Joyce and Vanda of the McMurdo Dry Valleys, Antarctica. All of these lakes are permanently stratified and have unusually stable redox zones. Vertical separations in dissolved iron and manganese profiles ranged from tens of centimeters to several meters. The contrasting profiles of Cd, Co, and Cu in Lakes Vanda and Joyce are highlighted. Both lakes indicate that these metals cycle with Mn as opposed to Fe. In Lake Vanda, metals are released by the reductive dissolution of Mn oxides. For Lake Joyce, the 2+ ions (Cd and Cu) appear to be influenced by changes in pH with depth, whereas Co (a 3+ion) is released with the dissolution of Mn oxides.

OS42N-10 1605h

Geochemical Cycling of Redox-Sensitive Trace Metals as Determined by Pore Water Profiles

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Concentrations of redox-sensitive trace elements in sediment cores are used to understand past changes in redox conditions. However, their use for this purpose is limited by our understanding of their present-day geochemical cycling. We seek to better constrain the present-day behavior of V, U, Re, Mo and Cd through high-resolution pore water profiles. We collected sediment cores in August 2001 from the Washington continental margin using a multi-corer, which ensured undisturbed sediment-water interfaces. The transect spanned a range of redox conditions, with oxygen penetration depths from 0.2 to 5 cm, which represents an ideal opportunity to study redox-sensitive element cycling and its relationship to Mn and Fe oxidation and reduction zones. Pore water separation was done at 4 degrees C, and slicing and filtering were done under a nitrogen atmosphere to reduce the potential for sample oxidation. Initial pore water results suggest that when the oxygen penetration depth is extremely shallow (0.3 cm), Mn and Fe reduction occur close to the interface. Uranium and Mo are removed from pore waters at the depth of Fe reduction and deeper, respectively, whereas the depth of Re removal is obscured by a large peak in the pore water profile. When the oxygen penetration is deeper (2.5 cm), Mn and Fe reduction occur at 5 and 10 cm, respectively. Molybdenum, V and Re are released to the pore waters in the top cm, perhaps during oxic degradation of organic matter. Analyses are still in progress and data will be presented from the nine stations that make up this transect.

OS42N-11 1620h

Influence of a Turbidite Deposit on the Postdepositional Behavior of Carbon, Sulfur and Iron in a Sediment Core From Guaymas Basin, Gulf of California, Mexico

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Post-depositional mobility of redox-sensitive elements under different sedimentary environments have been described under the assumption of steady-state conditions. However, diagenetic reactions and distribution of redox-sensitive elements can be very different form those predicted by these conditions if fluctuations, such as deposition of turbidites, are introduced into the system. Guaymas Basin, an hydrothermally-active zone located in the Gulf of California, Mexico, have sediments with high concentrations of organic carbon (approx. 4 percent by weight) and it is a region where presence of turbidites has been widely documented. Hence, these sediments can be used to study the mobility of metals under non-steady state conditions. In this work we use profiles of different diagenetically important species (C, S, N and Fe) in one sediment core from Guaymas Basin that was subjected to an organic-poor turbidite incursion to interpret their postdepositional behavior. Results indicate that sediments not influenced by the turbidite layer achieved 100 percent degrees of pyritization and, by extension, that pyrite production is Fe-limited in these sediments. However, the mud slide intrusion apparently supplied enough reactive Fe to transfer essentially 98 percent of the total S present at the base of the mud slide layer (17-19 cm) to the pyrite reservoir. C/S ratios showed rapid decreases with depth, from a high of 38 close to the sediment-water interface, to minimum values of 2.8 at the lower limit of the turbidite intrusion, a ratio equal to the average C/S value of normal marine modern sediments, where concentrations of organic carbon and pyrite supposedly have attained quasi-steady values. Our data appears to indicate that intrusion of the organic-poor and (relatively) Fe-oxide rich turbidite rearranged the distribution of Fe, C and S in the turbidite layer as well as in the nearby sediments influenced by this layer.

