

A New Deep-sea Towed Digital Camera and Multi-rock Coring System

PAGES 69, 73

Photographs of the sea floor provided some of the first clues about the abundance of life in the deep ocean, lava flows on the mid-ocean ridge crest, and evidence for hydrothermal venting [e.g., *Hersey*, 1967; *Heezen and Hollister*, 1971; *Ballard and Moore*, 1977; *Lonsdale*, 1977]. These direct observations of the ocean floor are critical to understanding the physical, chemical, and biological processes occurring there.

Last year, a team of engineers at the Woods Hole Oceanographic Institution (WHOI), in collaboration with engineers at DeepSea Power and Light (DSPL) of San Diego, California, designed and successfully built and tested a new, digital deep-sea camera and multi-rock coring system. The system has been used during three expeditions thus far: the East Pacific Rise at 9°50'N, the Galápagos Rift at 86°–89°W, and most recently, to the Hess Deep in the equatorial eastern Pacific. To date, it has acquired ~20,000 digital sea floor images and 50 volcanic glass chip samples during 20 lowerings.

Why the Need?

The driving force for developing this system derived from the need in the U.S. oceanographic community for a routine multiple-rock coring system coupled to a deep-sea digital camera that could be used on any UNOLS (University-National Oceanographic Laboratory System) ship or other vessel equipped with standard CTD (conductivity, temperature, depth) winch and cable. While this system provides important capabilities for sampling mid-ocean ridge crests where the terrain is commonly dominated by glassy lava, it can also be used for reconnaissance for a wide range of deep-sea mapping and sampling programs. The system has also been designed to satisfy the need for a rapid-response imaging and sampling capability for studying sea floor sites associated with mid-ocean ridge tectonic and volcanic events (e.g., NSF's Ridge2000 Program; see Web site:

<http://ridge2000.bio.psu.edu>). It provides a method for scientists to accurately determine the location and geological setting of recent submarine volcanic eruptions and associated hydrothermal venting.

Components, Capabilities of TowCam

The new WHOI Towed Digital Camera and Multi-rock Coring System (TowCam) (Figure 1) is an internally recording digital deep-sea camera system that also provides methods for the collection of volcanic glass samples, using six small rock corers and CTD water properties data. The current electronics and frame permit triggering a maximum of 12 corers per lowering. A proposed additional capability will permit small (~2 to 5 liter) Niskin bottles to be triggered by the same system (any combination of corers or bottles up to a maximum of 12 per lowering), thereby allowing samples of both volcanic glass and bottom water to be collected during each lowering.

The TowCam is deployed using a standard UNOLS 0.322-inch, co-axial CTD sea cable, permitting real-time acquisition of digital depth, altitude, and CTD water properties data. These data are used to help tow the system ~5–7 m above the sea floor at speeds of up to $\leq 1/2$ knot, allowing for the quantification of the size of objects in the digital images, and for recording near-bottom sea floor profiles. By operating either at night in between Alvin dives, or in conjunction with high-resolution side-scan sonar surveys, or during other oceanographic programs, the TowCam provides sample collection and photographic information of the sea floor to be recorded for near real-time analysis and planning subsequent submersible dives, or other sampling and surveying.

The WHOI TowCam is rated to operate to a depth of 6000 m, and is powered by four 24VDC, 42 amp/hr, oil-compensated Pb-acid batteries. The digital camera and winch system are each powered by one battery; the other two batteries, connected in parallel, power the deep-sea strobe (Benthos model 383 electronics and two model 386 remote heads, each head capable of 300 watt/sec output). The system can take ~1000

high-resolution (3.3 megapixel) color digital photographs (Figure 2) on each lowering at intervals of 10–60 seconds (longer intervals are possible because the digital camera can also be used for time-lapse imaging). The camera was developed by DSPL (see DigiSeacam product line at: <http://www.deepsea.com>), in collaboration with the TowCam Group at WHOI. Each image is ~0.6–1 Mb in size (depending on content and illumination), and recorded in .jpeg format using a date/time stamp of when the image was acquired as the file name. A WHOI-designed strobe monitor (dubbed the "Flash-bird") is connected to a spare analog port in the SBE25 and indicates when the strobes are fired. The strobe signal is displayed on a laptop computer on the surface ship, and provides real-time verification that the camera is functioning and strobes are firing; a digital record of the time each photograph was taken is also provided.

