increases rapidly, a response to the increased atmospheric ^{14}C caused by nuclear weapons testing. From 1954 to 1986 the record displays clear seasonal variability from 15 to 60 (per mil). The quick response to the increased atmospheric ^{14}C and the high post-bomb peak (+160 per mil) indicate a North Pacific source to the waters entering the Indonesian Throughflow. Sensitivity tests were run to investigate the role of surface mixed layer depth and parameterization using an atmosphere/ocean coupled model (GFDL MOM) and compared to the coral radiocarbon time series. The model results exhibit a post-bomb peak that is too high and slightly early but displays the seasonal signal shown by the coral. The model also retains too much radiocarbon after the bomb-peak suggesting the model is exchanging too much CO_2 and not mixing it through the water column rapidly enough.

OS31D-06 1135h

The Effects of the Indonesian Throughflow on the Indian Ocean Meridional Overturning Circulation and Heat Budget

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The sensitivity of the Indian Ocean meridional overturning circulation (MOC) and heat budget to the Indonesian Throughflow (ITF) transport variability is investigated in an ocean general circulation model that is coupled to an atmospheric mixed layer model. Four experiments are performed: (1) ITF blocked, (2) 10Sv ITF, (3) 20Sv ITF and (4) 10Sv ITF but with vertical transport profile more thermocline intensified. The Indian Ocean MOC responses to the net transport input of ITF by introducing net southward transport south of the entrance latitude of ITF to the Indian Ocean (about 10S). The compensating southward transport in the southern Indian Ocean occurs mostly in the upper 1000m within the Agulhas Current with minor proportion within the Leeuwin Current. The deep overturning cell (below 1500m) south of 10S is insensitive to the ITF transport variability. The ITF heat flux into the Indian Ocean associated with its transport is mostly compensated by the ocean meridional heat flux (OMHF) in the southern Indian Ocean, while surface heat fluxes over the Indian basin plays a minor role and insignificantly varies with the ITF transport. The anomalous OMHF, comparing any ITF-open scenario with the ITF-blocked scenario, caused by the velocity anomalies dominates that caused by the temperature anomalies. Between the two components of the OMHF, the meridional overturning component and the horizontal gyre component, the former is more important in delivering the ITF heat flux southward out of the Indian basin than the latter. The magnitudes of both components are positively correlated with the magnitude of ITF heat flux. With more ITF transport in the thermocline rather than in the surface layer and hence less ITF heat flux, the magnitudes of both the OMHF and net surface heat fluxes decline.

OS31D-07 1150h

The Ocean Circulation of the Ross Sea, Antarctica during the 1990s

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During the 1990s several major United States and Italian research programs worked concurrently in the Ross Sea. Here we take advantage of recent hydrographic and current meter data collected over the Ross Sea continental shelf to describe the ocean circulation and its interannual variability during the 1990s. The hydrographic data reveal a well-defined cyclonic gyre in the southwest Ross Sea and in many locations this result is supported by direct current meter observations. The most notable departure from the simple circulation pattern portrayed by the hydrographic data occurred in the Ross Sea Polynya where strong, wind-forced, upper-ocean flow opposed the baroclinic circulation. The atmospheric circulation over the Ross Sea during the 1990s appears to have been strongly modulated on interannual time scales by the El Niño-Southern Oscillation (ENSO) phenomenon. Evidence is presented here suggesting that the upper-ocean currents within the Ross Sea Polynya respond on interannual time scales to changes in the strength of the imposed wind forcing (i.e. years with stronger atmospheric forcing appear to have stronger upper-ocean flow). Sea ice adjacent to the Ross Ice Shelf (RIS) also varied on interannual time scales and achieved its minimum values during 1996 and 1999, the two La Niña years. Ocean currents near the shelf break (mooring B') during those two years showed northward export of a thick layer of shelf water, presumably in response to stronger buoyancy forcing near the RIS. In contrast, large changes in the near-bottom shelf flow north of Ross Island (mooring A'/Adelie) occurred during 1997-1999 roughly in phase with the development and later relaxation of the 1997/1998 El Niño. It is suggested that remote forcing through interactions with the subice cavity are responsible for the observed interannual changes at A'/Adelie.

OS31D-08 1205h

Decadal Variability of Shallow Cells and Equatorial SST in a Numerical Model of the Atlantic

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The relative role of extra-equatorial mechanisms modulating decadal SST anomalies in the equatorial Atlantic is investigated using an ocean general circulation model (OGCM) forced by observed wind stress and/or computed heat flux from the associated advective atmospheric mixed layer model. Longterm variability of the shallow meridional overturning circulation, the Subtropical Cells (STCs), which conduit subducted water to lower latitudes, can lead to potentially relevant SST anomalies in the eastern tropics by either (1) equatorward advection of temperature anomalies formed by the subduction process in the subtropics or (2) by changes in the strength of the STCs themselves, varying the amount of cold water that is transported into the tropics. A suite of sensitivity studies is applied to isolate each of the mechanisms at work and to estimate their particular impact on equatorial SST anomalies in the model.