OS42N-12 1635h

Reduced sulfur in euxinic sediments of the Cariaco Basin: Sulfur isotope constraints on organic sulfur formation

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Reduced sulfur accumulation in Holocene and latest Pleistocene euxinic marine sediments from the Cariaco Basin, Venezuela, was investigated to constrain the timing and possible pathways of organic matter sulfurization. Data were collected for a diverse suite of sulfur species, including concentrations and sulfur isotope compositions of pore-water sulfide, pore-water sulfate, pyrite sulfur, total organic sulfur, kerogen sulfur, and polar bitumen sulfur. Results suggest that there was a period during which almost no diagenetic pyrite formed in the sediments of the Cariaco, coincident with a shift from high to lower sedimentation rates and a concomitant change in the delivery of organic matter to the sediments. The sulfur isotope composition of organic matter was predicted based on assumed pathways using weighted isotopic mass balance calculations, and compared to measured isotope values for organic sulfur. These results indicate that organic sulfur is derived primarily from pore-water sulfide (or water column sulfide), with minor contributions from primary bio-sulfur (e.g. in proteins derived from algae and bacteria). The predicted sulfur isotope values of organic sulfur compounds suggest that pore-water sulfide is the ultimate source of reduced sulfur for incorporation into organic matter. It is possible, however, that reactive sulfur intermediates such as elemental sulfur or polysulfides react directly with organic matter. These intermediate sulfur species are likely formed through partial oxidation of sulfide by anaerobic sulfide-oxidizing microbes living in the sediments.

OS42O HC: 316 B Thursday 1330h

Oceanic Internal Tides III

Presiding: **R Pinkel,** Scripps Institution of Oceanography**; J Ledwell,** Woods Hole Oceanographic Institution

OS42O-01 1330h

Production and Offshore Transport of Low Potential Vorticity Water around the Kuril Straits Associated with the K1 Tide.

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Internal waves excited by a tidal flow over a topographic feature can be classified into three wave types; unsteady lee waves, mixed tidal lee waves, and internal tides. As opposed to internal tides, unsteady lee waves are predicted to be able to exist at latitudes higher than the critical latitude of the corresponding tide and cause enhanced diapycnal mixing, since these waves should be easily amplified even by a subcritical flow [Nakamura and Awaji 2001].

One example of this effect is the subinertial K1 tidal flow near the Kuril Islands. The Okhotsk Sea Mode Water (OSMW) characterized by low potential-vorticity (PV) is the most likely origin of the North Pacific Intermediate Water (NPIW) [Yasuda 1997]. Observations, however, indicate the presence of intense mixing in the Kuril Straits which connect the Okhotsk Sea and the North Pacific [Kawasaki and Kono 1994]. Nakamura et al. [2000] suggested that the K1 tidal flow, which is the predominant component, is capable of producing strong mixing, through the generation of large-amplitude unsteady lee waves, which repeatedly break around a sill top. Thus, clarification of the influence of the tidal mixing around the Kuril Straits is a key to better understand the linkage of the Okhotsk Sea and the North Pacific.

To this end, we have investigated water transformation and transport processes associated with the K1 tide around the Kuril Straits, by using a 3-D nonhydrostatic model. The results show that low PV water (i.e., vertically uniform water) is produced in the straits and around the islands where strong vertical mixing is induced. This effect reaches down to the density layer of the NPIW. In contrast, vertical mixing is weak in the deep regions away from the islands, leading to the formation of tidal fronts around the islands. These fronts and accompanying geostrophic flows with strong vertical shear sustain a baroclinic instability, eventually leading to the formation and release of anticyclonic eddies with low PV water in its core. This leads to the prediction that low PV water formed by tidal mixing is supplied to both the Kuril Basin and the North Pacific (in addition to the OSMW), as eddies are pinched off from energetic baroclinic instability waves.

Interestingly, a very recent observation in the Kuril Basin identified a pinched-off eddy which contains vertically mixed water in the Kuril Straits [Ohshima et al. 2001]. Since the barotropic tides should provide energy to internal waves continuously, which in turn should provide available potential energy (APE) to the tidal fronts, the release of the APE may result in the continual formation and detachment of baroclinic eddies. Through such an energy transfer, the K1 tide could also contribute to the Kuril Basin isopycnal mixing required for the formation of the OSMW.

