

OS31F-96 0830h POSTER

Fluctuation in Flow Velocity and Temperature of Hydrothermal Fluids at Suiyo Seamount, Izu-Ogasawara Arc, Western Pacific

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We deployed a deep-sea fluid monitoring system, Medusa/Gemini, at Suiyo Seamount, Izu-Bonin Arc, Japan, in August 2001. The Medusa/Gemini is an instrument designed by a team lead by A. Schultz and monitors the flow rates and temperature of effluent flowing out of a cased seafloor borehole. We deployed three Gemis G3, G4 and G5 and recovered G3 and G5 by ROV "Hakuyo 2000". We recovered G4 using submersible "Shinkai2000" 23 days after the deployment. G3 was set up on two borehole sites with high temperatures of about 300°C for an hour. G5 was set up on the borehole with temperature of several tens of degrees for 9 hours. G4 was recorded flow rate, fluid temperature and seawater temperature for 23 days on the borehole site. Power spectrum analysis on this data shows clear periodicity. Flow rate and fluid temperature of Gemis shows wide variation with several peaks. Fluctuations in the fluid velocities show strong correlation with that of temperature for all Gemis. It suggests that the fluid is driven by buoyancy.

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OS31F-97 0830h POSTER

A month-long observation of thermal fluctuation at a hydrothermal site in the summit caldera of the Suiyo Seamount, Izu-Ogasawara Arc.

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Following the BMS drilling operations by R/V Hakurei-maru No. 2 at a hydrothermal site in the summit caldera of the Suiyo Seamount (Urabe et al., this meeting), we conducted seafloor observatory works by two successive cruises, i.e., an ROV "Hakuyo 2000" cruise supported by M/V Shinsei-maru from July 28 to August 11, 2001 and a manned-submersible "Shinkai 2000" cruise supported by R/V Natsushima from August 23 to September 18, 2001. We deployed and/or recovered 1 CTD with redox, pH, OBS and DO sensors, 2 precision pressure recorders, 5 ZABUTON thermal blankets, 3 SAHF heat flow probes, 5 seepmeters, 2 MAVS3 currentmeters and 3 sets of high temperature/redox recorders. Some of the instruments is still staying on the seafloor for a year-long monitoring. Except for the high temperature/redox recorders, the temperature probe devices were deployed at least several meters apart from visible vents.

The degradation of heat flow value to the west of the hydrothermal site was larger than that of the east, which indicated asymmetric thermal structure beneath the seafloor. Tidally-modulated temperature variations were commonly observed either in the temperature records of the water near the seafloor or in those of the sediment beneath the seafloor. Inverse correlation of temperature changes between several sites would imply simultaneous but different responses of fluid discharge and recharge against tidal loading.

Neither the temperature records from Aug. 5 to 24 in hot-water natural vent (292 to 298 deg C) nor those in warm-water vent (7 to 23 deg C) did not show apparent tidal component. The temperature of the hot

water gradually rose up to 297 deg C towards middle of Aug. 14 and then stayed around 296 deg C during the rest of the days. On the other hands, the temperature of the warm water vent rose up from 7 to 15 deg-C fluctuation to 23 to 12 deg-C fluctuation on Aug. 14.

This research was funded by the "Archaean Park" Project (International research project on interaction between sub-vent biosphere and geo-environment funded by Special Coordination Fund of the Ministry of Education, Culture, Sports, Science and Technology (MEXT), Japan. The R/V Natsushima cruise with the sub "Shinkai 2000" was a part of the Deep Sea Research project of the Japan Marine Science and Technology Center (JAMSTEC).

OS31F-98 0830h POSTER

Stable isotopic compositions of CO in hydrothermal fluids: signature of sub-seafloor biosphere?

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Concentrations and stable carbon isotopic compositions ($\delta^{13}\text{C}$) of CO_2 , CH_4 , and CO dissolved in hydrothermal fluids of the Suiyo seamount (ca. 1,380 meter depth), located in the southern part of the Izu-Bonin (Ogasawara) arc, have been determined precisely for each vent in the site, for the aim of searching geochemical signatures of subseafloor biosphere in hydrothermal fluids. If there would be some microbial chemosynthetic activities within the fluid conduit, concentrations and stable carbon isotopic compositions of such components must be altered through the activities, which could be result in heterogeneous compositions of such components within vents.

