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Expedition Cruise Report

Cruise EX-17-06 Laulima O Ka Moana: Exploring Deep Monument Waters Around Johnston Atoll (ROV/Mapping)

Cruise Report

Remotely Operated Vehicle (ROV) and Mapping Exploration of the Johnston Atoll Unit of the Pacific Remote Islands Marine National Monument

July 7 to August 2, 2017

Honolulu, Hawai‘i to Honolulu, Hawai‘i

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Abstract

EX-17-06 was a combined mapping and ROV cruise to the Johnston Atoll Unit (JAU) of the Pacific Remote Islands Marine National Monument (PRIMNM) that took place between July 7 and August 2, 2017. During the cruise, one ROV test dive was conducted offshore of O'ahu for engineering purposes and 14 ROV science dives were conducted from 250 to 2,600 meters on never before surveyed sites in the JAU to survey the biological and geological variability of oceanic habitats, including deep-sea coral and sponge habitats, ferromanganese (FeMn)-encrusted habitats on seamounts, and the water column biome. Thirteen dives were conducted on JAU seamounts to investigate deep-sea coral communities and FeMn-encrusted seafloor habitats, and one dive was conducted on the flank of Johnston Atoll that documented precious coral *Hemicorallium* sp. communities in this monument unit for the first time. Seven high-density, deep-sea coral and sponge communities that varied in diversity and species composition were discovered during the dives. Focused water column transects were conducted at the end of four dives to obtain information on animals living in the largest unexplored biome on the planet. 77 biological specimens were collected in total including 35 primary specimens and 42 associates consisting of corals, anemones, zoanthids, hydroids, sponges, sea stars, feather stars, brittle stars, squat lobsters, amphipods, shrimps, barnacles, snails, tube worms, bryozoans, polychaete worms, a sea slug, a sea spider, and an isopod. These collections will enable confirmation of new species designations, provide type specimens for descriptions, and enable genetic analyses to establish evolutionary relationships with other known species. As many as 44 of these specimens could represent new species, and most of the specimens from known species will represent new range records. More than 38,300 km^2 of seafloor was mapped during the cruise, including approximately 23,161 km^2 mapped inside the JAU of the PRIMNM. This included full coverage of eight seamounts in the JAU mapped for the first time with sonar and partial coverage of three seamounts. During ROV dives, 24 rock samples were collected for dating and geochemical analyses that will help reveal the geological history of seamount groups in the JAU and help improve understanding of the geological history of central Pacific seamounts.

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1. Introduction

The NOAA Office of Ocean Exploration and Research (OER) is the only U.S. federal program dedicated to exploring our deep ocean, closing the prominent gap in our basic understanding of U.S. deep waters and seafloor and delivering the ocean information needed to strengthen the economy, health, and security of our nation. Using the latest tools and technology, OER explores previously unknown areas of our deep ocean, making discoveries of scientific, economic, and cultural value. Through live video streams, online coverage, training opportunities, and real-time events, OER allows scientists, resource managers, students, members of the general public, and others to actively experience ocean exploration—expanding available expertise, cultivating the next generation of ocean explorers, and engaging the public in exploration activities. From this exploration, OER makes the collected data needed to understand our ocean publicly available, so we can maintain the health of our ocean, sustainably manage our marine resources, accelerate our national economy, and build a better appreciation of the value and importance of the ocean in our everyday lives.

NOAA Ship *Okeanos Explorer* is the only U.S. federal vessel dedicated to exploring our largely unknown ocean for the purpose of discovery and the advancement of knowledge. America's future depends on understanding the ocean. Exploration supports NOAA mission priorities and national objectives by providing a broad diversity of data and information about the deep ocean to anyone who needs it.

In close collaboration with government agencies, academic institutions, and other partners, OER conducts deep-sea exploration expeditions using advanced technologies on NOAA Ship *Okeanos Explorer*. From mapping and characterizing previously unseen seafloor to collecting and disseminating information about deep waters and seafloor—and the resources they hold—this work establishes a foundation of information and fills data gaps. Data collected on the ship adhere to federal open-access data standards and are publicly available shortly after an expedition ends. This ensures the delivery of reliable scientific data needed to identify, understand, and manage key elements of the ocean environment. As the only federal program dedicated to ocean exploration, OER is uniquely situated to lead partners in delivering critical deep-ocean information to managers, decision makers, scientists, and the public, leveraging federal investments to meet national priorities.

2. Expedition Overview

From July to August 2017, NOAA and partners conducted a telepresence-enabled ocean exploration expedition on NOAA Ship *Okeanos Explorer* to collect critical baseline information about unknown and poorly known deepwater areas in the JAU of the PRIMNM.

The 27-day expedition was divided into two parts: the first four days of the cruise were dedicated to shakedown operations (field tests of ship systems following a repair period) in the vicinity of Oʻahu while the remaining 23 days involved transit to and from the JAU where the ship conducted daily daytime ROV dives and overnight mapping operations.

- July 7-10: Shakedown operations offshore Oʻahu
- July 11-12: Transit to the JAU of the PRIMNM
- July 13-29: Daily ROV dives and overnight mapping in the JAU
- July 30-August 2: Transit and pull into port in Honolulu, Hawaiʻi

Baseline data from this expedition will help to improve our understanding of the geologic history and deep-sea habitats of the JAU. Data will also provide critical information for the development of management plans for marine protected areas; support local scientists and managers seeking to understand and manage fisheries resources; and provide a foundation of information to stimulate follow-on exploration, research, and management activities.

A. Rationale for Exploration

The 2017 expedition addressed science themes and priority areas put forward by scientists and managers from NOAA, monument management agencies, and the broad ocean science community. Operations complemented previous and planned work in the area. This expedition was part of NOAA's three-year Campaign to Address the Pacific monument Science, Technology, and Ocean NEeds (CAPSTONE), a major, multi-year effort to collect a foundation of baseline information in unknown and poorly known deepwater areas of U.S. marine protected areas (MPAs) in the central and western Pacific Ocean (Kelley et al., 2016).

Johnston Atoll and the surrounding 200 nm U.S. Exclusive Economic Zone (EEZ) comprises the JAU of the PRIMNM. The PRIMNM also consists of the waters around Howland, Baker, and Jarvis Islands as well as the atolls Wake, Palmyra, and Kingman Reef, which all lie to the south and west of Hawaiʻi. The PRIMNM is one of the largest marine protected areas (MPAs) in the world and an important part of the most widespread collection of marine life on the planet under a single country's jurisdiction.

More than 99% of the JAU is deep water. While some mapping had been conducted in this monument unit prior to the start of CAPSTONE, much remains unknown. Previous mapping efforts in the JAU include GLORIA side-scan sonar surveys (1990-1991), R/V *Atlantis II* surveys to Horizon Tablemount (1987), U.S. Extended continental shelf surveys using R/V *Kilo Moana* (2017) and the NOAA Ship *Okeanos Explorer* (2009 and later) to Horizon Tablemount and Necker Ridge, bathymetric surveys around Johnston Atoll with NOAA Ship *Hi'ialakai* (2006,

2015) and R/V *Ahi* (2006), and some underway transit data. Exploration of deep-sea habitats in JAU began long before the 2009 establishment of PRIMNM, when the Atoll was a National Wildlife Refuge. Several dozen dives reaching a maximum of 366 meters were conducted around Johnston Atoll in 1983 using the Hawaii Undersea Research Laboratory's *Makali'i* submersible to investigate fisheries resources, macroalgal habitats, and conduct oceanographic studies to support the U.S. Army's Johnston Atoll Chemical Agent Disposal System effort. In 1987, 10 submersible dives were conducted on Horizon Tablemount to investigate sediment transport processes and the geochemical behavior of sediment on seamounts by U.S. Geological Survey using the National Deep Submergence Facility's *Alvin* submersible. Despite all of this work, the vast majority of seamounts and features in the JAU lacked any modern sonar-derived bathymetry or data on seafloor habitats prior to 2015.

Following the 2009 establishment of JAU and the 2014 expansion of this unit out to the 200 nm US EEZ boundary, NOAA and partners initiated exploration of JAU's deepwater habitats in 2015 as part of the Hohonu Moana expedition (https://oceanexplorer.noaa.gov/okeanos/explorations/ex1504/welcome.html, last accessed March 2020) the first expedition in the CAPSTONE series. Operating from aboard the *Okeanos Explorer*, 11 ROV dives explored seafloor and water column habitats in the Johnston and Karin (Sculpin) seamount chains. Mapping operations acquired high-resolution sonar data over the Horizon Tablemount, Karin Ridge, and Johnston Seamount group. In January 2017, the Schmidt Ocean Institute's R/V *Falkor* added to this coverage by mapping six more seamounts in the Johnston Seamount Group.

The 2017 Laulima O Ka Moana Expedition summarized in this report continued the effort to explore and better understand the deep-sea habitats and resources within the JAU. Increasing baseline knowledge of ocean habitats is critical to the conservation of these remarkable ecosystems. Exploratory missions, such as those conducted via NOAA Ship *Okeanos Explorer*, are necessary to expand our knowledge of the unknown and to provide baseline data for resource managers.

Understanding biogeographic patterns between and among the Pacific Monuments and Sanctuaries was a coordinating theme for CAPSTONE science priorities. NOAA priorities for the expedition included a combination of science, education, outreach, and open data objectives that will support management decisions at multiple levels. Themes and objectives for the expedition series included:

- Acquire data to support priority Monument and Sanctuaries science and management needs, including habitat surveys in recently expanded boundary areas;
- Identify and characterize vulnerable marine habitats—particularly potential locations for high-density, deep-sea coral and sponge communities;
- Characterize seamounts within the Prime Crust Zone (PCZ). The PCZ is the area of the Pacific with the highest expected concentration of deep-sea minerals, including rare metals and rare earth elements;

- Collect information on the geologic history of central Pacific seamounts, including those that are or may be relevant to our understanding of plate tectonics and subduction zone biology and geology; and
- Provide a foundation of publicly accessible data and information products to spur further exploration, research, and management activities.
- Collect high resolution mapping data from all sonars in priority areas as dictated by operational needs as well as science and management community needs.

This expedition explored a number of areas of the JAU for the first time. Data and information from the expedition will be used in the development of Monument management plans, and provide a foundation to stimulate follow-on exploration, research, and management activities.

B. Objectives

EX-17-06 operations occurred in the U.S. EEZ waters surrounding Hawai‘i and Johnston Atoll, and the high seas areas during transit to and from the JAU. This cruise followed a dry dock period, and seagoing operations were divided into two parts. July 7 to 10 was four days dedicated to shakedown and calibration operations in the vicinity of O‘ahu. From July 11 to August 2, the expedition transited to and from the JAU and conducted ROV and multibeam surveys within the JAU to collect baseline data and information to support priority NOAA science and management needs. This cruise report focuses on the July 11 to August 2 JAU exploration portion of the cruise.

<u>July 7-10, 2017: Shakedown in Hawai‘i</u>

Mission objectives during shakedown period included:

1. ROV Engineering
    a. Calibrate Ultra-short baseline (USBL) transducer;
    b. Conduct shakedown ROV dive and work with Kraft manipulator. Continue training on new tools; and
    c. Conduct “dry run” of emergency ROV recovery with deck crew.

2. Video Engineering (Very Small Aperture Terminal (VSAT) ~15 mb/sec ship-to-shore; 2.5 mb/sec shore-to-ship)
    a. Test terrestrial and high-speed satellite links, and
    b. Ensure all systems are fully functional after the power off at dry dock.

3. Mapping
    a. Conduct Global Positioning System (GPS) Azimuth Measurement Subsystem (GAMS) calibration;
    b. Conduct multibeam patch test;
    c. Conduct 38 kHz and 300 kHz Acoustic Doppler current profiler (ADCP) calibration lines during transit out of harbor;

d. Conduct calibration of 38 kHz ADCP in deep water;
e. Assess Reson sound velocity probe (SVP) probe following cable repairs; if possible compare the SVP probe with the shipboard conductivity, temperature, and depth (CTD) cast;
f. Assess expendable bathythermograph (XBT) hand launcher to confirm the cabling was not impacted by dry dock activities; and
g. Test new, secondary sound velocity profiling computer (pending installation status).

4. Data Management
    a. Bring storage systems back online and confirm file systems are intact;
    b. Ensure timestamping systems are functional;
    c. Ensure "Warehouse" computers are functional; and
    d. Conduct normal pre-cruise checks.

5. Ship
    a. Conduct four days of Dynamic Positioning (DP) system testing and train personnel;
    b. Conduct emergency/safety drill within 24 hours of departure;
    c. Conduct CTD test cast;
    d. Conduct shipboard maneuvers and a full run of systems to evaluate readiness; and
    e. Fuel on day of departure.

<u>July 11-August 2, 2017: Exploration of the JAU of the PRIMNM</u>

Mission objectives for EX-17-06 included a combination of mapping/operational, science, education, outreach, and data management objectives:

1. Science
    a. Acquire data to support priority Monument and Sanctuary science and management needs;
    b. Explore the diversity and distribution of benthic habitats—including precious coral habitats, and high-density, deep-sea coral and sponge communities;
        i. Collect data on habitat size and extent, animal diversity and density;
        ii. Focus close-up imaging operations on potential new, rare, and poorly documented animals—as well as dominant members of the communities;
        iii. Collect and preserve biological samples of potential new species, new records, dominant community members if not easily recognized, and other animals to aid in site characterization;
    c. Characterize seamounts in and around the Prime Crust Zone (PCZ). The PCZ is the area of the Pacific with the highest concentration of commercially valuable deep-sea minerals;

d. Collect biological and geological data at sites to aid the understanding of the geologic history of Pacific seamounts;
e. Conduct ROV water column transects to acquire data on this largely unknown biome;
f. Continue to refine specimen collection protocols and processing procedures;
g. Ground-truth acoustic data using video imagery and characterize associated habitat (if relevant);
h. Engage a broad spectrum of the scientific community and public in telepresence-based exploration;
i. Successfully conduct operations in conjunction with shore-based Exploration Command Centers (ECCs) and remote science team participants; and
j. Create and provide input into standard science products to provide a foundation of publicly accessible data and information products to spur further exploration, research, and management activities.

2. Remote Science/ECCs
   a. Provide operational support and training to scientists and managers to enable remote participation in at-sea operations;
   b. Facilitate outreach and engagement activities and events at the ECCs;
   c. Test and refine ship-to-shore communications procedures that engage multiple ECCs and other remote participants;
   d. Test and refine operating procedures and products.

3. ROV Engineering
   a. Daytime ROV dives on exploration targets;
   b. Ongoing training of pilots;
   c. Ongoing system familiarization, documentation, and training;
   d. Test and refine new ROV systems and pilot sampling protocol.

