SCHMIDT OCEAN INSTITUTE

2014 Annual Report

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Pilot whales *(Globicephala)* were observed and studied off Hawaii Island during the first student cruise focused on deep diving whale behavior.

ERIC SCHMIDT, President
WENDY SCHMIDT, Vice President
Founders of Schmidt Ocean Institute

Sharing our Passion for Science, Technology, and Discovery

Our work is our passion, and with every expedition we observe something new! In 2014, Schmidt Ocean Institute continued building a tradition of research and exploration with nine expeditions spanning from the remote Northwestern Hawaiian Islands to the deepest part of the world's ocean

Schmidt Ocean Institute was founded in the spirit of exploration... to advance the pace of ocean research and discovery.

in the Mariana Trench. For the first time, we carried out three student cruises in one year. Participating students gained invaluable skills at sea while working with advanced oceanographic technologies and tools. Over the course of the year, 82 passionate students participated in research that will serve as a foundation for multiple dissertations, and provided indispensable ocean-going experience.

This year was marked by discoveries, including new species, and new understanding of places like the Hawaiian Islands where Schmidt Ocean Institute supported seafloor mapping work has helped to re-write the region's geological history. In December, news agencies around the world took note of the newly discovered "ghost fish" found during the Mariana Trench expedition, setting the record for the deepest fish definitively observed. None of these accomplishments would be possible without the passion of our scientific collaborators working side by side with our team on board *Falkor* to address the challenges of ocean sciences with state-of-the-art technologies. Schmidt Ocean Institute was founded in the spirit of exploration, to provide ocean scientists from around the world with access to some of the most innovative research technologies at sea

and advance the pace of ocean research and discovery. We continued our efforts to improve *Falkor*'s research capabilities to ensure she remains outfitted with many of the worlds most technologically advanced science systems. This year, for instance, we acquired a new cloud-based high-performance supercomputer for *Falkor,* the first of its kind on a research vessel. This system will provide our scientific collaborators on *Falkor* with vast computing power, and enable them to make informed research planning decisions interactively, while at sea, based on real-time data processing.

2014 was a busy year for Schmidt Ocean Institute. *Falkor* spent a total of 171 days at sea in support of scientific operations, a 60% increase from last year, and sailed over 21,000 nautical miles. We successfully built two full-ocean depth landers that aided in important deep-sea research during our first expedition to the Mariana Trench, and collaboratively developed the preliminary design for a new Hybrid Remotely Operated Vehicle (HROV) for exploring the world's deepest trenches. We helped shape future endeavors, holding a strategic planning workshop to identify critical opportunities for advanced shipboard oceanography. The workshop assembled 25 renowned ocean scientists, technology developers, facility operators, students, and post-docs from Australia, Canada, China, and the United States. Its outcomes have been instrumental in refining the definition of the strategic focus areas for Schmidt Ocean Institute in the next five years.

We worked with 131 science collaborators aboard *Falkor*, representing 25 institutions and universities from ten countries. *Falkor*'s multibeam and echo sounder system mapped almost a quarter million square kilometers of ocean floor, an area larger than the state of California. This included mapping 127,000 km^2 of one of the world's largest marine protected areas, Papahānaumokuākea Marine National Monument (PMNM), and 23,439 km^2 of the remote Ontong Java Plateau. These maps have led to the discovery of new species, and revealed new features and seamounts.

In 2014, Schmidt Ocean Institute continued reaching out to a global audience to share the stories about its research projects and high-impact data collected on *Falkor.* We accomplished this through virtual, in-person, and media channels including our website, publications, and presentations. This year, we gave over 25 presentations in 20 cities around the world. We reached 13 different classrooms with in-class presentations and live ship communication, as well as broadcast radio shows from *Falkor*.

BY THE NUMBERS

131 *science collaborators aboard Falkor, representing*

25 *institutions and universities in*

10 *countries.*

We are proud to share all that we have accomplished this year, and hope that you will take a few moments to explore the meaningful and impactful results of our pursuits. 2015 promises to bring even more research projects and we look forward to seeing what new discoveries are around the corner.

Focus on Innovation and Sharing

Schmidt Ocean Institute was established to advance the frontiers of ocean research and exploration through innovative technologies, intelligent observation and analysis, and open sharing of information.

Our program is structured around the following focus areas:

1

COMMITMENT TO EXCELLENCE IN OCEANOGRAPHIC RESEARCH OPERATIONS

Schmidt Ocean Institute is dedicated to supporting advanced marine science on research vessel *Falkor*, including technical and operational improvements, innovative shipboard scientific instruments and systems, supporting remote research via telepresence and satellite data streaming, and high performance computing for at-sea modeling and data analysis.

2

INFRASTRUCTURE, PLATFORM, AND TECHNOLOGY DEVELOPMENT FOR MARINE SCIENCES

Schmidt Ocean Institute supports pioneering research at sea; development and support of innovative scientific robotic vehicles, and deployable scientific platforms and instruments; testing of new research technologies on our vessel and vehicles, and technology focused research and development projects as part of the *Falkor* cruise program.

3

COLLABORATIVE SCIENTIFIC RESEARCH ABOARD *FALKOR*

Schmidt Ocean Institute provides scientists from around the world with access to *Falkor* to foster a deeper understanding of the global ocean, a critically endangered and poorly understood part of our environment. We support environmentally focused and societally relevant ocean research, projects with high intrinsic scientific value and meaningful impact potential, research that effectively leverages innovative technologies, and oceanographic research.

4

COMMUNICATIONS, EDUCATION, AND OUTREACH

Schmidt Ocean Institute hopes to inspire younger and older generations alike by demonstrating what is possible through technologically advanced oceanographic research. We do this by telling the story of projects supported aboard *Falkor*, providing a continuous online presence and resources for virtual visitors, holding workshops and symposia to discuss progress and future directions, and encouraging partnerships, as well as student, and educator participation.

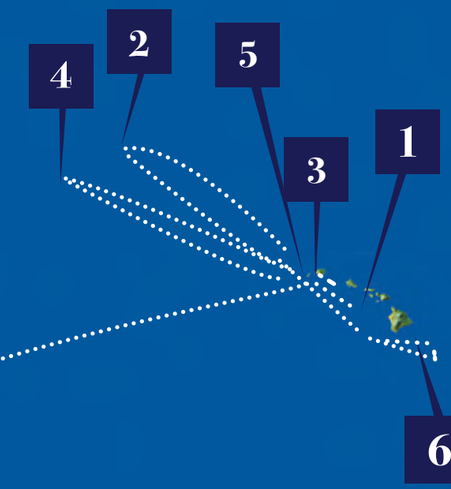
5

OPEN SHARING OF INFORMATION, DATA, AND RESEARCH OUTCOMES

Schmidt Ocean Institute supports open sharing of information to encourage wide use, stimulate a growing user community, and encourage further exploration, discovery, and deeper understanding of our environment. These efforts are supported through partnerships with data management experts in the oceanographic community that enable standards-compliant sharing of information and data collected during research cruises.

Where We Went in 2014

Falkor sailed 40,362 km or 21,793 nmi, and mapped 227,110 km² of ocean floor



	CRUISE DETAILS	Date	Length
01	STUDENT CRUISE LEG 1	*Feb 16 - Feb 22*	*1,436 km*
02	MAPPING PAPAHĀNAUMOKUĀKEA LEG 1	*Mar 7 - Apr 11*	*12,657 km*
03	STUDENT CRUISE LEG 2	*Apr 18 - Apr 24*	*1,353 km*
04	MAPPING PAPAHĀNAUMOKUĀKEA LEG 2	*May 2 - Jun 8*	*13,765 km*
05	STUDENT CRUISE LEG 3	*Jun 13 - Jun 19*	*380 km*
06	THE IRON EATERS OF LOIHI SEAMOUNT	*Jun 25 - Jul 7*	*1,212 km*
07	THE MYSTERIES OF ONTONG JAVA	*Oct 2 - Nov 2*	*7,592 km*
08	EXPLORING THE MARIANA TRENCH	*Nov 9 - Dec 9*	*1,433 km*
09	EXPANDING MARIANA TRENCH PERSPECTIVES	*Dec 15 - Dec 21*	*534 km*

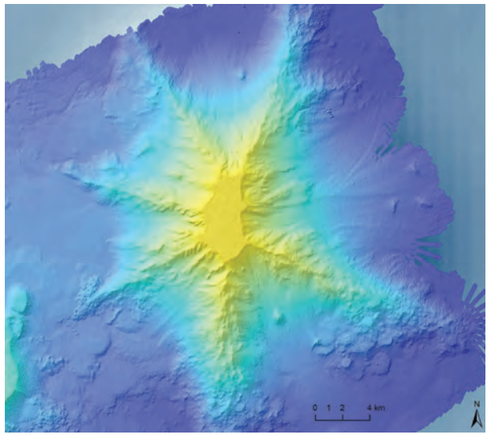
The sun sets through the bridge windows after another busy day at sea for the *Falkor* crew.