More than 30 samples have been sampled from more than 15 vents (both high and low temperature) in the site by using gas-tight water sampler (WHATS) attached to the Japanese manned submersible SHINKAI 2000, JAMSTEC. While $\delta^{13}\text{C}$ of CO_2 and CH_4 show homogeneous value with ± 0.5 ‰ variation in the site, those of CO show average $\delta^{13}\text{C}$ of -31 ‰ PDB with 1 ‰ variation of more than 2.0 ‰. The reason for the variation will be discussed in relation to the activities of sub-seafloor biosphere.

OS31F-99 0830h POSTER

Behavior of Bio-Essential Elements during Subvent Hydrothermal Alteration of Volcanic Rocks at the Suiyo Submarine Volcano, Japan

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Microorganisms require so-called bio-essential elements for their enzymatic activities and to construct their bodies. Mo, Mn, Cu, Zn and B are representative bio-essential elements and P is also essential major elements. In order to understand the ecological conditions of subvent microorganisms, it is necessary to understand the behavior of bio-essential elements in the hydrothermal fluids. The hydrothermal field of the Suiyo submarine volcano was drilled in order to examine the hydrothermal process and possibility of subvent microorganisms. Altered and less altered igneous rocks were recovered from these drilling procedures. Chemical compositions were determined on the bulk samples of drill cores to examine the elemental behavior during hydrothermal alteration. Also electron microprobe analyses were performed on the representative samples to examine the elemental distribution within the thin section scale (1cm x 1cm). Petrography and X-ray diffraction study indicate the various degree of alteration among the examined samples. Altered rocks contain abundant clays, sulfates and sulfides, and less altered rocks still exhibit the original igneous textures. Degree of alteration is related to the total REE concentrations or LREE behavior: LREE is depleted in heavily altered samples. It is found in this study that

bio-essential elements are, in general, extremely mobile during hydrothermal alteration. For example, concentrations of B are depleted in heavily altered rocks, suggesting B was simply leached away from original rocks. On the contrary, concentrations of other metallic elements, such as Mo, are increased in the heavily altered rocks, associated with precipitation of sulfide minerals. Notable feature is behavior of P during alteration. Electron microprobe analyses indicate (1) the strong depletion of phosphate minerals in altered rocks and (2) co-precipitation of phosphates with hydrothermal sulfides. These data suggest that the bio-essential elements will be available for subvent microorganisms right after these elements are leached from rocks before sulfide precipitation.

URL: <http://www.ganko.tohoku.ac.jp>

OS31G HC: Hall III Wednesday 0830h

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

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

OS31G-108 0830h POSTER

The National Deep Submergence Facility

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The Deep Submergence Vehicle ALVIN has a long history of service to the ocean biology community from shallow mid-water to depths of 4500 meters and has developed many tools and techniques to meet unique sampling objectives. The flexibility of ALVIN's electrical, mechanical, data, payload, and hydraulic systems allows rapid integration of new sampling equipment, techniques and instrumentation. The support vessel, RV ATLANTIS, provides the necessary technical and scientific support to carry out field programs.

The remotely operated vehicle (ROV) JASON II, the ARGO II towed survey system, and the DSL-120A sonar can all be accessed as part of the National Deep Submergence Facility (NDSF) in a manner similar to DSV ALVIN. JASON can operate in water depths to 6000 meters and carries a standard sensor suite consisting of various video and film based imaging devices, side scan sonar, sector scanning sonar and manipulator. Additional sensors such as an electronic still camera, temperature probes, multibeam sonars and magnetometer have been used on the ROV, and connections are available to incorporate other specialized instrumentation. JASON II is a new vehicle and will be placed in service in mid-2002. ARGO II is a deep-towed vehicle designed to support both high altitude down-looking video and acoustic sonar sensors. Normal tow altitudes for video and 35mm film coverage are 10m. ARGO II can support a wide variety of cruise specific instrumentation as the vehicle has similar interface capabilities to JASON. The DSL-120A is also a deep-towed sidescan sonar with phase-difference bathymetric capability. It is normally towed 100-150m above the seafloor and provides a nominal 1-km swath of backscatter imagery and high-resolution bathymetry. The community will inform about the capabilities of these systems.