4. Video Engineering (VSAT ~15 mb/sec ship-to-shore; 2.5 mb/sec shore-to-ship)
   a. Test terrestrial and high-speed satellite links;
   b. Support telepresence-enabled ROV operations;
   c. Collect/create all standard video products;
   d. Continue to refine new highlight video standard operating procedures (SOPs);
   e. Facilitate live outreach events between ship and shore;
   f. Test and refine updated video product workflows;
   g. Monitor and improve video/data timestamp agreement;
   h. Test new low latency protocols—Web real-time communication (WebRTC) and Phenix peer-to-peer (PhenixP2P) for commodity Internet users;
   i. Ensure all systems are fully functional after the power off at dry dock
   j. Work to repair ship-to-shore connectivity with the Real-Time Syndication Intercom System.

5. Mapping
    a. Collect high-resolution mapping data from all sonars in priority areas, as dictated by operational needs—as well as science and management community needs;
    b. Support planning of ROV operations with mapping products and visualization;
    c. Conduct mapping operations during transit(s), with possible further development of exploration targets;
    d. Collect XBT casts, as data quality requires, during mapping operations;
    e. Create daily standard mapping products;
    f. Collect sun photometer measurements as part of an ongoing Exploration Project of Opportunity (EPO) with the National Aeronautics and Space Administration (NASA);
    g. Continue to test the integration of the new Simrad EK60 split-beam frequencies and the ADCPs;
    h. Continue to train new Survey Technician on mapping operations and SOPs;
    i. Continue to integrate Qimera into standard multibeam bathymetric data processing routines; and
    j. As necessary, conduct contingency mapping on days where ROVs dives are not possible due to weather or other delays.

6. Data Management
    a. Provide a foundation of publicly accessible data and information products to spur further exploration, research, and management activities;
    b. Provide daily products to shore for operational decision-making purposes;
    c. Monitor and improve video/data timestamp agreement;
    d. Refine and formalize updated data management and video product workflow checklists and SOPs;
    e. Continue implementation of system and process monitoring software;
    f. Cross-train existing ROV dedicated personnel; and
    g. Ensure all systems are fully functional after the power off at dry dock.

7. Outreach
    a. Engage the general public in ocean exploration through live video and timely content (daily updates, topical essays and web logs, highlight videos, video clips, still imagery, and mapping products) posted on the Ocean Explorer website;
    b. Conduct ship tours for the partners and officials while in port in Honolulu, HI;
    c. Conduct Facebook Live event before commencing ROV operations to raise awareness of upcoming dives;
    d. Host live event with the NOAA Inouye Regional Center (IRC) Science Camp;
    e. Conduct live interaction with the National Museum of Natural History (USNM)—the “Expert is In“;
    f. Live interaction with the Exploratorium;
    g. Host live interactions with OER’s Professional Development Workshop;
    h. Live interaction with the National Transportation Safety Board (NTSB) at the Silver Spring ECC;

i. Live interaction with the new National Centers for Environmental Information (NCEI) Director to introduce her to telepresence operations and how NCEI supports NOAA Ship *Okeanos Explorer* operations at the Stennis Space Center ECC.

8. Ship
    a. Provide a high-quality, stable Internet connection with the new VSAT;
    b. Provide stable and reliable Voice over Internet Protocol (VoIP) telecommunications; and
    c. Continue training new deck department personnel in ROV launch and recovery.

C. List of participants

List of participants are listed in Table 1A and Table 1B listing at sea mission personnel and shore based science team respectively.

Table 1A: List of at-sea mission personnel.

Name	Role	Affiliation
Kelley Elliott	Expedition Coordinator	OER
Christopher Kelley	Biology Science Lead	University Corporation for Atmospheric Research (UCAR)/University of Hawai‘i (UH)
Christopher Mah	Biology Science Lead	UCAR/Smithsonian Institution (SI) National Museum of Natural History (USNM)
Matthew Dornback	Sample Data Manager	National Centers for Environmental Information (NCEI)
Mashkoor Malik	Mapping Lead	OER
Kevin Jerram	Mapping Watchstander	UCAR
Neah Beachler	Mapping Watchstander	UCAR
Nikola Rodriguez	EPP Intern	NOAA Educational Partnership Program (EPP)
Daniel Rogers	ROV Dive Supervisor	Global Foundation for Ocean Exploration (GFOE)
Fernando Aragon	ROV Engineering Team/ Data Management	GFOE
Josh Carlson	ROV Engineering Team/ Data Management	GFOE

Andy Lister	ROV Engineering Team	GFOE
Levi Unema	ROV Engineering Team	GFOE
Dave Casagrande	ROV Engineering Team	GFOE
Sean Kennison	ROV Engineering Team	GFOE
Chris Ritter	ROV Engineering Team	GFOE
Don Liberatore	ROV Engineering Team	GFOE
Dave Wright	ROV Engineering Team	GFOE
Emily Narrow	Video Engineering Team	GFOE
Tara Smithee	Video Engineering Team	GFOE
Roland Brian	Video/Telepresence Engineering Team	GFOE
Annie White	Video Engineering Team	GFOE
Bob Knott	Video/Telepresence Engineering Team	GFOE

Table 1B: List of shore-based science team members. These members participated from remote ECCs and from their home locations. Further information about the participation model/mode can be found in Section 3(D) of this report.

Name	Affiliation	Expertise	Participation Location
Abby Lapointe	University of Hawai‘i (UH)	Corals	UH ECC
Amanda Netburn	Florida Atlantic University (FAU) Cooperative Institute for Ocean Exploration, Research & Technology (CIOERT)/OER	Pelagic ecology	Silver Spring (SS) ECC
Amy Baco-Taylor	Florida State University	Benthic ecology, seamounts, deep-sea corals, genetics	FL
Asako Matsumoto	Planetary Exploration Research Center (PERC)/Chiba Institute of Technology (CIT), Japan	Octocorals, deep-sea coral, taxonomy	Japan
Brian Greene	Association for Marine Exploration	Mesophotic fishes	FL
Bruce Mundy	NOAA National Marine Fisheries Service (NMFS) Pacific Islands Fisheries Science Center (PIFSC)	Ichthyology—fish taxonomy, fish identification, fish biogeography	HI

Denise Breitburg	Smithsonian Environmental Research Center	Gelatinous zooplankton ecology	HI
Dhugal Lindsay	Japan Agency for Marine-Earth Science and Technology (JAMSTEC)	Midwater biology, particularly jellyfishes	Japan
Donald Kobayashi	NOAA NMFS PIFSC	Biological oceanography, larval fish, pelagic invertebrates, pelagic ecology	HI
Elisabeth Mcelwee	Woods Hole Oceanographic Institute (WHOI)	Biology	MA
George Matsumoto	Monterey Bay Aquarium Research Institute (MBARI)	Benthic biology, octocoral, cnidaria, biogeography, taxonomy	CA
Heather Judkins	University of South Florida St. Petersburg	Cephalopod ecology and taxonomy, invertebrate zoology	FL
Jaymes Awbrey	University of Louisiana at Lafayette	Octocoral and gastropod taxonomy and systematics	LA
John Smith	UH/School of Ocean and Earth Science and Technology (SOEST)	Marine geology and geophysics, submarine volcanic geomorphology, mapping	HI
Jonathan Tree	UH at Mānoa	Marine geology and geophysics, submarine volcanic geomorphology, mapping	HI
Karen Osborn	USNM	Midwater Biology	SS ECC
Katie Musser	University of Louisiana at Lafayette	Marine Biology	LA
Ken Sulak	U.S. Geological Survey (USGS)	Deep-sea fish ecology and identification	FL
Kevin Kocot	University of Alabama	Invertebrate zoology	AL
Leann Biancani	USNM	Midwater biology	DC
Les Watling	UH at Mānoa	Octocoral taxonomy	HI
Luke McCartin	WHOI	Deep-sea ecology	MA
Mary Wicksten	Texas A&M University	Invertebrate zoology	TX
Megan McCuller	Southern Maine Community College	Bryozoan taxonomy, invertebrate zoology and ecology	ME
Michael Vecchione	NMFS	Cephalopods	HI

Mike Ford	NMFS	Jellyfish	SS ECC
Nadege Aoki	USNM	Polychaete ecology	SS ECC
Nicole Morgan	Florida State University	Benthic biology—corals	FL
Nolan Barrett	FAU Harbor Branch Oceanographic Institute	Visual fish and marine invertebrate identification	FL
Scott France	University of Louisiana at Lafayette	Deep-sea corals, benthic biology and ecology	LA
Sonia Rowley	UH at Mānoa	Benthic biology/Octocorals	HI
Steven Auscavitch	Temple University	Deep-sea corals	PA
Tara Harmer-Luke	Stockton University	Deep-sea hydrothermal vent invertebrates, deep-sea biology	NJ
Timothy Shank	WHOI	Benthic biology	MA
Tina Molodtsova	P.P. Shirshov Institute of Oceanology, Russian Academy of Science (IO RAS)	Deep-sea biology, deep-sea corals, seamount and oceanic ridge fauna	Russia
Tracey Sutton	Nova Southeastern University	Water column ecology and taxonomy	FL

3. Methods

A. Operations Overview

Operations on the NOAA Ship *Okeanos Explorer* were conducted 24 hours per day. Mapping operations were conducted during transits between dive sites (transit mapping) as well as on sites targeted for focused mapping surveys, such as previously unmapped seamounts where dives were planned and previously unmapped seamounts that were not targeted for dives. In this latter case, the mapping was conducted to increase the coverage of the seafloor and reveal the topography of additional seamounts located in the monument.

During EX-17-06, ROV operations were conducted during daylight hours, with mapping operations conducted during non-ROV hours—at night or when ROV operations were cancelled. ROV dives during this expedition ranged in duration from just over four hours to just over 10 hours, depending on factors such as transits, weather, and mechanical issues with the vehicles or ship. ROV dive operations also included the collection of rock samples and biological specimens that were processed for archiving in the ship lab after the ROV was recovered. The ROV was equipped with CTD, dissolved oxygen (DO), light-scattering sensor (LSS), and oxidation reduction potential (ORP) sensors, which collected data continuously during the ROV dives. A summary of products created during this cruise can be found in Appendix A.

During EX-17-06, the onboard science team viewed existing gridded bathymetry data in collaboration with the onshore science team each day and dive tracks were planned for the next day. On occasion, data were too poor or did not exist for a dive site. In these situations, dive goals were discussed the night before, mapping operations were conducted overnight to acquire data of the dive area, and the science leads selected the dive track in the early morning, prior to the dive. Planned dive tracks were plotted in three-dimensions (3D) and shared with the team. Mapping operations were initiated as soon as the ROV was recovered each day and continued throughout the night, until ROV deployment the following day. Kongsberg EM 302 multibeam, Simrad EK60 split-beam, and Knudsen Chirp 3260 subbottom profiler sonar data were collected simultaneously during mapping operations. To ensure high quality multibeam data, sound speed profiles of the water column were obtained using XBTs every few hours during mapping operations. During the expedition, 57 XBT casts were completed.

B. Equipment

i. ROV

NOAA Ship *Okeanos Explorer* conducts high-resolution visual surveys to obtain baseline characterization data using NOAA's custom-built, dual-body, 6,000-meter-rated ROVs *Deep Discoverer* (*D2*) and *Seirios*. *D2* has five high-definition (HD) cameras, five standard-definition cameras, and 24 light-emitting diode (LED) lights that emit 144,000 lumens—resulting in some of the highest quality deep-sea footage in the industry. *D2* also has four custom-built lighting swing arms that allow for the position and angle of the light to be adjusted for optimal imaging. *Seirios* has one HD camera, five standard-definition cameras, and 18 LED lights that add 108,000 lumens to *D2*'s lighting. The vehicles work in tandem, with *D2* surveying the seafloor and *Seirios* providing additional lighting and situational awareness, as well as dampening the movement of the ship. Every dive, the HD video cameras on *D2* are color-corrected and white-balanced to ensure correct color in all HD video recordings.

D2 has two manipulator arms, a Schilling Orion arm and a Kraft Predator arm. The Kraft has a force-feedback capability and is outfitted with custom-built coral cutter jaws and intermeshing fingers to grasp rocks, tools, and rigging. This arm is more dexterous and also has a set of blades and urethane grippers that can snip and clamp a branch of coral. The Orion arm is used as a backup and this arm is outfitted with the color calibration card. Both vehicles have a Sea Bird 9/11+ CTD with DO, LSS, and ORP sensors. *D2* also has a temperature probe and a scoop.

D2 is currently equipped with four storage boxes: two semi-open containers for stowing geological specimens and two sealed and insulated containers for storing biological specimens. Each of the biological boxes has a divider so there are four distinct storage spaces for biological specimens. Approximately 4-6 samples total are collected during each dive - a minimal number of samples to aid in habitat characterization and enable discoveries.

ii. Sample Collection and Processing

Approximately 4-6 biological and geological samples total are collected during each dive - a minimal number of samples to aid in habitat characterization and enable discoveries. These limited biological collections focused on potential new species, records or range extensions; the dominant morphotype animal in a habitat if not easily recognized; and other specimens to aid in site characterization. Geological collections were typically rocks for age-dating and geochemical analysis, to determine ferromanganese content, and to support specific expedition objectives.

Biological Specimens

Specimens and rocks were removed from the sampling boxes following ROV recovery and carried to the ship lab in buckets. Both rock samples and biological specimens were photographed to document their condition, appearance, and coloration before preservation. Coral and sponge specimens were subsampled for genetic analysis and placed into either CHAOS or Ocean Genome Legacy (OGL) buffer that was provided by the OGL Center at Northeastern University, where they will later be shipped. These tissue samples were preserved for genomic deoxyribonucleic acid (DNA) and ribonucleic acid (RNA) extraction at OGL, who will make the results publicly accessible. The bulk of each specimen was then preserved in 95% ethanol for archiving. In some cases, subsamples were also taken and preserved in 10% buffered formalin, particularly when they had soft bodied commensals such as anemones or hydroids. Two whole specimens were also preserved in formalin during this cruise: a suspected ceriantharian and a large nudibranch. Histological protocol was exercised with all of the formalin-fixed specimens (including the sub-samples), whereby the formalin was removed 48 hours later by an overnight freshwater drip, followed by placing them in ethanol in an increasing concentration until a dilution of 70% was reached. Crustaceans—and any other commensal organisms found on the corals and sponges—were removed and placed in separate specimen containers.

After the ship reached Ford Island on August 2, all specimens were transported to Christopher Kelley's lab at the University of Hawai'i at Manoa (UH) to quality control the inventory, label, and database entries. Selected coral and sponge specimens were then split, with one aliquot going to Bishop Museum and the other to the Smithsonian Institute (SI). If it was determined that splitting would be too destructive to a particular specimen, it was provided to the SI intact in order to provide public access to as many researchers as possible. The inventory of biological specimens collected is available in Appendix G. Information on specimen discovery and access is in section 7 C.

