UNOLS DEep Submergence Science Committee
Annual Planning Meeting
Cathedral Hill Hotel
1101 Van Ness Avenue
Telegraph Hill Conference Rooms A & B
San Francisco, CA
Saturday, December 5, 1998

Appendices

Sunday, December 5, 1998

Introduction - DESSC Chair's report, and Introduction of new DESSC Chair:
Mike Perfit, outgoing DESSC Chair, opened the meeting at 8:15 am by welcoming the meeting participants. He thanked UNOLS, the community and WHOI for their help and input over the past three years during his term as Chair. Mike then turned the meeting and chairship over to Patty Fryer, the new DESSC Chair. Patty welcomed the group and reviewed the meeting format. These minutes reflect the order in which the meeting agenda was addressed. The agenda is included as *Appendix I* and a list of meeting participants is included in *Appendix II*.

UNOLS Report - Bob Knox, UNOLS Chair, provided a brief report on the status of the UNOLS fleet. In 1998, a committee was formed by NSF to perform a review the academic fleet. Over the next 15 to 20 years a large number of the 28 ships in the fleet will be facing retirement. It is important to start planning now for their replacement. The need and use of the UNOLS Fleet needs to be better integrated into the National Fleet.

Bob Knox presented Mike Perfit with a plaque in honor of his dedication and contribution as chair of the Deep Submergence Science Committee. Mike was presented with a pottery gift from the community. Dick Pittenger, on behalf of WHOI, provided Mike with various WHOI memorabilia.

1998 Science Reports from ALVIN and ROV Users:

Brief reports from Science PIs who had used ALVIN and/or the ROVs over the past year were presented. Viewgraphs and other material from the science reports are included as ***Appendix III***.

Alan Chave began with a report on his cruise to 9N on the East Pacific Rise from 24 November to 24 December, see ***Appendix III-A***. This was a two-ship operation using ATLANTIS and NEW HORIZON. All 23 ALVIN dives were successfully completed. ALISS camera interfacing issues were encountered due to a corroded ALVIN fuseblock resulting in lost data on 2-3 dives. The ship was heavily utilized with physiology studies (Childress); light at vents studies (Chave/Van Dover) and sulfur-fixing bacteria (Taylor/Wirsen). There were also ancillary nighttime science programs.

Alan also participated in a cruise at Juan de Fuca during 24 June to 4 July 1998 (see ***Appendix III-A***). High winds and high sea states were experienced during the cruise resulting in the loss of three of the nine planned dives. Studies of the Light at Vents and fluid chemistry were conducted, but the ODP cork servicing could not be accomplished. Night programs and ancillary programs were carried out.

Karen Von Damm reported on her ATLANTIS/ALVIN cruise, Voyage 3, Leg XXVIII, to the Southern East Pacific Rise on October 10 through November 17, 1998, see ***Appendix III-B***. The science party included 24 scientists from ten different organizations. The dive sites included 21°33'S with work at nine vents. Temperatures of approximately 405°C were measured at a depth of 2,860m. This may represent the first sampling of a super-heated, supercritical fluid. Other vent sites visited included 21°24-26'S (thirteen vents), 18°24-26'S (six vents), 17°43'S (two vents), 17°34-37'S (eight vents), and 17°24-26'S (seven vents). These areas had been mapped using ARGO during a previous Haymon/Macdonald cruise. Approximately 30% of what was seen by Haymon/Macdonald were still active. All 25 dives planned for the cruise were completed with only a few hours lost to weather. It was an extremely successful cruise. Forty-five hydrothermal vents were marked and/or temperature measurements were taken. Forty vents were fluid sampled. Night time activities included 32 CTD casts, three camera tows, and eight rock cores.

Miriam Kastner reported on her ATLANTIS/ALVIN cruise in June with Bobb Carson to the Oregon Margin, borehole site 892. The project was to study the flux of carbon from a modern accretionary prism. The planned operations included the recovery and deployment of a dummy plug at Hole 892B, sampling of CORK and bore hole fluids, Seabed sampling, and water column sampling. The first day of the operations was used to try to pull the borehole plugs, however the dive was lost. Miriam showed a schematic of their instrumentation as well as photographs. ALVIN operated the whole system very well. A lot of methane was evident. An IV was connected to the borehole and a flow of three liters per day was measured. The experiment was released in September. It was considered very successful.

Chuck Fisher reported on two ATLANTIS/ALVIN cruises he had in 1998; one to the East Pacific Rise in May and the other to the Juan de Fuca Ridge on 29 July to August 9. The May cruise to EPR was with Lauren Mullineaux and Charles Peterson to study, community development and structure at hydrothermal vents, and life after recruitment. The goal of the project is to test how recruitment patterns of hydrothermal vent animals are influenced by larval supply, physiological adaptations, and species interaction. A full list of the program goals, accomplishments and highlights are included in ***Appendix III-C***. Chuck plans to return to the site in April 1999. The other cruise Chuck participated in at Juan de Fuca was to study primary production and nutritional interactions in vestimentiferan aggregations. The details of this cruise are also highlighted in ***Appendix III-C***. A return to the Juan De Fuca site is planned for late August 1999. Chuck concluded by reporting that he had lost a thermister array with the housing in August at the Endeavor Segment of the Juan de Fuca Ridge. A flyer about the missing piece of equipment is included in ***Appendix III-C***.

Paul Johnson reported on his ATLANTIS/ALVIN cruise with **Jim Cowen** to Juan de Fuca in July. The dive series was primarily in support of a LExEn project. The primary goal of their LExEn project is to test the hypothesis that there is a substantial microbial biosphere within the oceanic crust. A critical component of their study is to learn how this biosphere varies under different crustal-geothermal regimes, and how the organic-carbon evidence of the subsurface microbial activity is manifested at sites of different crustal age and sediment cover. They dove at ODP Hole 1026B and Baby Bare; Endeavour axis; and Axial Seamount. The project entailed development of particle and dissolved organic carbon scavenging columns and bases designed to focus diffuse flow, exiting from the seafloor, through a 'filter cartridge-organic scavenging resin-thermisters-flow meter' assembly. The scavenging columns were deployed using ALVIN. Paul described their instrumentation that required a cement base on the sea floor. Paul provided viewgraphs showing the dive sites and instrumentation used, see ***Appendix III-D***.

Dana Yoerger reported on his ALTANTIS/Jason cruise to Guaymas Basin in April, see ***Appendix III-E***. A variety of tasks were accomplished including mapping, heat flux measurements, water sampling, and SeaNet system demonstrations. Additionally, some mosaicing was accomplished using digitized images from Bob Ballard's 3-chip camera. Jason performed well throughout the cruise. It spent 69% of its station time on the bottom. Repair time consumed only 1% of the time. Fine scale mapping and bathymetry using several types of sonar systems was accomplished. The SM2000, near bottom multibeam system being tested on Jason, was very effective and was also used as a forward looking obstacle avoidance system. Dana's viewgraphs include imagery, bottom photos, tracklines, and bathymetry.

Bill Chadwick reported on his THOMPSON cruise in August which used Jason for deployment of a test of his array of acoustic extensometer instruments which will be deployed by Jason next year, see ***Appendix III-F***. The array will be used in a seafloor observatory experiment in the Cleft Segment of the Juan de Fuca ridge. Instruments were deployed across the sea floor and include acoustic modems that can relay data to the surface. Bill showed a schematic of the equipment and the extensometer array. The data collected looks great and the survey went well. Six Jason days are planned to deploy the experiment using THOMPSON in 1999.

Debra Stakes reported on the results of her THOMPSON cruise to the Cleft Segment of the Juan de Fuca Ridge in August, see ***Appendix III-G***. The objective of the cruise was to begin collecting data for a geological map of fine-scale bathymetry on a section of the ridge. This will ultimately help lay the groundwork for the long-term objective of establishing a seafloor observatory. They obtained a multidimensional, high resolution bathymetric swath of data across the rift valley at the Cleft Segment. This included coincident data from DSL-120 phase bathymetry, side scan sonar, Imagenix scanning sonar, and SM300 multibeam bathymetry. The data have been processed and are of very high resolution. The excellent agreement between all the sonar systems used shows how good long baseline navigation can be when using multiple deep ocean systems and when attention is paid to bottom moored navigation array set up and data processing. In using the DSL-120 system, ten transponders were deployed and six were left at the site. Debra commented that the ArcView based GIS system was very useful.

Debbie Smith reported on her work to investigate the Puna Ridge off Hawaii in October using DSL-120 and Argo II, see ***Appendix III-H***. THOMPSON was the support platform. DSL-120 was used for 21 days and accomplished 400nm of side scan sonar and phase bathymetry acquisition. Argo II was used for seven days. The operating conditions were very challenging with strong tradewinds, steep and irregular slopes, ten to 15-foot waves and strong currents. Stern slamming from the large swell caused vehicle pitching. Still, an excellent data set was obtained. DSL-120 was operated in the shallowest water ever worked as well as the deepest water ever worked. Debbie commented that an altimeter on the DSL-120 would have been very helpful. A website has been created as a "voyage to Puna Ridge," www.punaridge.org.

Dick Hey provided a report on his multidisciplinary DSL-120 side scan, CTD towyo hydrothermal prospecting cruise south of Easter Island. The cruise was on MELVILLE to perform hydrothermal and structural investigations along the fastest spreading segment of the mid-ocean ridge system, the 28°S to 32°S East Pacific Rise reorganizing plate boundary, see ***Appendix III-I***. The cruise involved collecting high-resolution deep-towed sidescan and phase bathymetry using the WHOI DSL-120 system to map the detailed patterns of faults, fissures, and recent volcanic eruptive sites. Dick reported that the data collected was very good. The WHOI towed camera sled was used to collect photographic data of suspected new flows and active hydrothermal sites. The sheet flows were very flat and glassy. NOAA-PMEL personnel headed by E. Baker also participated in the hydrothermal part of the cruise. Dick commented that the DSL-120 bathymetry experienced processing problems that need to be fixed so that the DSL120 bathymetry data will be as good as the sidescan data.

Alan Chave discussed his Jason H_2O installation cruise, see ***Appendix III-J***. The cruise was conducted from 28 August to 21 September on THOMPSON. Jason was used as a work vehicle as opposed to a survey vehicle. They found the ATT telephone cable on the seafloor, surveyed it, successfully cut it, and spliced into it with the junction box developed for H_2O. They also performed a Junction box recovery operation. Alan provided viewgraphs showing the seismometer package assembly as well as a photo of Jason performing the cable cutting operations. Seven Jason/Medea deployments were completed with bottom time varying between one hour and two days.

A report was given on **Tetsuro Urabi**'s Ridge Flux project using ATLANTIS/ALVIN in September. The operations area was Southern EPR at 16°-19°S. Science activities included recovery of monitoring instruments, towing of three-component magnetometer and proton magnetometer, tow-yo and hydrocasts using the CTD-rosette sampler, deployment of optical fiber sensor distribution-type temperature sensor system, a dye tracer experiment, seafloor measurements using in-situ sensors, and fluid and rock sampling. They were able to successfully recover all but one instrument that had corroded. These were instruments that had been deployed in 1997 with SHINKAI. Evaluation of the data is on-going.

Agency Reports:

National Science Foundation (NSF) – Don Heinrichs gave the report for NSF and began by reporting that the Ocean Science budget is up approximately seven percent. One major proposal change being implemented this year is that the shared use equipment (e.g. like shipboard multibeam systems) costs will now be funded out of the technical support program (Sandy Shor) as part of the technician grants. PIs will no longer need to include these costs in their science proposals.

There have been some personnel changes with Ocean Sciences Facilities group. Dick West retired in October. His work is temporarily being divided between Dolly, Sandy and Don. They plan is to hire an Associate Program Manager to work with Dolly in the Ocean Facilities section.

.t has been a relatively quiet year for NSF's internal working group that addresses ALVIN/ROV issues. Over the past year, NSF had initiated internal actions to review their role in the selection of scientific projects and scheduling priorities for the NDSF. The group will review the process and focus of multi-year planning and strategic thinking. A management team of Don Heinrichs, Dolly Dieter, Dave Epp, Phil Taylor, and Bruce Malfait was established for this purpose. There were no actions from the working group in 1998.

The Memorandum of Agreement between NSF, ONR and NOAA has been drafted and should be ready for signature. The MOA extends the NOAA/ONR/NSF agreement for five years. It restates the competition clause.

Don commented on NSF's Academic Fleet Review. The NSF Academic Research Fleet Review Committee, headed by Dr. Roland Schmitt, has met three times. The first meeting, held in June at NSF, was primarily for information gathering of UNOLS and NSF programs associated with the Fleet. The second meeting was held on 1-3 September at Scripps. This meeting included a site visit of SIO's Marine Facility where they were able to tour ATLANTIS, ALVIN, MELVILLE and SPROUL. Two days of the meeting were dedicated to a variety of briefings on science trends and opportunities, and comparative operations. Presentations were made by Ken Brink, Ocean Studies Board; Ken Johnson, UNOLS; Don Heinrichs, NSF; RADM Bill Stubblefield, NOAA; Steve Ramberg, ONR; Al Sutherland, OPP; CMD Jim Trees, NAVO; Steven Peck, Canadian Coast Guard; Paul Stone, UK/NERC program; and Mike Reeve, NSF.

As part of the NSF Review Study, NSF solicited letters from ship users asking how they perceived the academic fleet. Fifty responses were received. Most of the letters were favorable and expressed that the fleet is in good state and is an effective system. Some problems were cited such as the need for more shipboard technical support, more equipment upgrades and that there are too many scheduling scenarios. There were comments on the need to start the replacement of intermediate ships. Don will continue to update the survey as new letters arrive.

A third meeting was held at the University of Rhode Island on 2-3 December. The Committee heard the report of financial consultant Bill Humphreys as well as selected science reports. The remainder of the meeting was a closed session for deliberation and preparation of the report. The Committee's report should be out in the first half of 1999.

Office of Naval Research – A representative from ONR could not be present. A written report is included as ***Appendix IV***.

National Oceanic and Atmospheric Administration/National Undersea Research Program (NOAA/NURP) – A written report was submitted by Barbara Moore in advance of the meeting, see ***Appendix V***. Dolly Dieter summarized the report by noting that NOAA/NURP is interested in remaining a partner in deep submergence facilities support and planning. NOAA/NURP has made a conscience effort over the years to utilize the facilities.

West Coast and Polar Regions NURP – Ray Highsmith made a report on the WCNURP activities, see ***Appendix VI***. In 1998 there were approximately 34 proposals submitted and peer reviewed. Roughly 16 were funded. The 1998 ALVIN projects included projects for Colleen Cavanaugh, John Lupton, Ken Smith, and Marta Torres. In 1999, NURP planned to fund NDSF programs at Juan de Fuca and the East Pacific Rise (nine days), San Diego (21 days) and Gulf of Alaska (37 days) for a total of 67 days. However, NURP has been informed of a $1M budget reduction. As a result, Ray reported that the UAF center budget is short over $700K for support of their planned

1999 operations. This jeopardizes the Gulf of Alaska programs. [Note: Following the December DESSC meeting, DESSC sent a letter of concern regarding this situation to Dr. Barbara Moore at NURP. In early 1999, NURP funding was reallocated so that most of the Gulf of Alaska work will be done.]

Hawaii Undersea Research Laboratory (HURL) – A fact sheet on the history and facility description of HURL is included as ***Appendix VII***.

<u>**National Deep Submergence Facility – Operator's Report:**</u>

Introduction – Dick Pittenger began the NDSF facility report by noting this is the first year in a long while that the National Deep Submergence Facility has not been in a transition phase. ATLANTIS, ALVIN and the ROVs are in full operation. The WHOI viewgraphs are included as ***Appendix VIII***. Dick reported that over the year there have been a number of promotions and honors among the WHOI personnel. Dan Fornari, Andy Bowen and Dudley Foster were all promoted. Barrie Walden received the senior technical staff award. WHOI has hired Jon Alberts to replace Don Moller as the facility coordinator. Christina Courcier, staff assistant to Jon, comes on line in January 1999. Dick Pittenger reported that Tony Blair, Prime Minister for the UK, sent a letter to Bill Clinton commending the efforts of Dolly Dieter and Andy Bowen in making the DERBYSHIRE survey a success. A copy of the letter is included as ***Appendix IX***.

Information on the 1998 NDSF operations is included in ***Appendix VIII***. ALVIN made 137 dives at an average depth of 2265 m. The average dive duration was 8.16 hours with an average bottom time of 5.42 hours. Thirteen science programs were conducted. Five ROV programs were carried out. Support platforms included MELVILLE (1), ATLANTIS (1) and THOMPSON (3). The total number of lowerings for Jason, DSL-120, Argo-II and the tow camera was 35 for 924.5 hours of bottom time.

Deep Submergence Group (DSG) Upgrade Items – Barrie Walden reported on the DSG upgrade items. The full list is included in ***Appendix VIII***. The list includes datalogger and video upgrades. WHOI hopes to be able to install the video improvements in 1999. The virtual ALVIN development is underway. It will allow for dive scenario planning and more effective utilization of power. Two scanning sonar units are planned, one for ALVIN and one for the ROVs. Refurbishment of scanning altimeter housings for both Jason and ALVIN are underway. Slurp pumps were purchased over a year ago and are still operating. WHOI has the ring laser gyro and will continue to test it on upcoming Jason cruises. When used with the Doppler it allows vehicle navigation without transponders, in some settings. The digital in-hull cameras are funded and as soon as they are available will be installed. The steerable elevator upgrade was funded by the institution with a Green award. The ICL temperature probes are very useful although the tips are breaking off. WHOI is working on modifying the design of the tips. Information on the ICL science interface is available in the back of the room. The hot water samplers are new and refurbished. Seventeen bottles are now available. The Nautronics and Winfrog transponder navigation hardware/software are still experiencing problems. Nautronix has provided new software that is being tried out. WHOI continues to experiment and work on new navigation packages for the vehicles.

Archive Policy – The NDSF Archive Policy has been approved. An Internal WHOI committee, Scientific Data Advisory Committee (SDAC), lead by Brian Tucholke was set up to review all WHOI scientific data archiving policies and issues, including the National Deep Submergence Facility Archives. The committee prepared the policy, which was reviewed by DESSC and the federal agency representatives. The policy will be posted on the UNOLS website and is included as ***Appendix X***.

ATLANTIS Improvements in 1998 – Dick Pittenger reviewed the items that were implemented on ATLANTIS in 1998. These were things performed during the ship's Post Shakedown Availability (PSA) period and during its September dockside. The full list can be found in *Appendix VIII*. Dick also reviewed ATLANTIS' pending projects in detail. Funding for the pending items has not been identified and priorities have not been established. Dick encouraged everyone to provide their input regarding these items by submitting the checklist provided in *Appendix VIII*.

ALVIN Overhaul Plans – Barrie reported that the next ALVIN overhaul is planned for October 2000 to March 2001. The community is welcome to suggest items for improvement during the overha

SEA CLIFF Engineering Study – Barrie Walden reviewed the status of the WHOI SEA CLIFF engineering study, see *Appendix XI*. SEA CLIFF is presently in shrink wrap at Otis Air Force base. As part of the study, WHOI will examine the world's deep human occupied vehicles. This includes the vehicles of Japan, France, Russia, as well as the U.S. SEA CLIFF is a heavy vehicle at approximately 55,000 lbs. It was designed and built for Navy missions as opposed for science research. Barrie showed maps comparing the ocean bottom coverage that would be achieved with a vessel of 6,000 m capability to vehicles with a 4500 m depth capability. Dick reviewed the pros and cons of integrating SEA CLIFF into the NDSF. WHOI hopes to have the engineering study completed by the middle of 1999. The result of the study will be a cost matrix of the various options for integrating SEA CLIFF and/or its parts into the National facility. Dick commented that it would be a challenging effort to swap the ALVIN hull with SEA CLIFF's hull since SEA CLIFF is very heavy and requires a lot of foam. WHOI has already taken the sonar system from SEA CLIFF and installed it on ALVIN. WHOI did not receive the manipulators or trim systems with SEA CLIFF, but did get the batteries, which were dead. Another set of silver zinc batteries is available.

There was some discussion by the meeting participants on whether the added bottom coverage offered by SEA CLIFF could be also be adequately covered by ROVs. It was noted that this is a topic for DESSC and in fact they had addressed it to some degree in their SEA CLIFF Working Group report. The summary of that report basically recommended that ALVIN's current capabilities, including maneuverability and bottom time, should not in any way be degraded by a SEA CLIFF integration. The study also recommended that it would be desirable to go as deep as possible using an ROV.

Another concern of the working group was the potential downtime during any transition/conversion period for ALVIN.

Upgrade to NDSF Tethered Vehicles – Andy Bowen reported on the upgrade plans for the NDSF tethered vehicles, see *Appendix XII*. A proposal for a next generation ROV, Jason II is being prepared. The upgrade addresses the identified shortcomings of the Jason/Medea system: its manipulative capabilities, payload, speed and thrust, increased depth to 6500 m, tether management and underwater winch. The current system is constrained to .680-inch cable. It would be a significant investment to convert from this wire to another considering the ATLANTIS, SIO and flyaway winches that are currently in service. Andy reported that Jason II is to be electric.

Upgrades planned for the other NDSF tethered vehicles include telemetry and control upgrades for DSL120 and Argo II. They will try to ensure cross platform compatibility in terms of support and sensor mobility. They hope to provide the vehicles with dedicated sensors. The proposal will also address known shortcomings in the vehicles such as with Argo II lighting and DSL 120 digital sonar electronics.

Andy provided a matrix showing the planned upgrades and the applicable vehicle(s). The upgrade proposal is in preparation. WHOI is committed to the upgrade and will share 30% of the cost. Other details of the proposal include obtaining two manipulators and a tool sled. The estimated cost of the proposal is $2.5M. MBARI was visited for technical consultation in preparation of the proposal.

DSL-120 Upgrade – Dan Fornari reviewed the DSL-120 sonar data collection and processing upgrades and provided information handouts, see *Appendix XIII*. Dan Scheirer (Brown U.) collaborated in the upgrade effort and provided examples of processed data which used the EndUser set of plotting scripts developed for the DSL-120 data. These are available from: ftp://lise.geo.brown.edu/pub/scheirer , the file to click on for downloading is: Enduser.v1.0.tar.z

Other Facility Operations

ROPOS:

Keith Shepherd (ROPOS) gave the facility report for ROPOS, see *Appendix XIV*. He provided information on the Canadian Scientific Submersible Facility and its ROV, ROPOS. Keith provided an overview of how ROPOS can be used for research. Standard equipment includes navigation, 3-CCD Video, laser scales, color scanning sonar, variable speed suction sampler, a Pacman sampler, and manipulators. The system can also accept user supplied tools such as, hot fluid samplers, manifold samplers, suave chemical scanner, chain saw, downward looking scanning sonar, and a tubeworm stainer. This year they were able to integrate the MBARI Rock Drill. Keith reported on some of the operations ROPOS has been involved with over the past year. For next summer, upgrade plans include a new computer and a new winch.

Henry Dick continued the report by discussing his cruise to the Indian Ocean using ROPOS. They visited ODP Hole 735B. Dick showed slides from his cruise operations. His work was to study the accretion of the Lower Crust. The MBARI rock drill was used. Survey work as well as dredging operations was conducted.

Bob Embley reported on his operations using ROPOS from RON BROWN in late summer 1998. This cruise was primarily in support of New Millennium Observatory (NeMO98) activities. They were on-site 23 days, had 21 dives for a total of 252 hours of bottom time. Funding for the operation came from a variety of sources with major support from NOAA. Some of the areas that they were trying investigate during the cruise included: The origin of event plumes, evaluation of hydrothermal activity, NeMO 1998, and the Axial Volcano Diking Event of 25 Jan to 6 Feb 1998.

Bob showed the NeMO98 cruise track. A variety of equipment was used on ROPOS including osmosamplers, microbial taps, temperature probes, etc. They made an Imigex map. Information about the cruise is included in ***Appendix XV***. A full description of the cruise and findings can be found at the website, http://newprot.pmel.noaa.gov/nemo_cruise98/report98.html

Bob noted that it is logistically difficult to mount a rapid response operation to study vent activity.

John Delaney continued by reporting on his THOMPSON cruise to Juan de Fuca using ROPOS. Support for this program included funding by the American Museum of Natural History. The ultimate goal of the program was to recover one or more large sulfide structures for the museum's "Hall of Planet Earth" exhibit to open in 1999. In 1997 Jason was used for the preliminary survey work of the area. In 1998 ROPOS was used for its hydraulic capabilities to actually remove the chimney. Both vehicles were needed and were very complimentary to each other. A full description of the expedition can be found at http://www.amnhonline.org/expeditions/blacksmokers/home.html

They visited three sites during the cruise: Salty Dawg, High Rise and MEF. The sulfide chimney was divided and part of it is designated for museum use and the other part will be used for scientific studies to "micro" map the inhabitants of microbiological structures. The sample showed the distribution of microbial communities of the interior to the exterior of the chimney (from hot to cold). John showed a video of the chimney removal operation. They removed the top two meters of a chimney and it grew back in five days. Debbie Kelley (UW), who participated on the cruise, described the recovery of four structures from Phang, Roone, Fin and Gwenen. The Fin structure had the highest temperature. They were able to accomplish of very good pristine sampling. The Gwenen sample was 1.5 meters long.

Marine Physical Laboratory (MPL):
Christian de Moustier provided an update on the deep submergence facilities at MPL, see ***Appendix XVI***. A full description of the MPL Deep Tow facilities can be found at http://www-mpl.ucsd.edu. He reviewed their seagoing operations from 1997-1998. Christian reviewed the various tools available, which includes the Deep Tow instrument package,

control vehicle, deep sea instruments, precision transponders, high sound-velocimeter, and seafloor borehole reentry package.

The Deep Tow instrumentation system is a 110 kHz side-looking sonar and includes cameras, water samplers, biological sampling net, a temperature gauge, transducers, transponders, and a magnetometer cable. The data collected can be mosaiced. Christian described the Wireline Reentry System. The control vehicle is a 500 kg package with two thrusters suspended from a 0.68" standard cable. Its maximum operating depth is 6,000 meters. It is maneuverable for positioning at boreholes. It is equipped with sonars (12 kHz and 23.5 kHz), pan and tilt video, lights (1000 W), 8-mm video recorder and long-baseline transponder navigation. Ship requirements for support of the vehicle include a winch, 0.68" electromechanical wire capable of work at 2300V. SIO has been funded to upgrade their fiber optic cable, which should be available by mid 1999.

Christian reported that a new version of SeaBeam software is to be released by January 1999. By the early part of 1999, they hope to have an idea of how the package is working.

Fred Spiess reported on the various operations supported by MPL over the past year. The control vehicle was used for the Ocean Seismic Network experiment, off Hawaii. The control vehicle was used for seven wireline reentries. THOMPSON was the support platform for these operations. Each item was recovered twice.

Monterey Bay Aquarium Research Institute
Steve Etchemendy provided a brief report on MBARI's vehicles, see ***Appendix XVII***. He provided handouts on the specifications of ROV VENTURA and ROV TIBURON and indicated that there will be some availability for use of these vehicles by the community. Steve reported that Jim Bellingham has been hired as the new director of engineering for MBARI.

NDSF ATLANTIS/ALVIN and ROV Schedules for 1999-2000

1999-2000 Schedules – John Alberts, the new WHOI Marine Operations Coordinator, provided a summary of the ALVIN and ROV operations planned for 1999-2000, see ***Appendix XVIII.*** In 1999, operations are planned for the Southern EPR, Hess Deep, Northern EPR, off California, Gulf of Alaska, and Juan de Fuca. Jon provided his contact information for anyone with questions regarding operations:

Telephone: (508) 289-2277
Fax: (508) 457-2185
e-mail: jalberts@whoi.edu

Long Range Planning Session

2000 and Beyond – Mike Perfit summarized the proposals and letters of interest for use of ALVIN and the ROVs, see *Appendix XIX*. He provided a map showing proposed work areas as well as areas with funded programs for the outyears. The map clearly shows that there is deep submergence research interests all over the world. Areas of high interest continue to be in the traditional ALVIN areas, but there is also interest globally. There already are funded programs in 2000 and beyond in the Atlantic, Gulf of Mexico, Juan de Fuca, North EPR, Hawaii, and Indian Ocean. Mike reported that interest is building for work in the Western Pacific.

There was discussion on how the community can be kept abreast of the high interest areas and funded work areas. The UNOLS website includes a world map that shows all proposed work graphically, http://gso.uri.edu/sst/sst.html. By accessing the world map and clicking on the areas of interest, a scientist can quickly find out whom, when and what vehicles are proposed for a particular region. The map information is generated by the ship time requests submitted electronically by PIs. It was suggested that a mailing be sent to the community to let them know where the funded work areas are located.

Session I: Planning for Expeditionary Science – There was a general discussion on how to manage expeditionary as well as time series science experiments. Additionally the time needed to maintain and upgrade the deep submergence vehicles must be considéred. Observatory planning and operations also needs to be considered. It was suggested that international collaborations should be pursued for expeditionary type work when feasible. It was also suggested that AUVs have a strong potential for deep submergence operations support in the future and should be considered especially in regard to observatory type operations.

Session II: Traditional Work Areas (Juan de Fuca, Northern EPR, Northern MAR) – There was a general discussion on how to manage traditional work areas while at the same time conducting expeditionary programs. Patty Fryer reported on the MOMAR conference she attended. The conference was held in Lisbon, Portugal in the Fall and was attended by the international community. The focus area of MOMAR is the Azores. The meeting addressed a variety of issues including time series observatory, interdisciplinary science, on-land biological laboratories, educational components, vent activity response and multinational assets. Shore to observatory site cables did not rank highly on the interest list. A follow-on MOMAR conference is already funded.

1999 Deep Submergence Workshop Plans – Patty Fryer announced that plans are underway to hold a three-day workshop in 1999 to address future submergence science and facility needs. Workshop announcements and details will be sent out from the UNOLS Office. The goal of the workshop will be to identify the future science issues and then determine the tools needed to meet these science research needs. Stay tuned. This would be the next major meeting and report following *The Global Abyss* report which was generated from the Deep Submergence workshop held in 1992 by Jeff Fox. Copies of this report are still available at the UNOLS Office.

<u>**Other Business:**</u>

Europa – John Delaney reported on Europa and plans for its exploration. There will be a need to perform a 4-D survey of the planet's oceans. Sensors will be needed on its "sea" floor, in the column, and on the surface. In five year's time a fleet of AUVs is envisioned to perform this work. NASA is not experienced in studying a planet's water. They could benefit by the expertise of oceanographers and marine engineers. NASA's funding has historically been at a much higher level than that of ocean science. Oceanographers should take advantage of this opportunity. The National Oceanographic Partner Program (NOPP) has funded a small engineering group to look at NEPTUNE and determine its potential for making observations.

NASA – John Rommel of NASA continued this discussion by reinforcing John's comments. NASA has expressed interest in funding scientists to work in the extreme conditions of the deep ocean as a simulation of the conditions that they might encounter on Europa. Europa will likely require AUVs for exploration.

The meeting was adjourned at 5:00 pm

Appendix I

Revised 12/1/98

UNOLS DEep Submergence Science Committee

Planning Meeting
Cathedral Hill Hotel
1101 Van Ness Avenue
Telegraph Hill Conference Rooms A & B
San Francisco, CA
Saturday, December 5, 1998

08:00 **Coffee, Distribution of Meeting Material (Written Reports)**

08:15 **Introduction - DESSC Chair's Report, introduction of new the DESSC Chair**

08:30 **1998 Science Reports - Presentations by Principal Investigators**

- ALVIN users
- ROV users
- Users of other tools

10:15 - 10:30 **Break**

10:30 **Agency and UNOLS reports**

10:45 **National Deep Submergence Facility Operator's Report (WHOI)**

- Introduction
- Operations Summary
  - ⇒ Personnel Integration
  - ⇒ ALVIN
  - ⇒ Jason
  - ⇒ Data Archiving
- WHOI Perspective on NDSF Future
  - ⇒ ATLANTIS
    - * Work Done
    - * Work to be Done
  - ⇒ ALVIN
    - * Overhaul (Oct 2000- March 2001)
    - * SEA CLIFF Engineering Study
  - ⇒ Jason Upgrade Proposal
- 1999-2000 Schedules

12:00 - 13:00 **Break for Lunch (Lunches will be available at the meeting for $10.)**

13:00 **Reports from Other Facility Operators.** (Handouts will be provided for each facility.)

- ROPOS
- SIO/MPL
- HURL
- West Coast NURP
- MBARI

13:30 **Long-Range Planning Session I: Planning for Expeditionary Science**

- Western and Mid-Pacific
- South Atlantic
- Southern EPR
- Indian Ocean and Mediterranean

14:30 - 14:45 **Break**

14:45 **Long-Range Planning Session II: Planning for Science in Traditional Work Areas**

- Juan de Fuca
- Northern EPR
- Northern MAR

15:45 **Discussion and Planning for early 1999 UNOLS Deep Submergence Meeting**

16:30 **Adjourn**

Appendix II

DESSC - Dec. 5, 1998

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Appendix III

9°N Alvin Dive Series
24 Nov-24 Dec 1997

Two ship operation

- Atlantis (Chave, chief scientist)
- New Horizon (Childress, chief scientist)

23/23 Alvin Dives Completed

- Submersible problems minor
  - ALISS camera interfacing issues due to corroded Alvin fuseblock--data lost on 2-3 dives
  - Fiber optic penetrator desirable
- Ship problems minor
  - A-frame failure nearly resulted in emergency recovery procedure being utilized

Major Programs

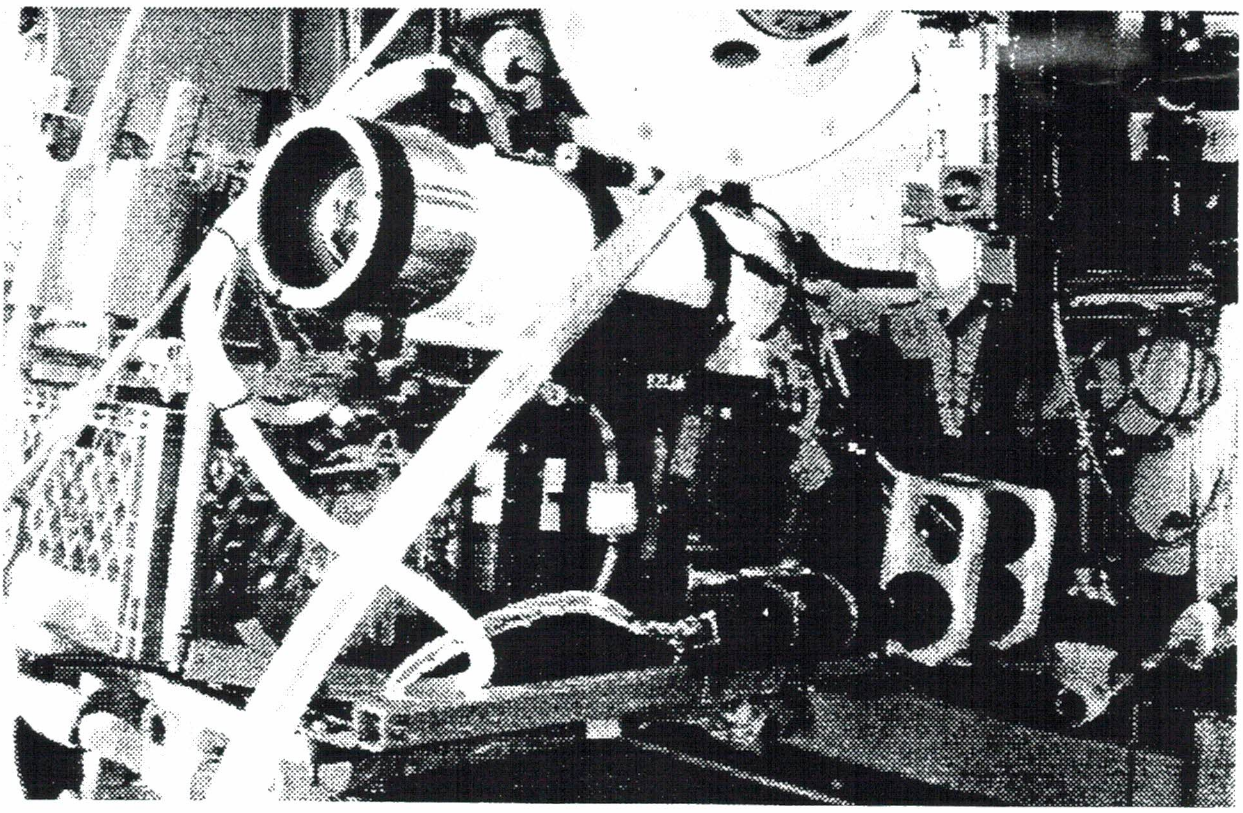
- Physiology (12 dives, Childress)
- Light at Vents: ALISS (6 dives, Chave/Van Dover)
- Sulfur-fixing Bacteria (5 dives, Taylor/Wirsen)

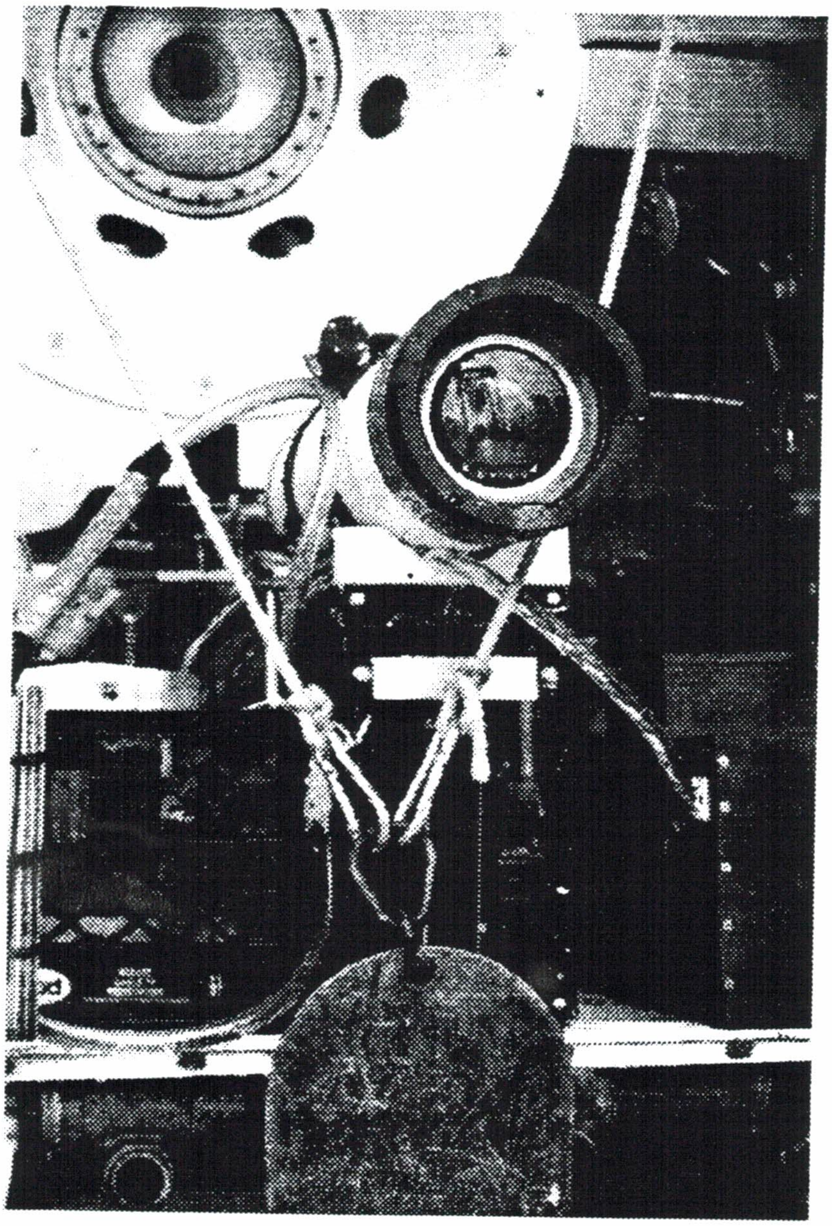
Ancillary Programs

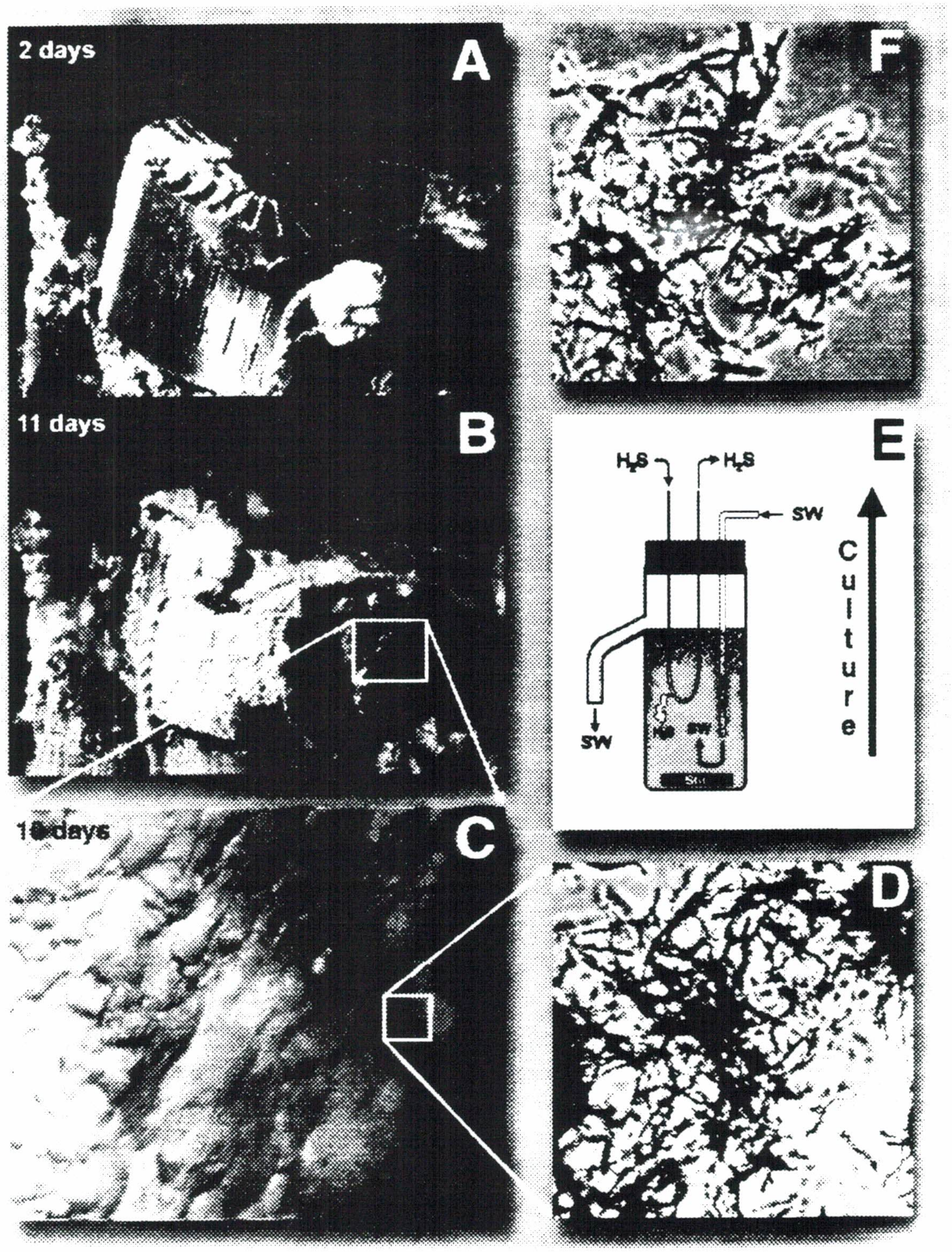
- Crab Reproduction (Cary/Dittle)
- Alvinellid Studies (Gaill)

Night Programs

- Tiltmeter Test Deployment (Evans/Chave)
- Plume Trace Element Studies (Ravizza/Godfrey)






2 days
A
11 days
B
C
F
E
H2S
H2S
SW
SW
Culture
D

Juan de Fuca Alvin Dive Series
24 June-4 July 1998

6/9 Alvin Dives Completed

- High wind/sea state loss of 3 dives
- No weather contingency built into schedule

Major Programs

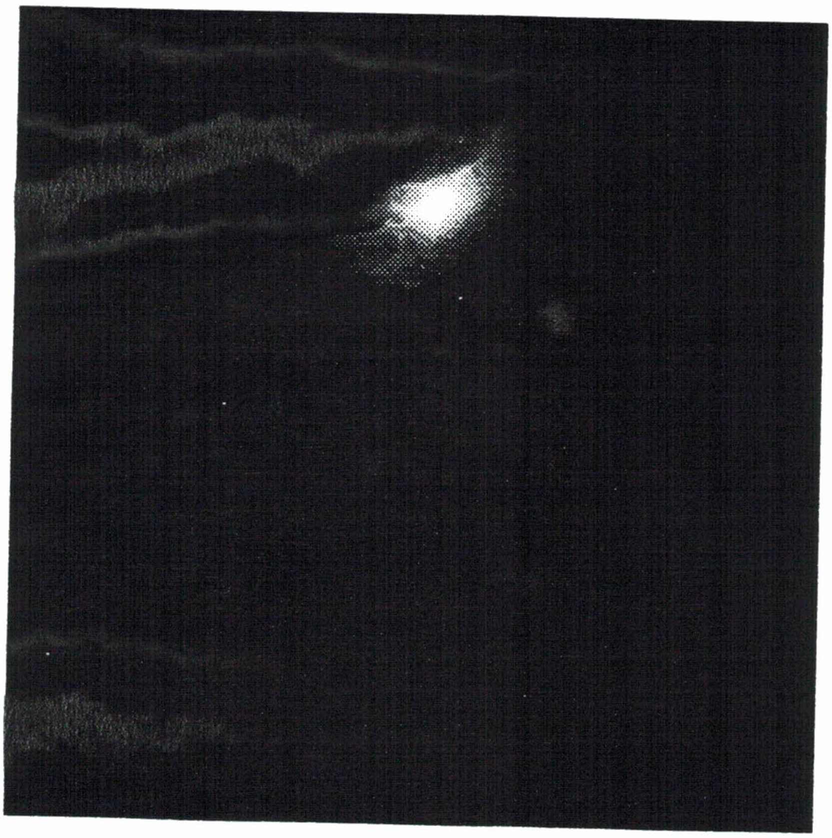
- Light at Vents: ALISS (6 dives, Chave/Van Dover)
- Fluid Chemistry (2 dives, Lilley/Zierenberg)\
- ODP Cork Servicing (1 dive, Becker/Davis)

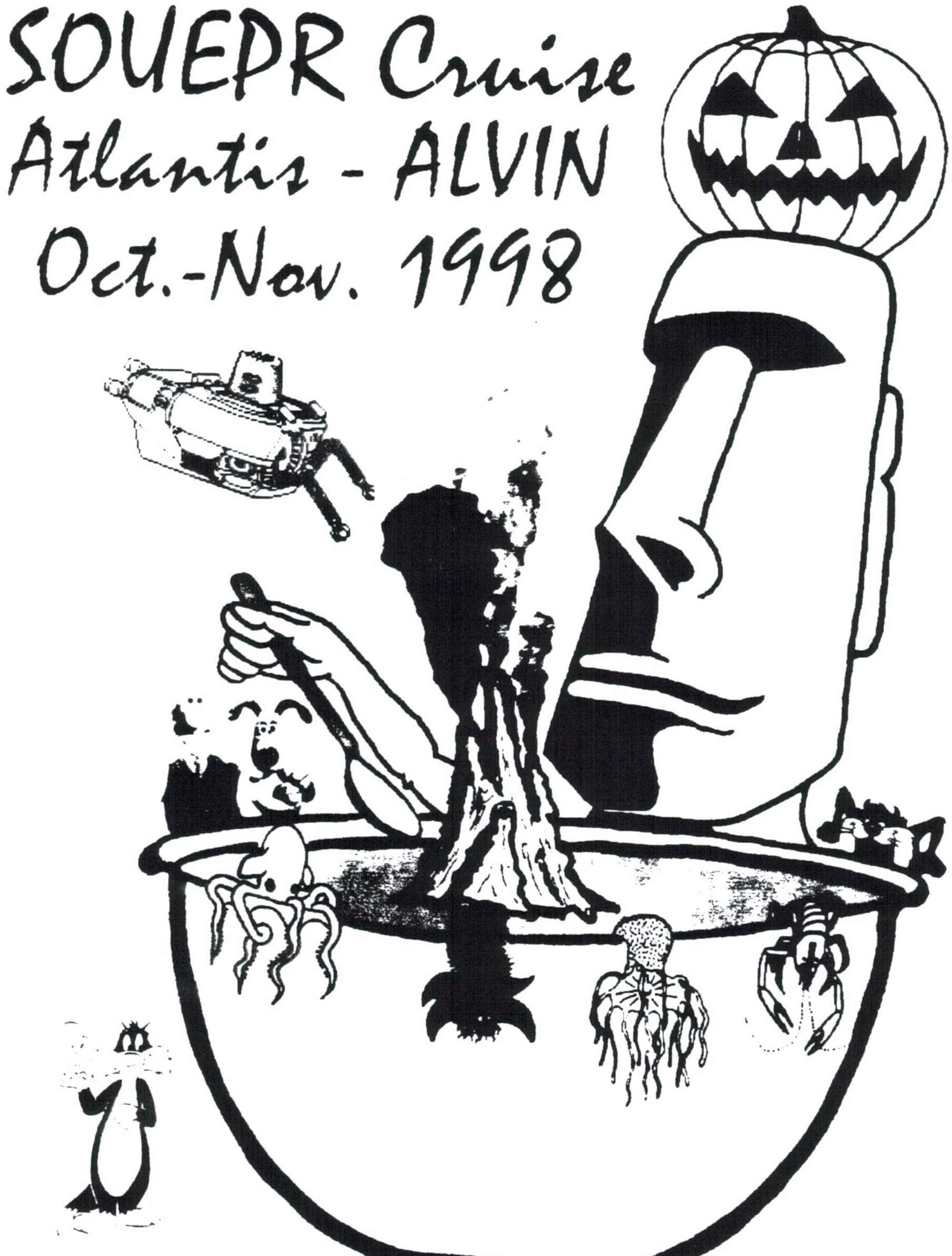
Ancillary Programs

- Paralvinellid Studies (Van Dover)
- Vent Fluid Sampling (Lilley)
- H Probe Testing (Seyfried/Ding)

Night Programs

- Cork Data Acoustic Download (Davis)
- Heat Probe Testing (Davis)




SOUEPR Cruise
Atlantis - ALVIN
Oct.-Nov. 1998

Atlantis Voyage 3 Leg XXVIII - SouEPR

October 10 - November 17, 1998
Easter Island - Manzanillo

Science Party: 24 scientists
UW, UNH, UCSB, UH, OSU, WHOI, Rutgers, USGS, UF, Japan

Marv Lilley - chief scientist (UW), Karen Von Damm - co-chief scientist (UNH), Bob Collier (OSU), Jim Cowen (UH), Rachel Haymon (UCSB), Meg Tivey (WHOI), Dan Fornari (WHOI), Ko-ichi Nakamura (Japan), Betsy McLaughlin-West (Rutgers), Tim Shank (Rutgers), Eric Olson (UW), Andy Graham (UW), Giora Proskurowski (UW), Alison Bray (UNH), Melinda Brockington (UNH), Kevin O'Grady (UNH), Jon Kaye (UW), Dale Hubbard (OSU), Margaret Sparrow (OSU), Don McGee (UH), Scott Brinson (USGS), Jo O'Neill (UCSB), Jozee Sarrazin (WHOI), Buffy Cushman (UF).