URL: http://www-ocea.kugi.kyoto-u.ac.jp/nakamura/index-e.html

OS42O-02 1345h

Tidal Mixing in the Southern Weddell Sea and Beneath Filchner-Ronne Ice Shelf

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The Weddell Sea has been recognized as being the major site of Antarctic deep and bottom waters formation in the Southern Ocean. Tides are supposed to play an important role in this formation process, contributing the energy for mixing of different water masses. Therefore, have long been of scientific interest, though their real importance in polar oceanography is still speculative.

In the framework of the *Bremerhaven Regional Ice Ocean Simulations* (BRIOS), a three-dimensional tidal model was developed to investigate tides and tidal processes, with special focus on tidal mixing quantities in the southern Weddell Sea. The model is based on the free surface *S-Coordinate Primitive Equation Model* (SCRUM), modified to allow for the inclusion of the ice shelf cavities.

Model results show the generation of a M_2 internal tide of moderate strength over the continental slope, propagating in the along-slope direction, but dissipating rapidly. On the continental shelf, a thick bottom boundary layer develops due to the proximity of the critical latitude for the M_2 frequency. Typical M_2 and S_2 baroclinic tidal currents at the shelf break are 7 cm s^{-1} and 4 cm s^{-1}, respectively. Beneath Filchner-Ronne Ice Shelf (FRIS), M_2 tidal currents reach up to 20 cm s^{-1}. Even stronger currents are found near the ice shelf edge where the water column thickness is reduced compared to the southern part of the cavity. The magnitude of the modeled baroclinic tidal currents agrees with available observations.

Tidal currents produce strong mixing in the bottom boundary layer at the continental shelf break, on the shelf, and in the FRIS cavity leading to high vertical eddy viscosity/diffusivity coefficients of up to 10^{-1}. Outside the cavity, tidally induced mixing has a strong seasonal variation according to the stratification; mixing near the surface is increased during summer. In

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addition, tidal mixing varies horizontally with levels at the southern Weddell Sea continental shelf break higher further to the east. In the ice shelf cavity, however, tidal mixing has higher values further to the west near the ice shelf front. The model results suggest that tides contribute significantly to the turbulent mixing at the continental shelf break of the southern Weddell Sea and beneath FRIS.

OS42O-03 1400h

Observations of Internal Tides along the Kaena Point Ridge

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The Kaena Point Tidal Mixing Survey was conducted off Oahu from the R/V Ka'Imikai O Kanaloa during January 8-13, 2001. This period was chosen, from theoretical considerations, to maximize the barotropic to baroclinic tidal energy conversion in the Kauai Channel. A McLane Moored Profiler (MMP) was deployed in 2600 m of water about 3 miles south of the steep southern wall of the Kaena Ridge, that extends from 2500 m to about 1000 m The MMP made continuous profiles between 1600 m and 600 m for more than 3.5 days. Shipboard time series of full-depth CTD profiles were made at 2 sites near the MMP, and one on the north side of the ridge. Three tow-yo CTD sections were made from the top of the ridge into deep water.

The MMP returned 62 profiles of velocity, temperature, conductivity and pressure (as well as substantial engineering data). The time-mean buoyancy frequency varied from 1 to 2 cph over the depth range. The time-mean flow showed a northward flow maximum ($\sim$0.04 ms^{-1}) at the depth of the ridge crest. An equally strong maximum was found in the along-ridge flow at 1500 m. Tidal signals dominated cross-isobath flow and potential density variability. Cross-isobath flow variations were more vertically coherent than flow along the ridge, and there were no obvious indications of ridge crest influences. M2 and K1 velocity amplitudes are comparable (0.05-0.12 ms^{-1}) though their vertical structures are quite different. M2 isopycnal displacements reached 60 m in the range 1200-1400 m and 20-40 m elsewhere, with uniform phase over the depth range. K1 displacements ranged from 5 to 20 m, with downward phase propagation over most of the depth range. The results of these new observations will be compared to recent modeling results. The relationship of Richardson number statistics to the internal tides will also be discussed.

