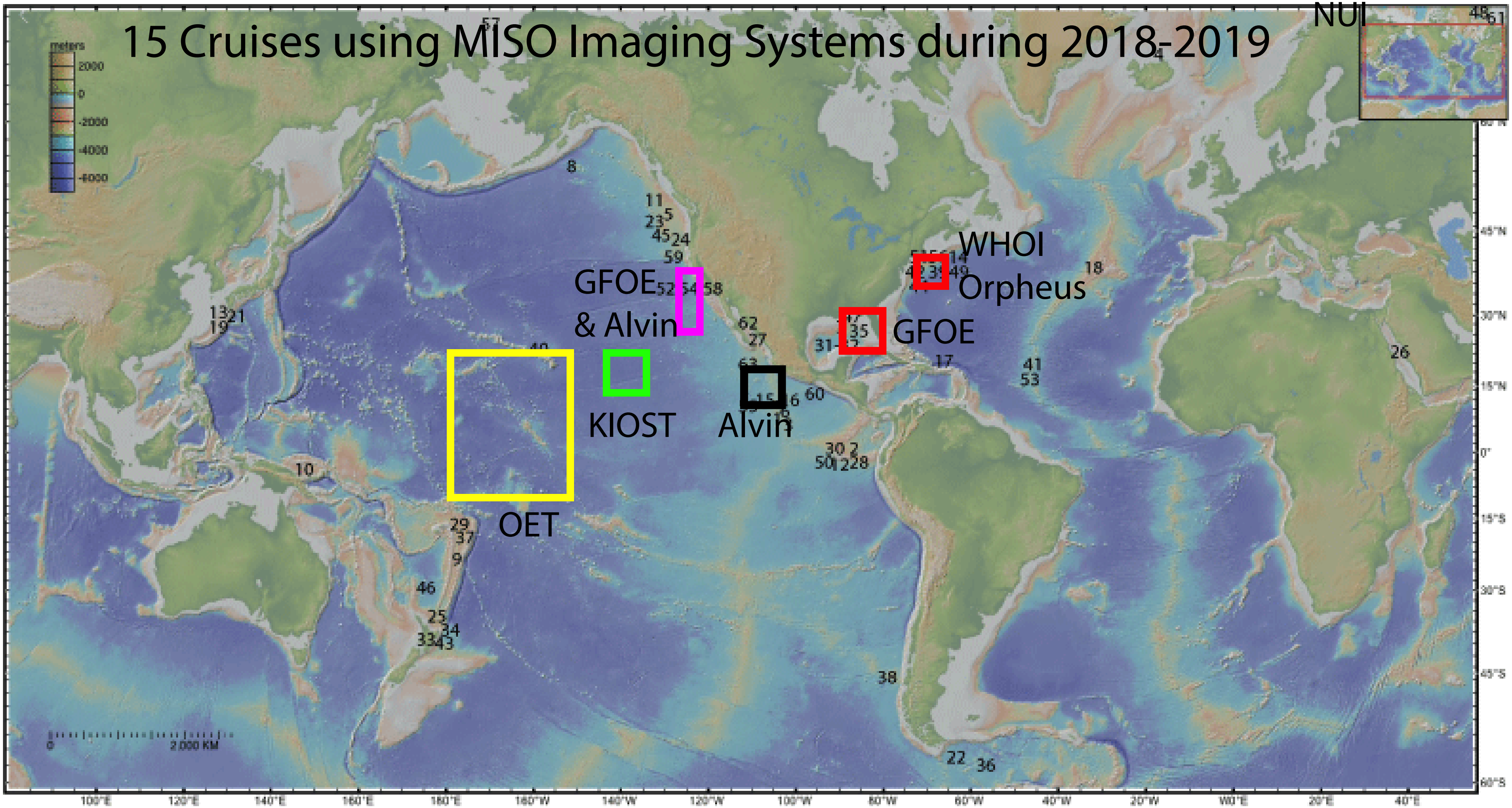
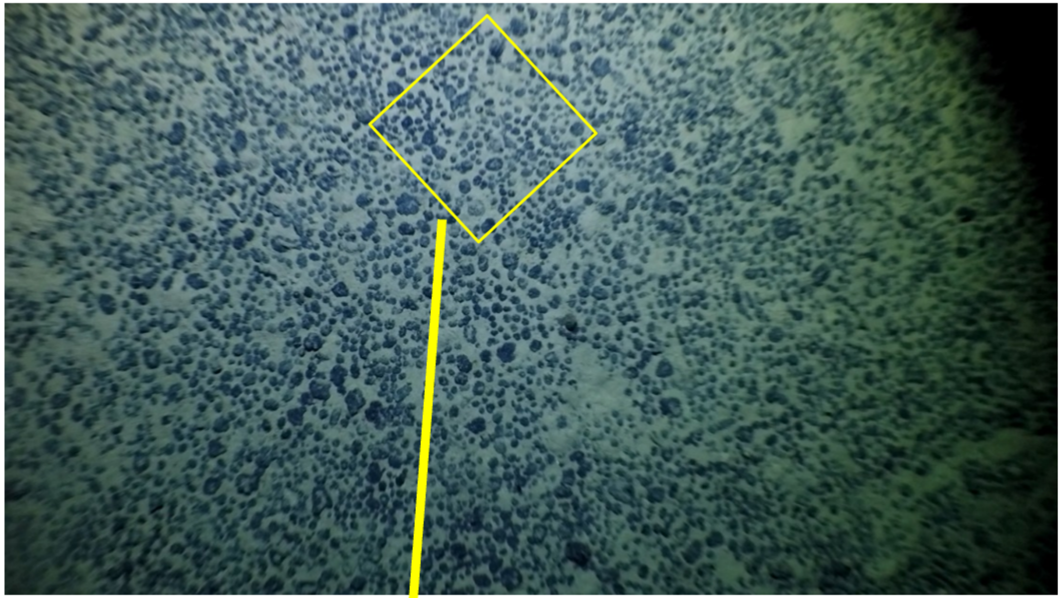
MISO TowCam & Imaging Systems Cruises - 2002-2017

