40 cm/s in the dockside chamber. The results for *M. californianus* are not as yet available. Notwithstanding, it is evident that there are species specific responses to fluid dynamic forces that exist in marine bivalves. The implications of these results to the evolutionary ecology of mussels and to trophic transfer in benthic ecosystems will be discussed.

URL: http://quarles.unbc.ca/nres/jda.htm

OS32N-11 1620h

Growth Rates of Interface-Feeding Benthos in Laboratory Flumes.

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Spionid polychaetes feed at the sediment-water interface, facultatively switching from deposit feeding to suspension feeding as flow and the flux of suspended food increase. Juveniles of *Polydora cornuta* tend to suspension feed more than adults, especially at slow flows. To determine the degree to which juvenile growth is enhanced by near-bottom flow, we performed a series of experiments in which pre-measured individual worms were implanted into counter-rotating annular flumes containing natural sediment and suspended microalgae. The flux of suspended food was manipulated by setting flumes to 1 of 3 unidirectional flows (U* = 0.3, 0.5, 0.8 cm/s) and by adding 1 of 2 concentrations of suspended food (0.16 and 0.26 mg N/liter). Measurements of body volumes after 3 days in the flumes revealed rapid growth rates on an ecologically relevant time scale (3 d) during which flow often varies in nature (e.g., due to storms and the lunar tide cycle). The relative growth rate of *Polydora* ranged between 0.2-0.7 per day and was significantly enhanced by increasing the flux of suspended food. In addition to measuring growth rates in various hydrodynamic conditions, we tested the effects of intraspecific density on growth by implanting various numbers of adults in close proximity to a targeted juvenile. At slower flows (U* < 0.6 cm/s) dense assemblages of adults produced extensive fecal mounds, and the growth rate of juveniles was negatively correlated with adult density (presumably because the adults or their fecal mounds interfered with the feeding activity of juveniles). At flows fast enough to erode the fecal mounds, however, adult density had no effect on juvenile growth rates. We also measured rates of growth and regeneration following the loss of either one or both feeding palps (simulating non-lethal predation). Within the 3-day experimental period, worms were able to fully regenerate lost palp tissue, and total body growth was significant. The combined results demonstrate the general inadequacy of growth-rate estimates obtained from still-water experiments. Growth-rate data from realistic hydrodynamic conditions are especially needed for accurately modeling population dynamics and secondary production in benthic communities.

OS32O HC: 316 A Wednesday 1330h

Physical, Chemical, and Biological Processes Associated With Active Submarine Volcanism in the Pacific II

Presiding: **T Urabe,** University of Tokyo**; C de Ronde,** Institute of Geologican and Nuclear Sciences

OS32O-01 1335h

Sub-seafloor Aquifer Structure Deduced from Direct Drilling into the Hydrothermal System at Suiyo Seamount, Izu-Ogasawara Arc, Western Pacific

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A high-temperature hydrothermal system related to island-arc volcanism has been drilled in June 2001 using a tethered, submarine rock-drill system BMS (Benthic Multi-coring System) on-board the *R/V Hakurei-Maru # 2.* The purpose of the operation which is a part of the **Archaean Park Project** is described elsewhere (Urabe et al., 2001). The hydrothermal field spreads for 200 meters by 200 meters on the caldera floor (depth=1,390m) of the Suiyo Seamount (28°34ON, 140°38OE), Izu-Ogasawara Arc, western Pacific. Numerous short black smokers (Tmax.=317°C) were observed in addition to extensive low temperature simmerings with mussel colonies on the sandy floor (Watanabe and Kajimura, 1994). Six out of seven shallow drilled holes (av. hole-length=5m) produced fluid of various temperatures ranging from 40-60°C to 304°C. Casing pipe has been inserted to prevent the holes from the collapse. The drilling intersected dacite lava and/or pyroclastic rocks about 1-3 meter below the unconsolidated sediments of volcanic sands and pumice fragments. Intensive hydrothermal alteration is observed in sedimentary unit and the upper part of the volcanic rocks. The drilling indicated that an impermeable sheath develops beneath each high temperature vent that prevents the end-member fluid to mix with low-temperature seawater within the permeable sediment layer. Clay minerals and anhydrite cement are the main component of the sheath in addtition to pyrite and other sulfide minerals. The sheath is likely to be formed by self-sealing process of anhydrite. The end-member fluid is ponded beneath the sheath and the sheath acts as a cap rock of the terrestrial geothermal systems. The degree of hydrothermal alteration within the volcanic rocks decrease downwards. The cased holes were visited by *ROV Hakuyo 2000* during the *Shinsei-Maru* cruise which was conducted in July-August 2001, about a month after the drilling. The temperature of the fluids from the casing pipe was measured to be between 9.2°C and 308°C. We noticed that sulfide minerals clog the high-temperature holes. On the other hand, low-temperature holes were sealed by a mixture of iron-hydroxide and bacterial mat. These lines of observation suggest that the aquifer structure beneath the hydrothermal system of the Suiyo Seamount shares many similarities with that of the Kuroko deposits in Japan. (Reference) Urabe, T., A. Maruyama, K. Marumo, N. Seama, J. Ishibashi ,2001, *InterRidge News*, v.10 (1), 23-25. Watanabe, K. and Kajimura, T., 1994, *Shigen Chishitu*, 44, 133-140 (in Japanese with English Abstract).