OS42O-04 1415h

Observations of Non-Linear Internal Tides and Large Amplitude Solitary Internal Waves Over the Continental Shelf. Observations of Non-Linear Internal Tides and Associated Large Amplitude Solitary Internal Waves Over the Continental Shelf.

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A three week observation of strong internal tides and solitary internal waves were made at site offshore from Tillamook Oregon, during the COPE experiment in September 1995. FLIP was moored at 150m depth providing a stable platform for high resolution near-surface current measurements spanning 3m to 45m depth. An automated microstructure profiler concurrently measured temperature, conductivity, and microscale velocity shear and temperature gradients allowing high resolution density and dissipation profiles to be made to 35m every 1.5 minutes.

Freshwater outflow from the Columbia River and a warm summer surface layer maintained a sharp, shallow pycnocline at an 8m equilibrium depth and buoyancy of 30 cph. through most of the experiment. A semidiurnal internal tidal bore was consistently observed with pyncoline vertical excursions of 5 - 10m and up to 0.5 m/s top layer currents throughout the neep/spring tidal cycle spanned by the observation period. The downward excursion of the internal tide usually had a steep leading edge with groups of large amplitude (up to 25m), rank-ordered solitons along the internal bore.

Vertical shear, water column stability and dissipation rates resulting from the propagation of the internal tidal bore and solitons are estimated from properties mapped into constant density surfaces for two 24 hour periods representative of neep and spring tidal forcing conditions. Relative energy losses from the low frequency internal tide are contrasted with that of the leading edge solitons.

OS42O-05 1430h

Scaling turbulent dissipation on a continental shelf

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The relationship between turbulent dissipation rate and shear on a continental shelf was found to have a different functional form than that in the open ocean. We use microstructure, CTD and ADCP measurements taken on the New England continental shelf as part of the Coastal Mixing and Optics experiment to explore this relationship. During August 1996, the majority of shear came from packets of near-inertial and semidiurnal low-mode internal waves. The depth-averaged magnitude and vertical distribution of shear changed substantially over the fortnight of observations due to changes in both the energy and relative modal content of passing wavegroups. There was little correlation between the energy of low and high mode waves on these timescales. From late April to mid May 1997 we witnessed the onset of spring restratification; the depth averaged buoyancy frequency quadrupled in a three week period. The strength of near-inertial shear from passing storms grew dramatically as the stratification developed. For both the summer and spring data, traditional mixing parameterizations (Henyey et al. 86, Gregg 89, Polzin et al. 95) do not capture the functional relationship between dissipation rate and shear. We propose a modified ray-tracing type scaling that accounts for the observed wavefield characteristics.

OS42O-06 1505h

Shear and Mixing Produced by Tidal Currents Along the Hawaiian Ridge

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During October 2002 as part of the Survey phase of the Hawaii Ocean Mixing Experiment (HOME) we observed shear and turbulent mixing at 12 stations between French Frigate Shoals and Oahu. Each station was occupied for 25 hours, two tidal cycles, and sampled continuously with a 50 kHz Sonar that obtained good data to 700 m and with Deep Advanced Microstructure Profilers (DAMPs) that went as deep as 1100 m. Some stations were sampled near flood and spring tides, and shallow stations were observed with repeated lines across the topography.

Where the ridge crest is below the surface, mixing levels over it rise to 10^{-3} to 10^{-2} m^2 s^{-1} during maximum ebb or flood flows. In the Kauai Channel this mixing is associated with displacement signatures similar to those found in hydraulic jumps. Levels gradually decrease with distance from the ridge, and are about 10^{-4} m^2 s^{-1} 50-100 km away. Consequently, the entire vicinity of the ridge appears to have mixing significantly more intense than typical of the open ocean far from topography.