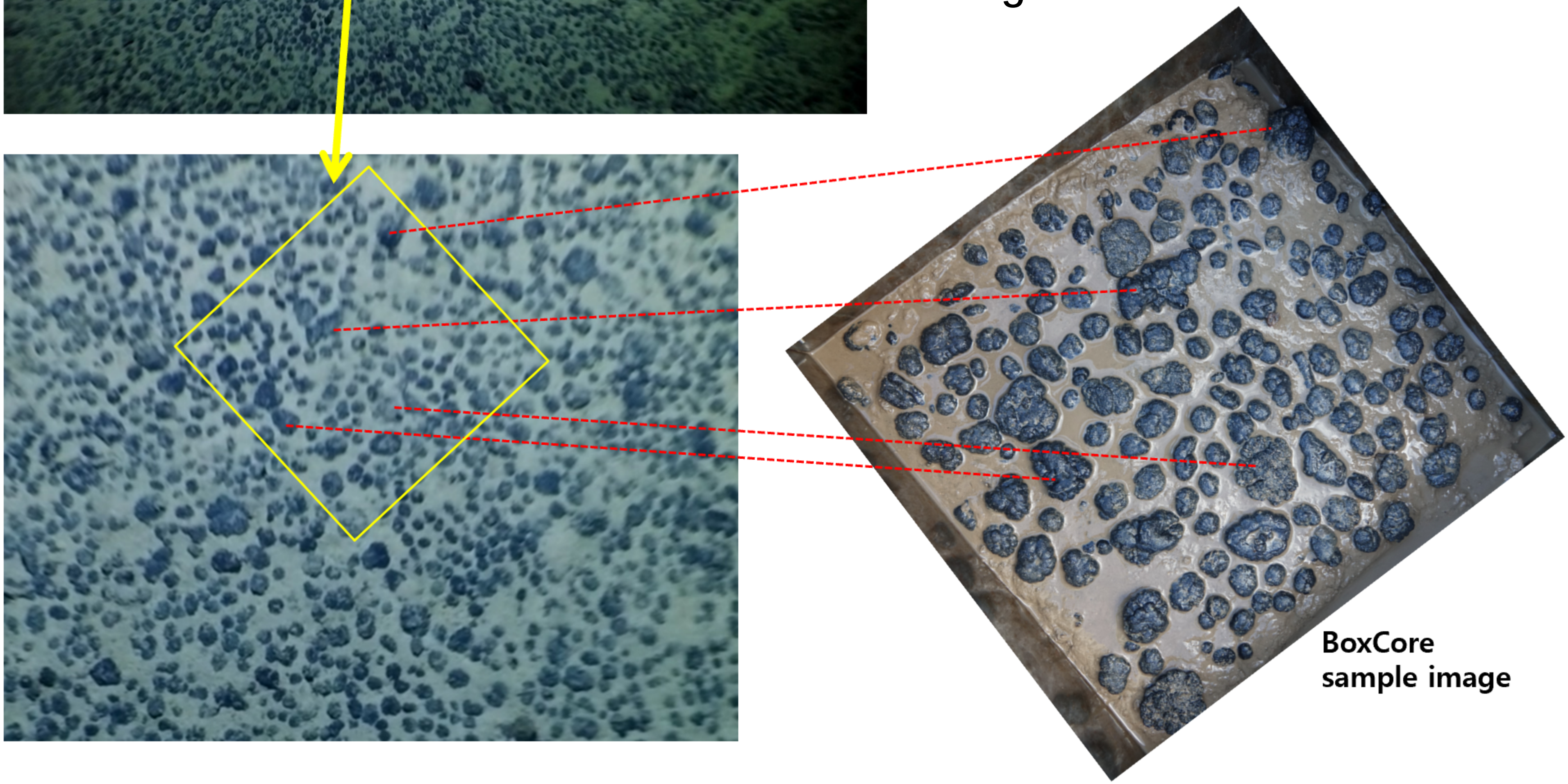
Gakkel Ridge



BoxCore Video image



HD Video frame-grabs taken during box coring for KIOST on RV Kilo Moana and actual sample image below



BoxCore sample image

| EDITORIAL FOCUS |

QUIESCENT IMAGING FOR DEEP-SEA SCIENCE: ADVANCES IN TECHNOLOGY AND PRODUCTIVITY

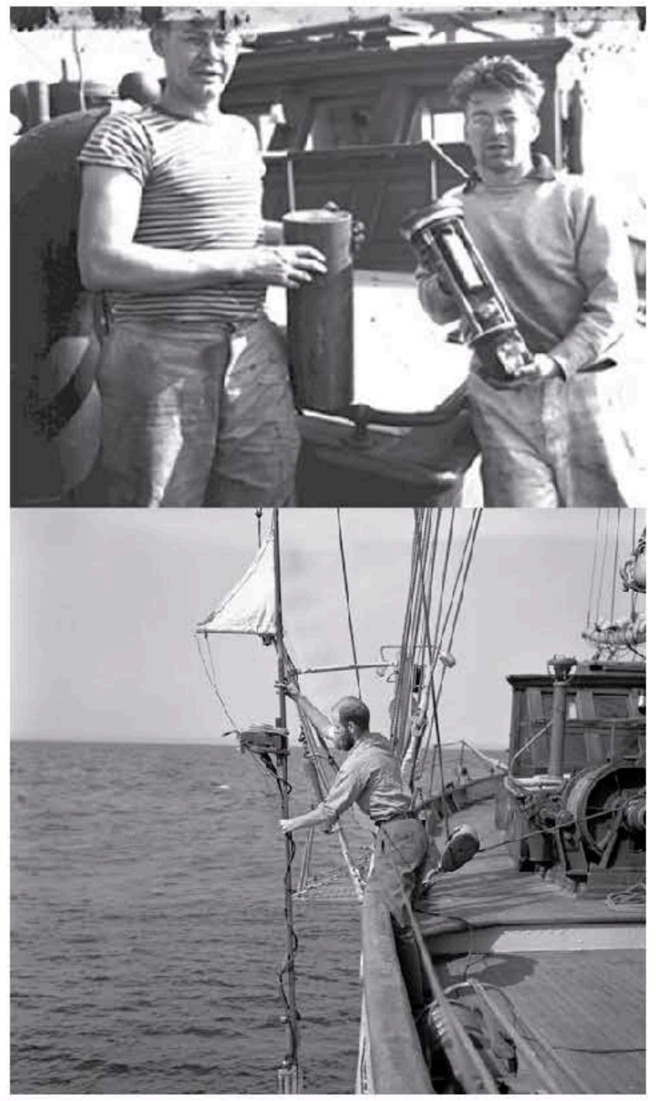
By Daniel J. Fornari – Woods Hole Oceanographic Institution
Aaron Steiner – DeepSea Power & Light (DSPL)
Stacey Church – DeepSea Power & Light (DSPL)
Eli Perrone – EP Oceanographic, LLC & Ocean Imaging Systems

Special thanks to the Woods Hole Oceanographic Institution and the DSPL team for their contributions to this article, as well as to the National Science Foundation's Division of Ocean Sciences for their support.