This system is also equipped with a WHOI-designed electronic interface between the SBE25 CTD and the command module that communicates with up to 12 rock core winches (Figure 1) (the current system has six winch/corer units installed). The winch/corer units permit the user to remotely take discrete glass samples by triggering the CTD deck unit in much the same way as a CTD Niskin bottle is triggered on a rosette system. It is envisioned that sampling sites would be pre-determined based on local morphological features displayed in multi-beam bathymetry, or inferred geological contacts recognized in high-resolution side-scan sonar imagery. When a corer is triggered via the SBE33 deck-unit and command module, the corer winch on the TowCam starts turning, and in so doing, a ~3.5-kg, wax-coated, stainless steel core head is released and free-falls to the sea floor on a ~10-m, 250-pound-test tether. The core head impacts the bottom and is dragged over lava flows as the TowCam continues its traverse, thereby breaking off chips of glass and embedding them in the wax.

Each corer winch is designed to reel up the ~10 m length of tether in approximately 4 min.; however, the amount of time that the core head is actually in contact with the sea floor varies, depending on the altitude when deployed. Nominally, at ~5 m altitude (optimal for imaging a 4.5 m x 6 m area), the core head is in contact with the sea floor for about 1–1.5 min. At a speed of ~1/4 knot, this equates to a horizontal distance traveled of approximately 10 m. When the core head is fully retrieved, a current limiter prevents the winch motor from over-pulling