OS42O-07 1520h

Topographically Induced Mixing in the Eastern Atlantic

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In this presentation we focus on microstructure measurements taken near the chain of seamounts Great Meteor, Irving, Heyres, and Cruiser in the Canary Basin of the Eastern Atlantic. Analyses of the kinetic energy dissipation rate and turbulent diffusivities reveal significant enhancement of turbulent mixing above the summits and at the rims of the seamounts. Tidal flow is considered as the major player of generating turbulence via interaction with topography. Spatial propagation and the decay of the energy of internal tides in the region were also analyzed using available mooring data. Upstream of the seamounts, the background level of the dissipation rate is less than 10^{-9} W/kg. Above the summit of the seamount Irving, the dissipation rate increases by more than two orders of magnitude. Downstream of the summit, the dissipation decreases to the background level over a distance of approximately 70 km, which corresponds to a half of the wavelength of the semidiurnal internal tide. The spatial decrease of dissipation can be approximated by an inverse function of the normalized horizontal distance. A similar power-law can be used to approximate the spatial decay of energy density of the baroclinic internal tidal waves propagated away from the chain of seamounts. The data taken from other regions (Equatorial Pacific and Indian Ocean) also follow an inverse power law. Numerical calculations were also made on the decay of internal tidal energy, and the results are in general agreement with observations.

URL: http://ceaspub.eas.asu.edu/oceanrus/

OS42O-08 1535h

Internal Tides and Sedimentary Processes on Oceanic Slopes

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Recent long-term current, temperature, salinity, and suspended sediment measurements off northern California and south of Honolulu, Hawaii, in about 450-m water depth are used to demonstrate the importance of internal tidal currents in affecting sedimentation on continental slopes. In both locations large increases in along and across slope internal tidal velocities occurred episodically throughout the records. Near-bottom current speeds during these episodes reach 50 cm/s and higher. These pulses of enhanced bottom currents are capable of resuspending local bottom sediment and inhibiting deposition of fine-grained suspended sediment onto slope surfaces. Bottom sediment ripples and sand waves that were previously identified in multi-beam and side-scan sonar maps and in bottom photographs indicate active internal-tide induced transport of bottom sediments on the Hawaiian slope.

Comparisons of internal wave characteristics and bottom gradients show that semi-diurnal and higher frequency internal waves are critical in different sections of these slopes. These relationships are presented in GIS map formats to illustrate the spatial complexity in these rugged areas of seafloor. Bottom gradients were derived from recent multi-beam sonar bathymetry; internal wave characteristics were calculated from available density profiles. These results add to growing evidence that internal tides and other internal waves significantly influence sediment transport, depositional patterns, and bed characteristics on oceanic slopes.

Based on a simple model for energy production and dissipation we show that bed shear velocities caused by near-critical and critical internal tides over a linear slope are high enough to inhibit deposition of fine-grained sediment and potentially erode the seabed. Over long periods of time, inhibited particle settling and possibly local erosion influence the shape and gradient of oceanic slopes. The net result can produce seafloor surfaces that are in equilibrium with internal tidal energetics.

OS42O-09 1550h

Internal Tide-Induced Variations in Primary Productivity and Optical Properties in the Mona Passage, Puerto Rico

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Internal tides of near-semidiurnal frequencies were observed in the euphotic zone. The maximum observed height (crest to trough) was 26 m. Maximum concentrations of chlorophyll-a (1.2 mg Chl-a m^{-3}) occurred near the crest during high upward velocities (> 40 m h^{-1}). Additionally, increases in vertical eddy diffusivity above 6 x 10^{-3} m^2 s^{-1} were observed one hour before the arrival of the internal tide trough. The development of K-H instabilities during the breaking of the internal tide can explain the formation of high diffusivity patches. Inside the patches (κ_d > 0.004 m^2 s^{-1}) increments in primary productivity of the order of 0.05 mg C m^{-3} h^{-1} were measured. The patches generated a NO3 flux equal to 1.058 x 10^{-4} mmol m^{-2} s^{-1} and can sustain a new production equal to 724 mg C m^{-2} d^{-1} or 264 g C m^{-2} yr^{-1}. These numbers are much higher than the estimates attributed to mesoscale eddies. Higher values of primary productivity were observed near the wave trough, than those observed during periods of maximum solar irradiance at noon. Significant changes in the attenuation coefficient (from 0.03 m^{-1} to 0.05 m^{-1}) for the following SeaWiFS bands: 412, 443, 490 and 512 nm corresponded to events of maximum upward velocities and higher diffusivity. These processes seem to be easy to detect in oceanic waters, out of the influence from high nutrient load waters due to river discharge.