Areas Worked

21°33.2′S
9 vents, $T \leq 405°C$, $d \leq 2860m$

21°24-26′S
13 vents, $T \leq 354°C$, $d \leq 2840m$

18°24-26′S
6 vents, $T \leq 382°C$, $d \leq 2680m$

17°43′S
2 vents, $T \leq 350°C$, $d \leq 2630m$

17°34-37′S
8 vents, $T \leq 350°C$, $d \leq 2600m$

17°24-26′S
7 vents, $T \leq 376°C$, $d \leq 2590m$

Total of 25 Alvin dives completed.

Samples Collected

45 hydrothermal vents marked
and/or T measurements taken

40 vents fluid sampled
35 new vents
5 previously sampled

283 vent fluid samples

33 niskin samples of near-field plume

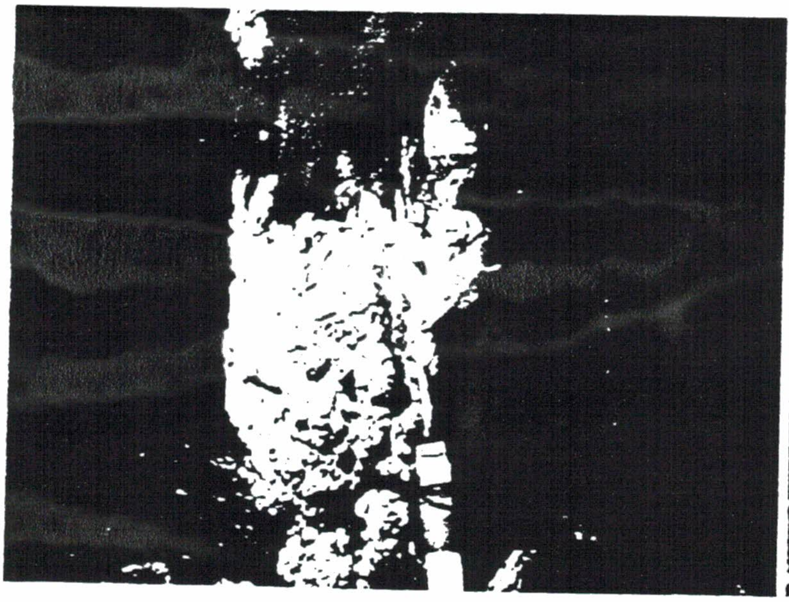
98 sulfide samples

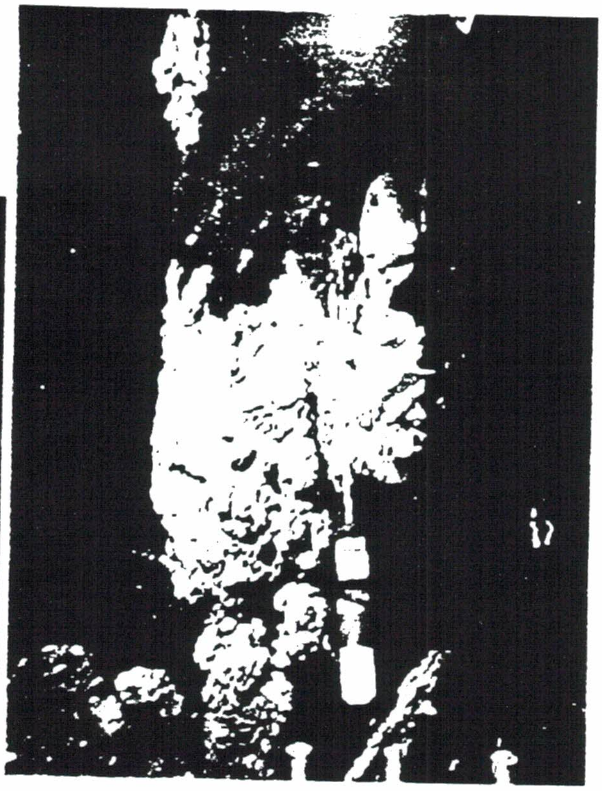
56 basalt samples

~91 biological samples
(~60 species from 24 sites)

Night-time:
32 CTD casts
3 camera tows
8 rock cores

Dive 3302 Vents





Brandon Vent with Hobo installed

Community development and structure at hydrothermal vents: Life after recruitment

Lauren Mullineaux, Charles Peterson, Chuck Fisher
"Block Party IV"
Spring 1998

The overall goal of the project is to test how recruitment patterns of hydrothermal vent animals are influenced by larval supply, physiological adaptations, and species interactions. In the second phase of the project we have added experiments to examine post-recruitment interactions and their role in structuring hydrothermal vent communities.

During the cruise we had several objectives, which were basically all accomplished.
1) Collect recruitment blocks which had been deployed on the three past cruises (three time intervals). About 80% of the blocks were located and recovered, sorted on the surface, and newly recruited vestimentiferans identified to species by molecular techniques on board ship.
2) Collection and turn around of about 12 Hobo thermistors
3) Establishment of two experiments to test effect of mussel presence on recruitment. Both involved transplantation of LOTS of mussels, one utilized freshly cleared basalt and the other recruitment blocks. Both benefited from excellent piloting etc.
4) Transplanting of blocks from one zone to another to test history of block on further recruitment.
5) Collection of as many mobile predators as possible (octopuses, crabs, and fishes), using the suction sampler, nets, and traps.
6) Feeding preference experiments with 24 hr video deployments.

Alvin highlights:
The scientist-operated, pan and tilt video!
Block recovery of very well hidden blocks.
Very elegant establishment of two experiments involving mussel transplants
    Transport of way tooooo many mussels
    Clearance and video temp doc of study sites
Opportunistic collection of mobile predators
Video deployments.

Primary Production and Nutrional Interactions in Vestimentiferan Aggregations on the Juan de Fuca Ridge
(7/29/98 - 8/9/98)

Overall Project Goals:

- Characterization (temperature and chemistry) of microhabitats occupied by the morphotypes of *Ridgeia piscesae*
- Determination of growth rates and physiological condition of the different morphotypes of *Ridgeia piscesae* in different environments
- Delineation of the nutritional interactions between the vestimentiferan tubeworms, associated fauna and non-vent organisms
- Quantitative characterization of the different biological community types
- Successful REVEL cruise

Study Sites (Endeavour segment of the Juan de Fuca Ridge):

- Easter Island
- S&M
- Clam Bed
- Mothra

Work accomplished:

- Recovered and redeployed three long-term thermistor arrays at tubeworm growth study sites
- Collected stained tubeworms from six different study clumps
  - Total number of stained individuals recovered: 253
- Established four new tubeworm growth study sites
- Collected six biological communities using the Chimney Master
  - Quantitative collections: 4
- *In situ* chemical and temperature scan of most study sites using SUAVE
- Deployed a time-lapse video camera and two single probe thermistors on Roane to document new biological colonization
- Deployed a temperature monitor array on the growing Finn sulfide structure
- A very successful REVEL cruise

L O S T

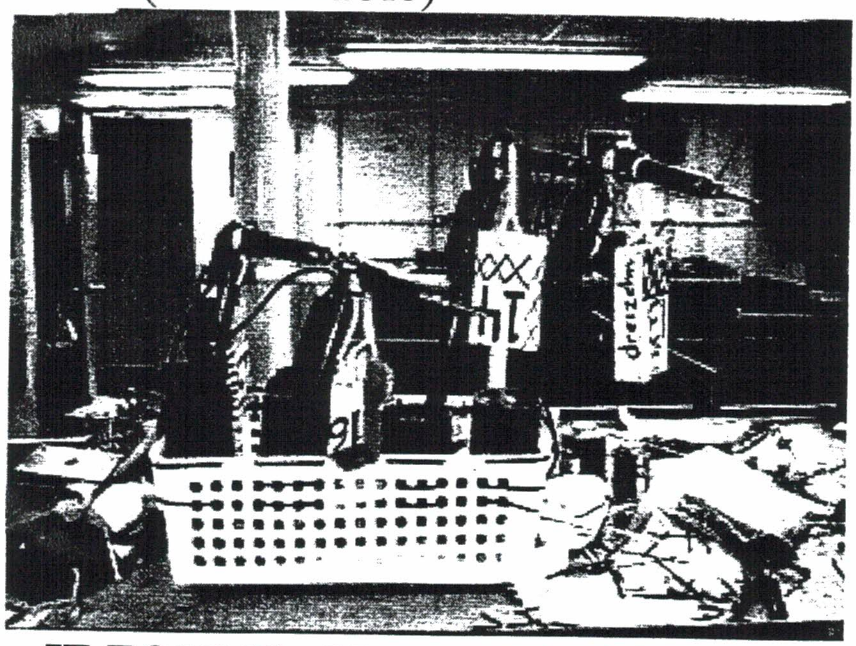
WHAT: Thermistor Array with Housing

WHERE: Main vent field, Endeavour Segment of the Juan de Fuca Ridge within 1 mile of S&M chimney

WHEN: August 5th, 1998

VALUE: One year's data + $10,000

REWARD: Significantly less than the value (consumable)



<u>IF FOUND, PLEASE CONTACT:</u>

The International Society for Underwater Collection of Stuff
(IT-SUCS)

Dr. Charles Fisher

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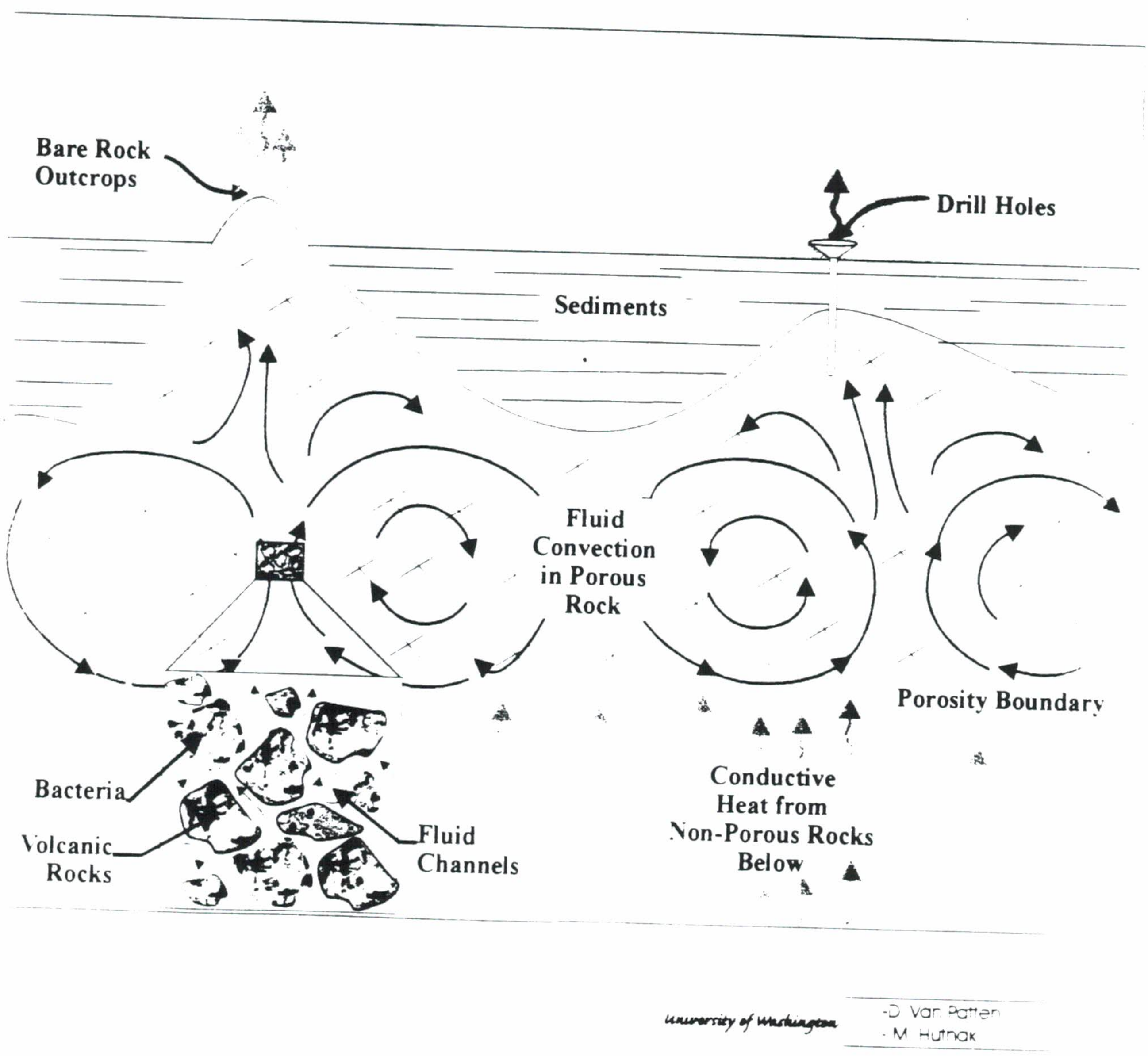
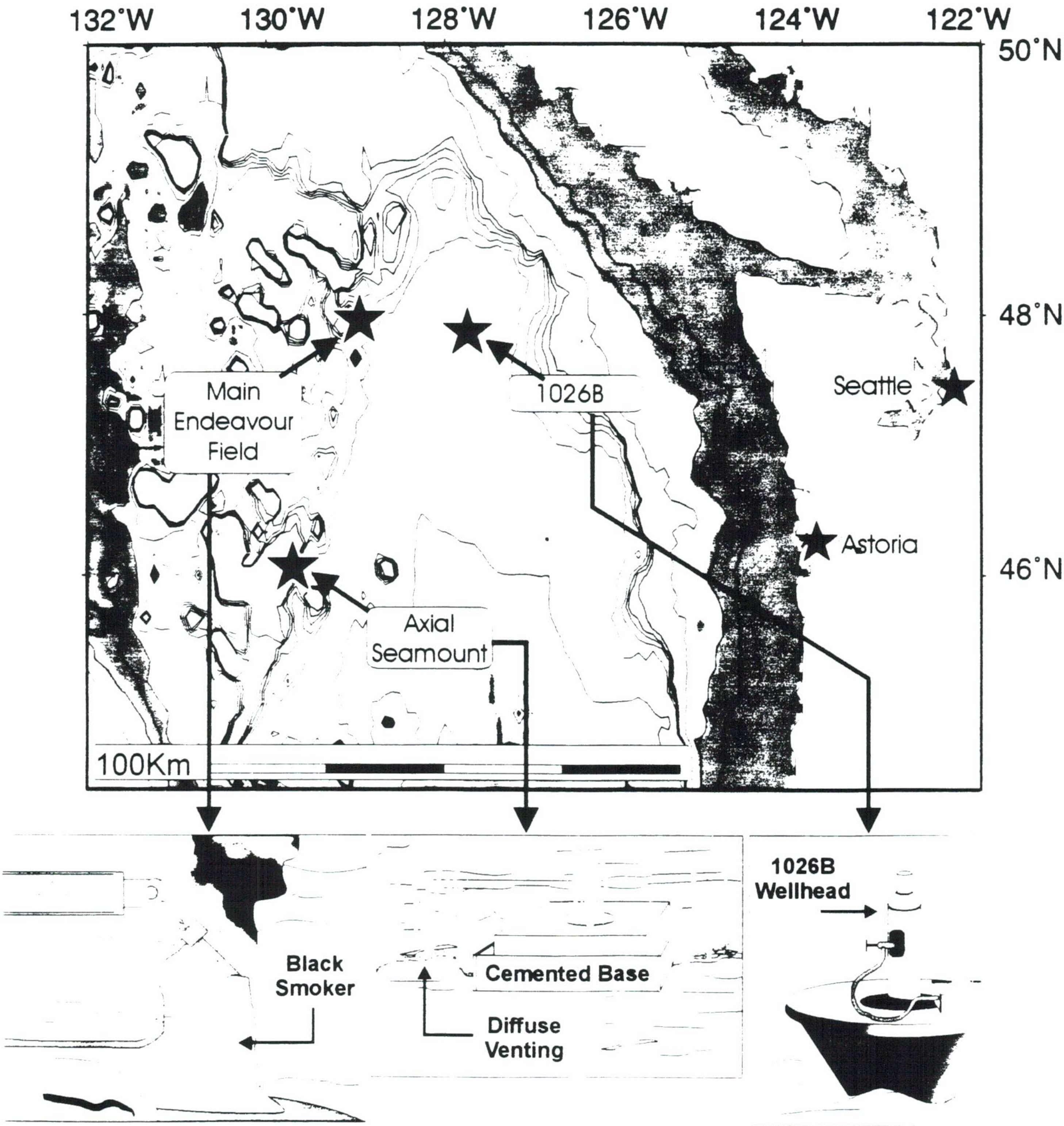
NSF LExEn Program

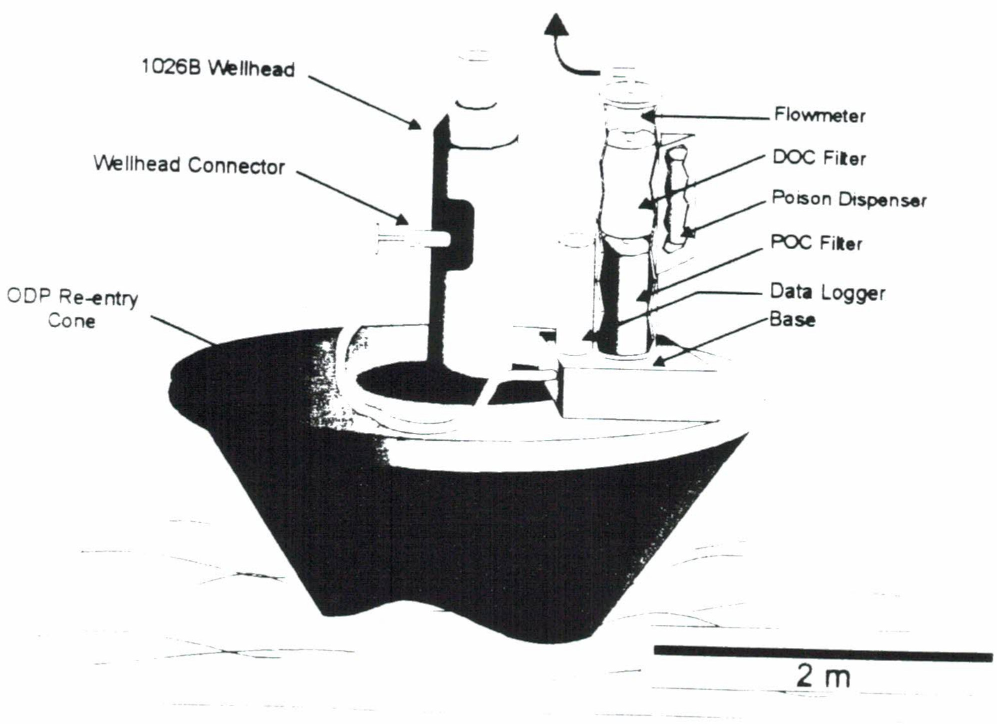
H. Paul Johnson - University of Washington
James B. Cowen - University of Hawaii



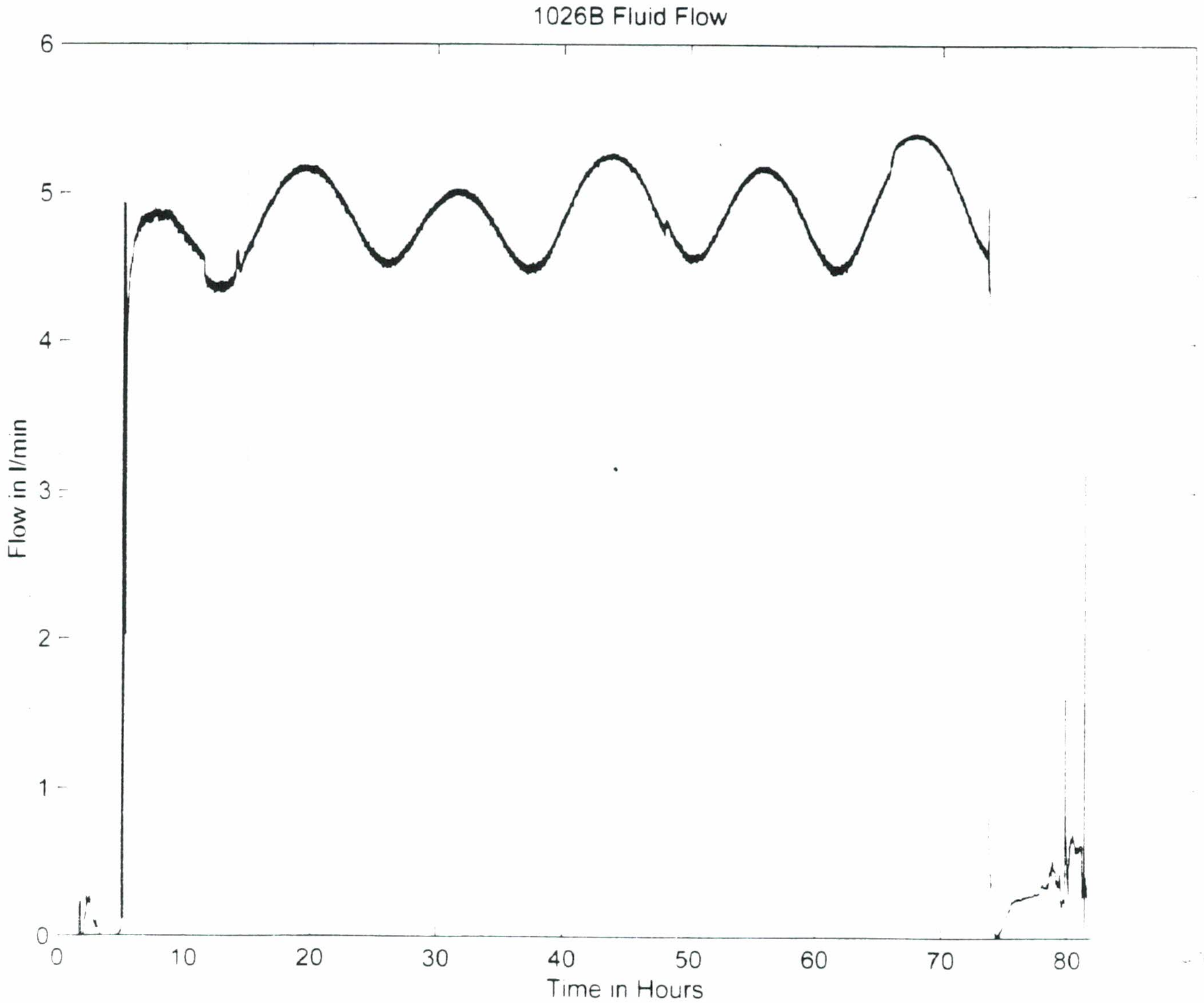

132°W
130°W
128°W
126°W
124°W
122°W
50°N
48°N
46°N
Main Endeavour Field
1026B
Seattle
Astoria
Axial Seamount
100Km
Black Smoker
Cemented Base
Diffuse Venting
1026B Wellhead

NSF LExEn Program

H. Paul Johnson - University of Washington
James B. Cowen - University of Hawaii

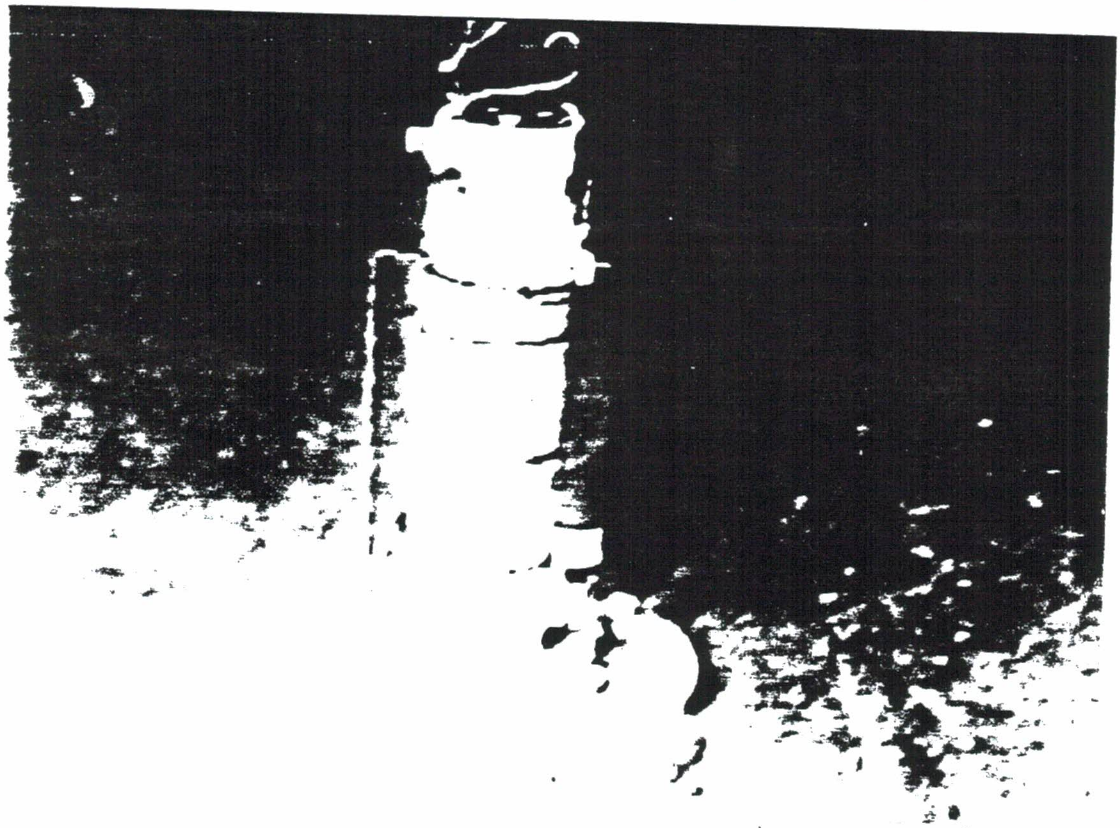


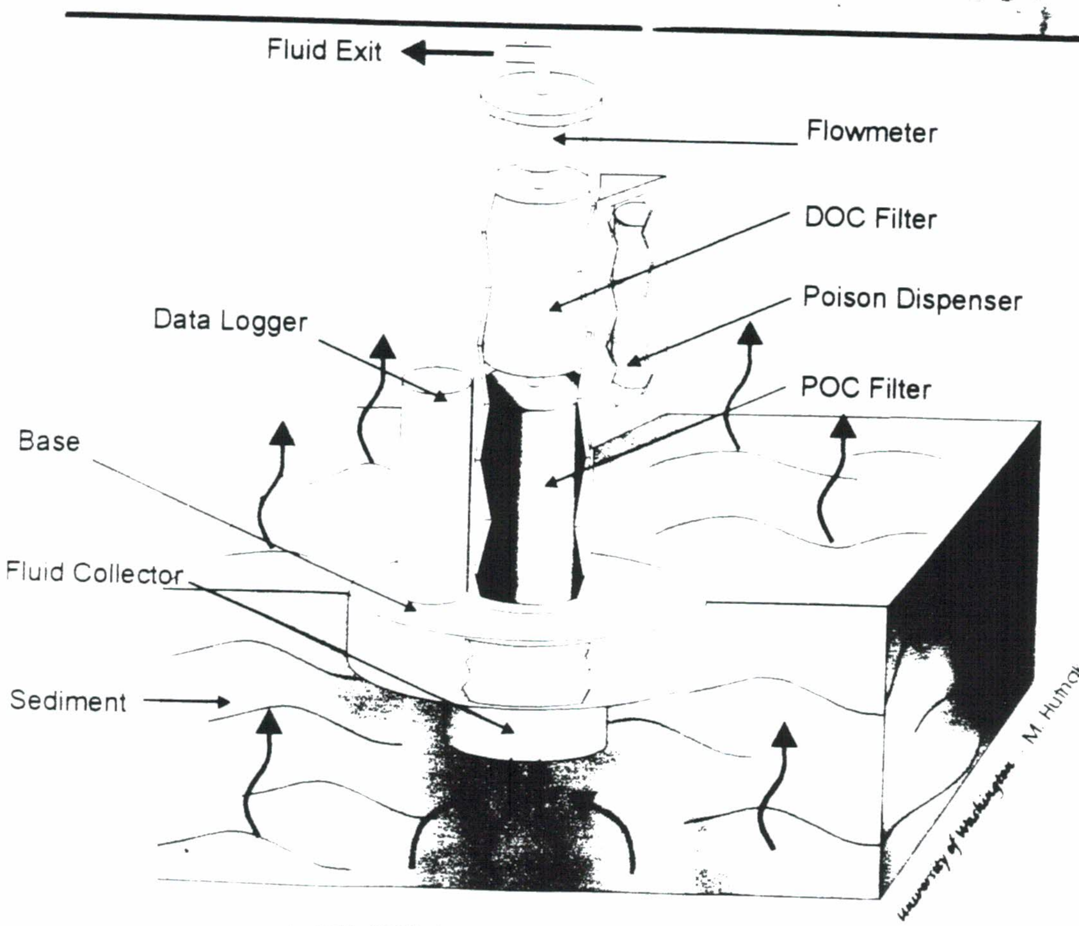
LEXEN Column - 1026B


1026B Fluid Flow
Flow in l/min
Time in Hours
0
1
2
3
4
5
6
0
10
20
30
40
50
60
70
80

NSF LExEn Program

H. Paul Johnson - University of Washington
James B. Cowen - University of Hawaii



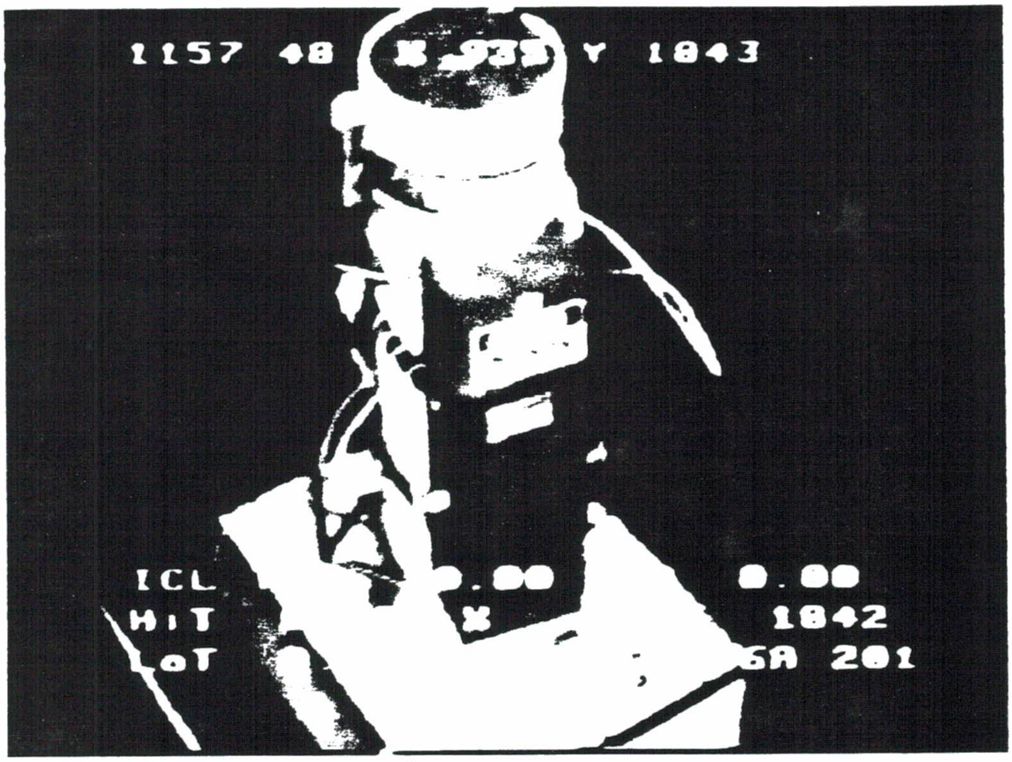


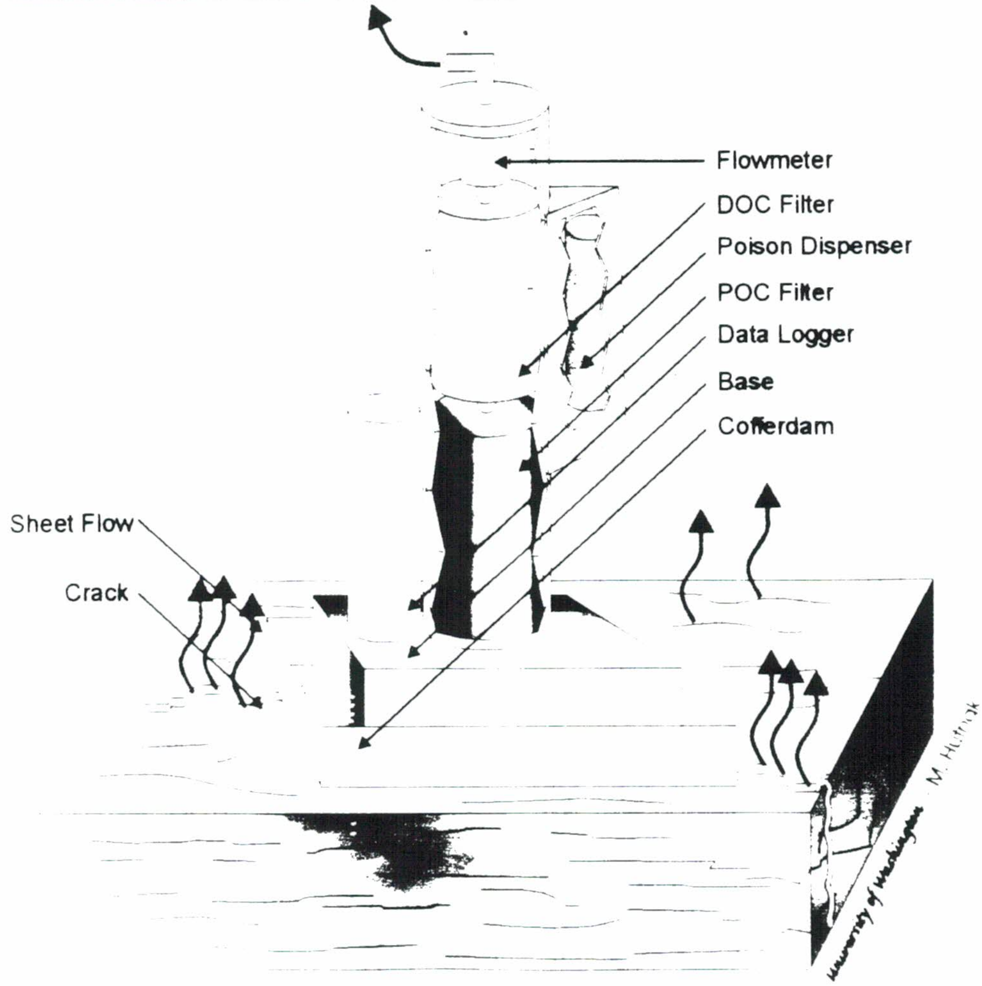
LEXEN Column - Baby Bare

NSF LExEn Program

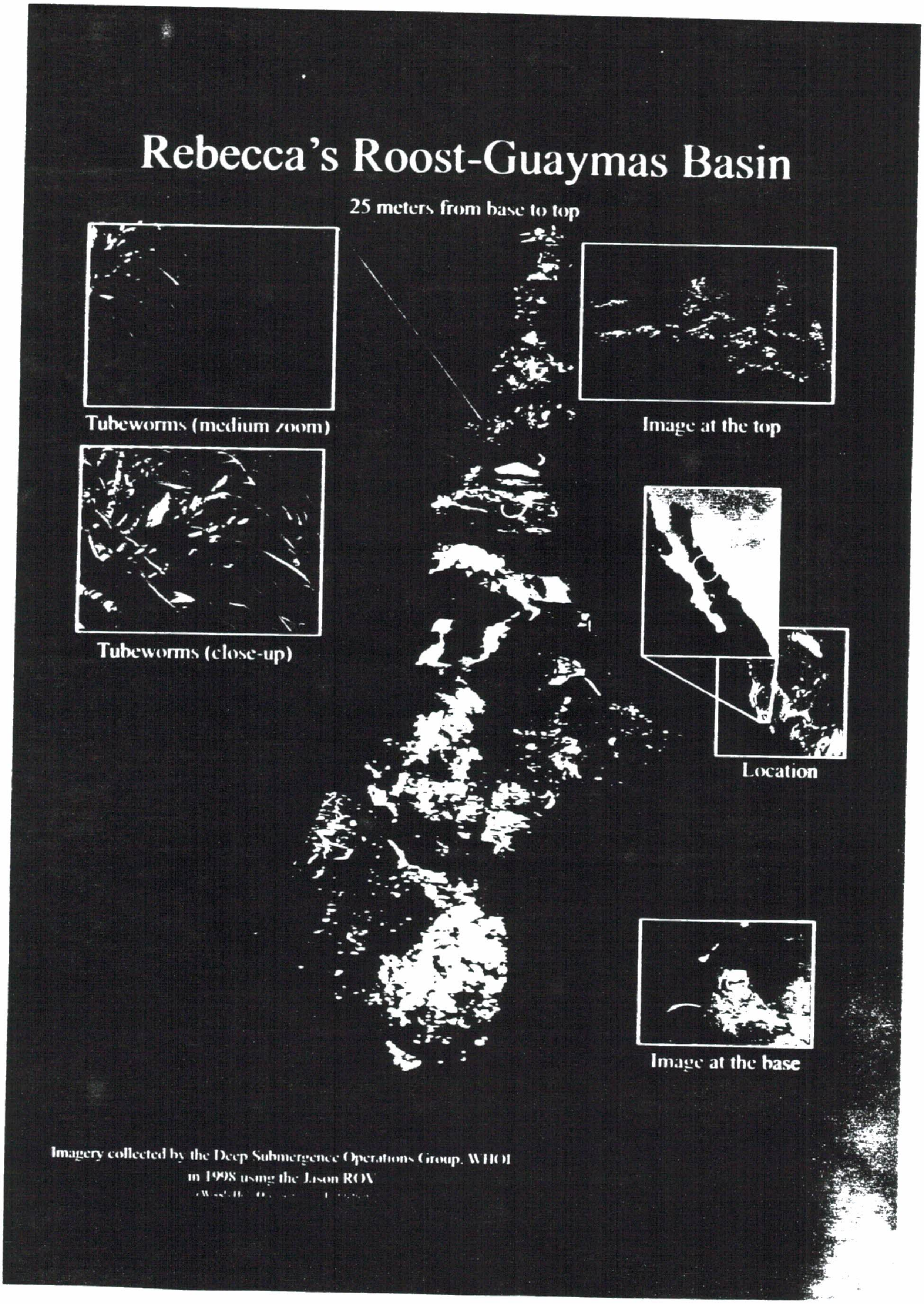
H. Paul Johnson - University of Washington

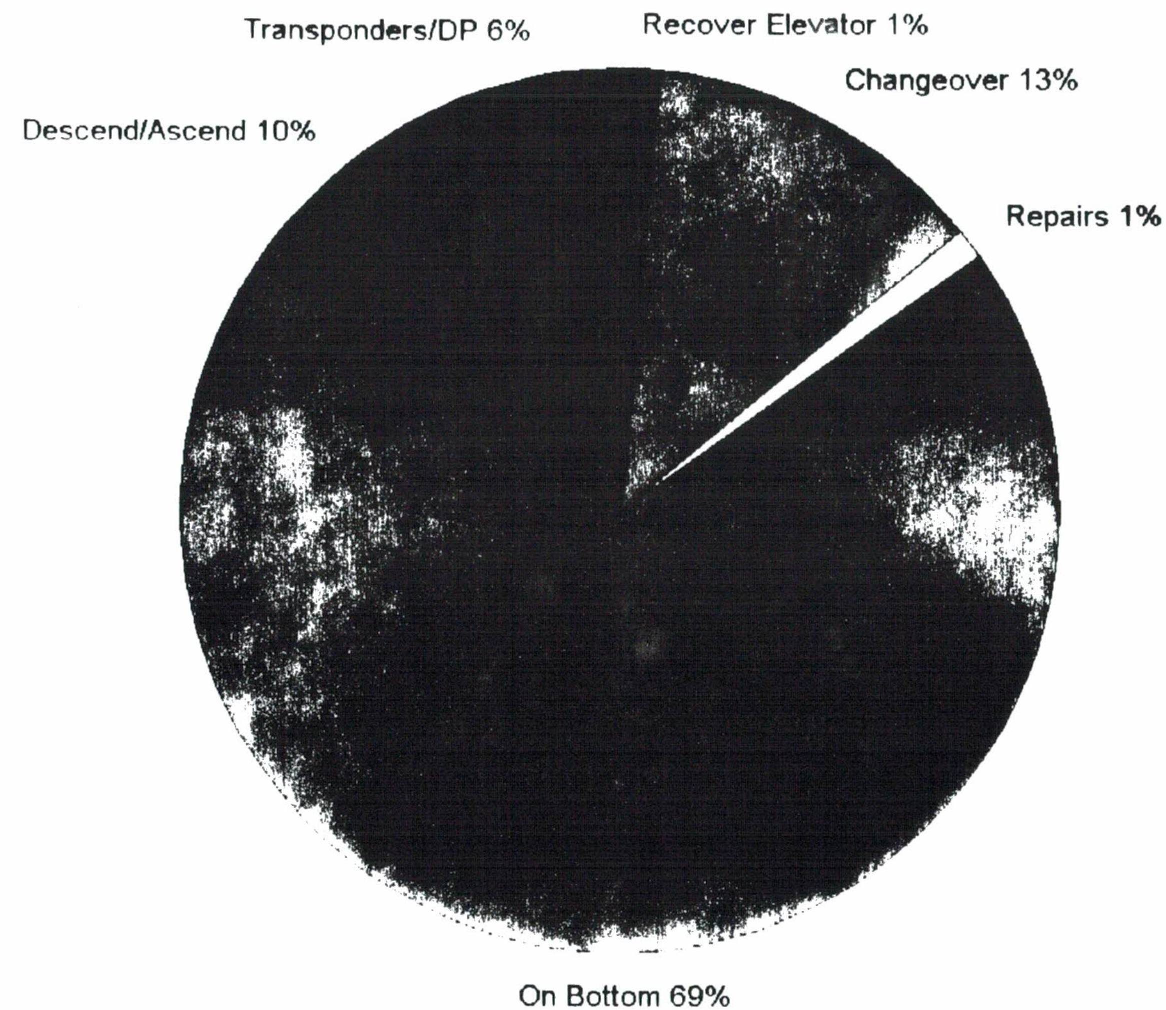
James B. Cowen - University of Hawaii



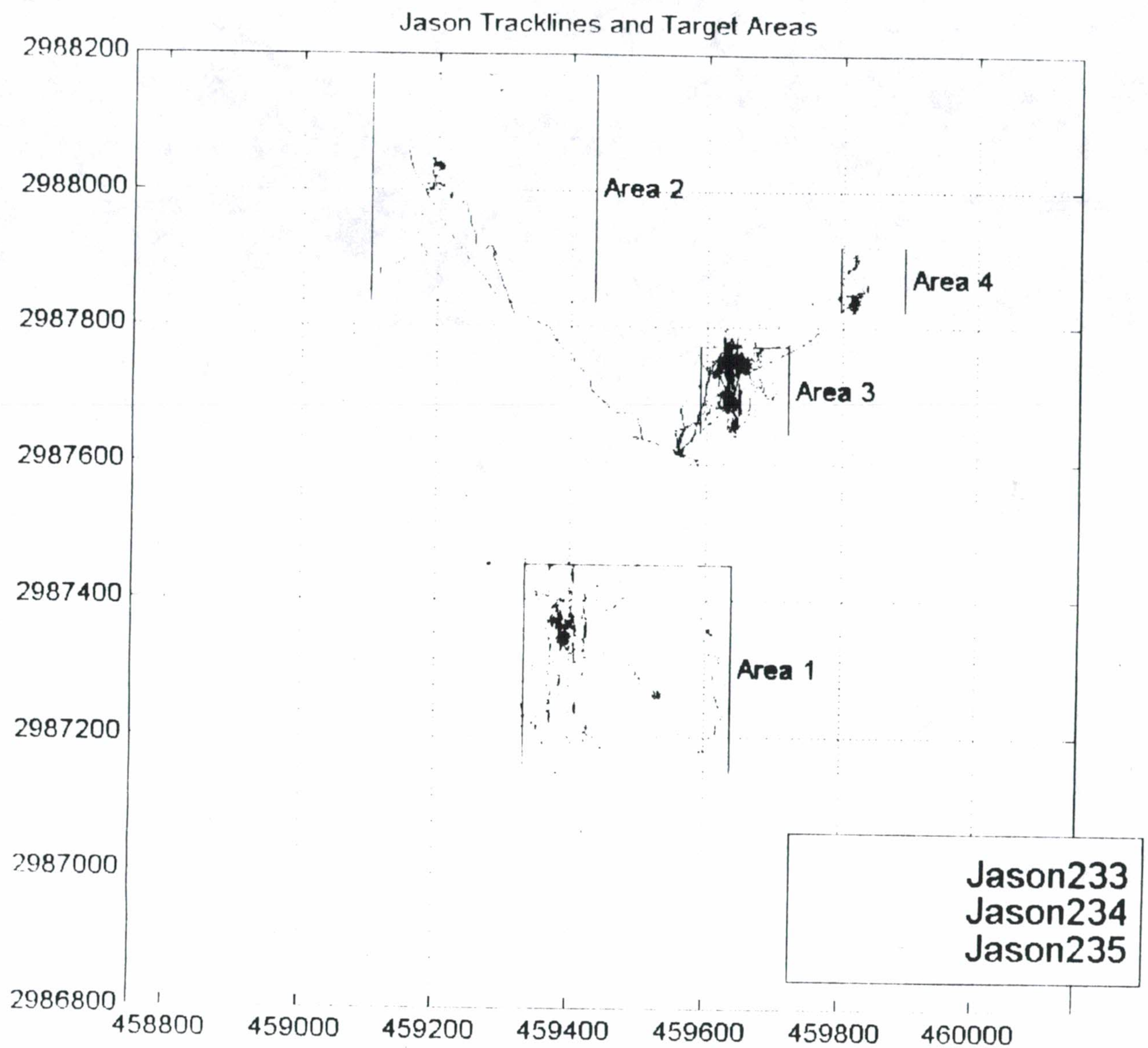


LEXEN Column - Axial Seamount


Rebecca's Roost-Guaymas Basin
25 meters from base to top
Tubeworms (medium zoom)
Image at the top
Tubeworms (close-up)
Location
Image at the base
Imagery collected by the Deep Submergence Operations Group, WHOI
in 1998 using the Jason ROV