Since its emergence in the 19th century, underwater imaging has been responsible for many of the discoveries and advancements in the oceanographic sciences. With over 80% of the ocean undiscovered according to the National Oceanic and Atmospheric Administration (NOAA),[1] the need for high quality underwater imaging remains true today. Mapping the seafloor, studying the geochemical processes taking place in the ocean, observing marine life, and the myriad of other research initiatives related to understanding the world's oceans all benefit from high-resolution, data-rich images. Photographic and direct observations of the ocean floor are intimately tied to understanding the dynamic and interactive physical, chemical and biological processes occurring there.

HISTORY AND TECHNOLOGICAL DEVELOPMENTS

Subsea imaging can be traced to the earliest days of underwater photography when French inventor Ernest Bazin took photographs from a diving bell in the 1860s. Nearly a century later, Harold Edgerton, an engineering professor at MIT, developed the deep-sea strobe light, providing the "sunlight" required to take photographs of the deep ocean and seafloor for the first time. That development, coupled with the engineering efforts at the Lamont Geological Observatory of Columbia University and the Woods Hole Oceanographic Institution (WHOI), led to the first generation of modern deep-sea cameras[2]. These systems were simple by today's standards, but they provided key photographic evidence of animals and seafloor features over small areas in the deep ocean.



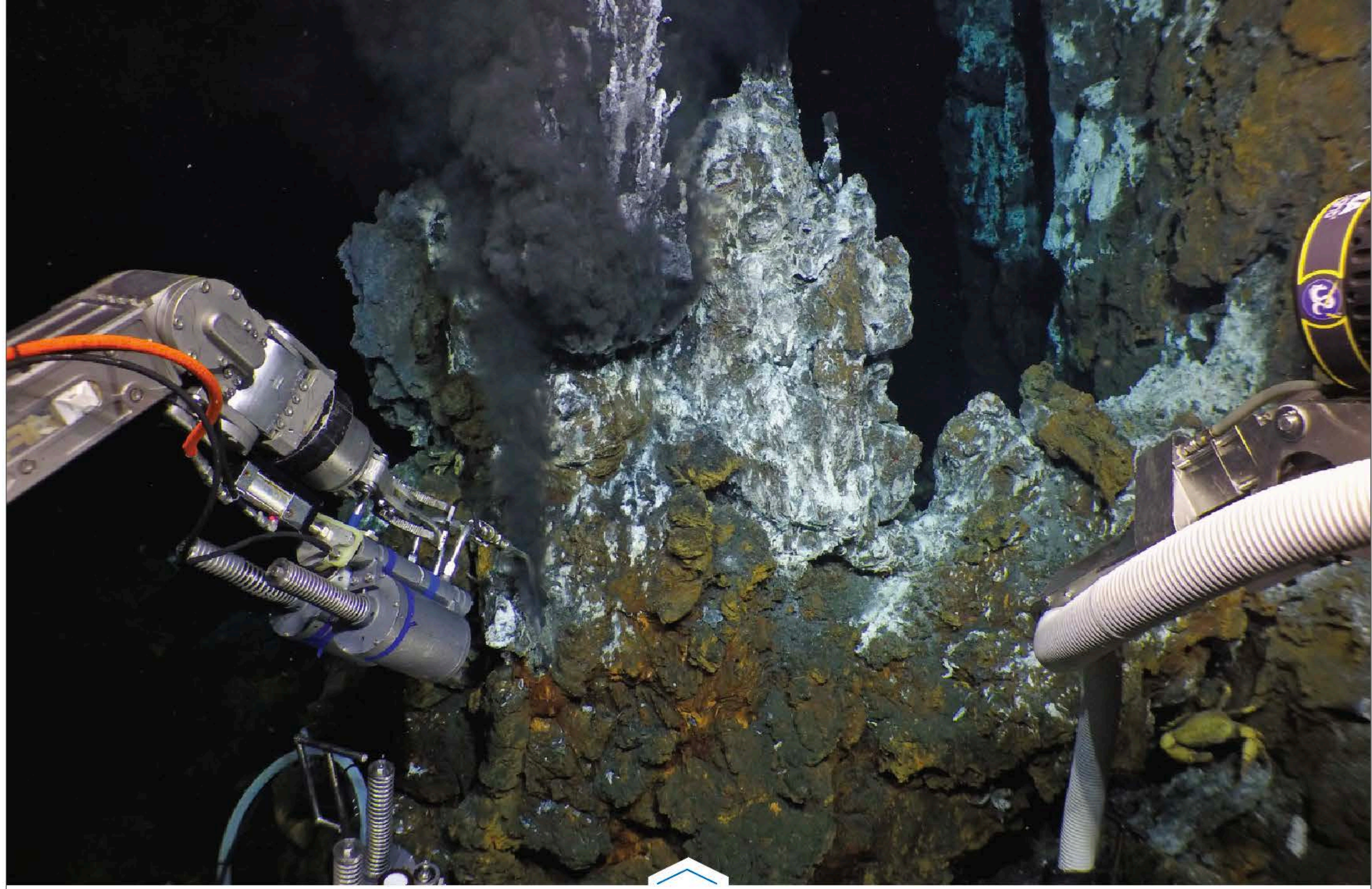
» *Maurice 'Doc" Ewing (top left) and Allyn Vine (top right) on the original RV Atlantis holding one of the first deep-sea 35 mm cameras developed in the late 1950s. (Bottom) David Owen deploying a deep-sea camera from the RV Vema in the late 1950s.*[3]

Subsea imaging capability leapt forward with the advent of digital imaging. Today, the ability to digitally image a large area and merge the constituent images together in a photomosaic provides a powerful tool for mapping and understanding the geological relationships between features of various dimensions – from centimeter scale to tens or hundreds of meters in size. Biological features on the seafloor, and the distribution of biota in different environments, also lend themselves to precision study using digital images and mosaics. Revisiting various deep-sea study areas is now common, and has been an important research theme within the US Ridge2000 Program.[4]

SUBSEA IMAGING AT WOODS HOLE OCEANOGRAPHIC INSTITUTION

High-resolution subsea imaging is at the core of the research performed at the Multidisciplinary Instrumentation in Support of Oceanography (MISO) Facility at the Woods Hole Oceanographic Institution (WHOI). MISO was developed with National Science Foundation – Ocean Sciences (OCE) Division funding to support US investigators requiring deep-sea digital imaging and sampling capabilities for seafloor experiments and surveys. MISO imaging systems have been used for a diverse suite of geological, biological, and biogeochemical investigations ranging from deep-sea coral studies; benthic biology traverses; hydrothermal vent research; and mid-ocean ridge and seamount volcanism, among others.