Geological Specimens

As mentioned above, the collected rocks were photographed after being brought into the lab. They were also inspected for the presence of associated animals that may have been collected incidentally, and those found were removed and treated in the same

manner as other biological specimens. The rocks were then rinsed in fresh water and dried for two days prior to being bagged and stowed in labeled rock bags.

After the ship reached port, the rocks were transported to Chris Kelley's lab (UH) where they were subjected to a similar inventory and quality control process as the biological specimens. All of the rocks were then shipped to the Oregon State University's (OSU's) Marine Geology Repository (http://osu-mgr.org/) where they were entered into the Repository's sample library. The Repository is curating the rocks, describing them from a petrology perspective (e.g. mineral content, texture, alteration, rock name), and making polished microscope-thin sections and microphotographs of the thin sections. The repository has provided online metadata information about the rocks and how to request samples of them.

The OSU Marine Geology Repository is one of a number of facilities in the U.S. and abroad (http://www.ngdc.noaa.gov/mgg/curator/curator.html) that provide the ocean sciences community with access to marine rock and sediment samples. NOAA partners with OSU through its Cooperative Institute of Marine Resources Studies.

iii. Sonars

The *Okeanos Explorer* has three types of scientific sonars that are operated simultaneously during mapping operations: a Kongsberg EM 302 (30 kHz) multibeam system, Simrad EK60 (18 kHz, 38 kHz, 70 kHz, 120 kHz, and 200 kHz) split-beam fisheries sonars, and a Knudsen Chirp 3260 (3.5 kHz) subbottom profiler sonar. Mapping operations onboard the *Okeanos Explorer* occur continuously throughout the day and night except when the ROV is deployed.

Multibeam

The *Okeanos Explorer* Kongsberg EM 302 (30 kHz) multibeam sonar is used to collect seafloor bathymetry, seafloor backscatter, and water column backscatter. Backscatter represents the strength of the acoustic signal reflected from some target, whether that's the seafloor or bubbles in the water column. The EM 302 is a deepwater multibeam system designed to map in depths ranging from approximately 200-7,000 meters.

Split-Beam Sonar(s)

The *Okeanos Explorer* is equipped with five Simrad EK60 split-beam sonar transducers operated at the following frequencies: 18 kHz, 38 kHz, 70 kHz, 120 kHz, and 200 kHz. The Simrad EK60 (18 kHz) split-beam sonar was used to detect features in the water column, such as gas plume or seep sites, and to obtain information about biomass and distributions of marine fauna. The EK60 split-beam sonars are quantitative scientific echosounders to identify water column acoustic reflectors—typically biological scattering layers, fish, or gas bubbles—providing additional information about water column characteristics and anomalies.

Subbottom Profiler

The primary purpose of the Knudsen Chirp 3260 (3.5 kHz) sonar is to provide echogram images of surficial geological sediment layers underneath the seafloor to a maximum depth of about 80 meters below the seafloor. The subbottom profiler is normally operated to provide information about the sedimentary features and the bottom topography that is simultaneously being mapped by the multibeam sonar. The data generated by this sonar are fundamental in helping geologists interpret the shallow geology of the seafloor.

ADCP

The *Okeanos Explorer* is equipped with two ADCPs: a Teledyne Workhorse Mariner (300 kHz) and a Teledyne Ocean Surveyor (38 kHz). However, only the 300 kHz ADCP was operational during this expedition. The hull-mounted ADCP transducers project four beams to record backscatter from the water column and compare the Doppler shift between the four beams to generate profiles of water velocity at various depths. ADCP measurements were, therefore, critically useful in characterizing the physical oceanography of an area and identifying small to mesoscale ocean current features. In addition to these scientific benefits, the science team used ADCPs to assess currents near ROV dive locations to inform dive planning and ensure safe ROV deployment and recovery operations.

XBTs

XBTs were deployed to obtain sound velocity profiles to help calibrate the multibeam system and ensure accurate bathymetric mapping. The XBT type is the Deep Blue probe produced by Lockheed Martin Sippican. XBTs were collected every three to six hours at an interval defined by prevailing oceanographic conditions to correct multibeam data for changes in sound speed in the water column, and were applied in real-time using Seafloor Information Software (SIS). Sound speed at the sonar head was determined using a Reson SVP-70 sound velocity probe, and salinity measurements near the transducers were taken using the ship's flow-through thermosalinograph (TSG).

Data Acquisition

Throughout the cruise, multibeam data quality was monitored in real time by acquisition watch standers. Lines were spaced to ensure 25-30% overlap between adjacent lines of multibeam sonar swaths. Cutoff angles in the SIS software were generally set between 60° and 70° on both the port and starboard sides. Ship speed was adjusted as necessary to maintain data quality and as transit time to the next dive site allowed.

All multibeam sonar data collected during the expedition were fully processed according to established onboard procedures and archived with NOAA's National Center for Environmental Intelligence (NCEI). Additional details about data archival can be found in

Section 6 of this report. Raw multibeam bathymetry data files were acquired by SIS, and were imported into Teledyne Computer Aided Resource Information System (CARIS). In Teledyne CARIS, attitude and navigation data stored in each file were checked, and erroneous soundings were removed using CARIS Swath Editor and Subset Editor. Once per day, cleaned and gridded bathymetric data were exported to American Standard Code for Information Interchange (ASCII) text files (y,x,z) at 50-meter cell size in World Geodetic System 1984 (WGS84 datum). The ASCII files were then used to create Fledermaus Scientific Data (SD) objects. These SD objects were then exported to geotiff and Google Earth Keyhole Markup language Zipped (KMZ) files, which were copied to the shoreside file transfer protocol (FTP) on a daily basis to support shoreside scientist participation.

For more detailed information about the sonar systems, see the ship's readiness report, which can be obtained by contacting the NOAA Ship *Okeanos Explorer* Mapping Team (oar.oer.exmappingteam@noaa.gov).

iv. Video Data Processing, Chatlog, and SeaScribe Annotation Log

The primary data set collected by the ROVs is high-definition video. The video includes an audio overlay of the real-time conversation that occurred during the dive between shipboard scientists, shore-side scientists, and ROV pilots. The video is recorded and archived in several different formats and resolutions. The dives are recorded in their entirety at 720p five megabit-per-second. In addition to the full dive recording a subset of the video collected is preserved in ProRes 4.2.2. 1080i 145 megabit-per-second at the discretion of the science lead and the video engineers on the ship.

The video clips are time coded to Universal Time Coordinated (UTC) time to coordinate with all data products collected on the ship. These clips do not reflect 100% of the dive, and are selected to document the vast majority of the events of the dives and capture nearly all the geological features and organisms that are observed. For discoverability each ProRes clip is compressed and at least one frame grab is captured from the clip to allow for easy access and searching without having to manage the high volume of data associated with the ProRes clips.

During ROV dives, participating researchers communicate between ship and shore using an instant messaging chatlog. The chatlog is a persistent chat room where all comments, discussions, and requests are logged and provided a UTC timestamp. The timestamp can later be correlated to the operations, location, and data feeds coming off the ship at that time.

SeaScribe was the primary annotation log used during ROV dives during this cruise. SeaScribe is a web-based real-time annotation tool developed by Ocean Networks Canada (ONC) that complements SeaTube (http://dmas.uvic.ca/SeaTube, last accessed March 2020), a video viewer and annotation interface for ROV operations. SeaScribe serves as the digital equivalent to the scientist's logbook. It is used by shipboard and shoreside cruise participants to log real-time observations on a variety of topics—in

particular scientific observations and animal identifications. These observations are UTC timestamped and include the commenters name as well as the latitude, longitude, and depth of the ROV at the time of comment. SeaScribe is accessible to authorized participating researchers to add observations during and after *Okeanos Explorer* ROV expeditions.

With about 15 minutes of delay, the video and annotations from SeaScribe become available on SeaTube. SeaTube is a freely-accessible online tool to browse video and search through and edit the video annotations.

C. Exploration Project of Opportunity

NASA Maritime Aerosol Network (MAN)

During the cruise, marine aerosol layer observations were collected to support the NASA-led, long-term MAN research effort, a component of the Aerosol Robotic Network (AERONET). AERONET is a network of sun photometers which measure atmospheric aerosol properties around the world. MAN compliments AERONET by conducting sun photometer measurements on ships of opportunity in order to monitor aerosol properties over the global ocean. Observations were made by mission personnel (as time and weather allowed) with a sun photometer instrument provided by the NASA MAN program. Resulting data were delivered to the NASA MAN primary investigator Alexander Smirnov by the mapping team lead. All collected data are archived and publicly available at:
http://aeronet.gsfc.nasa.gov/new_web/maritime_aerosol_network.html

Equipment resides on the ship and is stewarded by the Expedition Coordinator. See Appendix B for full Exploration Project of Opportunity Form.

D. Operating Model

During the expedition more than 44 scientists, students, and managers participated from 22 different institutions. This number includes onboard participants, and scientists from U.S. states, Japan, and Russia. The cruise was conducted primarily via a “distributed” participation model. The primary, core team of scientists who participated daily joined from multiple locations around the world. Some joined from an ECC, some tuned into their institutions Internet2 connection at their home office, and many others joined using the standard Internet connection from their home or office. Two primary ECCs were used by scientists during the cruise: UH at Mānoa and NOAA’s IRC, both in Honolulu, HI.

E. Permits/Clearances

The expedition was planned and conducted by NOAA, as an agency of the U.S. federal government, in partnership with NOAA NMFS Pacific Islands Regional Office (PIRO) Marine National Monument Program. NOAA does not require a permit to work in the PRIMNM.

In order to support or conduct Marine Scientific Research within the U.S. EEZ, work funded, authorized, and/or conducted by NOAA must be compliant with the National Environmental Policy Act (NEPA). NOAA Administrative Order (NAO) 216-6A Companion Manual

(https://www.nepa.noaa.gov/docs/NOAA-NAO-216-6A-Companion-Manual-03012018.pdf, last accessed March 2020) describes NOAA's specific procedures for NEPA compliance. Among these is the need to review all proposed NOAA-supported projects with respect to their environmental consequences. In compliance with NAO 216-6 and NEPA, a memorandum describing the project's scientific sensors' possible effects on the environment was submitted for the project. As expected with ocean research with limited time or presence in the marine environment, the project has been determined to not have the potential to result in any lasting changes to the environment. As defined in Sections 5.05 and 6.03.c.3 (a) of NAO 216-6, this is a research project of limited size or magnitude or with only short-term effects on the environment and for which any cumulative effects are negligible, and, as such, the project is categorically excluded from the need to prepare a full-scale NEPA environmental assessment. The categorical exclusion met the requirements of NAO 216-6 and NEPA, and authorizes the Marine Scientific Research conducted for the project (Appendix C).

Informal consultation was initiated under Section 7 of the Endangered Species Act (ESA), requesting NMFS's Protected Resources Division concurrence with our biological evaluation determining that the *2017 Laulima O Ka Moana: Exploring Deep Monument Waters Around Johnston Atoll* expedition—and all other planned 2016-2017 *Okeanos Explorer* operations may affect, but are not likely to adversely affect, ESA-listed marine species. The informal consultation was completed on February 3, 2016, when OER received a signed letter from the Regional Administrator of NMFS PIRO, stating that NMFS concurs with OER's determination that conducting proposed *Okeanos Explorer* cruises are not likely to adversely affect ESA-listed marine species (Appendix D).

OER has completed consultation with NOAA's Habitat Conservation Division on potential impacts of our operations to Essential Fish Habitat (EFH). They concurred that our operations would not adversely affect EFH, provided there was adherence to OER's proposed procedures and their guidance stated in the letter (Appendix E).

4. Summary of Operations

During the cruise, 15 ROV dives were conducted in water depths 250 to 2,600 meters to survey the biological and geological variability of oceanic habitats, including deep-sea coral and sponge habitats, ferromanganese (FeMn)-encrusted habitats on seamounts, and the water column biome.

- One engineering test dive was conducted offshore of the Hawaiian Island of O'ahu.
- 14 dives were conducted on never before surveyed sites in the JAU of the PRIMNM (***Fig. 1***).
- 13 dives in the JAU were on seamounts to investigate deep-sea coral communities and FeMn-encrusted seafloor habitats.
- One dive was conducted on Johnston Atoll and documented precious corals in the JAU for the first time.

- Four dives included focused water column transects to obtain information on animals living in the largest unexplored biome on the planet.

Seven high-density, deep-sea coral and sponge communities, which varied in diversity and species composition, were discovered in the JAU. High-density communities during EX-17-06 were defined as having at least 3,000 combined coral and sponge counts per kilometer with very high-density communities having over 10,000 counts per kilometer. Moderate-density communities are defined as those with 1,000-2,999 combined counts per kilometer and low-density communities are those with less than 1,000 combined per kilometer.

During these dives, 77 biological specimens were collected including 35 primary specimens and 42 associates (Appendix G)—including corals, anemones, zoanthids, hydroids, sponges, sea stars, feather sea stars, brittle stars, squat lobsters, amphipods, shrimps, barnacles, snails, tube worms, bryozoans, polychaete worms, a sea slug, a sea spider, and an isopod. These collections will enable confirmation of new species designations, provide type specimens for descriptions, and enable genetic analyses to establish evolutionary relationships with other known species. As many as 44 of these specimens could represent new species, and most of the specimens from known species will represent new range records.

More than 38,300 km^2 of seafloor was mapped during the cruise. About 23,161 km^2 was mapped inside the JAU of the PRIMNM. This included full coverage of eight seamounts in the JAU mapped for the first time with sonar (***Fig. 1***) and partial coverage of three seamounts. Operations also included adding coverage to previously-mapped areas, conducting focused surveys to support ROV dive site planning, and doing underway transit mapping of unmapped areas outside of the JAU.

