HAWAII UNDERSEA RESEARCH LABORATORY

QUICK LOOK REPORT MISSION NO. P5-402

MISSION STATUS

Location:	Pele's Pit
Mission Date:	17 October 1998
Maximum Depth:	1300 m
Project Title:	Lo'ihi Underwater Volcanic Vent Probe
Principal Investigator:	Dr. Arthur L. Lane w/ Prof. Gary McMurtry (UH)
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Observer 2:	
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Scientific Data Acquired: Prepare an abstract outlining your objectives, techniques, findings, etc.

Objectives:

To develop a probe containing a near-field imaging system capable of operating within oceanic underwater hot vents at temperatures of up to 400°C and pressure depths of 2000 m. Probe to also contain a temperature measurement system to obtain simultaneous temperature of areas being imaged, as well as providing temperatures of critical internal electronic components. Other principal objective is to develop and understand approaches to implementing real-time in-situ physical and chemical measurements which a scientist/observer can use to make decisions that optimize the information return of each dive activity.

Techniques:

For the 402 dive the probe contained a video-rate CCD imager in the cool temperature zone coupled to a coherent imaging fiber optic bundle that connected the hot probe tip region to the cool CCD zone. The bundle contains about 1.88 M individual fibers which delivers a high spatially resolved image plane to the camera. Illumination is provided by a set of blue, green, orange and red super-luminous LEDs located in the cool zone and piped to the hot tip imager region by individual fused

silica optical fibers. A single, larger core fiber (1 mm diameter) connects to a quartz-halogen bulb for additional broadband illumination of the area to be imaged. The imaging and temperature data are displayed and recorded inside the Pisces. Command and control go from the scientist/observer to the instruments via direct umbilical connections.

Results/Findings:
A full system test was performed after integration of the probe into the Pisces basket container. Full functionality was obtained, with all components performing as expected.

During descent and travel to the first site, illumination system was tested. LEDs operated, but current draw limits within the Pisces set an upper bound on quartz-halogen drive current to about 6 amps; desired 10 amps because optical output increases almost exponentially with current. External 250 w Pisces lamp used to illuminate probe and front of sub; that light was detected in the imager, including 'bright-spot' glare. Temperature sensor in the probe tip matched that measured by the Pisces temperature wand in the ambient water. The other temperature sensors responded nominally.

First deployment of probe at upper jet vent site, marker 15: Time from ship release > 1hr. Camera powered on, but it was difficult to distinguish features in the images. Saw water spots and moisture film on images. Temperature system seemed ok; recorded 80°C, less than that recorded by the Pisces wand thermometer probe. But JPL probe has significant metal bulk mass and was not inserted to full depth that Pisces probe attained.

On second deployment, saw what appeared to be water rising over imaging lens as JPL probe was moved from horizontal to vertical position. Review of recorded images after dive confirmed this interpretation. Estimated that by +2 hr into dive, vertical water depth in probe shaft was between 15 and 20 cm. Turned off system to prevent electrical shorts.

Probe inspected after recovery (in water over 9 hrs). Inspected about 2 hr after recovery. No obvious leakage problems; imaging window was intact with no cracks. After wipedown, noticed two small 'tears' forming at location of 2 of the 17 optical fiber penetrations into the illuminator feedthru flange. Further inspection showed slow droplet formation continuing there, and not elsewhere on probe surface. Removal of probe tip released internal pressure and about 3 liters of water flowed from probe interior. Further inspection of the fiber optic feedthru assembly and window area will be performed under high power microscopes at JPL to determine nature of leakage path.

MISSION EVALUATION:

Limitations, failures, or operational problems noted:

1). Probe shaft apparently had minute leakage paths in two of the 17 illumination optical fiber delivery penetrations through the stainless steel interface plug. These were not detectable by inspection, but might have been detected by a vacuum-technique helium leak check. The leakage apparently caused the probe to fill with seawater over a 4+ hour interval.

2). Need more current capability within the Pisces to support present and future equipment concepts in which on-board command, control and data analysis are part of in-situ exploration approach.

3). Need ability to not only pressure test hardware at UH, but be able to electrically run experiments and receive data during testing.

4). Basket carriage support failed during Pisces recovery in a heavy-sea condition. Lost two water sample bottles which presumed fell to ocean floor -- might be recoverable in the future.

Recommendations for corrective action or improvement:

1). Next probe will have all wall penetrations helium leak-checked before and after testing.

2). Examine more closely proposed experiment operational needs and re-arrange power/circuit breaker layout to provide a better separation of experiment and Pisces operational power requirements.

3). My understanding is that this testing capability for running instruments during pressure testing is recognized and will be implemented soon.

4). Have Pisces operational team look ahead to the future when the potential for more significant in-situ exploration is possible with a wide variety of new instrumental techniques. There is a need for high bandwidth fiber optic data links from exterior environment into Pisces for utilizing these interactive, realtime anlaysis instruments. Also begin to consider a development pathway to higher communication/data rates to the surface vessel.

In your opinion, did the mission essentially achieve its purpose? Compare actual work accomplished with the work that was expected to be accomplished.

Yes, purpose was mostly achieved. Demonstrated that a system could be developed (quickly) for in-situ imaging studies in an inhospitable environment. Developed a hot-zone imaging capability and a technique for in-vent illumination. The last 10% or so of the task was to acquire a collection of images from within vents -- that was not possible because of the leakage of seawater into the probe. That will be fixed and tested for robustness prior to next dive opportunity. Measurements around several bacterial mats showed temperatures exceeding 110°C -- definitely on the upper edge of known hermophilic extremophiles. A sample was collected on dive 403 for laboratory testing.

List specimens or samples collected on the mission:

Two water bottle samples were acquired during dive for McMurtry & Hilton; unfortunately they were dropped when the basket carriage broke in heavy seas during Pisces recovery.

Dive PS-402

DATA RELEASE

Data may be retained by the project leader for up to 2 years after the mission date with the following exception. NOAA may request to use photos for publication or publicity purposes at any time.

Fill in the appropriate statement below and sign this form.

I hereby release the data archived by HURL for public consumption following mission

Loihi Underwater Volcanic Vent Probe (project title)

held on 17 Oct 98 (date) in the following way:

a. CTD data by 10/21/98 (date)

b. voice transcripts, video, and still camera film by 10/21/98 (date)

c. other 10/21/98 (date)

d. I will give my written consent to individuals wishing to use these data prior to the above dates depending on the nature of the request(s).

Principal Investigator