OS32O-02 1350h INVITED

Subvent Hydrothermal Processes at the Suiyo Submarine Volcano, Japan: Constraints from Sulfur Isotope Compositions of Sulfides and Sulfates

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Sulfur isotope analyses were performed on sulfides and sulfates in the drilled core materials from the Suiyo submarine volcano, Japan. Drill core samples were collected from 6 locations (core #01, 02, 03, 04, 05, 07): #01 and 03 drill core samples were collected from the eastern part and others were from the central part. Petrographic studies indicate that samples were extremely altered by the hydrothermal process. Notable feature of the examined samples is the high abundance of sulfide (e.g., FeS2, CuFeS2, ZnS and PbS) and sulfate minerals (e.g., CaSO4, BaSO4). These sulfide and sulfate minerals were separated from the drill core samples, and then, sulfur isotope compositions were analyzed on these minerals by the conventional method and also by the Nd-YAG laser microprobe method. The total ranges of sulfur isotope compositions are +1 to +6 per mil for sulfides and +13 to +21 per mil for sulfates. Regional differences are found in sulfur isotope compositions between the eastern and central areas: (1) sulfur isotope compositions of sulfates are homogeneous (+19 to 21 per mil) in the eastern drill sections, but heterogeneous (+13 to +20 per mil) in the central area; and (2) sulfur isotope compositions of sulfides are heavier (2 to 6 per mil) in the central region compared to the eastern area (1 to 3 per mil). These regional differences indicate that: (3) oxidation of hydrothermal H2S, resulting in production of sulfate, is more vigorous in the subvert zone at the central region compared to the eastern region; and (4) temperatures of subvert hydrothermal fluids are generally lower in the eastern region compared to the central region. The oxidation of H2S is caused by the mixing of oxic seawater and reduced hydrothermal fluids, and this mixing process may control the redox boundary in the subvent zones. Those processes are recorded in the drill core samples from the Suiyo hydrothermal field.

OS32O-03 1405h

Seafloor hydrothermal alteration at Suiyo Submarine volcano: Niberalogical and geochemical.