The WHOI-MISO Towed Digital Camera System (TowCam)[6] and related deep-sea imaging resources provide 6,000 m depth-rated equipment for oceanographic research in a range of seafloor environments, from mid-ocean ridges to continental shelves. Since completion of their construction in mid-2002, the WHOI TowCam systems and the imaging capabilities within MISO have been used successfully on more than 60 research cruises. The current MISO camera and TowCam systems have recorded more than 1 million deep-sea photographs since being placed in service. MISO deep-sea camera capabilities have also played an important role over the years in advancing imaging systems on WHOI's research submersible *Alvin* and ROV *Jason*, which are part of the National Deep Submergence Facility (NDSF) operated by WHOI for the US University-National Oceanographic Laboratory System (UNOLS).[7]



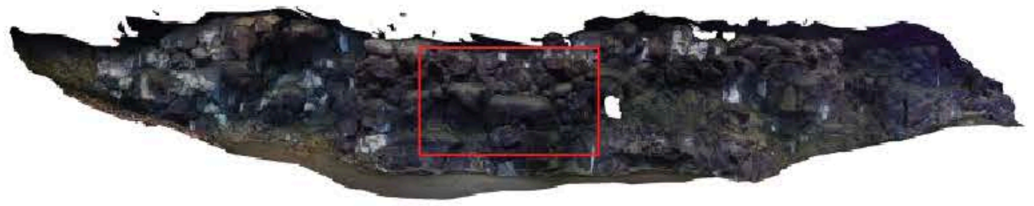
» *Image captured by a MISO-OIS GoPro 12MP camera of the HOV Alvin sampling ~360°C hydrothermal fluids from the Bio9 vent at the East Pacific Rise axis at 2,510 m depth. Rapid, 5 sec. interval, quiescent imaging documented seafloor features, context and operations without requiring any resources from either the pilot or the two observers. The science objectives required intense manipulative tasks to sample biota, fluids and microbiology from the vent chimneys as well as to coordinate imaging with the DSPL 4K Apex camera mounted on the starboard manipulator forearm. Images such as this one have been acquired routinely on Alvin over the past ~3 years to assist in image acquisition for both science and operations, and to improve the quality of imaging capabilities.*[5]

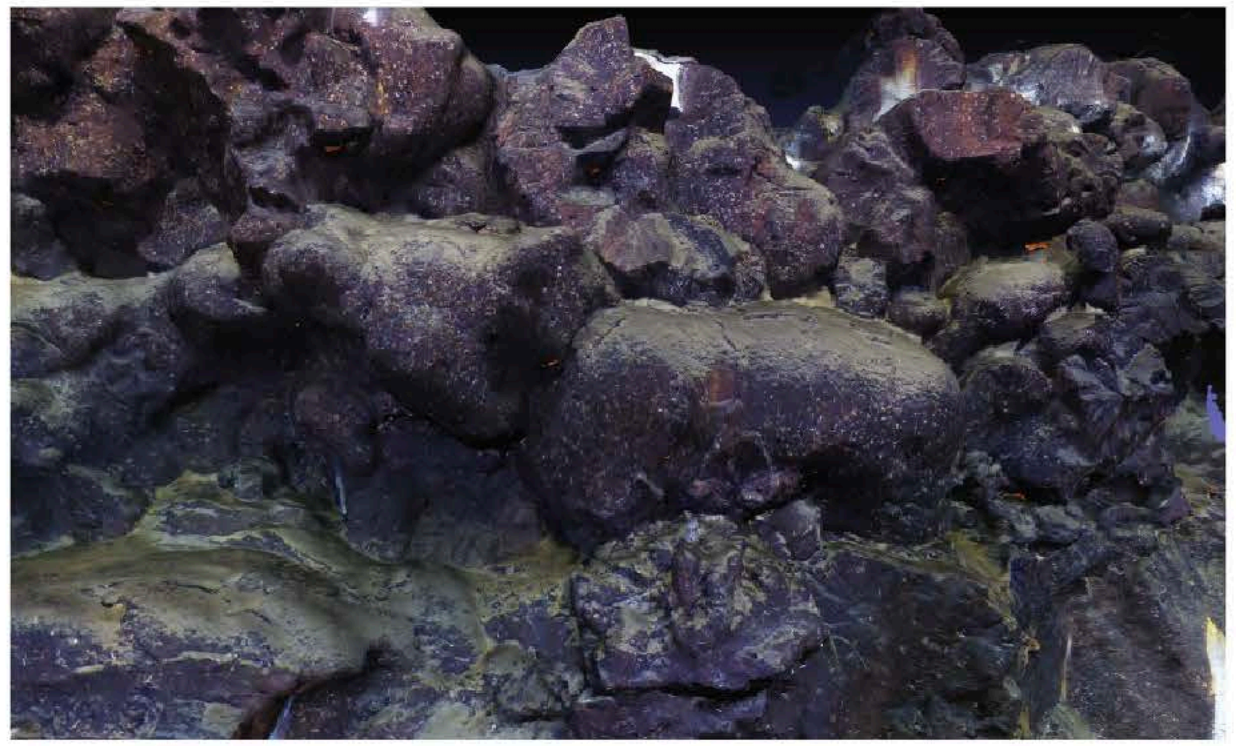
A Brief History of Imaging with TowCam

The original camera used for the MISO TowCam was developed by DeepSea Power & Light (DSPL) in the early 2000s using an original water corrected dome design by Mark Olsson at DSPL and a digital camera module based on the Nikon 995 series. The DSPL Digi SeaCam camera, rated for operations to 6000 m, was used for nearly a decade. The current camera used for TowCam imaging was developed by the late W. "Bill" McElroy of Ocean Imaging Systems (OIS). Since its original 12MP capability, it has been upgraded to 24MP using a Nikon D3300 35 mm DSLR and 20 mm Nikkor lens coupled with water-corrected dome optics, providing resolution from ~1 m to infinity. The MISO Facility currently operates five, 6,000 m rated OIS 24MP digital still cameras.