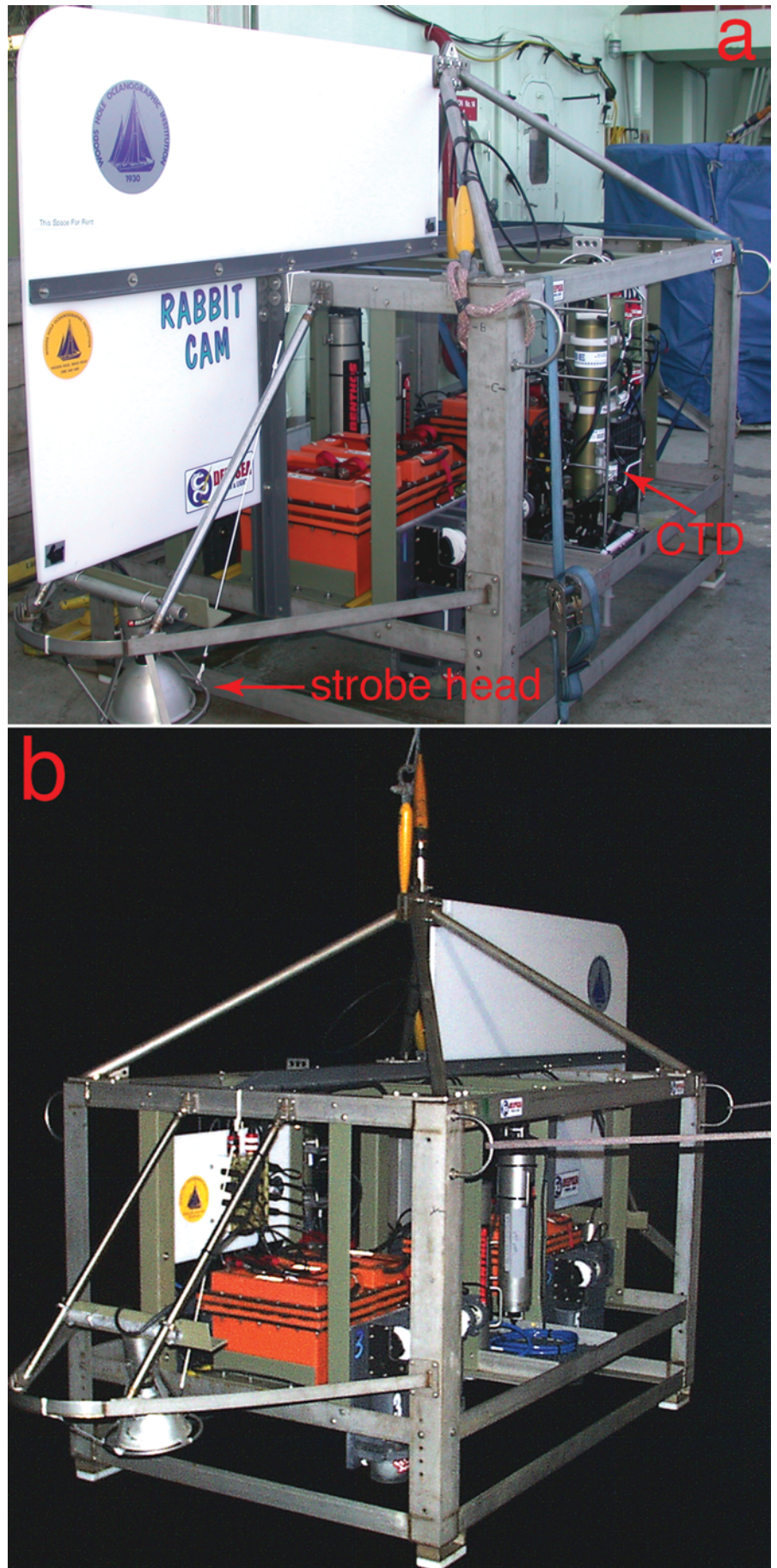


Fig. 1. (a) View from the tail-end of the WHOI TowCam showing placement of strobe heads at either end of the system within the protective framework, and the SeaBird SBE25 CTD. Orange boxes are the batteries. Rock core winches can be seen along right side of frame. Large plastic tail-fin helps stabilize the system as it is towed near the bottom. The digital deep-sea camera is centered within the frame (not visible) just to the left of the CTD, and is ~1.3 m from each strobe. Yellow line near the termination of the coaxial CTD cable is a safety line that is attached to a 3500-kg weak-link; (b) Front-view of the TowCam during night deployment. Four rock core winch units are aligned along the side of the frame. White cylinders on the corer units house the oil-compensated winch motors. Spools on end of each winch are designed to contain the reeled-up tether during recovery of each corer.

and stops the motor. The core head is stowed inside a ~9 cm-diameter, plexiglass tube beneath the core winch, and a mechanical gear-stop prevents it from redeploying. The time of each corer deployment is recorded by the CTD system, and verification of corer deployment is also provided in much the same way that confirmation of bottle firing is recorded during a CTD cast.

Available to the Science Community

The WHOI TowCam may be operated by technicians or scientists familiar with the basic components and experienced in towing near-bottom imaging packages. Complete documentation of the system and its components, as well as "quick-start" sheets for basic operation and maintenance, have been produced and are available as .pdf files. Costs for operation of the system have been tentatively set at \$1,000 per tow. This fee includes all expendables, a per-tow maintenance cost, and archiving of acquired images on CDs for the science party. In addition to the per-tow costs, users should budget for shipping the system to and from the research vessel to Woods Hole, Massachusetts, and over-the-side insurance to cover the ~\$196,000 replacement cost of the system (insurance premiums have been in the range of \$1,000–\$1,500 per month). System operational costs, insurance, and shipping logistics can be provided through WHOI as a subcontract. Interested users should contact Dan Fornari (dfornari@whoi.edu) for details regarding the system, scheduling, availability of seagoing technicians (if required), and cost estimates. Information on the TowCam is available at the Web site: http://www.whoi.edu/marops/support_services/list equip_towed_camera.html.

Acknowledgments

WHOI TowCam Group: Andy Billings, Rod Catanach, Steve Liberatore, Marshall Swartz, Terry Hammar, George Meier, Matthew Gould, Paul Fucile, Ken Doherty, Al Duester, Albert