OS32A MCC: Level 1 Wednesday 1330h

Recent Advances in Understanding Submarine Environments and the Future of Submergence Research and Facilities Posters *(joint with B, T, V)*

Presiding: **P Fryer,** University of Hawaii**; D Fornari,** Woods Hole Oceanographic Institution

OS32A-0224 1330h POSTER

The New Alvin and the Scheduling/Planning Processes for the National Deep Submergence Facility Jon C. Alberts, Barrie B. Walden, Richard F. Pittinger

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The United States Deep Submergence Facility is in the process of obtaining support for construction of a new manned submersible as a replacement for DSV Alvin. A new 6000+ meter manned submersible will provide U.S. scientists with access to an additional 35 per cent of the ocean floor including some currently unreachable portions of the U.S. EEZ. Researchers will have a vehicle designed for the missions currently conducted and those of the foreseeable future having the power and endurance to maximize the usefulness of available research time. They will have a more comfortable vehicle with a larger interior, improved viewport placement, greater battery capacity, and generally better able to handle the burgeoning scientific equipment requirements. Lastly they will have a vehicle that builds on the experience and improvements of 35 years that have made ALVIN the most successful research submersible in the world. The adaptability of the National Deep Submergence Facility (NDSF) to a wide variety of science needs is its strength, but this complexity can also confuse and intimidate new users. The NDSF maintains strong science liaison services and provides potential users with assistance throughout the process of cruise planning, proposal preparation, and execution of field programs. Procedures for gaining access to these vehicles are not difficult and potential users are assisted both directly by the NDSF personnel and also through a user group of scientists dedicated to providing the benefit of their experience. A successful mechanism for obtaining feedback between users and operator has been established through the Deep Submergence Science Committee (a UNOLS oversight committee) and the science community. Programs are selected for funding on a competitive basis through various federal funding agencies by standard agency review processes. DSV ALVIN and its support ship R/V ATLANTIS are owned by the U.S. Navy and operated under charter agreement with the Office of Naval Research. Operation of the NDSF remotely operated vehicle (ROV) assets can be arranged in a fly-away mode on appropriate vessels within the UNOLS fleet or on commercial vessels or foreign research vessels provided they are suitably equipped. Scheduling of the R/V ATLANTIS is arranged through UNOLS, as is the use of the ROVs on UNOLS ships. Coordination between funding agencies and the UNOLS scheduling process strives to provide the users with the optimal scheduling of the assets in a given year. Requests for at-sea use of these assets remain strong for the foreseeable future.

OS32A-0225 1330h POSTER

Navigation Upgrades to the National Deep Submergence Facility Vehicles D.S.V. Alvin, Jason 2, and the DSL-120A

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We report on recently completed enhancements to the navigation systems employed on the 4500m submersible Alvin and the 6500m ROV Jason 2 and DSL-120A sonar system of the UNOLS National Deep Submergence Facility (NDSF) of the Woods Hole Oceanographic Institution (WHOI). Over the last two years we have significantly improved the accuracy and update rate of the six degree-of-freedom vehicle position and velocity navigation data available for these vehicles, thus improving the quantitative accuracy of acoustic surveys, optical surveys, and sampling operations. The navigation upgrades have also enabled improvements in the closed-loop dynamic positioning accuracy of the Jason 2 ROV, thus improving the vehicle tracking precision during survey and sampling operations. We have sought to employ more a uniform suite of navigation instruments, navigation data processing software systems, and data logging format standards for NDSF vehicles to improve the utility and ease-of-use of data by science users. Improved navigation instruments deployed on each of these vehicles in 2001 and 2002 include the following: (a) A 1200 KHz Bottom Lock Doppler Sonar (RDInstruments Inc.) providing three dimensional vehicle velocity information with respect to the ocean floor and the water column at an update rate of up to 10 Hz, providing a single-ping beam-velocity error standard deviation of 0.3% for a nominal advance velocity of 1 meter/sec. (b) A north-seeking fiber-optic gyroscope (IXSEA Inc.) providing true-north heading, pitch, and roll with a rated accuracy of 0.1 degree. Improved navigation data processing software systems deployed on these vehicles in 2001 and 2002 includes Dvlnav, an interactive navigation program developed at JHU for precision navigation of underwater vehicles and submersibles. DVLNAV employs a variety of sensors including bottom lock Doppler sonar, long baseline (LBL) acoustic navigation, gyro compasses, magnetic compasses, depth sensors, altimeters, and (when available) GPS. All navigation data are logged in ASCII data files time-stamped to 0.001 second, and also logged in simple spreadsheet files with headers containing navigation data at one second intervals, enabling simplified transfer to popular data processing programs. Operational results (e.g. Rzhanov et. al. poster in OS-10 session) indicate the utility of this navigation system. Elements of this navigation system have been adopted for use by the University of Southampton's (UK) new ISIS ROV. We anticipate that future improvements to this navigation system will include improved LBL navigation hardware, an improved LBL navigation processing software application, inertial navigation sensors, and improved post-processing software tools. http://www.whoi.edu/marops/vehicles http://robotics.me.jhu.edu/dscl/dvlnav

OS32A-0226 1330h POSTER

Jason 2: A Review of Capabilities

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The family of remotely operated vehicles (ROVs) operated by Woods Hole Oceanographic Institution (WHOI) for the United States oceanographic research community through the University National Oceanographic Laboratory System (UNOLS), represent some of the most advanced tools and technology available for accomplishing a wide variety of deep submergence science and operations. Over the past five years, research done using these vehicles has provided major contributions to the understanding of deep-sea geological, chemical and biological processes at mid-ocean ridges (MORs). The ROV systems have also contributed to successful deployment of ocean floor observatory monitors and various sensors that seek to understand the geophysical and geotechnical properties of young crust and provide an ability to make routine time series measurements. As a result of experience gained during over 25 cruises with Jason and its companion vehicles and input from the user community and the DEep Submergence Science Committee (DESSC) of UNOLS, WHOI has recently completed an upgrade to the Jason vehicle. This has resulted in substantive additions to the vehicle's capabilities, particularly in the area of propulsion power and manipulative capabilities. During its first complete year of operation, the vehicle has operated a cumulative total of approximately 60 days in the water at depths up to a maximum of 6,500 meters. This poster will describe the capabilities of the new Jason vehicle and briefly review if achievements.