WHOI has two autonomous underwater vehicle systems (AUV) for use in submergence science operations, the Autonomous Benthic Explorer (ABE) and Remote Environmental Monitoring UnitS (REMUS). Although these are not formally a part of the NDSF, they are operated by WHOI personnel and are compatible with the NDSF assets. ABE was designed principally to address the need for long-term monitoring of the seafloor. It is powered by rechargeable gelled lead-acid batteries to facilitate testing and maintain low cost and has reliable and precise navigation and control. As presently configured, ABE's principal data is CTD, magnetometer, bathymetry, and monochrome stereo image pairs. REMUS is a low cost AUV designed for coastal monitoring and multiple vehicle survey operations. REMUS has been primarily funded by NOAA's National Undersea Research Program (NURP) and ONR's 6.1 and 6.2

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programs to support the scientific concepts of LEO-15 and the Autonomous Ocean Sampling Network. REMUS vehicles equipped with lead acid batteries routinely do 20-kilometer surveys while collecting ADCP, CTD, and side-scan sonar data. A vehicle equipped with lithium batteries has run several missions of over 50 kilometers and one of over 60 kilometers in the open ocean. It is estimated that the vehicle can travel over 80 kilometers at 3 knots, and in excess of 100 kilometers at lower speeds.

Access to National Deep Submergence Facility assets is by formal and competitive proposal submission, or by direct hire. Procedures to request use of the assets vary between funding agencies (examples of procedures for NSF, NOAA, and ONR are shown). Web resources for requesting use of these assets are available.

OS31G-109 0830h POSTER

The Dive and Discover Web Site: A Mechanism for Outreach and Education in the Oceanographic Sciences

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The role that scientists play in providing key social, economic, and technological stimuli for society as a whole, as well as mentors and role models for students throughout the educational process, has been firmly established. However, there is an urgent need for scientists to better and more frequently communicate the importance and relevance of their work to the general public. The growth of the Internet and global communications, and the ease with which text-based and visual information can be transmitted, has facilitated the means by which scientific experiences and data can be relayed from anywhere on the planet (or from space) into schools, libraries, and homes. However, harnessing the full capabilities of web-based communications, and providing effective, understandable and meaningful information to a lay audience about science and the quest for basic knowledge is often difficult for scientists and engineers. One example of a federal program that fosters the integration of research and education is the National Science Foundations Awards to Facilitate Geoscience Education (NSF-AFGE). This program is intended to facilitate the initiation of highly innovative educational activities by research scientists, and assist them in developing new techniques and avenues for effective communication with students and the public.

With NSF-AFGE support and cost-sharing from our institution, we have been developing over the last year a web-based education and communications platform for providing near real-time access to ongoing oceanographic research at sea. The Dive and Discover web site, <http://www.divediscover.whoi.edu>, is targeted at middle-school students (Grades 6-8) and the general public. It is structured to provide multiple layers and levels of information. The backbone of the site is a series of educational modules that address basic science concepts central to the research being conducted at sea. References and links are made throughout to provide the viewers with easy access to more detailed and related information. When a cruise is taking place, the site provides daily updates on the progress of the cruise. This includes: still and video images from the seafloor and of shipboard operations, graphical representations of a wide variety of oceanographic data, explanations about the technology being used, and general information about life at sea and the scientists, engineers, and mariners that make oceanographic research possible. In addition, a "Mail Buoy" allows students to communicate directly by email with scientists at sea.

URL: <http://www.divediscover.whoi.edu>

OS31G-110 0830h POSTER

Bacterial Diversity of A Deep-Sea Hydrothermal Vent Chimney Structure.

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In the chimney structures of deep-sea hydrothermal vent sites, steep environmental gradients of temperature, pH, oxidation-reduction potential, and various chemicals are found, which provide diverse microhabitats for microbial communities. Molecular techniques were

used to characterize the bacterial diversity present in a beehive chimney structure of a hydrothermal vent site from 9°N at the East Pacific Rise. The chimney was collected with the submersible Alvin from a depth of 2515m in February 2000 (Dive 3531). The temperature of the fluid exiting the top of the chimney reached approximately 350°C. The structure was 30-35cm long and 10-13cm wide and was covered with patches of white precipitates. Material was scrapped from the external walls of the bottom, middle, and top parts of the chimney and from the inside of the clogged orifice. Then the chimney was vertically dissected in three parts and material was scrapped from five distinct zones of different colour and texture along its horizontal axis. DNA was extracted using freeze-thawing cycles and polyadenylic acid and subsequently amplified by polymerase chain reaction (PCR) using specific bacterial primers for the 16S rRNA gene. PCR products were purified and cloned. A total of 32 and 29 clones were sequenced from the external surface and the inside of the chimney, respectively. A phylogenetic analysis of 16S rRNA gene sequences obtained from external surface of the chimney revealed sequence similarities with uncultured bacteria from other hydrothermal vent sites, a novel lineage of e-Proteobacteria that seems to be widely distributed among deep-sea hydrothermal vent sites, ectosymbionts of vent macrofaunal species, hydrocarbon and sulfur associated hyperthermophilic bacteria. Community profiles from external wall surfaces are compared with those from the inside of the chimney.