Jason IX, Percent of Total Time on Station, 5.7 days



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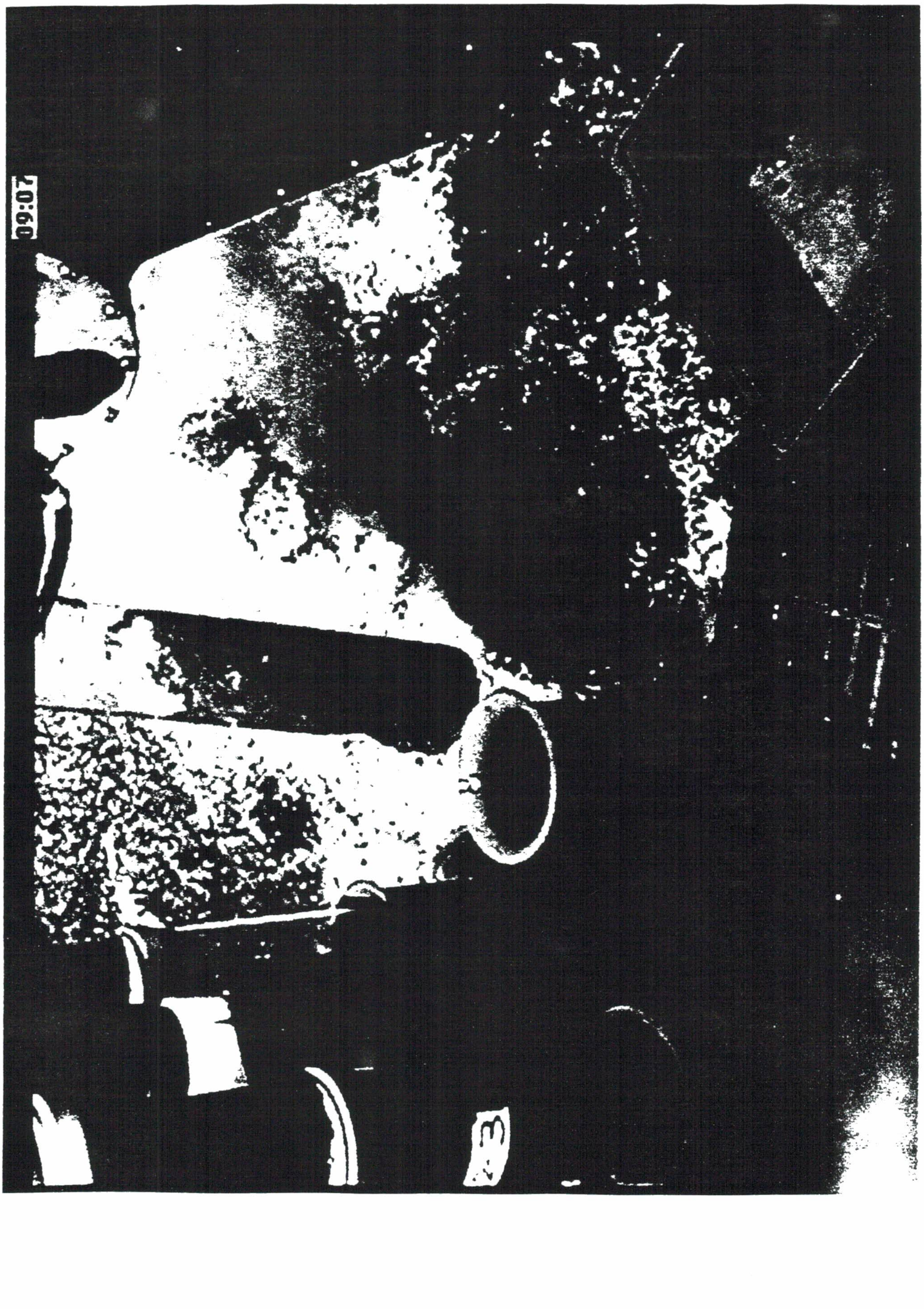
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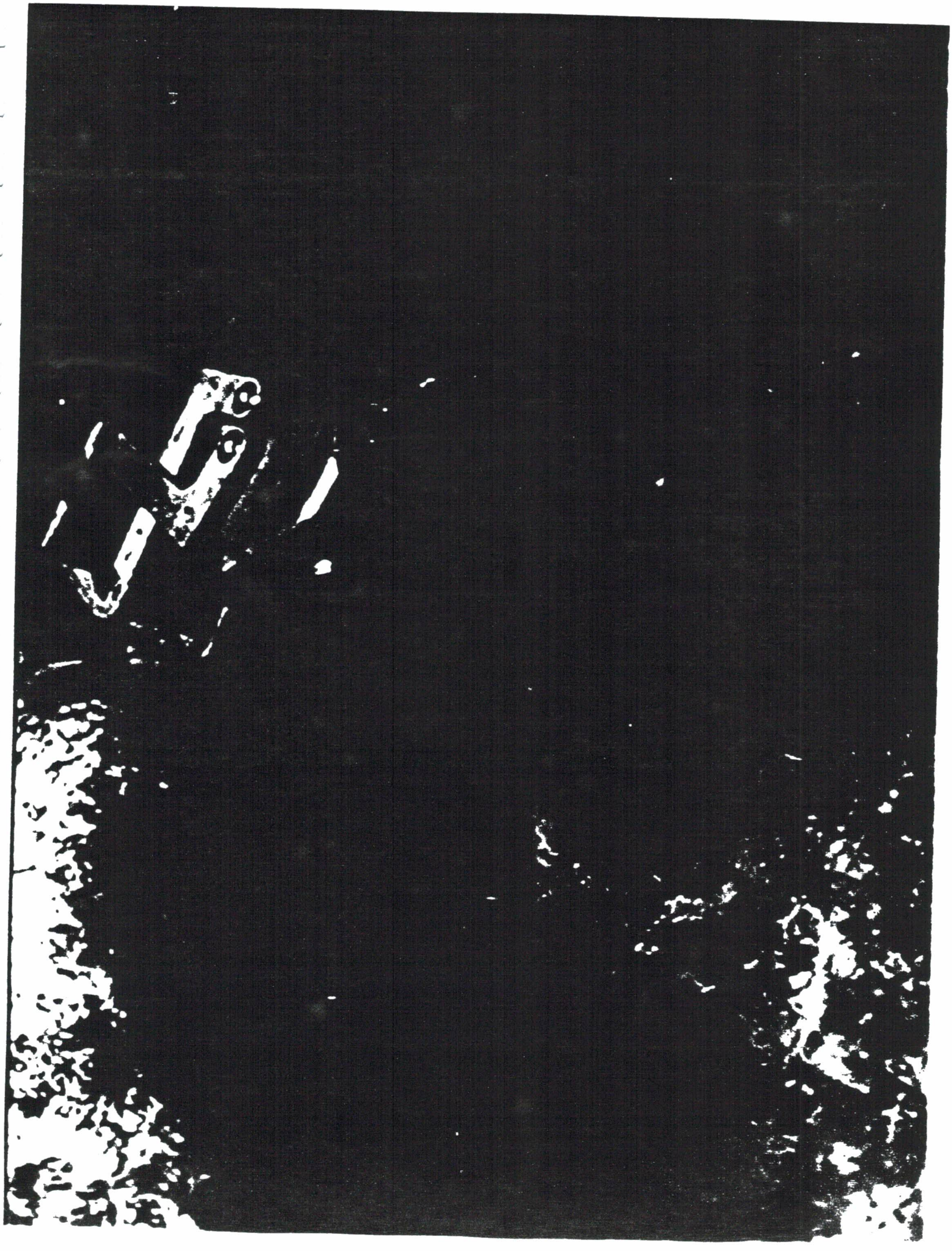

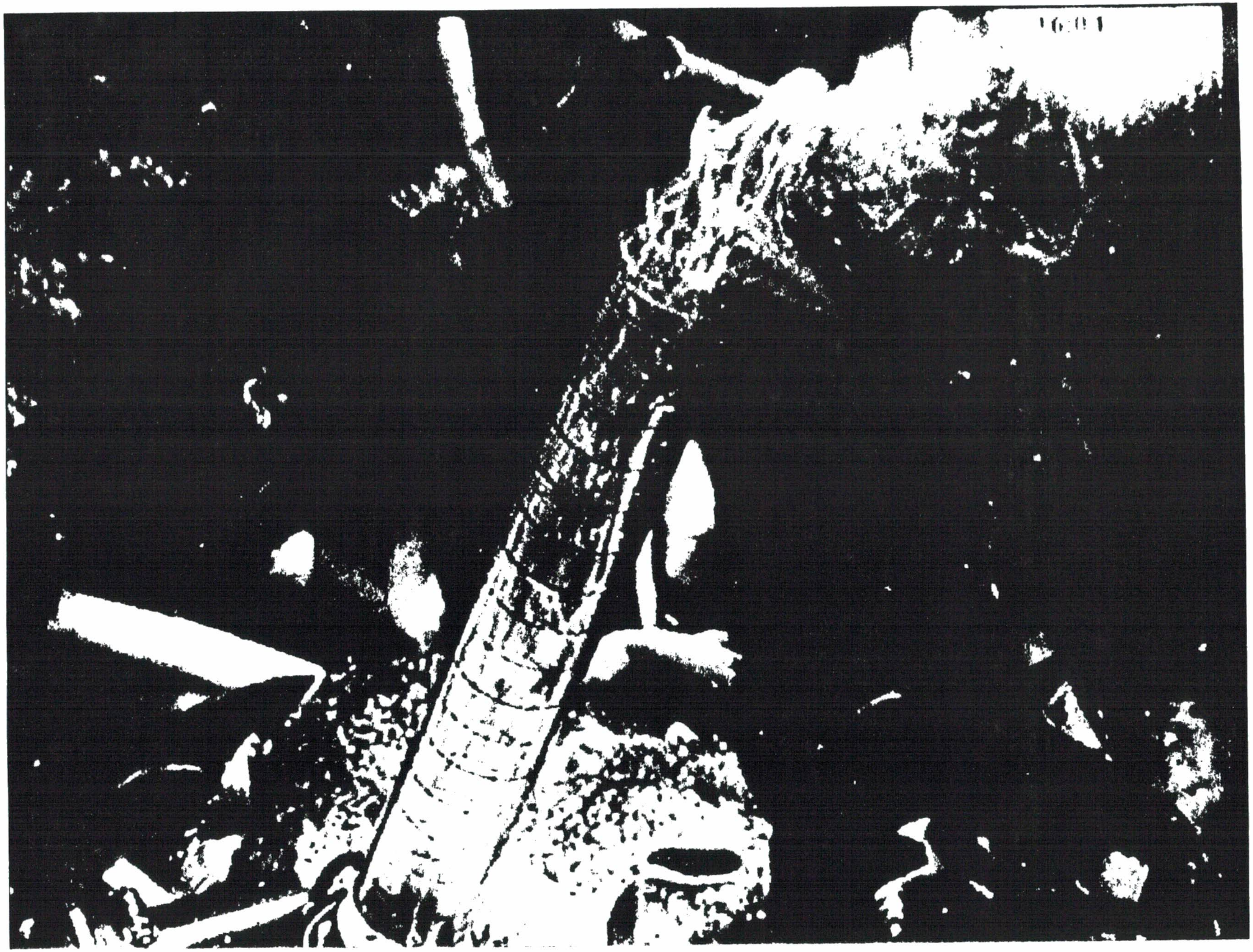

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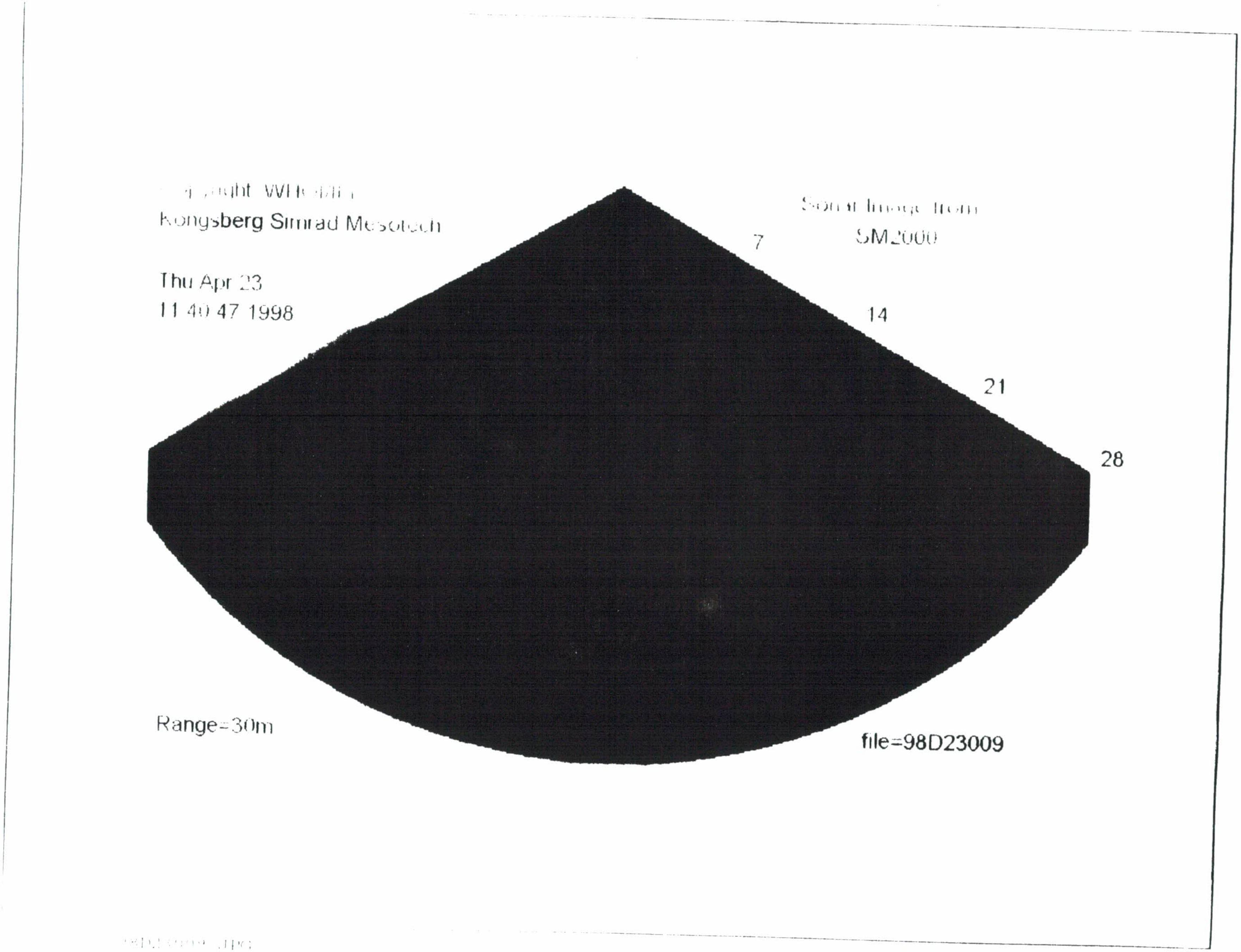
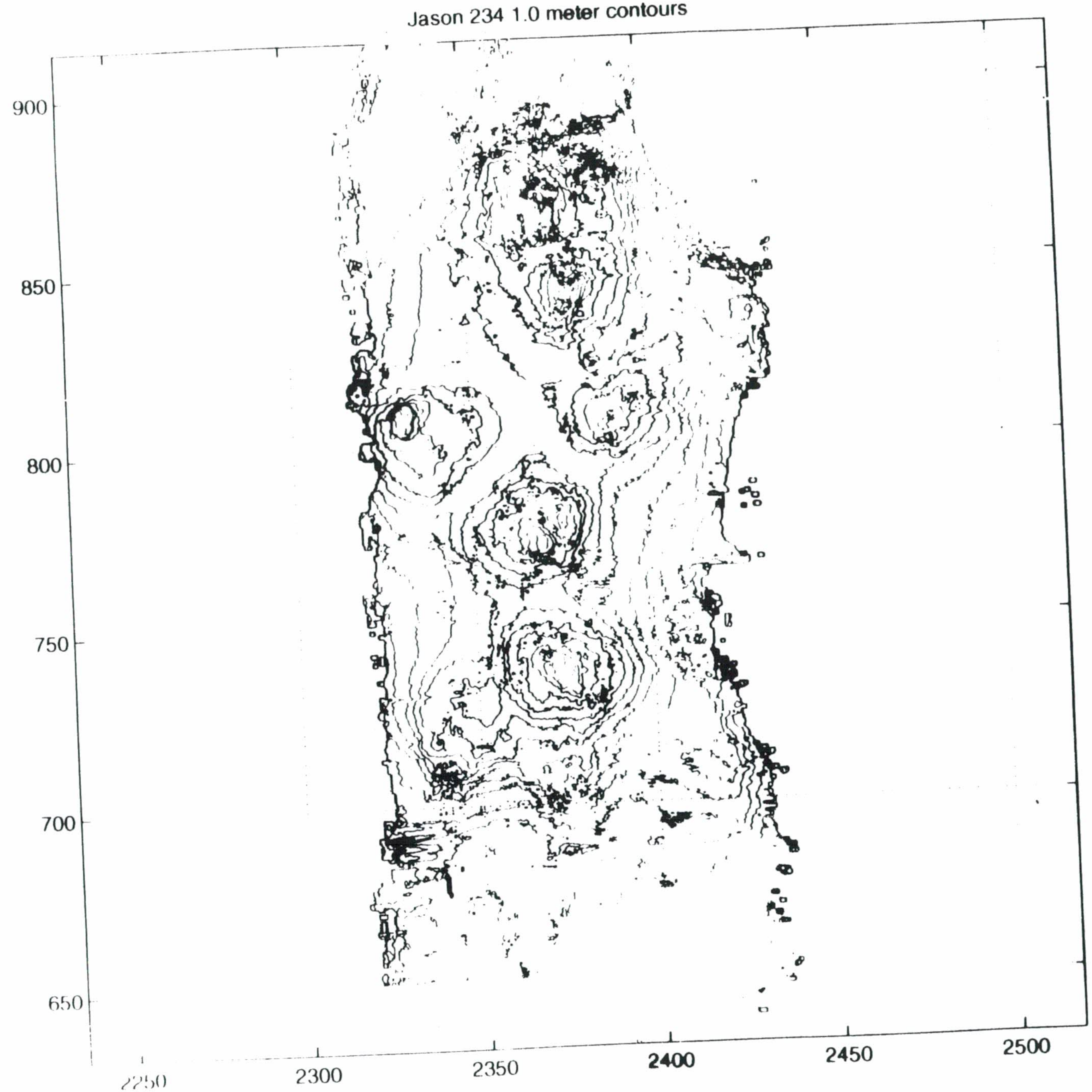
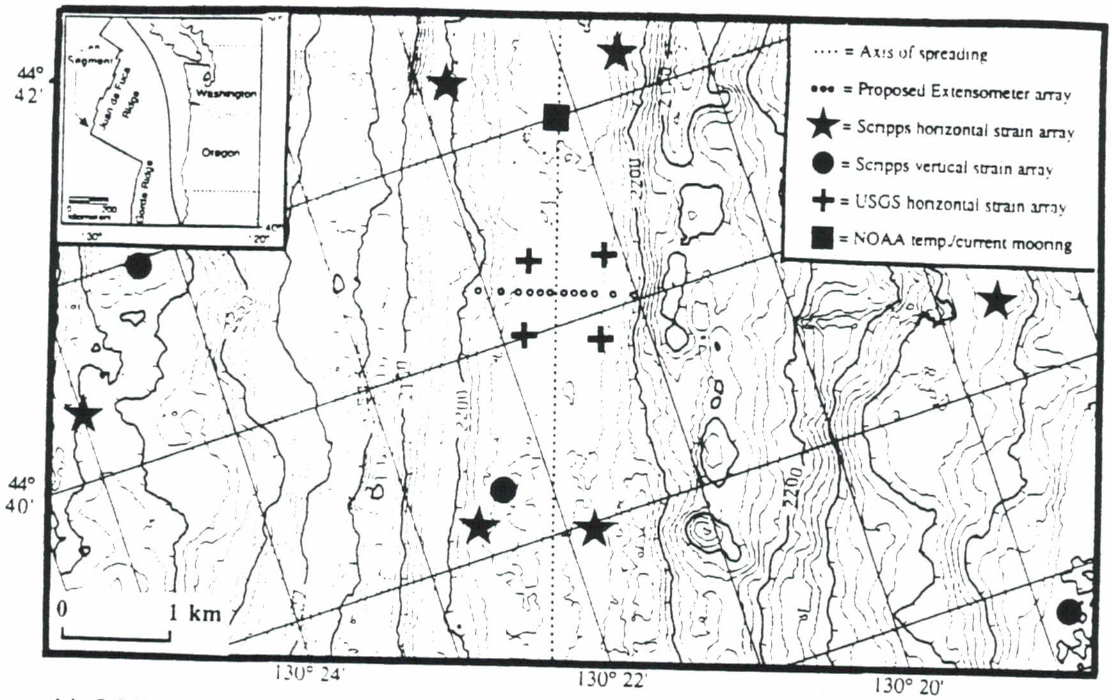

Kongsberg Simrad Mesotech
Thu Apr 23
11 40 47 1998
Sonar Image from
SM2000
7
14
21
28
Range=30m
file=98D23009

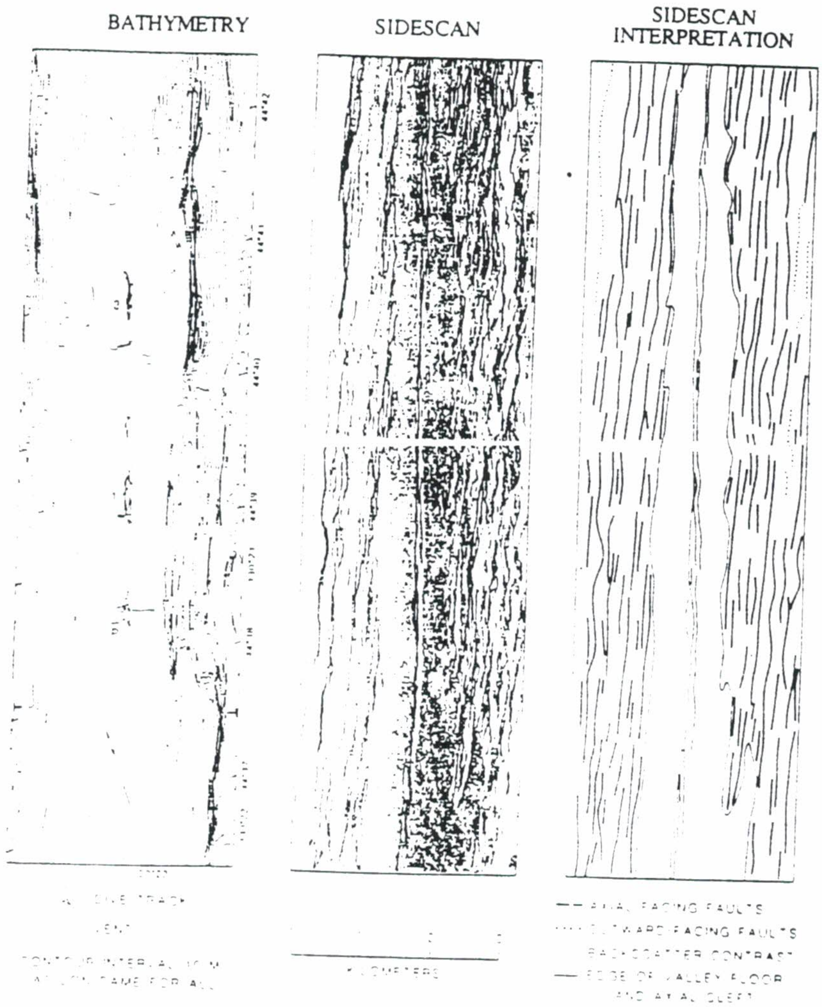
Jason 234 1.0 meter contours



a) SOUTH CLEFT (PHASE 1)



b) SOUTH CLEFT GEOLOGY



c) WHOLE CLEFT (PHASE 2)

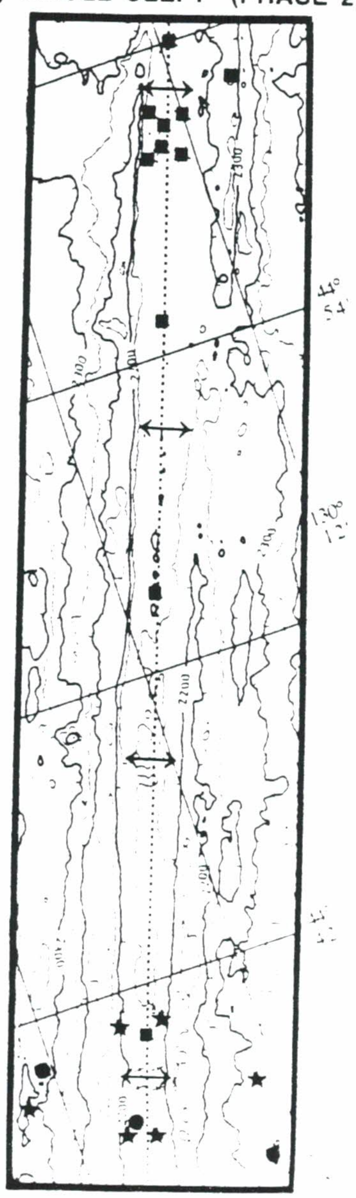
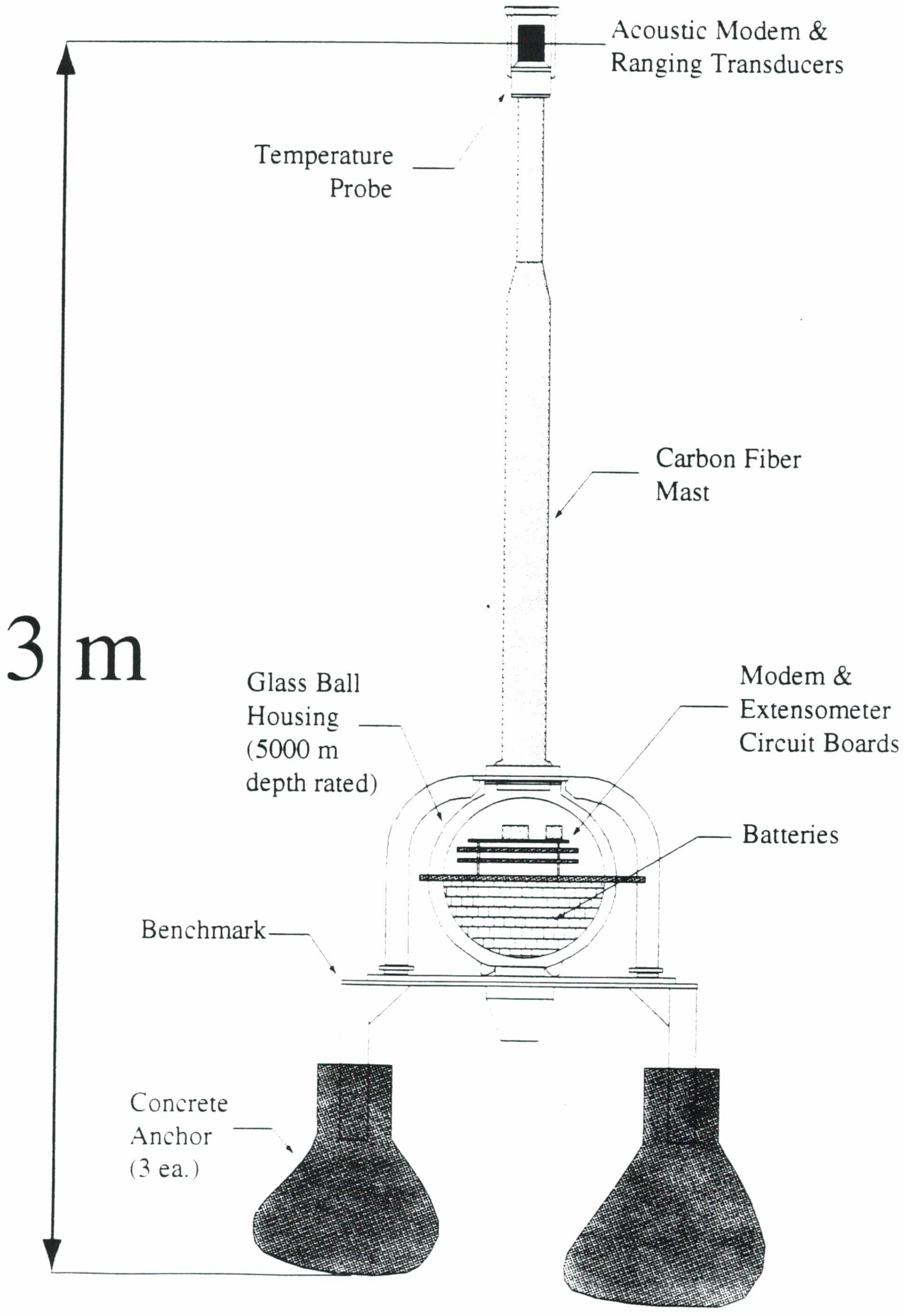


Figure 3. (a) Map of S. Cleft segment, JdFR (10 m contours) showing location of proposed extensometer baseline during PHASE 1, in the context of other observatory experiments. (b) Figures from *USGS* (1986) showing the narrow "cleft" marking the spreading axis at south Cleft. (c) Map of entire Cleft segment (50 m contours) showing proposed Extensometer baseline in PHASE 2 of this experiment (double arrows).



Acoustic Modem &
Ranging Transducers
Temperature
Probe
Carbon Fiber
Mast
3 m
Glass Ball
Housing
(5000 m
depth rated)
Modem &
Extensometer
Circuit Boards
Batteries
Benchmark
Concrete
Anchor
(3 ea.)

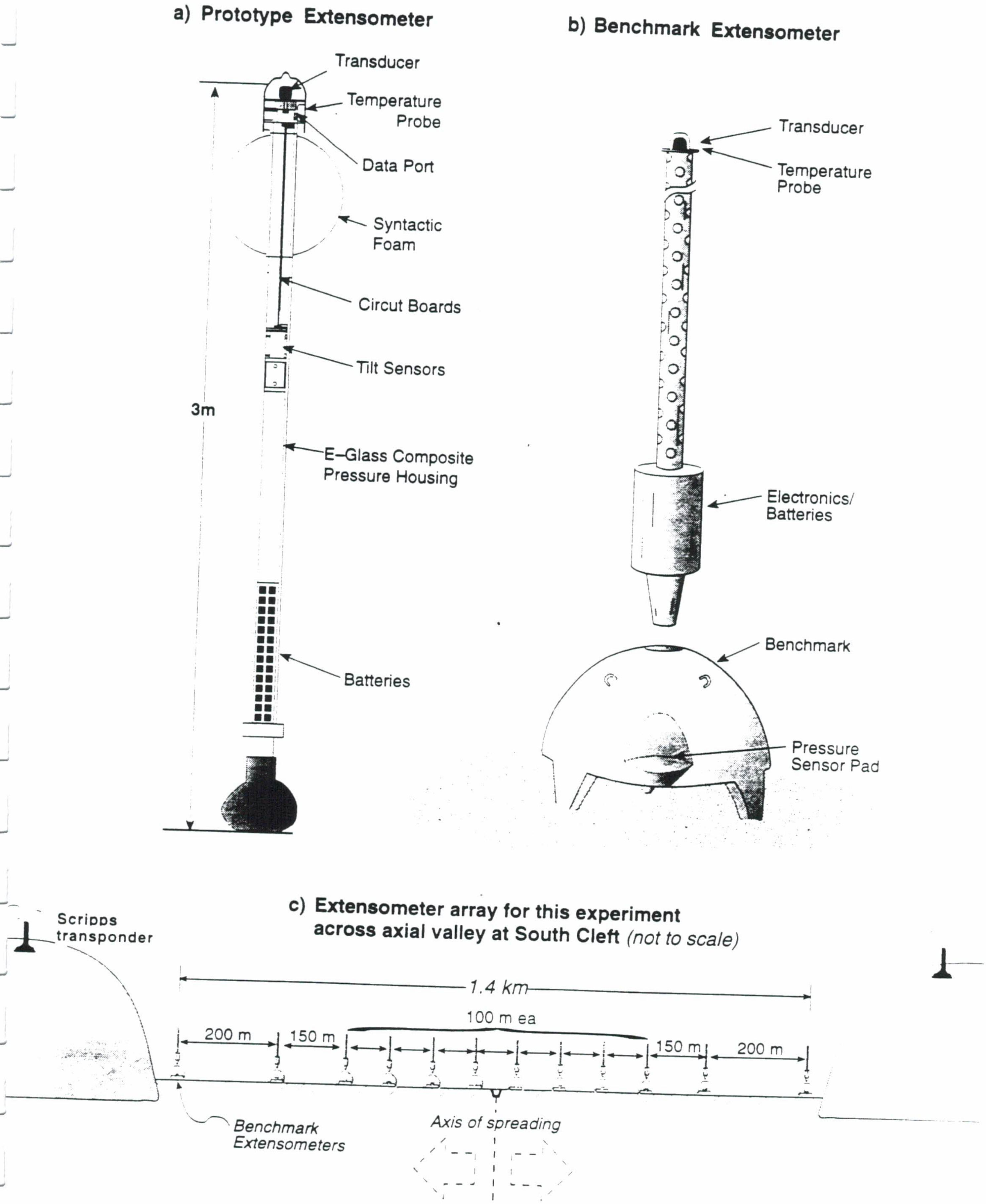
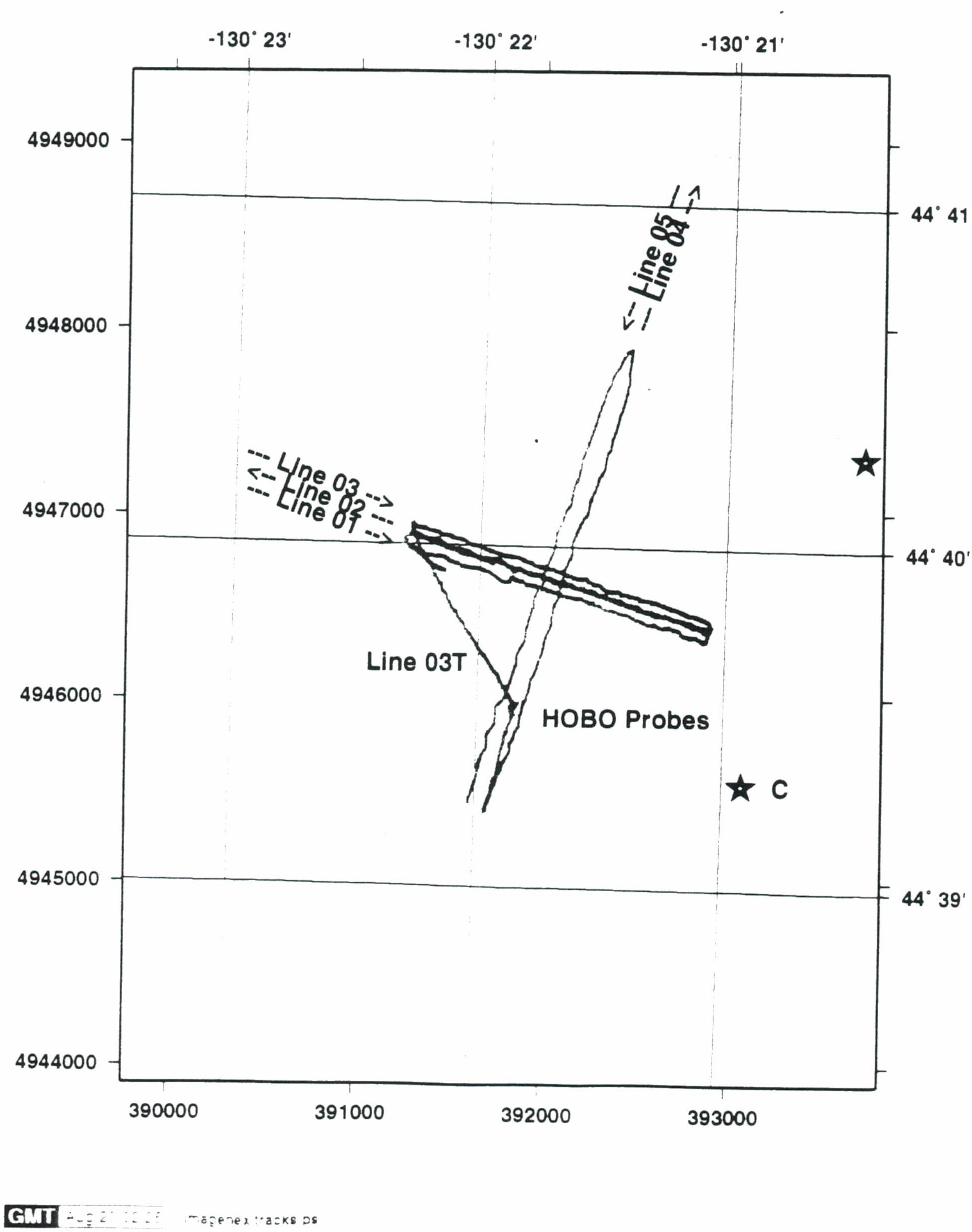


Figure 4. (a) Prototype Extensometer. (b) Conceptual diagram of seafloor benchmark and new "Benchmark Extensometer" design. (c) Proposed deployment of extensometer array in relation to spreading axis and axial valley

Cleft98 -- Imagenex tracks



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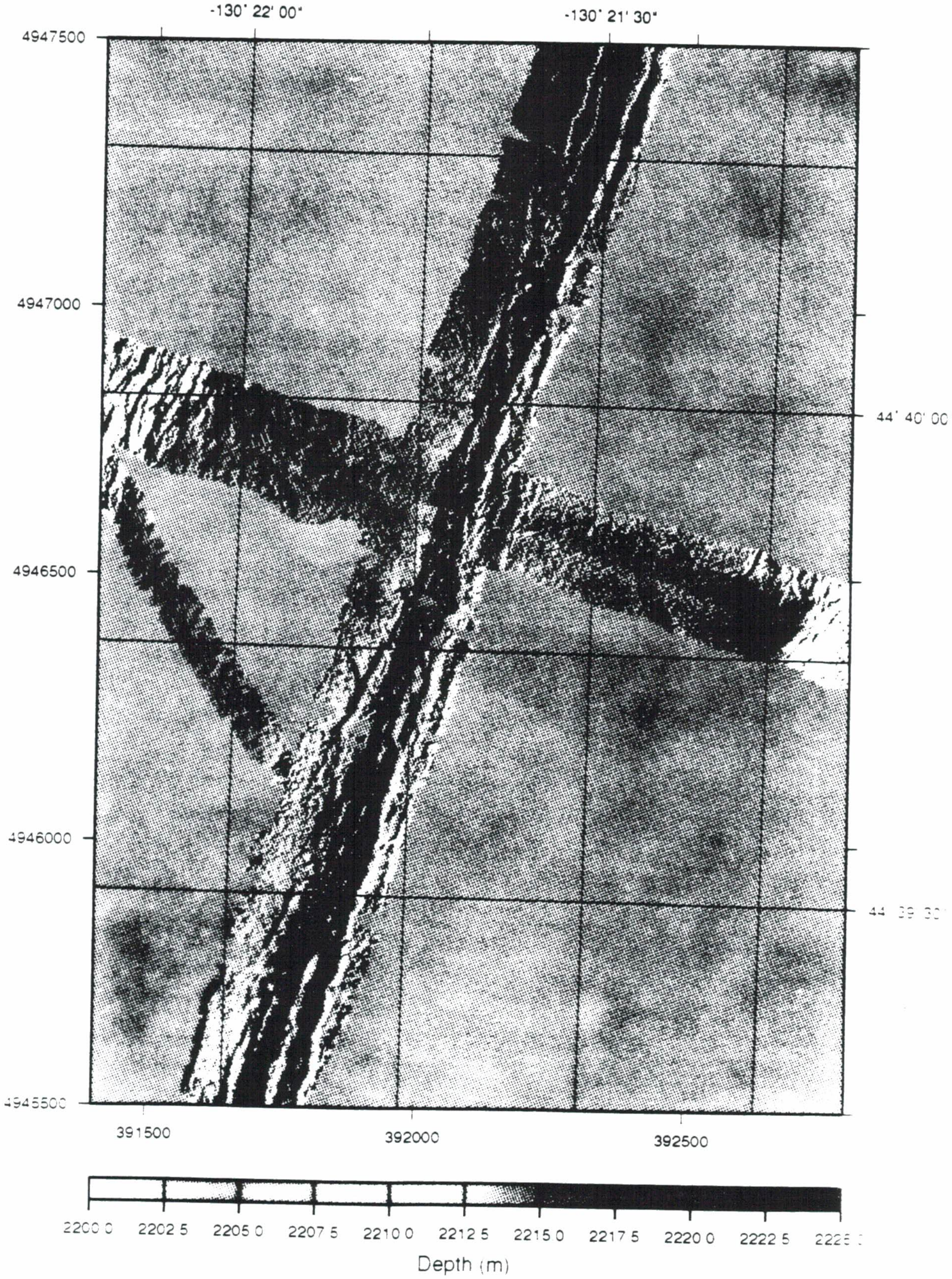

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III-

M B A R I

RESEARCH

1998 Projects

Project 4

Temporal dynamics of mid-ocean ridges and submarine volcanoes

Principal Investigator: Debra Stakes

Co-investigators: Dave Clague, Jennifer Reynolds, Michael Begnaud

Collaborators: Jim McClain, Karen McNally

The creation of oceanic crust is volumetrically the most important process in Earth's geology. About 80 percent of all volcanic activity occurs at the mid-ocean ridges. The continual circulation of water through hydrothermal systems at the ocean floor has kept seawater chemical concentrations within ranges that have allowed life on the planet to persist for at least two billion years. To understand the linkages between the volcanic, tectonic, hydrothermal, and biological systems at all stages of crustal processes is the goal of this project. The investigative efforts fall into two main categories: collecting and comparing rock samples from various locations that span from the oldest crust accessible to recently formed crust, and measuring ongoing seismic and volcanic events with seafloor instruments left in place for extended periods. The project elements are:

P4A Submarine volcanic processes of the Hawaiian Islands and Pioneer, Taney, and Davidson seamounts—Ocean crust is formed at mid-ocean ridges and oceanic volcanoes by a complex series of melting and cooling events. These episodes leave a geochemical "imprint" in the make-up of the crustal rocks. Unraveling the events that formed such rocks provides insights into the processes occurring in Earth's mantle, the source of the molten magma that wells up to feed volcanic eruptions. In some instances submarine volcanic activity produces chains of volcanoes, as in the mid-Pacific, where the Hawaiian Islands are the above-water representatives of a 6,000-kilometer (3,700-mile) chain of extinct volcanoes stretching to the northwest. Eruptions and the internal movements of magma within active oceanic volcanoes trigger earthquakes and landslides, which reshape the volcanoes. Under this sub-project, MBARI geologists will investigate several areas to gain a better understanding of the complex processes that modify ocean crust and oceanic volcanoes:

- **Offshore of Central California**—On seamounts believed to have formed in the same era as the San Andreas fault system, researchers will use the ROV *Tiburon* to collect rock samples and survey the seamounts and their structures. The samples will be analyzed for their compositions, ages, and alterations made by

Aquarium/
MBARI joint
projects

1997 Projects

be analyzed for their compositions, ages, and alterations made by past hydrothermal activity. Researchers are interested in knowing whether the seamounts were ever above sea level, and why some of them have very large calderas (volcanic craters formed by explosive eruption or collapse of the volcano). From these findings institute scientists hope to better reconstruct the history of the continental margin off Central California.

- **Hawaii**—The extensive study of sub-aerial (above sea-level) volcanoes has revealed much about their evolution after they have built an edifice large enough to emerge from the sea. However, much less is known about processes of earlier, submarine volcanic stages and how they compare to above-water volcanic stages and to mid-ocean ridges. Institute studies off the island of Hawaii will shed new light on these questions. In February, as part of the first leg of MBARI's survey project (under Project 11), researchers will conduct a sidescan sonar survey of the underwater flank of Kilauea volcano. Geologists will use the resulting maps and other larger-scale maps for comparing Kilauea's underwater structure with the much-better-studied terrestrial portion of the volcano and with mid-ocean ridges. MBARI researchers will participate in two other research cruises on Kilauea's submarine rift zone, using a submersible to collect lava samples and high-resolution sonar information to map the depths and details of lava flows, vents, and other features. In addition, they will use a human-occupied submersible to survey areas of Loihi, the youngest volcano in the Hawaiian chain. Laboratory analysis of lava samples from past submersible dives on Loihi continues. The findings thus far have raised intriguing questions about processes, such as submarine explosions, which researchers previously considered unlikely to occur on deep submarine volcanoes.

- **Other locations**—Past research on submarine volcanic activity from other locations is being completed. These projects include studies on seamounts in the Austral Islands region (near Tahiti) and analyses of samples from the Hawaiian Islands and the Gorda Ridge and East Pacific Rise, both parts of the global mid-ocean ridge.

P4B Study of altered oceanic crust and hydrothermal precipitates from mid-ocean ridges and ocean islands—The formation of oceanic crust is intimately related to cooling and modification of the crust by seawater. Mapping the distributions of minerals known to be formed under high temperatures identifies permeable zones in the rock where hydrothermal processes occur. Solid compounds precipitate out of the hot vent fluids as they flow into the cold seawater. The make-up of the precipitates reflects variations in the temperature and chemistry of the venting fluids. Analysis of rocks of various ages and locations collected by MBARI researchers should reveal much about these key processes.

In March institute geologists will make an expedition to the Atlantis Bank in the southwest Indian Ocean, where one of the best exposures of the lower oceanic crust exists. The crust formed at a mid-ocean ridge and was transported away as newer crust displaced it. Over the ages fractures formed paths for water to seep in and buoy the crust up *to relatively shallow depths (700-2,500 meters). Institute scientists will* collect samples at Atlantis Bank with the MBARI multi-core rock drill mounted on the Canadian ROV *ROPOS*.

Samples to be collected from seamounts off the Central California Coast (P4A) will represent quite different geologic settings and eras. Davidson Seamount is believed to be a failed mid-ocean ridge; together with Pioneer and the Taney Seamounts, it is tied to the evolution of the San Andreas Fault system. The seamounts have resulted from volcanism superimposed on crust from mid-ocean ridges. Deciphering past hydrothermal activity at these offshore sites will tie in to ongoing regional geologic studies at MBARI.

The rocks from the Atlantis Bank and Central Coast offshore seamounts also will be compared to basalts (volcanic rock) from Monterey Canyon and samples from cruises to the Juan de Fuca Ridge, an area of very active underwater volcanism and hydrothermal venting. The comparative studies will help researchers address large questions such as how much oceanic crust is chemically altered by hydrothermal activity. The findings will also contribute to models that attempt to describe the flow of heat in Earth's outer layer.