MAR 7 - APR 11 // MAY 2 - JUN 6

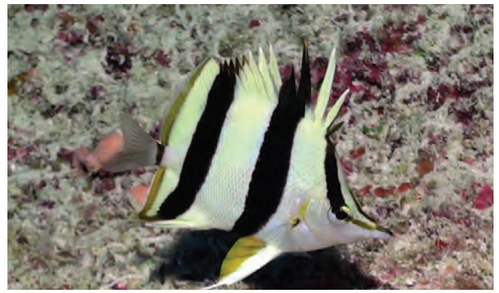
Mapping the Hidden Papahānaumokuākea Marine National Monument

The Papahānaumokuākea Marine National Monument (PMNM) is known for its unique marine ecosystems, as it hosts a lesser-known geology, including fossil coral reefs that provide insight into how the Hawaiian Archipelago was formed. Ninety-eight percent of the PMNM seafloor is 100 m or more below the ocean's surface, making the area difficult to access and describe. Two *Falkor* expeditions totaling 72 days were dedicated to mapping this unique area led by Dr. Christopher Kelley from University of Hawai'i Mānoa.

The creation of high-resolution seafloor maps produced with *Falkor*'s sonar systems, proved to be an essential precursor to making significant biological and geological discoveries in the Monument. Scientists and *Falkor* technicians were able to map 127,000 km^2 of the PMNM, an area 7.6 times the size of the main Hawaiian Islands. These maps supported NOAA scientists as they returned to the Monument later to collect specimens and photographs of rare and newly discovered marine life. The NOAA team found Struhsaker's Chromis fish, never before seen in the Monument, and the rare Hawaiian pig fish.



This was the first time deep tablemounts were found in the Monument. Researchers from this expedition believe that they were formed during the Cretaceous Period 65-75 million years ago.

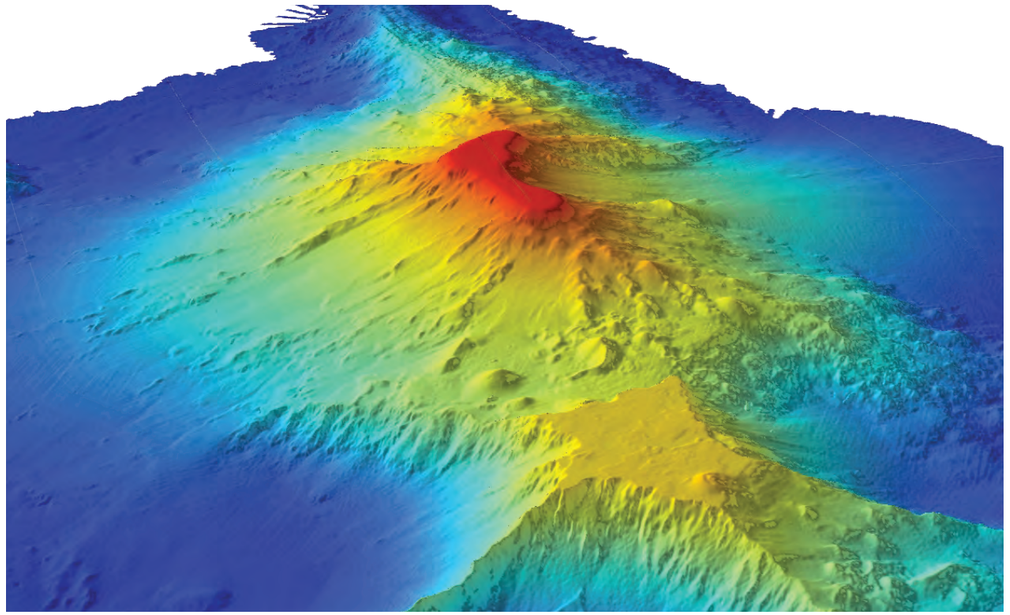


...more than any other type of seafloor topography, seamounts capture our imagination, making us wonder how they formed and what strange creatures live on these mountains in the deep.

They also found a new species of butterflyfish, now in the process of being described, as well as a new species of wrasse.

The *Falkor* cruises focused on the remote northern half of the Monument, mapping 18 seamounts, nine of which are unnamed. Upon completion, Dr. Kelley's excitement shone through, "...more than any other type of seafloor topography, seamounts capture our imagination, making us wonder how they formed and what strange creatures live on these mountains in the deep." From new data, the team identified four types of features including deep tablemounts (guyots), which were found in the PMNM for the first time. These tablemounts are of interest because they are believed to have been formed during the Cretaceous Period (65-75 million years ago), not by the Hawaiian volcanic "hotspot" that formed the bulk of the Hawaiian Islands, as originally thought. This discovery reveals what was already present on the seafloor when it was erupting, rewriting previous geological history of the region.

Drowned reef terraces, landslides, and rift zone ridges were the emphasis of the second leg, focusing mapping efforts on an area called Gardner Pinnacles. The mapping efforts revealed a curious secondary cone, a previously unknown



landslide, and large numbers of drowned reef terraces. While the presence of landslides was previously known, the data collected by *Falkor* exposed an unidentified landslide that took off a significant portion of the eastern side, resulting in a razor sharp summit edge that extends for almost 23 km, and created one of the most dense deep-sea coral and sponge habitats found in the Central Pacific. Without this mapping data, the mechanism by which this summit was created would have remained hidden. Mapping of these reefs revealed dramatic structures at depths between 40-60 m.

Bank 9, a major seamount in one of the world's largest marine protected areas, the Papahānaumokuākea Marine National Monument.

OPPOSITE PAGE:
Rare and newly discovered marine life in Monument waters, clockwise: Struhsaker's Chromis fish (*Chromis struhsakeri*), Hawaiian pigfish (*Bodianus bathycapros*), undescribed wrasse, and undescribed butterfly fish.

BY THE NUMBERS

2
Falkor expeditions

72
Days at sea

127,000 km²
Mapped of the Papahānaumokuākea National Monument

Students prepare the CTD Rosette, which measures salinity (conductivity), temperature and depth from sea water samples during one of the student cruises.

OPPOSITE PAGE:
Students examined whale diving activities off Hawaii Island to determine feeding behavior on the first student cruise.

FEB 16-22 // APR 18 - 24 // JUN 13-19

Inspiration at Sea

Student Cruises

This year Schmidt Ocean Institute offered graduate and undergraduate students from University of Hawai'i at Mānoa (UH) a unique opportunity to work aboard *Falkor* on three separate cruises. This inaugural program was inspired by a charge from Wendy Schmidt, to find new ways to inspire a deep passion for ocean science among students.

During the cruises, 48 students and advisors from UH and National Oceanic Atmospheric Administration (NOAA) conducted hands-on research. In the process, they gained critical skills and experiences at sea working on *Falkor*, and were exposed to inspirational science to propel them on their paths towards ocean science careers.

FEEDING BEHAVIOR OF DEEP-DIVING WHALES

On the first expedition, students traveled aboard *Falkor* to Hawaii's Kona Coast, to study the feeding habits of deep-diving whales such as beaked, short-finned pilot, and sperm whales. One student project focused on tracking whale dives to determine if they target an area known as the deep scattering layer (DSL)—where smaller fish, crustaceans, and jellyfish tend to concentrate. A second project examined what type of prey might be most attractive to foraging whales, testing a hypothesis that the whales are targeting large squid attracted to the DSL for their own feeding.

The students ran surveys to track whales and the DSL position, collecting water samples to further characterize food concentrations at different depths. To explore the idea that whales might be interested in larger prey drawn to the DSL, the team deployed a Dual-Frequency Identification Sonar, which produces remarkably detailed images that make it possible to identify organisms underwater, even from 30 m away.

Ultimately, better understanding of where whales are found and why could aid conservation efforts by identifying areas that require increased protection. The students presented results from the cruise during two talks at the Acoustical Society of America's fall meeting. One, given by chief scientist Adrienne Copeland, won the first place student award. "That cruise was pivotal for us," says Copeland, "I definitely learned a lot about how to run a scientific mission from start to finish."

Ultimately, better understanding of where whales are found and why could aid conservation efforts by identifying areas that require increased protection.