OS31G-111 0830h POSTER

Two New Submersible Techniques for Deepwater Fisheries Research in Hawaii

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For several years, the Hawaii Undersea Research Laboratory (HURL) has been conducting studies on deepwater snappers in the Hawaiian Islands. These fish are found between -150 and -350 meters, a depth range accessible only by deep submergence vehicles. Therefore, HURL's Pisces submersibles and RCV-150 ROV have been integral to this research. However, snappers typically avoid such vehicles and are therefore difficult to document in situ. Recently, HURL partnered with the Hawaii Institute of Marine Biology (HIMB) to develop new visual and acoustic techniques to overcome this problem. Visual data were obtained with a ROS 20/20 Navigator CCD camera mounted on the submersibles' pan and tilt. A preliminary test showed that this camera could effectively capture images on a mini-DV recorder to a depth of -350 meters without artificial lighting. To document snappers at particular locations, the camera was used at bait stations during which macerated squid and fish was placed in front of the vehicle. With the lights off, the ROS camera recorded fish attracted to the bait for 30-minute sampling periods. Using this technique, long segments of video were recorded of several species that had previously been difficult to image. To obtain in situ acoustic data on these fish, a transducer and high-resolution sonar system were constructed for use in conjunction with the ROS camera. The system used a short, 50 ms, broadband signal, modeled after a dolphin echolocation click, which had a 35 kHz bandwidth and a center frequency of 120 kHz. Data acquisition was triggered by the outgoing signal and echoes were digitized at sampling rate 500 kHz with a National Instruments 6062E PCMCIA DAQ card connected to a single board computer. A composite piezo-electric ceramic transducer with a beam angle of 12 degrees at the center frequency was mounted to the pan and tilt used to control the camera, allowing synchronous recording of both video and acoustic data. Snappers crossing in front of the camera/transducer array were ensnared by manually triggering a set of acoustic pulses, which fired every 700 ms for one minute. To synchronize the video with the acoustic data, the tape position and time were recorded precisely at each triggering. While the data is still being analyzed, we believe these two new visual and acoustic techniques will become standard tools for use in deepwater fisheries research in the near future.

OS31G-112 0830h POSTER

Using MIR Submersibles and the Navy's NR1 Nuclear Submarine to Explore Seafloor Mud Volcanoes.

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We have had the unique opportunity to use both the MIR submersibles (owned and operated by the Russian Academy of Sciences) and the US Navy's NR1 research submarine to investigate the biology, chemistry and geology of mud volcanoes and their association with methane hydrates. Both platforms offer unique features not available in comparable platforms and are relatively inexpensive to use.

The MIR submersibles were used in 1998 to investigate a mud volcano located on the continental slope off the southwestern Barents Sea. The region of investigation lies in 1200-1300m water depths, too deep for most other submersibles. High resolution photographs, videos, sediment samples, biological samples (including demersal fish and bacteria mats sucked up by the slurp gun), water samples, heat flow data, CTD and dissolved methane data were successfully collected from the submersibles. Bottom time averaged about 8-10 hours.

NR1, which is owned and operated by the US Navy, was deployed along the upper Storegga slide scar in 1999 to search for mud volcanoes and other vent sites, but none were discovered in two weeks of operations. NR1 was again used in 2001 to investigate and sample mud volcanoes along the Spanish margin. NR1 is equipped with state-of-the-art high resolution video equipment and is capable of collecting CTD data. The submarine is also currently equipped with a forward-looking obstacle avoidance sonar (OAS), a 200 kHz sidescan sonar system and a 3.5 or 7 kHz subbottom profiler - all extremely useful instruments for detailed seafloor mapping. Biological and sediment sampling can be difficult due to the lack of fine-scale maneuverability of the mechanical arm and to the requirement that the seafloor be nearly level. The submarine is nuclear-powered, so dive time, up to several weeks, is limited by waste water storage space rather than fuel. The NR1's maximum dive depth is about 850 meters. This platform operates in a specific region each year, so the user is obligated to propose a project in the region of operation only. Military-related use of NR1 takes precedence over basic science or archeology uses. Previously approved non-military science missions may be canceled on short notice. The cost to the user varies, depending on the particular systems required. NR1 can accommodate a maximum of two scientists at any one time, and a normal crew of eleven.