OS42O-10 1605h

A view of internal tides courtesy the venerable tide gauge: Discrimination of barotropic and baroclinic contributions.

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Tide records provide one of the few multidecadal to century long timeseries measurements in oceanography. With renewed interest in internal tide phenomenon and with the launching of large field programs aimed at quantifying internal tide variability, tide gauge analysis of internal tides may provide an interesting long-term perspective, and coastal boundary condition. We have devised a method for separating the barotropic and baroclinic contributions to a standard tide elevation record. Our model is a phase and amplitude modulated internal tide from a few sources, which is superimposed on a steady tidal constituent. Phase modulation of the internal tide, presumably due to a variable thermocline, plays a dominant role, and leads to frequency smearing of tidal energy (a phenonemon that Munk and Cartwright in 1966 named tidal cusps). The connection of phase modulation to the variable thermocline suggests a tantalizing possibility for using baroclinic tide phase to measure the thermocline. Using demodulation and for a single internal tide source, we can solve the problem completely for the internal tide amplitude, and phase time history, as well as the barotropic tide amplitude and phase. We will present results from a toy model of barotropic and baroclinic tides, and we will apply the method to Hawaiian island tide records. A discussion of the application of the method to more complicated multiple source and/or baroclinic modes will be given.

OS42O-11 1620h

Spatially Broad Observations of Internal Waves in the Upper Ocean at the Hawaiian Ridge

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The internal wave field at the Hawaiian Ridge is studied using SeaSoar and hydrographic Doppler sonar data. Observations and models have demonstrated that the Hawaiian Ridge is an important generation site of lunar semidiurnal (M2) internal tides. Internal tides are the intermediate step in the energy cascade from the barotropic tides to turbulent mixing. Is internal wave activity at the Hawaiian Ridge enhanced above open-ocean background levels? At which topographic features along the ridge is internal wave activity largest? Over what distances do the internal tides propagate before being dissipated to mixing? These questions are investigated here through the use of underway finescale observations of the density and velocity structure of the upper 400 m made at a variety of topographic features and within 200 km of the ridge. Internal waves with a 60 m peak-to-peak maximum amplitude are found southwest of Oahu along a line normal to the ridge. The mean-square isopycnal displacement in the Kauai Channel region peaks at 10-20 times Garrett-Munk open-ocean values 60 km south of the ridge crest. This location of enhanced displacement is consistent with the upper ocean terminus of an internal tidal ray emanating from the base of the steepest part of the southern edge of the ridge. There is significantly more internal wave activity on the southern side of the ridge than on the northern side. This asymmetry is potentially related to the asymmetry in the slope of the across-ridge bathymetry west of Oahu which is steeper and clearly supercritical for the M2 internal tide on the southern side. Results of a spectral analysis of the internal wave field are reported. The density field, velocity field and vertically integrated baroclinic energy density of selected cruisetrack legs are compared to the results of a regional numerical model forced by the M2 tide.

OS42O-12 1635h

Along-slope Current Generation by Obliquely Incident Internal Waves

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A series of numerical experiments is performed to investigate the breaking of obliquely incident internal waves propagating towards a bottom slope. The case of critical reflection is considered, where the angle between the wave group velocity vector and the horizontal matches the bottom slope angle. The flow evolution is found to be principally different from the evolution observed previously in simulations of normally incident waves. The divergence of the Reynolds stress in the breaking zone causes a strong along-slope mean current, which changes the flow structure dramatically. The wave does not penetrate the current but breaks down at its upper surface as the result of a critical layer interaction. Continuously broadening mean along-slope current of an approximately constant velocity is produced. We propose a simple model of the process based on the momentum conservation law and the radiation stress concept. The model predictions are verified against the numerical results and are used to evaluate the possible strength of along-slope currents generated by this process in the ocean. The interaction of multiply incident waves shows that an unbalanced equilibrium can be established where incident waves from different directions interact with the boundary current in different nonlinear manners and produce a situation where the properties of the mean flow change in time. The net energetics show that approximately one third of the incident wave energy goes to irreversible mixing, one third goes to the mean current, and the remaining third is reflected away from the bottom slope as smaller scale internal waves.

