Adriatic that show a change in both sediment dispersal and sediment supply across the last 50 years. The Apennine Rivers that once went hyperpycnal every couple of years would seldom (once ever 100 years) go hyperpycnal in their dynamics. Intra annual variability is very high for the Po and Apennine rivers despite the regulation and this is brought on by the strong frontal dynamics that control precipitation in this part of southern European continent.

OS51A-05 0900h

Numerical modeling of hyperpycnal flow generated by the discharge of Apennine Rivers

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Under natural conditions, the Apennine Rivers are likely to develop hyperpycnal discharges; a few (i.e. 25 yr to 50 yr return interval floods) will last for greater than 24 hours, but many more events are likely to occur for shorter duration. Hyperpycnal flows may account for 20 to 40 % of the total sediment flux from these Apennine Rivers. These relatively small rivers transport on average between 0.4 and 1.3 MT/yr. A single hyperpycnal event, however, can transport between 0.3 and 4 MT in one day. Hyperpycnal flow generated at the mouth of dirty' rivers carrying large concentration of silt and clay can have major impact on the continental strata formation. Here, we considered five Apennine Rivers (Chienti, Potenza, Pescara, Toronto, & Metauro) for simulated hyperpycnal events and their impact on the sea floor morphology. We have used a 2-D depth-integrated finite volume model of density/turbidity current to study the spreading of hyperpycnal flow and the resulting deposition of sediment in the Adriatic. We used results from *Hytrotrend* model runs under pre and post dam scenario as input conditions in our simulation. It has been found that alongshore current can significantly impact the spreading and deposit pattern of a hyperpycnal flow. In addition, the effect of the variability of flood intensity on the deposit pattern is also studied.

OS51A-06 0915h

Emplacement and Modification of the Autumn 2000 Po River Flood Deposit

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During October - November 2000, flooding by the Po River (northern Italy) created a flood deposit on the adjacent prodelta (10 to 30-m water depth) of the Adriatic Sea. An event-response cruise in December 2000 and six additional cruises during the ensuing 30 months have yielded a rich data set pertaining to the initial distribution and properties of the flood bed and its subsequent physical and biological modification. In contrast to previously documented flood deposits (e.g., Eel River, northern California) the deposit was located immediately adjacent to the river's mouths, exhibited clear proximal-distal indicators and had sharp thickness gradients. In addition, wide variation in bed thickness (up to 40 cm) and a diversity of physical sedimentary structures suggest that multiple emplacement processes (e.g., gravity-driven transport, and suspension fall-out) may have operated during the creation of the flood deposit. The flood deposit is evolving in a variety of ways. First, a rich subsurface stratigraphy with unique marker beds has permitted quantitative estimates of erosion and deposition. On most portions of the margin, there is little evidence of net erosion, but much evidence of physical reworking. Bed consolidation is also being quantified using digital x-radiographs and compared to results from a micro-resistivity profiler. Lastly, bioturbation structures have increased in abundance and depth within the deposit, such that in some areas of the margin the flood deposit, despite being many centimeters thick, is almost completely obliterated.