OS31G-113 0830h POSTER

Enhanced Lifetime of Methane Bubbles Within the Deep Ocean

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We recently reported on extended lifetimes of a rising stream of methane bubbles within the hydrate stability field as a consequence of the formation of a hydrate skin (1), based on in situ measurements of methane and argon bubble dissolution in the depth range from 400 to 800 m. Extending this work, we performed a series of ROV-based experiments to measure the lifetime of methane gas bubbles between 1800 and 900 m. Single gas bubbles were injected from ROV *Ventana* into an attached box, open at the top and the bottom, which was equipped with a back-lighted illumination to enhance contrast. Gas release was performed from a compressed gas cylinder at various depths, using a hydraulic piston for the additional compression needed for experiments deeper than 1000 m. The ascent of individual bubbles within the imaging box was then recorded with *Ventanas* HDTV camera system by

piloting the 3-ton vehicle upward, at the exact rise rate of the bubble, for up to 400 m of vertical transit.

The observed rise rates were of the order of 30cm/sec for both gases. Post-dive analysis of the HDTV tapes allowed detailed measurements of the bubble shrinking rates. The results of the earlier and new experiments lead to the following conclusions: 1. Methane bubbles released below the hydrate stability field can show markedly enhanced methane bubble lifetimes, which is attributed to the formation of a hydrate skin. Diameter shrinking rates of 15 $\mu\text{m}/\text{sec}$ above the hydrate stability field and less than 3 μm at the deepest release depth indicate an increase in lifetime of at least a factor of 5. 2. The lifetime of bubbles released within the hydrate stability field increases with distance in P-T space from the hydrate phase boundary. 3. Before the nucleation of a hydrate skin, the methane bubbles show a shrinkage rate comparable to the rates found above the hydrate stability field. The onset time before nucleation, although random in nature, also seems to decrease with distance from the hydrate phase boundary (super pressurization and super cooling with respect to hydrate formation).

We relate these findings to formal calculations of the solubility and density of methane as a function of pressure, and reviewing the effect of superpressurization on hydrate nucleation. The results are used to parameterize an advanced bubble propagation model (2), and experimental and model results are compared.

The increased lifetime of methane bubbles within the hydrate stability field greatly increases the ease with which methane gas released at depth can penetrate the shallow ocean layers. Our findings increase understanding of the methane distributions above modern deep gas vents, and gas leakage from under-sea pipelines, and will help to refine scenarios of ancient, present, and future climate feedback associated with methane releases.

References: (1) Rehder, G., P.G. Brewer, E.T. Peltzer, and G. Friederich, Enhanced lifetime of methane bubble streams within the deep ocean, *Geophys. Res. Lett.*, in press, 2001. (2) Leifer, I., and R.K. Patro, The bubble mechanism for methane transport from the shallow sea bed to the surface: A review and sensitivity study, *Cont. Shelf Res.*, in press, 2001.

OS31G-114 0830h POSTER

Utilizing a commercial ROV "Hakuyo 2000" for scientific research in a hydrothermal field in the Western Pacific

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The "Hakuyo 2000" which is a Hysub 50-2000 ROV of ISE Ltd., Canada has been operated by SNK Ocean Co., Ltd. (former English and current Japanese name: Shin Nippon Kaiji Co., Ltd.) mainly for crashed aircraft recovery, maintenance service of oil rigs as well as deep-sea coral fishery in the western Pacific since its construction in 1994 (<http://www.snk-ocean.co.jp>). An English-Japanese bilingual operator in the ROV operation team supports smooth communication with international customers.

In the summer of 2001 (July 28 to August 11), we used "Hakuyo 2000" for the first time for scientific operation in a hydrothermal site in the Suiyo Seamount summit caldera as a part of the "Archaean Park" project (International research project on interaction between sub-vent biosphere and geo-environment funded by Special Coordination Fund of the Ministry of Education, Culture, Sports, Science and Technology (MEXT), Japan. Extensive modification was necessary to fit the work ROV for the operation to deploy/recover many observatory instruments and to sample fluids and microbes. We modified the basket mounted on the back of the ROV cage (2 m (W) x 0.7 m (D) x 1 m (H)) which is regularly used for recovery of deep-sea corals. It allowed us easy and safe recovery of instruments and sample boxes. We also designed and manufactured another smaller removable basket for speedy instrument deployment operations. It was released from the cage by the hydraulic system according to a command from the surface. We also attached seawater pump, rotary valve, manifold sampler and filter systems on the ROV to collect fluid and microbe samples.