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gArchaean Park Projecth focuses on the influence of magma-hydrothermal activities on biological communities of a seafloor hydrothermal system developed on atop of Suiyo seamount, Izu-Ogasawara island-arc, western Pacific. We made 10m-depths drilling at the active seafloor hydrothermal areas of Suiyo seamount, using the Boring Machine System (BMS) and RV Daini-Hakurei Maru. We also determined the hydrothermal mineral assemblages in the BMS core samples by XRD, XRF and TEM methods to describe the interaction of volcanic rocks and hydrothermal fluids beneath seafloor. The drill hole APSK-01, penetrated 2.88m depths , was located the south-east margin of hydrothermal area with a mound standing several dead chimneis and Shinkai-Hibarigai. The core samples contained sulfides, anhydrite, barite with some minor amounts of Mg-chlorite. The drill hole APSK-02 with 6.99 m penetration was drilled at south-west end of the hydrothermal areas, although no hydrothermal fluid was observed. The core samples were clay-rich containing significant amounts of montmorillonite and anhydrite. At the APSK-04 site, we drilled 3.85m with surface pumice sand and underlying highly hydrothermally altered dacite at the center of hydrothermal aeas where several hydrothermal mounds were observed. This hydrothermal alteration was characterized by Al-chlorite (sudoite), Mg-chlorite with anhydrite. The bottom core sample contained quartz and mica. The drill hole APSK-05 was located at 70cm away from a sulfide mounds with acitice venting. We penetrated 6.65m of clay and anhydrite veins. Mg-chlorite and Al-chlorite were dominant hydrothermal clay minerals, mica and quartz. The central active venting site was drilled by the drill hole APSK-07 up to 2.69m depths. The core samples contain anhydrite with Mg-chlorite and Al-chlorite from the top to bottom. The Mg-chlorite and Al-chlorite in the cores may be formed by the interaction of heated seawater and dacite. The seawater may have been heated rapidly by the heat source of dacite at the subsurface of the seafloor. Magnesium, calcium and sulfate in the seawater was lost by the heating process and the subsequent water-rock interaction precipitating Mg-chlorite and anhydrite. The pH of the heated seawater decreased by gaining hydrogen from dacite and that the fluid fell in the stability field of Al-chlorite.

OS32O-04 1420h INVITED

Organic Geochemical study of the deep-sea floor deposits and subvent drilled cores in Suiyo seamount hydrothermal system: Evidence of life activity in the subvent extreme environment

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Archaean Park Project focuses on the evaluation of a seafloor hydrothermal system developed on atop of Suiyo seamount, Izu-Ogasawara island-arc, western Pacific. Suiyo seamount is an active volcano, where active

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venting of many black smokers occurs on a caldera floor atop of the seamount. The seafloor deposit and subvent drilled cores were recovered during several cruises in 2000 and 2001, these samples were offered organic geochemical study for finding an evidence of biological activity at subvent extreme environment. Biomarker analysis for the seafloor deposits and elemental analysis for the subvent cores were carried out, then the bulk carbon isotope compositions of some relatively carbon rich core samples were determined. The fatty acid compositions, which are alkaline-hydrolysis products of total extracted organic matter from the deposits, can be characterized by a large proportion of short chain ($<C_{20}$) monounsaturated acids to total fatty acids, and a low proportion of long chain ($>C_{20}$) saturated acids originating from higher plant wax. The monounsaturated fatty acids are bacterial in origin, indicating that these fatty acids are produced mainly by bacterial activity associated with the hydrothermal activity. The hydrocarbon fractions of the total extracts from deposits include significant amount of anteiso- formed saturated hydrocarbons ranging from C_{18} to C_{29}, and alkyl cyclopentane ranging from C_{18} to C_{25}. These compounds have been observed from several acidic lake and hot spring sediments, suggesting that the acidophilic bacteria are dominant at the vents. A significant amount of pyrolytic-origin polycyclic aromatic hydrocarbons were also detected, indicating hydrothermal pyrolysis of organic matter occurs around the vents. Concentrations of the total organic carbon (TOC) and total nitrogen (TN) in the drilled core samples were less than 0.02 and 0.004 weight %, respectively. Although the TOC and TN values of the cores tend to decrease with depth from seafloor, these values of many core samples are almost background level. The carbon isotope compositions of some core samples, which include more than 0.01% of TOC, varies ranging from -35 to -25$^{o}/_{oo}$(relative to PDB). During drilling, the core samples could not avoid contamination of the grease, which had an uniform carbon isotope compositions approx. -26$^{o}/_{oo}$. However, the wide range of carbon isotope compositions suggest that a life activity should occur at the subvent extreme environment.

OS32O-05 1435h

Analysis of Archaea Community in Hydrothermal Fluid Collected at Suiyou Sea-Mount on the Izu-Ogasawara Arc

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Archaeal communities in extreme environment have been analyzed by amplifying and cloning 16S rDNA gene. The culture-independent method revealed archaeal communities with much higher diversities than those found by conventional culture methods. In this work we have extended the culture-independent method to the analysis of microbial diversity in a deep-sea subfloor.