OS32A-0227 1330h INVITED POSTER

Submersible Research in Extreme Environments Using a Novel Light-Tethered Hybrid ROV

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The Hybrid Remotely Operated Vehicle (HROV) will provide the U.S. oceanographic community with capable and cost-effective technology for routine access to the world's oceans to 11,000 meters. The hybrid vehicle design permits operation as an untethered, fully autonomous vehicle, and also as a self-powered ROV employing a 3mm diameter optical fiber tether for real-time telemetry of data and video to operators on a surface ship. Several environments that are currently inaccessible for detailed research have sufficiently mature and testable scientific problems that could be addressed using the HROV. The greatest depths on the surface of Earth are found in oceanic trenches. The complex effects of subduction of oceanic lithosphere beneath both continental and oceanic lithospheric plates are subjects of intense interest in the marine geological and geophysical community because they are prime areas where oceanic lithosphere is recycled back into the mantle. Recent studies of the Challenger Deep (CD) in the Mariana Trench show potential fluid conduits on the subducting plate that occur at depths greater than 10,000 m. The inner trench slope in the vicinity of the CD is a site where fluids derived from the down-going plate and talus from the overriding plate may be interacting. The processes of talus accumulation at this locality and the ultimate fate of the material may be critical to understanding the processes of tectonic erosion and of arc recycling in convergent plate margins. Also, the biology and microbiology of these sites is virtually unknown. The HROV will be ideally suited to conduct pioneering mapping and sampling of these seafloor environments. Over the past few decades, mid-ocean ridge studies have been enabled by deep submergence vehicle access and capabilities, and likewise, this branch of science has provided compelling need for the current family of synergistic deep submergence systems. With the recent identification and first-order mapping and dredging studies of ultra-slow spreading ridges in the Arctic, for instance, scientists are poised to make breakthroughs in our understanding of this important end-member of seafloor spreading environment. The ability to sample and observe detailed geological, biological and chemical processes occurring at these slowest spreading MORs will undoubtedly revolutionize our understanding of how seafloor spreading is manifested in these settings. In addition, we expect to find a host of novel biological communities and chemical-biochemical processes associated with recently discovered hydrothermal venting on Gakkel Ridge in the Arctic Ocean as a consequence of tectonic isolation starting in the late Mesozoic. It was not until the middle Miocene that deep water communication was reestablished with the north Atlantic and not until 3Ma with the north Pacific . Currently, Iceland essentially blocks potential migrations from the mid-Atlantic ridge to the Gakkel ridge. The HROV will be highly applicable to operations under-ice, such as those that will be required for survey, close-up inspection, and sampling of sites on the ultra slow spreading Gakkel Ridge in the Arctic Basin.

OS32A-0228 1330h POSTER

Hybrid ROV For 11,000 Meter Operations

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The goal of this project is to provide the U.S. oceanographic community with the first capable and cost effective technology for regular and systematic access to the world's oceans to 11,000 meters. The vehicle will be able to operate untethered as a fully autonomous vehicle and also as a self-powered vehicle employing a 3mm diameter optical fiber tether for real-time telemetry of data and video to its human operators on a surface ship. We term this new class of vehicle a Hybrid Remotely Operated Vehicle (HROV). For the past 50 years, vehicle limitations have restricted direct access to depths of 6,500 m or less. Only a few deeper vehicles have ever been developed, notably the Trieste, which Piccard and Walsh piloted to the floor of the Marianas Trench in January 1960 and Japan's Kaiko ROV, which dove to 10,912 m depth in 1995. These deep deployments did not produce substantive scientific research results, indeed the technical and practical limitations rendered these efforts largely engineering trials. The scientific community has established the imperative to investigate the deep ocean floor at depths below 6500 m, yet a lacuna of practical technology prevents routine access to the deepest ocean. This virtually unexplored area of the ocean includes a wide range of tectonic regimes that pose significant questions about broad, fundamental problems in the earth and ocean sciences. The proposed HROV described in this poster will have capabilities of both an AUV and ROV. While operating untethered, the vehicle will operate as a traditional AUV, which has proven highly effective for a variety of survey operations. While connected to the surface with a lightweight fiber optic tether, high bandwidth two-way communications will permit the return of high quality video and sensor data, enabling close-up inspection, sampling, and instrument deployment/recovery operations to be conducted under the command of pilots and scientists onboard a research vessel. Our vehicle concept allows conversion from an AUV to a Hybrid-ROV (HROV) while at sea, thereby enhancing the science mission capabilities on a single cruise. Our technical approach builds on the success of WHOI ROVs such as Jason 1 and Jason 2, and AUVs such as ABE, that have proven to be effective for scientific operations. Additionally, we have established collaborations with other research groups that have pioneered the use of lightweight fiber optic tethers and ceramic pressure housings for 11,000 meter operation.

OS32A-0229 1330h POSTER

The Autonomous Benthic Explorer and Sentry: Autonomous Underwater Vehicles for Near-Bottom Geophysical Survey

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The Autonomous Benthic Explorer (ABE) and Sentry are autonomous underwater vehicles (AUVs) designed for deep-ocean near bottom surveys. ABE has completed over 100 science dives while Sentry is under construction and nearing completion. Both vehicles have a maximum depth of 5000m and travel at typical speeds of 0.6 m/sec. At this speed, ABE has sufficient power for over 33 hours of level survey with its basic sensor suite, LBL navigation system, sonar altimeter, conductivity and temperature, precision depth, optical backscatter, 675 kHz scanning bathymetric sonar and a magnetometer. Optional sensors currently include an 80-element 200kHz multibeam sonar and a 1280x1024 12 bit CCD camera with xenon flash. In typical ocean ridge conditions, image quality is good up to 10m off the bottom. ABE is a holonomic vehicle and can maneuver safely over rugged terrain. If desired, ABE's position in the LBL net can accurately be monitored from the ship although ABE can operate completely unattended. ABE includes an emergency acoustic command link for control from the ship if necessary. Sentry is designed to have lower hydrodynamic drag than ABE but sacrifices true holonomic control by eliminating direct lateral drive. Sentry will carry all the sensors of ABE plus an ADCP and INS navigation package.