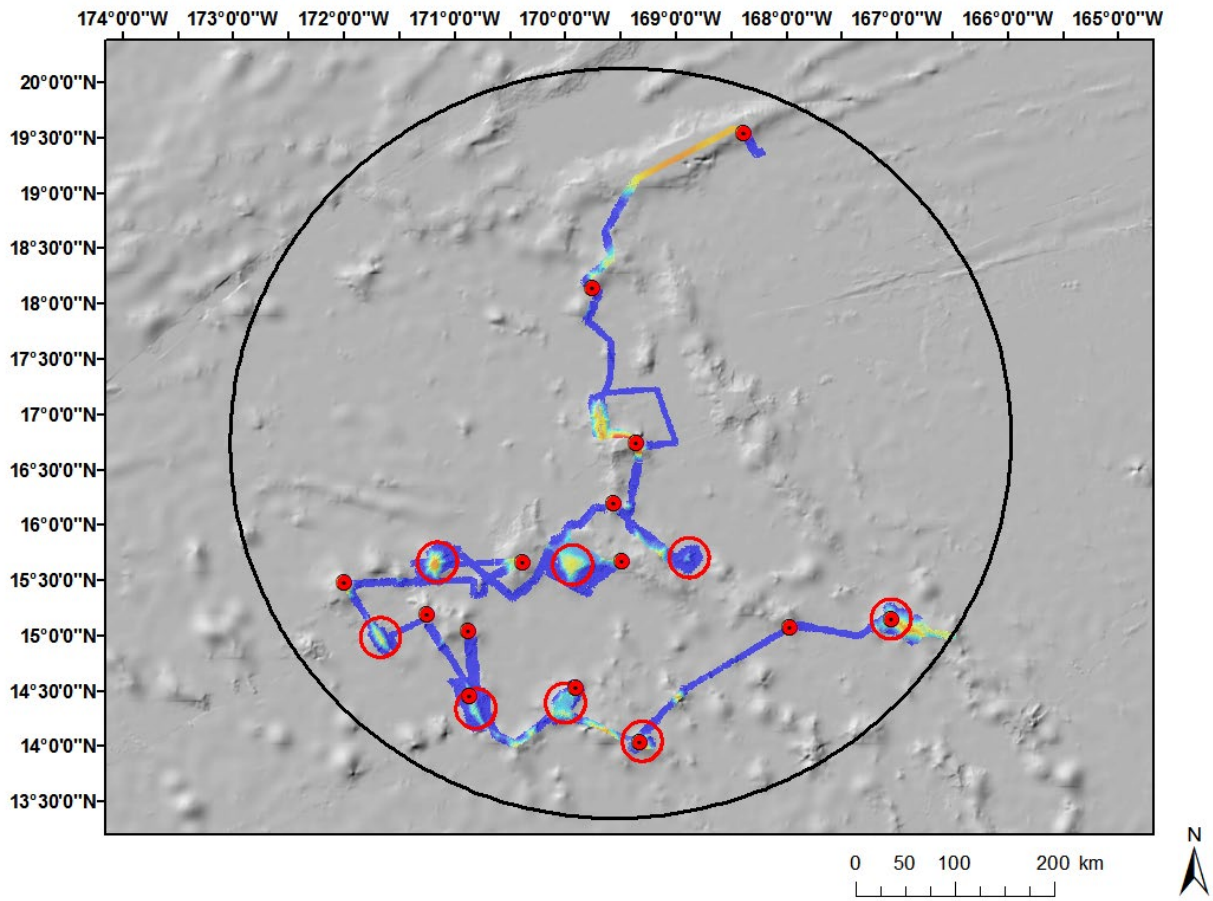

Figure 1*: Overview map of EX-17-06 operations in the JAU. Red dots are dive sites and red circles are seamounts newly mapped in their entirety.*

During the dives, 24 rock samples (Appendix G) were collected for dating and geochemical analyses that will help reveal the geological history of seamount groups in the JAU and help improve understanding of the geological history of central Pacific seamounts.

More than 12 terabytes (TB) of data were collected, including multibeam, single beam, subbottom, ADCP, CTD, XBT, surface oceanographic and meteorological sensor, video, image, and associated dive and video products. All of the data from this expedition is publicly available through national archives.

A. Calendar of Events

Table 2 provides the chronological details of expedition.

Table 2: Calendar of events for the expedition.

Date	Activities
7/5/2017	Mission personnel arrive to ship in Honolulu, HI.
7/6/2017	Orientation, training, and mobilization.
7/7/2017	Start of expedition with NOAA Ship *Okeanos Explorer* leaving port, fueling, shakedown operations (GAMS calibration, EM 302 patch test).
7/8/2017	Continued shakedown operations (EM 302 patch test, DP testing).
7/9/2017	Continued shakedown operations (USBL Calibration, CTD test cast, DP testing and training, mapping test surveys).
7/10/2017	Continued shakedown operations and conducted Dive #1—a test dive—off O‘ahu. Initiated transit mapping to the JAU.
7/11/2017	Transit mapping to the JAU.
7/12/2017	Transit mapping to the JAU.
7/13/2017	Dive #2, the first dive inside the JAU, on Horizon Tablemount with overnight mapping.
7/14/2017	Dive #3 on an unnamed seamount north of Johnston Atoll that included midwater transects, overnight mapping, and transit.
7/15/2017	Dive #4 on the slopes of Johnston Atoll with overnight mapping and transit.
7/16/2017	Mapping after dive was cancelled due to weather.
7/17/2017	Dive #5 on “Sally” Seamount that included midwater transects, overnight mapping, and transit.
7/18/2017	Dive #6 on “Keli” Ridge. Dive was aborted prematurely after the vehicle lost power.
7/19/2017	Mapping and repairs to ROV cable.
7/20/2017	Mapping and continued repairs to ROV cable.
7/21/2017	Dive #7 on “Edmondson” Seamount with overnight mapping and transit.
7/22/2017	Dive #8 on “Pierpoint” Seamount that included midwater transects, overnight mapping, and transit.

7/23/2017	Dive #9 on “Wetmore” Seamount with overnight mapping and transit.
7/24/2017	Dive #10 on “Wetmore” Seamount East with overnight mapping and transit.
7/25/2017	Dive #11 on “Ridge” Seamount with overnight mapping and transit.
7/26/2017	Dive #12 on “New Seamount 5” with overnight mapping and transit.
7/27/2017	Dive #13 on "New Seamount Summit" Cone with overnight mapping and transit.
7/28/2017	Dive #14 on South East Guyot Ridge at “Keli” Ridge that included midwater transects, overnight mapping, and transit.
7/29/2017	Dive #15 on “New Seamount 8” Cone, started transit mapping back to Honolulu.
7/30/2017	Transit mapping back to Honolulu.
7/31/2017	Transit mapping back to Honolulu.
8/01/2017	Transit mapping back to Honolulu.
8/02/2017	Pull into port in Honolulu, HI.

B. Expedition Daily Log

July 7: NOAA Ship *Okeanos Explorer* departed the pier at Ford Island today around 9:00 AM and transited through Pearl Harbor to the Fuel Pier. Most of the day was spent fueling up for the more than 2,000 nm journey ahead. After fueling, the ship departed Pearl Harbor and headed to the multibeam patch test location. ADCPs were turned on while leaving the harbor and were kept on with bottom tracking (for the purposes of calibration). The data will be examined by UH. Overnight, the ship conducted GAMS calibration for the purposes of calibrating heading determined by Position and Orientation System for Marine Vehicles (POS MV). After GAMS calibration, the ship conducted a Patch test for the EM 302.

The Reson SVP-70 (to measure sound speed at EM 302 sonar head) stopped working overnight. Currently there are no data coming out of the Reson SVP-70. EM 302 has been switched to use sound speed coming out of TSG sensor.

July 8: After completion of the multibeam patch test overnight, testing of the Kongsberg DP system was conducted during the day and went well. Simultaneous testing of a new multibeam functionality to image the seafloor from multiple directions was conducted over a known wreck site. In the evening, the mapping team continued the multibeam patch test, processing, and assessment of data.

Testing of ship systems and preparation, orientation, and training of onboard personnel continues. By the end of the day, the multicast feeds were being seen at all locations.

July 9: Overnight, the ship continued test surveys in water depths of 900-3,000 m. USBL calibration was successfully conducted in the morning, followed by a CTD casts down to 760 m. During the CTD upcast, the connection to the CTD failed and displayed an error. Senior Survey Technician (SST) Wilkins will troubleshoot before attempting to dismantle the CTD frame. Kongsberg DP testing and training was conducted in the evening and a mapping test survey was run overnight.

The Internet1 (I-1) Streams from YouTube are now online and working, however the ship's Internet connectivity continues to be problematic. Troubleshooting of the Electronic Chart Display and Information System (ECDIS) continues, as does general maintenance and training of onboard personnel.

July 10: Final DP testing and training was conducted in the morning, followed by a shakedown ROV engineering dive to train using the manipulator arm and test a prototype camera. All data systems were checked during the engineering dive, Dive #1. During the dive, the science leads went over the computers, software, and communications systems in the control room that will be used during the ROV dives. After the dive, the ship steamed closer to shore and deployed the small boat to take the Kongsberg technician back to shore, and bring the expedition sample data manager to the ship. Once all personnel were safely onboard, the ship started transit mapping operations directly to the first planned ROV dive site. An ADCP calibration line was run until a depth of 1,450 m. Overnight the ship made speeds between 10-11 knots and based on current estimates, we should arrive in time to dive on July 13. The overnight rebroadcast of the day's dive was also tested.

The ONC primary ship server is now connected to shore and has been updated. The backup server is still not responding. Internet connectivity on the ship is still spotty and unreliable. Impacts to operations are already occurring, and if the current connection does not improve, negative impacts are expected to affect real-time, ship-to-shore operations and OER data products.

July 11-12: The ship conducted underway transit mapping to our first science dive (Dive #2) at the JAU of the PRIMNM. While underway, the team onboard continued training, maintenance, updating and automation of procedures, review of safety and emergency procedures, and preparations for the first science dive. On July 12, a Facebook live event was held and received 4,360 views. A presentation was given each night by one of the onboard science leads.

Troubleshooting of the onboard ONC server continued. By the end of 7/12, several guest science user accounts were able to login to the shipboard ONC server. The ship's WiFi Internet connectivity continues to be an issue and personnel continue to troubleshoot from shore.

July *13:* Dive #2, Horizon Tablemount. Overnight mapping operations continued until arriving at the dive site in the morning. During pre-dive preparations, a card failed in the DP system and resulted in a delayed ROV dive launch by several hours. Dive #2, the first science dive of the cruise, was conducted today on Horizon Tablemount. About 20 scientists participated in the ROV dive, and operations went well despite onboard WiFi connectivity issues.

Ship-to-shore transfers are up to date. Work on the topside workflow, and automation of the creation of a sound speed profile from the ROV CTD data continues. The intermittent WiFi connectivity issues persist.

July 14: Dive #3, Unnamed Guyot north of Johnston Atoll. Overnight mapping operations were successfully completed. Dive #3 was conducted today on an unnamed seamount about 90 nm north of Johnston Atoll. Two rocks and two biological specimens were collected. After coming off bottom, the dive also included 10-minute water column transects at 100 m increments from 800 m to 300 m, during ascent to the surface. The ROV team experimented with different speeds, lighting arrangements, and camera positions while implementing the recently modified procedure for midwater transects. Operations went well with 19 shoreside science participants.

Two meetings were held and significant testing was conducted on the wireless Internet onboard that has been experiencing connectivity issues. The topside production workflow has been completed and tested—it is now live.

July 15: Dive #4, Johnston Atoll. Dive #4 was conducted today on the east side of Johnston Atoll. Launch was delayed by about an hour as we finalized a dive site, based on the conditions; the team had to adjust the launch location, as those conditions rapidly changed. A successful dive was conducted that imaged deep-sea coral and sponge communities, including observation of the precious coral *Hemicorallium* spp*.,* accomplishing the goal of the dive—to document precious corals in the JAU. Eleven scientists participated from shore and two samples were collected—a coral and a sea star. Overnight mapping operations continued to add coverage to existing multibeam data. No issues were encountered during mapping operations.

SST Wilkins started work on removing the Sea-Bird Electronics (SBE) 32 from the frame; he made good progress today in removing several stripped bolts. The top portion of the frame has now been removed.

July 16: Today's dive, originally planned in relatively shallow water offshore of Johnston Atoll, was cancelled due to high, variable currents and rough seas close to Johnston Atoll—and deteriorating conditions. Instead, the team spent the day conducting mapping operations to add multibeam coverage to seamounts mapped by the *Okeanos Explorer* in 2015. New data were collected over ridge features extending northeast from "Keli" Ridge, resulting in a nearly complete map of the feature. Data were also acquired over top of a seamount to the east and resulted in a complete map of this unnamed seamount—providing new data and insights on the many seamounts and ridges in the JAU of the PRIMNM. Overnight, the ship transited to

location of “Sally’ seamount in preparation of the next day’s ROV dive. The onboard team spent the day working on SOPs, installing updates, troubleshooting issues, and catching up on work.

July 17: Dive #5, “Sally” Seamount. Overnight mapping coverage was added to the existing *Okeanos Explorer* data from 2015. Dive #5 was conducted on “Sally” Seamount. The dive began at 2,170 m, exploring the north ridge of a guyot-like feature, traversing to its plateau. Deep-sea coral and sponge communities, a variety of echinoderms, a few fish, and elevated mounds of pillow lava were observed. Two corals, one sponge, and two rocks were collected. Midwater surveys were conducted during ascent—six transects between 900 m to 350 m. During the dive operations, EK60 surveys were operated continuously in support of water column transects. Twenty-one scientists remotely participated in the dive.

The ADCP still continues to provide high temperature reading. Chief Electronics Technician (ET) Blessing, SST Wilkins, Malik, and Wright (GFOE) worked on assessing the ADCP transducer. While rebooting the ADCP system, the 300 kHz system did not start. Further trouble shooting of the ADCP continues. However, the 38 kHz is operational.

The team evaluated the quality of the *Seirios* CTD data today, after replacing a faulty cable during the weather day. The team saw great improvement and considers the issue resolved. However, a similar issue was noticed with the DO sensor on *D2*; there is a plan to investigate.

SST Wilkins and Malik were able to disassemble the CTD frame today. The SBE 32 has now been recovered from the frame and will be ready for shipment at the end of the current expedition to Seabird for further evaluation and repair.

The ROV team has noticed a considerable drop in the insulation resistance of the topside bender over the course of this cruise. They have all of the necessary supplies, and will plan to do this on either the next weather day or on one of the transit days at the end of this cruise.

July 18: Dive #6 “Keli” Ridge. The ship transited to the Dive #6 location overnight, collecting mapping data over a previously unmapped seamount. ROV deployment was briefly delayed today while a squall passed over the ship. Dive #6 was conducted on “Keli” Ridge to explore the shallower end of a N-S trending ridge that was surveyed at deeper depths (2,436 m to 2,090 m) in 2015. During descent, a live interaction was conducted with the Silver Spring ECC. About an hour into the dive, the live feeds stopped transmitting to shore. After about 2.5 hours of troubleshooting the live feeds were restored, but shortly after, all power to the vehicles was lost. The engineering team responded well, coordinated with the bridge to move the vehicles into a safe configuration, and conducted a safe and effective "dead vehicle recovery". After recovery, mapping data acquisition continued over the unnamed seamount.