As a part of the "Archaean Park ProjectOL supported by Special Coordination Fund, several holes were bored in the crater of the Suiyou Sea-mount on the Izu-Ogasawara arc, Japan (about 1,800 depth). Hydrothermal fluids were sampled at various sites at Suiyou Sea-mount, including the fluids from the bored holes. The fluids were filtered to collect the microbial cells. Filters were crushed and DNA were extracted and purified. The DNA was used to amplify archaeal 16S rDNA fragments by PCR using an archaea specific primer set. The PCR fragments were cloned and sequenced. We obtained several types of clones; clones related to isolated hyperthermophilic archaea, clones related to methanogens, and the clones related to uncultured Crenarchaeota and Euryarchaeota. Archaeal communities at different sites showed different spectra.

OS32O-06 1450h

Gene Transfer Particle From Hyperhydrothermal Vent.

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Viruses or virus-like particles (VLPs) have been acknowledged to be general constituents of aquatic ecosystems and to play possible roles in microbial population control and gene transfer. However, VLP-host interactions and such gene transfer in thermal environments is not clear yet. We have reported a relatively high number of VLPs in geothermal hot spring water (up to 10^6particles per ml). Mature VLPs were observed inside about 12 % of the bacteria, which were classified as a novel hyperthermophilic chemolithotrophic sulphur-turf predominant bacteria belonging to the deepest-branching lineage of the domain *Bacteria* (*Aquificales*). VLP-mediated gene transfer was experimentally demonstrated using auxotrophic mutants of *Escherichia coli* and *Bacillus subtilis* with an average efficiency of 10^6 per particle. The "VLP" originated from these thermophilic bacteria may be a xenotrophic gene transfer particle. The particle from thermophilic, sulphur-oxidizing bacteria was able to accomplish gene transfer from Gram-negative bacteria to Gram-positive bacteria.

From these results, it is strongly suggested that at least some of the widely distributed VLPs could be general gene transfer agents among a wide range of microbial host cells and might function as a universal vector. Considering that "particles", which could mediate gene transfer between genetically distinct host cells, were obtained from such dissimilar environments as hot spring and the ocean, gene transfer mediated by "VLPs" may be a ubiquitous event in the natural environment.

In order to examine such a high transduction frequency, the objective was extended to the thermal water column, and "VLP"-mediated gene transfer experiments were conducted. VLP and cell abundance in water samples from a hydrothemal vent (255 - 308^{o}C) in the Suiyo Seamount was *ca* 10^4 per ml. Preliminary results using "VLPs" from this hydrothermal vent supported the above hypothesis. The non-specific gene transfer by such particles from a hydrothermal vent implies that such gene transfer particles have mediated gene flux among phylogenetically diverse bacterial communities since the early age of the Earth.

OS32O-07 1525h INVITED

An Extensive Hydrothermal Plume of Unknown Origin in the Tonga-Fiji Region of the South Pacific

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Recently an unusual hydrothermal plume was discovered in the Tonga-Fiji region of the south Pacific marked by a large excess ^{3}He in the water column at depths of 1500-1700 m. The strongest helium signal of $\delta(^3\mathrm{He}) = 43.4\%$ was found at about 15°S, 173°W in the bathymetric gap between the Samoa Islands and the northern end of the Kermadec Arc. This hydrothermal ^{3}He signal was also found at several other stations to the west, indicating westward transport of the hydrothermal signal. The relatively shallow depth of this plume, and the fact that it is several thousand kilometers away from the East Pacific Rise indicate that it did not originate along the mid-ocean system. The basin-wide helium distribution in the Pacific shows that this plume is the strongest hydrothermal signal at this depth in the entire Pacific basin. The strength and areal extent of this Tonga-Fiji plume are greater than those emanating from Loihi Seamount near Hawaii or Axial Seamount on the JdFR, and are comparable to plumes originating on the fastest spreading portions of the East Pacific Rise.