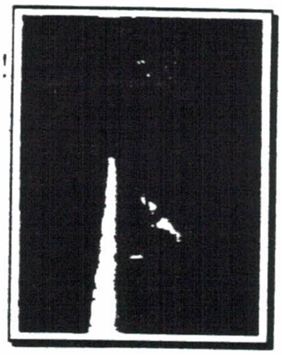
P4CBenthic observatory on the Juan de Fuca Ridge—To lay groundwork for the long-term objective of establishing a seafloor observatory on the south end of the ridge, geologists will begin by collecting data for a geological map of fine-scale bathymetry on a section of the ridge. A large-scale, combined side-scan/bathymetric survey will provide continuous data of the entire southern Juan de Fuca Ridge and the western half of the adjoining Blanco Fracture Zone. This will be followed by a higher- resolution survey that will be centered over the most hydrothermally active area of this ridge segment. MBARI researchers will also deploy a small number of seismic instruments in collaboration with NOAA. Ultimately, the goal is to join with NOAA and other agencies in setting up a series of instruments and samplers that will continuously monitor events (such as earthquakes and magma movements) related to ocean crust formation and sample seafloor fluids that have been modified by interaction with cooling crustal rocks. The goal of the 1998 efforts is to determine the kinds of instrument systems that should be developed and the optimal design for the seafloor observatory.

P4D Margin seismology system development— During 1997, in the MOISE (Monterey Ocean Bottom International Experiment) MBARI scientists and collaborators successfully deployed a variety of seismic instruments in Monterey Canyon for extended periods, which registered many regional and distant earthquakes. In 1998 they are developing new technologies for long-term observations; the permanent deployment of short-period seismometers is the highest priority. These seismometers, which record local events with high accuracy, are placed in coreholes drilled by an ROV. Up to five instruments will be placed in seafloor locations to provide seismic signals from several stations, which will improve the accuracy in determining earthquake locations and regions of stress release. These sensors will register microseismicity—signals from minor earth movements that reveal aspects of the mechanisms of earthquake faults, such as the angle of the fracture and the way fault movement occurs. From this, scientists can glean much about the underlying structure of the canyon and the behavior of active faults and pinpoint which faults might generate potentially damaging earthquakes. The seafloor seismic data will be combined with earthquake data from land-based stations. Used together, the records will assist scientists in determining more precisely the locations of both offshore and onshore earthquakes. A better understanding of the fault systems of the canyon will also likely shed light on the patterns of fluid flow from the seafloor and the occurrence of landslides that reshape the canyon—both intimately linked to the faults.

Next: Marine microbial ecology

Last updated: 22 September 1998

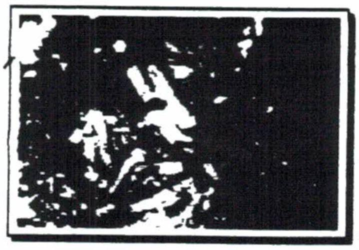
Voyage to Puna Ridge



Join an international team of scientists on a 36-day ocean voyage to Hawaii's most spectacular volcano!

Share the excitement of discovery as we explore a volcanic ridge three miles under the sea!

On January 3, 1983, fountains of lava erupted from a fissure on Hawaii's Kilauea volcano, sending rivers of molten rock flowing towards the sea. Nearly 16 years later, the eruption continues with no sign of letting up.



Scientists from all over the world have converged on Kilauea to witness these fireworks. More is now known about Kilauea than any other volcano in the world. Yet many of Kilauea's secrets remain hidden beneath the Pacific-until now.

Drop an M&M in the ocean and see what happens!

Deep underwater on Kilauea's east flank, numerous eruptions have built a ridge that extends 75 kilometers from the shore and plunges to a depth of 5,400 meters. This is the Puna Ridge. Within it lie vital clues to Kilauea's past and future. Join us as we uncover these secrets.

- Read daily updates as scientists for the first time map, photograph, and collect samples from Puna Ridge.
- Learn about life on board a research ship, the scientific process, and the day-to-day decisions that go into carrying out such an ambitious project.
- Participate in the innovative learning activities directed by the Hawaii E-School teacher-on-board

Web Site Sponsors

National Science Foundation

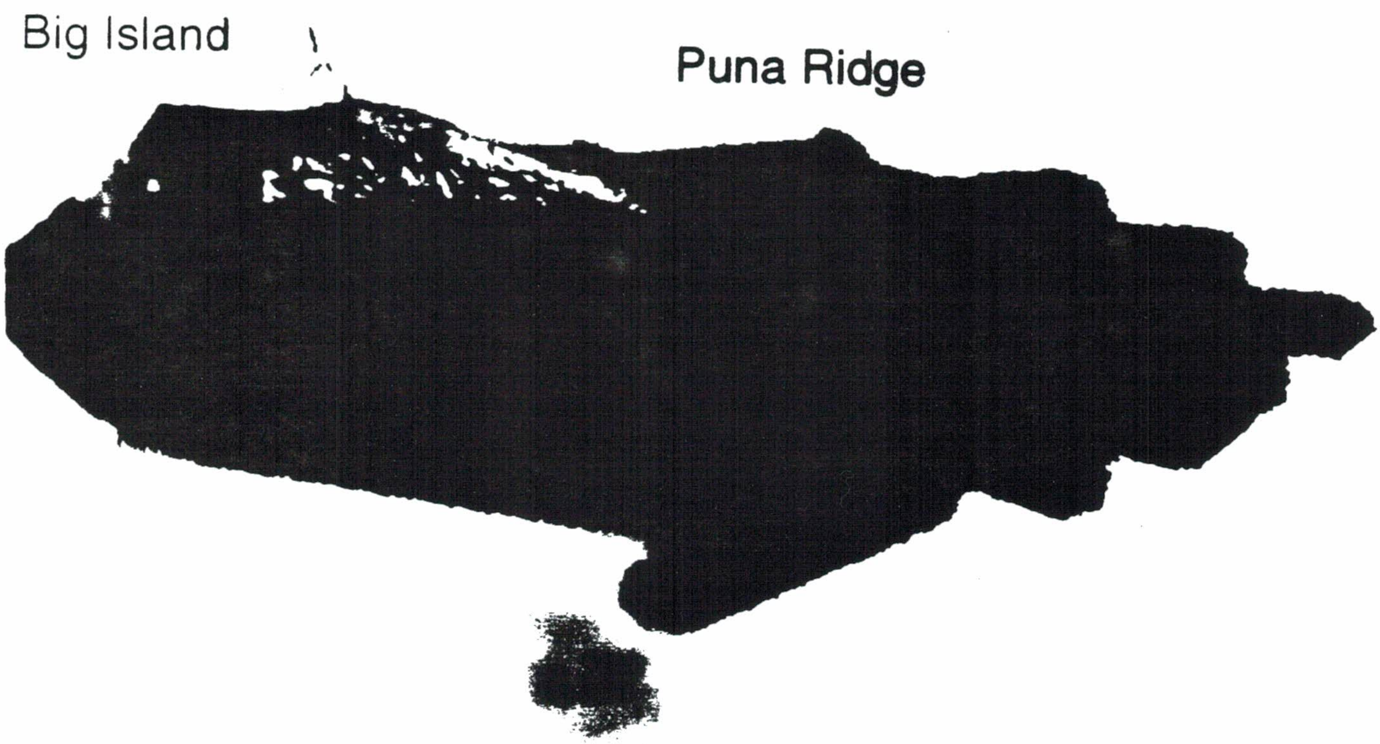
Woods Hole Oceanographic Institution

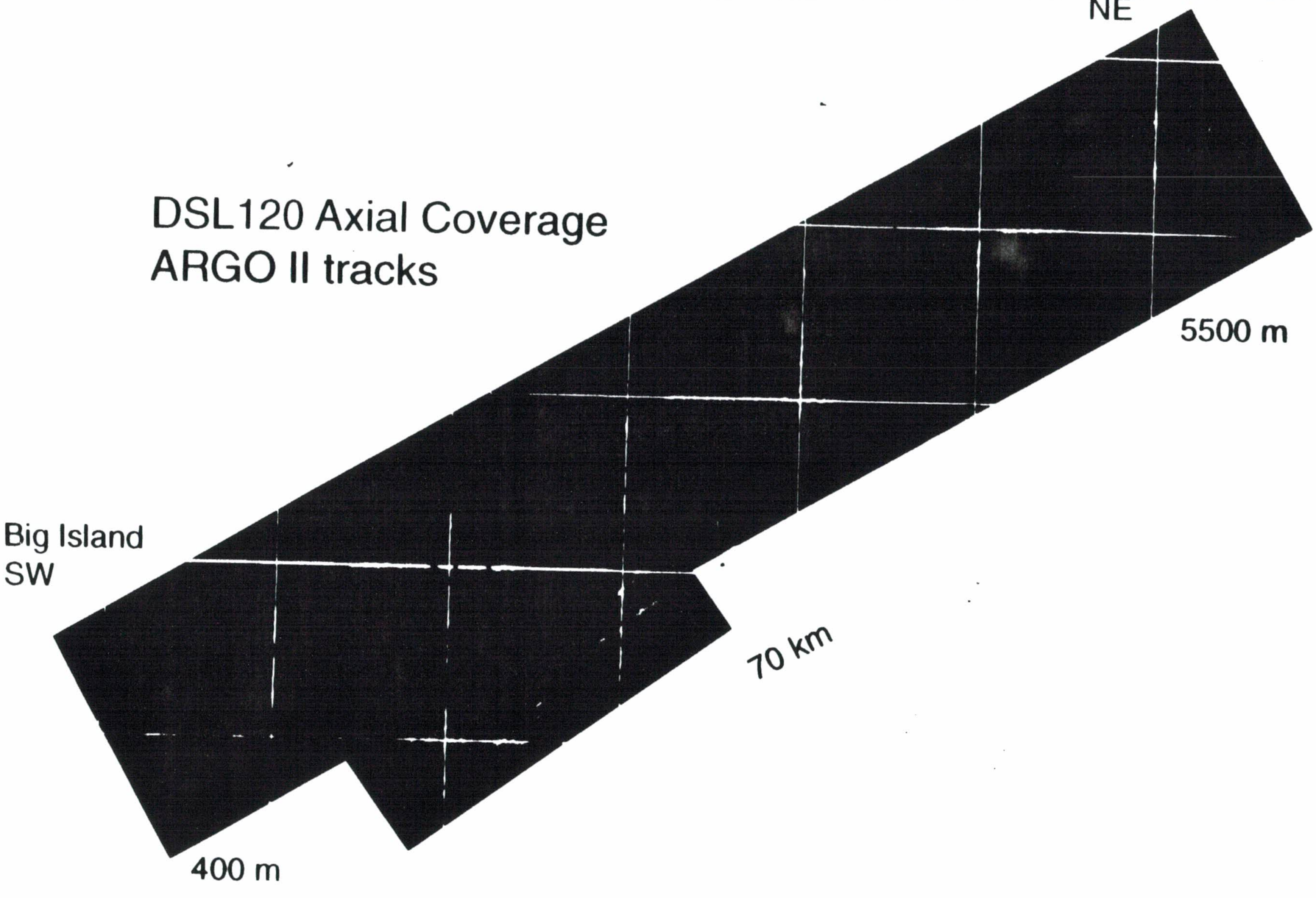
Hawaii Department of Education

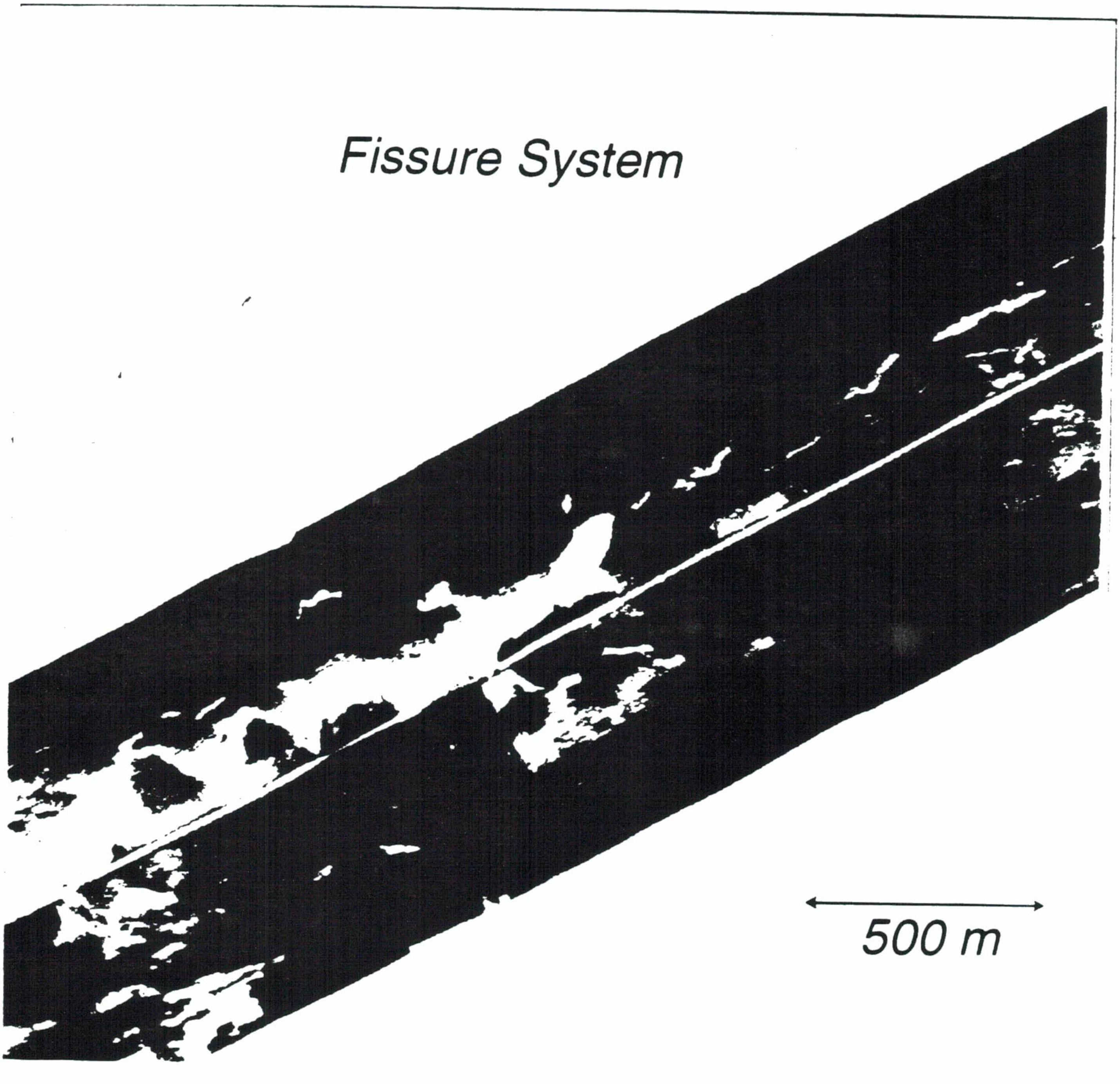
Contact Us

For more information about this web site contact our web administrator.

Investigating the Puna Ridge, Hawaii



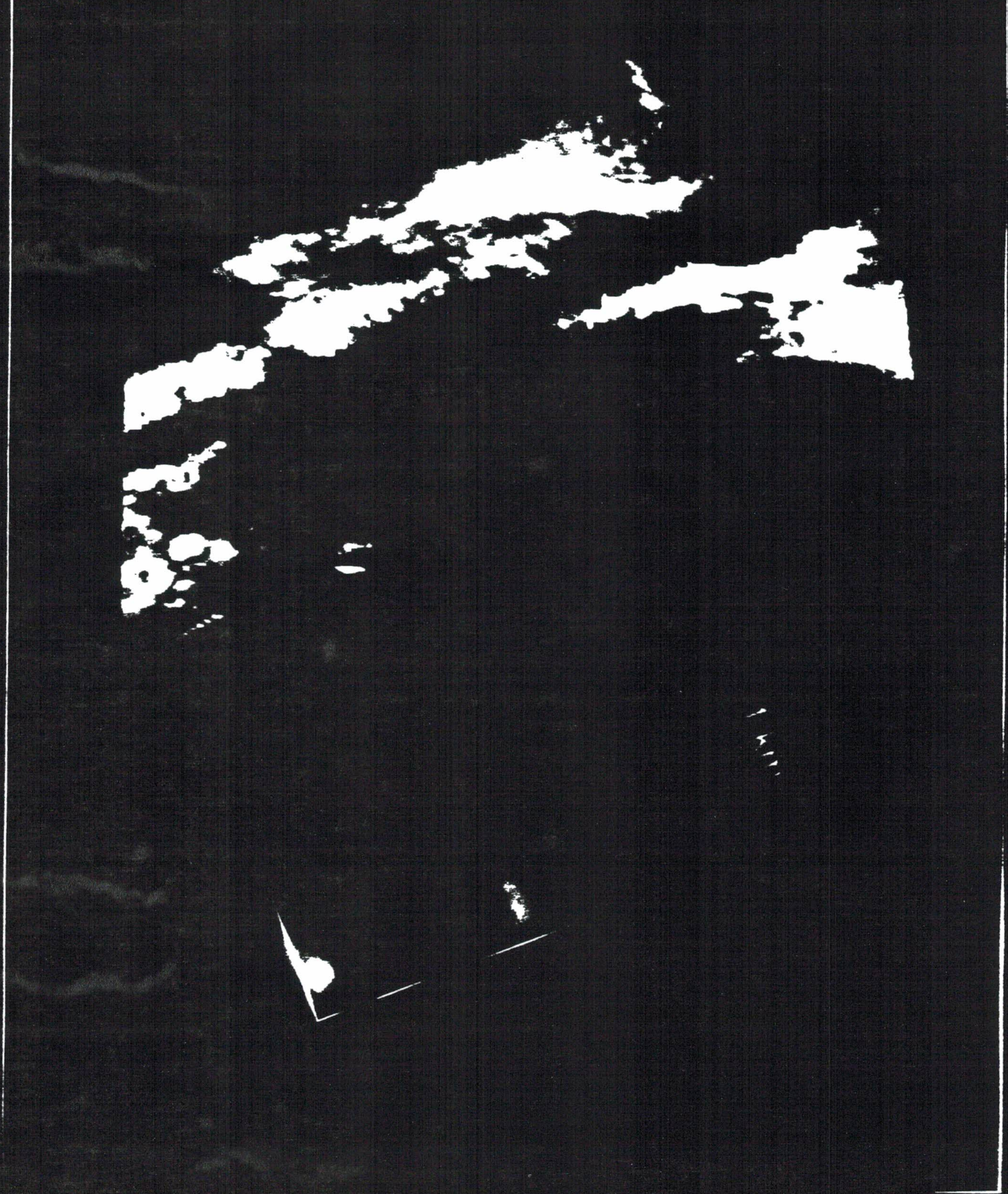

DSL120 Axial Coverage
ARGO II tracks
NE
5500 m
Big Island
SW
70 km
400 m


Fissure System
500 m

Fissures/Cracks

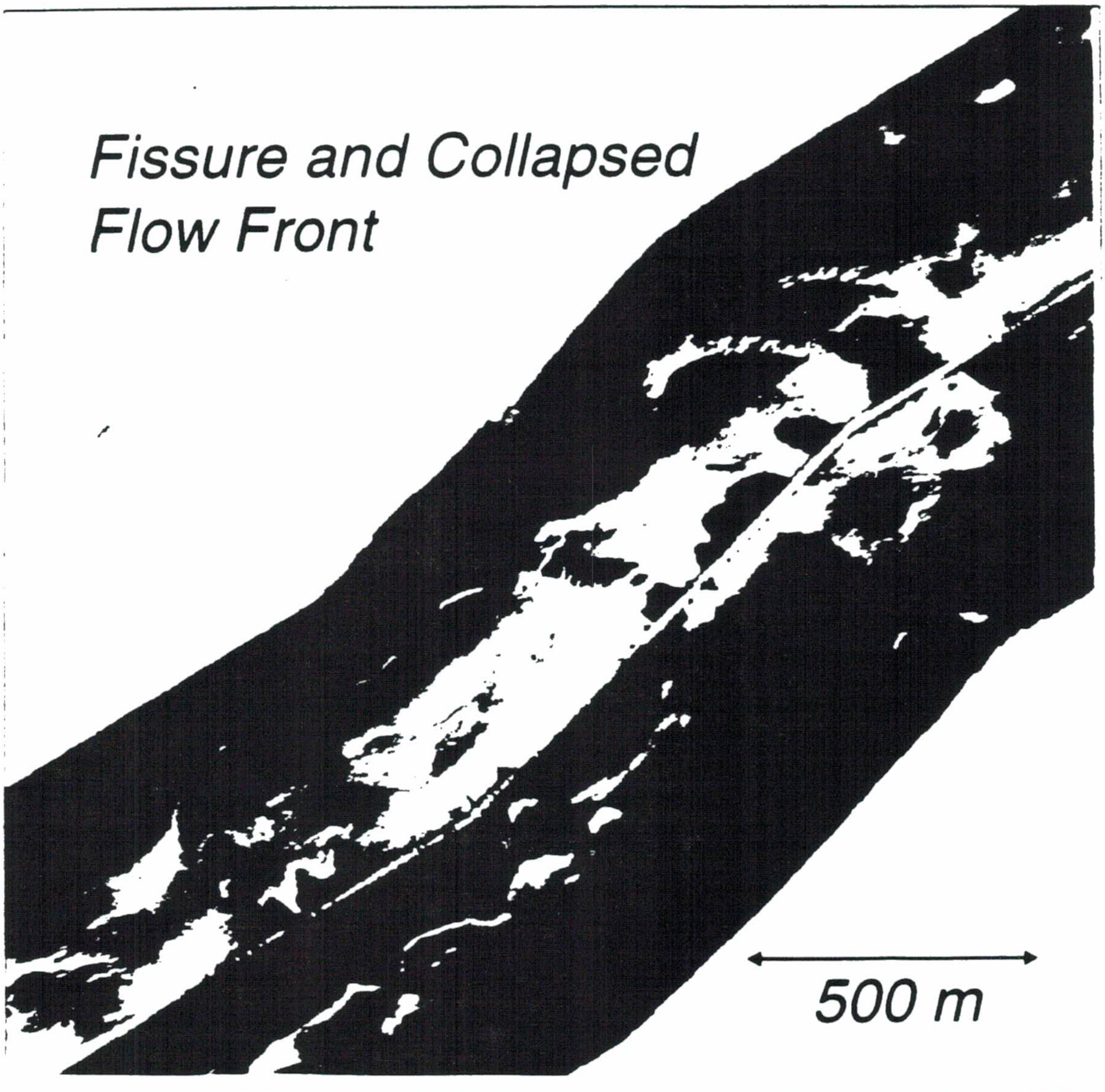
~10 m

Axial Terrace with Crater

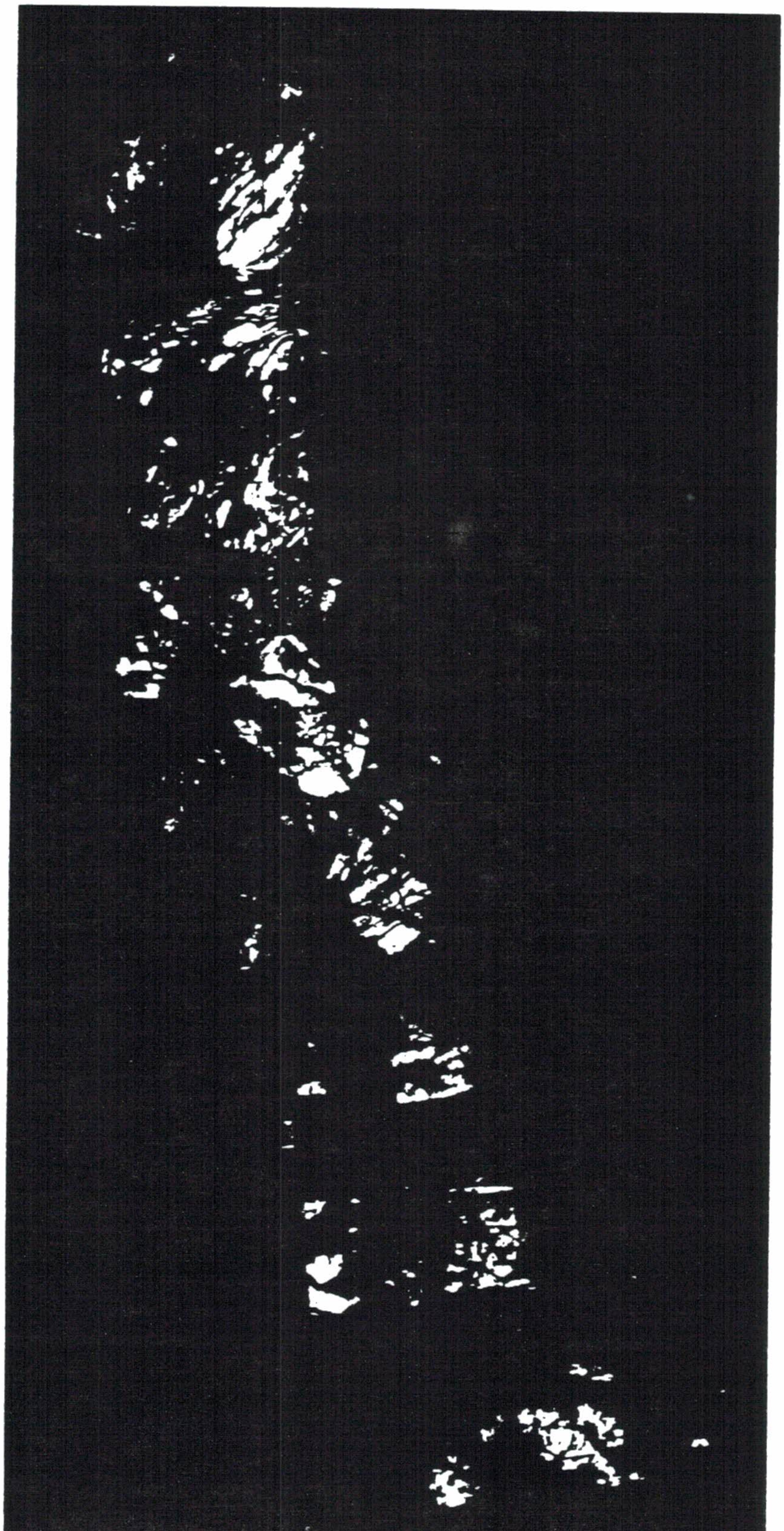


Collapsed Pits over Tube

~10 m


Fissure and Collapsed
Flow Front
500 m

Flow on Distal Toe



~15 m

Flow on Distal Toe

SCRIPPS INSTITUTION OF OCEANOGRAPHY

III-I

There are three general objectives of this proposed work. First, to understand the structural controls of hydrothermal venting at superfast spreading rates. Do boundaries of morphotectonic/structural 4th order segments correspond to the boundaries of hydrothermal activity on superfast- spreading ridge segments as proposed for the fast-spreading northern EPR and intermediate-spreading Juan de Fuca ridge? Does the degree of hydrothermal activity along individual tectonic segments of ridge crest correspond more closely to high-frequency variations in the rate of magma supply (e.g., cross-sectional inflation, axial depth) than to low-frequency variations (e.g., spreading rate)? Large-scale surveys of hydrothermal activity on intermediate- to superfast-spreading ridges indicate that the relative spatial frequency of hydrothermal plumes increases linearly with spreading rate. This correlation implies that variations in hydrothermal activity are a function of large-scale, and thus low-frequency, variations in the magma supply rate. However, plotting plume incidence against either axial depth or cross-sectional area also yields linear correlations. This is because in the three areas in the Pacific surveyed to date, the mean values of axial depth, inflation, and spreading rate are nearly perfectly correlated. To identify which parameter is dominant we need a large survey area with morphological trends much different than the previously surveyed areas. Our proposed study area offers an ideal laboratory for examining the effect of these three parameters on the distribution and composition of hydrothermal discharge. Is the degree of hydrothermal activity greater along a plate boundary undergoing rapid reorganization than along segments of similar morphology and spreading rate along a stable boundary as proposed based on DSDP results near 19ûS? Our proposed study area is unique because of the large-scale reorganization of spreading center geometry presently occurring by duelling rift propagation that may be evolving toward microplate tectonics, and thus offers a unique opportunity to evaluate the effect of such structures on the development of hydrothermal circulation. Second, to understand the temporal controls of hydrothermal venting. Do high ratios of volatiles/heat and volatiles/metals in hydrothermal fluids and in the overlying water-column plumes indicate that the ridgecrest volcanic/hydrothermal system has been recently perturbed by input of magma, as proposed for the Juan de Fuca ridge and northern EPR? Third, to understand the relative importance of hydrothermal venting and deep ocean currents in forming far-field plumes. Is the absence of a far-field helium plume to the west of the EPR at ~30ûS due to the pattern of deep ocean currents which carry the hydrothermal effluent eastward at this latitude, or to the absence of hydrothermal sources on the EPR axis south of the Easter Microplate?

In order to test these hypotheses we propose an integrated geophysical/hydrothermal survey. We first propose to collect high-resolution deep-towed sidescan and bathymetry using the WHOI DSL-120 system to map the detailed patterns of faults, fissures, and recent volcanic eruptive sites. CTD/nephelometers mounted on the vehicle and wire will provide precise plume distributions in conjunction with the deep-tow geophysical measurements. We then propose continuous mapping of hydrothermal anomalies using the PMEL SUAVE system in the tow-yo technique, continual raisings and lowerings of the instrumentation through the plume interval while the ship slowly steams ahead, to determine two-dimensional anomalies of temperature, particle concentration (light scattering/attenuation), and the dissolved fraction of certain chemical species (e.g., Fe and Mn). Tow-yo surveys are powerful tools for both thorough reconnaissance mapping and high-resolution discharge location. Comparison of plume surveys with vent location by camera or submersible has shown close agreement. We then propose to collect discrete samples from tows and vertical casts to determine the first-order composition of the discharging hydrothermal fluids.

The combination of high-resolution bathymetric, acoustic, and hydrothermal plume data we plan to acquire will allow us to make quantitative measurements of the distribution and composition of hydrothermal venting and its relation to specific geologic characteristics of the ridge at three spatial scales of progressively increasing size. This unique data set will be used to test a series of hypotheses that address fundamental questions about the relation of hydrothermal processes to the morphotectonic/structural environment in which they exist. This proposed work will result in significant advances in understanding the pattern of hydrothermal venting at the fastest present-day spreading rates.

Email: shipsked@ucsd.edu

Return to Ship Home Page

Return to SIO Home Page

Jason H2O Installation
28 Aug-21 Sep 1998

Thomas G. Thompson as base vessel

7 Jason/Medea Deployments Completed

- Bottom time varied between 1 h and 2 d
- Jason utilized primarily as work vehicle
- Vehicle problems minor

Tasks Completed

- Submarine cable located, surveyed, and cut
- Multiple underwater-mateable connector plug operations
- Umbilical deployments and recoveries
- Junction box recovery
- Seismometer package assembly
- Seismometer sensor burial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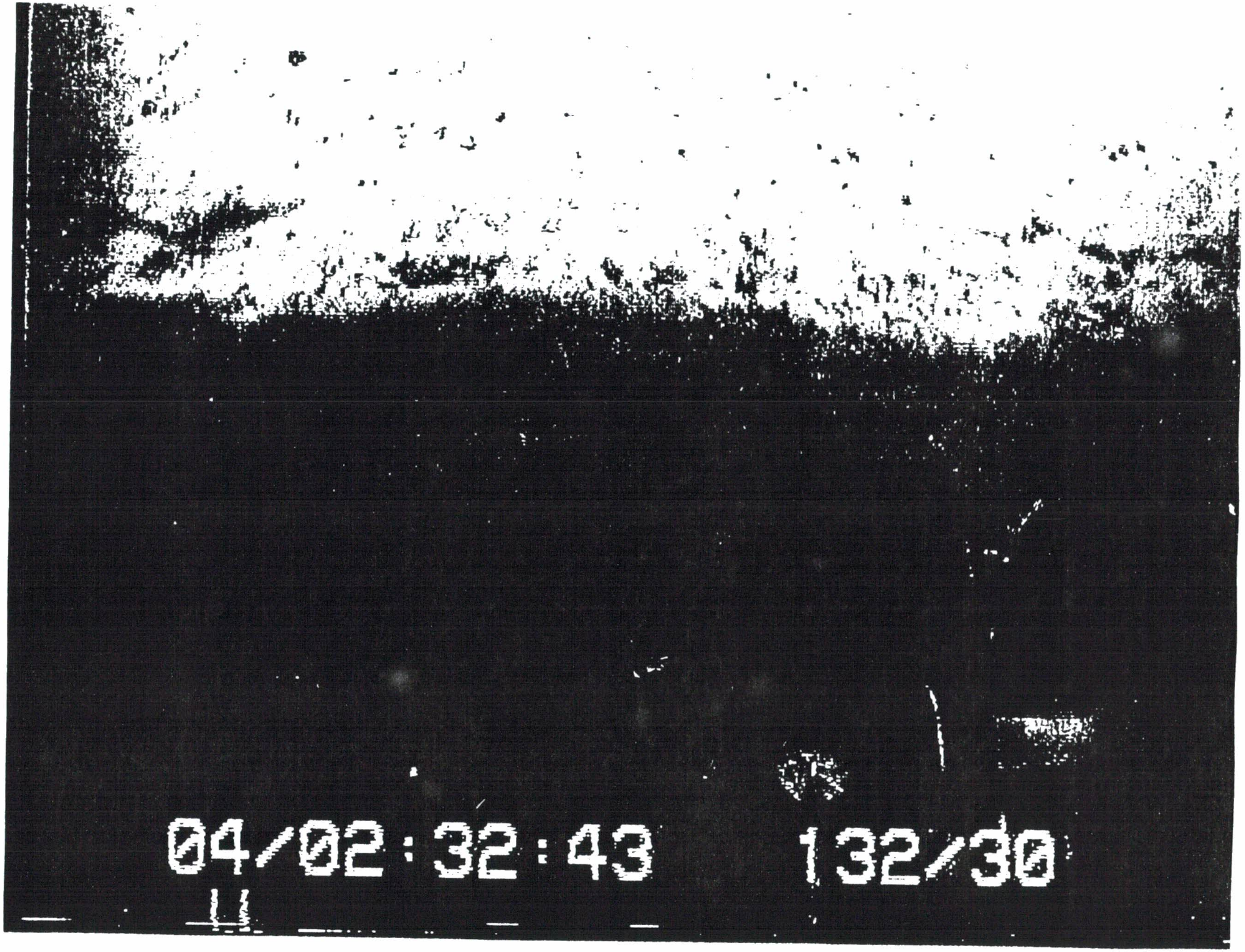
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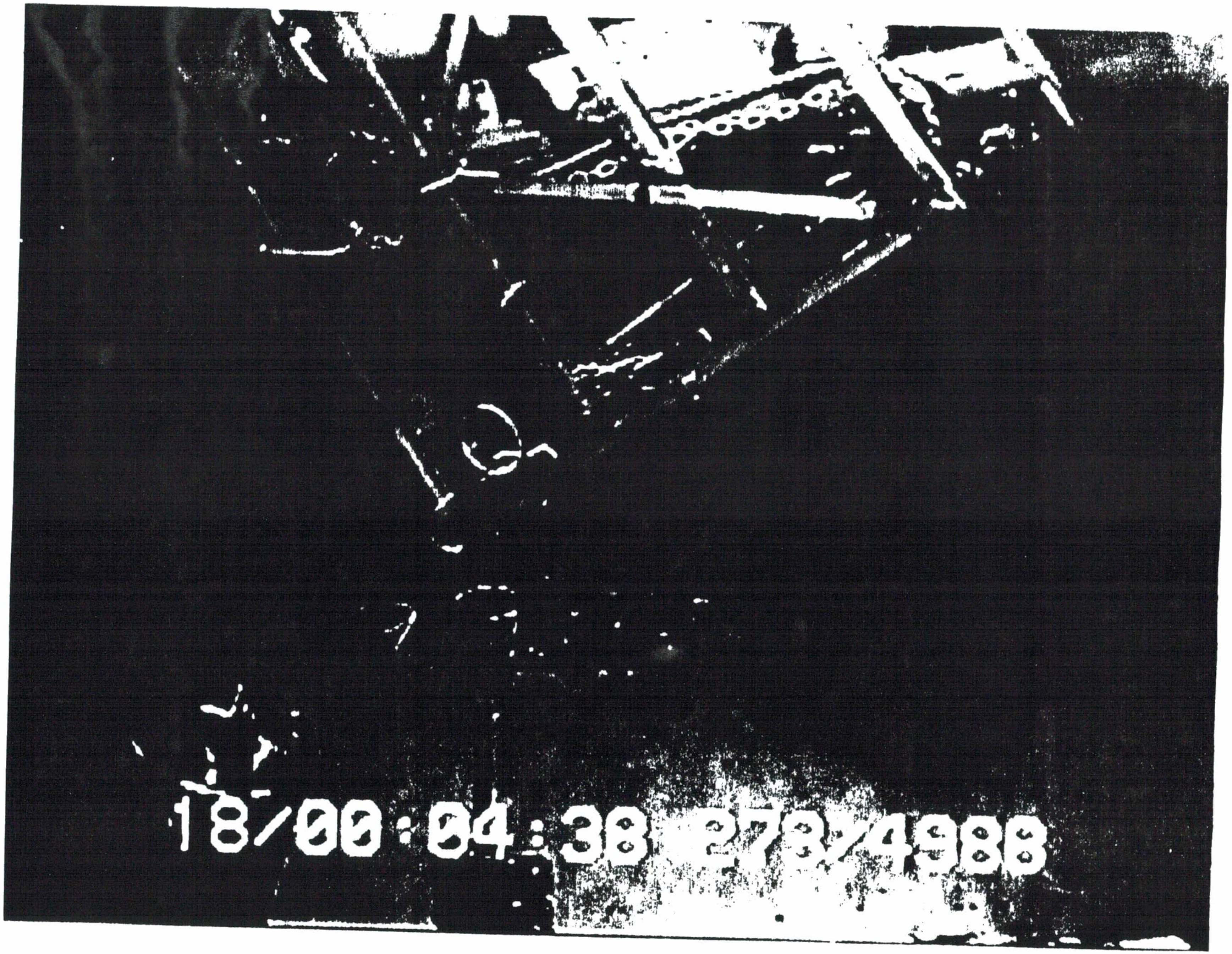
14/08:23:20 017/4984


15/23:42:48
/4988


Plugging in
17/22:52:24 177/4989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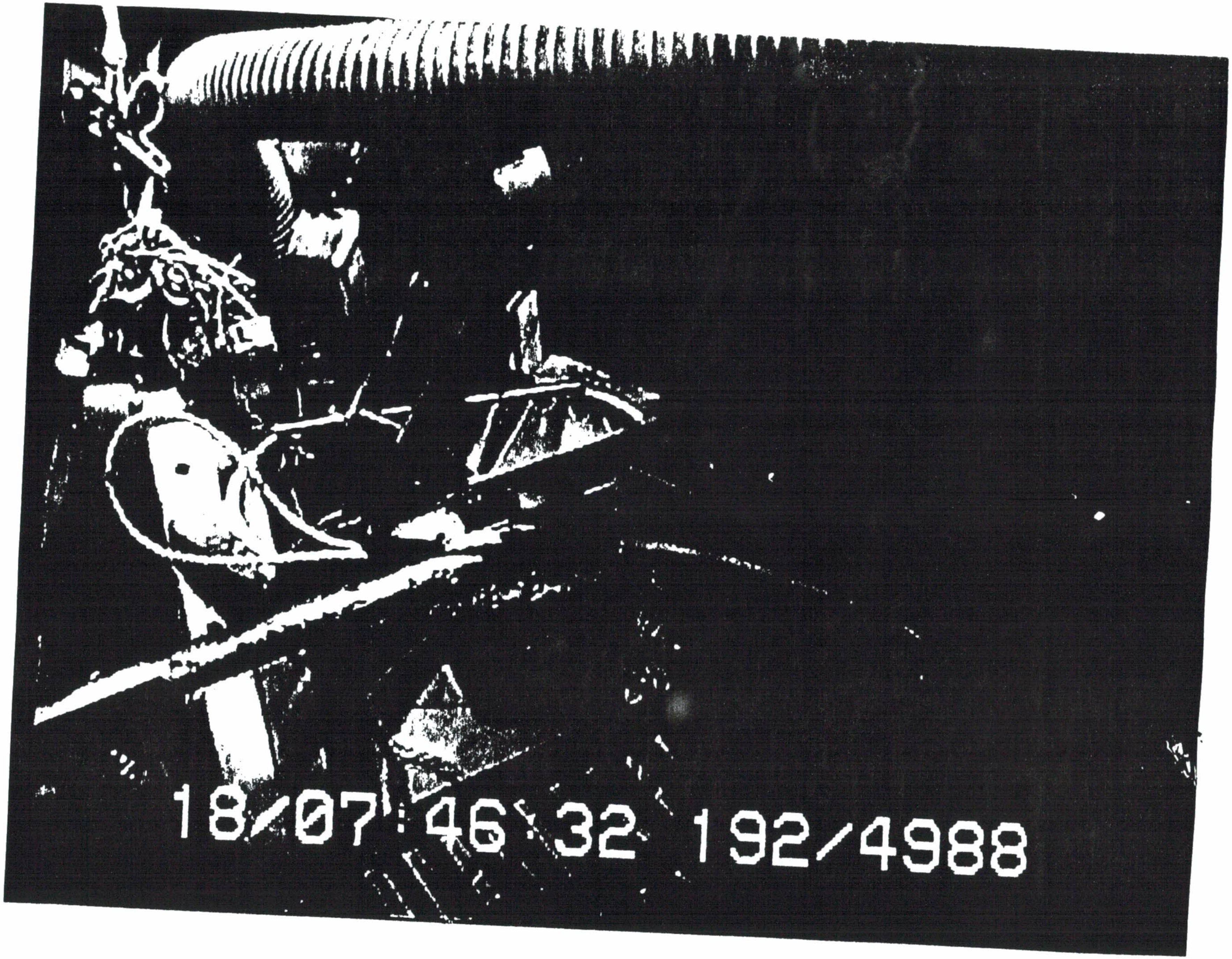
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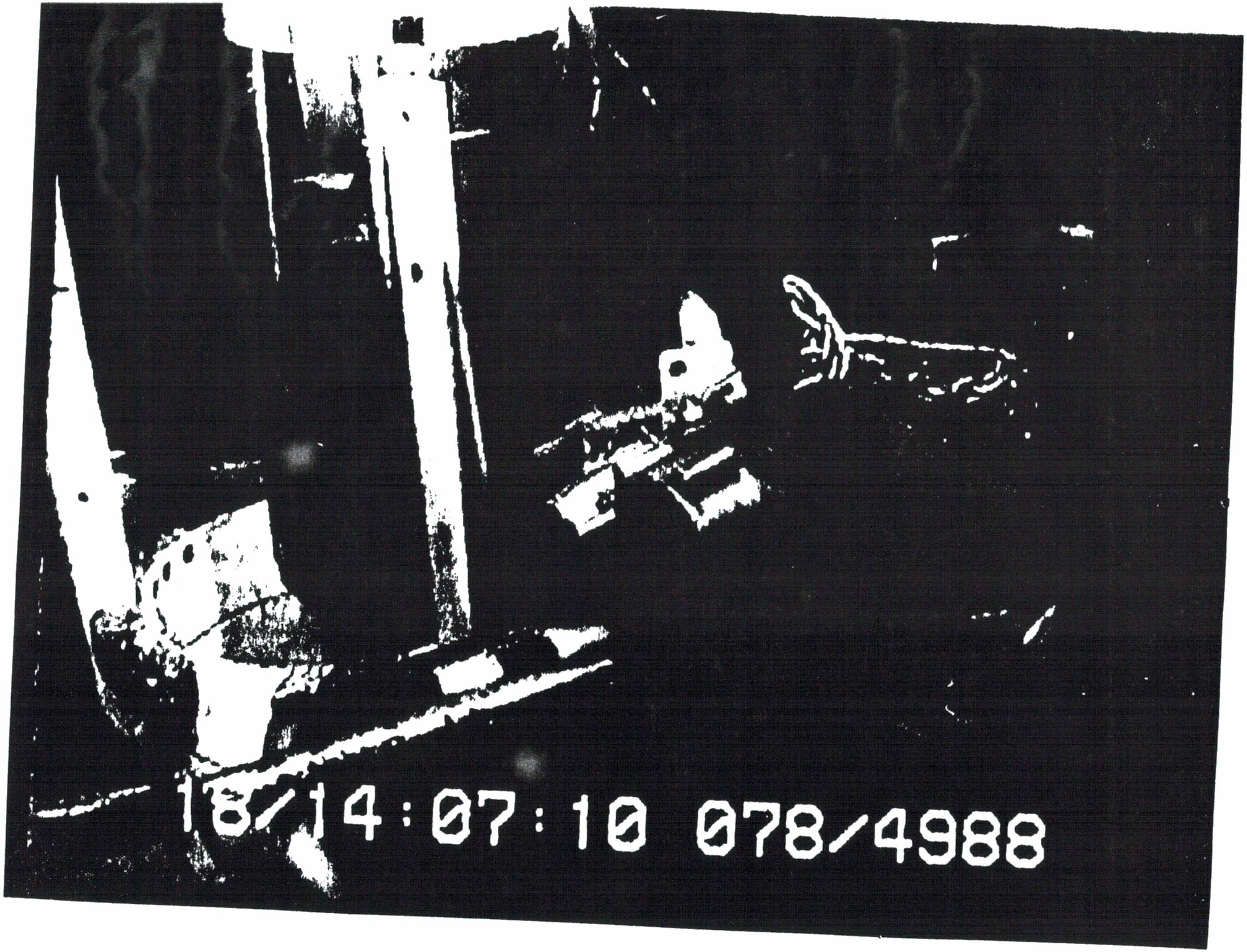
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Appendix IV

From MILLICS@ONR.NAVY.MIL Mon Dec 14 09:41:42 1998
Date: Fri, 4 Dec 1998 12:12:44 -0500
From: MILLICS@ONR.NAVY.MIL
To: desilva@gsosun1.gso.uri.edu, pfryer@soest.hawaii.edu
Subject: ONR report for DESSC

ONR report for DESSC.

ONR Report for DESSC: 12/5/98

Navy support for UNOLS in Calendar Year 99 comes to approximately $16M. Of this, $6M is in support of NAVO shiptime, approximately $8.5M in support of ONR shiptime, $1M in support of NRL shiptime, and $0.5M in support of NOPP time. This has been the result of actively introducing non-traditional users into the fleet.

Update on SEACLIFF:

SEACLIFF has been decommissioned as a Navy operational asset and transferred to ONR/WHOI this summer. The vehicle and its components are in temporary storage at Otis Air National Guard Base in MA.

There are several spare parts in the Navy supply system for DSV SEACLIFF, costing approx. $8.8M. In order for us to obtain these parts, we (ONR/NSF/NOAA) would have to pay for those parts. We are attempting to determine whether some of these parts can be transferred at no cost.

The SEACLIFF manipulators and its trim system were not transferred with the vehicle. The Navy has planned to use both the systems for other N873 programs already underway.

ONR and NSF have approved and funded an engineering study looking at the integration of SEACLIFF and ALVIN systems into a 6000m submersible.

Update on ATV:

The Navy has accepted the proposal from COMSUBDEVERON 5 (San Diego) to continue to operate the ATV. However, limited resources are available for the asset. And the user community should expect to see the cost of using the asset to rise. We don't have an estimate of the "new day rate" but it will cover all incremental costs for missions, and beginning in April 99, must cover all operating expenses incurred during training, certification, and qualification evolutions.

Appendix V

NOAA/NURP Report for the DESSC meeting 5 December 1998.

Dear friends, colleagues, and others interested in the use of deep submergence vehicles for underwater scientific research.

Unfortunately, NURP is unable to send a representative to this meeting. However, we do wish to reaffirm our enthusiastic support for the National Deep Submergence Facility, and to express our intentions to maintain our financial support at the level of recent years. This year, 1998, has been a particularly good year for NOAA funding support due to the success of researchers requesting deep submergence asset time through the NURP peer review process especially at our West Coast and Polar Regions National Undersea Research Center. NURP continues to carry out a policy of determining the projects it will support through the National Deep Submergence Facility at least one year in advance and through a competitive process managed by the National Undersea research Centers.

We would like to congratulate UNOLS, DESSC, and WHOI for a job well done in 1998, and we look forward to continuing successes in 1999 and beyond.