OS32A-0230 1330h POSTER

Complementary Fine-Scale Multibeam Acoustic Bathymetry and Photomosaicking from an Autonomous Underwater Vehicle

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In June of 2003, we surveyed portions of the New England Seamounts with the Autonomous Benthic Explorer (ABE). We used multibeam bathymetry and digital photo imagery to characterize the mountainous terrain and to search for environments where fossilized deep sea corals could be found, enabling efficient sampling by DSV Alvin. The surveys utilized ABE's long baseline acoustic navigation, bottom-following, and track-following capability along with its 80-element 200 kHz multibeam sonar to create detailed bathymetric maps. Then, these maps were used to plan photomosaicking runs that enabled the vehicle to follow nearly-constant depth profiles from a height of 6 meters. This technique not only produced photo runs from a nearly uniform depth, but it substantially improved the vehicle's bottom-following performance and reduced vehicle power consumption. The resulting complementary maps show areas where the desired fossil corals can be found, and relate those areas to the overall geological setting.

OS32A-0231 1330h POSTER

High-Resolution Photo-Mosaicing of the Rosebud Hydrothermal Vent Site and Surrounding Lava Flows, Galapagos Rift 86W: Techniques and Interpretations

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The Rosebud hydrothermal vent field was discovered in May 2002 in the Galapagos Rift near 86W during a series of Alvin dives and ABE autonomous vehicle surveys. Vertical-incidence digital imaging using a 3.1 Mpixel digital camera and strobe illumination from altitudes of 3-5m was carried out during the Alvin dives. A complete survey of the Rosebud vent site was carried out on Alvin Dive 3790. Submersible position was determined by post-cruise integration of 1.2 MHz bottom-lock Doppler sonar velocity data logged at 5Hz, integrated with heading and attitude data from a north-seeking fiber-optic gyroscope logged at 10Hz, and initialized with a surveyed-in long-baseline transponder navigation system providing geodetic position fixes at 15s intervals. The photo-mosaicing process consisted of three main stages: pre-processing, pair-wise image co-registration, and global alignment. Excellent image quality allowed us to avoid lens distortion correction, so images only underwent histogram equalization. Pair-wise co-registration of sequential frames was done partially automatically (where overlap exceeded 70 percent we employed a frequency-domain based technique), and partially manually (when overlap did not exceed 15 percent and manual feature extraction was the only way to find transformations relating the frames). Partial mosaics allowed us to determine which non-sequential frames had substantial overlap, and the corresponding transformations were found via feature extraction. Global alignment of the images consisted of construction of a sparse, nonlinear over-constrained system of equations reflecting positions of the frames in real-world coordinates. This system was solved using least squares, and the solution provided globally optimal positions of the frames in the overall mosaic. Over 700 images were mosaiced resulting in resolution of 3 mm per pixel. The mosaiced area covers approximately 50 m x 60 m and clearly shows several biological zonations and distribution of lava flow morphologies, including what is interpreted as the contact between older lobate lava and the young sheet flow that hosts Rosebud vent communities. Recruitment of tubeworms, mussels, and clams is actively occurring at more than five locations oriented on a NE-SW trend where vent emissions occur through small cracks in the sheet flow. Large-scale views of seafloor hydrothermal vent sites, such as the one produced for Rosebud, are critical to properly understanding spatial relationships between hydrothermal biological communities, sites of focused and diffuse fluid flow, and the complex array of volcanic and tectonic features at mid-ocean ridge crests. These high-resolution perspectives are also critical to time-series studies where quantitative documentation of changes can be related to variations in hydrothermal, magmatic and tectonic processes.

OS32A-0232 1330h INVITED POSTER

Upgrades to NDSF Vehicle Camera Systems and Development of a Prototype System for Migrating and Archiving Video Data in the National Deep Submergence Facility Archives at WHOI

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In recent years, considerable effort has been made to improve the visual recording capabilities of Alvin and ROV Jason. This has culminated in the routine use of digital cameras, both internal and external on these vehicles, which has greatly expanded the scientific recording capabilities of the NDSF. The UNOLS National Deep Submergence Facility (NDSF) archives maintained at Woods Hole Oceanograpic Institution (WHOI) are the repository for the diverse suite of photographic still images (both 35mm and recently digital), video imagery, vehicle data and navigation, and near-bottom side-looking sonar data obtained by the facility vehicles. These data comprise a unique set of information from a wide range of seafloor environments over the more than 25 years of NDSF operations in support of science. Included in the holdings are Alvin data plus data from the tethered vehicles- ROV Jason, Argo II, and the DSL-120 side scan sonar. This information conservatively represents an outlay in facilities and science costs well in excess of $100 million. Several archive related improvement issues have become evident over the past few years. The most critical are: 1. migration and better access to the 35mm Alvin and Jason still images through digitization and proper cataloging with relevant meta-data, 2. assessing Alvin data logger data, migrating data on older media no longer in common use, and properly labeling and evaluating vehicle attitude and navigation data, 3. migrating older Alvin and Jason video data, especially data recorded on Hi-8 tape that is very susceptible to degradation on each replay, to newer digital format media such as DVD, 4. improving the capabilities of the NDSF archives to better serve the increasingly complex needs of the oceanographic community, including researchers involved in focused programs like Ridge2000 and MARGINS, where viable distributed databases in various disciplinary topics will form an important component of the data management structure. We report on an archiving effort to transfer video footage currently on Hi-8 and VHS tape to digital media (DVD). At the same time as this is being done, frame grab imagery at reasonable resolution (640x480) at 30 sec. intervals will be compiled and the images will be integrated, as much as possible with vehicle attitude/navigation data and provided to the user community in a web-browser format, such as has already been done for the recent Jason and Alvin frame grabbed imagery. The frame-grabbed images will be tagged with time, thereby permitting integration of vehicle attitude and navigation data once that is available. In order to prototype this system, we plan to utilize data from the East Pacific Rise and Juan de Fuca Ridge which are field areas selected by the community as Ridge2000 Integrated Study Sites. There are over 500 Alvin dives in both these areas and having frame-grabbed, synoptic views of the terrains covered during those dives will be invaluable for scientific and outreach use as part of Ridge2000. We plan to coordinate this activity with the Ridge2000 Data Management Office at LDEO.