The magmatic source of this plume is an important hydrothermal target warranting further exploration. The location of the plume source is unknown, but possibilities include the Samoa Islands (a hotspot chain similar to the Hawaiian Islands), the Lau Basin back-arc spreading center, the Futuna Spreading Center, and several volcanic seamounts in the region. Just as the helium plume emanating from Loihi has helped our understanding of the circulation near the Hawaiian Islands [Lupton, 1996], this plume in the Tonga-Fiji region has great potential for delineating circulation in this region of the south Pacific.

OS32O-08 1540h

The Brothers Hydrothermal System, Southern Kermadec Arc, New Zealand

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Brothers volcano forms part of the active Kermadec arc south of 32°S, NE of New Zealand. It forms an elongate edifice striking NW-SE and is 11-13 km long by 7-8 km across. A caldera with a floor 1850 m deep and surrounded by 350-450 m high walls has a basal diameter of 3-3.5 km. A volcanic cone rises 350 m from the caldera floor and partially coalesces with the southern caldera wall. Rocks from Brothers volcano are predominantly dacitic in composition.

Multiple plumes were mapped from the bottom of the caldera upwards to a depth of 900 m and originate from two sites; one on the NW caldera wall the other atop the cone. Analyses of these plumes show that the two vent sites are chemically distinct. The cone site has plumes that contain relatively high concentrations of gas with a shift of -0.27 pH units (proxy for CO_2) and H_2S concentrations up to 4250 nM, total dissolvable Fe (TDFe) of 4720 nM, TDMn up to 260 nM and Fe/Mn values around 18.2. By contrast, plumes originating from the NW caldera wall have much less gas with a pH shift of -0.06 units and no detectable H_2S, TDFe up to 955 nM, TDMn up to 150 nM, and Fe/Mn values of around 6.4.

The NW caldera wall has a significant sulfide deposit. It mainly crops out along discrete, narrow, fault bounded ledges between 1600 and 1650 m, over strike lengths up to 500 m. Camera tows imaged at least 3 active 1-2 m high black smoker chimneys in this zone, together with numerous 1-5 m inactive spires, abundant sulfide talus, and subcropping massive sulfides. Dredges recovered massive sulfides, mineralized breccia, hydrothermally altered volcanics and relatively fresh glass. A single chimney was recovered from the lower ledge of the caldera wall and is dominated by a core of massive sphalerite and pyrite with an outer zone of amorphous silica, pyrite and marcasite. The chimney base contains rare chalcopyrite, and galena is seen intergrown with the sphalerite. This mineralogy suggests vent fluid temperatures in the range 250-350 °C. ^{226}Ra dating shows this chimney to be around 5,700 years old.

The NW caldera wall appears to be a chronic system dominated by evolved seawater. By contrast, several observations imply a magmatic component in vent fluids from the cone site: (1) high concentrations of H_2S and (inferred) CO_2 in the plumes, (2) an alteration assemblage dominated by quartz, opal-C, opal-A, native sulfur, pyrite, natroalunite and minor illite, and (3) negative δ^{34}S values for native sulfur (to -8.3 per mil), consistent with the disproportionation of SO_2.

OS32O-09 1555h INVITED

Loihi: Studies at an Active Submarine Hotspot Volcano

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Loihi seamount lies 30 km southeast of the Island of Hawaii on the flank of Mauna Loa Volcano where it is likely to become the next Hawaiian island in about 100,000 years. With a summit depth of about 1000 m, common earthquake swarms, volcanic eruptions, vent activity, and a nearby port, Loihi is an excellent site for study of active submarine volcanism. It is also an important location for monitoring Hawaii seismicity and the pacific Ocean sound channel. Intense activity at Loihi observed in 1996 was characterized by a severe earthquake swarm, formation of a pit crater more than 300 m across, surface faulting, volcanic eruption, and formation of new hydrothermal vents spewing hot water and microbial life. Historical and recent earthquakes recorded by the Hawaiian Volcano Observatory seismic array imply that Loihi wakes up roughly every three years, but monitoring by sensors on Loihi is needed to obtain precise locations and characterization of this activity. The Hawaii Undersea GeoObservatory (HUGO), installed in 1997, observed no activity at Loihi before the cable failed in April, 1998, but it did record the sounds of lava entering the ocean and submarine landslides at Kilauea volcano 50 km to the north. Study of Loihi provides insight into the processes that form volcanic islands and the structures and biology associated with submarine volcanism. Ocean floor observatories are likely to play a major role in this endeavor.