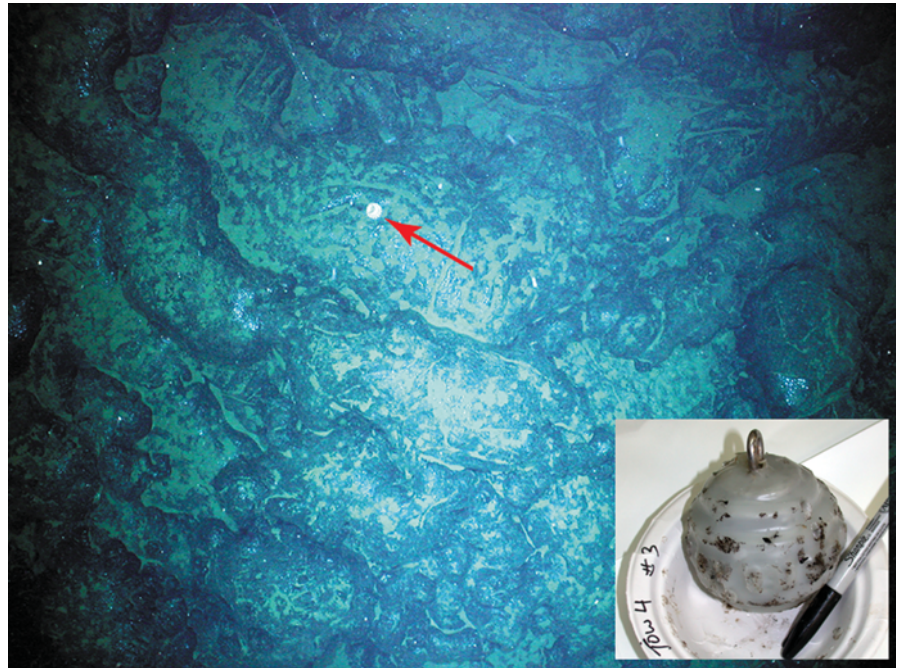


Fig. 2. Sinuous lobate lava terrain on the Galápagos Rift near 86°W at 2454 m depth imaged during Tow #4. Red arrow points to the wax ball that was just deployed. Distance across the image is ~5.5 m. Inset shows the recovered sample.

Bradley, Barrie Walden, Rick Chandler, Rhian Waller, Kate Buckman, and Maryanne Ferreira. Support for the development and construction of the WHOI TowCam was provided by the NSF Oceanographic Technology and Interdisciplinary Coordination Program, Grant #OCE-0097 084. We thank T. Shank and S. Hammond, Chief Scientists on R/V *Atlantis* AT7-13 (Galápagos Rift), and E. Klein and D. Smith, Chief Scientists on R/V *Melville-VANC-01* (Hess Deep) for their use and testing of the TowCam. M. Perfit and J. Goff provided useful comments that improved this article.

References

Ballard, R. D. and J. G. Moore, Photographic Atlas of the Mid-Atlantic Ridge Rift Valley, 114 pp., Springer-Verlag, New York, 1977.

Heezen, B. C. and C. D. Hollister, The Face of the Deep, 659 pp., Oxford University Press, New York, 1971.
 Hersey, J. B. (ed.), Deep-Sea Photography, 309 pp., The Johns Hopkins Press, Baltimore, Md., 1967.
 Lonsdale, P., Deep-tow observations at the Mounds Abyssal Hydrothermal Field, Galápagos Rift, *Earth Planet. Sci., Lett.*, 36, 91–110, 1977.

Author Information

Daniel J. Fornari and the WHOI TowCam Group, Woods Hole Oceanographic Institution, Mass.

Report Provides Roadmap for Improving Understanding of Impacts of Ocean Noise on Marine Mammals

PAGE 70

Several recent U.S. federal courts injunctions against marine acoustical research have caused some scientists to worry about the very future of this research. They say it provides the most useful and important remote sensing tool available for learning about the geological structure of the seabed and discovering sub-sea floor oil and gas reserves.

In addition, they question why the research community is being targeted by some environmental and other groups who filed for these injunctions in the courts, rather than marine based industries, which are a far greater source of anthropogenic noise in marine environments.

A new report on ocean noise and marine mammals could help provide a scientific roadmap for dealing with the issue, better protect acoustically sensitive marine mammals and other species, and educate the public about the importance of acoustical research.

"Ocean Noise and Marine Mammals," issued by the U.S. National Research Council (NRC) on 10 February, notes the possible impact of sound on marine mammals, the paucity of data on the topic, and the need for a broad research agenda in determining possible effects of marine acoustics on marine species.

Currently available data suggest that the question of whether the impact of anthropogenic

sound on marine mammals is sufficiently great to warrant concern "is indeed justified," according to the report. "[But] the data are still quite limited, and it will be important to develop a research program that will provide substantially more data on this topic."

George Frisk, chair of the NRC committee that issued the report, and a senior scientist in the ocean acoustics laboratory at the Woods Hole Oceanographic Institution in Massachusetts, said, "With respect to noise in the sea, we know a lot more than we do about its effects on marine mammals, but we still know very little."

One thing Frisk and other scientists involved with the issue know well is that humans, marine mammals, and other marine organisms depend on sound as a primary method for understanding the ocean environment. And these scientists said they want to find ways to continue conducting marine acoustical research both without harming marine life and without threats of injunctions.