The problem causing loss of power to the vehicles appeared to be in the 0.68 cable and/or the termination into *Seirios*. The ROV team has since discovered that there is a short between two of the conductors about three km into the ROV side of the cable. This is likely due to age and

natural degradation. The damage is irreparable. The expedition team will work with the appropriate points of contact at GFOE and OER to figure out a plan to move forward.

The work on ADCPs troubleshooting/repair continued. The problem with 300 kHz system was identified to be communication loss due to a disconnected serial cable. Chief ET Blessing and Wright made repairs, and the 300 kHz system is now operational. The 38 kHz system continues to show symptoms of water intrusion on the wet side.

July 19: Repairs and Mapping. Overnight mapping operations continued to add coverage to the unnamed seamount. ROV operations were cancelled today while the ROV team worked on the cable. The added mapping time was used to further map the unnamed seamount and to complete tests to improve backscatter results of multibeam sonar.

After discussing the issue with the shorted 0.68 cable with the ship's Commanding Officer, GFOE, and OER, it was decided to develop a plan to spool out the cable onto the deck, cut out the damaged section, and re-terminate the wire to *Seirios*. The ROV team used the entire day to plan and manually lay roughly 2,900 m of cable onto the deck next to the storage container. By the end of the day we were able to access the damaged section and test the remaining cable on the storage drum. The conductors and fibers were tested and found to be in adequate condition for re-terminating and continuing operations. The team expects to connect to *Seirios* and complete a full, high-voltage test by the end of tomorrow—and be ready to dive the following day. This was possible with the great support from the ship's officers and deck crew throughout this labor-intensive process.

July 20: Repairs and Mapping. Overnight mapping operations completed mapping over an unnamed seamount. After completion of mapping to ~4,000 m water depth around the seamount, the ship transited west to map another unnamed seamount.

The ROV team worked a long day in order to re-terminate the .68 cable, complete a strength test, connect to *Seirios*, and complete high-voltage tests. All system checks were successful and we are ready to dive again tomorrow.

A live event was conducted today with the USNM as part of their “Expert is In” series, featuring Chris Mah. Due to problems with their connection, the live interaction was ultimately a Q&A session conducted over the phone with Chris, but was well received and about 60 people attended the live interaction.

July 21: Dive #7, “Edmondson” Seamount. Mapping operations continued overnight while in transit to the location of the ROV dive. A successful dive was conducted today after removing the degraded portion of the .68 cable and re-terminating to *Seirios*. Dive #7 was conducted today on “Edmondson” Seamount, on an area believed to represent secondary volcanism. The dive track was conducted along a sharp ledge at the top of the feature where deepwater corals and sponges—and other animals—were observed. Twelve scientists remotely participated in the dive from shore. In the morning, during the dive, a live interaction was conducted with the

Exploratorium in San Francisco. The IRC ECC had a continuous stream of visitors throughout the day, and Web Coordinator Amy Bowman spent most of the day providing interpretive talks for visitors. After completion of the ROV dive, a straight transit line was laid to the next day's ROV dive site.

The CTD on *D2* has a ground fault that is believed to be impacting the O_2 sensor on the CTD.

July 22: Dive #8, "Pierpoint" Seamount. Mapping operations were conducted overnight. Dive #8 was conducted today on "Pierpont" Seamount to collect geological samples to better understand the geologic history of the seamount, and look for deep-sea coral and sponge communities. After the benthic portion of the dive, midwater transects were conducted from 800-300 m to investigate one of the most underexplored environments on the planet. The water column portion of the dive was led from shore by Mike Ford at the Silver Spring ECC. After the dive, mapping operations focused on a seamount south of "Pierpont" that has been identified as a target based on satellite-derived bathymetry.

We are noticing occasional erratic tracking on the USBL.

July 23: Dive #9, "Wetmore" Seamount. Overnight mapping over a seamount was completed. Dive #9 was conducted today on "Wetmore" seamount on a FeMn-crusted rift zone ridge extending SW to search for large-scale, high-density communities of deepwater corals and sponges. Fauna overall was sparse, with most species being found in low abundance. After completion of the ROV dive, the ship transited over another seamount that had no prior mapping data.

July 24: Dive #10, "Wetmore" Seamount East. Overnight, mapping coverage was added to the seamount selected for today's dive. Dive #10 was conducted today on "Wetmore" seamount on a FeMn-crusted rift zone ridge extending SE to search for large-scale, high-density deepwater coral and sponge communities. The community at this site could be described as high-density. During ROV descent, a live interaction was conducted with children, from grades five to eight, who were taking part in a Mini-ROV camp at the NOAA Pacific Marine Environmental Laboratory (PMEL) in Seattle, WA.

The mapping team has begun to synthesize the data and produce end-of-cruise mapping products.
The Inner Space Center (ISC) at the University of Rhode Island (URI) Graduate School of Oceanography reported that they have witnessed multiple dropouts from the various feeds for a couple of weeks now. The shoreside scientists have also been reporting the dropouts in the chat log. Data are being collected to further assess.

July 25: Dive #11, "Ridge" Seamount. Overnight mapping operations added further coverage to the seamount selected for Dive #11. Dive #11 was conducted on "Ridge" seamount—a seamount mapped two nights ago with a ridge shape running NW to SE. A moderate, and then high-density, coral and sponge community—composed predominantly of glass sponges, the so-

called “Forest of the Weird”—was documented during the dive. After the completion of ROV dive, the ship transited over several potential seamounts en route to the location of Dive #12.

The ONC backup server is still offline. Although the primary server continues to fulfill the current needs for SeaScribe, Kennedy and Malik are working with ONC to identify next steps to repair/replace the onboard backup server.

July 26: Dive #12, “New Seamount 5”. Overnight, the ship transited to the prospective Dive #12 location. Dive #12 was conducted on “New Seamount 5”, one of several placeholder sites for exploring seamounts in the southern part of the monument—where no previous mapping or ROV surveys had been conducted—in order to learn more about the geologic history of these seamounts and the habitats they contain. The seamount was mapped overnight and a dive site selected in the early morning, starting on a saddle and climbing up a ridge to the seamount summit and along the crest. Among the most unusual of species documented during today’s dive was a large (10.0 cm length) brown and likely undescribed sea slug of the genus *Bathydoris*. Nudibranchs are seldom observed from abyssal depths, making this a very unusual new record. It was collected. Eleven scientists participated remotely in the dive. Two rocks, one sea anemone, one sea slug, and one sea spider (on an *Iridigorgia* sp.) were collected. After the completion of the dive, the ship started transit to the next dive site—another seamount inferred from satellite-derived bathymetry.

July 27: Dive #13, “New Seamount Summit” Cone. Overnight mapping efforts focused on developing coverage on a seamount identified through satellite-derived bathymetry as prospective location for Dive #13. This dive was conducted on another unnamed seamount, mapped the night before the dive, with the dive site selected in the early morning. During the dive, an informal live interaction was conducted with the new NCEI Director, Mary Wohlgemuth. The ROV team continues to troubleshoot an occasional tracking issue with the USBL, which is not hindering operations. After completion of the ROV dive, the ship transited to location of Dive #14.

July 28: Dive #14, Southeast Guyot Ridge at “Keli” Ridge. Overnight the ship transited to the location of Dive #14. Due to heavy seas, only a straight line transit between dive site locations was selected to provide optimal ride conditions.

Dive #14 was conducted today on “Southeast guyot ridge feature extending SE off of the easternmost guyot comprising “Keli” Ridge that was mapped by the *Okeanos Explorer* in 2015. The dive included discovery of a huge field of “bottle-brush” shaped carnivorous sponges (Cladorhizidae), which we travelled through for most of the afternoon. A technical test was conducted in the morning, during ROV descent, with the Doseum in San Antonio, TX, in preparation for tomorrow’s live interaction. After completion of the ROV dive, the ship started her transit to the location of Dive #15 over an unmapped seamount.

July 29: Dive #15, “New Seamount 8” Cone. Overnight, the ship transited to the location of Dive #15 to conduct pre-dive mapping. Partial mapping of the seamount was conducted and

enabled the onboard team to select a dive site. Dive #15 climbed a volcanic cone on top of the guyot—starting at ~2,050m and ascending to its summit—to document seafloor communities, search for deep-sea coral and sponge communities, and collect rocks for age dating and geochemical analysis. A high-density of bamboo corals were documented at the top of the cone. In the morning, during the dive, a 30-minute live interaction was conducted with about 40 teachers taking part in an OER professional development workshop at the Doseum in San Antonio, TX. After the completion of the ROV dive, mapping operations continued overnight to complete mapping of the seamount before starting transit back to Honolulu.

July 30-31: Transit to Honolulu. After completing mapping coverage of the unnamed seamount explored during Dive #15, the ship departed the JAU and headed to Honolulu, HI. Mapping data continue to be collected while in transit to Honolulu. The onboard team is busy developing end-of-cruise products and working on the cruise report. Final cruise wrap-up meetings were planned. Video editors continue to work on each of their longer-form video highlights. The ROV team has used the transit days to carry out tasks for demobilization and clean up, and inventorying supplies. The team is also discussing options for removing the .68 cable from the ship once we are in port.

August 1-2: Expedition complete. Mapping data were collected while in transit to Honolulu. Overnight, a test was run to determine the maximum depth range and swath coverage for different modes of multibeam sonar (Extinction test). All mapping sensors were secured on the morning of August 2 at 4:30 AM. The ship pulled into Pearl Harbor in the early morning and fueled. Afterwards, the ship got underway and moved to Pier Foxtrot on Ford Island where she was tied up alongside by ~1:30 PM.

Cruise wrap-up meetings were held on Aug 1; the shoreside science team reviewed overall findings and accomplishments; in the afternoon, the team leads and the ship conducted the end-of-cruise debrief; and, in the evening, the mission team went over final cruise items and took a team photo. Afterwards, the onboard Science Leads each gave a presentation on the overall cruise results and findings to the onboard team.

Both days, the team continued working on and providing input into final cruise products and finishing up task for demobilization. The mapping team continues to make progress on end-of-cruise data processing and the creation of products.

The telepresence team powered down video servers, turned off feed three and modified feeds one and two to 3.5 megabytes (MB) each. Highlight videos were completed and loaded onto the EVS server for playback during any potential (unplanned) tours. The data management workflow was setup for the next cruise.

C. Dive Table

Dives conducted during the expedition are listed in Table 3. ROV dive summary forms are included as Appendix F.

Table 3: List of ROV dives conducted during the expedition.

Dive #	Site Name	Date	Region	On bottom position	Off bottom position	Max Depth (m)	Min Depth (m)	Length (HH:MM:SS)	Bottom Time (HH:MM:SS)	Bottom Distance Covered (m)	Focus Theme
1	Offshore Oahu	20170710	MHI	21°, 14.057' N ; 158°, 04.393' W	21°, 14.036' N ; 158°, 04.389' W	469	458	4:16:00	3:27:42		Engineering Test Dive
2	Horizon Guyot	20170713	JAU	19°, 33.093' N ; 168°, 22.611' W	19°, 33.197' N ; 168°, 22.693' W	1,920	1,896	4:28:14	2:15:44	260	Mn Crusted Summit Communities
3	Un-named Guyot North of Johnston Atoll	20170714	JAU	18°, 08.831' N ; 169°, 44.071' W	18°, 09.167' N ; 169°, 44.053' W	2,600	2,397	10:15:01	5:27:14	721	Mn Crusted Ridge Communities
4	Johnston Atoll Site 1	20170715	JAU	16°, 43.630' N ; 169°, 21.635' W	16°, 43.579' N ; 169°, 21.890' W	580	399	7:15:40	5:32:13	406	Precious Corals
5	"Sally" Seamount	20170717	JAU	16°, 11.911' N ; 169°, 33.720' W	16°, 11.697' N ; 169°, 33.934' W	2,184	2,102	10:00:56	5:45:50	675	Mn Crusted Ridge Communities
6	"Keli" Ridge Seamount	20170718	JAU	15°, 41.013' N ; 169°, 29.014' W	15°, 41.182' N ; 169°, 28.931' W	1,250	1,204	4:18:49	3:03:11	353	Mn Crusted Ridge Communities
7	"Edmondson" Seamount	20170721	JAU	15°, 40.836' N ; 170°, 22.156' W	15°, 40.641' N ; 170°, 22.432' W	1,275	1,132	8:03:19	6:23:22	730	Mn Crusted Summit Communities
8	"Pierpont" Seamount	20170722	JAU	15°, 28.133' N ; 171°, 59.032' W	15°, 28.275' N ; 171°, 59.609' W	1,613	1,487	10:06:32	6:07:46	765	Mn Crusted Summit Communities
9	"Wetmore" Seamount	20170723	JAU	15°, 09.980' N ; 171°, 15.295' W	15°, 10.140' N ; 171°, 15.069' W	2,575	2,515	8:05:18	5:08:10	614	Mn Crusted Summit Communities
10	"Wetmore" Seamount East	20170724	JAU	15°, 02.262' N ; 170°, 52.175' W	15°, 02.351' N ; 170°, 52.498' W	2,078	1,973	7:59:33	5:39:48	739	Mn Crusted Summit Communities
11	"Ridge" Seamount	20170725	JAU	14°, 28.462' N ; 170°, 51.435' W	14°, 28.330' N ; 170°, 51.298' W	2,441	2,346	7:28:32	4:43:22	510	Mn Crusted Ridge Communities
12	"New Seamount 5"	20170726	JAU	14°, 32.038' N ; 169°, 55.400' W	14°, 32.233' N ; 169°, 55.389' W	2,326	2,180	8:00:02	5:21:01	555	Mn Crusted Cone Communities
13	"New Seamount Summit Cone"	20170727	JAU	14°, 03.582' N ; 169°, 18.523' W	14°, 03.648' N ; 169°, 19.212' W	1,598	1,282	7:30:22	6:20:13	800	Mn Crusted Cone Communities
14	SE Guyot Ridge at "Keli" Ridge	20170728	JAU	15°, 05.490' N ; 167°, 57.666' W	15°, 05.683' N ; 167°, 57.606' W	2,555	2,368	9:58:12	5:16:11	775	Mn Crusted Ridge Communities
15	"New Seamount 8" Cone	20170729	JAU	15°, 09.640' N ; 167°, 02.151' W	15°, 09.352' N ; 167°, 02.094' W	2,027	1,797	8:10:19	5:54:33	622	Mn Crusted Cone Communities

5. Summary of Findings

A. Summary of Completed Science Objectives

a. *Acquire data to support priority Monument and Sanctuary science and management needs*:

Fourteen dives were conducted within the JAU of the PRIMNM. One of these surveyed the shallow flank of the atoll itself for commercially valuable precious corals, resources managed by NMFS that had never been documented in the JAU. Four of the dives were conducted on seamounts that had never before been mapped and, therefore, required mapping prior to the dives. These were all located in the previously unexplored southern region of the monument unit. Five dives were conducted on seamounts that had only recently (Jan. 2017) been mapped by the Schmidt Ocean Institute's research ship R/V *Falkor*, in the unexplored western part of the monument unit. Two dives were conducted north of Johnston Atoll, one on the southern side of Horizon Tablemount and the other on an unnamed guyot first mapped by the *EX* in 2015. Two other dives were conducted on seamounts previously mapped and dove on by the *Okeanos Explorer* in 2015 (see 2015 Hohonu Moana Expedition, cruise EX-15-04 Legs 1 and 4: https://oceanexplorer.noaa.gov/okeanos/explorations/ex1504/welcome.html, last accessed March 2020) however, in different locations this time, to further scientific understanding of deep-sea communities found on ridge topography.