QUIESCENT IMAGING

In recent years, quiescent, fixed-focus imaging has emerged as an important complement to other user-controlled imaging systems. With quiescent imaging, the camera is set up to record video and/or capture stills at regular time intervals, requiring no further user input. Within WHOI-MISO, there is an identified need for high-resolution, high-capacity quiescent cameras for automated image acquisition on deep submergence vehicles. In collaboration with Ocean Imaging Systems (OIS), WHOI integrated a 5.4 mm non-distortion lens into a GoPro Hero4 camera with internal power. Used with DSPL Digi SeaCam and Super SeaCam housings and water-corrected dome optics, this design is the basis for a family of self-contained quiescent cameras to meet WHOI's research requirements.





» Photomosaic of a volcanic, constructional fault scarp at 2,350 m depth at Loki Castle hydrothermal vent field acquired in quiescent mode. Images were taken using the MISO-OIS 12MP deep-sea digital still camera mounted on the Ægir6000 ROV.[8]

The time and attention of the human occupants in a submersible is a critical resource when conducting subsea operations. Tools that can operate with little or no input significantly leverage the mission time, especially when they can be put to uses that improve the quality and context of data acquired through other operations. This is how the MISO-OIS GoPro camera is routinely put to use on HOV *Alvin*. Mounted above the pilot's window, this camera sees and captures wide angle, full 12MP still images at intervals customized to the mission profile and provides a complete record of the dive operations, capturing images of geological and biological samples in the environment they were collected from. The camera also records how these samples were collected, so any follow-up on methods or approach can be addressed directly. Since the camera is separate from *Alvin's* onboard systems there is nothing for the occupants to attend to. This frees them to completely focus on the intense job of piloting the submersible while conducting sampling, imaging, and other manipulator tasks.

Post-processed imaging data collected in 2018 with the MISO OIS GoPro camera system in collaboration with the University of Bergen on the Ægir6000 ROV shows the potential of this technology for documenting subsea features. In the image above, a series of 263 images were combined to produce a mosaic of a scarp feature about 100 meters long at the Loki Castle hydrothermal vent field in the Norwegian Arctic. A low-speed auto-position transverse operation was used during the data collection, allowing both the ROV positioning and imaging to take place semi-autonomously.

Another initiative that took advantage of quiescent imaging capabilities was the OASIS Expedition AT37-05 cruise on the R/V *Atlantis*. During this expedition, researchers gathered high-resolution mapping and imaging along the 8° 20'N Seamount Chain to better understand magma distribution and melting processes in the mantle on the flanks of a fast-spreading mid-ocean ridge. The 24MP OIS camera mounted on HOV *Alvin* provided high-resolution imaging at 10-second intervals; this was an important mapping component that allowed investigators to quantitatively determine bottom type and faunal distribution along transects up the flanks of individual seamounts at various distances (up to ~200 km) from the East Pacific Rise axis.

More recently, in 2019, The Five Deeps Expedition deployed three landers to accompany the 11,000 m rated submersible, *Limiting Factor*, on a record-breaking series of dives to the deepest parts of the world's oceans. The landers primarily serve as sample return boxes and acoustic waypoints to aid Limiting Factor in navigating the water column and seafloor. Additionally, they have been outfitted with water sampling and coring equipment and a quiescent imaging system using the IP Multi SeaCam and LED-SeaLites from DSPL. With the onboard recording capability of the IP Multi SeaCam, the Five Deeps team has been able to extend the range of science activities, providing additional seafloor context on biodiversity, geology, and hydrologic conditions without burdening primary submersible operations. Discoveries of potential new species were announced just weeks after being observed.

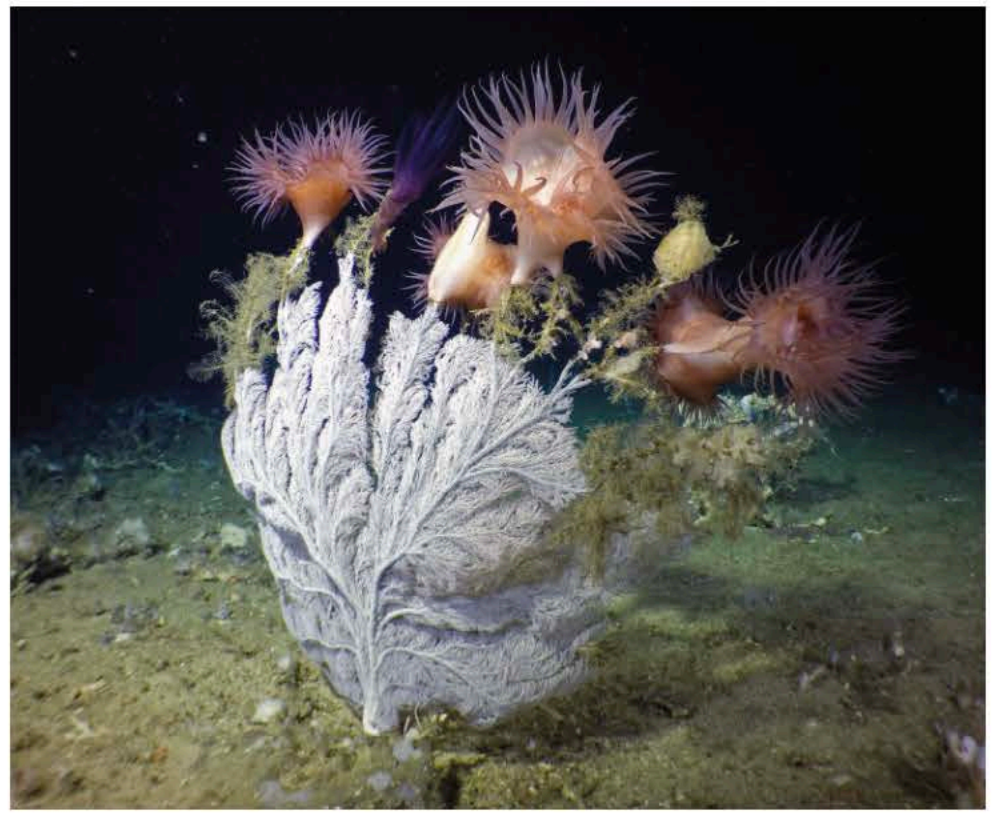
» Sediment-covered pillow lavas on a volcanic seamount west of the East Pacific Rise axis along the 8° 20'N Seamount Chain taken on the OASIS Expedition. The pillows are heavily encrusted with Mn-coating and host abundant deep-sea fauna such as corals, sea fans, gorgonians, crinoids, holothurians, and sponges. The distance across the bottom of the image is ~4 m.[9]

Subsea imaging has been intimately tied to our understanding of the world's oceans since its beginnings. Today, along with the use of sophisticated vehicles and acoustic and chemical sensors, scientists use underwater imaging systems to expand our knowledge of the dynamic processes happening far below the water's surface. Quiescent imaging systems, like those developed at WHOI and that take advantage of DSPL optical design and housing technology, free up time for scientists to observe and perform experiments while high-resolution images are captured. As more complex tasks are performed at extreme depths, quiescent imaging represents an important future component of hadal research.