OS32A-0233 1330h POSTER

Use of Thermocouple Arrays to Investigate the Environment Within Actively Forming Chimney Deposits, Guaymas Basin

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Four Ti-thermocouple arrays were deployed in March 2003 at 3 discrete vent structures in Guaymas Basin to trace the evolution of environments within newly formed chimney walls, and to determine the distribution of microorganisms within this temporal, chemical, thermal, and spatial framework. Temperatures were recorded as the thermocouples were enveloped during chimney growth. Upon recovery (after 4 and 72 days), the solid material (dominantly calcite and anhydrite) adjacent to each thermocouple was sub-sampled for molecular, chemical, and isotopic analyses. Final recorded temperatures within the 3 chimneys ranged from 110C to 303C. At a lower temperature, more hydrocarbon-rich vent site, thermocouples remained dominantly within warm flow and the small amount of material that formed around two of the thermocouples (that recorded maxima of 71C and 176C) washed away during recovery. Periodic (including diurnal) variability was observed in many of the temperature records including from inside the hottest channel (0.3C amplitude), within chimney walls (up to 15C amplitude), and outside the structures. The within-structure periodic temperature variability likely reflects advection of cold fluid through the walls in response to pressure changes caused by strong bottom currents. Similar temperature variability within growing chimneys has been attributed to pressure changes caused by bottom currents at other vent sites, and provides evidence for walls being very permeable. Fluids exiting each structure were sampled and are being analyzed; the data will provide constraints for diffusive and advective transport models used to determine the chemical environment within chimney walls so that microbial populations can be placed in a unified chemical, thermal, and temporal context.

OS32A-0234 1330h POSTER

Hydrothermal deposits in the Southern Trough of Guaymas Basin, Gulf of California: Observations and Preliminary Results from the 2003 MBARI Dive Program

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During Leg 2 of the 2003 MBARI expedition to the Gulf of California, the ROV Tiburon completed eight dives to active vent fields in the Southern Trough of Guaymas Basin. Six venting areas were investigated in detail. Tiburon operations included (1) sampling mineral deposits that range from mini-chimneys a few centimeters high to 10-meter-tall sulfide-carbonate structures with wide flanges; (2) collection of 90C to 303C methane, carbon dioxide, and hydrogen-rich vent fluids in gas-tight samplers and plume-laden particulates in Niskin samplers; 3) collection of warm (up to 83C) hydrocarbon-rich sediment push cores; 4) long-term monitoring of three vent sites using thermocouple arrays (see adjacent Tivey et al poster) and osmotically-driven fluid samplers. Seventy days later, the ROV returned to recover the thermocouple arrays and ingrown chimneys. At the lowest temperature sites, fluid (up to 90C) discharged from orifices in sediment surrounded by white to yellow microbial mats. Combined Eh-ISUS (InSitu Ultraviolet Spectrophotometer) sensors mounted on Tiburon identified local increases in bisulfide and decreases in the oxidation/reduction potential (a proxy for methane and hydrogen sulfide) associated with these sites. Massive barite chimneys recovered from the margins of moderate-temperature vent sites are permeated with oil. Chimneys from higher temperature sites, in contrast, lack the liquid hydrocarbon component, and are largely composed of calcium carbonate with lesser anhydrite, amorphous silica, barite, pyrrhotite, Mg-silicate, galena, sphalerite, and chalcopyrite. Mineral precipitation at the southernmost site (Toadstool) is characterized by the formation of carbonate-rich flanges directly above a substrate of altered diatomaceous sediment. The upper sediment crust lies above a stockwork of calcite veins. High-temperature structures at Rebecca's Roost and Broken Mushroom have pagoda-like carbonate-rich flanges trapping pools of hydrothermal fluids that facilitate the growth of centimeter-thick layers of euhedral carbonate and pyrrhotite. Rapidly formed, anhydrite-rich chimneys are present at the summit of the pagoda structures. In-situ laser ablation Sr isotopic analyses of calcite and anhydrite indicate that minerals within flanges precipitate from vent fluids with less than 5% seawater dilution, whereas minerals within the more permeable anhydrite-dominant chimneys precipitate from mixtures of vent fluid with up to 70% seawater.

URL: http://www.mbari.org/expeditions/GOC/Mission/leg2.htm

OS32A-0235 1330h POSTER

First Expeditionary Deployments of the Deep Ocean Raman In Situ Spectrometer

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MBARI's *in situ* laser Raman spectrometer (DORISS – Deep Ocean Raman In Situ Spectrometer) was deployed at gas vents in Guaymas Basin, Gulf of California in April 2003. The first *in situ* Raman spectra of natural gas venting from the seafloor were obtained. These spectra will be compared to GC analyses of samples collected at the same vent and Raman analyses of pure methane deployed as a standard for at-sea testing. Laser Raman spectroscopy is a powerful geochemical technique for analyzing the chemical composition and molecular structure of solids, liquids, and gases. The prototype deep-ocean Raman instrument is based on an off-the-shelf laboratory model from Kaiser Optical Systems, Inc. Engineering test deployments conducted over the past 1.5 years have proved that Raman spectra of high quality can be obtained in the deep ocean. We have acquired spectra from solid, liquid and gaseous standards deployed as deep as 3600 m in the ocean. We are currently in the next phase of development which consists of using DORISS for exploratory measurements of natural targets in the deep ocean. During an expedition to the Gulf of California on the R/V Western Flyer in April 2003, DORISS was deployed successfully by the ROV Tiburon at natural gas vents on the seafloor (∼1700 m depth). The laser probe head was focussed into a small volume of gas trapped in a sampling funnel. Spectra were collected of gas samples at the vent site and at depths above the hydrate stability zone. Bands for methane dominate the spectra. Attempts to collect spectra of natural gas hydrates at the vent were difficult due to the stringent positioning requirements of the probe head when analyzing solid, opaque targets. This problem has been addressed by the development of a precision underwater positioner that provides a stable platform for analyses and movement of the DORISS probe head with a precision of 0.1 mm.