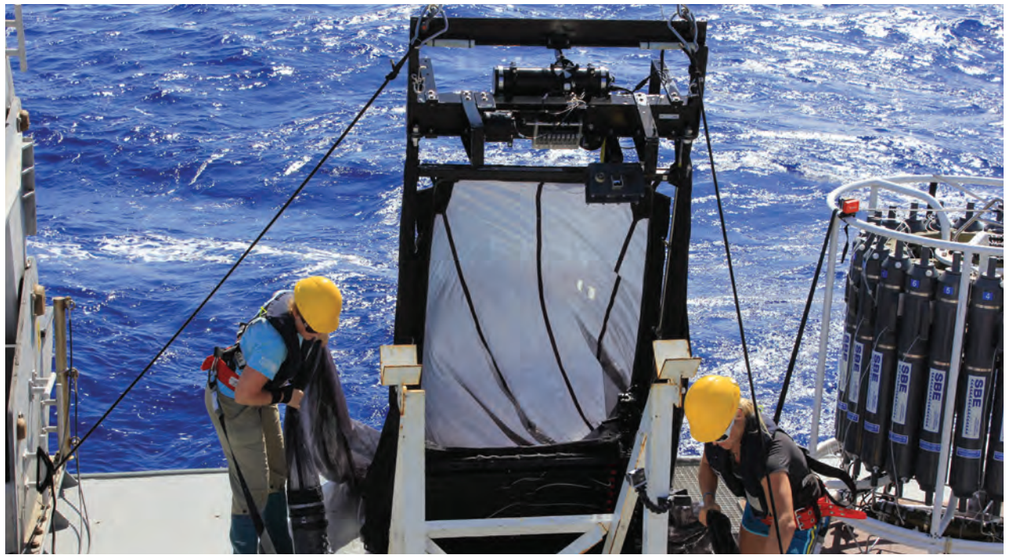
GEOLOGICAL SURVEY WORK IN THE HAWAIIAN ISLANDS

The second 2014 student cruise focused on the geology of a partially submerged structure known as Maui Nui. This geological complex includes the islands of Maui, Molokai, Lanai, and Kahoolawe, which collectively are part of an underwater mountain whose formation remains puzzling. A faculty advisor from UH guided students through work that could help solve the puzzle of Maui Nui. The project involved utilizing *Falkor*'s high-resolution sonar mapping system and a gravimeter. The gravimeter was used to take precise measurements of minuscule gravity fluctuations that offer clues about rock structures hidden below the reach of sonar. The students' work made it possible to identify relatively narrow, denser areas known as dikes—the paths that erupting magma flowed out of as Maui Nui grew. This information will help scientists better understand the timing and pattern of the different islands' formations.

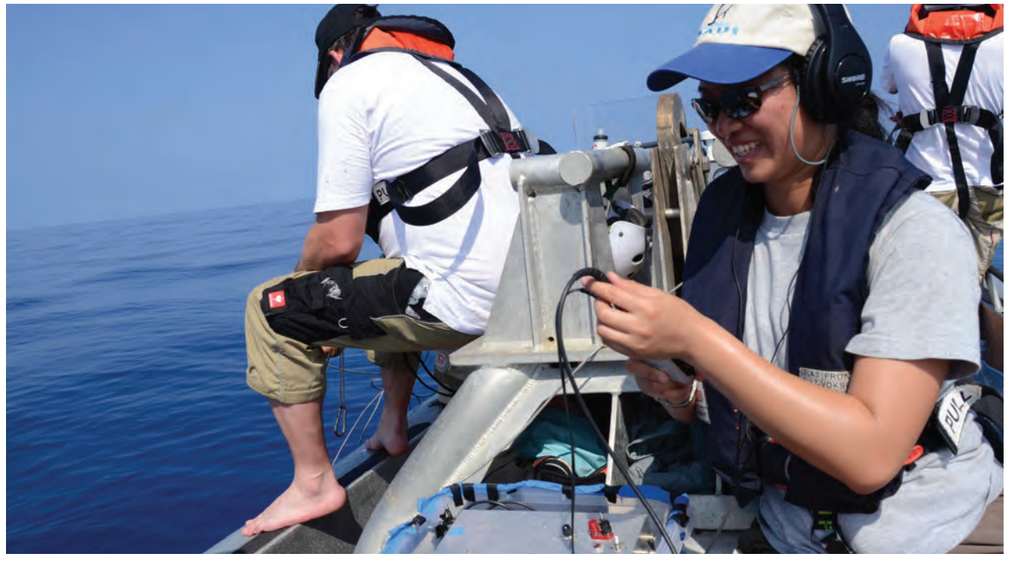
During the second portion of the cruise, a separate group of students focused on an underwater ridge that extends from Oahu's west side to investigate internal tides—submerged

Marine Technician Paul Duncan shows University of Hawaii students how to work the video matrix in the control room during the second student cruise.

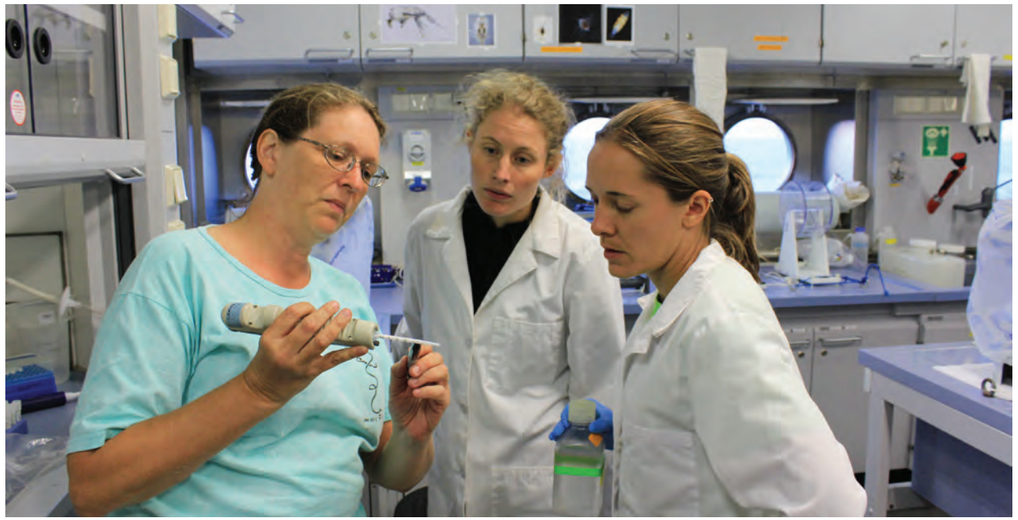
waves formed by tides that push water against features like this ridge. The students examined internal tide turbulence as it mixed nutrients from deeper waters together with plankton in surface waters, potentially supporting more biological productivity than would otherwise be possible. They used an instrument called a microstructure profiler to create a detailed map of the waters' turbulence, and *Falkor*'s CTD rosette collected water sample data with its various sensors. Students processed the samples to determine what animals were present at different depths, and to look for chemical clues about where organisms get their food.



Students were trained on the Multiple Opening/Closing Net and Environmental Sensing System (MOCNESS) to collect zooplankton samples off Oahu on the third student cruise.



PhD student Jessica Chen listens for whales off *Falkor*'s work boat.



University of Hawaii graduate and postdoctoral students were able to collect zooplankton samples for copepod (a type of zooplankton) grazing and paternity experiments as part of their own research during the third student cruise.

INVESTIGATING COPEPODS AT STATION ALOHA

The final student cruise took a team 100 km north of Oahu to Station ALOHA (**A L**ong-term **O**ligotrophic **H**abitat **A**ssessment). Though an established research destination, much remains unknown about the diversity of the area's zooplankton. Students were able to gather information about these animals, while developing new techniques for studying them. They focused on crustaceans known as copepods, which are so ubiquitous that identifying them and tracking changes in populations remains challenging. The team collected the copepods using a MOCNESS (**M**ultiple **O**pening and **C**losing **N**et with **E**nvironmental **S**ensing **S**ystem), a system of ten computer-controlled nets that open and close at desired depths to collect a cross section of animals.

One student project collected copepod larvae, *nauplii*, from various depths in order to learn what they feed on, a key component in ocean nutrient cycling. Another study focused on identifying which copepods have fluorescent proteins, to explore what advantages these proteins might provide, such as aiding with mating or offering UV protection. The students also helped chief scientist Dr. Erica Goetze with ongoing work to develop an easier, faster way of analyzing zooplankton samples, because conventional methods are difficult and time consuming. Specifically, they applied DNA sequencing techniques to identifying species and their numbers from samples collected with the MOCNESS down to 1,500 m. Such techniques could eventually expand understanding of global zooplankton populations and how they shift over time in response to climate changes.

48
students and advisors conducted hands-on research.

3
student cruises

BY THE NUMBERS

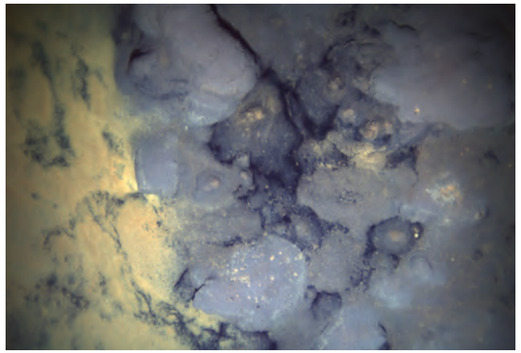
View of *Falkor*'s CTD and water sampling system in the clear waters of the Pacific.

View of Maui from the upper deck of *Falkor* while performing multibeam mapping between Maui nui, a geological complex that includes the islands of Maui, Molokai, Lanai, and Kaho'olawe.

The science team places Autonomous Underwater Vehicle (AUV) *Sentry* back in her cradle after a successful dive exploring Loihi Seamount, Hawaii's underwater volcano.

OPPOSITE PAGE:
Photo of deep microbial field mats at FeMO Deep at a depth of 4981 m. The gray areas are aged pillow basalts, the black and light gray is thin ferro-manganese oxide crusts, and the yellow is iron oxide produced by iron-eating bacterial mats.