Extensive multibeam mapping was also conducted in the JAU during this cruise. As a result, complete or near complete high-resolution bathymetry and backscatter coverage is now available for eight new seamounts in the monument unit that had never before been mapped. Two other seamounts were partially mapped for the first time and additional coverage was added to fill data gaps on four other seamounts.

b. Explore the diversity and distribution of benthic habitats in the JAU–particularly those that support commercially valuable precious corals and deeper high-density coral and sponge communities:

One dive was conducted to determine if commercially valuable precious corals were present in the monument. The only location shallow enough for species under the management of NMFS is at Johnston Atoll itself. Previous *Makali'i* submersible surveys conducted around the atoll in the 1980s did not document any of these species, possibly due to the submersible's maximum depth of 366 m. The dive conducted during EX-17-06 surveyed an escarpment edge from 399-579 m. Twelve of the other 13 dives surveyed depths between 1,100 and 2,500 m, the depth range within which high-density communities of deep-sea corals and sponges had been documented by *Okeanos Explorer* dives elsewhere in the Central and Western Pacific. One dive was conducted between 2,500-2,600 m, a suspected lower boundary depth for these communities. Rocky habitats were prioritized to meet this objective, since deep-sea corals and sponges often settle and grow on this type of substrate.

c. Characterize seamounts in and around the Prime Crust Zone (PCZ). The PCZ is the area of the Pacific with the highest concentration of commercially valuable deep-sea minerals:

All of the seamounts within the JAU of the monument are located in the PCZ and, therefore, all 14 dives were on sites within the PCZ. The optimal depth range for mining cobalt-rich FeMn crusts in the PCZ is 800-2,500 m (Hein et al., 2009). All but two of the 14 dives were within this depth range, the exceptions being the shallow dive on the flank of Johnston Atoll (399-579 m) and the second dive on "Wetmore" seamount, which was just outside of this range (i.e., 2,515-2,575 m). All dives, except the shallow one, were conducted on consolidated—and in parts unconsolidated—substrate consisting of FeMn-crusted nodules, boulders, blocks, and pillow lava bedrock. Furthermore, 11 of the dives were conducted on guyots, which are the types of seamounts that are being targeted for future mining activities due to their flat tops and old age.

d. Collect geological data/samples at sites to aid the understanding of the geologic history of Pacific seamounts:

The geologic age of a seamount can only be determined by geochemical analyses and Argon–argon ($^{40}Ar/^{39}Ar$) basalt dating techniques of collected rock samples. For this reason, rocks were collected at every site except for two: 1) the shallow site on Johnston Atoll where the substrate was carbonate instead of basalt, and 2) Horizon Tablemount where the dive time was short (two hours and 15 minutes) and suitable rocks (i.e., rocks free of the seafloor and likely containing basalt) were not encountered. In addition to samples, the dive video at 13 of the 14 dive sites clearly showed thick FeMn crusts on exposed rocks, which is also indicative of great age (i.e., 60-80 million years). Mapping data also provided clues to the ages of some of the previously unmapped seamounts. Five of the newly mapped seamounts were guyots having summits below 1,000 m, which are characteristic of Cretaceous volcanoes that had once been at the surface.

e. Conduct ROV water column transects to acquire data on this largely unknown biome:

Water column transects were carried out following seafloor surveys at four dive sites selected on the basis of their location in the monument, which were north of the atoll, just south of the atoll, and at two sites in the western and southern areas of the JAU. Transects were generally carried out between 800 and 300 m, where the EK60 revealed significant backscatter layers. This depth range also encompassed the oxygen minimum zone (OMZ), which occurred at between 350 and 500 m, depending on location. Since the OMZ in the JAU is significantly shallower than in the Hawaiian Islands (i.e., 750-800 m), it was of interest to examine if the composition of the midwater community differed as a result.

f. Continue to refine specimen collection protocols and processing procedures:

The collection protocol used during the EX-17-06 dives was broadened somewhat to include a wider range of animal phyla than in previous years. CAPSTONE generally prioritized corals and sponges for collection as a result of OER's partnership with NOAA's Deep Sea Coral Research and Technology Program (DSCRTP). Corals and sponges are some of the most common organisms encountered during benthic ROV surveys, and are relatively easy and time-efficient

to collect with the ROV manipulator. However, with an echinoderm specialist serving as an onboard scientist, a larger than usual number of sea stars were collected on the dives, along with a holothurian and a number of crinoids. A nudibranch mollusk, a bryozoan, and several unusual arthropods (a glass vase shrimp and a sea spider) were also collected. Standard processing procedures were utilized as they were appropriate for all taxa.

g. Ground-truth acoustic data using video imagery and characterize associated habitat (if relevant):

This objective was geared towards ground-truthing any newly discovered water column anomalies (e.g. bubbles suggesting the presence of seeps) identified in multibeam backscatter data, however none of the water column anomalies of interest were encountered during the cruise.

As mentioned earlier, four of the ROV dive sites were located on seamounts that required mapping prior to the dives, since the only data available prior to the cruise were derived from satellite altimetry. These seamounts were mapped a night or two before the dives, and the specific ROV dive sites were chosen from both the bathymetry and backscatter acquired. In this sense, the ROV video was, therefore, able to ground-truth the multibeam data by gathering imagery of the seafloor and acquiring depth data, although that was not considered a major objective of the dives.

Additionally, Simrad EK60 echosounder data were acquired during midwater exploration activities and used to inform midwater transect depths.

h. Engage a broad spectrum of the scientific community and public in telepresence-based exploration:

More than 44 scientists and students from 22 different institutions participated during EX-17-06. These scientists joined from the ship, 12 U.S. states, Japan, and Russia. Full coverage of the expedition is available on the oceanexplorer.noaa.gov website; the website content received ~30,700 views during the cruise, and the live video feeds received more than 1.1 million views via multiple platforms—including Facebook and YouTube. Four live interactions were conducted during the cruise with various groups around the U.S.: the SI's National Museum of Natural History (USNM), Exploratorium, and NOAA Science camps in Honolulu, HI and Seattle, WA, to engage and share the expedition with about 452 teachers, students, and the general public. A Facebook Live interaction at the start of the cruise received about 8,700 views. Two additional live interactions were conducted with representatives from NOAA and four other U.S. government agencies to demonstrate the use of telepresence technology for seagoing investigations.

i. Successfully conduct operations in conjunction with shore-based ECCs and remote science team participants:

Onshore scientists (operating from ECCs and/or remote science team participants) played key roles in dive planning and dive execution. Throughout each dive, scientists on shore provided valuable feedback on sampling and guidance on where to direct the ROV. More than 44 scientists from 22 different institutions participated during EX-17-06.

j. Create and provide input into standard science products to provide a foundation of publicly accessible data and information products to spur further exploration, research, and management activities:

Daily products were completed to enable initial site characterization of areas explored during the cruise. This included mapping data and products, ROV dive summary forms (Appendix F), ROV navigation products, *in situ* data from environmental sensors on the ROVs, high-definition video and still frame images from ROV dives, science annotations in SeaScribe, still images of onboard samples, and a database of biological and geological specimens.

B. Biology

The biological communities living below 366 m inside the JAU of the PRIMNM were first documented in 2015 by the *Okeanos Explorer* during cruise EX-15-04-L4 (https://oceanexplorer.noaa.gov/okeanos/explorations/ex1504/background/plan/welcome.html, last accessed March 2020). A total of 11 dives were conducted within monument waters, and subsequent annotation of the dive video identified over 490 different morphotypes of invertebrates and fishes. The depth range surveyed was 1,180-4,238 m, and focused primarily on seamounts in the northern and eastern portions of the monument. During EX-17-06, a total of 14 dives were conducted in the JAU, all but two of which were on completely different seamounts than EX-15-04-L4, and with most dives concentrated in the southern and western portions of the monument. ***Fig. 2*** provides an overview of the locations of all 25 *EX* dives conducted to date in the JAU. The depth range for EX-17-06 dives was 399-2,600 m, with all but one taking place below 1,100 m. In general, there was substantial overlap in the depth ranges explored during both cruises, and the types and abundances of different phyla documented on FeMn-crusted seamounts during EX-17-06 was similar to those of other CAPSTONE cruises focused on these types of features. Cnidarians, particularly octocorals, were the most abundant animals observed, followed by sponges (both glass sponges and demosponges), echinoderms (mostly brittle stars), and arthropods (mostly squat lobsters). Fishes were observed in relatively low abundance on all dives, with the exception of the shallow dive off Johnston Atoll, where a relatively large number of deepwater cardinalfish (Epigonidae) were encountered.

An interesting environmental phenomenon is present within the JAU, whereby the northern and southern portions are potentially divided by large currents moving in opposite directions: east to west in the north and west to east in the south. EX-17-06 ROV dives focused on more southerly seamounts—not explored in 2015—to determine whether the different flow features might be expressed by differences in the composition of animal communities seen between the two monument halves at depths between 1,000 and 2,500 m. Another interesting

environmental phenomenon is the fact that the oxygen minimum shoals in a north to south manner in this region of the central Pacific. Specifically, within the monument, the lowest oxygen levels are reached at approximately 500 m depth in the northernmost seamounts, and at 350 m depth in the southern seamounts. This pattern was clear from a cursory examination of the CTD data during the dives. Any ecological effects from the shoaling oxygen minimum across a relatively small distance would best be observed during surveys within this depth range, which, at the seafloor was just a single dive around Johnston Atoll itself in each of the two years the area was explored. However, 300-800 m midwater transects conducted at both northerly and southerly sites surveyed the oxygen minima, providing data to investigate the effects of the shoaling oxygen minimum on water column organisms. The locations of the four dive sites selected for midwater transects were selected based in part based on this interest. The midwater transects are summarized in Section 5(B)3 of this report. The consequences of these two environmental phenomena, if detectable, can only be determined after the dive video has been carefully annotated.

One of the objectives related to oxygen levels was to determine whether precious corals exist in the monument, something that had not been confirmed previously. High-density precious red coral beds have been found in the 350-600 m depth range in the northern end of the Papahānaumokuākea Marine National Monument (PMNM) during submersible dives in 2003. The oxygen minima have been found around 900-1,200 m in that area of the monument, and it's been proposed that the much lower oxygen levels in the JAU may inhibit precious coral bed development around Johnston Atoll. However, a spectacular bed of the precious coral *Hemicorallium* sp. was seen at 400-550 m and in very low oxygen conditions (***Fig. 3***) on Johnston Atoll. A tentative conclusion from this discovery is that the commercially harvested shallower coralliid species can apparently tolerate a wide range of oxygen levels and, and thus can potentially colonize a relatively wide latitudinal range in the central Pacific.

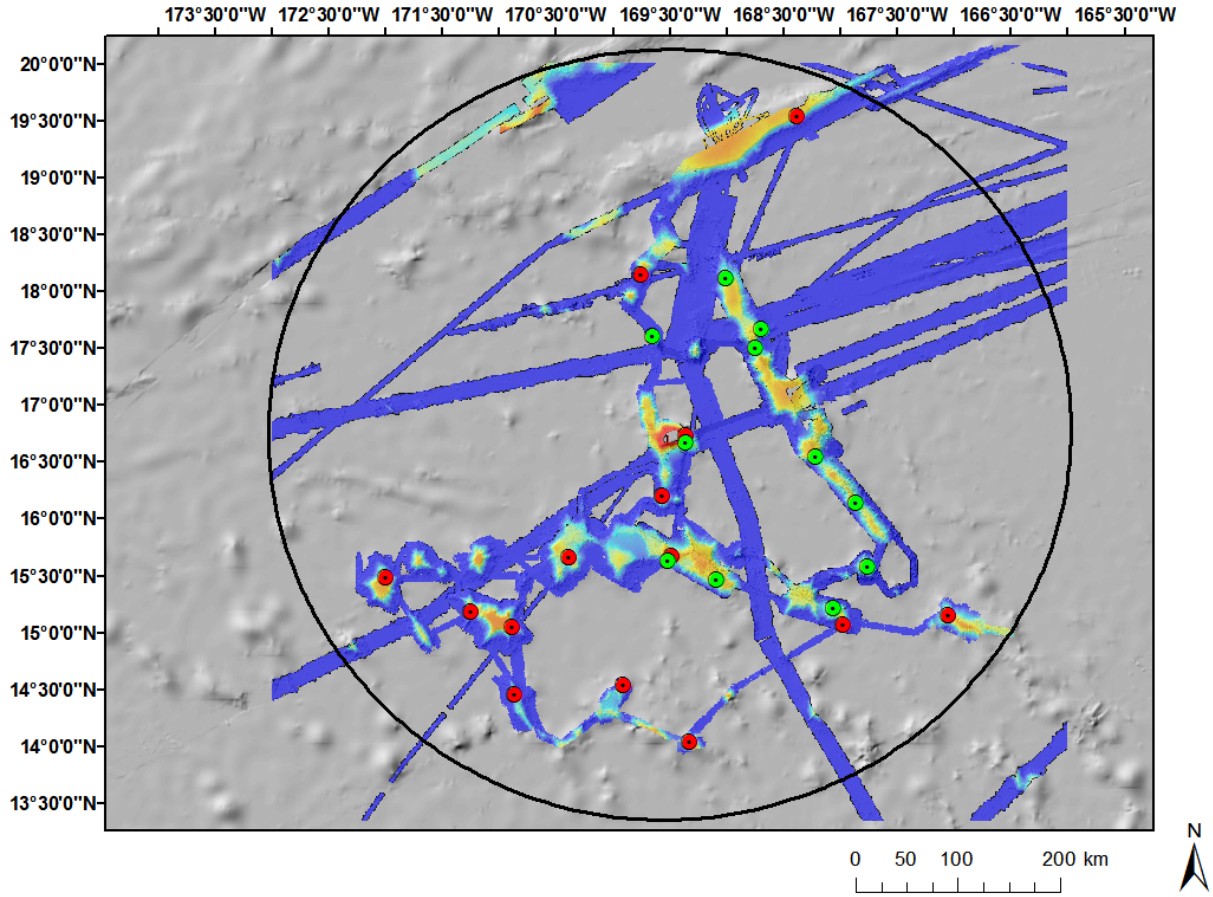

Figure 2: *Overview of all NOAA Ship Okeanos Explorer dives in the JAU conducted in 2015 and 2017 (EX-15-04-L4 dives shown as green dots and EX-17-06 dives shown as red dots).*