OS32A-0236 1330h POSTER

Development of a Precision Underwater Positioner for *In Situ* Spectrographic Applications

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MBARI has developed and deployed a precision underwater positioner for use with its laser Raman spectrometer (DORISS – Deep Ocean Raman In Situ Spectrometer). The DORISS instrument is capable of obtaining chemical and structural information *in situ* from gaseous, liquid or solid targets in the deep ocean. However, when analyzing solid, opaque objects, the instrument probe head must be positioned with a precision of ∼0.1 mm. Additionally, the probe head must be free of vibration and other motions induced by the ROV, and stable for tens of minutes for data acquisition. The Precision Underwater Positioner (PUP) was developed as an off-loadable platform to meet the stringent positioning requirements of the DORISS instrument. The functional requirements call for a positioner that can be carried and deployed by an ROV; is off-loadable onto the seafloor to decouple the sensor head from ROV-induced motion or vibration; is stable on various types of seafloor terrain; incorporates a camera, lights, and crossing lasers to help with proper positioning; is controllable by a shipboard scientist via a GUI which provides position feedback; has variable speeds; and has a full range of 15 cm in each direction with a precision of 0.1 mm. While the PUP was designed to meet the needs of the DORISS instrument, it is a stand-alone system that can also be used with other sensors that require similar positioning requirements. The Precision Underwater Positioner is 5 degree of freedom positioner on a tripod platform – Z, R, θ, and pan and tilt at the sensor head. Adjustable legs allow it to accommodate uneven seafloor. Phase I of the PUP consists of only 2 degrees of freedom (Z and R), and has rigid legs. It has been built, tank tested, and deployed on the seafloor (∼175 m depth) for at-sea tests. This testing has verified that the PUP meets the stipulated requirements and is capable of providing the stability and positioning necessary to collect quality Raman spectra of solid and opaque targets on the seafloor (to depths as great as 4000 m).

OS32A-0237 1330h POSTER

Comparison of Sidescan and Swath Bathymetry and Imagery Merging Various Types of Swath-Mapping Sonar Data Sets Using a Variety of Post-Processing Display Techniques

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Recently collected bathymetry and sidescan data from seamounts on the Mariana forearc show the potential for interpretation of geologic processes using new techniques for post-processing and display of these data. These techniques and algorithms employ freely available software packages in the public domain that are in general use in the academic community. Swath data acquired recently with the R/V *Thompson* EM300 and Hydrosweep systems, the R/V *Melville* SeaBeam system, the HMR1 sidescan sonar system, and the DSL120 sidescan sonar system show the full spectrum of application of these systems to the various tectonic provinces of a convergent margin of the Western Pacific (Pacific Plate and Mariana forearc). The HMR1 bathymetry and imagery combined with SeaBeam and Hydrosweep bathymetry provides data for the subducting plate and the deepest portions of the trench. A DSL120 survey of the abyssal plain of the Pigafetta Basin, 1800 km NE of Guam, provides the best-quality product from this upgraded sidescan system. The DSL120 and EM300 systems were both used to prepare detailed images of the summit regions of seamounts on the Mariana forearc. The EM300, Hydrosweep, and HMR1 systems provided regional survey data and detail of the deeper forearc areas. The recently upgraded DSL120 system provides both imagery and bathymetry data of the summits of the forearc seamounts. Merging data collected by these different systems, mounted on different platforms, each yielding different types of data at differing resolutions provides multiple renderings that can be used to highlight a variety of aspects of a given geologic feature. Fly-bys and 3-D stereo anaglyph renderings bring the geology into immediate contextual focus. The data manipulation techniques applied are powerful tools for interpretation, but the inexperienced researcher initially faces a steep learning curve. On-line tutorials and manuals that are constantly being updated provide the necessary first steps as well as help for the more experienced user. The techniques we use to merge data sets augment the utility of the various online software packages for processing these data and make them more compelling and accessible for the novice.

OS32A-0238 1330h POSTER

A New Method For Processing Backscatter Imagery Collected By Multibeam Sonars: The HAWAII MR1 Sidescan Sonar Software Suite

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The Hawaii Mapping Research Group of the University of Hawaii has developed and used in-house software to process seafloor acoustic imagery (sidescan sonar) data acquired by its own shallow-towed HAWAII-MR1 phase-difference sidescan bathymetry mapping system, as well as phase-difference sonars operated by other institutions (NAVO SEAMAP-C, LDEO SCAMP, WHOI DSL-120A). During 2003 the HAWAII MR1 software tools were modified to operate on multibeam backscatter data collected by the University of Hawaii research vessel Kilo Moana to test whether the software could improve the quality of the multibeam backscatter and the resulting data products. We found that the MR1 processing tools are effective in eliminating speckle and stripe noise, and cross-track amplitude variability due to angle-varying gain. HMRG software was also used to produce final mosaics of sonar imagery. Once we determined the viability of using the MR1 tools to process Kilo Moana data, we expanded the toolkit to allow operation on data from other multibeam systems as well. HMRG processing software runs on Linux, Unix and Irix platforms. The main processing modules can be run in either graphical or command-line modes. The preferred processing scheme involves using the graphical interface to interactively determine noise filters appropriate for each survey. Once characterized, these filters are then applied in batch processes that run faster than graphical methods allow. Once processing is completed, the HMRG software is used to grid the data and then to assemble individual grids into mosaics. The mosaics can be output as Sun raster files, geotiffs, or Generic Mapping Tools (GMT) grids, which allow the mosaics to be imported into other GIS and charting programs. Here we present results from several recent surveys that used different hull-mounted multibeam systems: 12kHz Sea Beam 2112 data from the US Coast Guard Cutter Healy, 12kHz Simrad EM120 data from deep water surveys aboard the R/V Kilo Moana, shallow-water 95kHz EM1002 imagery from R/V Kilo Moana, and very shallow-water 240kHz survey data collected using a Reson 8101 aboard the National Oceanic and Atmospheric Administration survey launch R/V AHI. This new application of HAWAII MR1 software provides users of these systems a new, flexible approach to cleaning, displaying and disseminating backscatter imagery from multibeam sonars.