JUN 25 - JUL 7



Underwater Volcanoes

and Iron Eating Bacteria at Loihi Seamount

Dr. Brian Glazer from University of Hawai'i Mānoa (UH) led an expedition aboard *Falkor* to explore the geology, chemistry, and microbial communities found at Loihi seamount, an underwater volcano off of the island of Hawaii. Certain bacterial communities found in this hydrothermal habitat feed on iron and may play an underappreciated role in balancing ocean chemistry. Hydrothermal vents and microbial communities found at Loihi's summit were previously well-documented, but Dr. Glazer and colleagues discovered similar iron-oxidizing bacterial formations at 5,000 m below sea level, by the base of Loihi during this expedition. The goal for this cruise was to gauge the full extent of this deep microbial activity.

Due to the loss of the world's only full ocean depth capable HROV during an expedition on another research vessel, Woods Hole Oceanographic Institution and Schmidt Ocean Institute went to great lengths to achieve mapping and bottom imaging objectives by mobilizing the autonomous underwater vehicle (AUV) *Sentry*. *Sentry* was used to complete work complementary to what could be done with *Falkor*'s sonar and sampling equipment.

AUV *Sentry* dove for over 100 hours and traveled almost 220 km around the base of Loihi

Seamount to record over 49,000 images and collect 150 km^2 of bathymetric mapping data. This imagery and mapping data has allowed scientists to create photo mosaics of the microbial mat coverage, and identify specific target areas for future investigation. Additionally, data collected from Loihi may give scientists a glimpse at how large-scale iron deposits found in the geologic record on land and undersea called umbers were formed—whether through biological activity similar to that at Loihi, or through geology and chemistry.

The Native Hawaiian high school program, Upward Bound, followed the cruise online. Classroom visits and a ship tour were offered to the students, who also followed the expedition blogs and participated in scientist interviews for a live radio show broadcast from *Falkor*. Additionally, the cruise received significant media attention, with scientists doing six radio show and television appearances, and news coverage in over 20 articles. Chief scientist Brian Glazer also worked with the UH Media Production office on an informational video about the underwater volcano and *Falkor* cruise using footage from this, and previous, expeditions.

Graduate student Isabelle Bacconais looks at collected seawater from Loihi Seamount to determine the presence of iron, a key piece of information in understanding the iron-eating bacteria and underwater volcanic environment.

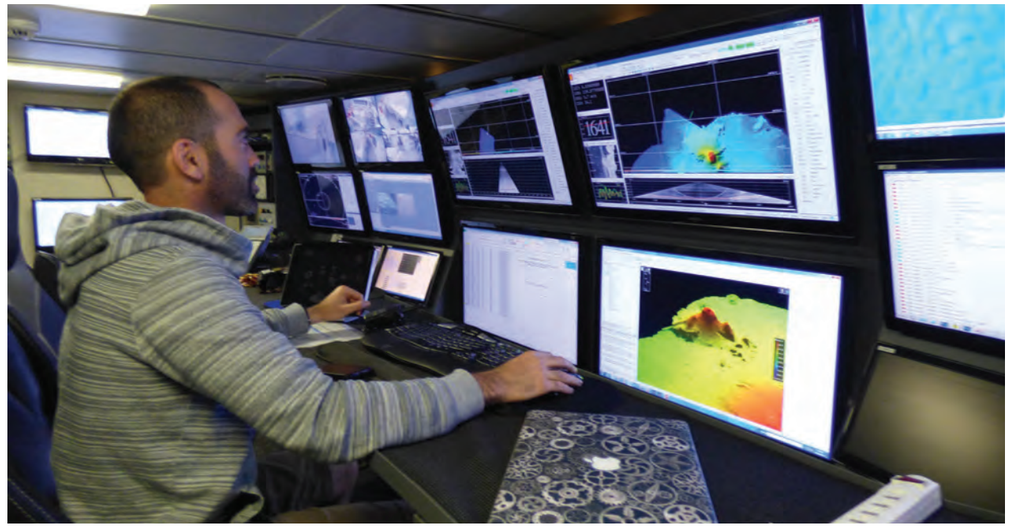
BY THE NUMBERS

100 *hours spent diving with AUV Sentry*

49,000 *images recorded*

150 km^2 *of mapping data collected.*

Photo collected by AUV *Sentry* at Loihi Seamount, in the vicinity of the Shinkai Deep microbial mat field. The photo was collected at a depth of 4,657 m, and the field of view spans a steep basalt wall greater than 10 m high.



OCT 2 - NOV 2

Ontong Java Plateau: Mapping Underwater Canyons and Atolls

The largest volcanic eruption in the planet's history likely formed the Ontong Java Plateau (OJP), a submerged seafloor platform slightly larger than Alaska. In October, *Falkor* took an international team of scientists from Australia, the United States, the United Kingdom, Germany, Israel, Papua New Guinea, and Japan to Ontong Java to explore aspects of the plateau's geology that remain mysterious because of limited research in this remote area, and to improve the region's tsunami preparedness. Chief scientist Dr. Mike Coffin is a marine geophysicist at the University of Tasmania's Institute for Marine and Antarctic Studies who has been studying the region for two decades. "Highly accurate navigation and state-of-the-art multibeam echosounding were two keys to the expedition's success," says Coffin, "To our fortune, *Falkor* excels at both. Aboard the ship, technology rules."

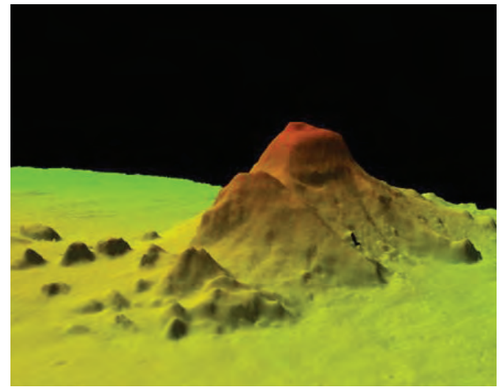
The origin of Ontong Java Plateau is one of its primary mysteries. Past research suggests it formed during a single massive event, but has not conclusively revealed what could have caused it. To solve the mystery researchers need more and deeper rock samples from the plateau. On this cruise the team used sonar mapping to identify possible sites for future collections, including

features in the 4,000 m deep Kroenke Canyon—an access point to otherwise unreachable lower levels of the plateau.

Kroenke Canyon's formation is also something of a mystery. This 500 km long crevice on the eastern side is so large that it is difficult to explain where enough water could have come from to erode it. The team searched for an erosional path to the plateau's two atolls, or to some ancient landmass now submerged. They did find one interesting candidate but were not able to map its full extent—another task for a future expedition. Coffin hopes to return to the plateau aboard *Falkor* to sample the canyon and other sites and complete more mapping.

The science team completed two full mapping circumnavigations of the plateau's inhabited Ontong Java and Nukumanu Atolls, creating seafloor maps needed to improve tsunami risk assessments, which could save numerous lives.

Highly accurate navigation and state-of-the-art multibeam echosounding were two keys to the expedition's success.



Once the data are processed, they will go to the Secretariat of the Pacific Community's Applied Geoscience and Technology Commission, which oversees the region's tsunami risk management. Given the frequent incidence of tsunamis in the region, any resulting improvements in risk assessment will be welcomed.

LEFT IMAGE: Graduate Student A.J. Reyes from the University of Guam assists to deploy the CTD and water sampling system.

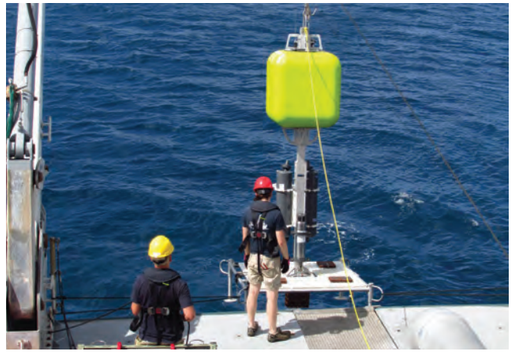
RIGHT IMAGE: The newly mapped volcano found near Ontong Java plateau, standing approximately 900 m tall.

OPPOSITE PAGE: Hydrographer Tomer Ketter from the Israeli National Institute for Oceanography, sits in the control room monitoring high resolution mapping data.

A cusk eel and a rattail photographed by one of the full ocean depth landers in the Mariana Trench.

OPPOSITE PAGE:
The *Falkor* crew launches the brand new full ocean depth lander off the aft deck *Falkor*.

NOV 9 - DEC 9



Making Biological and Geological Discoveries

Mariana Trench Part One

The deepest reaches of the sea, beyond 6,000 m, are one of the planet's last true frontiers. Interest among researchers in understanding this extreme region is growing, and in November, Schmidt Ocean Institute collaborated with a group of biologists and geologists on the first of two expeditions to the world's deepest area, the Mariana Trench. The team discovered new species, including the deepest fish ever recorded, and gathered the deepest rock samples ever collected. The samples are providing new information about how animals survive the crushing pressures of these deep zones and evidence of a possible underappreciated role for trenches in ocean carbon storage. "There were so many exciting discoveries - we have so much more to learn from the samples, it will keep us busy for years," says Dr. Jeffrey Drazen, a deep-sea biologist at University of Hawai'i Mānoa (UH). The expeditions co-chief scientist, Patricia Fryer*, a marine geologist with UH said, "The cruise has been a great success, looking at all we have accomplished is invigorating."