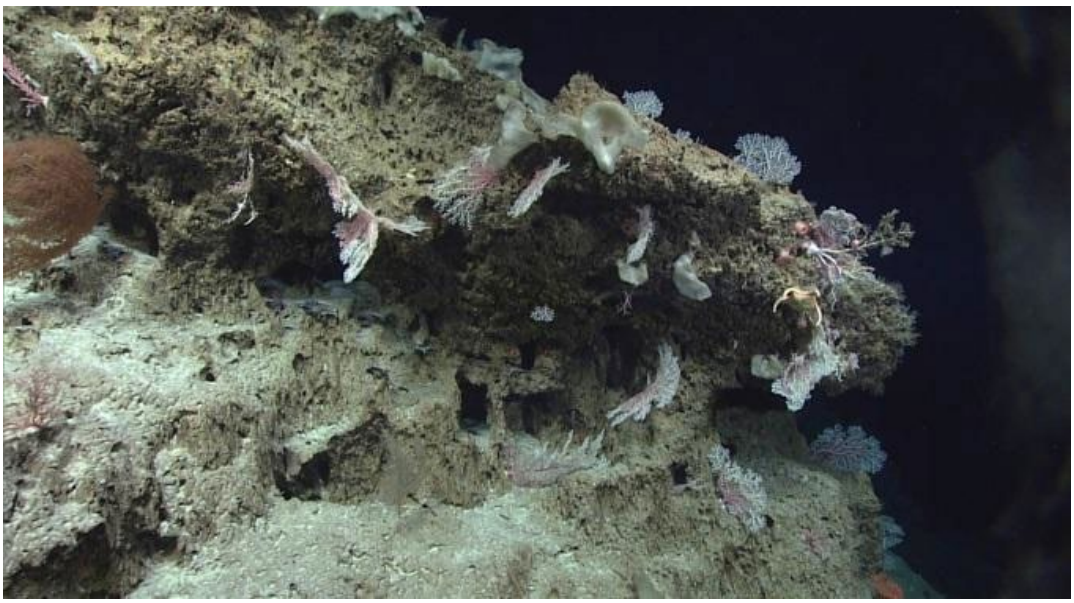

Figure 3: *A bed of the precious coral Hemicorallium sp. discovered on the slopes of Johnston Atoll during Dive #4.*

1) FeMn Crusts and High-Density Communities

Documenting FeMn crust communities has been a major CAPSTONE priority for the last three years and, consequently, 12 of the 14 dives were conducted within the FeMn crust depth range of 1,000-2,500 m, of interest for critical minerals mining. The ROV spent a considerable amount of time during the dives carefully recording not just corals and sponges, but also many other invertebrates and fishes encountered on crust substrate. The data acquired from this cruise will be combined with those from other cruises in 2015 and 2016, to provide the most detailed compilation yet of FeMn crust communities in the PCZ. A particularly important objective related to this priority was to determine whether additional high-density coral and sponge communities exist in the JAU besides the single one found in 2015 that was dominated by *Chrysogorgia* sp. Of the 13 dives conducted in the FeMn crust depth range of 1,000-2,500 m, consistently high-density coral and sponge communities were found on four sites; each of these had a different species composition and dominant taxa (***Fig. 4***). The first encountered was on "Sally" Seamount during Dive #5, where a bamboo coral-dominated community was discovered on a northern rift zone ridge. The second community was found during Dive #7 on the edge of an escarpment on the summit of "Pierpont" Seamount located in the western area of the monument. This diverse community was dominated by deep species of *Hemicorallium*, but also included many sponges, primnoids, and whole colonies of corals overgrown by zoanthids. The third community was dominated by sponges in the families Euplectellidae and Farreidae, and was dubbed by the videographers as the "forest of the weird". This spectacular high-density community was found during Dive #11 on the summit of a ridge seamount in the southern portion of the JAU. The last high-density community was dominated by large branched bamboo corals found on the flanks and peak of a guyot summit's volcanic cone during Dive #15.

Three other "patchy" high-density communities were found on Dives #10, #13, and #14. The dive tracks on these sites traversed both sparsely and densely populated areas, the latter usually being where large blocks and/or other types of elevated topography occurred. The communities found on Dives #13 and #14 were particularly noteworthy (***Fig. 5***). Dive #13 was conducted on a guyot summit's volcanic cone, with the ROV landing next to the cone then traversing the flank until it reached the peak. The substrate was sparsely populated with chrysogorgiids, isidids, a few other octocorals, and antipatharians—until the ROV reached approximately two-thirds of the way to the peak. At that point, a densely populated community of plexaurid octocorals was encountered that continued to the peak of the cone (***Fig. 5 left***). This dramatic change clearly supported a topographic influence on the structure and density of the community at this site, which is a pattern that has been observed at other sites as well.

Figure 4: *High-density coral and sponge communities found during EX-17-06, during Dive# 5 (upper left), Dive #7 (upper right), Dive #11 (lower left), and Dive #15 (lower right).*

Dive #14 was conducted on a guyot ridge in the southeastern part of the monument. The latter half of the dive was denoted by the sudden appearance of a dense community of narrow, needle-like carnivorous sponges (Cladorhizidae, possibly *Asbestopluma* sp., ***Fig. 5 right***). These were abundant and covered numerous rocky surfaces in evenly-spaced aggregations along the survey line, especially on large boulders and cliffs where currents ran over the edges. Abundance varied across the distance surveyed, with higher densities observed near areas of high current flow, while lower densities were observed away from these areas. In one location near the end of the dive, we observed significant numbers of bryozoans and zoanthids mixed in with the sponges, creating one of the most unusual communities any of us had ever seen.

Figure 5: *Patchy high-density communities found on Dive #13 (left) and Dive #14 (right).*

2) Noteworthy Animal Observations and Collections

There were also numerous noteworthy and unusual animal observations and collections that took place during this cruise. At least four potentially new species of glass sponges (Hexactinellida) were collected, including what can only be described as a branching, vaseless *Walteria* sp.; a branching Tretodictyidae, tentatively identified as in the genus *Sclerothamnus*; a strange yellow *Poliopogon* sp., which turned completely black in ethanol (EtOH); and a farreid that was first photographed in 2015 and misidentified to a different family until it was collected on this cruise. Unusual cnidarians included a swimming ceriantharian, a potentially new species of *Paragorgia*, a black coral in the genus *Lillipathes*, and a bamboo coral only identified as in the subfamily Keratoisidinae. Echinoderm collections included one holothurian—believed to be in the family Laetmogonidae—and five sea stars, three of which are potential new species in the families Goniasteridae and Ganeriidae; the latter is an undescribed new genus and species similar to the Antarctic *Cuenotaster* that has never before been reported from the central Pacific. Ultimately, over 30 species of asteroids were observed during the cruise, most of which had not previously been observed alive and several were later identified as undescribed species. Two other unusual collections included a deep-sea sea slug, tentatively identified as being in the genus *Bathydoris*, and a bryozoan. A selected few of these specimens are shown in ***Fig. 6***.

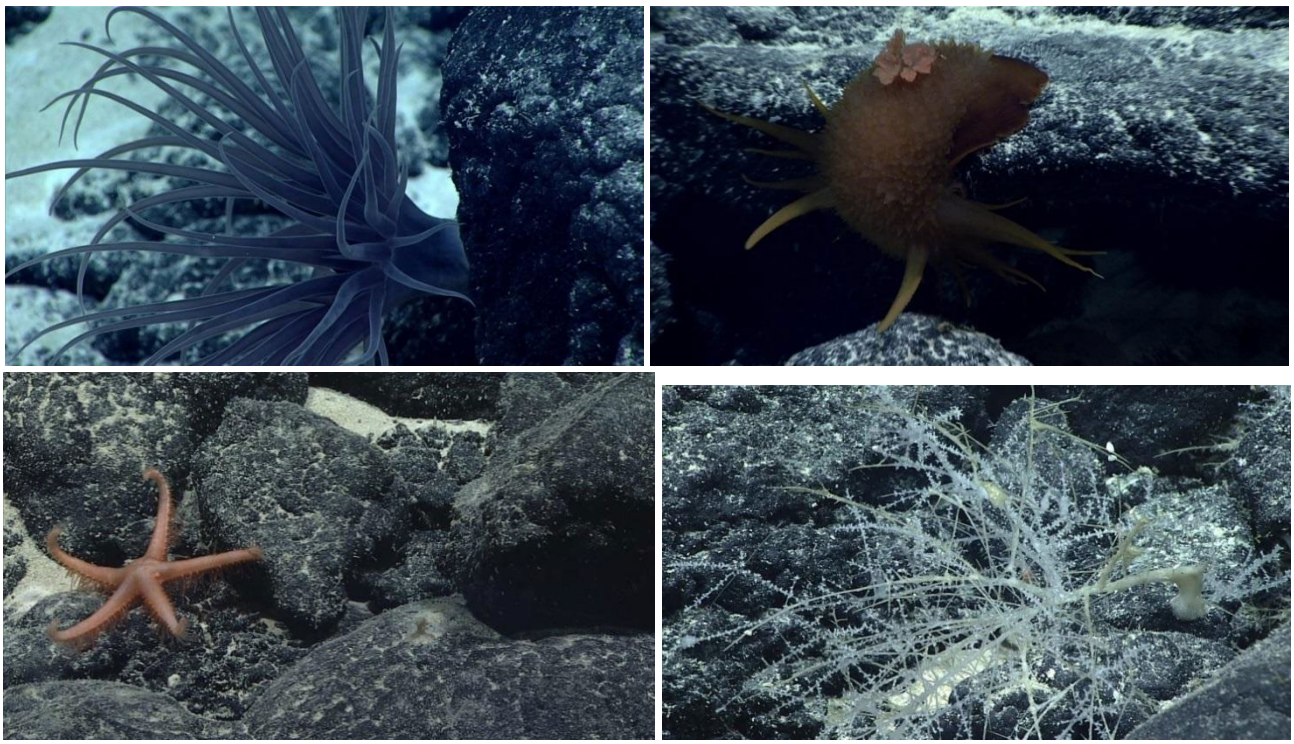

Figure 6: *Potential new species of a tube anemone (Ceriantharian, upper left) from Dive # 12, sea slug Bathydoris sp. observed on Dive # 12 (upper right), a new genus and species of sea star (lower left) from Dive # 9, and glass sponge Walteria sp. branching (lower right) from Dive # 15.*

Noteworthy unusual animals recorded on video, but not collected, included a very small unusual brittle star (*Astrophiura* sp.), a spatangoid irregular urchin believed to be in the genus *Phryssocystis*, a regular urchin believed to be in the family *Habrocidaris*, and a snailfish believed to be in either the genus *Psednos* or *Paraliparis*. *Astrophiura* is a small brittle star with very short arms and a flattened body which superficially resembles a sea star. This genus has been known only from specimens since its description in 1878, when it was thought to have been an "evolutionary missing link" between sea stars and brittle stars. Although eight species are known, with the most recent discovered in 2001, this unusual genus had never been imaged *in situ* until this cruise (Dives #9, #10, and #11). These observations also represent a new record for the Johnston Atoll region, and likely a new species—since most *Astrophiura* spp. are known from shallower than 1,000 m. The animal thought to be *Phryssocystis* sp. was documented on Dive #2 (Horizon Guyot) where it was observed burrowing through a sediment pond leaving a pronounced trace in its wake. Deep-sea irregular urchins are uncommon to rare, and *Phryssocystis* spp. have been recorded from very few specimens since first described by Alexander Agassiz in 1898. ***Fig. 7*** provides photos of these animals.

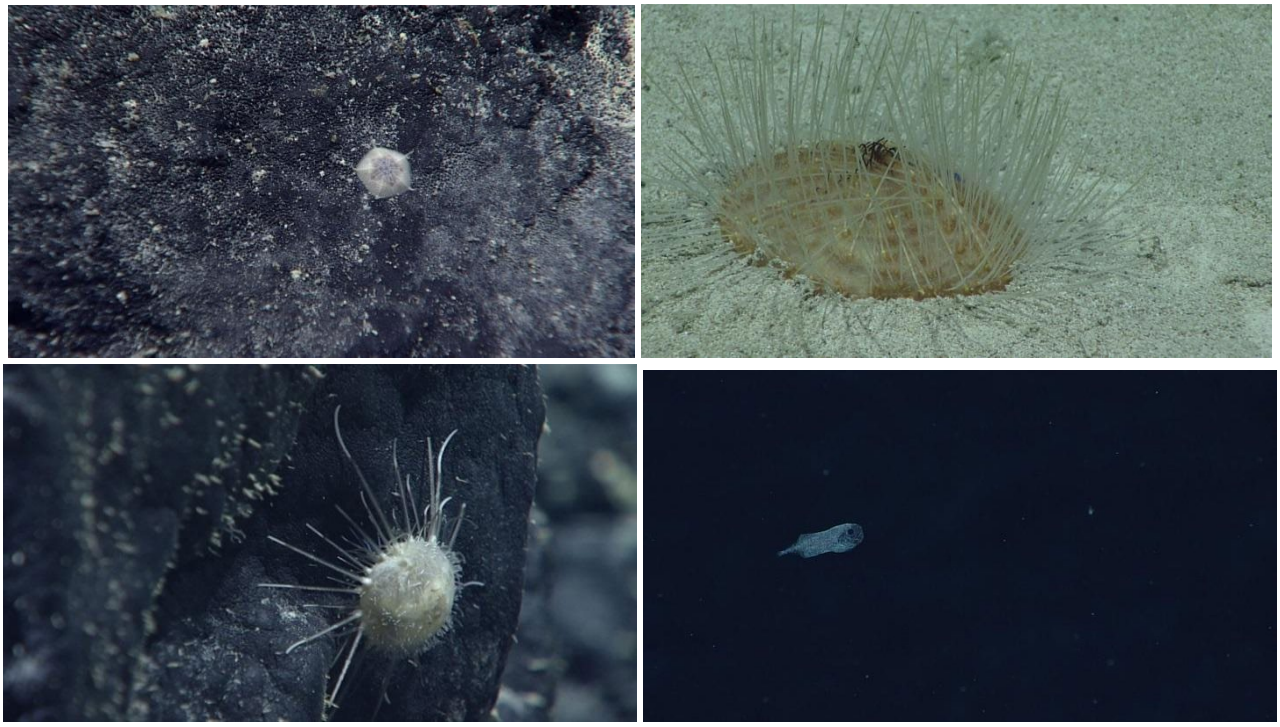

Figure 7: *Unusual animals observed during EX-17-06 included the brittle star Astrophiura sp. (upper left), the irregular urchin Phryssocystis sp. (upper right) from Dive # 2, the regular urchin Habrocidaris sp. (lower left) from DIve # 6, and the snail fish Psednos or Paraliparis (lower right) from Dive # 14.*

3) Midwater Exploration

Midwater transects were conducted during the ascent phase of four EX-17-06 dives (Dives #3, #5, #8, and #14). These transects were led remotely from shore by biologists who specialize in pelagic organisms and included Dhugal Lindsay from the Japan Agency for Marine-Earth Science

and Technology (JAMSTEC); Amanda Netburn from the Cooperative Institute for Ocean Exploration, Research & Technology (CIOERT); Karen Osborn from the NMNH; Don Kobayashi from NOAA Pacific Islands Fisheries Science Center (PIFSC) in Honolulu, HI; Mike Vecchione from NMFS; Heather Judkins from the University of South Florida St. Petersburg; Tracey Sutton from Nova Southeastern University in Ft. Lauderdale, FL; George Matsumoto at Monterey Bay Aquarium Research Institute (MBARI) in Moss Landing, CA; and Denise Breitburg of the Smithsonian Environmental Research Center (SERC). Ford and Netburn hosted Osborn and Breitburg, as well as a dozen students, at the Silver Spring ECC for Dive #14.