Although the operational days were limited to 7.5 days by two typhoons, "Hakuyo 2000" performed 33

instrument deployment/recovery as well as temperature measurement of natural/drilled hot water discharges, which were sometimes over 300 degrees C, sampling/filtering vent fluid and rock/sediment sampling during total 68 hours and 38 minutes operation by 12 dives. The ROV operators' high areal searching technique, well trained by the deep-sea coral fishery, provided us quick identification of seven drilled holes/casing on the 1380m-deep seafloor. Precise positioning of the ROV by DGPS and HIPAP acoustic positioning system mounted on the newly built work boat, M/V Shin-sei maru (Gross/International tonnage: 697/997t, 40 crew and cruise staff) made smooth returns to the drill holes and deployed instruments.

Many scientific results by this ROV cruise are presented in the special session, OS38, "Physical, Chemical, and Biological Processes Associated With Active Submarine Volcanism in the Pacific" in this meeting. We are planning to use the "Hakuyo 2000" again for the 2002 summer field program as a part of the "Archaean Park" project.

URL: <http://www.snk-ocean.co.jp>

OS31G-115 0830h POSTER

Integration of High-Resolution Multibeam Sonar Imagery of the Seafloor with Direct Observational Data From Occupied Submersibles and ROVs to Classify Bottom Types for Habitat-Based Groundfish Assessments at Heceta Bank, Oregon

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With the evolution of fishery science, methods for assessing fish stocks have greatly improved through the development of enhanced sampling equipment and techniques. Despite these improvements, the fishing industry and related management entities often criticize these methods for not yielding accurate and precise estimates of biomass. One possible alternative to traditional single-species assessments involves using the knowledge of important fish-habitat associations to inform a model design for conducting habitat-based community assessments.

One important preliminary step in performing such habitat-based assessments is to classify seafloor bottom types. The integration of data from high-resolution multibeam sonar imagery and geomorphologic data from direct observations enables the classification of bottom types at Heceta Bank - a shallow, rocky shoal off the central Oregon coast. This bottom-type classification is based on the premise that distinct signatures observed in sonar backscatter are associated with distinct seafloor bottom types. Using a combination of previously developed and new GIS methods, imagery that depicts the locations of these bottom types on Heceta Bank was created.

Future integration of other geomorphologic parameters will produce a more robust classification to serve as a framework for integrating observational data on fish densities. Our hope is that this classification will provide a context to support improved estimates of abundances of various stocks of groundfish on a scale useful for regional stock assessments. Additionally, our methods for classifying seafloor bottom types could potentially serve as a model for other habitat-based community assessments.

URL: <http://newport.pmel.noaa.gov/heceta/index.htm>

OS31G-116 0830h POSTER

Continuing Lewis and Clark's Legacy: Exploring the Habitats of Astoria Canyon, Oregon through NOAA's new Program in Ocean Exploration

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During spring and summer of 2001, an interdisciplinary consortium of scientists, representing a diverse array of governmental agencies, universities, conservation organizations and museums, conducted an exploration of Astoria Canyon. The team mapped, explored, and documented the physical, chemical, and biological systems of this canyon. Sidescan and multibeam echosounders were used to create high-resolution, three-dimensional images that clearly depict features of the Canyon that have never been observed and documented. Immediately following the mapping effort, a 32-member research team aboard the R/V RONALD H. BROWN conducted detailed surveys of the canyon using a variety of remote sensing and sampling devices, including a sophisticated remotely operated vehicle, ROPOS. Deployed from the BROWN, ROPOS provided the interdisciplinary team with broadcast-quality video images that were critical for studying the geological and epibiotic structure of the seafloor, and for viewing and collecting samples from both the seafloor and water column, including many samples of invertebrates, some likely new to science. Biological oceanographers collected acoustic data with a SIMRAD EK500 echosounder configured with down-looking 38, 120, and 200 kHz transducers mounted in a towed-body. A chartered commercial fishing vessel was employed to sample sound scattering layers with a rope trawl to groundtruth the acoustic data. CTD casts, shipboard ADCP, and heavily instrumented current meter moorings were used to monitor the oceanographic conditions under which biologically important material is transported and concentrated within the canyon. Preliminary results from the expedition will be presented, highlighted by views of complex habitats determined by the geologic history of the Canyon. A dramatic example of this was found on the north wall of the upper canyon, where the tops of large slump blocks formed a mosaic of jumbled blocks that hosted an array of invertebrates, and a surprisingly low number and low diversity of bottom-dwelling fishes. Education and outreach components were an essential and critical part of this expedition.