The expedition involved the first systematic survey within the Mariana Trench, focusing on the 10,700 m Sirena Deep, part of the United States Mariana Trench Marine National Monument. This is likely the second deepest spot

in the world after Challenger Deep, the target of Schmidt Ocean Institute's second cruise in this region. From *Falkor*, the team not only surveyed the bottom of Sirena Deep, but also its sloped sides, at 1,000 m increments enabling a broader view of life in the trench. Researchers completed the survey using Schmidt Ocean Institute's newly built full-ocean depth landers, as well as other landers, equipped with cameras, sensors, and collection devices.

There was immediate recognition we were looking at something completely new. The press later referred to the find as the "ghost fish of the deep."

One major goal was to assess what types of animals could be found at each depth zone. Several samples gathered were entirely new species, including a snailfish that has remained unknown to science despite being common in the 6,000-8,000 m range.

One of the most amazing discoveries came when one of the landers equipped with a camera recorded another snailfish species deeper than what had ever been seen before. "There was immediate recognition we were looking at something completely new," says Drazen. This ethereal fish had tissue-thin fins and an eel-like tail resembling a ghost; the press later referred to the find as the "ghost fish of the deep." The team observed the remarkable species on three separate occasions.

However, because none were caught in the traps, scientists will not yet be able to make an official taxonomic description of the species. Regardless, one of the lander recordings came from 8,143 m depth, making it the deepest fish ever definitively observed.

TOP IMAGE
Falkor Captain Bernd Buchner and Chief Scientist Dr. Jeff Drazen hold a super-giant amphipod.

BOTTOM IMAGE
Samples of sediment from the Mariana Trench were collected by the rock grabber and extracted using syringe cores to answer questions about faunal communities and organic composition. These are some of the deepest mud samples ever collected.

OPPOSITE PAGE
The science team on this expedition broke the record for the deepest-fish when a "ghost-like" snailfish was caught on the lander cameras at 8,145 m depth.

The team also investigated whether trenches are underappreciated repositories for carbon. To explore this concept, scientists used a lander that inserted a tube into the seafloor and measured

This expedition was part of the international Hadal Ecosystems Studies program, funded by the National Science Foundation.

how much oxygen animals within a contained sediment consumed during a set time period. In simplest terms, the more oxygen consumed, the more organisms there are, meaning more carbon fuel needed to support them. During three deployments, oxygen consumption rates were the highest ever recorded deeper than about 2,000 m; suggesting high carbon levels and providing evidence of substantial carbon storage.

The science team and *Falkor*'s crew were able to equip one lander with a rock grabber that returned with multiple rocks, including the deepest rock samples ever collected. Much of the understanding of trench geological processes such as earthquakes, despite their importance, remains theoretical because of limited access. Ongoing analyses of the samples could confirm existing hypotheses, or open new questions.

8,720 m
is the deepest site rocks have been collected from

8,143 m
is the deepest fish to have been definitively observed

BY THE NUMBERS

* ADDITIONAL LEAD SCIENTISTS WERE:
Alan Jamieson, Dan Mayor, and Stuart Piertney of the University of Aberdeen, Tim Shank from Woods Hole Oceanographic, Amanda Demopoulos from the U.S. Geological Survey, Craig Young from the Oregon Institute of Marine Biology, and Paul Yancey from Whitman College

A lander attracts amphipods in the Challenger Deep, Mariana Trench, at 10,920 m depth.

Falkor crew members oversee the deployment and retrieval of the landers off the aft deck.

OPPOSITE PAGE:
The amphipods collected will not only provide information about that species, but the many microbes that live within the amphipod as well.

DEC 15 - DEC 21

Collecting Microbes and Recording Sound in the Deepest Part of the Ocean

Mariana Trench Part Two

After a brief turnover in Guam, a new team with a different suite of landers boarded *Falkor*, this time for work in the Mariana Trench's deepest spot, the Challenger Deep. Outfitted mainly for the collection of microbes and deep sound recordings, Chief Scientist Dr. Douglas Bartlett, from the Scripps Institution of Oceanography, and his colleagues, pushed further toward understanding life in the deepest environments. "The Challenger Deep is the Mount Everest of deep-sea habitats," says Bartlett, "At nearly 11,000 m down, it is an alien-like world where we know life exists, we just don't know quite how it exists."

The researchers used landers to collect water samples for bacterial analyses, including at one point from 10,920 m down, likely the deepest lander deployment in history. The landers took samples with unpressurized bottles as well as one pressurized container designed to maintain the pressure experienced in the depths, something never before attempted in water deeper than 3,000 m. The team is studying the samples in hopes of answering a key question about microbial life in the hadal zone—which species can really take the pressure?

By analyzing which bacteria are active in the pressurized samples, and comparing to species in the unpressurized samples, the team hopes to delineate key hadal bacterial players. "This is a raging debate among the small number of us who think about microbial activity in the deep ocean," says Bartlett.

Baited traps with camera systems were also sent down on multiple lander deployments, one of which returned with 23 samples of amphipods, crustaceans that dominate the deepest zones, and spectacular footage of the amphipods' behaviors. Team member Dr. Pei-Yuan Qian will be studying the animals' genetics to determine whether new species were collected, and to

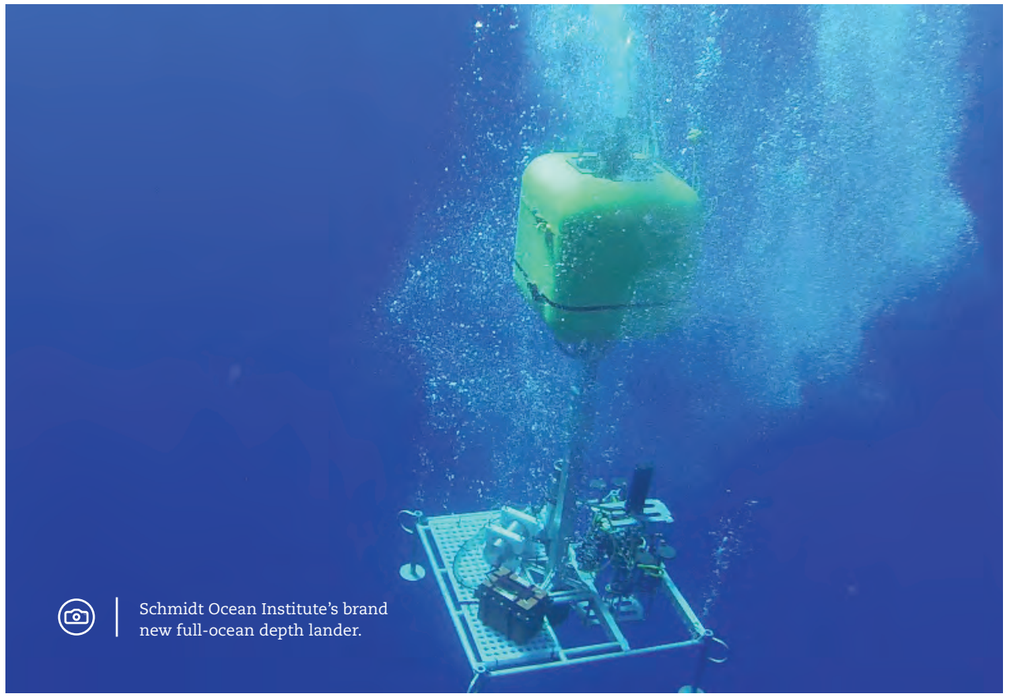
The team successfully deployed a sound recording lander to 9,000 m and captured audio that will help researchers understand how animals may be using sound in deep trenches.

learn more about how they survive. Such work should shed light on high-pressure adaptions such as genes that code for essential compounds. The team also successfully deployed a unique lander to 9,000 m that recorded audio files to help researchers understand how animals use sound in deep trenches. The team suspects that trench animals might be especially dependent on sound because mates and food are sparse, and because trenches are especially conducive to the travel of sound. One audio sample contained a rumbling sound that team member Dr. David Barclay from Dalhousie University suspects may be movement of the tectonic plates that formed the trench.

TOP IMAGE: The science team processes seawater samples collected from the deepest point in the ocean, Challenger Deep.

BOTTOM IMAGE: David Barclay checks out the Deep Sound 2 lander after its historic dive of more than 8,900 m in the Mariana Trench, collecting the deepest underwater sounds ever recorded.

Several different types of landers were used to explore the Mariana Trench. Pei-Yuan Qian and Dave Price inspect one of the landers after a dive.



Schmidt Ocean Institute's brand new full-ocean depth lander.

Building New Technology

Schmidt Ocean Institute was founded to serve as a research facility operator that applies technological innovation to advance the pace of ocean research, exploration, and discovery. In 2014, we accomplished this in a number of ways, including adding a new supercomputer, building two full-ocean depth elevators/landers for oceanographic research, and establishing a new underwater robotic vehicle program.