URL: http://www.soest.hawaii.edu/hmrg

OS32A-0239 1330h POSTER

The IMI-30 Seafloor Imaging System: Development of A New NSF Deep-Towed 30kHz Bathymetric Sidescan Sonar System

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The Hawai'i Mapping Research Group (HMRG) has been funded by the U.S. National Science Foundation (OCE-0097822) to build and operate a new deep-towed 30kHz phase-difference bathymetric sidescan sonar, the Imaging & Mapping Instrument - 30kHz (IMI-30) . IMI-30 will simultaneously acquire sidescan sonar imagery, phase difference bathymetry, and multibeam subbottom data, with the ability to host other user-supplied instruments as well. Construction of IMI-30 began in early 2003, and the first funded research survey using the system is anticipated to be scheduled in 2004. Here we discuss the planned capabilities of the system, describe the current state of development, and present results from recent test cruises. The IMI-30 design is functionally similar to the HAWAII MR1 and DSL-120 towed sonars, sharing fundamental electronic characteristics, data acquisition computers, and sonar processing software. These shared characteristics allow hardware, software, and support staff to be shared between these systems, resulting in lower operational costs and a larger pool of engineers, technicians and scientists familiar with the maintenance, operation, and data processing requirements of this family of sonars. IMI-30 is fully portable for use on UNOLS global- or ocean-class vessels. Once operational, IMI-30 will be available to all NSF-funded researchers as an NSF facility maintained as part of the University of Hawai'i shared-use equipment pool. Transducers for IMI-30 were fabricated in-house using surplus United States Navy DT605 hydrophones recovered from decommissioned Sturgeon-class submarines. These transducers were designed for use at 30 kHz, and are of an advanced design with multiple element ceramic stacks and exotic materials for head and tail masses. To create long arrays we encapsulated parts of the DT605 array in smaller modules, and tested the sample modules at the Acoustic Test Facility at the Naval Undersea Warfare Center in Keyport, WA. We compared the observed performance with commercial 30 kHz transducers provided by the Unites States Geological Survey. The performance of the modules fabricated at HMRG is excellent (phase response, frequency response, and beam pattern), at a significant cost savings. More recently, system integration tests involving deployments aboard the UH R/V Klaus Wertke have been conducted that demonstrate the capability of the sonar, telemetry, data acquisition and data processing systems, and we present these results here.

URL: http://www.soest.hawaii.edu/hmrg/imi30

OS

OS32A-0240 1330h POSTER

HURL's 2003 OE and NURP Deep Submergence Science Program in the NW and Main Hawaiian Islands and Projects Planned for 2004-2006.

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This presentation will emphasise the advantages of using manned submersibles in conjunction with ROV pre-surveys during UH's NOAA-funded Hawaii Undersea Research Laboratory 64-day Ocean Exploration research cruise in the NW Hawaiian Islands scheduled for Sept 3-Nov 6, 2003. The up-leg to Kure Atoll will focus on "Submarine Canyon and Scavenger Communities" (PIs Craig Smith & Eric Vetter) and "Characteristics of Deepwater Fish and Precious Corals on the Seamounts Neighboring Hawaii's Most Remote Seal Colonies" (PI: Frank Parrish). Two projects for PIs Amy Baco-Taylor & Timothy Shank are scheduled for the down-leg: "Seamount Surveys of Deep-Water Corals as Related to Geological Setting in the NWHI" and "Reproductive Biology and population genetics of Precious Corals in Hawaii". For 2004 -2006, HURL has 18 peer-reviewed projects approved. These include 45 submersible dives for projects in US Flag Waters SE of Hawaii, during a joint NURP-OE Expedition to American Samoa, scheduled for late 2004 and early 2005. Dives for most projects in the Main and nearer NW Hawaiian Islands will be scheduled for 2006, with a few exceptions. The scope and rationale of this planned program exemplifies the synergy between NOAA's Ocean Exploration and Undersea Research Program objectives.

URL: http://www.soest.hawaii.edu/HURL/research.html

OS32A-0241 1330h POSTER

Paleodictyon, a Living Fossil on the Deepsea Floor

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We report new observations based on high resolution imagery, in situ experiments, and recovery of samples made in conjunction with filming of the IMAX movie, "Volcanoes of the Deep Sea", which reveal hitherto unknown features of an enigmatic form on the deep seafloor. Thousands of strikingly hexagonal patterns (typically 5 to 7 cm diameter) formed by intersecting rows of tiny black dots were originally imaged on a veneer of calcareous lutite along 3 km of a camera tow up the lower east wall of the rift valley of the Mid-Atlantic Ridge between water depths of 3600 m and 3200m at 26o 09'N, 44o48'W (Rona and Merrill, 1976). Defying classification into either a known invertebrate phylum or as the product of a known organism, the hexagonal pattern was tentatively interpreted as the surface expression of a trace fossil (Paleodictyon nodosum) found in deepsea flysch sediments of Eocene age (Seilacher, 1977). Subsequent discoveries revealed that the modern Paleodictyon occurs in an outlying area of the Trans-Atlantic Geotraverse (TAG) hydrothermal field, where high-temperature activity ceased some hundreds of years ago and the veneer of lutite overlies metalliferous sediments. In situ observations show that the black dots are indeed vertical shafts about 1 mm in diameter, each of which connect to the midpoint of a strikingly regular network of horizontal tunnels or tubes 2 to 3 mm beneath the sediment surface. The surface patterns range from sharp shield-like forms several millimeters high that expose underlying metalliferous sediments and are surrounded by shallow moat-like depressions, to flat forms with rounded edges entirely in lutite. This variation suggests a degradation sequence under prevailing (c. 5 cm/s) or episodic near-bottom currents over hundreds of years based on the radiometrically measured regional sedimentation rate. The 3D morphology revealed by artificial erosion confirms identity with the fossil Paleodictyon nodosum. Biological studies of core samples recovered on a recent DSV Alvin dive are underway to test alternative hypotheses for the origin of the Paleodictyon pattern. In the paleontological view, the pattern is a tunnel system constructed as part of the feeding strategy (bacterial farming) of an unknown benthic invertebrate. Another hypothesis claims that we deal with the tubular body of an infaunal member of the Xenophyophorea, a poorly known group of foraminifera, like protozoans