Best regards,

Barbara Moore, Director, NURP

Gene Smith, NOAA/NURP liaison for Deep Submergence Activities

Appendix VI

West Coast & Polar Regions Undersea Research Center

School of Fisheries and Ocean Sciences

UNIVERSITY OF ALASKA FAIRBANKS

Established 1990

West Coast & Polar Regions Undersea Research Center

Raymond C. Highsmith - Director

C. Geoff Wheat - Regional Coordinator

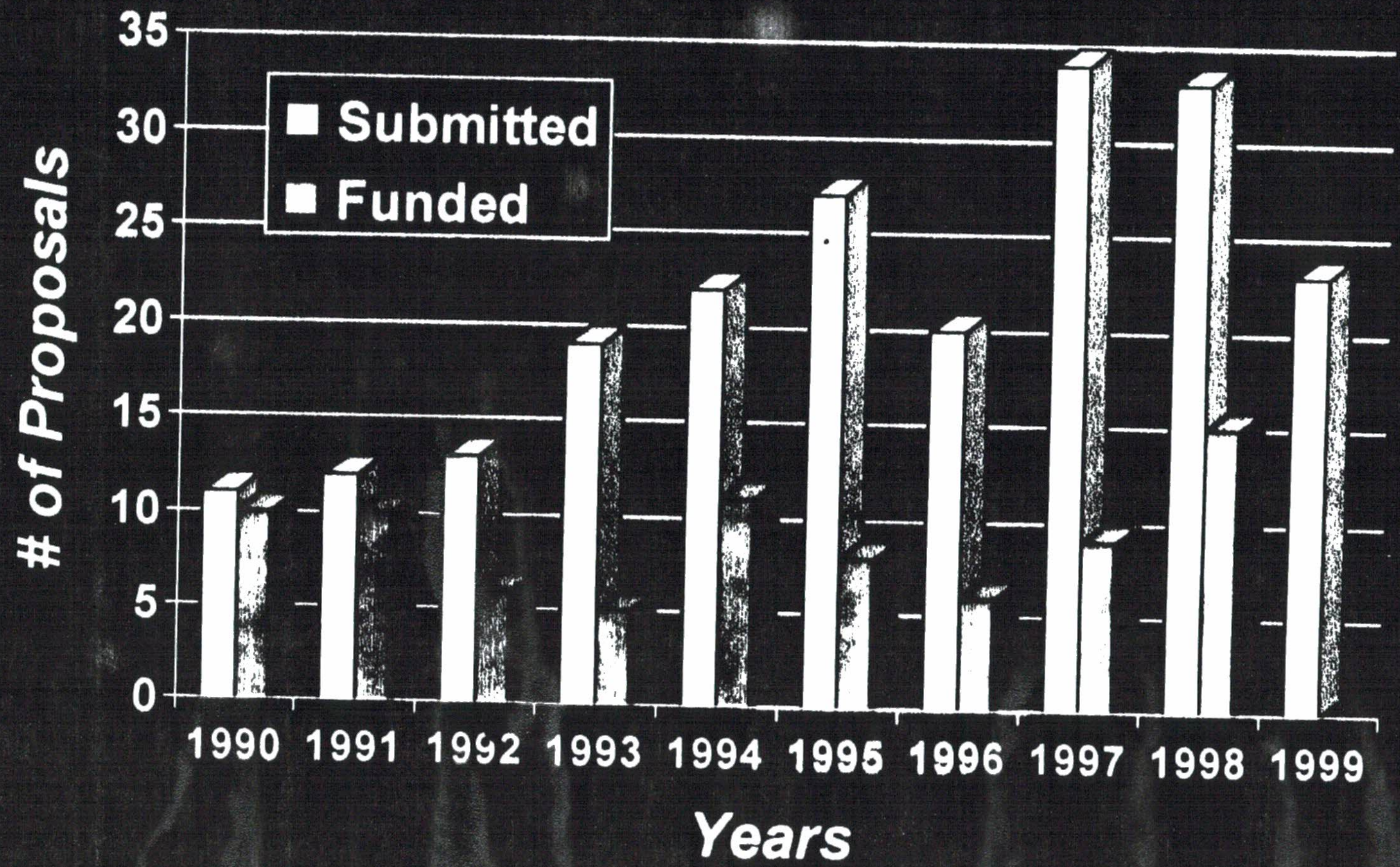
David A. Doudna - Operations Manager

Dana Kapla - Administrative Assistant

1998

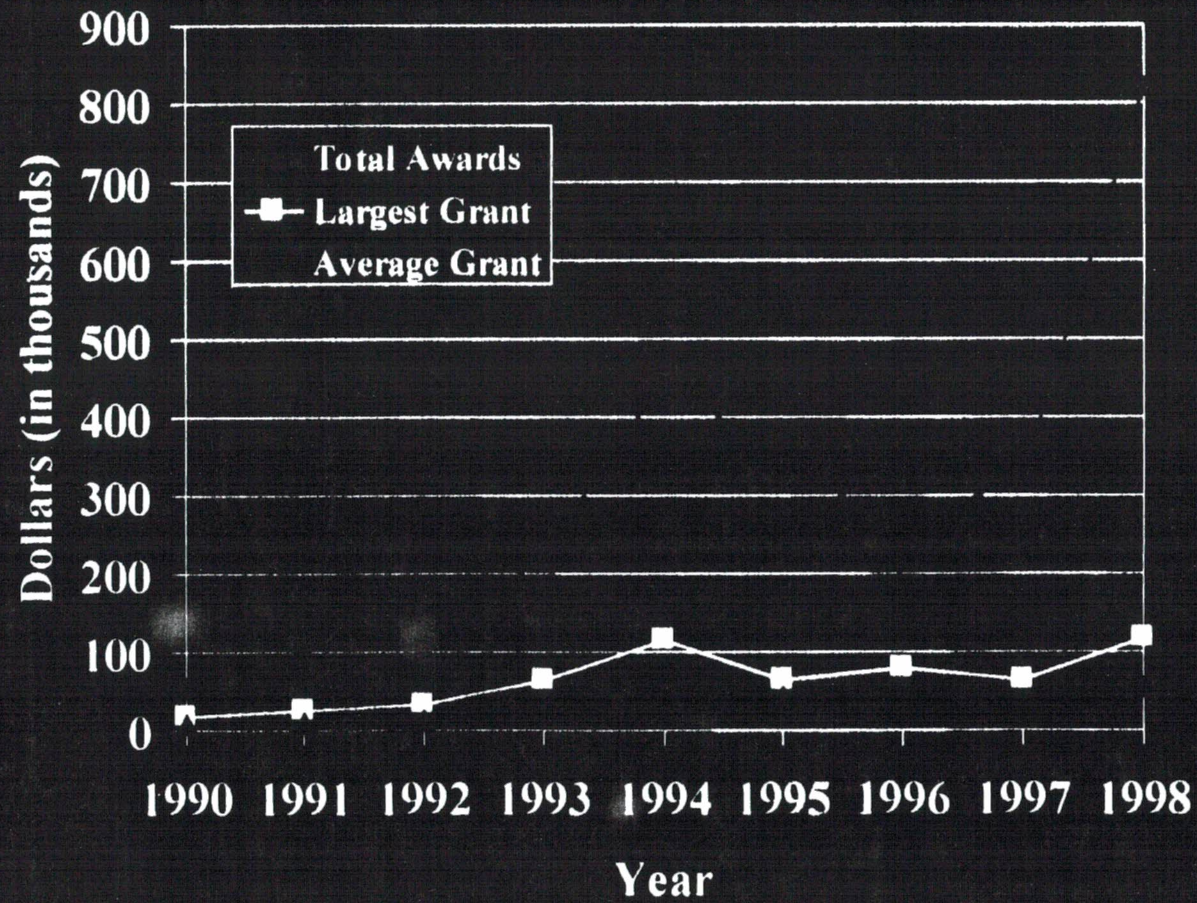
PEER-REVIEW PROPOSALS

Submitted vs. Funded



Awards to Scientists

Does not include facility costs



ALVIN PROJECTS

PRINCIPAL INVESTIGATORS	TITLE	DIVE DAYS
Cavanaugh	Environmental, physiological, and molecular factors influencing stable carbon isotope ratios of deep-sea chemoautotrophic symbioses	0*
Lupton *et. al*	Investigation of hydrothermal systems on the superfast-spreading East Pacific Ridge	17
Smith *et. al.*	Early succession, persistence and seep affinities of [illegible]de-fall communities on the northeast Pacific [illegible]	6
[illegible] *et al*	Sources [illegible] consequences of fluid discharge [illegible] San Clemente Fault Zone	1

[illegible] NURP has agreed to support 9 days during 1999

1999

	days
JdF & ERR	9
Joint cruise San Diego	19
trans	2
	21
Gulf of Alaska	37
Total	67

FY99 Appropriation Language

National Undersea Research Program (NURP) - The conference agreement provides $14,550,000 for the NURP, of which $1,750,000 is for continued support of the JASON program, and $300,000 is to continue support for the Aquarius undersea Laboratory. The remaining $12,500,000 is provided for the existing nationwide undersea research centers, a $1,000,000 reduction from the current level. This reduction is to be distributed proportionately among each of the centers, as well as program administration.

The FY98 appropriation of $13.5 million was reduced by $1 million or 7.4%.

UAF Center Funding

FY	Center Allocation	ALVIN Award	Hawaii KoK	Total
98	$2,500,000	$500,000	--	$3,000,000
99	$1,300,000	$500,000	$300,000*	$2,100,000
Reductions	$1,200,000(48%)			$900,000(30%)
7.4% Adj on 98	$2,315,000	$500,000		$2,815,000

*of no use to our Center as will only yield about 2 operations days, port to port

Appendix VII

THE HAWAI'I UNDERSEA RESEARCH LABORATORY

In July of 1980, the Hawai'i Undersea Research Laboratory (HURL) was established by a cooperative agreement between the National Oceanic and Atmospheric Administration (NOAA) and the University of Hawai'i. It is one of six National Undersea Research Centers that comprise NOAA's National Undersea Research Program (NURP). HURL is the only undersea facility in the world whose sole mission is to study deep water marine processes of islands in the Pacific Ocean. Its location in Hawai'i provides a golden opportunity to study natural resources, oceanic processes, and man's impact upon the submarine environment of Pacific islands.

HURL functions as a research laboratory within the University of Hawai'i, under the leadership of Alexander Malahoff (Director), John Wiltshire (Associate Director) and Keith Crook (Science Program Director). An Operations Director oversees the HURL submersible facility and the ROV department operates under an ROV Manager.

Projects (see Table) that are supported as part of NURP are the major components in HURL's research program. In addition, HURL conducts research in response to funded requests from agencies of the State of Hawai'i such as the Natural Energy Laboratory of Hawai'i. HURL also participates in certain international collaborative research projects in the Pacific that fall with the scope of its major research program themes. HURL's facilities support marine research projects that require data acquisition at depths greater than SCUBA limits.

EQUIPMENT AND FACILITIES

The HURL operations center is located on the Makai Research Pier at Makapu'u Point on the east coast of the island of Oahu. The center is approximately 15 miles from the city of Honolulu. A submersible shed is located on the pier, which also houses the operations office, diving locker, machine and electronic shops. Ship operations are managed by the UH Marine Center at Snug Harbor, on Sand Island Access Road in Honolulu. The ROV facility also operates at this location. The HURL administrative offices, data processing center, and labs are located on the University of Hawai'i at Manoa campus in Honolulu.

***Pisces V* Submersible** is a 3-person, 1-atmosphere submersible that has a depth capability of 2,000m (6,560 ft.). *Pisces V* usually operates with one pilot and two observers, although there are two pilots and one observer for Loihi dives and certain other dives. The pressure hull is 2.13m (7 ft.) in diameter. The submersible is equipped with two hydraulic manipulators and a sonar ranging device. Dive duration is 6 to 8 hours with emergency life support for 72 hours. Equipment carried by or used in conjunction with the submersible includes:

- sample storage baskets
- color 8mm and digital video cameras, monitors and recorders
- flood and video camera lights
- 35mm still camera and strobes
- sediment grab samplers
- temperature probes
- rotating Niskin water samplers (18)
- directional antenna for site relocation
- titanium water samplers
- dictaphone tape recorder
- CTD recorder for salinity, temperature density and depth
- Mini-Ranger navigation system
- short-baseline submersible tracking system
- suction sampler with rotating specimen containers

R/V *Ka'imikai-o-Kanaloa* is the University of Hawai'i mother-ship for *Pisces V* and the *RCV-150*. The vessel is 222 feet in length. There are facilities for 18-20 scientists and technicians (including the submersible and ROV crews) and a ship crew of 14. The ship has A-frame launch capability, wet and dry labs, and photographic processing facilities. It is equipped with a CTD winch and rosette system for water column sampling. The ship can remain at sea for up to 50 days. In addition, it has a hull-mounted SeaBeam' 210 (hybrid) multibeam bathymetric mapping system which consists of the original 16 hardware-former narrow beams capable of ensonifying a swath roughly 70% of water depth. SeaBeam' 210 uses the modern SeaBeam' 2100 projectors and receivers and Silicon Graphics-based (UNIX/IRIX) shipboard post-processing software packages including the standard "GMT-System" and "MB-System". Large and small format color plotters are available for map generation at-sea. SeaBeam' 210 does not presently have sidescan backscatter capability.

***RCV-150* Remotely Operated Vehicle** consists of the vehicle and launching garage, a transportable winch/A-frame unit, and associated power and control consoles. The vehicle's compact hydrodynamic design and neutrally buoyant tether cable permit close-up inspections and a high degree of maneuverability at speeds up to 3 knots. The vehicle can operate to depths of 800m (2,625 ft.) and in currents up to 2.5 knots. Color video and a single manipulator are standard equipment on the *RCV-150*. The investigator will have the choice of recording the video and vehicle data (depth, heading, etc.) at any given time and will verbally annotate the recording in real time.

Hawai'i Undersea Geological Observatory is a multiplexed system of ocean floor instruments linked to shore on the Island of Hawai'i by an electro-optical cable providing real-time data. A microwave link transmits the data from the shore station to Oahu. The Loihi submarine volcano is an ideal environment to monitor the development of a growing hotspot volcano that will eventually become a new Hawaiian Island. In order to monitor the volcanic processes on Loihi, a number of instruments have been developed and deployed annually by HURL including time lapse video recorders, seismometers and ocean bottom pressure gauges. The PI of HUGO is Dr. Fred Duennebier, of the Department of Geology and Geophysics, SOEST, University of Hawai'i.

HURL Data Center processes, organizes, and archives the original data (35mm slides, digital and 8mm video, CTD, QLR) obtained on the dive missions. HURL's audiovisual processing capabilities include 8mm and HI-8mm editing functions as well as production of prints from video. The Data Center also maintains a library of public relations videotapes and publications. HURL video and slides are requested and used in diverse programs including educational programming, nature documentaries, interviews, and technology reports. HURL has compiled photo record and video record databases which are available to researchers. These databases can be manipulated and specific inquiries answered.

Number of Personnel: 24 positions, comprising 8 scientific, 10 technical (incl. 1 part-time) & 6 administrative (incl. 2 part-time).

Operating Costs: The submersible and mothership cost to users other than scientists supported through NURP is ca. $18,500/dive.

Number of Operating Days: 100 days in 1998.

Average bottom time for submersible and ROV operations: Submersible dives last 8 hours, daylight only. ROV traverses are typically 2-3 hours duration, with deployments conducted for 6 hours nightly and up to 8 hours during daylight.

Important Changes in Vehicle Facilities, Sensors or Operations: HURL's ROV, *RCV-150,* was deployed operationally for the first time during HURL's 1998 field season. It operates well in transit mode at ship speeds up to 0.7 kt. Deployments in hover mode depend on ship station-holding capability, which is sea-state limited.

Contact information: http://www.soest.hawaii.edu/HURL/hurl.html;

Director: <malahoff@soest.hawaii.edu> **Science Program:** <crook@soest.hawaii.edu>

Appendix VIII

Deep Submergence Science Committee

- Introduction
- Ops Summary
  - Personnel Integration
  - *Alvin*
  - *Jason*
  - Data Archiving
- WHOI Perspective on NDSF Future
- 1999-2000 Schedules

DESSC, Meeting
December 1998

National Deep Submergence Facilities
Promotions/Awards/Hires

Dan Fornari	**Promoted to Senior Scientist**
Andrew Bowen	**Promoted to Research Specialist**
Dudley Foster	**Promoted to Research Specialist**
Barrie Walden	**Senior Technical Staff Award**
Jon Alberts	**Marine Ops Coordinator (Don Moller's replacement)**
Christina Courcier	**Jon Alberts' Staff Asst. (new hire)**

DESSC Meeting
December 1998

National Deep Submergence Facility

Woods Hole Oceanographic Institution

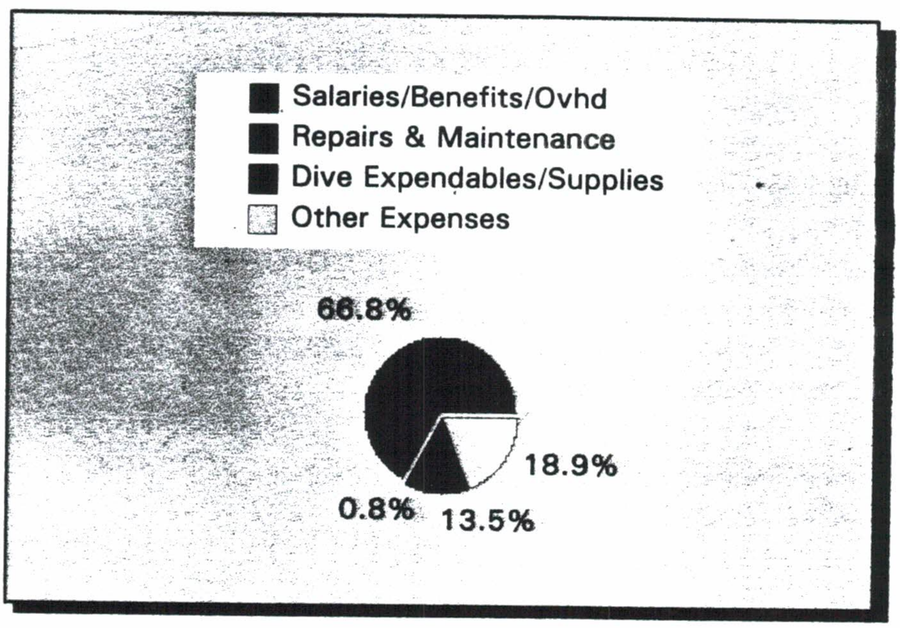
1998

DSV ALVIN	Argo-II
Jason ROV	DSL-120

Operations Personnel	20
Engineering/Management Personnel	11

Operating Costs

$3,679,600

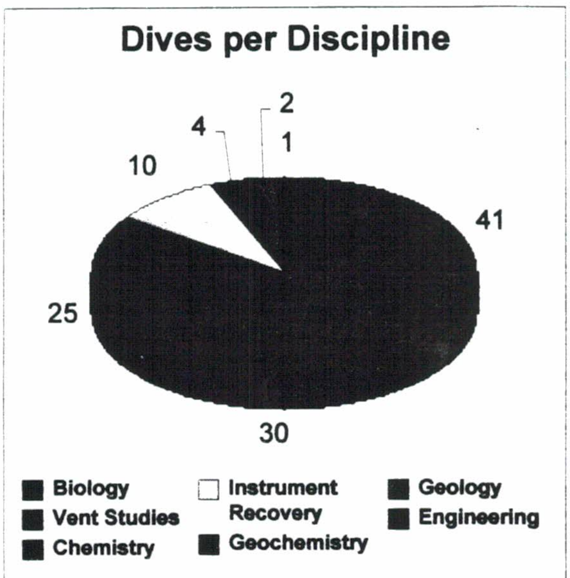


DSV-2 ALVIN

Operating Days	251
Dives	137
Average Depth	2265 m
Average Dive Duration	8.16 hrs
Average Bottom Time	5.42 hrs

*(Increased **42** minutes/dive since 1996)*

13 Science Programs



Ekman	Southern California
Jannasch	Guaymas Basin
Mullineaux	Northern EPR
Smith	Southern California
Carson	Oregon Margin
Chave, *et al.*	Juan de Fuca
Cowen	Juan de Fuca
Fisher	Juan de Fuca
Ekman	Southern California
Urabe	Southern EPR
Lilley/Von Damm	Southern EPR
Manahan, *et al.*	Northern EPR
Vrijenhoek, *et al.*	Southern EPR

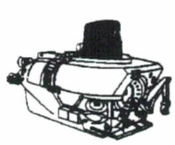
12 dives lost to weather
(6 of these on Southern EPR)

Upgrade Items Complete:

- ✔ *100-pound buoyancy increase*
- ✔ *"Virtual ALVIN" beta release*
- ✔ *Ring laser gyro tested*
- ✔ *Slurp pumps provided*
- ✔ *New in-hull 35mm cameras*
- ✔ *ICL temperature probes in use, commercial science interface available*
- ✔ *Major water samplers refurbished/replaced*

Upgrade Proposed for 1999:

- ✔ *300 KHz Doppler sonar*



National Deep Submergence Facility
http://www.marine.whoi.edu

1998 DSL/DSOG Operations Summaries By Cruise

Cruise ID(s)	Vessel	Chief Sci(s)	Work Area	Vehicle(s)
Hey 98/Panorama V	MELVILLE	Hey/UH	Southern EPR 30S, 112W	DSL-120, Tow Camera
Guaymas 98/AT3-17	ATLANTIS	Yoerger/WHOI	Guaymas Basin 27N, 111W	Jason
Cleft 98/TN082	THOMPSON	Stakes/MBARI, Chadwick.OSU	Endeavor Ridge 45N, 132W	DSL-120, Jason
H2O/TN083	THOMPSON	Chave/WHOI	H2O Site 28N, 142W	Jason
Puna Ridge 98/TN084	THOMPSON	Smith/WHOI	Puna Ridge 19N, 154W	DSL-120, Argo-II

1998 DSL/DSG Vehicle Lowering Summaries

Vehicle	Lowerings	Bottom Hrs	Lowering Hrs	Miles Covered
Jason	11	193.4	260.4	NA
DSL-120	15	580.9	661.9	805.3
Argo-II	4	125.2	139.5	31.3
Tow Camera	5	25.0	37.8	NA
Totals	35	924.5	1099.6	836.6

ALBL transponders launched	41
Elevators	2
EXACT Deployments	1
Electronic Still Camera photos	43,249

Upgrade Items Complete:

- ✔ *Replaced DSL-120 end caps because of corrosion*
- ✔ *Added heavy lift capability to Jason/Medea*
- ✔ *Installed 3HP auxiliary motor to Jason*

Upgrades Proposed for 1999:

- ✔ *Replace control vans due to corrosion*
- ✔ *Refit traction winch*
- ✔ *Altimeter for DSL-120*

ALVIN Inductively Coupled Data Link

The inductively coupled data link available for use with ALVIN is intended to allow RS232 communications with sea floor instrumentation without the need for a physical connection or the use of the instrument's power. There are two modules involved: an ALVIN-manipulated unit and a mate intended for mounting on the science instrument. The "ALVIN module" is powered from the submersible and provides power to the "science module". The power available is adequate for 9600 baud RS232 communications with a small amount left over (100ma @ ~24vdc), possibly to be used as a "wake-up" signal for the science instrument.

In practice the science instrument would be outfitted with a "science module" arranged in a manner allowing easy access by the submersible's manipulator. The instrument's electronics would be configured to collect and store data autonomously after deployment. When the instrument required servicing, ALVIN would place the "ALVIN module" in a receptacle on the instrument designed to act as an alignment fixture. The ALVIN module would then transmit power across the "seawater gap" resulting in a "trigger" input from the science module to the science instrument electronics. This would indicate that the ALVIN module was in place and attempting to establish communications. After that, RS232 communications would proceed following a predetermined protocol. Data and/or instructions could be transferred in either direction without the interface using power from the science instrument.

ALVIN Module

Part # INPUD-SL-RS232-PG36-T
Titanium housing, 47mm dia x 80mm long (excluding connector)
Connector: Impulse IE55-1206-BCR (titanium shell)

Science Module

Part # INPUD-SL-RS232-PG36-R
Titanium housing, 47mm dia x 80mm long (excluding connector)
Connector: Impulse IE55-1206-BCR (titanium shell)
(mates with Impulse IE55-1206-CCP)
Cost ~$1,500
These units are not stock -- allow at least two months for delivery

Purchased from:

Mesa Systems Co.
119 Herbert Street
Framingham, MA 01702
Attn: John Kussmann
(508) 820-1561

WHOI's Perspective on NDSF Future

- *Atlantis*
  - ➢ Work done
  - ➢ Work to be done

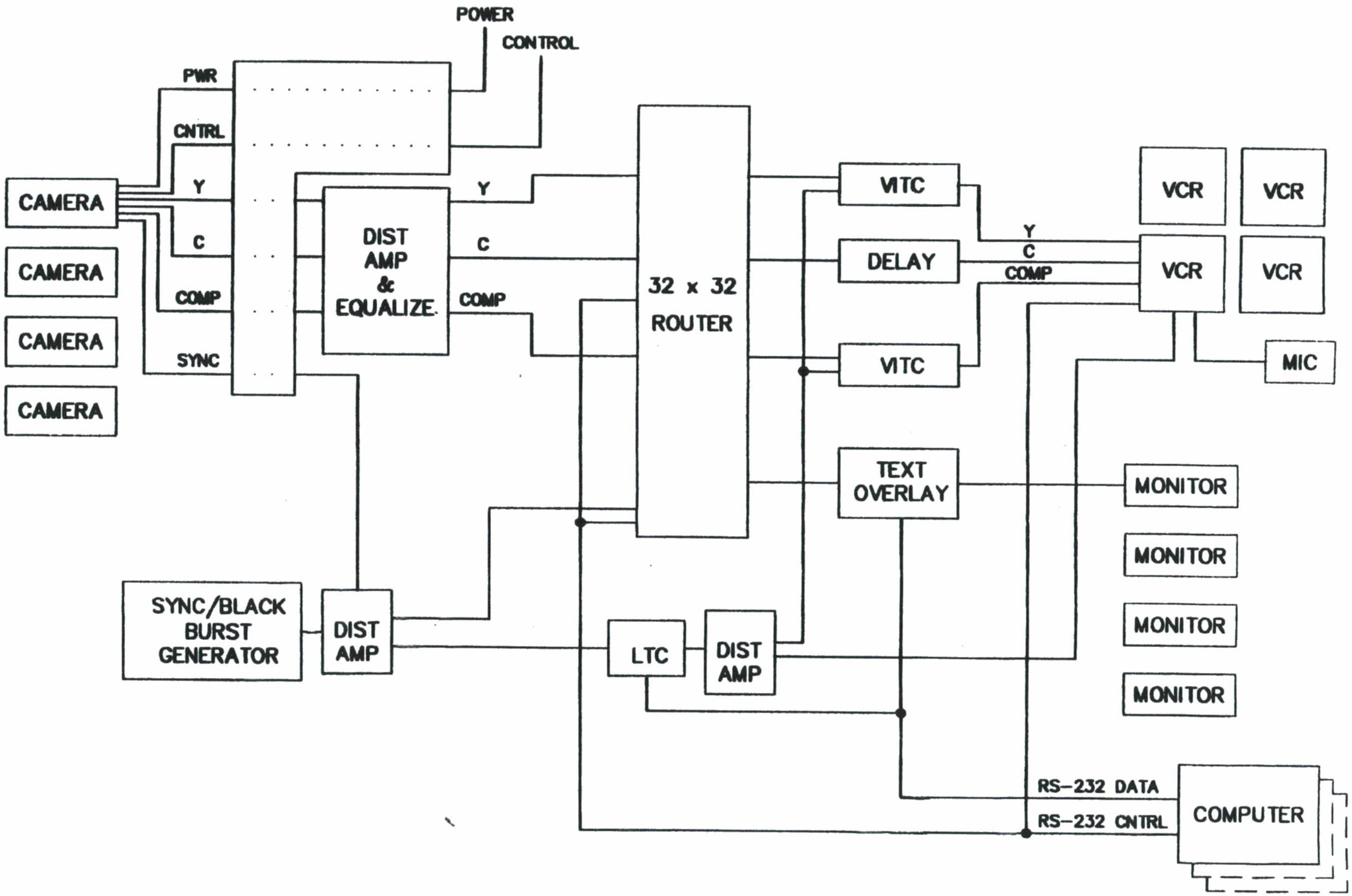
- *Alvin*
  - ➢ Overhaul (Oct. 2000 - March 2001)
  - ➢ *Sea Cliff* Engineering Study

- *Jason* Upgrade Proposal

DSG Upgrade Items

- ❑ Datalogger
- ❑ Video
- ❑ ALVIN flotation
- ❑ Jason flotation
- ❑ "Virtual ALVIN"
- ❑ Scanning sonar
- ❑ Slurp pumps
- ❑ Ring laser gyro
- ❑ Digital in-hull cameras
- ❑ Steerable elevator upgrade (Greene Award)
- ❑ ICL temperature probes
- ❑ ICL science interface
- ❑ Hot water samplers (new & refurbished)

ALVIN VIDEO BLOCK DIAGRAM



Woods Hole Oceanographic Institution AOPE Dept.	BETSEY DOHERTY VIDBKDIA ALVIN/ELECSYS	date 12/31/96 revised 11/30/96

Atlantis Improvements 1998

Post Shakedown Availability (PSA):

- Installed bow thruster noise abatement
- Added additional hydrophone openings
- Installed transducer well air lock
- New foremast and IMET arrangement
- More fume hoods
- Main deck doors modified to improve access to labs, etc.
- Improved Scientific Hold deck and storage arrangement
- Installed magnetic door hold backs on main deck
- Improved the port hydroboom to 46,000 pound capacity
- Relocated hinged opens in bulwarks at hydrobooms
- Installed hydroboom work platforms
- Deck drains added in *Alvin* hanger
- Switchboard improvements
- Upgraded both cranes to dual function capability
- Installed *Alvin* battery power conditioners
- Placed dial telephones in each stateroom
- Installed a mission announcing system
- Upgraded autopilot system including computer nav charts
- Bridge windows changed to improve visibility
- Substantially improved the Cimplicity (engine control) system
- HVAC upgrade
- Installed additional fuel oil purifier
- Installed a waste heat evaporator
- Relocated rescue boat
- Modified anchor seating area (3rd attempt)

Atlantis Improvements 1998

September Dockside:

- Installed more dependable reverse power relays
- Increased whip and extension speed on both cranes
- Installed sequence valves on one crane
- Installed soft starts on both cranes
- Installed sewage pump soft starts
- Split the A-frame power and control circuits between propulsion and SS busses
- Installed a larger capstan on the aft deck
- Increased lab compressed air supply pressure to 100 psi
- Installed a new carpenter's van
- Modified both Hiab cranes for safer use
- Installed additional slop tank capacity
- Modified work boat launch/recovery system
- Insulated galley ventilation against condensation
- Installed new juice machine
- Increase galley storage with center cabinet shelving
- Provided additional winch read outs on bridge
- Extended incinerator stack 15' higher
- Completed isolation of main deck head and bosun day room
- Installed stainless hinges on both bulwark openings and increased size of starboard opening
- Improved anchor seating arrangement (4th attempt)

Atlantis Pending Projects for Next Shipyard Period

- ☐ Complete propulsion control upgrade
- ☐ Further HVAC improvements (Need specific comments on deficiencies)
- ☐ Correct Caterpillar engine smoking problem
- ☐ Rationalize lab power - More extensive UPS & clean power distribution
- ☐ Correct anchor handling/slamming deficiency
  - Chain-wildcat problem. Appears to have been corrected.
  - Fix anchor slamming
- ☐ Improve lab drains
- ☐ Additional deck drains
- ☐ Work boat launch & storage system
- ☐ Renew several weather doors - Rusted out from within
- ☐ Increase space for gymnasium workout
- ☐ Improve STBD Hydroboom fairlead
- ☐ Complete next phase of bow thruster noise abatement -Increase airflow
- ☐ Additional Berthing {Crew, Science
- ☐ Increase fresh water storage capacity -Had to buy water in foreign ports
- ☐ Correct *Alvin* battery charging power - Soft start for cranes may rectify problem. Completed. Believe OK now.
- ☐ Improve *Alvin* dehumidifier system
- ☐ Procure two critical circuit breaker spares (Ordered)
- ☐ Improve mooring chocks - Improper installation, damaged again
- ☐ Design & install accommodation ladders
- ☐ Modify (fix) AFFF system (Aqueous Foam Fire Fighting System)
- ☐ Improve darkroom - Deficiencies (mostly light leaks) remain from Halter construction

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December 1998

Atlantis Pending Projects for Next Shipyard Period (continued)

- ☐ Replace engine coolers {Jacket water coolers have temporary fix ; fuel oil coolers need replacing
- ☐ Add window in the aft door from the outside to the Main Lab
- ☐ Improve/replace output printer for the 12 kHz system
- ☐ Add computers for science and crew
- ☐ Improve: Outside camera system; Inmarsat A & B systems; smell in walk-in cooler; storage space for ship/*Alvin* crew personal gear
- ☐ Modify sub A/C to get/return air from doghouse as a reservoir source. Also put dehumidifier in doghouse.
- ☐ Modify 01 hangar access and move engine room air intake up to 02 deck.
- ☐ Modify main deck passageway into hangar and mechanical shops.
- ☐ Modify side hangar door with drain sill/gutter like main hangar door and move main door drain aft.
- ☐ Remove hangar personnel side door.
- ☐ Add fire alarm bells in hangar and on aft deck outside hangar.
- ☐ Replace three-ton hand hoist in hangar with electric hoist. Two-ton would be more than adequate.
- ☐ Remove 8" stub from teleleg tail line guide. (Prevents tail line hook from coming up high enough when mating to sub and jams hook into sub/skins.)
- ☐ Improve securing system for hold weights.

DESSC / December 1998

R/V ATLANTIS – Backlog or Pending Projects

Funding for these items has not been identified, and priorities have not been established.

Please check the items that you would most like to see implemented during *Atlantis'* next scheduled shipyard period.

- ☐ Complete propulsion control upgrade
- ☐ Further HVAC improvements (Need specific comments on deficiencies)
- ☐ Correct Caterpillar engine smoking problem
- ☐ Rationalize lab power - More extensive UPS & clean power distribution
- ☐ Correct anchor handling/slamming deficiency {Chain-wildcat problem (appears to have been corrected); fix anchor slamming
- ☐ Improve lab drains
- ☐ Additional deck drains
- ☐ Work boat launch & storage system
- ☐ Renew several weather doors - Rusted out from within
- ☐ Increase space for gymnasium workout
- ☐ Improve STBD Hydroboom fairlead
- ☐ Complete next phase of bow thruster noise abatement - Increase airflow
- ☐ Additional Berthing - Crew, Science
- ☐ Increase fresh water storage capacity - had to buy water in foreign ports
- ☐ Correct *Alvin* battery charging power - soft start for cranes may rectify problem. Completed. Believe OK now.
- ☐ Improve *Alvin* dehumidifier system
- ☐ Procure two critical circuit breaker spares (Ordered)
- ☐ Improve mooring chocks - Improper installation, damaged again
- ☐ Design & install accommodation ladders
- ☐ Modify (fix) AFFF system (Aqueous Foam Fire Fighting System)
- ☐ Improve darkroom - Deficiencies (mostly light leaks) remain from Halter construction
- ☐ Replace engine coolers {Jacket water coolers have temporary fix ; fuel oil coolers need replacing
- ☐ Add window in the aft door from the outside to the Main Lab
- ☐ Improve/replace output printer for the 12 kHz system
- ☐ Add computers for science and crew
- ☐ Improve: Outside camera system; Inmarsat A & B systems; smell in walk-in cooler; storage space for ship/*Alvin* crew personal gear
- ☐ Modify sub A/C to get/return air from doghouse as a reservoir source. Also put dehumidifier in doghouse.
- ☐ Modify 01 hangar access and move engine room air intake up to 02 deck.
- ☐ Modify main deck passageway into hangar and mechanical shops.
- ☐ Modify side hangar door with drain sill/gutter like main hangar door and move main door drain aft.
- ☐ Remove hangar personnel side door.
- ☐ Add fire alarm bells in hangar and on aft deck outside hangar.
- ☐ Replace three-ton hand hoist in hangar with electric hoist. Two-ton would be more than adequate.
- ☐ Remove 8" stub from teleleg tail line guide. (Prevents tail line hook from coming up high enough when mating to sub and jams hook into sub/skins.)
- ☐ Improve securing system for hold weights.
- ☐ Additional Suggestions: (Use back of sheet if needed.)

This form can be submitted to: UNOLS Office
P.O. Box 392
Saunderstown, RI 02882

Submitted by (optional): ____________________

Appendix IX

10 DOWNING STREET

LONDON SW1A 2AA

THE PRIME MINISTER

8 May 1998

Dear Bill,

I am writing to express my personal thanks for the United States' role in the investigation into the sinking of the MV Derbyshire, a British bulk carrier which sunk in a typhoon in September 1980 with the loss of 44 lives. The project was funded jointly by the UK Government and the European Commission, with an important role played by the US through the UK's Memorandum of Understanding with the National Science Foundation.

This investigation was one of the greatest feats of underwater detective work ever undertaken, and the results were amazing. The work carried out by the project team represents a magificent effort, and a significant advance in marine accident investigation. Using the most up-to-date submersible video and stills photographic equipment, the Assessors have been able to piece together how the ship was lost. The survey results have shown that the marine community can now investigate accidents even in the deepest oceans.

The outcome would not have been possible without the use of technology developed by the Woods Hole Oceanographic Institute who maintain the United States Deep Submergence Science Facility. I would like to thank the experts from Woods Hole who worked on the survey, especially Andy Bowen, Jonathan Howland, Steven Lerner and Dana Joerger.

Can I also thank Dolly Dieter and her colleagues at the National Science Foundation for their assistance in providing access to Woods Hole and the use of the Research Vessel Thomas G Thompson operated by the University of Washington, under the command of Captain Glenn Gomes. While our own UK/EC team played their part, their efforts would have been in vain without the sustained effort of the Woods Hole Team and the ship's crew throughout the 53 day research cruise.

Please convey the United Kingdom Government's sincere appreciation to all those involved on your behalf.

Yours ever

Tony

The President of the United States of America

Appendix X

Final
NDSF ARCHIVING POLICY
Revised Dec. 3, 1998

STATEMENT OF PURPOSE

The Woods Hole Oceanographic Institution (WHOI) maintains an archival system for oceanographic data and samples, as well as visual and digital information, obtained using the vehicles and sensors of the National Deep Submergence Facility (NDSF). The federal funding agencies that support WHOI's Deep Submergence Group (DSG) provide funding to help support these archives.

This archiving policy is intended to allow the WHOI DSG to fulfill its commitment to properly document and archive these data for future scientific and educational use, **without compromising the Principal Investigator's (PI) right to sole use of the data for scientific purposes during the first two years of the project following the observational period.**

Because there will be changes and improvements in imaging technology, recording media, and operational characteristics of the NDSF facilities in the future, details of this archiving policy may be revised from time to time. WHOI, as Operator of the NDSF, will provide the funding agencies and the DEep Submergence Science Committee (DESSC) with periodic updates on the status of WHOI-archived NDSF data as part of normal WHOI facilities reports during DESSC meetings, together with any suggestions for improvements.

PROTOCOLS FOR DATA HANDLING AND ARCHIVING

Each cruise that uses NDSF facilities has a Chief Scientist or Co-Chief Scientists (hereafter "Chief Scientist"). The Chief Scientist is designated by agreement between the Principal Investigators and WHOI prior to the cruise. He/she acts on behalf of the Principal Investigators to:

1) provide a Cruise Prospectus to WHOI prior to the cruise,
2) conduct the expedition and complete dive forms during the cruise,
3) assure that all data are properly documented and distributed to Principal Investigators,
4) specify to WHOI who will receive data post-cruise,
5) provide a Cruise Report to WHOI at the end of the expedition.
6) meet all requirements associated with foreign obligations for cruises that operate in Exclusive Economic Zone of other nations.

Data are made available to the scientific party during the cruise as agreed among WHOI, the Chief Scientist and the Principal Investigator(s), with the exception of 35mm transparency films which are provided after they are processed at WHOI following the cruise. Data are available to scientists post-cruise as specified by the Chief Scientist. Duplicating costs for additional copies of data will be charged to the individual receiving the data.

To assist in the proper archiving of data, and to assure that the data will always be useful to the scientific community, Chief Scientists are required to provide a complete Cruise Report to WHOI Marine Operations at the end of the cruise. This report will outline events and data acquisition during the cruise such that archived data are fully documented and usable by any interested party once the data become accessible following the proprietary period noted below. The Cruise Report will be archived at WHOI.

When operating in the Exclusive Economic Zone of other nations, certain protocols and deliverable data products are part of the agreement which the United States has with those nations when clearance is granted to conduct work in their waters. The Chief Scientist is responsible for meeting all the foreign obligations associated with the scientific data for their cruise. All principal investigators associated with a cruise are responsible for providing pertinent information to the Chief Scientist.

A copy of this Archiving Policy will be provided to the Chief Scientist at the time that he/she is designated. The Chief Scientist has the responsibility to assure that the entire shipboard scientific party is aware of this policy.

STANDARD DATA ACQUISITION BY NDSF VEHICLES AND INSTRUMENTS

Data acquired by NDSF vehicles and instrumentation are considered "standard data" and will be archived at WHOI as described below. Details about NDSF vehicle/instrument inventory, data acquisition (e.g., processing, formats, recording media), and operational procedures are available in the NDSF Users Manual which is routinely updated and available on WHOI's World Wide Web pages. All data are provided to the scientific party for scientific research, as outlined under Protocols, above.

Video Imagery

On each dive or lowering of ALVIN, Jason, and Argo II, two video channels are recorded, one on each of two master recorders. These video data are duplicated at sea and first-generation copies are provided to the scientific party. The original video tapes are archived at WHOI.

35 mm Still Imagery

Standard operations provide for still photography using a 35mm camera mounted on the vehicle. Following shore-lab developing, first-generation duplicates of all transparencies are provided to the scientific party. Transparency originals are archived at WHOI.

Electronic Digital Still Camera Imagery and Sonar Data

Digital images collected using electronic still cameras are recorded and processed at sea as standard image format files. The original media and a copy of the processed standard image format files are archived at WHOI, and a copy is provided to the scientific party.

Digital sonar data acquired using the DSL-120 sonar vehicle consist of side-looking sonar imagery and phase-difference bathymetric data. Raw data tapes as well as tapes of data processed at sea by DSG personnel or using NDSF processing facilities will be archived at WHOI. A copy of all processed data is provided to the scientific party. If a scientist wishes to archive the raw sonar data at his/her laboratory, arrangements should be made prior to the cruise.

Vehicle Navigation and Attitude Data, and Summaries

Vehicle navigation and attitude data are provided as ASCII data with all data columns identified. A tabular summary of all vehicle lowerings (geographic location, data/times, etc.) is also provided as a text file and a hard copy. Digital and hard copies of these data are archived at WHOI.

Geological, Biological, and Geochemical Samples

While at sea, the scientific party will document all samples collected (e.g., type, dive number, location, water depth, disposition (i.e., repository where they will be stored), etc.), and they will provide a copy of this information to the WHOI shipboard technician responsible for data archiving. This copy will be archived at WHOI together with a copy of any auxiliary data (e.g., descriptions, shipboard analyses) that are generated by the scientific party at sea. Unless otherwise directed by the Chief Scientist, geological samples will be archived in the Seafloor Samples Laboratory at WHOI. Non-geological samples will not be archived at WHOI. It is the responsibility of the scientific party to arrange and pay for transportation of any samples to be stored at WHOI.

Other Data

Images from the ALVIN pilot's hand-held camera and pilot voice tapes are not routinely collected, however, when they are collected they will be archived at WHOI and will be provided to the science party on request, and for the cost of reproduction only. Such data generated by other observers will be archived at WHOI if the observer so requests and provides the necessary documentation.

DATA ACQUIRED USING THIRD-PARTY TOOLS

Scientists may occasionally use sensors or samplers other than those in the normal DSG inventory to accomplish their scientific objectives. Data acquired with these tools should be fully documented by the scientific party. It is understood that in some circumstances, tools which are prototypes or under development may not have data formats fully established, or specifications that could change in the future. At the end of the cruise, the Chief Scientist will provide a copy of this documentation, together with a list of how the data are being distributed, to the WHOI shipboard technician responsible for transmitting data to the archives at WHOI. The data are the property of the Principal Investigator who acquired them; but they may be archived at WHOI by special arrangement negotiated prior to the cruise.

However, if a third-party tool displaces a standard NDSF tool, or if NDSF data loggers are used to record data from a third-party tool, a copy of the data from the third-party tool will be archived at WHOI unless other arrangements have been negotiated prior to the cruise.

ACCESS TO AND USE OF ARCHIVED DATA

During a proprietary period following the cruise, archived data may be accessed only by the Chief Scientist, or by others documented by the Chief Scientist in writing, as noted under Protocols, above. The length of this proprietary period is the same as that dictated by the policies of the agency funding the expedition (e.g., normally 2 years after the acquisition of the field data during the cruise for NSF and ONR funding). At the end of the proprietary period, all data are available for general use by scientists and educators, and for public outreach. Access to deep submergence data is viewed as important and every effort will be made to facilitate access to this information via the WHOI Archives and the News Office. Data will be made available to non-commercial users for the nominal cost of reproduction and distribution.

Archived data are the property of WHOI, and rights for commercial use of the imagery data are vested in WHOI. Exceptions may be negotiated on a case-by-case basis if warranted. Such negotiations are to be conducted well in advance of the cruise on which the data will be collected. Otherwise the above policy will apply. Fees to be charged to commercial users of NDSF imagery will conform to industry standards and will keep in mind the importance of disseminating this type of information and providing the public with access to the results of deep submergence science and technology.

Principal Investigators may use their discretion in distributing archivable images and data directly to the scientific and educational communities and to the news media for non-commercial use, or they may refer outside requests for such material to WHOI. Principal Investigators must insist that appropriate funding agency and institution acknowledgments accompany all such distributed material. (A standard credit might be:

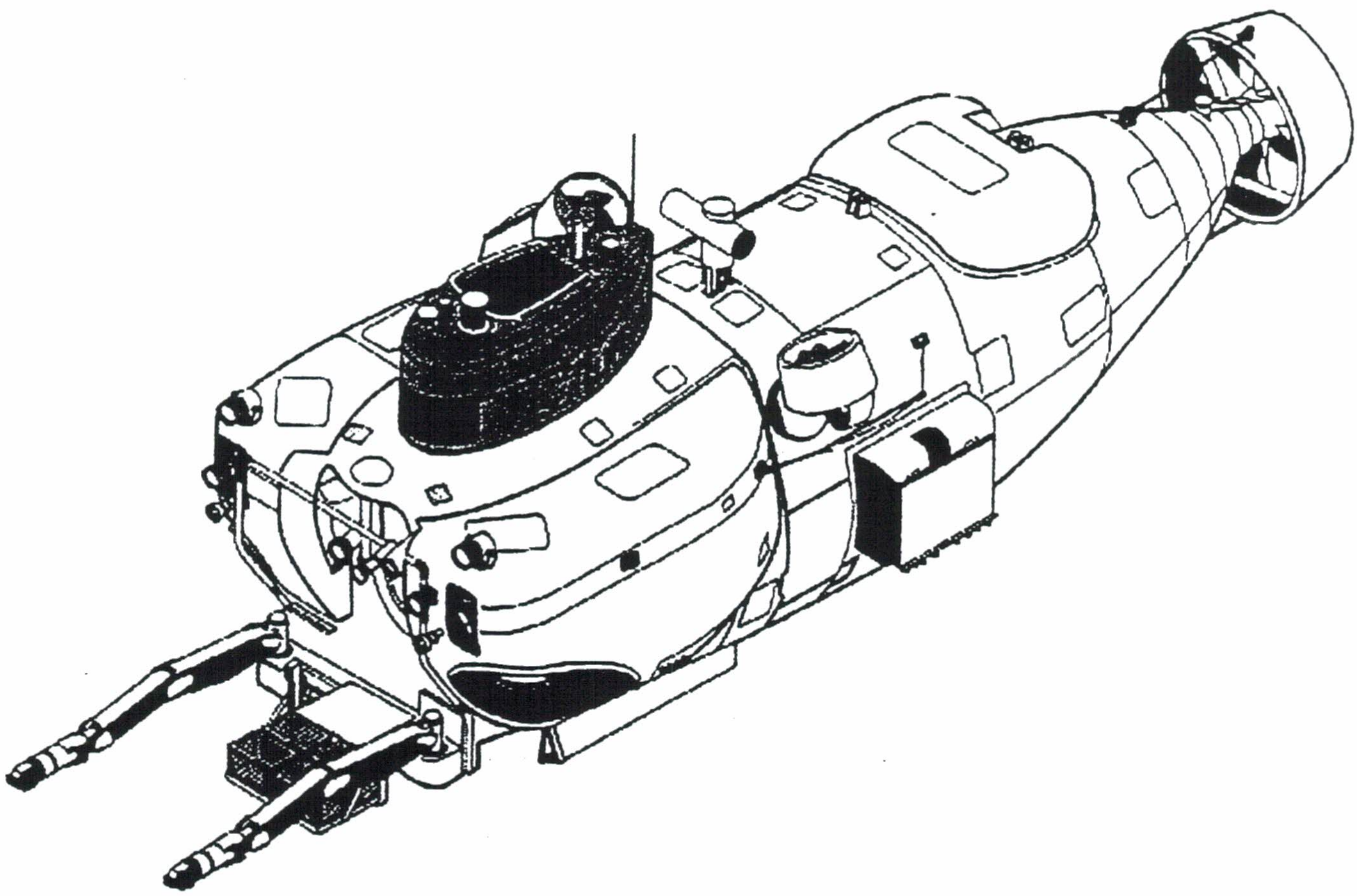
Courtesy of Woods Hole Oceanographic Institution and NSF; John Doe, Principal Investigator, XYZ University.)