HIGH-PERFORMANCE COMPUTING

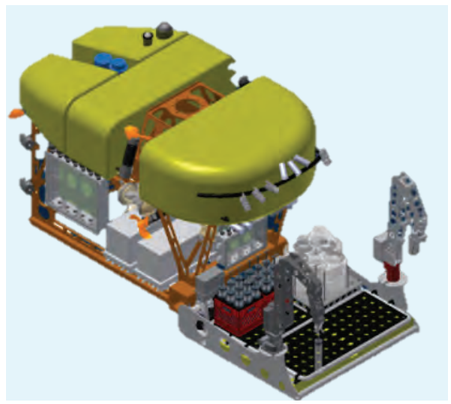
As of 2015, research teams on *Falkor* will have access to the ship's new cloud-based supercomputer, which offers massive storage and processing capabilities. This is important to scientists who often must wait until they are back in their shore-based labs to process their data. The new *Nebula One* system provides high performance computing capacity and enables scientists on *Falkor* to run complex process simulations. In some cases this will make real-time modeling possible at sea, with the potential to improve field observations and sampling programs.

1 *New Super Computer*

2 *Full-ocean depth elevators/landers*

& *an underwater robotic vehicle program.*

BY THE NUMBERS



OCEAN LANDERS

Schmidt Ocean Institute commissioned development of two innovative underwater landers that were built this year for exclusive use on *Falkor*. The elevator/lander systems brings instruments up and down the water column independently, with the capability to travel to full ocean depth. The landers were the first of their kind to be built using syntactic foam that reduces their size and weight. Modular bases allow for a variety of scientific instruments to be added. These new landers were used on our first expedition to the Mariana Trench, in November.

UNDERWATER ROBOTIC VEHICLES

Schmidt Ocean Institute always looks to progress ocean research through the use of technologically advanced infrastructure. The largely unexplored, deepest parts of the ocean comprise a collective area almost as large as Australia. However, only four vehicles have ever been able to work safely at full-ocean depth (11,000 m), and none are currently in operation. In 2014, Schmidt Ocean Institute completed preliminary designs for development of a full-ocean depth robotic research vehicle. The Hybrid Remotely Operated Vehicle (HROV), will be completed in a phased approach for exclusive use on *Falkor*. The planned vehicle will offer a full spectrum of instrumentation, including two robotic manipulator arms, sensors, advanced lighting, and camera systems for live 3D-HD video.

TOP IMAGE
Falkor is the first ship with a cloud-based high performance computing system on board.

BOTTOM IMAGE
The HROV development path is expected to include the design and construction of a series of ROVs each successively greater in capability, culminating in the delivery of a full-ocean depth (11,000 m) capable HROV.

Making Connections and Inspiring Others

Many new and continuing initiatives were undertaken during the last year to share the cutting-edge science occurring on *Falkor*. We do this by producing content and engaging with our audiences in ways that allow them to experience the spirit of ocean exploration and excitement for learning. In 2014, we did this through presentations, ship tours, class visits, press, social media, and our website.

OUTREACH

Schmidt Ocean Institute and our collaborators were proud to share some of the exciting outcomes from research completed on *Falkor* with both international and national audiences. Over 25 presentations were given to institutions in 20 cities across 10 countries. Collaborating scientists shared their analyses of data collected on *Falkor* through 45 academic publications and presentations in 2014. Work aboard *Falkor* also contributed to several graduate students' dissertations.

Schmidt Ocean Institute aims to inspire the communities that we work in. This year we offered ship tours to over 100 people in Hawaii and Guam, the two primary locations where *Falkor* was docked. We interacted with local communities by offering teacher workshops, public lectures, and classroom visits. Thirteen classrooms received presentations with hands-on science activities and live connections with scientists during cruises. Middle and high school classes from Hawaii, Guam, Ireland, and Australia all participated in these exciting activities.

MEDIA

In 2014, more than 250 news stories covering Schmidt Ocean Institute expeditions appeared in international and national television, radio, print, and web outlets. The deepest fish ever documented, during our expedition in the Mariana Trench, made waves online and in the press. The video of the "ghost fish" was viewed by millions. Schmidt Ocean Institute's YouTube page received 1,450,461 views in 2014, the equivalent of three and a half years watching content on our site. Additionally, we were proud to have one of our 2013 cruises on *Falkor* featured this year in the documentary Reaching Blue, produced by Ocean Networks Canada, which was screened at five film festivals in 2014. The Hawaii-based All Things Marine radio show also partnered with Schmidt Ocean Institute, broadcasting live from *Falkor* during four different research cruises.

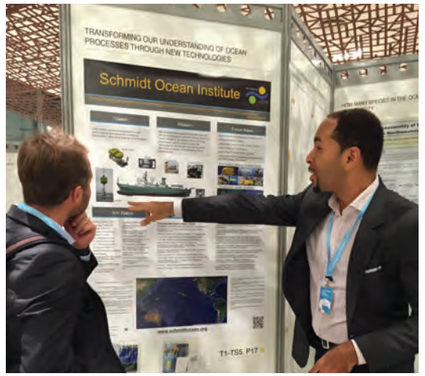
WEB PRESENCE

Schmidt Ocean Institute's website is the hub of information sharing, offering daily blog updates during cruises and a taste of the numerous research programs that we host. In 2014, we posted over 110 blogs and exceeded 186,000 sessions for over 621,000 page views by computer users in 200 countries. Sixty-eight percent of these were new visitors to the website. We also acquired a significant rise in users on our social media channels; with Facebook up by 6% and Twitter up by over 35%.

TOP IMAGE
Schmidt Ocean Institute's Leonard Pace gives a presentation at the 2014 International Ocean Research Conference in Barcelona, Spain.

BOTTOM IMAGE
Lead Marine Technician Leighton Rolley was interviewed by Hawaii press following *Falkor*'s return from Loihi Seamount.

OPPOSITE PAGE
The University of Hawaii Lab School students connect with Professor Mike Coffin to learn about mapping at the Ontong Java atoll.



10,270
viewers on Facebook

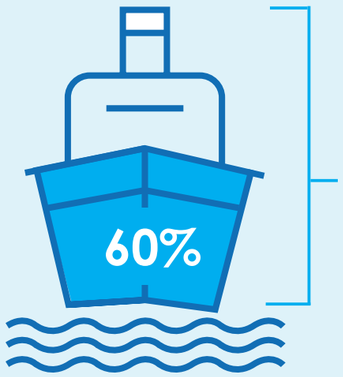
4,447
viewers on Twitter

106,663
connections on Google+

BY THE NUMBERS

Numerically Speaking

A VISUAL YEAR IN REVIEW



Falkor led **NINE EXPEDITIONS,** and spent **171 DAYS AT SEA,**

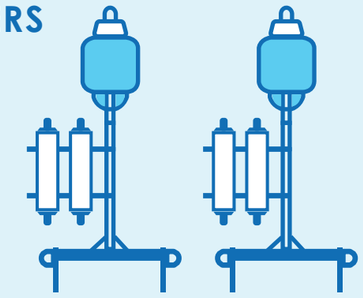
a 60% increase since last year.

She sailed **40,362 km** and mapped **227,110 km²** of ocean floor.

We hosted **131 SCIENCE COLLABORATORS, 82 STUDENTS,** and **540 VISITORS** aboard the ship.

TWO NEW FULL-OCEAN DEPTH LANDERS were built this year, and over

95 LANDER DEPLOYMENTS occurred off *Falkor*.



1.4 MILLION+ YOUTUBE VIEWS, the equivalent of **3.5 YRS** spent on our site.

18 SEAMOUNTS, NINE UNNAMED, were mapped in the Papahānaumokuākea Marine National Monument

Schmidt Ocean Institute obtained a **CLOUD-BASED SUPER COMPUTER**, for use on *Falkor*

Schmidt Ocean Institute gave **25 PRESENTATIONS** in **14 COUNTRIES**.

ROV ROPOS was used in 2013 off of the west coast of Canada to study life in lower-oxygen zones.

OPPOSITE PAGE:
The wet lab on *Falkor* used for processing samples. During the Open Ocean to Inner Sea cruise, scientist analyzed the oxygen levels in water samples collected with the CTD and water sampling system on *Falkor*.

Looking Back:

Research Updates from 2013 Expeditions

IMAGING THE K-T IMPACT STRUCTURE

Campeche Escarpment, Chief Scientist Charlie Paull, MBARI

The objective of this cruise was to map the entire northern face of the Campeche Escarpment, which exposes the geological remnants of the massive asteroid or comet impact thought to have caused the dinosaurs' extinction. The team used bathymetry collected aboard *Falkor*, along with existing data, to identify where deposits associated with the impact were exposed. Dr. Charlie Paull hopes to return to the region to collect samples that might illuminate this critical event in Earth's history. The first paper from this cruise was published this year in the journal *Marine Geology*, demonstrating that stratigraphic sections associated with the asteroid's impact are exposed and available for sampling. Detailed bathymetric maps of the Campeche Escarpment were presented in October at the Geological Society of America conference and evidence for a previously unknown distant history of landslides and resulting tsunamis tied to the Escarpment were presented at the 2014 American Geophysical Union (AGU) fall meeting.