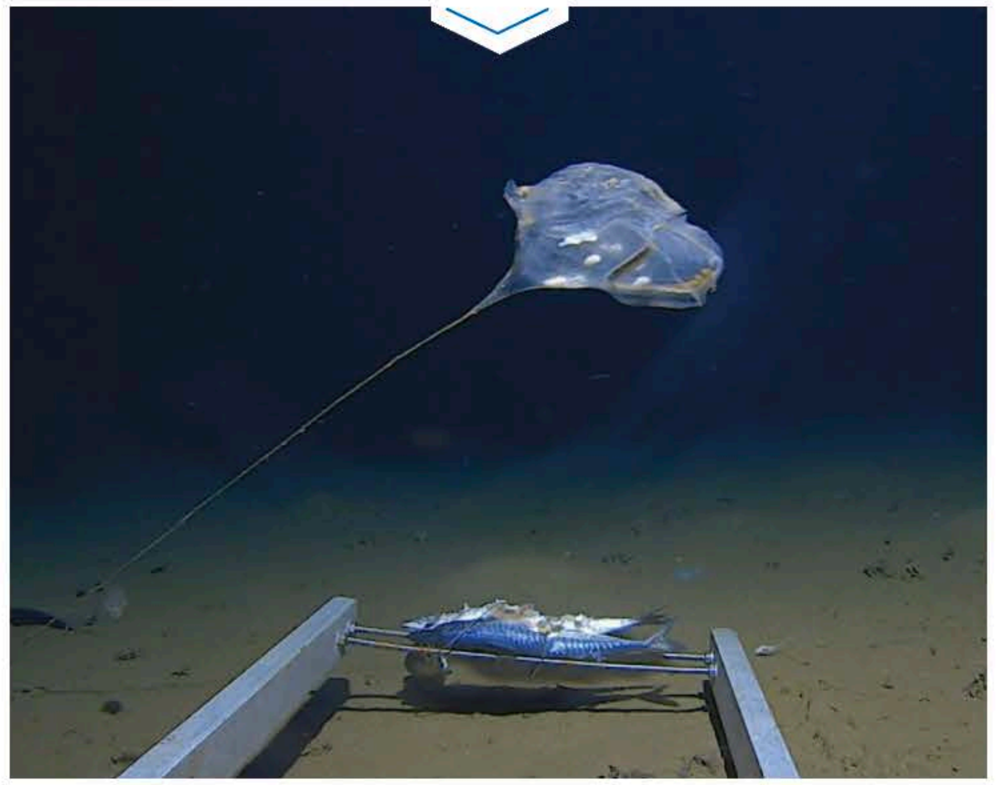
It remains to be seen what further technological advancements will be made in subsea imaging, but one thing is certain: it will continue to play a key role in revealing the wonders of the abyss.

To watch 4k video clips that were acquired with both quiescent MISO GoPro and DSPL 4k systems on HOV Alvin, go to this link or scan the QR code.

media.dspl.com/quiescent-imaging-1



» A Primnoid sea fan hosting a collection of purple anemones and yellow-brown branching hydroids and sponges. Image was taken with a MISO-OIS GoPro camera from the HOV Nadir operating from the MV Alucia in the Galápagos between Santa Cruz and Santiago Islands in 2015. This expedition was a collaboration between WHOI and Boise State University to perform geological and geochemical studies of the Galápagos Platform. The MISO-OIS camera augmented the research activities by capturing 10-second interval images throughout the HOV operations, documenting sampling sites and giving investigators a detailed baseline on the faunal diversity of this section of the Galápagos Marine Protected Area.[11]



» A potential new species of stalked sea-squirt observed by one of the IP Multi SeaCam quiescent HD imaging cameras on the science landers built for the Five Deeps Expedition. This specimen was observed below 6,500 m in the Java Trench during the successful attempt to dive the deepest point in the Indian Ocean. Dr. Alan Jamieson, chief scientist for the expedition, said "amongst many other rare and unique observations, the stalked Ascidean was a really significant moment. It is not often we see something that is so extraordinary that it leaves us speechless. At this point we are not entirely sure what species it was, but we will find out in due course."[10]

1 "How much of the ocean have we explored?" National Ocean Service. National Oceanic and Atmospheric Administration. Accessed July 22 2019.

2 Ewing *et al*., 1946; Hersey (ed.), 1967
Hersey, J. B. (ed.) 1967. *Deep-Sea Photography*, Baltimore: The Johns Hopkins University Press.
Ewing, M. A., Vine, A. C. and Worzel, J. L. (1946). Photography of the Ocean Bottom. *Journal of the Optical Society of America*, 36, 307.

3 Photo credit: Woods Hole Oceanographic Institution Photo Archives. © Woods Hole Oceanographic Institution.

4 E.g., Fornari et al., 2012.
Fornari, D.J., S. Beaulieu, J. Holden, L. Mullineaux, M. Tolstoy, (2012) Introduction to Special Issue - From RIDGE to Ridge2000", *Journal of The Oceanography Society*, p. 12, vol. 25-1, http://dx.doi.org/10.5670/oceanog.2012.01

5 Photo Credit: Courtesy of D. Fornari, WHOI/NSF/HOV Alvin 2018, ©Woods Hole Oceanographic Institution.

6 Fornari, 2003.

Fornari, D.J., (2003) A New Deep-sea Towed Digital Camera and Multi-rock Coring System, *Eos, Trans. Am.* Geophys. Union, **84**, 69 & 73.

7 www.unols.org/.

8 Photo Credit: T. Barreyre and R. Pedersen - K.G. Jebsen Centre for Deep Sea Research, Department of Earth Science, University of Bergen. ©K.G. Jebsen Centre for Deep Sea Research, Department of Earth Science, University of Bergen.