URL: http://www.soest.hawaii.edu/HUGO/hugo.html

OS32O-10 1610h

Seamless Sampling and Enrichment of Hydrothermal Vent Organisms from Peles Pit, Loihi Submarine Volcano, Hawaii

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Peles Pit, located on the summit of Loihi submarine volcano, is a 300-meter deep pit crater with a floor depth of 1,300 meters that formed as a result of a summit collapse event on Loihi during July-August of 1996. As a result, new hydrothermal vent fields with vent temperatures of up to 190 degrees C were formed at the pit crater floor to pit crater wall interface, at the contact with exposed hot dikes. During September 1996, Pisces V submersible dives into the pit crater showed that extensive and diverse microbial mats were formed around the vents and draped on the rocks of the pit crater wall above the vents. During October 1999, a detailed sampling program of the mats was initiated, using a variety of Pisces V submersible-mounted samplers that did not retain the ambient vent temperatures or pressures upon ascent from the vents to the surface. Careful shipboard laboratory techniques allowed the viable preservation of microorganisms between shipboard and shore-based laboratory sites. In March 2000, a novel bacterium was isolated from these samples. The nucleotide sequence of the 16S rRNA gene from a Loihi vent sample showed highest homology with that from an unculturable eubacterium collected from an 11,000-meter water depth in the Mariana Trench. In order to continue this study and evaluate the biodiversity of the Peles Pit hydrothermal vents, a seamless system for collecting and incubating samples from the vents while maintaining the ambient temperature and pressure of the vents was designed and fabricated. The system consists of submersible-mounted samplers that maintain temperature and pressure during transport from vent to shipboard bioreactors, a helium activated transfer system and 30 one-liter Teflon-lined stainless steel bioreactors. The bioreactors sustain pressures of up to 300 atmospheres and temperatures of around 100 degrees C. The system uses helium to transfer vent samples from the sampler to bioreactors and smaller transport pressure vessels. The system was deployed during an October 2001 Pisces V submersible diving expedition to the Peles Pit vents. The maximum vent temperatures where the samples were taken were up to 90 degrees C. Samples for all the 30 bioreactors were successfully sampled from the vents and transferred aboard ship to the bioreactors. The biota was successfully incubated and the system with the samples transferred upon arrival in Honolulu from the ship to the microbiology laboratory at the University of Hawaii.

OS32O-11 1625h

Preliminary Multibeam Mapping and Dredging Results Along the Nazca Ridge and Easter/Salas y Gomez Chain

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We will map and sample the Nazca Ridge and the Easter/Salas y Gomez volcanic chain in an effort to assess hotspot fixity in the Pacific Basin, using the R/V Revelle from November 5 through December 14, 2001. We will present our preliminary shipboard results from our expedition, including new Simrad EM 120 multibeam data and rock descriptions from our anticipated 50-75 equally spaced dredges along the chain. These new data will be used in plate motion models to test hotspot fixity and also to test the prediction of the Steinberger and O'Connel (1998) mantle convection model, that the Hawaiian hotspot and the "Easter" hotspot are converging at 20 mm/yr. Over the 30 Ma age of the Nazca Ridge, this predicts about 600 km of convergence between the two hotspots. The scientific party, including other PI's involved in the project are: R. Duncan, J. Mahoney, B. Donahue, G. Berman, A. Wright, K. Ciembronowicz, L. Elgin, E. Desjardins, Y. Harada, H. Sheth, J. Ray, and C. Russo.

URL: http://www.marine.usf.edu/geo

OS32O-12 1640h

Rotten Stepping Stones in the Deep Sea? Evolutionary Relationships of Whale-Fall, Sunken Wood, Cold Seep, and Hydrothermal Vent Mussels

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The evolutionary origins of hydrothermal-vent and cold-seep mytilid mussels have been the subject of speculation. Hypotheses include evolving from a seep ancestor and evolution from shallow water to the deep sea. Little attention has been given to organic-remain habitats. We examined DNA sequences for mitochondrial 16S and COI genes to determine the recent evolutionary relationships between mytilids from a range of deep-sea reducing habitats including hydrothermal vents, cold seeps, whale falls and wood islands. These genes provide evidence for an evolutionary sequence from sunken wood to whale falls to seeps and finally to vents that is consistent with previous 18S and allozyme studies. There is also some evidence of an evolutionary trend from shallow-water to the deep sea.