URL: http://oceanexplorer.noaa.gov/explorations/lewis_clark01/lewis_clark01.html

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OS31G-117 0830h POSTER

Coordinating a Fleet of Autonomous Underwater Glider Using a Decision Theoretic Approach in a Multi-agent System

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Autonomous underwater Gliders have the ability to patrol the subsurface Ocean for long durations. They surface at regular intervals to transmit data and download new sets of instructions. A small fleet of Gliders can improve efficiency and help scientists study the subsurface features of coastal waters around-the-clock and at controllable locations. A Glider fleet could be coordinated with a preset instruction set, but events measured from other scientific systems or model forecasts can change the sampling priorities. To direct the Glider Fleet to desirable locations there will be need for a scientist who studies data from various sources and provides new instructions for the Glider fleet to be downloaded. The focus of this research is to automate the coordination of the Glider Fleet given the information from the components of regional observation network to minimize direct human involvement.

It is proposed in this research to develop a flexible, autonomous and a responsive software tool to coordinate a Glider Fleet. The coordinating software design is based on a Decision Theoretic Expert System. The field of Decision Analysis studies the application of Decision Theory to solve actual decision problems. The system will make optimal decisions based on available evidence. This software will be both adaptable and adaptive. The adaptable behavior will allow it to take instructions from the user and change the download instructions for the Gliders accordingly. The ability of the software to change the instruction set for the Gliders without human intervention provided some evidence is available demonstrates adaptivity. The advantage of using Decision Theory over other approaches is its ability to incorporate uncertainty in the environment and taking into account the value of information before making decision.

URL: <http://marine.rutgers.edu/cool>

OS31H HC: 317 B Wednesday
0830h

Quantification and Regionalization of Benthic Flux Rates: Implications for Ocean Budgets I

Presiding: C Hensen, Fachbereich

Geowissenschaften Universitt Bremen ;

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OS31H-01 0830h INVITED

Implications of deep-sea benthic oxygen demand on the sinking organic matter flux, its reactivity, and the relationship to overlying productivity.

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Benthic oxygen fluxes in deep-sea sediments reflect both the influx of utilizable organic matter and the supply of oxygen from the bottom waters. When organic matter influx rates are low, oxygen penetrates relatively deep into the sediments and aerobic respiration predominates in the consumption of organic material. Under greater organic carbon rain rates, the supply of oxygen may become limiting and anaerobic metabolism may result. A simple diagenetic model of pore water oxygen was developed to look at the relationship of organic matter influx to the proportioning of aerobic versus anaerobic oxidation. The model is sensitive to the organic matter decay coefficient and where the

incoming organic matter has material of different reactivities, the relationship may become more complex. Under conditions where sediments are predominantly aerobic, measured benthic oxygen fluxes, reflecting the time-integrated rain rate, were correlated with overlying primary productivities estimated from recent global maps. The results suggest greater carbon input to the deep-sea than predicted from past sediment-trap relationships. The linkage of the model and the data correlations suggest the possibility for examining global distributions of greater aerobic or greater anaerobic metabolism, or for investigating global distributions of sinking organic matter reactivity.

OS31H-02 0850h

Quantification and Regionalization of Benthic Silicate Fluxes along the Continental Margin off W-Africa, California and Chile - a Case Study in Upwelling and low Lateral Transport Regions

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The quantification of benthic flux rates across the sediment-water-interface by identifying their control parameters and regional distribution patterns plays an important role in understanding the global ocean cycles.

Within a large database of control parameters the primary productivity, water depth or the total organic carbon content (TOC) were combined with the available determinations of benthic silicate flux rates to generate regional distribution maps of the benthic silicate release. The investigated areas comprise the continental margins of W-Africa, Chile and California because they belong to the most intensively investigated regions at present.

Generally, there exists a reasonable but not strong correlation of TOC with benthic silicate fluxes. But regionally, they are affected by other factors like currents induced a lateral transport process, which, however, complicates the relation between benthic processes and the upper water column. To overcome this problem, finally, we have defined five biogeochemical provinces along the continental margin of W-Africa. Therefore independent geographical and oceanographically boundary conditions, like climate regions of the hinterland, distances to the coast, current systems, fluvial input or location of oxygen minimum zones have been considered. These regions are known as high productive areas and different terrigenous input.

At first, we can show that there is a strong and significant relation between the benthic silicate release and the TOC, which is specific in each province and characterize them. Regression analyses verify the high significance of these relations by a regression coefficient of more than $r^2=0.92$. Based on this findings a Siflux(TOC) function could be formulated for every biogeochemical province. The empirically determined transfer functions were applied on a new generated TOC grid in a $0.2^\circ \times 0.2^\circ$ resolution grid via kriging interpolation method and provide a high-resolution benthic silicate flux grid.