OS32B MCC: Level 1 Wednesday 1330h

General Ocean Sciences: Estuaries Posters

Presiding: **M Tzortziou,** University of Maryland, College Park**; H A Zahakos,** Columbia University

OS32B-0242 1330h POSTER

Measurements of Remote Sensing Reflectance in Chesapeake Bay Using In-situ and Satellite (MODIS) Observations

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Obtaining accurate information on chlorophyll-a (Chl-a) concentration and dissolved organic material (DOM) composition in coastal waters, using remote sensing observations, is critical for primary production studies and carbon-cycling modeling. Since passive remote sensing relies on detecting the signal emerging from the oceans (water leaving radiance, nLw), it is of great significance to examine the accuracy of satellite water leaving radiances measured over coastal regions. In situ measurements of radiation fields and water optical properties were used to interpret satellite water-leaving radiance spectra measured by the Moderate Resolution Imaging Spectroradiometer (MODIS -Terra) over the estuarine waters of the northern mainstream of Chesapeake Bay. Good agreement between in-situ and MODIS data were obtained at longer wavelengths (488 nm and longer) including the spectral shape of the nLw values. There is a systematic problem at the shortest two MODIS wavelengths (412 and 443 nm) including a large percentage of negative or zero nLw values. The main issues that affect the accuracy of satellite estimations over such a highly complex estuarine environment (e.g. proximity to land mass, shallow waters, perturbed atmospheric conditions) were examined in this study.

OS32B-0243 1330h POSTER

Water Temperature Variability Along the West Coast of the Gulf of California

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The seawater temperature variability along the west coast of the Gulf of California for the time period March 2002 to March 2003 is discussed. The observations used for the analysis correspond to hourly samples at 10, 15, 20, and 25 m depths from moorings deployed in 35 m total depth at four locations along the west gulf coast, from its mouth to Ballenas channel: Cabo Pulmo (23° 23' N, 109° 25 W), Isla Espíritu Santo (24° 33' N, 110° 24' W), Punta Chivato (27° 04' N, 111° 58' W), and Bahía de los Ángeles (28° 58' N, 113° 31' W). Mean sea water temperatures increase along the gulf from the temperate north region to the subtropical gulf entrance (17 to 26°C). Temperature variability shows periodicities ranging from the seasonal to the semi-diurnal frequencies with decreasing amplitudes as frequency increases. Temperature seasonal cycle changes along the Gulf coast. Its amplitude diminishes from north to south were maximum temperature values are reached about 30 days later. Maximum and minimum values in the cycle increase northward; in contrast to the southward decreasing amplitude. Frequencies higher than seasonal exhibit two distinct patterns: An active spring and summer period and a quiet fall and winter one. During spring and summer vertical temperature differences increase and variability is dominated by 2 to 5° C amplitude oscillations at diurnal, 5 to 7 day, and quarterly frequencies. Fall and winter exhibit an almost constant vertical temperature distribution with weak oscillations ($< 1°$ C amplitude) at the same frequencies.

OS32B-0244 1330h POSTER

Impact of Stratification on Summer Hypoxia in Narragansett Bay, RI: Time-Series Observations and Numerical Modeling

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Determining water column structure in a partially-mixed estuary, such as Narragansett Bay, is important for understanding the impact stratification has on phytoplankton productivity and dissolved oxygen concentrations. Stratification reduces vertical mixing and influences the vertical flux of ecologically important variables such as phytoplankton, heat, oxygen, and nutrients. We utilize a combination of buoy data and numerical modeling to better understand processes surrounding the evolution and breakdown in stratification in Narragansett Bay for a range of environmental conditions. Autonomous sensors have been deployed in Narragansett Bay to collect continuous high temporal resolution chemical and hydrographic data. Data were collected every fifteen minutes 0.5 m below the surface and 1 m from the bottom from July 2001 to December 2001 and from July 2002 to December 2002 at two locations in Narragansett Bay and the Providence River, RI. The suite of water column variables measured were surface and bottom temperature, salinity, dissolved oxygen and pH, and surface chlorophyll. Results show that stratification events occur intermittently in the Providence River and Narragansett Bay and that increased phytoplankton productivity and hypoxia were associated with summertime stratification events. The Regional Ocean Modeling System (ROMS) model, a three-dimensional hydrodynamic model developed by Rutgers University, New Jersey, has been applied to Narragansett Bay to determine how the basic layered flow can be perturbed by runoff events and variable winds. For instance, in the basic stratified flow pattern in Narragansett Bay there is an outward flow of fresher water at the surface and an inward flow of deep denser water within the channel, however, strong south winds shutdown the deep return flow. Time series observations combined with model relationships have been able to enhance the understanding of the development and breakdown of stratification and the impact stratification has on phytoplankton blooms and dissolved oxygen conditions in Narragansett Bay.