The preceding policies do not apply in cases involving U.S. Government classified material. Such material will be archived at WHOI only by direction of the sponsoring agency.

The NDSF will provide an accounting of all commercial income generated from deep submergence data as part of the annual Operator's report to the DESSC.

All proceeds from the commercial use of NDSF data or images are to be used to support the NDSF and the archiving of data from NDSF vehicles.

Appendix XI



Sea Cliff

Capacity:	3 people	**Descent Rate:**	100 ft/min
Length:	31.5 ft	**Ascent Rate:**	100 ft/min
Width:	10.5 ft	**Vehicle Frame:**	Titanium
Height:	12 ft	**Personnel Sphere:**	Titanium
Weight:	~55,000 lb	**Viewports:**	3 (forward, port, & starboard)
Operating Depth:	20,000 ft at 1 atm	**Skin:**	Glass-reinforced plastic
Max Speed:	2.5 kn		
Endurance*:	10 h (nominal) 18 h (extended)		

SEA CLIFF (DSV-4)

Positives

- ✔ 6000 meter titanium sphere
- ✔ 553 ft^3 of 6000 meter rated syntactic foam
- ✔ Updated search sonar system
  (Continuous Transmission Frequency Modulated)
- ✔ Three (3) spare underwater telephone systems
  (same as ALVIN)
- ✔ Many spare variable ballast system components
  (compatible with ALVIN)
- ✔ Two high tech manipulators
  (one with force feedback) - if released by the Navy
- ✔ A replacement trim system (non mercury)
  (if released by the Navy)

SEA CLIFF (DSV-4)

Negatives

- ✗ Sphere has same viewport arrangement as was originally designed for the ALUMINAUT and used in the succeeding three (3) generations of spheres (ALVIN, TURTLE, and SEA CLIFF)

- ✗ Weight -- air weight is 20,000 lbs greater than ALVIN and 16,000 lbs greater than current rating for ATLANTIS A-frame

- ✗ Size -- too large for ATLANTIS hanger

- ✗ Maneuverability is poor

- ✗ Operating Expenses

  Silver Zinc batteries (high cost and short life)

  Expensive and specialized Mil Spec components

THE WORLD'S DEEP HUMAN OCCUPIED VEHICLES

	JAPAN	FRANCE	RUSSIA	USA
Vehicle	SHINKAI 6500	NAUTILE	MIR 1 & MIR 2	ALVIN
Operator	JAMSTEC	IFREMER	Shirshov Institute of Oceanography	WHOI
Depth	6500 meters	6000 meters	6000 meters	4500 meters
Length	31 ft	26 ft	26 ft	24 ft
Weight	52,000 lbs	42,000 lbs	42,000 lbs	36,000 lbs
Sphere	2.0 meters ID Titanium	2.1 meters ID Titanium	2.1 meters ID Maraged Steel	2.0 meters ID Titanium

HUMAN OCCUPIED VEHICLE SUPPORT

"A US platform with a proven performance record is needed. It is **essential as a nation** that we not lose the 6 km capability. Because much of **scientifically interesting seafloor** falls between **4500 and 6000 meters**, this direct observation function is critical. While ROV's and AUVs can replace many of the functions of manned submersibles, direct observation of the seafloor is critical for **many biological** and **chemical studies** of **soft-sediment habitats**. Work in the Western Pacific is > 4500m deep and work on mid- ocean ridges has axial depths in the 4000-5000m range. **Tectonic/petrology studies** of **transforms** and **ridge-transform intersections** will also require submersible depth capabilities in this range. Extensive fine-scale manipulations, to date, can best be carried out only by manned submersible; without this capability, work at 4500-6000m depths is limited."

–From the UNOLS Deep Submergence Science Committee SEA CLIFF Working Group Report, July 1997

HUMAN OCCUPIED VEHICLE SUPPORT

"... there is **strong support for HOV depth capability to 6,000 meters** to allow for research over a wide range of tectonic, sedimentologic and geographic environments."

"... makes a compelling argument that deep submergence science is mature enough to identify many important biological, chemical, geological, and engineering problems that require human presence, *in situ*..."

"Individual comments by respondents stressed that there is **no substitute for human presence in the deep ocean**..."

"The majority of responses indicated that **SEA CLIFF should NOT replace ALVIN**, citing SEA CLIFF's poor track record and ALVIN's proven capabilities."

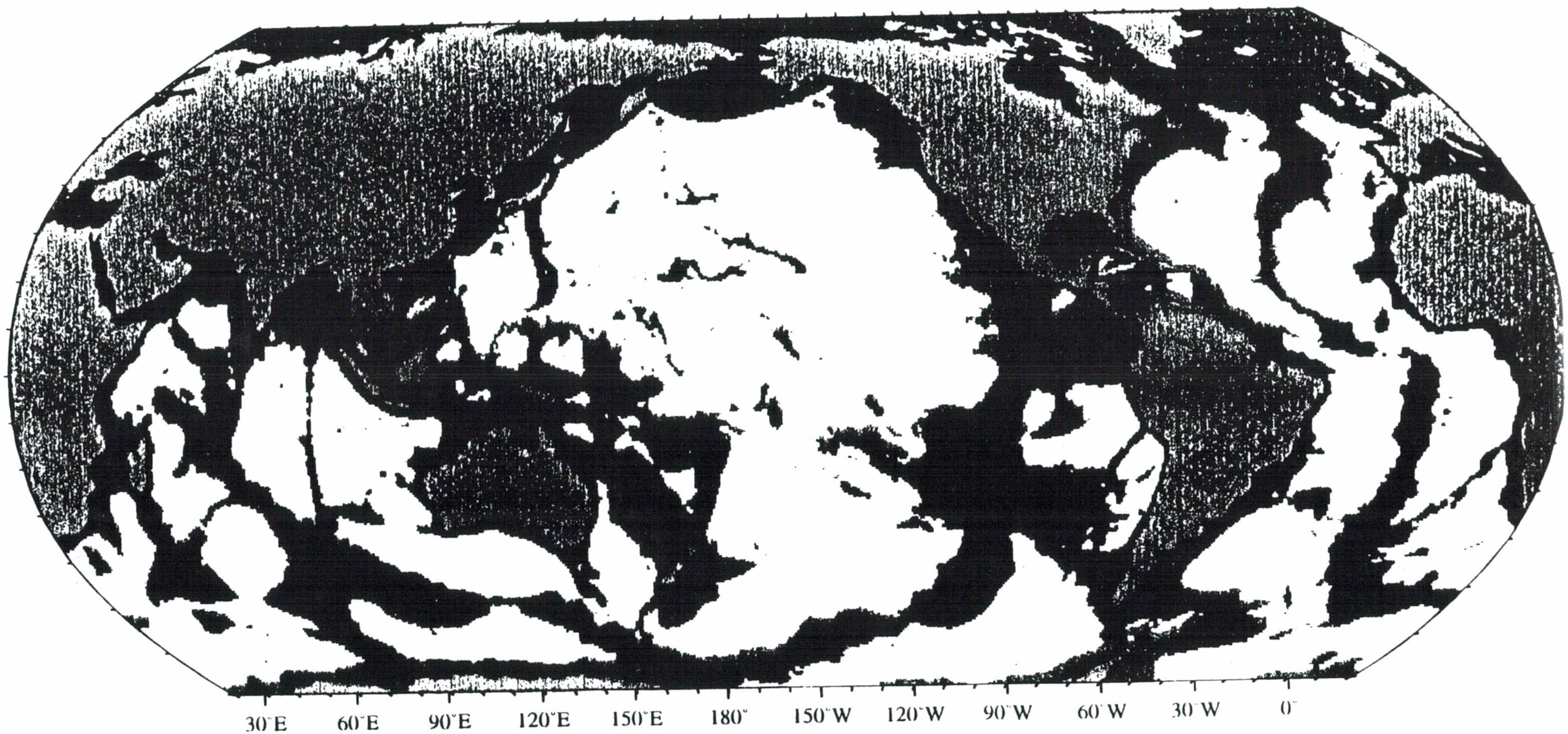
–From the UNOLS Deep Submergence Science Committee SEA CLIFF Working Group Report, July 1997

HUMAN OCCUPIED VEHICLE SUPPORT

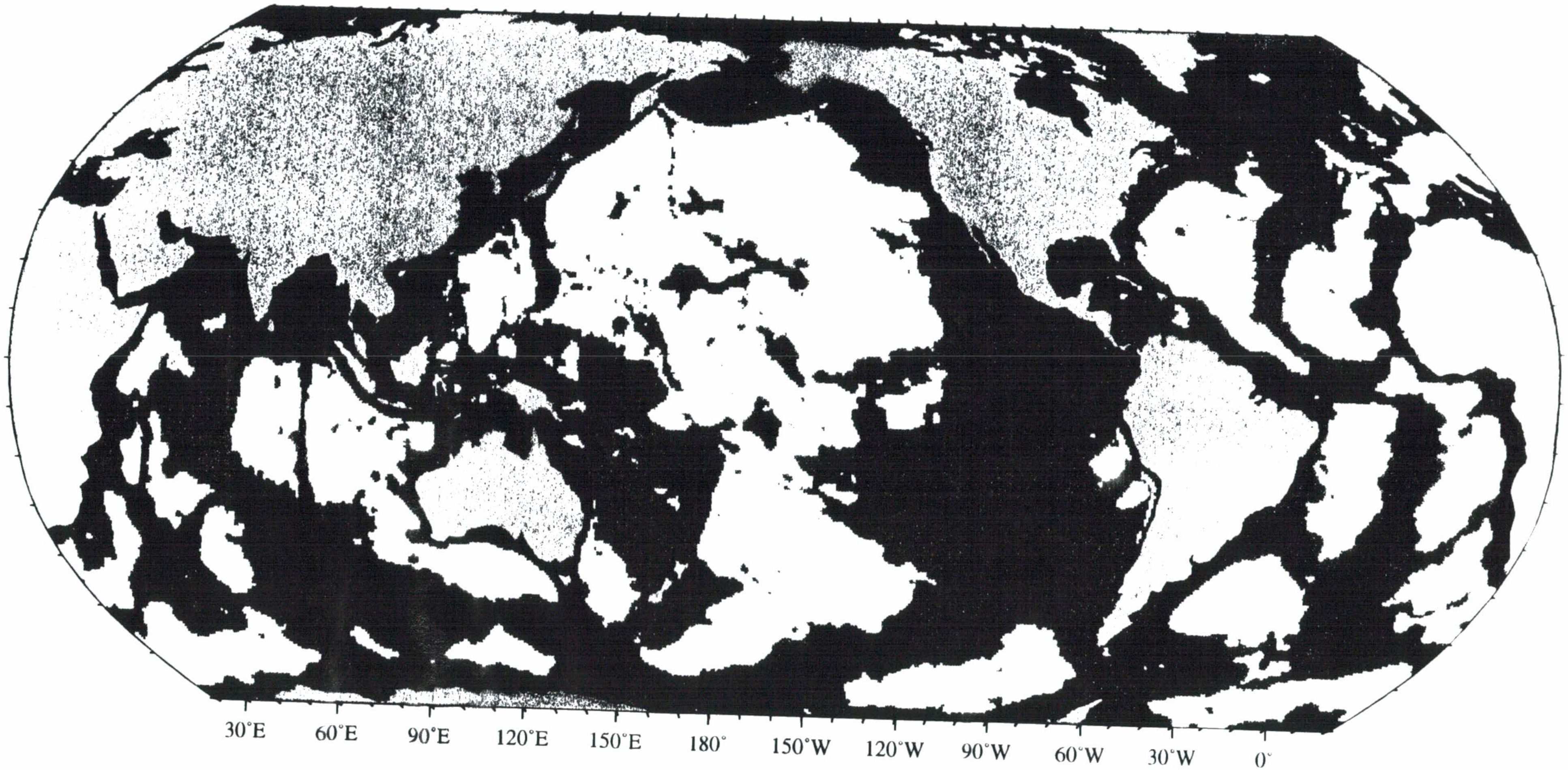
"There is **no adequate substitution** for human presence. Given an almost equal cost, experimental work has better chances with HOV. Some instrumentation still requires manned operations and a scientist on site for real time assessments. The need for **manned submersibles is a "key" component to any deep sea research program**. Work in the Western Pacific needs the greater depth capability. With emphasis on "observatories" studies (coastal or mid-ocean ridges) human-occupied subs are still needed down to 4500m until ROV's are capable of comparable manipulation of experiments. HOV combinations with ROV are envisioned."

–From the UNOLS Deep Submergence Science Committee SEA CLIFF Working Group Report, July 1997

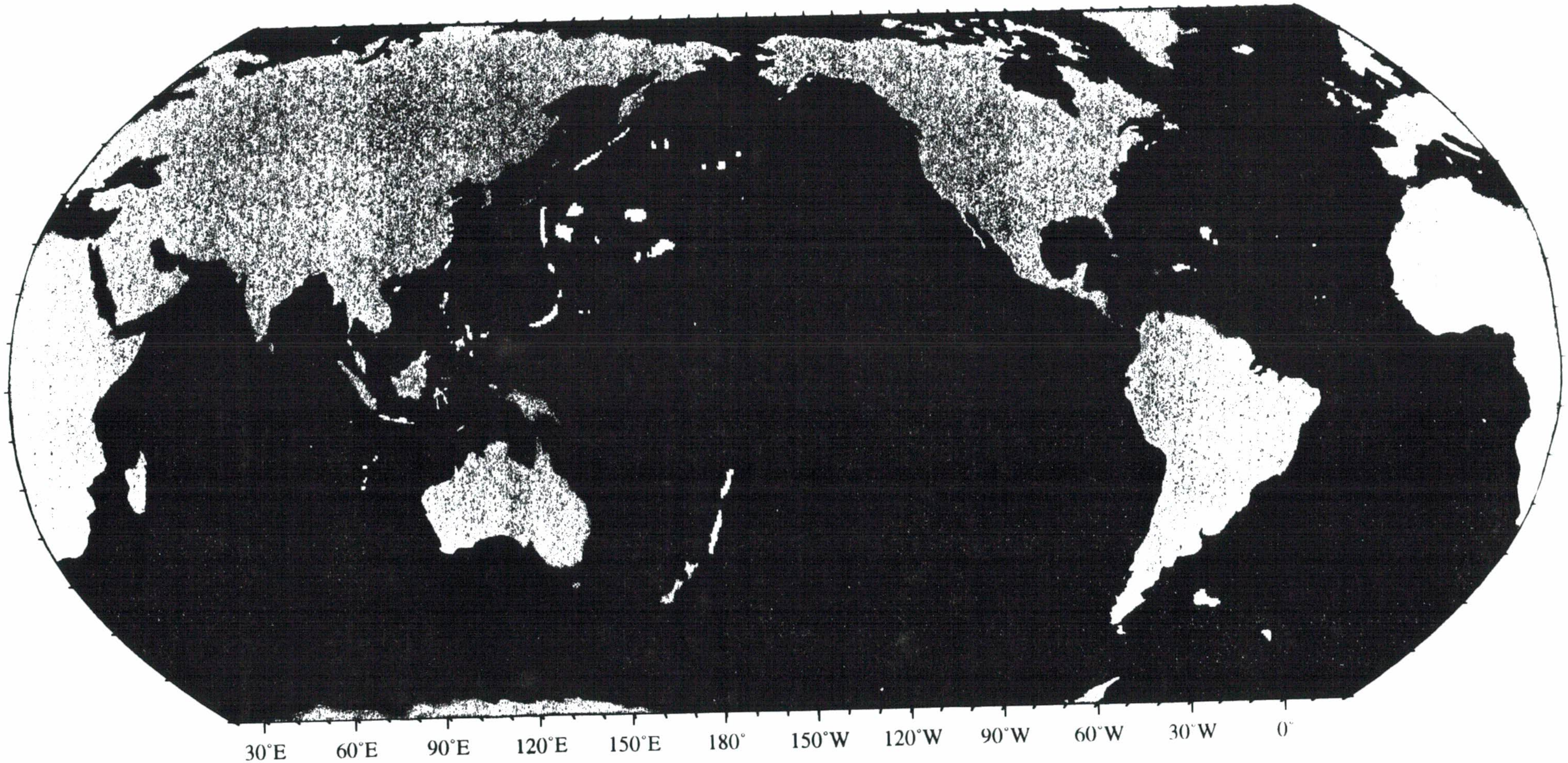
ALVIN 4000m Dive Coverage



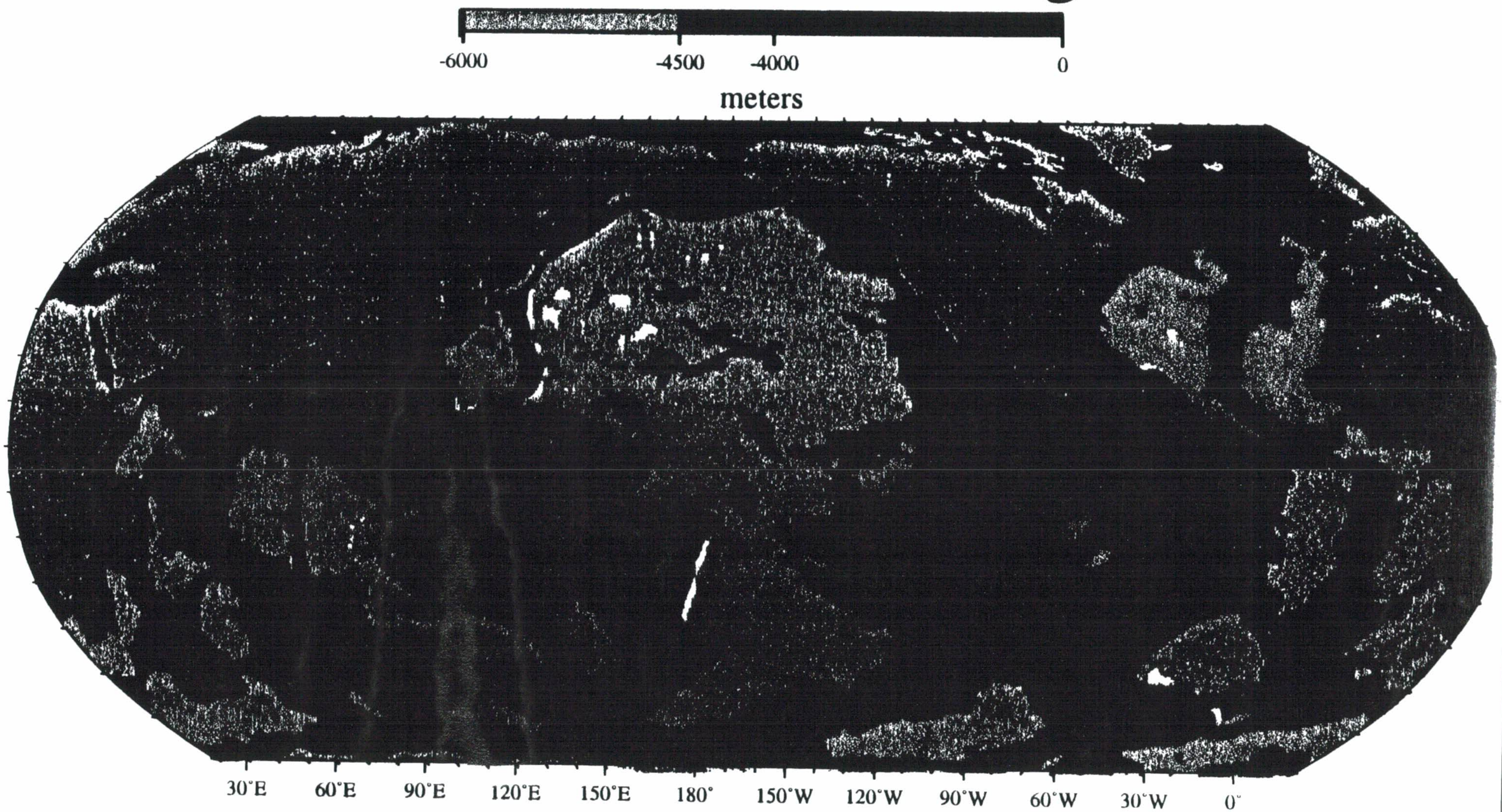
ALVIN 4500m Dive Coverage



ALVIN 6000m Dive Coverage

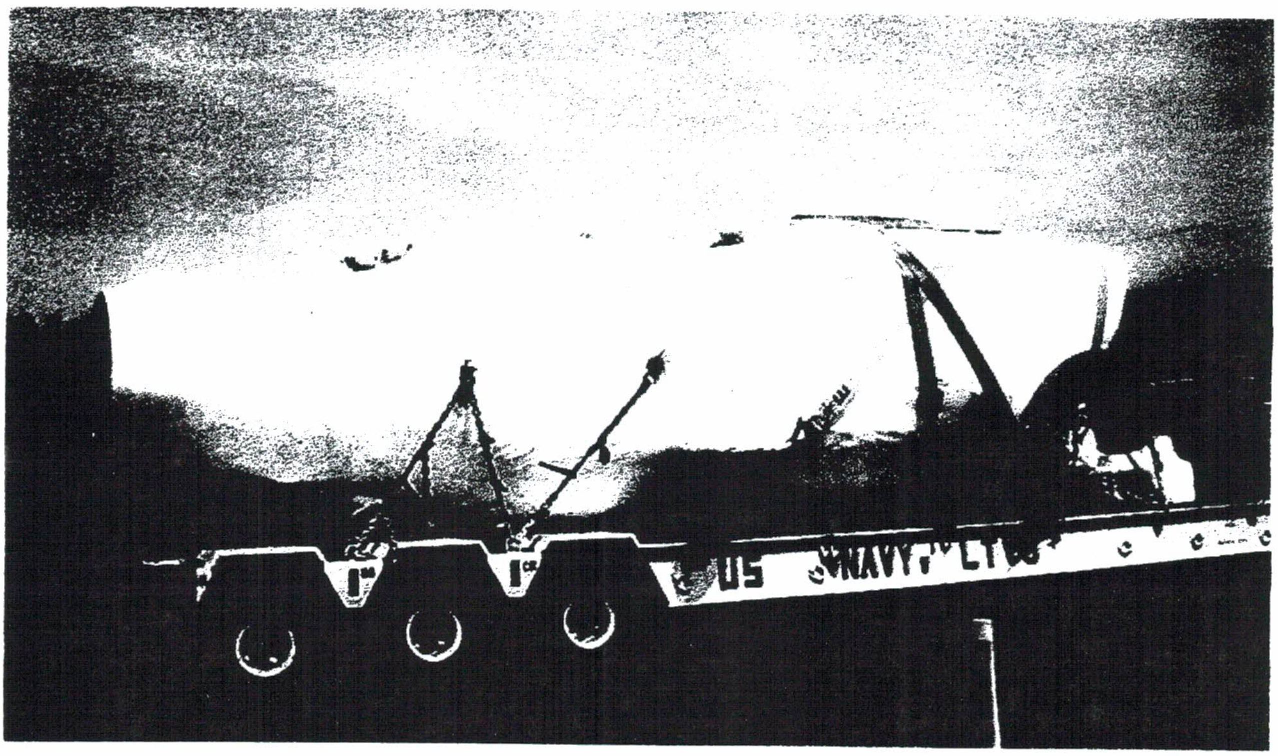


ALVIN Dive Coverage



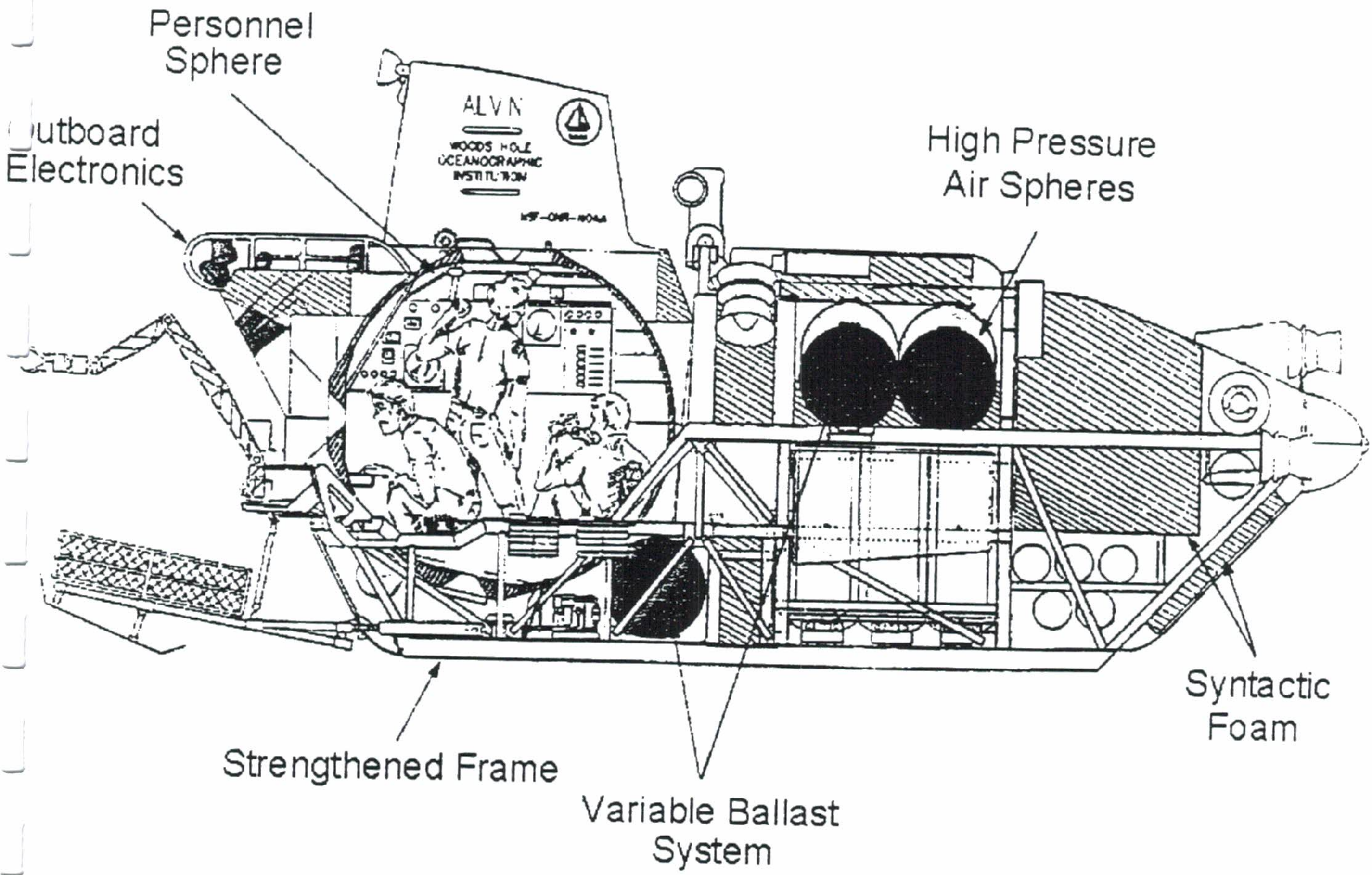
SEA CLIFF
(DSV-4)

Status Report

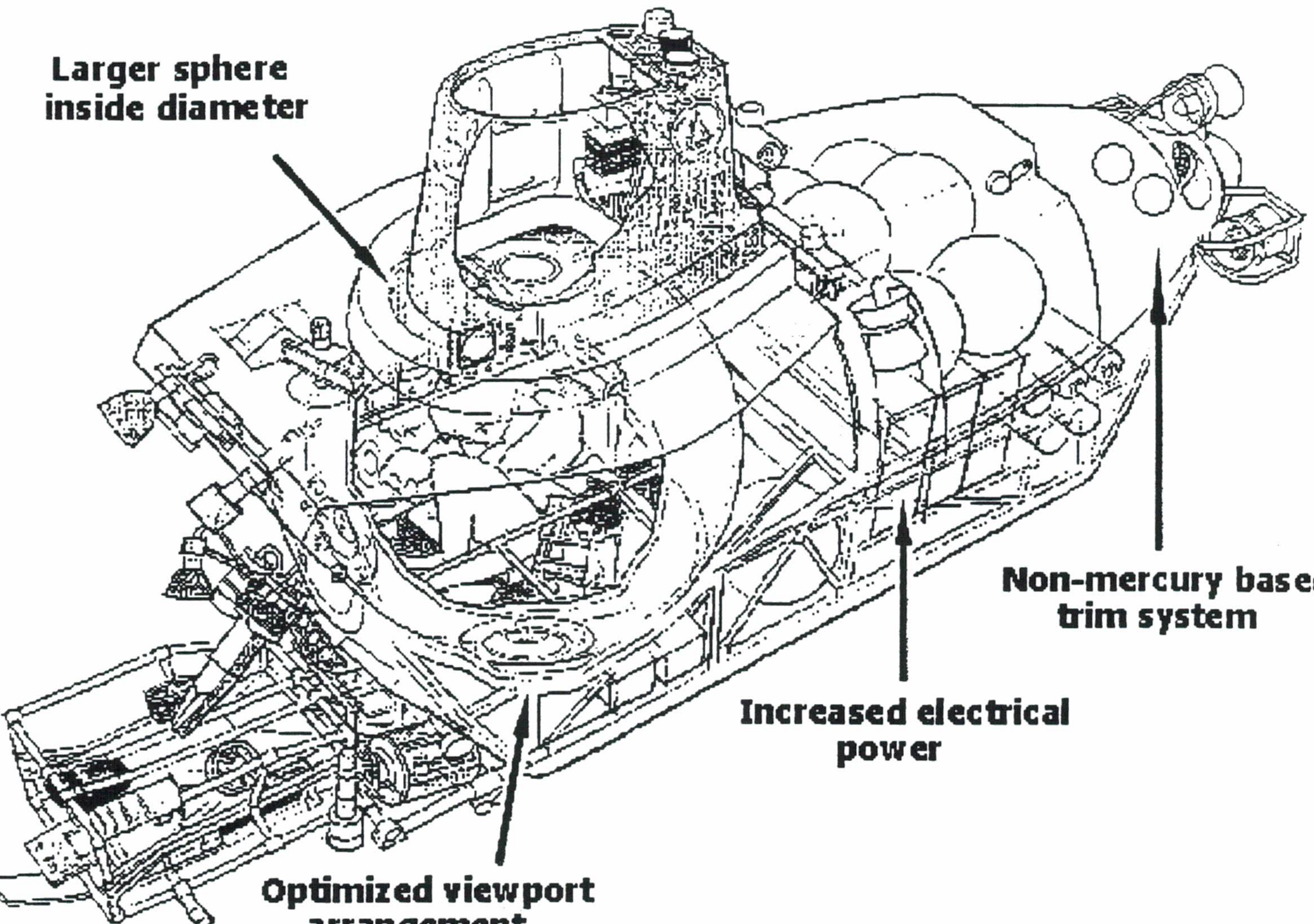


Arrived August 5, 1998

6000m Upgrade Requirements



While We're At It ...



Increased ascent/descent speeds

Multiplexed control and data collection systems

Engineering Study

- Approved and funded
- Integration of SEA CLIFF and ALVIN systems into 6,000m submersible
  - Detailed study of SEA CLIFF systems
    - *Study plans, manuals and material history*
    - *Study actual vehicle, components & material on site*
  - Investigation of 6,000m submersible component market
  - Inspection of currently-operating 6,000m submersibles
  - Investigate sphere construction and viewport location issues
  - Develop design concepts and cost projections

Current Projects

- Layup maintenance program
- Long-term storage arrangements
- Obtaining manipulators and replacement trim systems from Navy
- Obtaining spare parts from Navy
- Obtaining maintenance and engineering records

SEA CLIFF/TURTLE Parts in Current Use

- EDO/Straza 1510 CTFM sonar
- Spare UQC underwater telephone

Appendix XII

Upgrade to Tethered Vehicles of NDSF

- Address identified shortcomings of Jason/Medea system:
  - Manipulative capabilities
  - Sample and equipment payload capacity
  - Speed and thrust
  - Increase depth to 6500m min.
  - Tether management

Upgrade to Other NDSF Tethered Vehicles

- Include telemetry and control upgrades to DSL 120 and Argo II
- Provide stand alone control and telemetry electronics for Argo II
- Ensure cross platform compatibility
  - support
  - sensor mobility
- Provide vehicles with dedicated sensors (depth, altimeter, etc.)
- Address known shortcomings

Argo II:	lighting
	compatible propulsion
DSL 120:	digital sonar electronics
	tow dynamics

Summary of Planned Upgrades

Upgrade	Jason II	Argo	DSL 120
Propulsion Increase	✓	✓	
Lighting	✓	✓	
Manipulation	✓		
Control/Telemetry	✓	✓	✓
New Structure/Frame	✓		✓
Tether Management	✓		
Dedicated Sensors	✓	✓	✓
Increased Payload	✓		✓
Sonar Electronics	✓		

Appendix XIII

To: Prospective Users of the DSL-120 Sonar System
From: WHOI- Deep Submergence Group
Date: December 3, 1998

DSL-120 Sonar
Data Collection and Processing Summary

Introduction

The principal purpose of this summary is to provide prospective users of the DSL-120 sonar with key information that will help in the preparation of proposals and planning for and executing field programs once proposals have been approved for funding. In addition, information is provided that will allow science users to better understand the data acquisition and processing schemes used and the type of computer equipment needed to process the high-resolution sonar data. References are made to various sonar processing software used and WWW sites where it is available, as well as the Enduser software developed by Dr. Dan Scheirer (Brown U.) specifically to permit users to easily plot the sonar data at different scales. Reference is also made to the new DSL-120 sonar acquisition/processing system purchased from Oceanic Imaging Consultants (OIC) of Honolulu, Hawaii (Dr. Tom Reed)

The DSL-120 sonar is a phase-difference sonar system operated by the Woods Hole Oceanographic Institution's (WHOI) Deep Submergence Facility as part of the UNOLS National Deep Submergence Facility (NDSF). The system was developed by engineers at WHOI's Deep Submergence Laboratory (DSL) in collaboration with the Applied Physics Laboratory of the University of Washington and the Acoustic Marine Systems, Inc. of Redmond, WA. The sonar vehicle is neutrally buoyant, and is towed at speeds of ~1 kt (varies with terrain roughness) behind a depressor weight to minimize sea surface/ship motion. Towing altitude is usually 100 m from the seafloor. It has a depth rating of 6000m and operates on standard 0.680 fiber optic cable. The frequency is 120 kHz, with source levels of 218 db and 228 db and consists of two beams with 180° of separation, with horizontal beamwidth of 1.7° and vertical beamwidth of 120°. The system is normally used at a range scale of 1 km, which provides gridded sidescan (amplitude/imagery) pixel resolution of ~1 m, and vertical phase-bathymetric precision of ~1 m out to ~400 m from nadir to either side. As a guide, analysis of several datasets collected with the DSL-120 sonar suggest precision on multiple passes to within ~10 m (not considering navigation offsets). Since 1993 the system has been used for six field programs in the Atlantic and Pacific Ocean in various tectonic settings at depths between 1700 and 5100 m.

Advance planning in laying out the sonar survey, determining the tentative field logistics, and evaluating options for navigation (depending on the size of the areas to be surveyed and the roughness of the terrain) are critical to the success of the field program. In addition, it is important for the science user to:

- identify the scope of shipboard processing to be carried out by their scientific party,
- determine the need for near-real time sonar imagery and bathymetric data in order to plan sequential, nested deep submergence surveys using other vehicles or submersibles, and
- provide for adequate computing resources given the large volume of data produced by the DSL-120 sonar system and the large size (~10 to <~200 Mbytes) of gridded sidescan (amplitude/imagery) and phase-bathymetric data files.

Extensive dialog with the WHOI NDSF shorebased and seagoing Deep Submergence Group (DSG) prior to submitting proposals and implementing field programs is strongly encouraged after reviewing the information provided below.

System Descriptions

DSL-120 Sonar Data - Acquisition and Processing Pipeline at Sea

Raw, complex-quadrature data logged to Exabyte tape in real time
Intermediate data transferred in real time to post-processing system
Intermediate data copied using Unix "tar" utility for backup and archiving
Processed vehicle navigation and attitude ASCII files generated
Post-processing carried out on intermediate data using processed navigation and attitude data
Processed "oicp" individual ping records generated in OIC format
OIC formatted gridded files of sonar amplitude and phase-bathymetry generated
NetCDF (GMT) files generated for use by science party using GMT and EndUser software [Wessel and Smith, 1991; Scheirer, 1998] to make plots
Backup copies all processed products made to Exabyte tape.

Real Time Data Acquisition

Real-Time Shipboard Collection/Display System

CPU: SUN Ultra Sparc 2170, 128Mb RAM
One-4Gbyte hard drive for temporary storage of intermediate sonar data
Two-Exabyte tape drive
Acquisition Software: OIC/Geodas-DSL

Raw Data

Record-oriented, 5 min. binary files in OIC format,
Complex quadrature data continuously logged to Exabyte tapes in real time
Vehicle navigation and attitude header data stored with each ping
These data are generally NOT reprocessed (processing starts with Intermediate data)

Intermediate Data

Record-oriented, 15 min. binary files in OIC format
16-bit amplitude at full bandwidth/sidescan channel
Realtime estimates of angle relative to boresite vs time
Vehicle navigation and attitude header data stored with each ping and logged locally to a hard drive
Data are transferred via shipboard network to the Post-Processing System where further processing is carried out
Intermediate data are "tar" copied to Exabyte tapes as on-board backup and archived at WHOI

Navigation Data

Collected and displayed at Navigation console (long-baseline transponder (LBL), and GPS [P-code if available]). When not in a LBL transponder network layback navigation is calculated and used.
Navigation is sent to OIC/Geodas via shipboard network or serial data link where it is logged with raw and intermediate sonar records. Data is also logged locally as ASCII files.

Vehicle Attitude Data

Serial data from vehicle input to OIC/Geodas
Logged with raw and intermediate sonar records
Logged locally as ASCII files
Navigation, attitude, and sonar vehicle collection parameters and settings are logged with the raw and intermediate OIC records

Data Displays

Continuous waterfall display of backscatter (amplitude) and bathymetry in real-time.
Vehicle attitude and sensor parameters, data diagnostic profiles are displayed on the main Geodas real-time monitor
The main Geodas display is slaved to the fish-flyer's (winch control) monitor
A Raytheon thermal paper copy of real-time imagery/amplitude data displayed on the main Geodas monitor is produced and annotated automatically with date/time/position and other information.

Post-Processing Carried Out at Sea by WHOI DSOG

Shipboard Post-Processing/Display System

CPU: SUN Ultra Sparc 2170, 384Mb RAM
Two- 23Gbyte SCSI external hard drives for storage/processing
Two-9Gbyte SCSI external hard drives for storage/processing
One- HP 1600 InkJet printer
One- Exabyte drive

Software: OICSwath (main processing routine). Post-processing of navigation, attitude, sidescan (amplitude/imagery) and phase-bathymetry.

Processed Data Products

Currently, post-processing products consist of ASCII files of vehicle navigation and attitude, and binary files of gridded sonar data which consist of OIC exported grids of sidescan (amplitude/imagery) and phase-bathymetry at various resolutions depending on: science requirements, size of surveyed areas, shipboard vehicle use logistics, and other factors.

Basic page-size plots of the data are provided to the science party and filed with the archived data. The OIC grids are converted to NetCDF formatted files for input into GMT mapping software which is freely available to the scientific community [Wessel and Smith, 1991; http://www.soest.hawaii.edu/wessel/gmt.html] for ease of manipulation and plotting by the science party onboard, and post-cruise at their shorebased laboratories. Grids are organized in OICSwath post-processing routines by "Operations Areas" (Op_Area) which are user definable work/survey areas. A tailored software package called "Enduser", that permits easy plotting of DSL-120 NetCDF files was developed by Dr. Dan Scheirer (Brown U.) as part of the DSL-120 upgrade proposal funded by NSF in 1996. Enduser relies on various elements of the GMT and MB-Systems programs, and is available via anonymous ftp from "emma.geo.brown.edu" in the directory "/pub/scheirer" (the program is a compressed tar-file and is called "Enduser.v1.0.tar.Z").

OICSwath also produces processed sonar ping records ("oicp" files) which are not gridded. MB-System [Caress and Chayes, 1993; http://www.ldeo.columbia.edu/MB-System/], is a freely available software package for displaying and processing various types of high-resolution sonar data. The latest version of MB-System (v4.6) includes a beta plug-in to allow users to display and process OIC formatted ping data within the MB-System suite of sonar software.

Shipboard Data Storage & Processing Guidelines

The shipboard WHOI-DSG is responsible for all data storage and processing requirements through the generation of the suite of NetCDF gridded files of sidescan (amplitude/imagery) and phase-bathymetry for the surveyed areas agreed to in discussions with the Chief Scientist or their designee. All of these files are also archived at WHOI and provided to the Chief Scientist on Exabyte tape.

Gridded NetCDF files, after they are produced and archived by the DSG, become the responsibilty of the science party to maintain and manipulate depending on their science objectives. DSG will make page-size plots of these files for their records and for the science party, and will maintain backups of the processed gridded sonar files. The science party is responsible for manipulating the gridded data to produce additional plots at what ever size is needed for their work.

Users should note that these gridded files can be VERY large depending on the grid resolution and the size of the gridded area. For example, during a cruise to the Juan de Fuca Ridge in 1997 (EdRex97) gridded files at 2 m resolution for areas covering 8 km x 16.5 km were 132Mb each for the sidescan (imagery/amplitude) and phase-bathymetry. Gridded 10 m resolution files for same area were 5.3Mb each. Experience has shown that OICSwath can generate FAR larger gridded files than users can manipulate easily with GMT. A simple rule of thumb, that has worked reasonably well to date, is to limit grid sizes to <4,000,000 elements (e.g. 2000 x 2000 nodes, 2 km x 2km of 1 m grid resolution, or 10km x 10km of 5 m grid resolution).

The digital storage and processing equipment provided by the science party at sea should be adequate to carry out manipulation of the gridded files with GMT type software or the equivalent depending on the scope of the real-time utiliation of the sonar data during the cruise and the expertise of the science party. Normally, WHOI-DSG provides six (6) technicians for intensive DSL-120 field surveys. WHOI-DSG can provide additional technical personnel at sea to assist with sonar data processing, and it is recommended that at least one additional WHOI-DSG sonar processor be factored into the science budget and shipboard party for cruises where shipboard processing and analysis of DSL-120 data will be carried out in support of the science program. Arrangements should be made for the additional WHOI sonar processing personnel at both the proposal stage and well prior to the cruise. While the requirements for sonar data post-processing can vary considerably depending on the type of work being done, it is recommended that at a minimum the science party provide the following basic computing and digital storage devices if they plan to carry out any shipboard data manipulation:

Suggested Science User-Supplied Sonar Processing Computers and Peripherals for use At-Sea

One- Sparc Ultra or SGI Unix computer (or equivalent) with a minimum of 200 MHz clock speed
128 Mbyte or greater of RAM
(N.B. that Sparc Ultra and SGI Unix computers are what WHOI-DSG uses)
Network compatibility (software/hardware)
One- 9GByte or preferably one 18 Gbyte external SCSI hard drive for data storage/manipulation
One- Exabyte tape drive
One - other removeable media drive (e.g. JAZ - 1-2 Gbyte drives and disks) as needed.

Users should note that most UNOLS ships have onboard computing and plotting facilities which may facilitate some aspects of the processing and plotting of sonar data at sea. Scientists should coordinate the use of those facilities and the specific characteristics of the computers and plotters with the institution that operates the ship.

Additional Information, Contacts:

Any questions regarding the this summary, or for further information on the DSL-120 sonar or other UNOLS National Deep Submergence Facility vehicles (Alvin, ROV Jason, Argo II, DSL-120 sonar) please contact the WHOI Marine Operations and Deep Submergence website at:

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

or

Mr. Andy Bowen
WHOI-Deep Submergence Group
Deep Submergence Laboratory
Woods Hole, MA 02543
Tel: 508-457-2643
email: abowen@whoi.edu

SUMMARY OF DSL-120 SONAR SINCE 1993

FIELD PROGRAMS

1993 - ARSRP - MAR (B. Tucholke et al. - WHOI)
1994 - TAG (M. Kleinrock & S. Humphris- WHOI)
1996 - Lucky Strike- MAR (D. Fornari & S. Humphris - WHOI)
1996 - S. EPR (R. Haymon & K. Macdonald - UCSB)
1997 - Derbyshire SW Pacific (R. Williams - UK Dept. Transport/NSF)
1997 - Juan de Fuca (EDREX Program, J. Delaney - UW)
1998 - S. EPR (R. Hey - U. Hawaii)
1998 - Juan de Fuca (CLEFT - D. Stakes - MBARI)
1998 - Puna Ridge, Hawaii (D. Smith - WHOI)

DSL-120 Lowering Summaries (1993 - 1998)

Year	# Lowerings	Bottom Hrs	Lowering Hrs	# Line Km
1993	5	180	211	332
1994	4	231	255	614
1995	0	0	0	0
1996	7	242	282	597
1997	4	76	73	147
1998	15	581	662	1491
Totals	35	1308	1483	3181

SYSTEM UPGRADES
1996-1998 - NSF funded upgrade ($135,000) to replace sonar acquisition and processing system and purchase high capacity hard drives for real time storage and processing. Purchased Sun Ultra-SPARC based system from Oceanic Imaging Consultants (T. Reed) in Honolulu, Hawaii. Included subcontra Dr. Dan Scheirer - Brown U. to assist with developing map based sonar output routines and assist with evaluation of new acquisition/processing system.

SYSTEM STATUS
1. DSL-120 sonar system now acquires data routinely in the field with virtually no downtime. Old system had many quirks and was much less reliable pri upgrade effort. Acquisition system now very robust and there is system redundancy in the CPU hardware (2 Ultra-SPARCs) so that data acquisition is assu

2. DSOG, with assistance of trained personnel in the science party, has capability to produce near-real time map based output: i.e. sonar backscatter and ph bathymetry data in geodetic coordinates.

3. D. Scheirer (Brown U.) has developed a set of GMT and MB-System based scripts ("Enduser") for routine plotting of OIC output .grd data to produce real-time backscatter and phase-bathymetry plots.

4. Currently, the data provided to science consists of gridded files of amplitude and depth data. Intermediate OIC ping data acquired by the DSL-120 son also available but requires MB-System software or other sonar processing software to produce maps.

5. D. Caress and D. Chayes (co-authors of MB-System) just announced the next release of MB-System (4.6) which supports the DSL-120 OIC format This will allow users to process their DSL-120 ping data outside the OIC software environment.

USER CONCERNS
1. Quality of phase-bathymetry data and artifacts
2. At-sea data processing is very complex
3. Delivery of phase-bathymetry data
4. Towfish dynamics
5. Bottom detection in rough terrain

FUTURE IMPROVEMENTS NEEDED
1. System factory recalibration
2. New SIMRAD sonar control and transmit/receive electronics
3. Improve towfish hydrodynamics and towing characteristics to minimize induced noise and vehicle attitude excursions
4. Further streamline and document real-time acquisition/processing pipeline.
5. Install independent altimeter sensor (in progress, started with Smith Puna Ridge cruise, still needs work)
6. Install gyro (ring-laser gyro upgrade for ROVs and Alvin is a candidate).