HABITAT CHARACTERIZATION FOR DEEP-SEA CORAL REEF COMMUNITIES

Honduras, Chief Scientist Peter Etnoyer, NOAA National Centers for Coastal Ocean Science

In 2013, the *Falkor* team completed the first-ever high-resolution map of deep reefs near the island of Roatan. Now,

scientists and even the general public can view the seafloor at resolutions in the 5-10 m range. In one day, *Falkor*'s crew mapped a few hundred square kilometers of the continental slope in depths from 100-2,500 m, amounting to nine percent of the Meso-American Reef off Honduras. The maps have allowed researchers to target the most interesting portions of the reefs for exploration, and raised interest in the Meso-American Reef area. For example, *Falkor*'s mapping activities helped inspire an E/V *Nautilus* expedition to explore Roatan and nearby Belize in August 2014. The *Nautilus* team was able to map 15% of the Meso-American Reef slope off Belize. These are the first ROV explorations of the Meso-American Reef deeper than 300 m, and the first real-time observations of deep-sea corals and sponges in the region. The bathymetric data from the *Falkor* work is now publicly available in NOAA's National Geophysical Data Center. Additionally, the maps were part of a poster presentation at the Benthic Ecology Meeting in March.

HYDROTHERMAL EXPLORATION OF MID-CAYMAN RISE USING HROV NEREUS

Mid Cayman Rise, Cayman Islands, Chief Scientist Chris German, WHOI

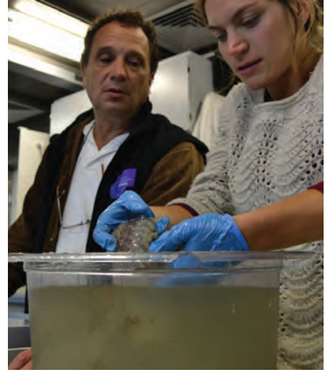
This cruise marked only the second time that HROV Nereus was used purely on a research expedition. Surveys using the vehicle led to the discovery of a novel form of low-temperature seafloor fluid flow, which the team observed at multiple sites around a group of subsea mountains on the Mid-Cayman Rise called the Mt. Dent oceanic core complex. The expedition was a successful test of Nereus's research capabilities. The investigations extended the known range of physical conditions under which seafloor hydrothermal venting and associated chemically-fueled life can exist on Earth.

Working at the Von Damm and Piccard hydrothermal vent fields, the team collected shrimp living in association with the vents. Team members Drs. Cindy Van Dover and Max Coleman were able to dissect one shrimp species, *Rimicaris hybisae*, for the first time. Through gut analyses they discovered that the species can be carnivorous, possibly in response to habitat conditions or their molting cycle. Researchers have presented findings from this cruise at the European Geophysical Union General Assembly Meeting, the Biosignatures Meeting, hosted by the Nordic Institute of Astrobiology, and at the AGU fall Meeting. They also published articles on the National Aeronautics and Space Administration (NASA) Jet Propulsion Laboratory's website and Spiegel Online. This research would not have been possible without the support of NASA and the National Science Foundation (NSF).

OPEN OCEAN TO INNER SEA: DYNAMICS OF HYPOXIA

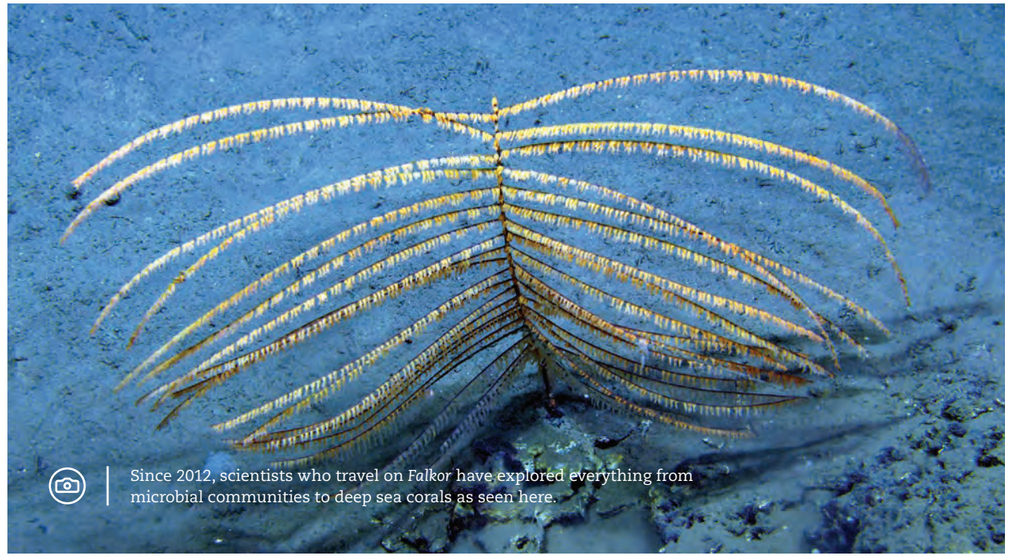
Vancouver Island, Canada, Chief Scientist Kim Juniper

The overarching goal of this project was to map the patterns, pathways, and habitats of low-oxygen ecosystems. The team completed 16 dives with ROV ROPOS, and conducted over 2,800 water column profiles, resulting in extensive mapping of the distribution of low-oxygen water at sites around Vancouver Island. Surveys of animals associated with these hypoxic conditions were also completed. This cruise marked the first time such large-scale work had been conducted to complement ongoing research at the region's two seafloor observatories. Data from this project is now shared through the Ocean Networks Canada Data Management Portal, where data collected from *Falkor* can be plotted and downloaded.



TOP IMAGE
Falkor transits to her next location after a full day of science operation

BOTTOM IMAGE
Scientists examine an anemone off the west coast of Canada.



Since 2012, scientists who travel on *Falkor* have explored everything from microbial communities to deep sea corals as seen here.

SUBSEAFLOOR MICROBIAL ECOSYSTEMS AT AXIAL SEAMOUNT

Axial Seamount, British Columbia, Canada, Chief Scientist Julie Huber

Researchers collected hydrothermal fluid samples around Axial Seamount to study the community of microbes living within the seamount's rocky outer layer, including their genetics. The team evaluated growth, metabolite production, and energy consumption rates and worked to determine chemical and isotope signatures for these subseafloor communities. They collected fluid samples using ROV ROPOS to achieve a deeper understanding of how the viral and microbial communities interact and alter the flow of carbon and nutrients in this ecosystem. The researchers are using this data to inform the development of a holistic ecosystem model that will estimate primary productivity for poorly understood subseafloor microbes. Using results from *Falkor*, the team designed, constructed, and successfully tested an *in situ* incubation instrument at Axial Seamount in August 2014 used to collect and preserve warm hydrothermal vent fluid from the seafloor. They are comparing resulting data to data collected aboard *Falkor* in 2013, and presented this research at the Gordon Research Conference on Marine Microbiology, the International Society for Microbial Ecology Conference, the Ninth International Symposium on Subsurface Microbiology, and at the AGU fall meeting.

The science team views a dive with ROV ROPOS from *Falkor's* control room.

OPPOSITE PAGE:
The scenic base of the Escargot sulfide structure examined during the 2013 Axial Seamount expedition.

Publications and Presentations Resulting from Cruise Data

JOURNALS:

Estapa, M.L., J.A.Breier & C.R.German. Particle dynamics in the rising plume at Piccard Hydrothermal Field, Mid-Cayman Rise. *Earth Planet*. Sci. Lett., in review.

Garcia-Pineda, O., I. MacDonald, & W. Shedd. (2014). Analysis of Oil-Volume Fluxes of Hydrocarbon-Seep Formations on the Green Canyon and Mississippi Canyon: A Study With 3D-Seismic Attributes in Combination With Satellite and Acoustic Data. *Spe Reservoir Evaluation & Engineering* 17(4): 430-435.

Paull, C.K., D.W. Caress, R. Gwiazda, J. Urrutia-Fucugauchi, M. Rebolledo-Vieyra, et al. (2014). Cretaceous – Paleocene boundary exposed: Campeche Escarpment, Gulf of Mexico. *Marine Geology*, 392-400.

Reveillaud, J., E.Reddington, J.McDermott, J.L.Meyer, S.Sylva, J.Seewald, C.R.German & J.A. Huber. Subseafloor microbial communities in hydrogen-rich vent fluids from hydrothermal systems along the Mid-Cayman Rise (in revision).

THESIS/DISSERTATIONS:

McDermott, J.M. (2014). *Geochemistry of Deep-Sea Hydrothermal Vent Fluids from the Mid-Cayman Rise, Caribbean Sea*. WHOI-MIT Joint Program.