9 Photo Credit: Courtesy of P. Gregg, Univ. of Illinois, D. Fornari, WHOI, and M. Perfit, Univ. of Florida, AT37-05 cruise on R/V Atlantis, NSF/WHOI-NSDF/WHOI-MISO, R/V Atlantis Officers and Crew, HOV Alvin Operations Group. ©Woods Hole Oceanographic Institution.

10 Photo Credit: Five Deeps Expedition, ©Atlantic Productions Limited.

11 Photo Credit: WHOI-MISO, Dalio Foundation – Dalio Explore Fund, MV *Alucia* officers and crew, HOV *Nadir* pilots, Galápagos National Park, Charles Darwin Research Foundation, INOCAR – Oceanographic Institute of the Ecuadorian Navy, © Woods Hole Oceanographic Institution.

2019 PFPE Equipment Inventory Overview By Ship

	`	Kilo Moana	Langseth	Healy	Palmer	Atlantis	Ride	Revelle	Sikuliaq	Thompson	Armstrong	At WHOI
Sensor	Sensor S/N	**219**	**213**	**221**	**210**		**224**	**218**	**222**	**225**	**220**	**227**
	Last Recal	3/13/17	1/11/2015	5/3/18	Dec 2013		7/1/2015	October 2007	12/1/2012	Sept 2015	December 17 2017	**226**
	Bias at Last Recal	853493.3941	852,513.7600	855271.5236	855,501.1160		855,328.1100	855,366.6260	856810.7551	855469.78	855842.7181	**218**
	Scale Factor (mgal/count)	5.073184939	5.096606269	5.017580451	4.994070552		4.982476286	4.99975539	4.949295987	5.003353363	4.99689149	
	Last known Bias (mgal)	853493.3941	852512.87	855271.5236	855504.4		855,331.5300		856882.67		855844.91	
	Last Tie	3/13/17	9/6/18	5/3/18	4/8/2017		12/8/2016		11/11/18	8/2/19	4/26/2019	**Dead**
Platform	Table S/N	322	315	324	331		327		325	317	323	**223**
	CPS S/N	219	325	324	332			316	323	313 NGA	332	
	Pitch Gyro	CO288			AO300				LO041	EO257	DO269	
	Roll Gyro	DO286	BO297		DO278				KO062	KO053	HO134	
Laptop	gravGUI	YES	YES	YES	YES		YES	YES	YES	YES	YES	**Title Holders:**
	version											**WHOI**
Last Service Visit		April 2017	September 2019	July 2019	April 2017	December 2018	December 2018	December 2018	March 2015	August 2019	April 2019	**SIO**
Personel		Lanagan	Fornari	Lanagan	Lanagan		Herr	Fornari	S. Faluotico	Faluotico, Lanagan	Faluotico, Lanagan	**UAF**
Spares	Gyro	HO128	FO235	HO132	GO183		AO301	G0173	NO017	7	2	**LDEO**
	Gyro	NO015	DO270	HO119	HO129		EO263		P13	8	20	**NGA?**
	Gyro			001					KO076	5		
	Gyro			004								
	Motherboard/Interconnect	129	131	105						8311-003 NGA	136 NGA	
	Control Board	3	42	41						40	052 NGA	
	Stab Board	none	39	45						37	45	
	Gyro Board	36	49	61						48	01 NGA	
	Sensor Clock Board	891							28			
	Fuses/LEDs		yes									
	Signal Cond	134	130							136		
Battery Status	2 Pack cell dates	3/2017	Jan 2014	custom						July 2019	April 2018	
	4 Pack cell dates	4/2007		custom						July 2019	April 2019	
Land Meter	L&R - S/N:	G-1	G-237	G-04	G-807		G-611	G-352	G-410	G-56	G-70	G-92
Last Update		4/25/19	4/11/19	3/13/19	3/13/19		3/13/19	3/13/19	3/13/19	10/3/19	4/30/19	
By		R. Palomares	Alan Thompson	Lanagan	Lanagan		Lanagan	Lanagan	Lanagan	Lanagan	Lanagan	
Other History			Removed for drydock, Stored at USGS Melno Park CA			Offloaded December 2018	Offloaded December 2018, in storage at Scripps	Offloaded December 2018, recal'ed and stored at WHOI				

To: UNOLS Ship Operator Technical Support Group Managers
(for ships carrying PFPE BGM-3 marine gravimeters for data collection)

From: Dan Fornari – WHOI SSSG/PFPE

Cc: Jim Holik - NSF
PFPE@WHOI
UNOLS Office
Suzanne Carbotte and Suzanne O'Hara – LDEO & R2R

Date: Oct 9, 2019

Subject: Collection of Gravity Tie Data at Each Port Stop and
Transmittal of that Information to R2R

Dear Colleagues
It has come to our attention that there may be some confusion regarding the need to acquire gravity tie information and to distribute this documentation along with gravity data sets. If you have a PFPE BGM-3 gravimeter onboard and it is part of your geophysical underway data collection suite, **gravity ties must be performed whenever possible for every major cruise, irrespective of whether the science party is using the data.** The data are recorded and will be utilized by national databases and scientists in the future and the tie data are critical to proper processing/analysis of the gravity data.

A gravity tie is executed to determine the bias (offset), in mGal, of the gravimeter, allowing the user to relate the sensor's relative gravity measurement to a known and accurate benchmark site which is considered stable and has been surveyed in by a very precise land based gravimeter. As such, doing a gravity tie requires the gravity value of an established gravity station where the ship is docked. The software provided on the PFPE laptop that all UNOLS ships using PFPE gravimeters now have onboard, includes a database of known, trusted gravity stations that will be expanded over time. If the ship's docking location does not have a station in the database, contact pfpe-internal@whoi.edu for a search in an extended database.

If no gravity station exists at the ship's exact docking location, a land tie is required before executing the gravity tie, to determine the gravity value of "station A" at the ship pier (see Fig. 1 below). PFPE has provided Lacoste-Romberg land gravimeters to UNOLS operators (kindly loaned to us by the National Geospatial Agency (NGA)), so we now have a land meter on every ship operating a PFPE BGM-3 gravimeter. A gravity tie made by the laptop at a PFPE trusted gravity station takes one hour to perform, and is mostly automated in the software. If the land station is some distance from the ship, that travel time would of course be added to the total time to take the measurement. Instructions to use the PFPE gravity tie interface are provided below, and have been extracted from the PFPE gravity best practices documentation that has been provided to all UNOLS operators using BGM-3 gravimeters. Instructional videos of key

PFPE and BGM-3 gravimeter related operations can be found at this URL:
https://drive.google.com/open?id=1AXJIJBverOOyv7ABfKclpmDtwdgdt2In

While in many cases the gravity tie data are recorded in the PFPE laptop, it has come to our attention that many data sets from UNOLS ships that are included in the cruise data distributions submitted to the R2R program for long-term archiving, have not included the gravity tie data. R2R handles routine, evaluation quality processing of gravity data provided gravity tie information is available.