Appendix XIV

CSSF

Welcome

Canadian Scientific Submersible Facility

Presentation

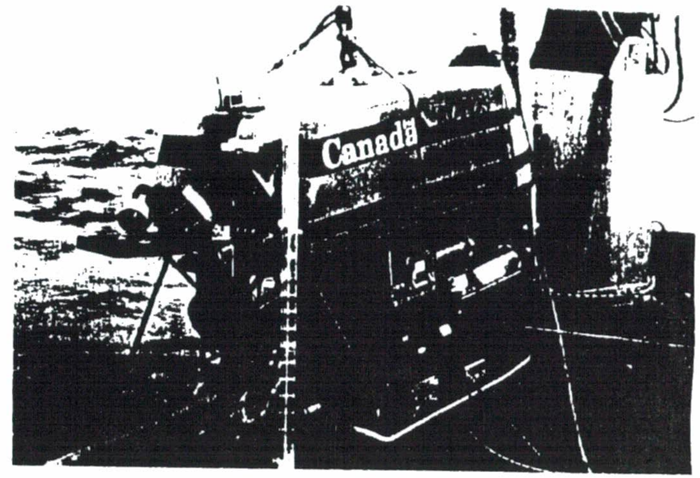
CSSF

Canadian Scientific Submersible Facility (CSSF)

- Formed in 1995 by a group of scientific submersible users
- Operates ROPOS (Remotely Operated Platform for Ocean Sciences) under a five-year agreement with Canada's Department of Fisheries and Oceans
- Has a team with a reputation of being expert, positive, hard-working, and dedicated to helping clients achieve their goals. Key members have 17 years experience
- Makes good use of enomous ocean science and technology capabilities in the Seattle-Vancouver-Victoria area from its Operational Base located at the Institute of Ocean Sciences on Vancouver Island

CSSF

What is ROPOS?



- A powerful, tethered electro-hydraulic Remotely Operated Vehicle (ROV)
- Designed and built by ISE (International Submarine Engineering)
- Capable of operating at a depth of 5000 meters for more than 24 hours per dive
- ROPOS has logged over 500 successful dives
- Can use a variety of tools and instrumentation needed by scientists & engineers
- ROPOS is continuously modified in close collaboration with scientific users

CSSF

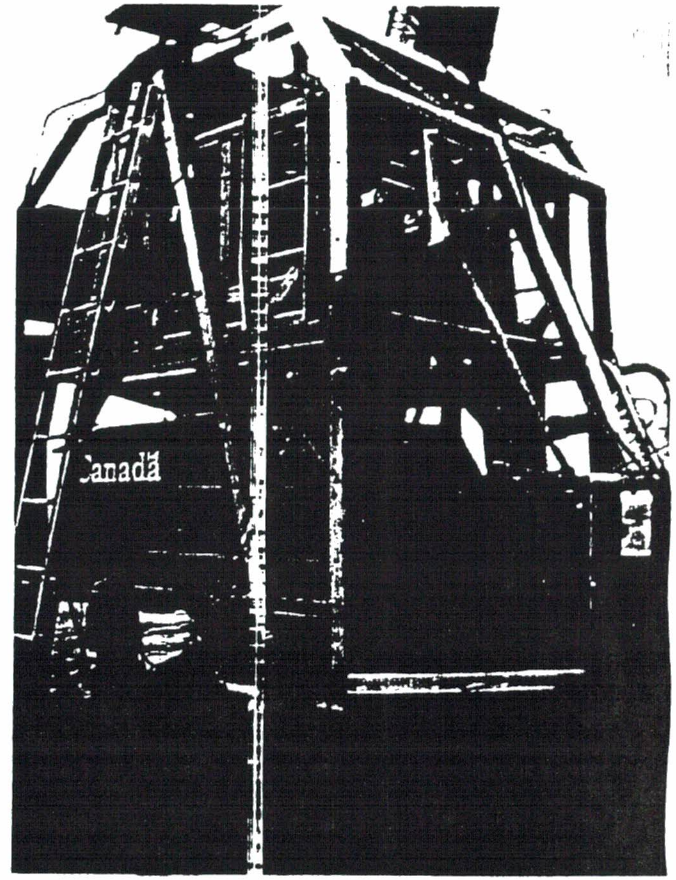
Vehicle / Cage / Support System – Deep Water

- In deep-water mode the vehicle is a component of a cage/vehicle system with full operational capability to 5000 metres depth

- ROPOS can return to a site or trackline in an hour, in a day or next year. The vehicle and cage are navigated with a customized acoustic long baseline tracking system calibrated with differential GPS

- It has an elevator for carrying samples or equipment between the sea floor and the surface without interrupting the ROPOS dive

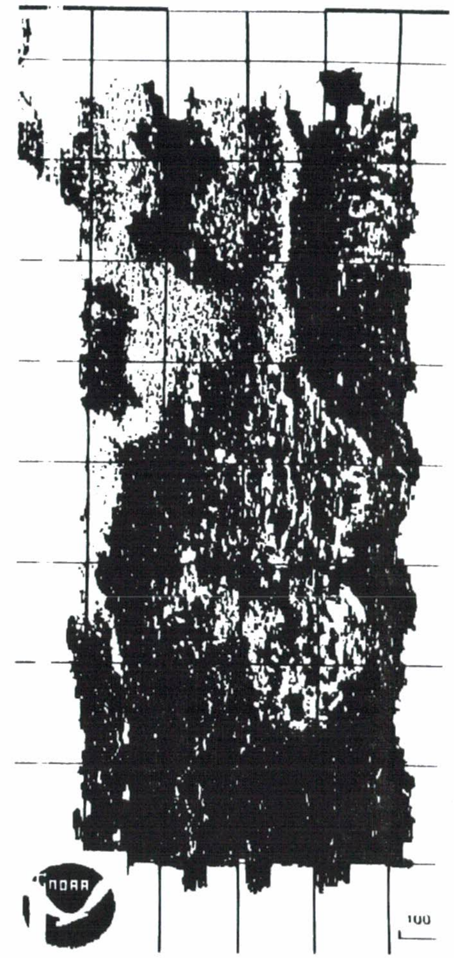
- ROPOS has worked five seasons offshore in up to 5000 metres of water



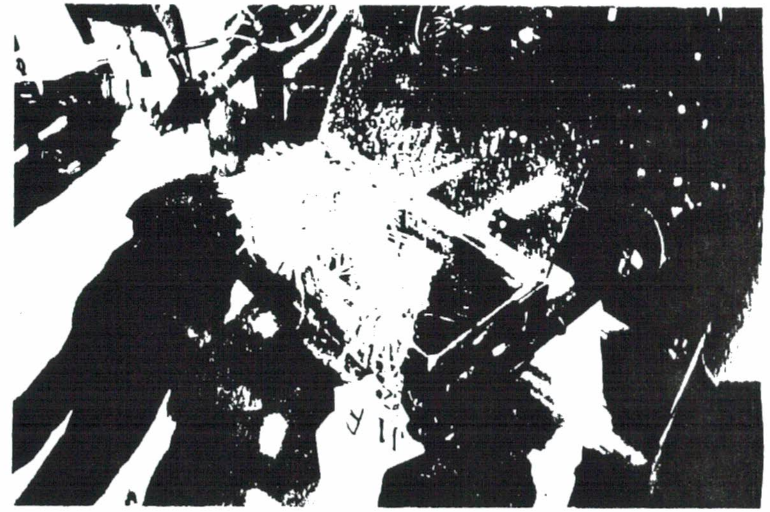
CSSF

What Would You Use ROPOS For?

- Geological Sampling and Surveys
- Geophysical Surveys
- Biological Sampling and Surveys
- Chemical Sampling
- Equipment Deployment and Recovery
- Disposal Site Surveys
- Cable/Pipeline Surveys
- Salvage
- Undersea Rescue & Recovery Operations
- Images for Television, Multi-media or Film Production



ROPOS Standard Equipment - I



Navigation

- A PC-based, long baseline, acoustic navigation system to provide 3-D navigation. Differential Global Positioning System (DGPS) permits accurate positioning and tracking

Manipulators

- ROPOS has both seven and five-function manipulator arms that can lift up to 275kg and put a probe within 5mm of a delicate organism

3-CCD Video

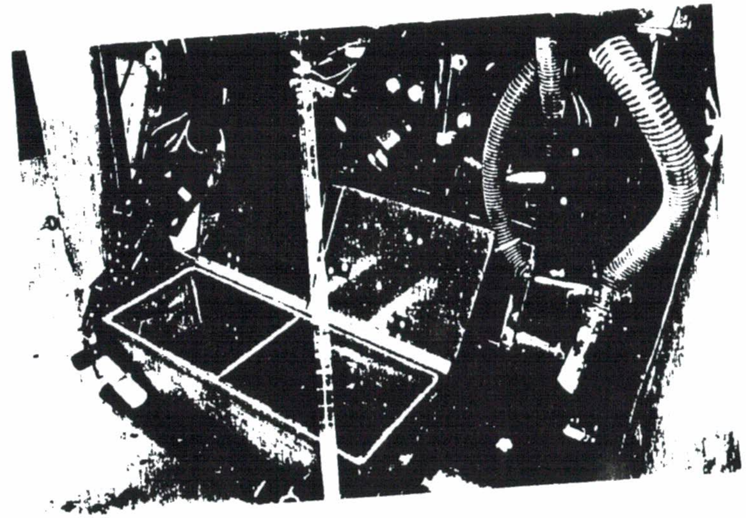
- A Sony DXC-950 broadcast quality video camera with a 16x zoom lens

Laser Scales

- For measuring object size or estimating organism density

CSSF

ROPOS Standard Equipment - II



Colour Scanning Sonar

- Helps find targets and avoid obstacles

Variable Speed Suction Sampler

- Used to collect water, bacterial mat, tube worms, clams, small fish and crabs, sediments and small rocks

Pacman

- The "Pacman" sampler is a clamshell shaped sampler for soft or fragile items or taking a quantitative sample from a specific area

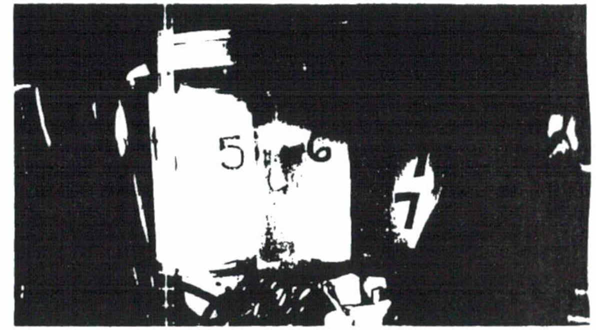
Sample Tray / Biobox

- Four to eight compartments for collecting geological and biological samples
- Biobox provides thermal insulation for temperature-sensitive organisms

CSSF

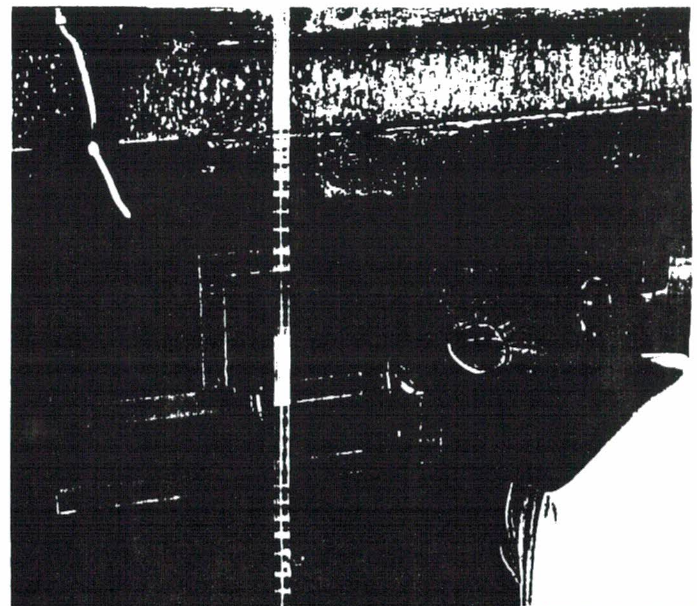
ROPOS Accepts the Users' Tools

ROPOS Hydraulic Power Pack and electrical interface makes it easy to adapt specialized tools. Scientific telemetry is completely separate from the vehicle control system.



Some examples of user supplied tools

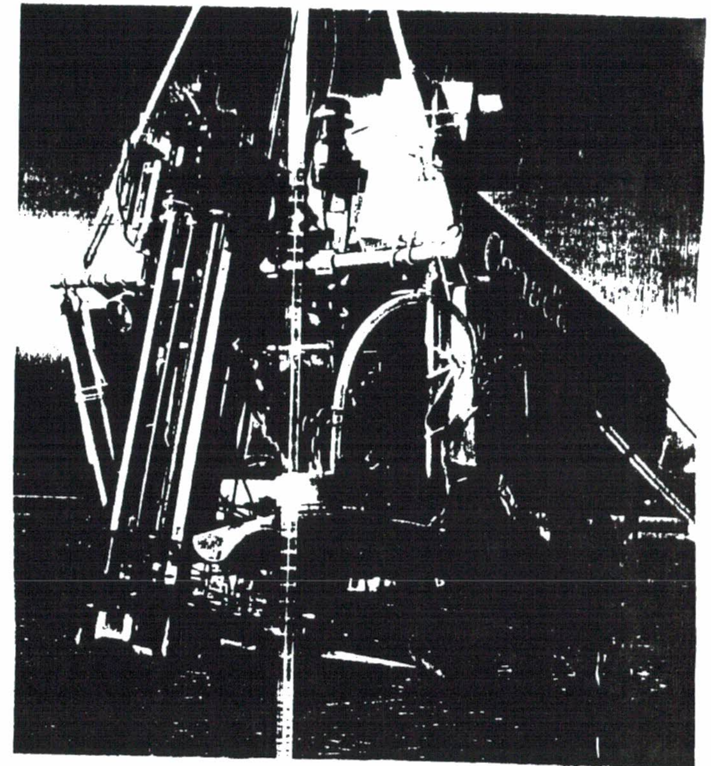
- Hot Fluid Sampler
- Manifold Sampler
- SUAVE Chemical Scanner
- ODP Borehole Data Link



CSSF

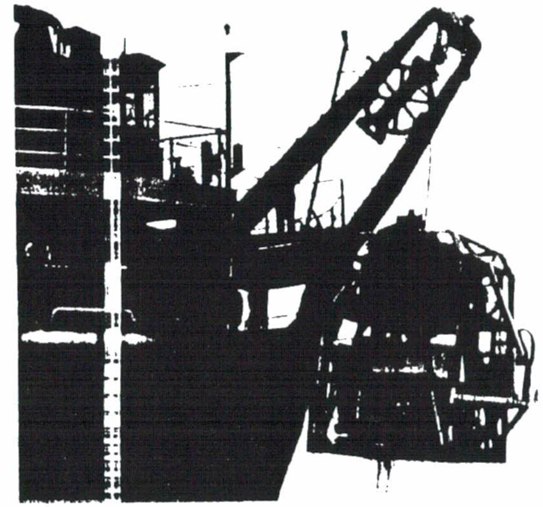
ROPOS Accepts the Users' Tools - continued

- Tube-Worm Stainer
- Rock Coring Drill
- Chain Saw
- Downward Looking Scanning Sonar



CSSF

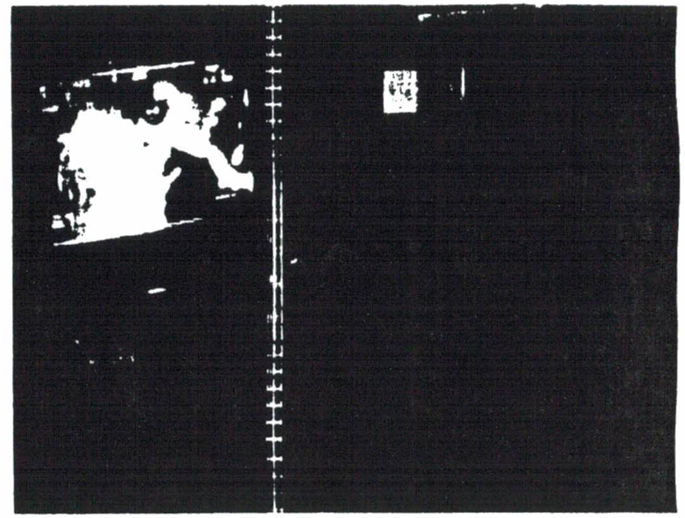
Using ROPOS Worldwide



- ROPOS can be shipped anywhere in the world and used on a variety of support vessels
- It has been used in both hemispheres, on 7 vessels belonging to four countries
- System requires 380 - 460VAC at 250 Amps and 50 / 60Hz to operate ROV and winch
- 115 - 120VAC 60Hz UPS desirable onboard
- Deep water ship must have A-frame or crane capable of carrying at least 14 tonnes
- Shallow water (typically deployed from ships less than 150ft.) system is easier to use

CSSF

Using ROPOS - Expertise



- Extensive project management and operational expertise. For more than 17 years key CSSF personnel have been building, maintaining and operating manned and unmanned scientific submersibles and related equipment.
- A proven track record of prompt and cost-effective delivery
- 6 Ship board ROPOS Operators / Maintainers can provide 24 hour per day service for deep-water operations
- 2 additional personnel are provided when CSSF is supplying navigation and tracking support
- DOTA (Deep Ocean Telepresence Alliance) formed to supply users with equipment and knowledge

CSSF

Clients

The US National Oceanic and Atmospheric Administration (NOAA)

Universities in Canada and the United States

American Museum of Natural History

The Canadian Natural Sciences and Engineering Research Council (NSERC)

GEOMAR

Woods Hole Oceanographic Institution

British Antarctic Survey

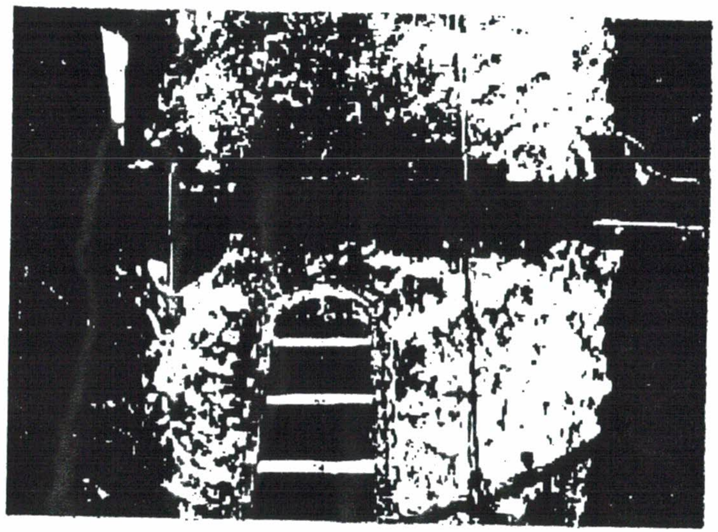
Natural Resources Canada

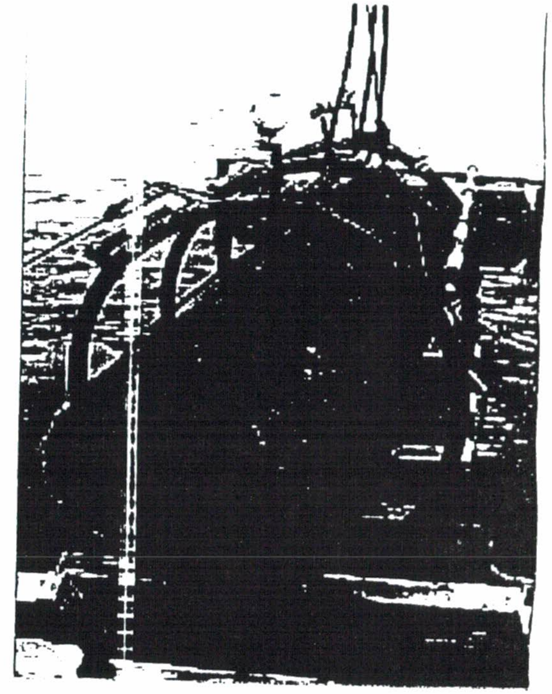
CSSF

Adventures With ROPOS

On the Juan de Fuca Ridge

- From the University of Washington ROPOS / REVEL expedition to the 'hot vents' of the Juan de Fuca Ridge



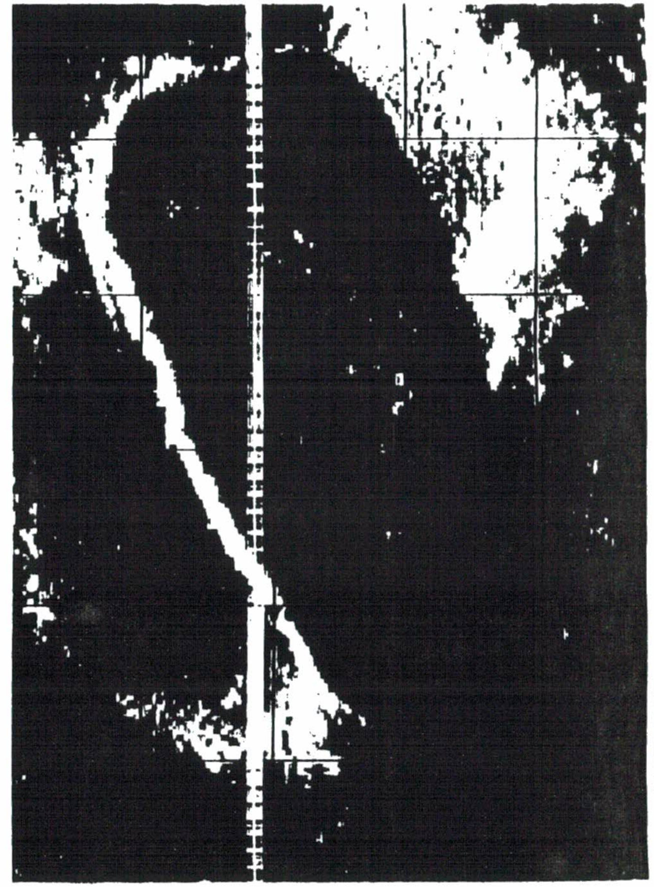


CSSF

Adventures with ROPOS

With NOAA on Axial Volcano

- Using ROPOS versatile array of tools to map changes resulting from the January 1998 eruption



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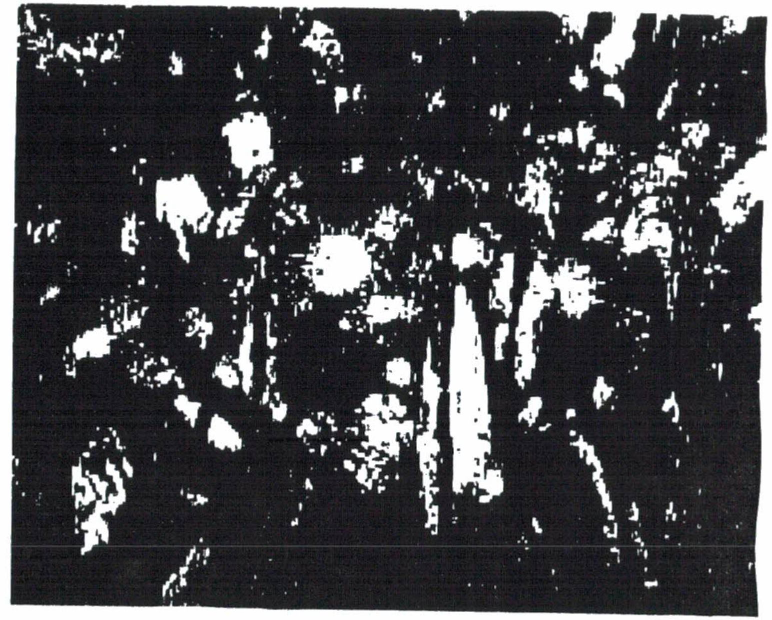
Adventures With ROPOS

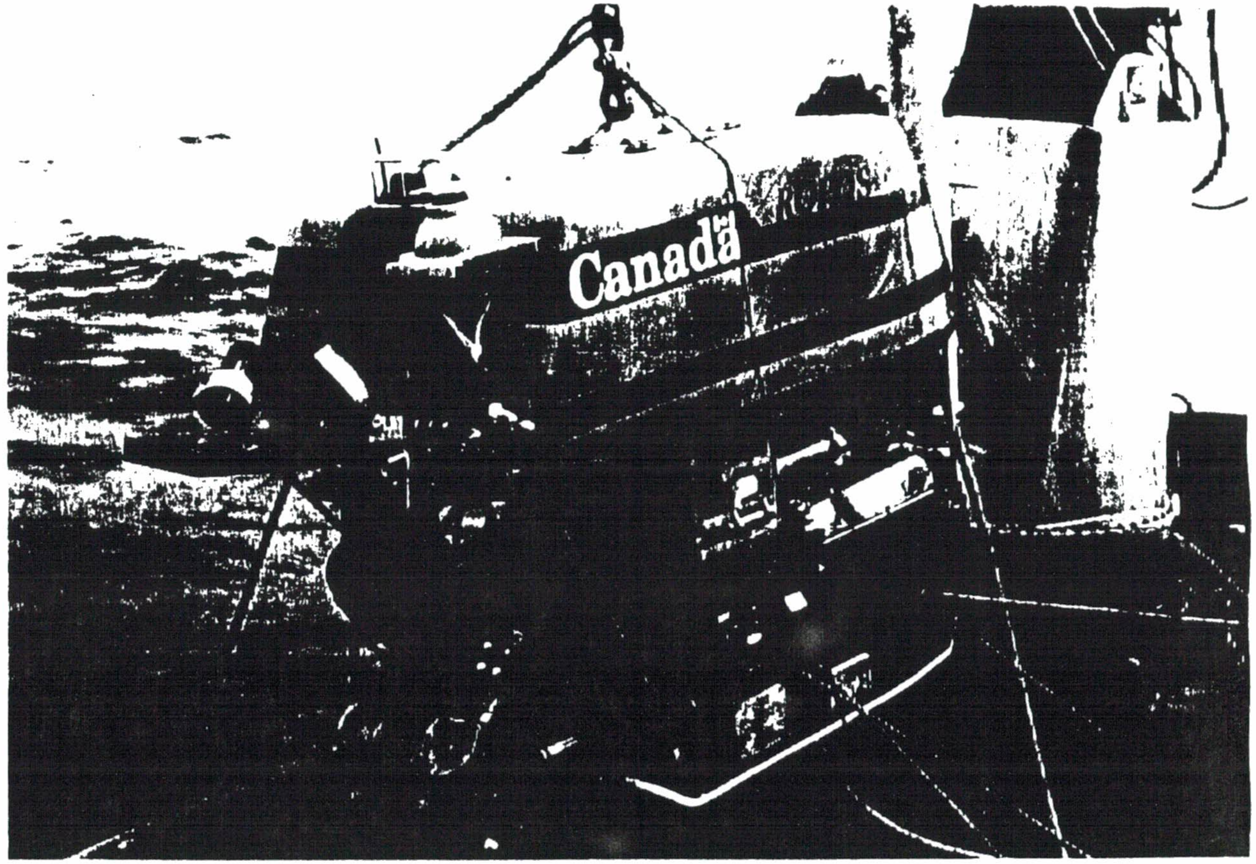


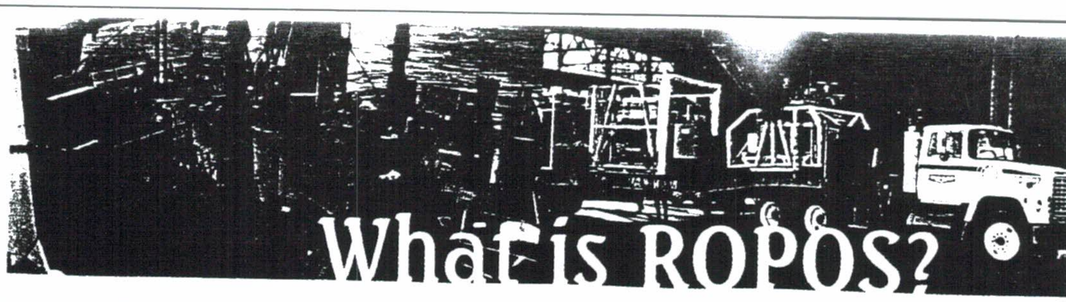
In the Aleutian Trench with GEOMAR

- Cold seeps in the Aleutian Trench off Kodiak Island were the site of ROPOS' deepest dive (4976m).

CSSF

Thank You





What is ROPOS?

ROPOS is a powerful, tethered electro-hydraulic Remotely Operated Vehicle (ROV) capable of operating at a depth of 5000 meters for more than 24 hours per dive. Designed and built by International Submarine Engineering, ROPOS has logged over 500 successful dives since 1986. The current version of ROPOS was delivered in 1997, replacing an earlier vehicle lost at sea in a 1996 fall storm.

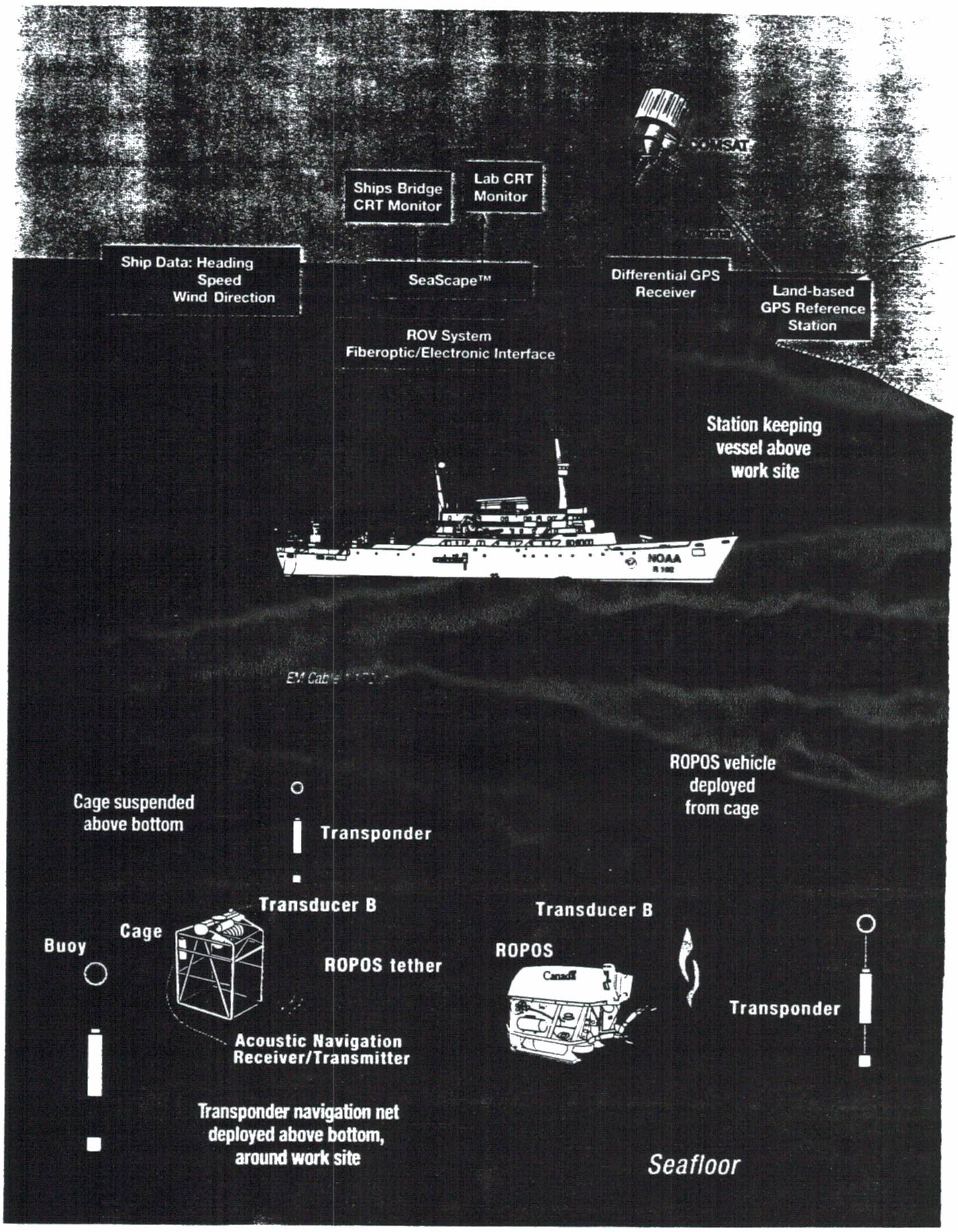
ROPOS is continuously modified to suit the changing needs of scientists and engineers. ROPOS can perform a wide range of functions using an ever-increasing variety of sophisticated tools and instrumentation. To date, applications have included:

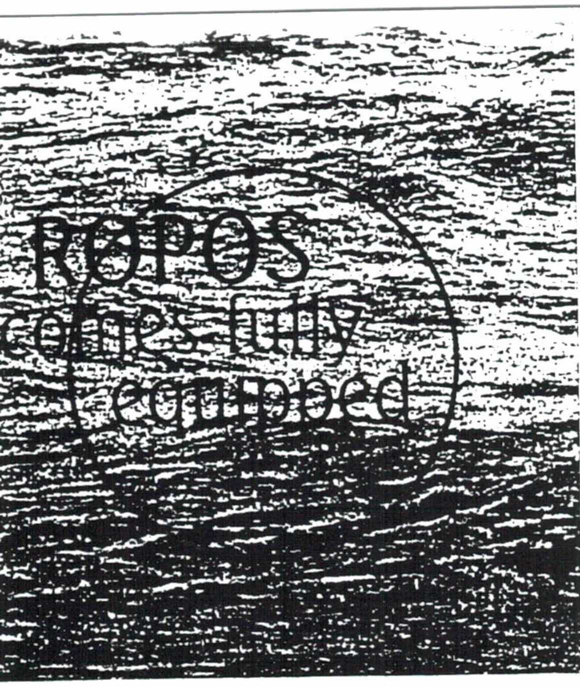
- ***Geological Sampling and Surveys***
- ***Geophysical Surveys***
- ***Biological Sampling and Surveys***
- ***Chemical Sampling***
- ***Equipment deployment and recovery***
- ***Disposal Site Surveys***
- ***Cable/Pipeline Surveys***
- ***Salvage***

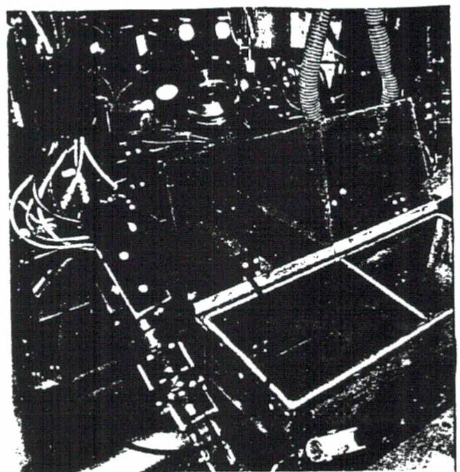
ROPOS is not limited to scientific or industrial applications. The onboard Sony DXC-950 broadcast quality video camera, for example, can be used for multi-media educational projects, full-length feature television production and news coverage of undersea rescue & recovery operations.

For deep water operations ROPOS is launched and recovered in a cage containing a winch with a 300m tether. The cage is linked to the support vessel by up 5000m of electrical-optical cable mounted on a large winch. This arrangement provides a de-coupling of the vehicle from the ship's motion while operating at depth. In shallow water live-boat operations ROPOS is deployed directly from the ship on a 500m tether.

ROPOS can be shipped anywhere in the world. It has been used in both hemispheres, on a variety of support vessels.







Navigation
ROPOS can return to a site or trackline in an hour, tomorrow or next year, using a customized version of the SeaScape Precision Navigation System developed by Software Engineering Associates, Seattle. This PC-based, long baseline, acoustic navigation system provides 3-D navigation of submersible vehicles from a vessel or platform. A cage-mounted acoustic range-meter transceiver and Differential Global Positioning System (DGPS) permit accurate positioning and tracking within a network of bottom-moored transponders provided by CSSF or the client.

Manipulators
ROPOS' seven - and five-function manipulator arms have been modified to increase dexterity and the ability to grasp small objects. They can lift up to 275kg at full extension. Fine control is so precise it can put a probe within 5mm of a delicate organism, put a 1cm sampling tube in a 2cm hole, or mate electrical connectors with the 'instrumented plug' in a drill hole.

3-CCD Video
A Sony DXC-950 broadcast quality video camera with a 16x zoom lens transmits an RGB signal via the fiber optic link to the surface, where it is recorded on a Betacam recorder and distributed in S-video format to the S-VHS video archiving system.

Laser Scales
Laser Scales provide scale in images for measuring object size or estimating organism density. The lasers project two parallel beams of light through the water. These appear in video frames as two points of red light on the surface of interest, 10cm apart, regardless of camera zoom and vehicle proximity to the target.

Colour Scanning Sonar
A forward-looking scanning sonar helps find targets and avoid obstacles.

ROPOS ACCEPTS A WIDE RANGE OF USER-PROVIDED TOOLS

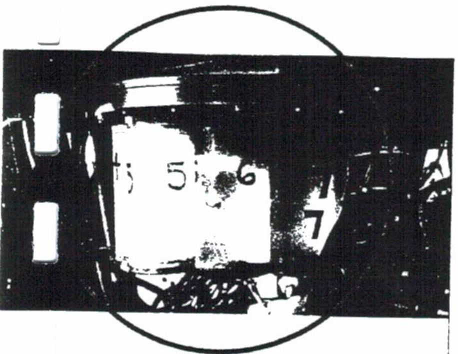
ROPOS' hydraulic power packs can provide up to eight separate functions for the users' scientific tools. Its scientific telemetry system, completely independent of the vehicle telemetry, can multiplex up to seven bi-directional RS-232 channels for real-time communication with, and control of, many instruments. Analog and digital input and output are available through an external junction box.

A few examples of user-provided tools used successfully on ROPOS:

Tube Worm Stainer
Developed by Dr. Charles Fisher of Penn State University in collaboration with Chris Tietze of the Harbor Branch Oceanographic Institution, this unique tool must be held in place for several minutes until staining is complete. New tube growth then appears as uncoloured tube and provides a measure of in-situ animal growth rate.

Hot Fluid Sampler
This device, developed by NOAA's Pacific Marine Environmental Laboratory, allows high temperature (up to 400°C) hydrothermal fluids to be routed to a variety of containers and collection devices.

ODP Borehole Data Link
ROPOS has successfully connected to the Ocean Drilling Program's bore-hole monitoring devices and downloaded stored data.



Suc[illegible]ion Sampler

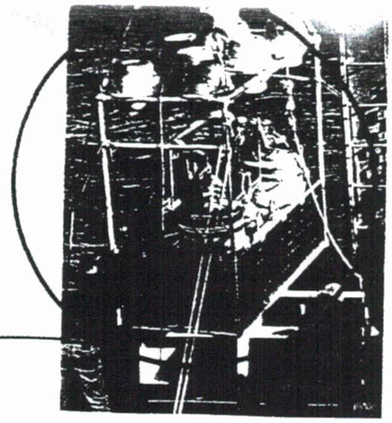
The variable-speed suction sampler is [illegible]d to collect water, bacterial mat, tub[illegible]worms, clams, small fish and crabs, sediments and small rocks. Samples are [illegible]llected in eight, two-litre jars tha[illegible] [illegible]ave a variable filter mesh to allow for the collection of a wide arra[illegible] of specimens.

Pac[illegible]an

"Pacman", a clamshell-shaped sampler, exc[illegible] at sampling soft or fragile items or t[illegible]ing a quantitative sample from a pecific area (0.045m2).

Sa[illegible]le Tray

A la[illegible]e rotary sample tray has proven o be a robust, well-used addition to he [illegible]stem. It incorporates four to eight om[illegible]rtments for collecting geological nd biological samples.

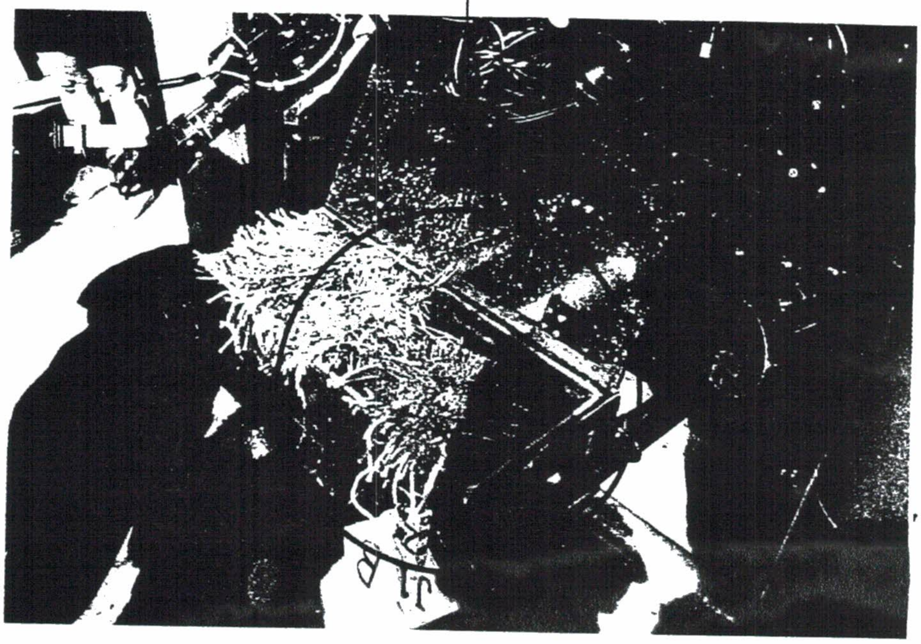


Elevator

An independent 'elevator' is available for carrying samples or equipment between the seafloor and the surface without interrupting the ROPOS dive.

Biobox

The hydraulically-actuated Lexan "biobox" provides thermal insulation for temperature-sensitive organisms sampled in deep water.



[illegible]oring Drill

[illegible] developed [illegible] at the Monterey Bay Aquarium [illegible] Institute [illegible] When [illegible] with ROPOS [illegible] vertically and horizontally [illegible] four samples per dive.

[illegible]wnward-Looking Scanning Sonar

[illegible] VENTS Program's [illegible] used on ROPOS to [illegible] an area 2400m by 600m on [illegible] Seamount. Flying 25m off the [illegible] ROPOS required about an hour [illegible] complete each of the [illegible]400m-long [illegible] spaced [illegible] apart.

SUAVE [illegible]hemical scanner

[illegible] SUAVE [illegible] chemical analyzer [illegible] for NOAA VENTS program [illegible] been carried on ROPOS. [illegible] unique ability to remain stationary for several minutes is critical to successful data gathering with SUAVE.

Chain Saw

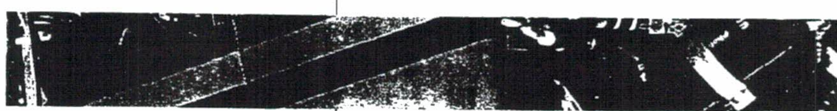
The chain saw was built [illegible] Stanley Underwater Tools and [illegible] by the Applied Physics Laboratory [illegible] the University of Washington. The saw is capable of cutting to [illegible] depth of 40cm through [illegible] granite rock face, permitting [illegible] of large samples from the sea floor.

Who is the Canadian Scientific Submersible Facility?

Formed in 1995 by a group of scientific submersible users, the CSSF operates ROPOS under a five-year agreement with the Canadian federal Department of Fisheries and Oceans.

The CSSF team has earned a reputation for being expert, positive, hard working and dedicated to helping clients achieve their goals. For more than 17 years, key team members have been building, operating and maintaining both manned and unmanned scientific submersibles and related equipment.

Located on Canada's west coast, in the heart of one of the largest ocean science and technology communities in North America– the Vancouver-Seattle-Victoria triangle, CSSF has ready access to an enormous pool of ocean technology capability. CSSF can develop and provide equipment for use with ROPOS or other submersibles.



Canadian Scientific Submersible Facility

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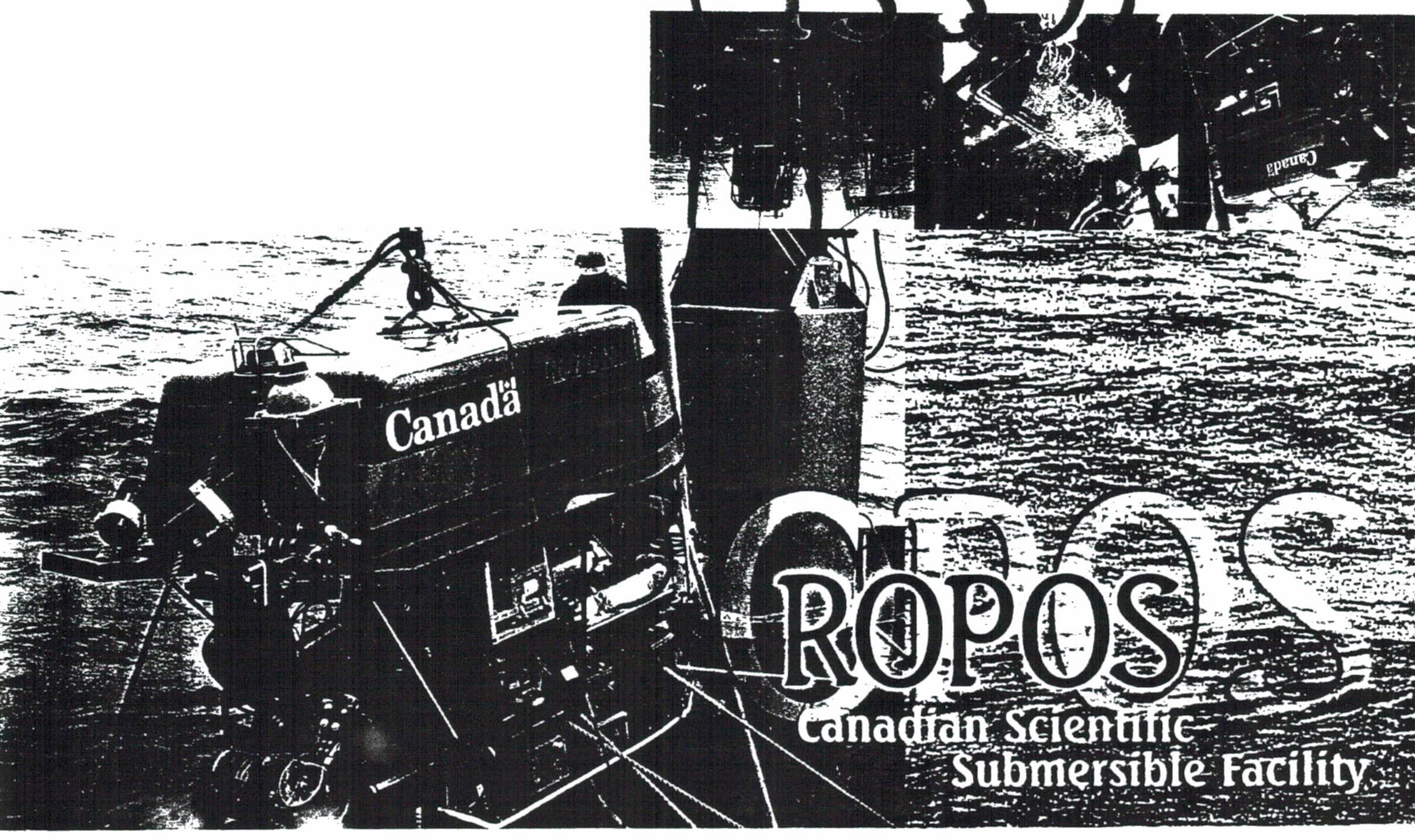

Appendix XV

NeMO 98

1.0 CRUISE OVERVIEW (R. Embley)

1.0.1 General Overview

This report details the results of the operations that occurred during the NeMO98 cruise on the NOAA Ship Ronald H. Brown from August 25th to September 20th, 1998. The team of 33 chemists, biologists, geologists, and engineers used the scientific remotely operated vehicle ROPOS (Remotely Operated Platform for Ocean Sciences) (Shepherd and Juniper, 1997) to investigate in detail the aftermath of the diking event and its effect on hydrothermal chemistry and on the seafloor and subseafloor biological communities. This was a highly leveraged expedition, with substantial operational support coming from several portions of NOAA (WCNURC, Sea Grant, PMEL VENTS) and from the Canadian National Science and Engineering Research Council of Canada (NSERC). Twelve principal investigators and eight graduate students from the U.S. and Canada participated in the expedition. Support for the research of the investigators and graduate students came from a variety of sources, including the NOAA Sea Grant Program, the National Science Foundation, NSERC, the NOAA VENTS Program, and MBARI (the Monterey Bay Aquarium Research Institute). More than 200 samples were collected, 40 experiments were deployed (most for a year deployment), and 15 experiments were recovered during the 252 hours (over 21 dives) of bottom time with ROPOS. The extraordinary amount of bottom time (about 100 hours more than an equivalent length submersible dive program) allowed the entire scientific party to participate in a careful exploration of the new eruption site and the other hydrothermal systems on the summit of Axial Volcano.