CONFERENCE PAPERS AND ACADEMIC PRESENTATIONS:

Ajemian, M.J., J.J. Wetz, M.K. Streich, & G.W. Stunz. (2014). Fish community assessment on artificial reefs of the western Gulf of Mexico: Potential impacts of 'Rigs-to-reefs' programs. Invited Seminar, University of Alicante, Alicante, SPA.

Ajemian, M.J., J.J. Wetz, & G.W. Stunz. (2014). Surveying Texas' Big Reefs: A micro-ROV survey methodology for submerged oil and gas platforms. *Annual Meeting of the Gulf States Marine Fisheries Commission*. Gulfport, MS.

Daneshgar Asl, S., J. Amos, P. Woods, O. Carcia Pineda, & I.R. MacDonald. (2014). Aerial survey validation of satellite SAR monitoring of anthropogenic hydrocarbon discharges in the Gulf of Mexico. Poster Presentation for *Gulf of Mexico Oil Spill & Ecosystem Science Conference*, Mobile, AL, USA.

Fisher, C. (2014). Footprint of impact from the Deepwater Horizon Incident. *Gulf of Mexico Ecosystem Research Conference*, Mobile, AL, USA.

Fisher, C. (2014). Corals as deep-water sentinels of anthropogenic impact: Lessons from the Deepwater Horizon oil spill. T*ech Week: Deep Blue Days*, Brest, France.

16 *Cruises*

4 *Papers*

41 *Presentations*

BY THE NUMBERS

Fisher, C. (2014). Impact of oil pollution from the Deepwater Horizon spill on deep water ecosystems. *Norwegian Ecotoxicology Symposium*, Stavanger, Norway.

Fisher, C. (2014). The deep water coral record of the Deepwater Horizon spill. *Earth Talks*, Penn State University, PA.

Fortunato, C.S. and coauthors. (2014) Using RNA-SIP and metatranscriptomics to determine the active autotrophic subseafloor microbial communities at Axial Seamount. *International Society for Microbial Ecology 15th International Symposium*, Seoul, South Korea.

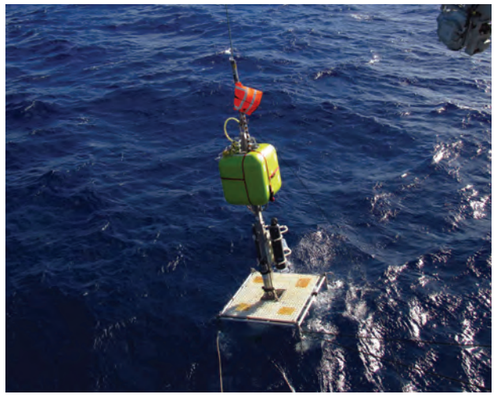
German, C.R. (2014). Hydrothermal exploration in distant oceans: Oases for life on Earth and Beyond." Invited paper at *Biosignatures Meeting* (Nordic Institute for Astrobiology), Bergen, Norway.

Hicks, D.W., L. Lerma, J. Le, T.C. Shirley, J.W. Tunnell, R. Rodriguez, & A. Garcia. In press. Assessing fish communities of six remnant coralgal reefs off the South Texas coast. *Proceedings of the 66th Gulf and Caribbean Fisheries Institute*, Corpus Christi, TX, USA.

TOP IMAGE
University of Hawaii graduate students arrive at *Falkor* during the second leg of the April student cruise.

BOTTOM IMAGE
Captain Heiko Volz gives a big welcome to a new science team on *Falkor's* outdoor lounge.

The sun sets on *Falkor*'s rosette and water sampling system.



Holden, J.F. and coauthors. (2014). Growth and methane production by high-temperature methanogens in hydrothermal regions of the subseafloor. *Korean Institute for Ocean Science and Technology, Ansan, South Korea & Department of Marine and Coastal Sciences, Rutgers University*, New Brunswick, NJ, USA & Program in Atmospheres, Oceans, and Climate, Massachusetts Institute of Technology, Cambridge, MA, USA.

Holden, J.F. and coauthors. (2014). Reactive transport model of growth and methane production by high-temperature methanogens in hydrothermal regions of the subseafloor. *Ninth International Symposium on Subsurface Microbiology*, Pacific Grove, CA, USA.

Huber, J.A. (2014). Subseafloor microbial life in venting fluids from the Mid Cayman Rise hydrothermal system. *Deep Carbon Observatory Deep Life Meeting*. Portland, OR, USA.

Huber, J., C. K. Algar, L. Zeigler Allen, D. A. Butterfield, C.S. Fortunato, et al. (2014). Investigating Microbes, Viruses, and Carbon Across Thermal and Chemical Gradients in the Subseafloor at Axial Seamount. Poster Presentation at *Gordon Research Conference on Marine Microbiology*, Waltham, MA, USA.

Huber, J.A. and coauthors. (2014). Application of RNA Stable Isotope Probing (SIP) to link community activity with microorganisms responsible for autotrophy in the subseafloor at Axial Seamount. *AGU Fall Meeting*, San Francisco, CA, USA.

IMAGE 1: The last lander deployment of the first Mariana Trench cruise.

IMAGE 2: The crew provides training on the aft deck of *Falkor*.

IMAGE 3: An empty CTD and water sampling frame is lifted off the aft deck of *Falkor*.

Janson, X., G. Hurd, & C. Kerans. (2014). Carbonate Gullies, Channels and Canyons Morphometrics, Annual research conference of the Reservoir Characterization Research Laboratory. University of Texas, Austin, TX.

Johansen, C., A.C. Todd, W. Dewar, W. Shedd, & I.R. MacDonald. (2014). Quantifying the volume and frequency of bubble release from hydrocarbon seeps in the *Gulf of Mexico*. *Poster Presentation for Gulf of Mexico Oil Spill & Ecosystem Science Conference GC600*, Mobile, AL, USA.

Joye, S.B., & A.P. Teske. (2014). Microbiology of Gulf of Mexico sediments and waters before and after the Macondo Blowout. *Gulf Oil Spill and Ecosystem Science Conference*.

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Kelly, C. (2014). 72 Days on the *Falkor*: New Maps and New Insights on the Seamounts and Banks in the Papahānaumokuākea Marine National Monument. Seminar Presentation for the Hawaii Institute of Marine Biology, University of Hawai'i, Mānoa, HI, USA.

Khanna, P., A.W. Droxler, & J. A. Nittrouer. (2014). Uppermost Pleistocene Banks along the South Texas Shelf Edge: A Clear Case of Drowning Based Upon Their Morphologies. *American Association of Petroleum Geologists Annual Meeting*, Houston, TX, USA.

Kleindienst, S., S. Grim, M. Seidel, et al. (2014). The microbial response to the Deepwater Horizon deep-sea plume. *Goldschmidt 2014 Meeting*. Sacramento, CA.

Klymak, Jody, Susan Allen, Richard Dewey, Stephanie Waterman, Rich Pawlowicz & Steven Mihaly. (2014). Evidence for cross-shelf exchange catalyzed by a coastal canyon. Poster Presentation at *Canadian Meteorological and Oceanographic Society*, Rimouski, Quebec, Canada.

MacDonald, I., C. Johansen, M. Silva, O. M. Garcia Pineda, & W. Shedd. (2014). Short- and Long-Term Dynamics of Gas Hydrate at GC600: A Gulf of Mexico Hydrocarbon Seep, Abstract OS11C-05. *AGU Fall Meeting*. San Francisco, CA.

McDermott, J.M., J.S Seewald, C.R. German & S.P. Sylva. (2014). Constraints on hydrocarbon and organic acid abundances in hydrothermal fluids at the Von Damm vent field, Mid-Cayman Rise. *American Geophysical Union Fall Meeting*, San Francisco, CA, USA.

Nash, H. L., J. Tunnell, Jr., & T. C. Shirley. In press. Mapping the South Texas Banks. Oral Presentation for *Proceedings of the Gulf and Caribbean Fisheries Institute*. Corpus Christi, TX, USA.

Orcutt, B.N., L. Lapham, P. Girguis, C.G. Wheat, K. Marshall, & J. Delaney. (2014). The Microbial Methane Observatory for Seafloor Analysis (MIMOSA): Long-term coupled geochemistry and microbiology experimentation in the deep-sea. *Goldschmidt 2014 Meeting*. Sacramento, CA.

Paull, C.K. (2014). Preliminary Source Characterization and Tsunami Modeling of Submarine Landslides along the Yucatan Shelf/ Campeche Escarpment, southern Gulf of Mexico. Poster Presentation for American *Geophysical Union Fall Meeting*, San Francisco, CA, USA.

Paull, Charles, David W. Caress, Roberto Gwiazda, Jaime Urrutia-Fucugauchi, Mario Rebolledo-Vieyra, Eve Lundsten, Krystle Anderson & Esther Sumner (2014). Extensive K-PG Boundary Outcrops Closest to the Chicxulub Impact Crater Identified in New Bathymetric Maps of the Campeche Escarpment. Oral Presentation at *Geological Society of America Annual Meeting*, Vancouver, Canada.

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Falkor spent two months in dry dock receiving upgrades to enhance her sea-going performance.

OPPOSITE PAGE:
Falkor docked in Hawaii

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