We are requesting that all UNOLS operators using PFPE BGM-3 gravimeters redouble their efforts to always perform gravity ties at the start/end of each cruise, and instruct your shipboard technicians on the importance of this data and the need to include this information as part of your cruise data distributions sent to R2R from each cruise.

If you have questions regarding this request, please don't hesitate to contact me by email with cc to pfpe@whoi.edu.

Best Regards,
Dan Fornari
WHOI SSSG/PFPE Facility

Gravity Tie information/instructions from PFPE Best Practices Manual

Definitions

Land tie	In port	As necessary to support gravity ties	Pre-Calibration; determine the mGal gravity value at the pier where the ship is docked
Gravity tie (ship-to-shore tie)	In port	Every port stop if possible or every 2 months, and before each geophysics cruise	Calibration; determine the gravimeter bias offset. May require a land tie to be executed before this

Ship to Shore Gravity-Tie instructions

A gravity tie is executed to determine the bias (offset), in mGal, of the gravimeter, allowing the user to relate the sensor's relative gravity measurement to a known and accurate benchmark site which is considered stable and has been surveyed in by a very precise land based gravimeter. As such, doing a gravity tie requires the gravity value of an established gravity station where the ship is docked. The software includes a database of known, trusted gravity stations that will be expanded over time. If the ship's docking location does not have a station in the database, contact pfpe-internal@whoi.edu for a search in an extended database. If no gravity station exists at the ship's exact docking location, a land tie is required before executing the gravity tie, to determine the gravity value of "station A" at the ship pier. A gravity tie made by the laptop at a PFPE trusted gravity station takes exactly one hour of time and it is mostly automated in the software. Instructions to use the gravity tie interface are:

Click the "Gravity tie" button on the GUI to open the gravity tie interface

Click the "new test" button on the new window

Select from the database the gravity station at the ship's exact docking location. NOTE: if a land tie had to be executed to determine the value of the gravity at the ship, in the database dropdown menu select "Other – Other – Other", then fill the fields with a reference ID to the land tie executed, and in the "mGal at pier" field enter the gravity value of station A that was determined at the end of the land tie procedure

Click the "Start recording" button. A progress percent indicator will display and the window will start plotting and buffering filtered counts from the system

Go immediately outside the ship, and measure the height difference (in feet and inches) between station A and the gravimeter location on the ship. Enter the value in the "Water height to pier 1" field in the gravity tie GUI window

At 50% progress for the gravity tie, go outside the ship, and measure the height difference (in feet and inches) between station A and the gravimeter location on the ship. Enter the value in the "Water height to pier 2" field in the gravity tie GUI window

At 100% progress for the gravity tie, go outside the ship, and measure the height difference (in feet and inches) between station A and the gravimeter location on the ship. Enter the value in the "Water height to pier 3" field in the gravity tie GUI window

If a land tie was executed to determine the "mGal at pier" field of this window, check the "Land tie used" checkbox

When the progress indicator shows "COMPLETE!", press the "Compute Bias" button. The new bias will be displayed to the right of the button

Compare the new bias to the old bias. The old bias is reported also in the GUI main window in the "Bias" field in the bottom right corner. If the new bias looks acceptable (i.e. is consistent with historical bias drift rate of the system), click the "Accept" button on the gravity tie window. This will generate a report and update the software to use the new bias. After clicking "Accept", verify that the "Bias" field in the bottom right corner of the GUI main window is now the new bias

NOTES:
If the software detects a system malfunction or a “data not valid” flag during the gravity tie, the gravity tie will automatically abort and the abort reason will be displayed on the gravity tie window. In this case, the system malfunction or “data not valid” should be investigated before restarting the gravity tie again

Land-Tie Instructions

A land tie is executed (and necessary) if no established gravity stations are available immediately next to (i.e., within 50m) where the ship is docked. The purpose of a land tie is to determine the gravity value (in mGal) at the location where the ship is docked (station A – new station), using: a) information from a land gravity meter and b) the gravity value of a known and well-established gravity station (station B – known station).

Figure 1. James Kinsey – WHOI, taking a reading with the LaCoste and Romberg Model G in Halifax Nova Scotia while installing a BGM-3 on the Canadian Coast Guard Ice Breaker Louis St. Laurent

When a land tie is required, a technician should use a land meter to record:
The time (and reading from the land gravimeter) at station A (repeated three times)

The time (and reading from the land gravimeter) at station B (repeated three times)

The time (and reading from the land gravimeter) at station A again (repeated three times)

When this data has been collected, the “Land Tie” button on the GUI opens a window to determine the value of the gravity at the pier (station A). Instructions to use the land tie interface are:

Click the "Land tie" button on the GUI to open the land tie interface

Click "NEW" to start a new land tie

Enter the first set of three land meter readings and times for station A in the first station A block

Enter the set of three land meter readings and times for station B in the station B block

Enter the second set of three land meter readings and times for station A in the second station A block

In the "Database – section B" block, select the appropriate ship, and the gravity station used for station B from the database. If the station B you used is not in the database, select "Other – Other – Other" and enter all the information required to fill out this block, including the "mGal at pier" field. ***NOTE***: this "mGal at pier" field is NOT the value of the gravity at the pier where the ship is docked, but the value of the gravity of station B (known station)

In the "New Station – station A" section, enter the latitude and longitude of the new station (A) that you are establishing (i.e., from a handheld GPS receiver), assign a name to the new station and use the text box below to enter any note that can help in better identify the location of the station (for example, indicate distances from bollards, from pier ends, from easily recognizable landmarks, etc…). These notes are useful to locate again the new station in the future

In the "Additional information" section, enter the name(s) of the personnel who used the land meter for this land tie and/or filled out the information in the land tie window. Enter the land meter temperature recorded during the readings in the field, and select the serial number of the land meter used. The software automatically uses the appropriate calibration table for the particular land meter S/N to compute the reading-to-mGal conversion

Click "COMPUTE" to compute the value of the gravity at station A. The computed value will be displayed to the right of the "COMPUTE" button

If the value computed is acceptable, click the "ACCEPT" button to generate and save a report.

---end---