However, the definition and the comparison of five biogeochemical provinces along the continental margin of W-Africa gives us the possibility to transfer and apply the developed Siflux(TOC) functions on comparable biogeochemical regions in the world ocean with a low database of measured benthic silicate fluxes. The results are very promising and put us in the position to receive benthic silicate release distribution maps on a global scale, based on a high-resolution database of the control parameter TOC.

URL: <http://www.geochemie@uni-bremen.de>

OS31H-03 0905h

In situ Measurements of Solute Transport Velocities in Permeable Shelf Sands

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Solute transport rates within the uppermost 2 cm of the sediment column of a continental shelf sand deposit, with a mean grain size of $450 \mu\text{m}$ and permeabilities of $1\text{-}2.5\text{E-}11 \text{ m}^2$, have been measured *in situ* by detecting the breakthrough of a pulse of dissolved iodide after its injection into the bottom water. These tracer experiments were conducted in the Middle Atlantic Bight at a water depth of $\sim 13 \text{ m}$ from a small tethered tripod that carried a microprofiling system for positioning and operating a solid-state voltammetric microelectrode, close-up video camera, acoustic current meter and a motorized 1-liter "syringe". When triggered by a switch operated on shipboard, the syringe delivered a solution of 0.21M KI and red dye through five nozzles positioned around and above the buried tip of the voltammetric sensor for 1 to 5 minutes. Mixing by bottom turbulence quickly dispersed the tracer, and a timed sequence of repetitive voltammetric scans was used to monitor the subsequent migration of iodide into the sand. The average one-dimensional vertical velocity, expressed as the depth of the sensor tip in the sand divided by the breakthrough time, was found to vary from 0.002 to 0.005 cm s^{-1} and to generally decrease with depth. Because of dispersion and episodic sediment transport associated with the greatest 5% of wave heights and current speeds recorded, some concentration versus time responses showed evidence of uneven solute migration. Pore water advection was also evident in oxygen profiles measured before and after tracer injection with the voltammetric sensor. These profiles showed irregular distributions and oxygen penetration depths of 4 to 4.5 cm.

OS31H-04 0920h

Quantification of Erosion Rates of Particulate Organic and Inorganic Matter in a Continental Shelf: Implication for Biogeochemical Cycles

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In most nearshore and continental shelf areas, the combination of high surface productivity and relative shallow water column depth results in high carbon sedimentation rates. Only a small fraction of the deposited organic matter becomes permanently buried whereas a significant fraction is influenced by resuspension processes. Thus sediment transport processes play an important role in the biogeochemical cycles in continental margin regions. If prediction of non-cohesive sediment transport is quite reliable, it is not the case for cohesive sediment because of the large number of parameters involved and their highly complex interactions. Modeling of sediment erosion and transport requires a description of erosional properties of the bed. For instance the two main variables of interest are critical shear stress and erosion rate. Unlike most experimental and modeling studies considering total particulate matter, we included the organic fraction in our resuspension process study. Resuspension experiments were performed in a recirculating flume using natural sediments from continental shelf of Gulf of Lion (Marseille, France) to assess their stability against erosion. Cohesive sediments were collected with a multi-corer at 3 sites (40, 100, 160 water depth) situated along a transect from the Rhne river mouth to the shelf break. Several sediment parameters, critical shear stress of erosion and erosion rates of both inorganic and organic particulate matter were measured. A high frequency sampling during the bloom revealed that erosion rates and critical shear stress vary temporally. Variations of critical shear stress were correlated with clay contents and those of erosion rates with silt contents. The sampling period presented two maximums of erosion rate of particulate organic matter, which are related to high sediment organic contents. An increase from coast to offshore areas in critical shear stress ($0.031\text{-}0.048 \text{ N.m-}2$) was observed along the transect. This can be related to the observed increase in bulk density ($1286\text{-}1561 \text{ kg.m-}3$). Consequently a decreasing erosion rates of particulate matter ($63\text{-}40 \text{ g.m-}2 \text{ .h-}1$) and particulate organic matter ($17\text{-}7 \text{ g.m-}2 \text{ .h-}1$) was measured. These results suggest that sediments located near the river mouth, which are more easily eroded, are likely to play an important role in transferring particulate organic matter through the water column. Indeed, first assessment shows that after one hour erosion at $0.2 \text{ N.m-}2$ corresponding to a frequently observed wind induced bottom stress, the input of organic phosphorous and nitrogenous particles represents around 10% of the stock within the overlying water column. A resuspension model was used to reproduce the suspended