1.0.2 Background

A major focus of the cruise was the NeMO (New Millennium Observatory) project. The primary goal of NeMO is to investigate the effect of dike intrusions and eruptions on the chemistry and micro- and macrobiology of hydrothermal systems (Haymon et al., 1993; Holden et al., 1998; Tunnicliffe et al., 1997; Butterfield, 1997; Delaney et al., 1998). NeMO was conceived in 1996 as a multiyear effort to perform chemical, biologic, hydrographic (plume), and geologic time series studies of Axial Volcano on the central Juan de Fuca Ridge (Fig. 1) (Johnson and Embley, 1990). Axial was chosen for this study because: (1) its shallow depth and large mass of Axial Volcano implies a long-term frequency and volume of volcanic activity significantly higher than the adjacent mid-ocean ridge [Baker, 1992 #60], and (2) hydroacoustic monitoring using SOSUS (Dziak and Fox, 1997) and an ocean floor pressure gauge (Fox, 1990; Dziak and Fox, 1997) showed that the summit of Axial is the most seismically active site on the Juan de Fuca Ridge (Embley et al., 1990), and (3) intensive seafloor surveys by camera and submersible in the 1980s showed extensive evidence for recent volcanism and hydrothermal activity at its summit.

The approach of NeMO is to combine baseline in situ sampling and high resolution mapping with continuous monitoring of the hydrothermal systems over several years with the expectation of several magmatic perturbations occurring within that interval. Extensive seafloor investigations using deep-towed cameras and submersibles took place in the 1980s (CASM, 1985; Johnson and Embley, 1990) and renewed investigations in 1995-97 provided an excellent baseline for the NeMO program. The continuous monitoring aspect of NeMO reached a critical level by 1997, when the instrument suite was expanded to three complementary components: (1) Volcano System monitors (VSMs) to measure vertical crustal motion and seismic tremor, (2) an array of current meter/temperature recorder moorings along the shallowest portion of the south rift zone within the caldera, and (3) deployment of an array of acoustic extensometers (from the R/V Sonne in 1996) capable of recording horizontal strain over a 400-500 meter distance across the north rift zone (Fig.

2). Long-baseline-navigated towed camera surveys and CTD casts and tows from the Sonne (P. Herzig, Chief Scientist) in 1996 and the Brown in 1997 (G. Massoth, Chief Scientist) and several dives with ROPOS in the caldera in 1997 (V. Tunnicliffe, Chief Scientist) provided important baseline data and set the stage for the extensive surveys and sampling planned for NeMO-98.

On January 28, 1998, an intense earthquake swarm lasting 11 days began on the summit of Axial. Migration of the seismicity 50 km southward during the first few days revealed the similarity of the event to Icelandic and Hawaiian diking/eruptive events (Dziak and Fox, 1998). After the first two days, virtually all of the events located either on the southwestern part of the summit or at the extreme end of the southern rift zone. In mid-February, a rapid response cruise on the Wecoma by NSF and NOAA investigators (J. Cowen, Chief Scientist) found enormous increases in the hydrothermal discharge from the summit of Axial (Baker et al., 1998). In July, 1998, Alvin made four dives into the caldera during a combined NSF and NOAA effort (J. Cowen, Chief Scientist), confirming an area of new hydrothermal activity within a zone of young lavas in the SE part of the caldera. The Brown completed an extensive plume survey in early August and recovered one VSM (Volcano System Monitor) and two of the three temperature sensor moorings deployed in 1997. Temperature data from two of the water column moorings (Fig. 3) recovered by the Brown showed a large heat pulse coincident with the onset of the earthquake swarm and a pressure gauge on the VSM recovered from the center of the caldera showed a 3 meter subsidence of the seafloor (Fox, 1998). The high probability of a summit eruption indicated from these data set the stage for NeMO-98.

1.0.3 New Eruption Site

Much of the bottom time was used to investigate the eruptive site of a new lava flow in the southeast portion of the caldera which erupted along a fissure system at least 3 km long (Figs. 2 and 3). We had an excellent, state-of-the-art set of tools on ROPOS to accomplish this. These included: (1) an in situ chemical scanner (SUAVE) which measured Fe, H2S, Mn, light scattering, and temperature, (2) a suction device primarily used for taking up to 8 samples of unconsolidated material such as microbial mats, meiofauna, and vent animals, (3) a new vent fluid sampler capable of taking as many as 18 water and particle samples for chemical and microbiological analyses, (4) a pencil beam scanning sonar for detailed mapping, and (5) a 3 chip RGB pan/tilt/zoom video system.

A large percentage of the surface of the lava flow was coated with a brown to tan microbial mat which masked the glassy surface of the new flow and caused some initial uncertainty about the age of the lava. The very recent age of this lava was eventually verified by the partial burial of a seafloor instrument (see below) and a line from a navigation transponder mooring that had been deployed in the summer of 1997. The eruption was in the form of a drained-out sheet flow, in contrast to the (primarily) pillow lava erupted during previously monitored NE Pacific eruptions. Sheet flow morphology is thought to be caused by a higher effusion rate, which is consistent with the enhanced magma supply at Axial. High resolution surveys with the downward-scanning sonar revealed that the source of the eruption was an en echelon series of north-south collapse depressions characterized by lava spires and floored by sheet flow. Camera tows and submersible dives in the 1980s and 1990s found numerous vent communities over several kilometers on the southeast part of the caldera where the south rift zone begins near the eastern wall of the caldera. The ROPOS dives showed dramatic changes in the hydrothermal systems on the southeast part of the caldera, most notably the partial burial of the pre-existing vent communities. The eastern part of the lava flow had numerous sites of diffuse venting with extensive white bacterial mats colonized by small polychaete worms and snails (Fig. 3). These sites were devoid of tubeworms except near the eastern edge, where colonization had begun to occur, probably from surviving communities east of the lava flow contact. At one location, dead tubeworms and clams were found partially buried by the lava flow. Farther south, older vent communities still survived just beyond the limit of the new eruption. In one place an older lava drainout area had been penetrated by the new lava. Here, old tube worm communities barely survived on top of lava spires or were dying or dead after the spires had been toppled, possibly by the impinging lava flow and associated seismic activity.

Accompanying the eruption was an intense microbial bloom that was still ongoing in August/September, seven months following the event. A dramatic manifestation of the bloom was the production of large

amounts of white floc, which filled shallow cavities in the lava flow and flowed out in large amounts when the seafloor was disturbed.

1.0.4 Mooring Searches

ROPOS recovered five "prototype extensometer" (PE) instruments (Chadwick et al., 1995), via an elevator mooring. The PE instruments had been recording acoustic range data since they were deployed across Axial's north rift zone in June 1996, at a site about 4 km north of Axial caldera (Figs. 2 and 4). These data (which are still being analyzed) will show any horizontal strain along the north rift zone caused by the dike injection to the south. During the last ROPOS dive of the NeMO98 cruise four PE instruments (the fifth instrument had not worked) were redeployed near the same location across Axial's north rift zone for another year of continuous strain monitoring. Arrays of these instruments are planned for both north and south rift zones over the next several years.

Another role for ROPOS was a search for two seafloor instruments deployed in 1997 that could not be recovered during a previous attempt by the Brown in early August. A current meter/temperature monitor mooring had not responded to acoustic commands and one of the VSMs ("Rumbleometers") confirmed a release from the deployment weight but subsequent ranging indicated that it remained on the seafloor. ROPOS located this VSM by acoustic ranging (Dive R461) and a careful survey of it revealed that it was apparently overcome by flowing lava which had prevented the package from floating free of its deployment weight (Fig. 3). Subsequent attempts to pry it loose with the ROPOS manipulator (Dive R461) and pull it free with a line attached to the cage (Dives R474 and R477) were unsuccessful. An extensive search for the missing water column mooring on R460 and R461 failed to locate it. A bottom search with ROPOS at the deployment location of the mooring base (R477) revealed that new lava covered the site, so it seems likely that the mooring base was overrun by the lava flow, possibly resulting in the release of the mooring.

1.0.5 Seafloor Experiments

ROPOS deployed short-term and long-term experiments (Fig. 4). Several types of experiments were deployed for a year duration at the eruption site. These include: (1) two osmotic fluid samplers, (2) a time-lapse camera, (3) five temperature probes, and (4) several microbial mat collectors. The camera, one of the osmotic samplers, a temperature probe, and several microbial collectors were placed at the Marker 33 site, at which the highest flow rate was observed and the highest temperatures recorded. A short-term osmotic sampler was deployed and recovered from the same site as the long-term experiments. These experiments complement additional NOAA instrumentation emplaced before and after the ROPOS cruise. A replacement VSM was deployed at the eruption site in early August from the Brown. Following the ROPOS cruise, nine water-column moorings were deployed in and around the caldera from the Brown. These moorings include temperature sensors, optical sensors, and current meters to monitor the hydrothermal plume discharge for the next year. Finally, data from a year-long array of ocean bottom seismometers (beginning in July, 1998) at the summit of Axial by Scripps scientists in July 1998 (R. Sohn, S. Webb, and W. Crawford) should provide very valuable correlations between subsurface activity and effects on the hydrothermal system as recorded on the mooring and the in situ experiments.

1.0.6 Studies of ASHES and other Vents

The ASHES high temperature vent field in the SW portion of the caldera (Butterfield et al., 1990)(Figs. 2 and 5) was also extensively surveyed and sampled by ROPOS. It is not yet clear whether the 1998 diking event induced significant changes at ASHES vent field, but detailed analyses of the chemical samples will reveal any major changes induced since the last sampling effort in 1995. Several temperature probes deployed at both diffuse flow and high-temperature sites were left and will be recovered in the summer of 1999. A short-term osmotic water sampler was deployed and later recovered from a high-temperature site and several microbial mat collectors were left in place until 1999.

ASHES was also the focus of detailed studies of the macrofaunal communities. Intensive studies of the ecology of the tubeworm and polychaete communities at this site used a combination of video observations, chemical scanning, and sampling to better understand the relationships between chemistry, temperature, and biology. ASHES has been the focus of more than a decade of studies of the macrofaunal communities and continues to be an important study site for hydrothermal ecology.

Other long-term venting sites in and near the caldera visited and sampled by ROPOS included the CASM site (CASM, 1995) located at the northernmost end of the caldera near the intersection of the caldera wall and a small diffuse vent about 5 km north of the caldera along the north rift zone. The chemical and biological samples taken during these dives will establish a firm baseline for future magmatic perturbations occurring on the north rift zone.

1.0.7 Other Operations

Between dive operations included rock coring and CTD operations. These operations provided valuable additional data about Axial Volcano and used the valuable shiptime with maximum efficiency. The rock coring program concentrated on the South Rift Zone. Very few previous basalt samples had been collected from this site, and extensive analyses of these samples will help put the chemistry of the 1998 eruption into better regional context. The CTD program represented a continuation of the post-eruption plume time series begun in February.

1.0.8 Outreach

A web site (http://www.pmel.noaa.gov/nemo_cruise98/) was updated (A. Bobbitt) on a daily basis with transmissions of still images, an occasional video clip, and descriptions of the latest results. A secondary school science educator (G. Williamson) provided material to a complementary shore-based educator (Mike Goodrich), who then gave daily public lectures on the seagoing activity at the Hatfield Marine Science Center Public Wing and publicized the web site to the educational community. This program will continue in 1999 with Sea Grant funding (V. Osis and W. Handshumaker).

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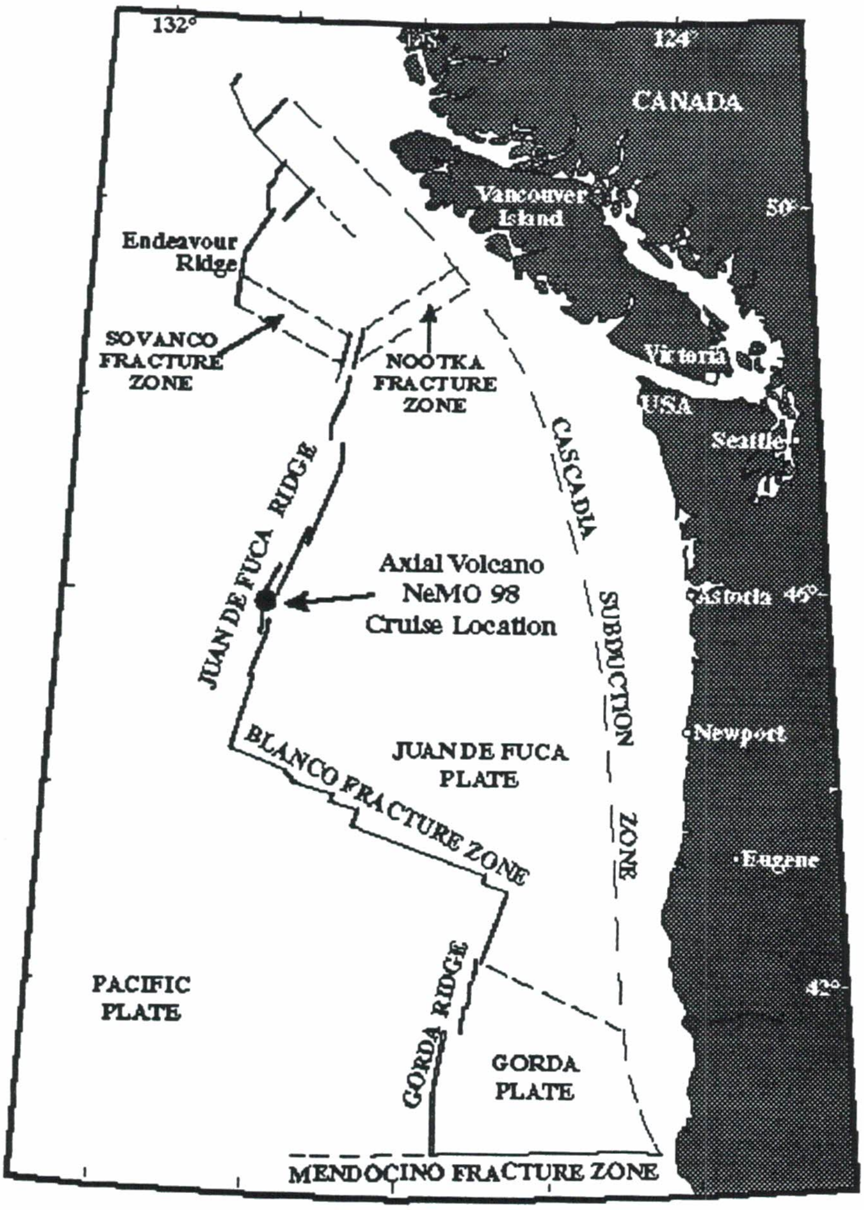

132°
128°
124°
CANADA
Vancouver Island
50°
Endeavour Ridge
SOVANCO FRACTURE ZONE
NOOTKA FRACTURE ZONE
Victoria
USA
Seattle
CASCADIA
JUAN DE FUCA RIDGE
Axial Volcano
NeMO 98
Cruise Location
Astoria 46°
SUBDUCTION
Newport
JUAN DE FUCA PLATE
BLANCO FRACTURE ZONE
ZONE
Eugene
42°
PACIFIC PLATE
GORDA RIDGE
GORDA PLATE
MENDOCINO FRACTURE ZONE

Figure 1

APPENDIX XVI

DEEP TOW GROUP

SEAGOING OPERATIONS 1997-1998

- SIDESCAN SURVEY & BOTTOM PHOTOGRAPHY OF CORTES-TANNER BANKS (June 1997)
- SINKEX SEDIMENT SAMPLING AROUND A SHIP WRECK (Aug. 1997)
- OSN-1 INSTRUMENTATION DEPLOYMENT (Jan-Feb 1998)
- NEAR-BOTTOM MAGNETICS & SIDESCAN SURVEYS (Apr-May 1998)
- OSN-1 INSTRUMENT RECOVERY & DOWN HOLE LOGGING (June 1998)

DEEP TOWED GRAVITY METER
(MAY 1998)

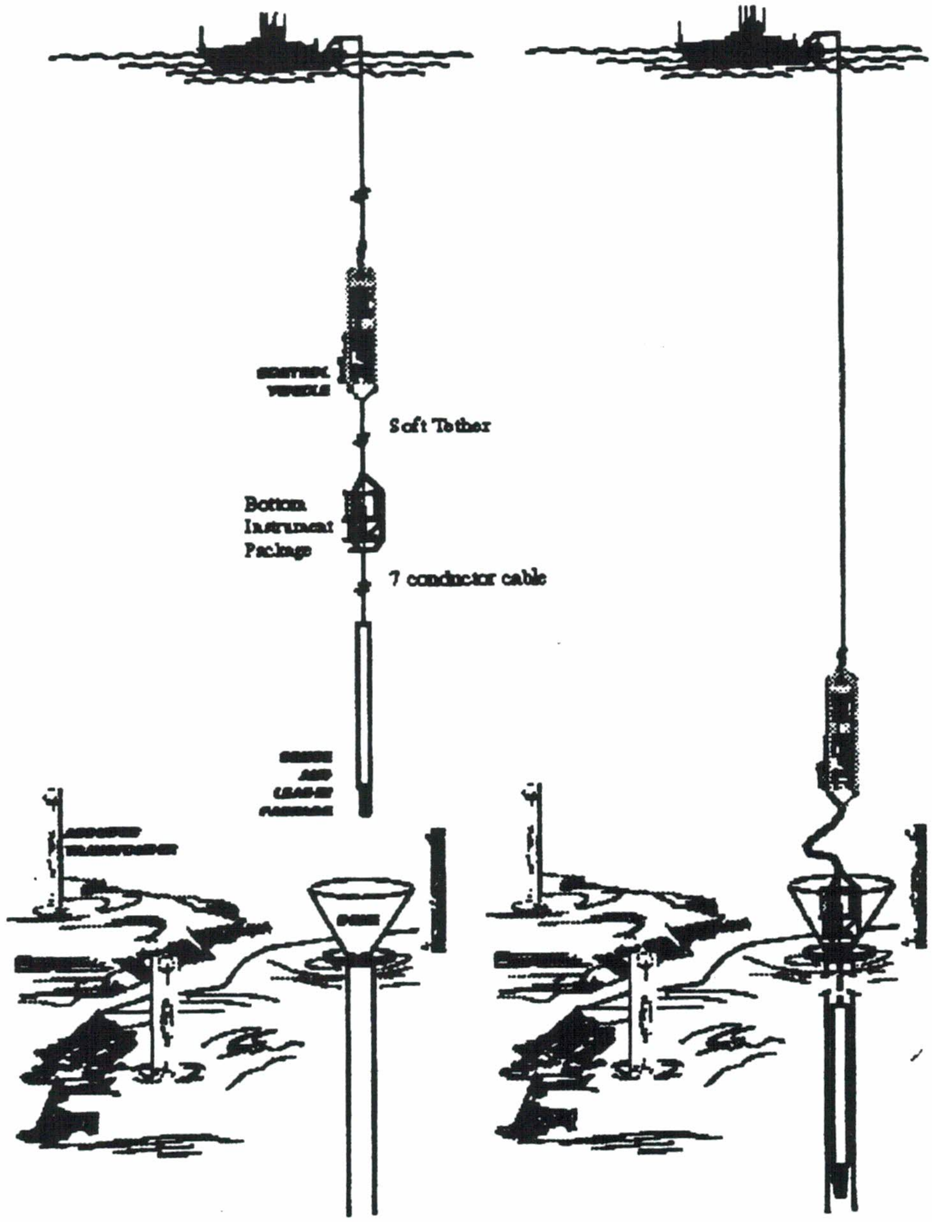


Figure 1-3: This schematic diagram shows the configuration of equipment used in a wireline deployed borehole seismic system (left). On BSS3 the borehole package is a single sonde consisting of the lead-in package, with a navigation transponder, lights and camera for re-entry, as well as the three component broadband seismometer. Telemetry, control, data acquisition and data recording electronics and batteries are housed on the Bottom Instrument Package (BIP). The Control Vehicle (or thruster) is used to maneuver the sonde into the borehole. One advantage of this system over other ocean bottom seismometers is that the the ship remains tethered to the seafloor system after deployment and data can be acquired on board ship prior to releasing the tether (right). After release of the tether the acquisition system on the BIP records continuous seismic data for over three months.

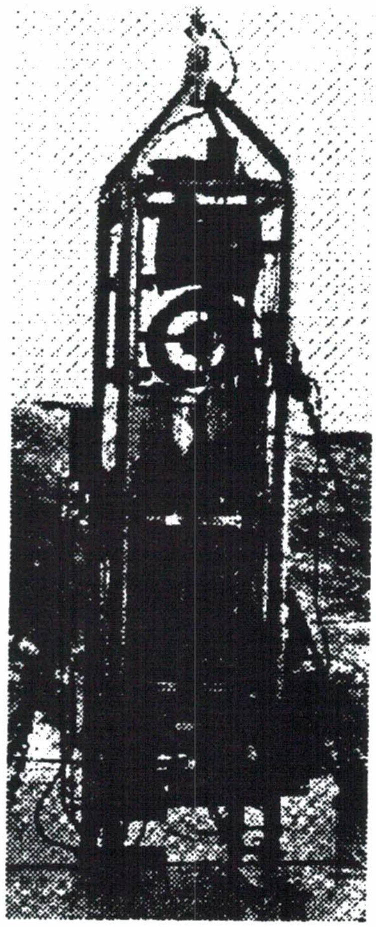


Plate 4a: The Control Vehicle (CV) contains thrusters, up and downlooking sonar, a navigation transponder, and telemetry electronics.

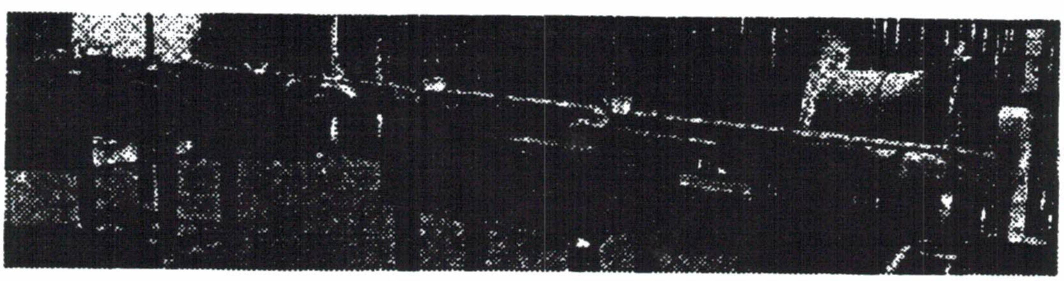
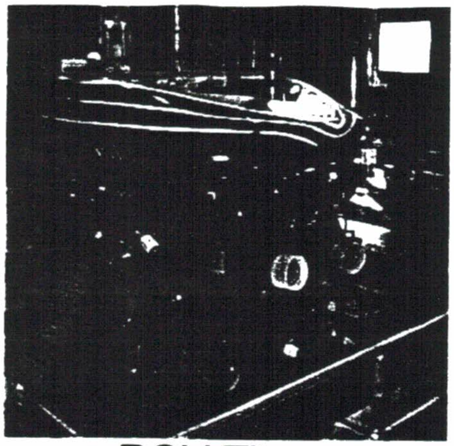


Plate 4b: The logging probe contains a camera, lights, navigation transponder, two calipers, and pressure and temperature transducers.

APPENDIX XVII



ROV Tiburon

M B A R I

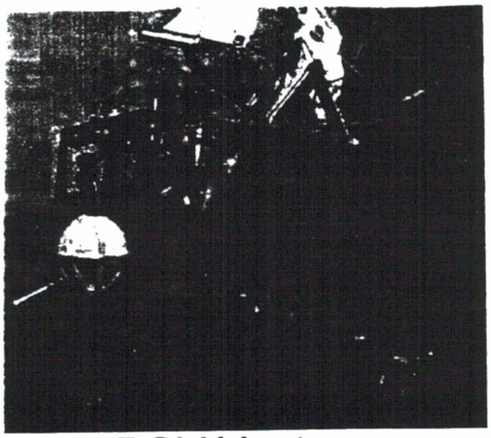
Monterey Bay Aquarium Research Institute
P.O. Box 628 Moss Landing, CA 95039-0628
Division of Marine Operations
voice: (831) 775-1900; fax: (831) 775-1652
www.mbari.org

The ROV Tiburon is an integrated, unmanned submersible, developed at MBARI. Tiburon is deployed and operated from MBARI's SWATH research vessel, R/V Western Flyer.

Personnel: maintained by 5 pilot/ technicians; generally flown by 2-3 pilots
Cost: $16499/day (ship+vehicle+personnel, 1998)
Operational Days: Operational for extended duration cruises (3 days or more)
Bottom time: Dependent upon mission & location. Most operational days include one dive which can last up to 10 hours.
Standard Equipment/Upgrades/Configurations:
Maximum depth: 4000 meters (13,123 feet); Minimum operating depth: 200 meters (656 feet)
Forward speed: 1.5 knots (maximum with no tether drag), 0.25 knot (at 4000 meters)
Vertical speed: Descent: 50 meters/minute; Ascent: 25 meters/minute
Vehicle weight: Tiburon + toolsled maximum: 3356.6 kg (7400 lbs.)
Maximum toolsled weight: 499 kg (1100 lbs.); Maximum toolsled weight in salt water: 204 kg (450 lbs.)
Variable buoyancy capability: 68 kg (150 lbs.); Adjustable at 2.27 kg/minute (5 lbs/minute)
Total power available: 15 kW
Thruster motors: 6 @ 3.7 KW (5 HP); Thrust: 978.56 N (220 lbs.) each motor
Voltage: 240 VDC (±15%) high; 48 VDC (±15%) low
Electrical Power: 20 Amps @ 250 volts (5 KW)
Communications: RS485 serial bus, RS232c, Ethernet (802.3)
Hydraulic Power: 13.25 L/min (3.5 gal/min) @ 17,237 kPa (2500 psi)

Hardware and software features summary:
- Mission-specific toolsled packages—benthic and midwater
- Precision manipulator arm
- Integrated scientific sensors and data logging
- Internet compatible data transmission and user displays
- Control room displays
- Adjustable high resolution video cameras with coordinated lighting
- Stationary video cameras and lights
- Video recorder (Digital Betacam)
- Fiber optic telemetry
- Electric thrusters for precise control, high thrust levels, and quiet operation
- Variable buoyancy system for low-disturbance operation at all depths and during sampling operations
- Equipped to deploy tools and collect samples
- Provision for placement, servicing, and retrieval of instrument packages
- Electric and hydraulic power available for equipment not normally part of the ROV

Instrumentation summary (partial):
- High resolution color video with zoom, high accuracy; Pan and tilts; HMI lighting
- Acoustic Doppler Speed log; Altimeter (echo sounder); Imaging sonar; Hydrophones
- Conductivity; Temperature; Pressure; Dissolved Oxygen; Transmissometer
- Manipulator arm



ROV Ventana

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ROV Ventana was built for MBARI by International Submarine Engineering. The vehicle was delivered in 1988 with a standard suite of instruments and cameras. Data collection sensors, a high quality Sony DXC3000 camera, and animal collection devices were added immediately. The **ROV Ventana** is deployed and operated from MBARI's Research Vessel Point Lobos.

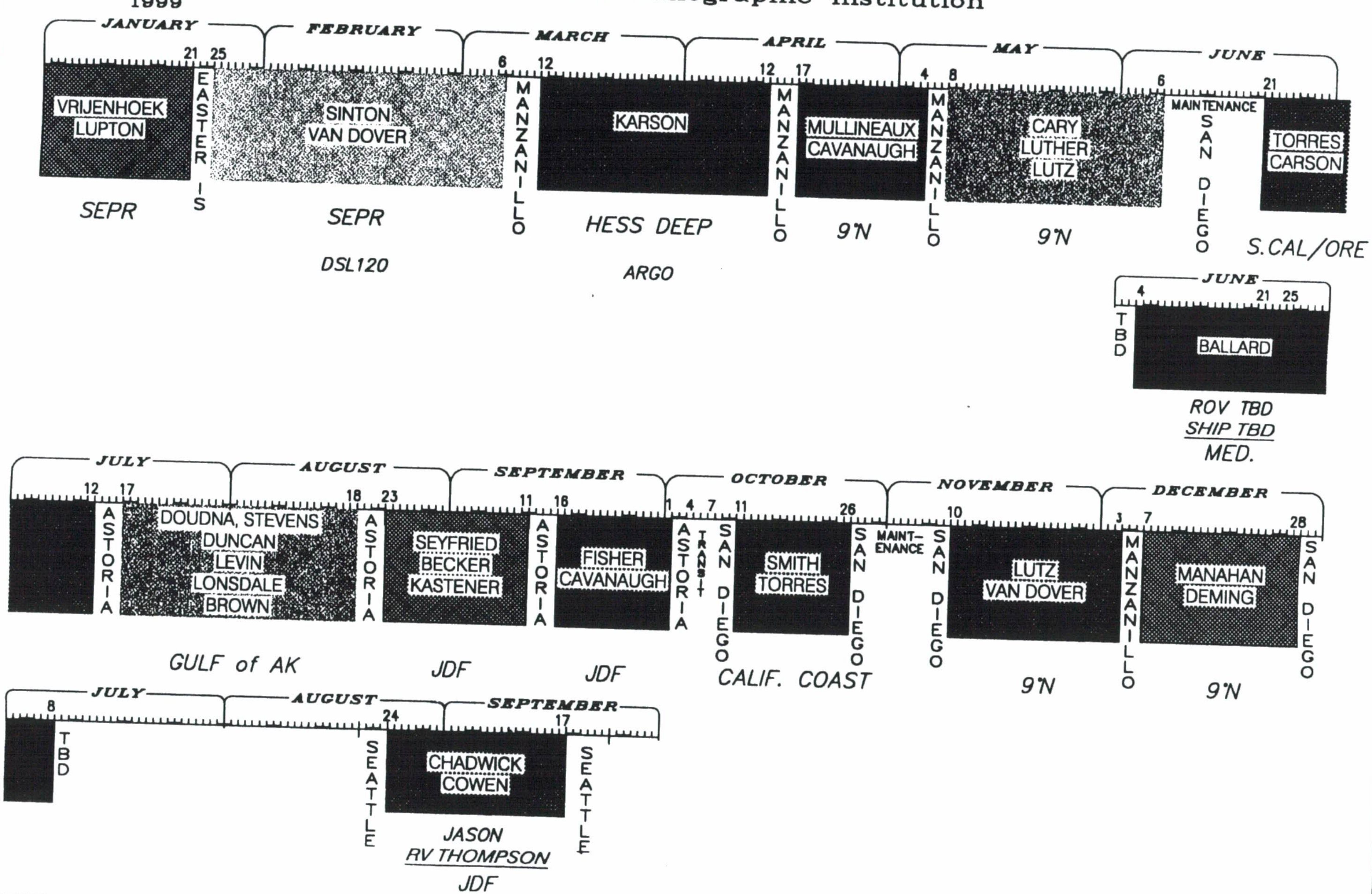
<u>Personnel:</u> maintained by 5 pilot/ technicians; generally flown by 2 pilots
<u>Cost:</u> $7738/day (ship+vehicle+personnel, 1998)
<u>Operational Days:</u> average 4 missions/week
<u>Bottom time:</u> dependent on mission & location - most operational days include two dives, ~2-3 hours ea.
<u>Standard equipment/Upgrades/Configurations:</u>
ROV Ventana's control system consists of three major components: Main control computer (rack-mounted 486 Intel) running Control System Probe (CSP) connected to an embedded controller (68000 Motorola) on the vehicle, also running CSP. Camera control graphical user interface (GUI) and lap controller station and single board computer (SBC) to drive the main camera. Toolsled GUI interconnected to the camera lap controller and an SBC to drive the toolsled power controller. Controls for the camera and the toolsled were developed at MBARI .Communication is achieved by use of local area network (LAN), multiplexed serial port technology, and analog interface. The various signals are driven down the fiber using lasers.
Vehicle dry weight: 2,338 kg. (5,150 lbs.)
Benthic toolsled: dry 157 kg (346 lbs.); full of water 236 kg (520 lbs.)
Coring sled: 318 kg (700 lbs.)
Midwater sled: dry 190 kg (420 lbs.); full of water 318 kg (700 lbs.)
Configurable ballast c/w benthic sled: 170 kg (375 lbs.)
Power and propulsion: 40 hp Franklin Electric Motor 2300 VAC; 1 Rexroth A10V-25 hydraulic pump;
6 thrusters: 2 Rexroth A2F/ISE nozzle; 4 Volvo F11-10/ISE nozzle;
2x5 servo valve manifolds; Atchley 240 (thrusters & auxiliary); Atchley 139 (manipulator);
3x8 station 4-way hydraulic valves (manipulator, sampler, P&T, auxiliary)
8 kW hotel power (3.4 kW lighting, 3.5 kW science use, 1.1 kW system)
Tether: 2100 meter umbilical; 5 x #12 power conductors; 8 multimode fibers
Altimeter: Mesotech Echo Sounder 807
Depth Sensor: Paroscientific 8B2000
Gyro: Humphrey Directional Gyro DG04-0138 (North Seeker)
Pitch & Roll: Sperry Accustar
Lights: 4x DSPL Daylight Lamps 400 watts; 4x DSPL incandescent Lamps 500 watts; 2x Aux Lights to 500 watts
Sonar: UDI Sonarvision 4000 500 kHz/200 kHz; USBL (Ship to ROV): Ferranti ORE Trackpoint II Responder to 3000m; USBL (ROV to Beacon): Sonardyne Homer Pro 4000m capable, 400m range(LOS)
Speedometer: Savonious Rotor/MBARI Electronics
Camera Systems: Sony DXC3000 3 chip Camera c/w Fujinon Zoom Lens f1.7 5.5 -47mm; 3 x Deep Sea Power & Light MSC2000 Pencil Cameras Lens f4 3,5mm; SGI Video Capture System (direct from RGB Sony Feed); Sony Betacam BVM30 Video Recording; Dynair 30 X 30 Video Switch (ROV control room); MBARI/Maxim 8 X 4 Programmable Video Switch (subsea); 2 X 4 STC Analog Video to Laser Multiplexers.

APPENDIX XVIII

Deep Submergence Group

1999 ALVIN & ROV OPERATIONS

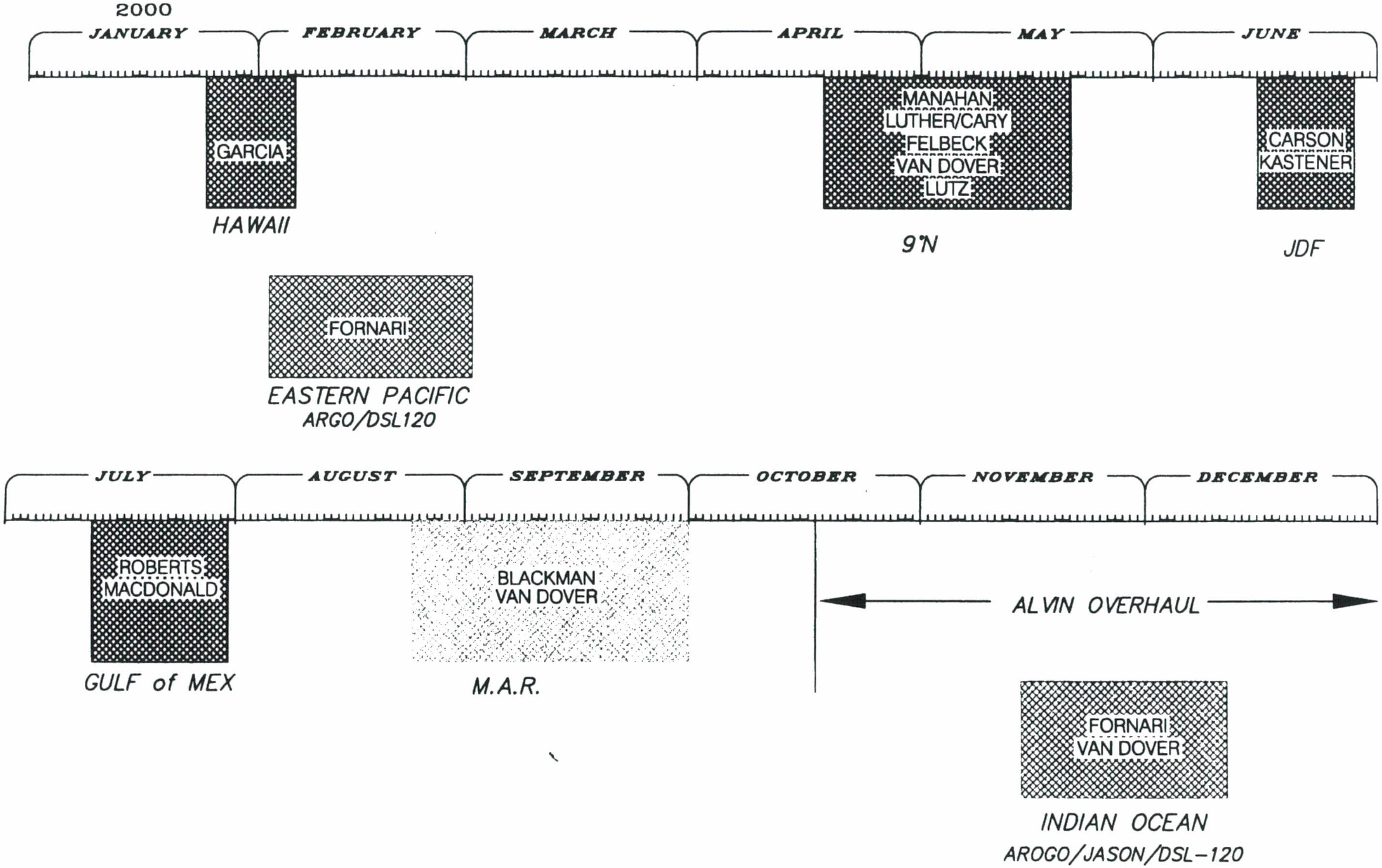
Woods Hole Oceanographic Institution



Deep Submergence Group

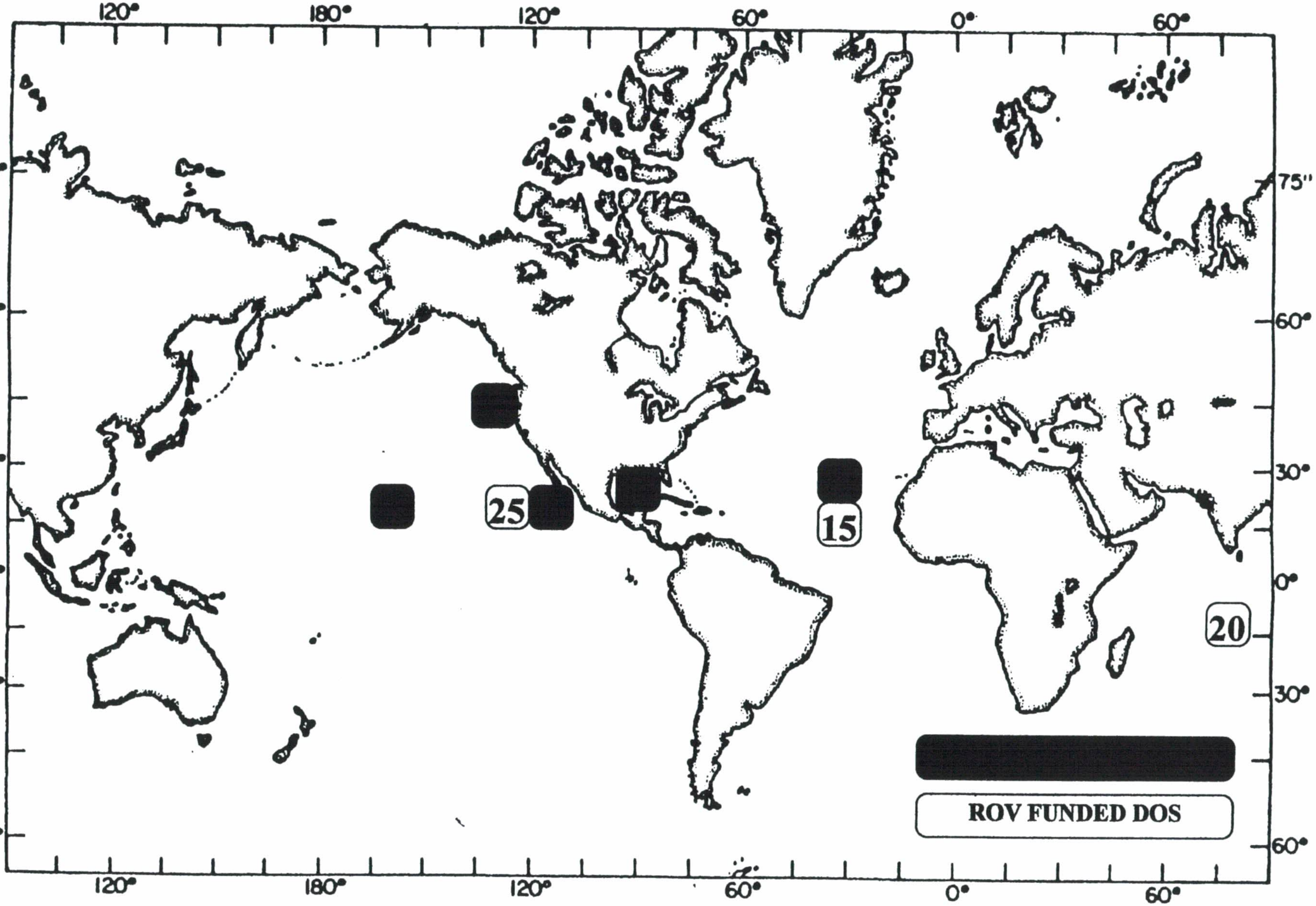
2000 ALVIN & ROV OPERATIONS

Woods Hole Oceanographic Institution

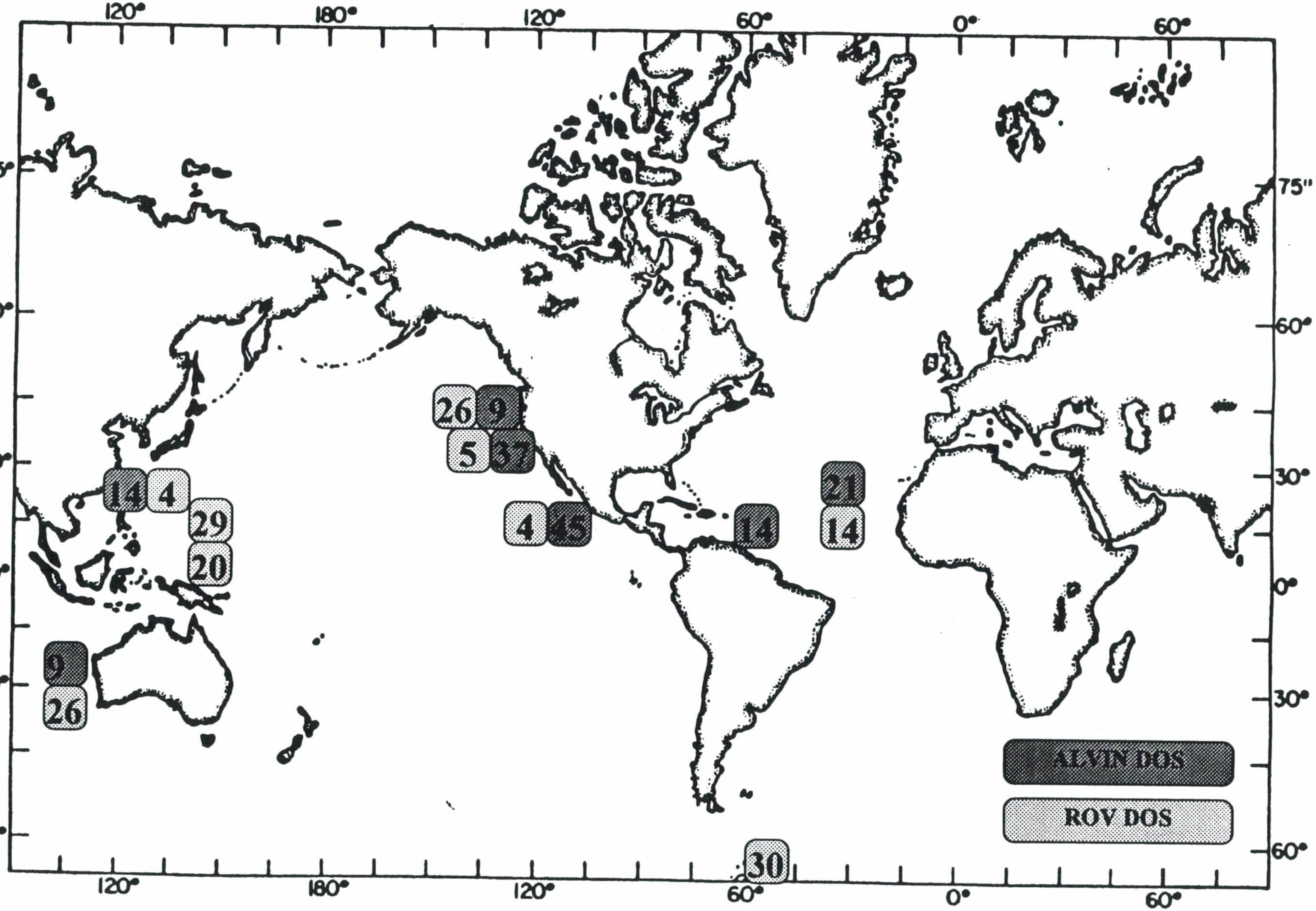


APPENDIX XIX

SUMMARY OF ALVIN & ROV FUNDED DAYS ON STATION: 2000 and Beyond



SUMMARY OF ALVIN & ROV PENDING REQUESTS: 2000 and Beyond



2000 and BEYOND:								
FUNDED ALVIN and ROV Programs (These programs have not been scheduled)								
Year	PI	ALVIN	Jason	Argo II	DSL-120	DOS	Funded	Sponsor
Mid-Atlantic Ridge								
2000	Blackman	14	10		5	25	yes	NSF
1999	Rona	20				21	yes	NSF
		34	**10**	**0**	**5**	**46**		
Gulf of Mexico								
2000	MacDonald	10	or 10			10	yes	MMS
		10	**0**	**0**	**0**	**10**		
Juan de Fuca								
2000	Carson	3				3	yes	NSF-ODP
1999	Embley		20			20	yes	NOAA
1999	Rona		10			12	yes	NSF
2000	Kastner	5				5	yes	NSF
		8	**30**	**0**	**0**	**40**		
Northern East Pacific Rise								
2000	Cary	16				16	yes	NSF
2000	Felbeck	6				6	yes	NSF
2000	Lutz	46	or 46			48	yes	NSF
2000	Lutz *	23				23	yes	NSF
2001	Manahan *	8				15	yes	NSF
		99				**108**		
<u>OTHER AREAS</u>								
Black Sea + Med Sea								
1999	Ballard		21	21	21	21	yes	ONR✓
Hawaii								
2000	Garcia	12				12	yes	NSF
Indian Ocean								
1999	VanDover/Fornari		11	6		20	yes	NSF
Other Area Totals		**12**	**32**	**27**	**21**	**53**		
TOTAL FUNDED		**163**	**72**	**27**	**26**	**257**		
* Time Series Programs								

Requested Program (not funded)

2000 and BEYOND:									
Requested (not funded)				ALVIN and ROV Programs					
Year	**PI**	**Vehicles**				**Days on**	**Funded**	**Sponsor**	**Scheduled**
		ALVIN	**Jason**	**Argo II**	**DSL-120**	**Station**			
Mid-Atlantic Ridge									
2000	Chave	8				8		NSF	
2001	Chave	6				7		NSF	
2000	Michael	10	10			28			
2000	VanDover	5				5		NSF	
		29	**10**	**0**	**0**	**48**			
Juan de Fuca									
2000	Gregg	9				9			
2000	VanDover	6				6		NSF	
		15	**0**	**0**	**0**	**15**			
Off California									
2000	Lonsdale	13		5		19			
2002	Thistle	24				24			
		37	**0**	**5**	**0**	**43**			
Northern East Pacific Rise									
2000	Kim	14				14		NSF	
2000	Tolstoy		4			4		NSF	
2000	VanDover	5				5		NSF	
2001	VanDover	5				5		NSF	
2001	VanDover	6				6		NSF	
2000	Van Damm	7				7		NSF	
2001	Van Damm	24				24		NSF	
		61	**4**	**0**	**0**	**65**			
<u>OTHER AREAS</u>									
Barbados									
2000	Schmitt	10				14			
Mariana Trough									
2000	Clift		13	10	6	29		NSF	
Off Western Australia									
2000	Orange	9	15		11	38		NSF	
Southern Taiwan									
2000	Reed	14			4	18			
New Guina - Huan gulf									
2000	Silver		30			20		NSF	
Antarctic									
2000	Lawver		30	30	30	30		NSF	
Other Area Totals		**33**	**88**	**40**	**51**	**149**			
TOTAL REQUESTED*		**175**	**102**	**45**	**51**	**320**			