OS51A-07 0930h

Measurements of Sediment Transport in the Western Adriatic Sea

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Instrumented bottom tripods were deployed at two depths (10 and 20 m) off the mouth of the Chienti River in the western Adriatic Sea from November 2002 to May 2003 as part of the EuroSTRATAFORM Po and Apennine Sediment Transport and Accumulation (PASTA) Experiment. Waves, currents, and proxies for suspended-sediment concentrations were measured with upward-looking acoustic Doppler current meters, downward looking pulse-coherent acoustic Doppler profilers, single-point acoustic Doppler velocimeters, and acoustic and optical backscatter sensors. Flow was dominated by the western Adriatic coastal current (WACC) during the experiment. Mean southward alongshore velocity 2 m below the surface was 0.10 m/s at the 10-m site and 0.23 m/s at the 20-m site, and flow was modulated by tides, winds, and fluctuating riverflow. The largest waves (3 m significant height) were generated by winds from the southeast during a Sirocco event in late November that generated one of the few episodes of sustained northward flow and sediment transport. Most of the time, however, sediment resuspension and transport was dominated by Bora events, when downwelling-favorable winds from the northeast generated waves that resuspended sediment and simultaneously enhanced southward flow in the WACC. Mean flow near the bottom was slightly offshore at the 20-m site (0.01 m/s at 3 m above the bottom), but there was no significant correlation between downwelling and wave-induced resuspension, and cross-shelf sediment fluxes were small. The combination of persistent southward flow with low rates of cross-shelf leakage makes the WACC an efficient conduit for sediment past the Chienti region. If these observations are representative of typical winter conditions along the entire western Adriatic, they may help explain the enigmatic development of Holocene shelf-edge clinoforms that have formed hundreds of kilometers south of the Po River, which provides most of the sediment to the Adriatic Sea. Future data analysis and modeling is planned to investigate the mechanism(s) that apparently limit(s) sediment leakage from the WACC.

OS51A-08 0945h

Sediment dispersal pathways on the Western Adriatic continental shelf

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A 100-year flood event of the Po River during October 2000 resulted in a thick, greater than 15cm, sediment deposit on the subaqueous delta in close proximity to the main Po distributaries. The processes that contribute to and redistribute the modern deposit were investigated by deploying an instrumented benthic tripod along the 12-m isobath, from January 2001 to May 2002, which collected time-series data of nearbed sediment transport parameters. An additional series of deployments occurred from October 2002 until May 2003, 3km south of the initial Po tripod, providing a third winter of time-series data. Spatial variations in processes were evaluated by examining water-column salinity, temperature, and sediment concentrations that were collected during nine seasonal cruises between December 2000 and May 2003. The dispersal of sediment away from the Po River mouth can be largely attributed to both surface plume and bottom boundary layer (BBL) processes. In environments with larger mean waves and currents, such as on the northern California and Amazon continental shelves, the BBL sediment load is almost always larger than the surface plume load over the depositional site. A majority of the Po sediment falls out of the water column in the form of flocs inshore of the 6-m isobath, but there is still sediment carried in the surface plume offshore of the 6-m isobath. During relatively calm conditions, sediment load in the Po River surface plume over the delta has been observed to be up to 5 times larger than that in the BBL along the 10- and 15-m isobaths. During storms, which occur about 10% of the time along the western Adriatic continental shelf, the BBL sediment load can exceed the surface plume load and the along-isobath currents can be enhanced, providing an opportunity for a considerable amount of resuspended sediment to be advected in the BBL. Bora wind resuspension events increase surface plume velocities and coastal currents, as well as adding to nearbed shear stress and BBL transport. The sediment transport dynamics are reflected in the distribution of flood sediment on the Po River delta, with most of the sediment being initially deposited in relatively close proximity to the river mouth from the surface plume and a small fraction of this being subsequently resuspended in the BBL during storm events and transported southwards.

OS51B MCC: Level 2 Friday 0830h

Beyond Hydrate Ridge: Studies of Natural Gas Hydrate From Around the Globe III Posters *(joint with A, B, PP, T, C, GC)*

Presiding: **G A Barth,** U.S. Geological Survey**; D W Scholl,** U.S. Geological Survey

OS51B-0840 0830h POSTER

Thermal Conductivity of THF Hydrate Between -25 °C and +4 °C

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We observe two temperature dependencies in the thermal conductivity of tetrahydrofuran (THF) hydrate at atmospheric pressure between -25 and +4° C. After accounting for 4± 2% H_2O in our sample, the thermal conductivity of THF hydrate between -25 and -4° C rises only 0.2%, from .507 to .508 W/mK. As temperature approaches +4° C, thermal conductivity rises nonlinearly to 1.822 W/mK, 350% of its value at -4° C. We attribute the rapid thermal conductivity rise to THF hydrate dissociation. Close to its stability temperature