OS42P HC: 323 C Thursday 1330h

Recent Advances in Understanding Submarine Biosystems and the Future in Submergence Research II

Presiding: **P Fryer,** University of Hawaii**; S Pomponi,** HBOI

OS42P-01 1330h

The Nested Survey Strategy for Deep Submergence Research: Examples From the use of National Deep Submergence Facility Vehicles

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The evolution of new paradigms in earth and ocean sciences over the past 40 years has been made possible largely through the development of enabling technologies. Key linkages between science and technology will be discussed as they relate to deep submergence vehicles and research, and a strategy termed - the nested survey approach - that can be applied to a wide range of investigations.

WHOI, over 30 years ago, understood the importance of developing deep submergence technology when it partnered with the US Navy to develop Alvin and its class of submersibles. Alvin allows the cognitive human eye and brain to reach into the abyss and observe relationships and processes that otherwise would not be possible. Similarly, over a decade ago, engineers and scientists at WHOI recognized that remotely operated and tethered vehicles, operated from a fiber optic cable that provides exceptional bandwidth, had the promise to revolutionize how we access the abyss and study the ocean and seafloor processes occurring there. ROVs and AUVs like ABE are critical to the nested survey approach to seafloor surveying because they provide enabling technology that allows intermediate and small scale features and processes to be resolved acoustically and optically.

Several applications of the nested survey strategy to the study of the geology, hydrothermal processes and biology at diverse seafloor sites will be discussed. The nested survey approach begins with broad area (100s to 1000s of square kilometers) multibeam sonar surveys with resolution of only 10-100 m (vertical and horizontal, respectively). Resolultion increases through use of high-frequency near-bottom sonar, like the DSL-120A, which can cover a swath of seafloor 1 km wide, but with resolution of features as small as 1-2m. Argo II and ROV Jason2 are then used in tandem to provide visual/optical imagery that permits the field relationships to be accurately placed and understood, and samples to be collected. Alvin dives are required for programs requiring in situ observations, delicate and complex manipulation, and heavy lift capacity.

The US National Deep Submergence Facility at WHOI has fostered this type of survey strategy by developing and operating the necessary vehicles for the oceanographic community, and by providing a research and engineering environment that continues to push the technological envelope that enables advances in scientific research.

URL: http://www.marine.whoi.edu/ships/ships_vehicles.htm

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Interstitial Water Chemistry of Sediments in the Eel River Basin: Implications for Carbonate Bioherm Formation

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We have undertaken a program of interstitial water studies in the Eel River Basin in conjunction with biological studies (c.f., contribution by Ziebis et al., this meeting). The principal aim of our program was to set a geochemical background to the methane seep activity in this area and to provide information on the formation of authigenic carbonate deposits. A total of four cruises have been carried out in this area. Studies of the depth distributions of Ca, Mg, SO4, HS, NH4, alkalinity, and the del13-C composition of dissolved HCO3, allow an evaluation of the geochemical processes affecting this area of seepage activity. Decreases in SO4 are accompanied by increases in alkalinity and sulfide. Ca and Mg decreases suggest carbonate precipitation reactions.

Especially the distribution with depth of del13-C is of importance in establishing the association with the del13-C of authigenic carbonates. Data on carbonates are presented for this area. In addition a comparison will be made with observations in the Monterey Bay, another area investigated by many workers for similar studies.

A generalized model of the seep activity will be presented. Differences in observations in methane seeps will be contrasted with observations in other areas both of Monterey Bay and Kodiak Trench.

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