Because many vent and seep mytilids have been shown to harbor sulfur-oxidizing and/or methanotrophic endosymbionts, we also examined stable carbon isotopes for these mytilids. Carbon isotope values support the evolutionary sequence suggested by the DNA phylogenies and imply increasing dependence on chemoautotrophy and later methanotrophy over evolutionary time.

These results taken together substantially support the hypothesis that organic remains in the deep-sea may have played a role as evolutionary stepping-stones for vent and seep species.

OS32P HC: 316 B Wednesday 1330h

Oceanic Internal Tides I

Presiding: **D Luther,** University of Hawaii at Manoa**; M Levine,** Oregon State University

OS32P-01 1330h

Internal Tide Radiation and Turbulence and Turbulence Along the Hawaiian Ridge

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Interaction of surface tides and rough topography in the deep ocean is thought to be responsible for significant (1.0 TW) tidal dissipation and deep-ocean mixing. The Hawaiian Ridge represents a prominent obstacle to the surface tides propagating from the northeast. Internal tides radiating north and south from the Hawaiian Ridge are investigated with full-depth profiles of horizontal velocity, temperature, salinity and kinetic energy dissipation rate ϵ collected along the 3000 m isobath as part of the Hawaiian Ocean Mixing Experiment (HOME) Survey program. Vertically integrated energy-fluxes $\langle \mathbf{v}'p' \rangle$ were as large as 36 (19) kW/m south of French Frigate Shoals (Kauai Channel) and as small as 1 (2) kW/m south of Nihoa Island (Necker Island) with the fortnightly cycle accounting for about half of this range. Observed energy-fluxes are broadly consistent though often larger than those from numerical simulations forced by surface M_2 and S_2 tides. In the vertical plane, energy-flux vectors are parallel to semidiurnal internal wave ray paths. Many modes contribute to the internal tide signal. Eddy diffusivities increase from 0.5 x 10^{-4} m^2/s in the water column shallower than 1800-m depth to (10-20) x 10^{-4} m^2/s in the bottom few hundred meters. They scale to within a factor of two with the Gregg-Henyey parameterization. Integrated over depth and 10-km distance, the local turbulent dissipation rates amount to 5-10% of the radiating energy-flux, indicating that most of the surface tide dissipation takes the form of radiating internal waves which must be lost to turbulence elsewhere. The ratios of the depth-integrated energy-fluxes and depth-integrated dissipation rates are O(1000 km).

URL: http://chowder.ucsd.edu/home

OS32P-02 1345h

Improved Estimates of Temporally Coherent Internal Tides and Energy Fluxes from Satellite Altimetry

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Satellite altimetry has opened a surprising new avenue to observing internal tides in the open ocean. The tidal surface signatures are very small—a few cm at most—but in many areas they are robust, owing to averaging over many years. By employing a simplified two-dimensional wave-fitting to the surface elevations in combination with climatological hydrography to define the relation between the surface height and the current and pressure at depth, we may obtain rough estimates of internal tide energy fluxes (Ray & Cartwright, *Geophys. Res. Lett., 28*, 1259, 2001). Initial results near Hawaii with Topex/Poseidon data show good agreement with detailed 3-D numerical models, but the altimeter picture is somewhat blurred owing to the widely spaced T/P tracks. The resolution may be enhanced somewhat by using data from the ERS-1 and ERS-2 satellite altimeters. The ERS satellite tracks are much more closely spaced (0.72° longitude vs. 2.83° for T/P), but the tidal estimates are less accurate than those for T/P. All altimeter estimates are also severely affected by noise in regions of high mesoscale variability, and we have obtained some success in reducing this contamination by employing a prior "correction" for mesoscale variability based on 10-day detailed sea-surface height maps developed by Le Traon and colleagues. These improvements allow us to more clearly define the internal tide surface field and the corresponding energy fluxes. Results from throughout the global ocean will be presented.

W E D