All midwater transects followed the same protocol. Midwater transects were conducted over about two hours following seafloor surveys. The Simrad EK60 echosounders were run as soon as the ROV left bottom to collect acoustic data; these data were used to detect deep scattering layers, which are comprised of organisms that reflect the acoustic signal. The scattering layers are interesting targets because they are likely to contain a high density of animals. All transects were 10 minutes long, with the first of each set occurring at 800-900 m. A total of six transects—spaced out at 100-meter depth intervals—were targeted for each dive, with the last taking place between 200-300 m. The exact depths were adapted in real-time based on the depths of deep scattering layers detected by the EK60 echosounder, oceanographic features (e.g., oxygen minima, salinity inversions, etc.) detected by the ROV's CTD on its initial descent, and availability of time. The exploratory transects are conducted by slow forward movement of the ROV, and stopping at the scientists' requests in order to image organisms of interest.

Based on SeaScribe annotations, chaetognaths and larvaceans were the most abundantly logged taxa within the 200-900m midwater depth range surveyed during the cruise. Midwater biologists also noted that the animals observed in highest abundances were those that were not generally well-sampled with nets—such as ctenophores, siphonophores, and protists. With the Ctenophora, lobate species were more common than cydippids, suggesting that marine snow and very small plankton are the major food source available in the region. It was further suggested that cydippids must be "losing out" to the siphonophores with regard to eating the larger crustaceans and fish. Some particularly noteworthy midwater invertebrates encountered include narcomedusae (genus *Bathykorus*), an opaque reddish jellyfish in the genus *Periphyllopsis*, an undescribed ctenophore that is so fragile it has never successfully been captured in one piece (dubbed "Intacta"), and siphonophores in the genus *Praya*. The saw-toothed eel, *Serrivomer* sp., and bristlemouth, *Cyclothone* spp., were among the most observed fish species observed. Other notable fish included a swimming cusk eel (*Borodinula infans*), a hatchetfish (*Sternoptyx* sp.), and another bristlemouth (*Sigmops gracilis)*. Perhaps the most striking among the deepwater organisms were protists, including a stunning "starburst" colored, shimmering radiolarian as well as a coelodendrid phaeodarian that possessed four bizarre tentacles. ***Fig. 8*** shows selected examples of midwater organisms documented on this cruise.

Figure 8: *Examples of midwater animals, which included a saw-toothed eel (upper left) on Dive # 3, "Intacta" ctenophore on Dive # 5 (upper right), protist (lower left) from Dive # 5, and a narcomedusa (lower right).*

C. Geology

Neither of the two science leads on EX-17-06 are geologists, so this summary of the geological findings is relatively brief and simplistic. Johnston Atoll and all of the seamounts located in the JAU are believed to be mid-Cretaceous in age, varying from approximately 80 million years old in the southern part of the monument unit to 90 million years old for Horizon Tablemount in the northern part of the monument (Garcia et al., 1993). The geological origins of Horizon Tablemount and the Karin Seamount, a NW trending seamount chain along the eastern section of the monument, are perhaps the best known of all of the seamounts in the JAU because they are considered to be the northernmost expression of the hotspot that created the Line Islands. Some information is also known about Johnston Atoll itself (, 1987), which is tilted to the south presumably due to differential loading on the underlying mantle. The origin of Johnston Atoll—and all other seamounts—is unclear, particularly since the seamounts in the southern part of the monument appear to be “cross-trending” with respect to the presumed direction of the Pacific plate during the mid-Cretaceous. These seamounts are enigmatic because none have been previously sampled by dredge or submersible. Obtaining rocks containing volcanicly-generated material for geochemical analysis, including $^{40}Ar/^{39}Ar$ dating, was an objective during the majority of dives in this part of the monument unit—as well as on other seamounts in the JAU.

Twenty-four rocks were collected during the cruise, two from each of 12 dive sites (***Fig. 9***). The only three sites that were not sampled were the engineering test dive site off Oahu, the dive site on Johnston Atoll (too shallow for basalt substrate), and the Horizon tablemount site (too

short of a dive to identify suitable rocks for collection). The total mass of the collected rocks was 195 kg and the mass of individual rocks varied from 1.7 to 18 kg (See Appendix G). All of the rocks were FeMn-encrusted to some degree, making it difficult to determine the amount of basalt each contained.

One piece of basalt rock collected during Dive #11, on a deep ridge, was particularly noteworthy because it had a very thin FeMn crust on its surface, which was clearly vesiculated (***Fig. 10***). This type of basalt is generally thought to result from eruptions close to the surface where escaping gas can cause small, round cavities in the surface as it cools. The discovery of vesiculated basalt was not expected on any of the dive sites due to the presumed age of the seamounts and thick FeMn crusting. It's likely that other interesting data will emerge once these rocks are subjected to geochemical analyses by geologists interested in this region of the Pacific.

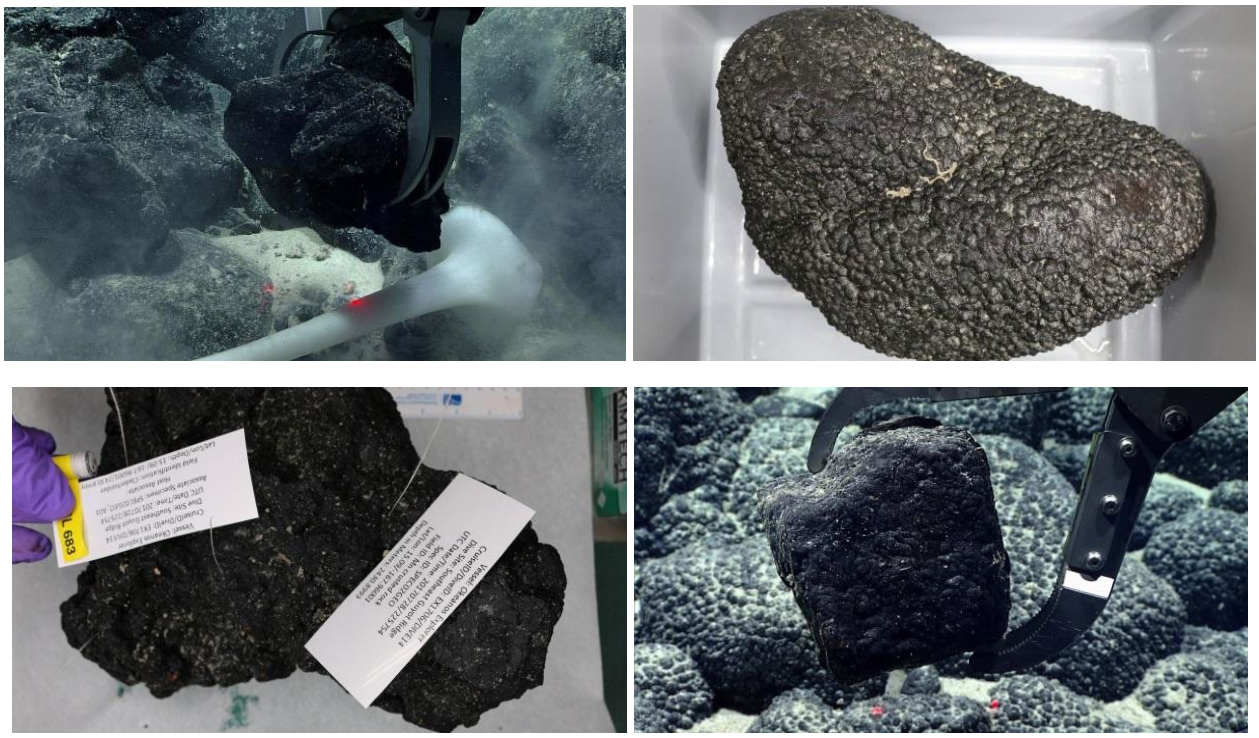

Figure 9: Example *In situ* and lab images of rocks collected during EX-17-06.

Figure 10: *a) Unnamed ridge south of Johnston Atoll where EX-17-06 Dive #11 took place, b) vesiculated basalt collected near the summit during that dive.*

6. Summary of Mapping

More details are available in the EX-17-06 expedition "Mapping Data Acquisition and Processing Summary Report", accessible from NOAA Archives (last accessed April 2020). Mapping statistics for the expedition are summarized as Table 4.

A. Mapping Statistics

Table 4: Mapping statistics of the expedition.

Date	July 7-August 2, 2017
Line kilometers of survey	~ 6,900 km
Square kilometers mapped with EM 302	38,331 km^2
Square kilometers mapped with EM 302 within the JAU	23,161 km^2
Number/Data Volume of EM 302 raw bathymetric / bottom backscatter multibeam files	568 files/29 GB
Number/Data Volume of EM 302 water column multibeam files	568 files/103 GB
Number/Data Volume of EK60 water column single beam files	160 files/18 GB
Number/Data Volume of subbottom sonar files	300 files/7.34 GB
Number of XBT casts	57
Number of CTD casts (including test casts)	1

B. Summary of Results

More than 38,300 km^2 of seafloor were mapped during EX-17-06, including about 23,161 km^2 inside the JAU of the PRIMNM. Mapping data were acquired on eight new seamounts, where no high resolution multibeam bathymetry or backscatter previously existed (***Fig. 11***). Five of these were revealed to be flat-topped guyots with summits below 1,000 m, typical of Cretaceous-era volcanoes that reached the surface and later subsided. Three of these had

cones or other structures on their summits, indicative of secondary volcanism that took place after the seamount sank below reef-forming depths. Two other seamounts were revealed to be "ridge-type" seamounts trending NW-SE and in line with the presumed movement of the Pacific plate. Neither of these seamounts had apparently reached the surface before volcanic activity ceased. Finally, one small seamount was revealed to be a typical deep conical volcano that never came close to the surface and whose magna chamber had not collapsed, allowing for the retention of its original shape. Example images of these newly mapped seamounts are provided in ***Fig. 12***.

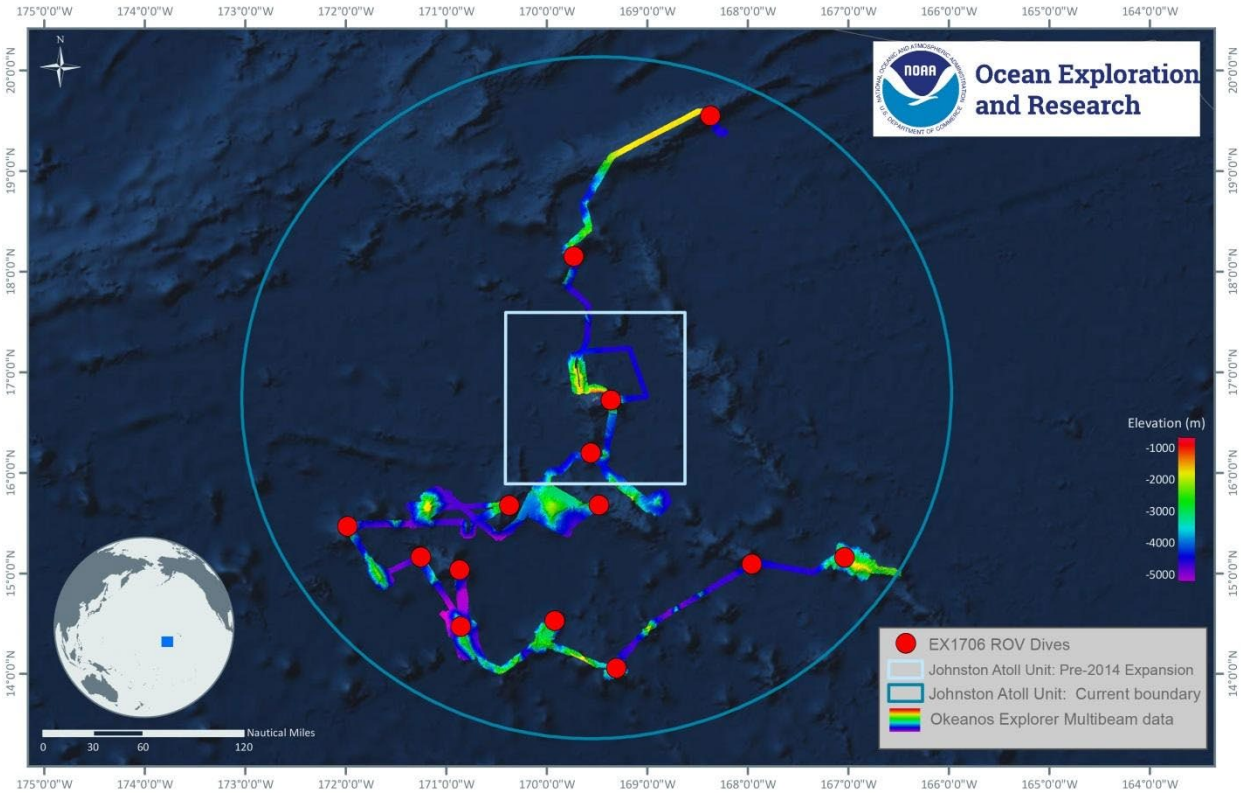

Figure 11: *Bathymetry and ROV dive locations in the JAU from cruise EX-17-06 on NOAA Ship Okeanos Explorer.*

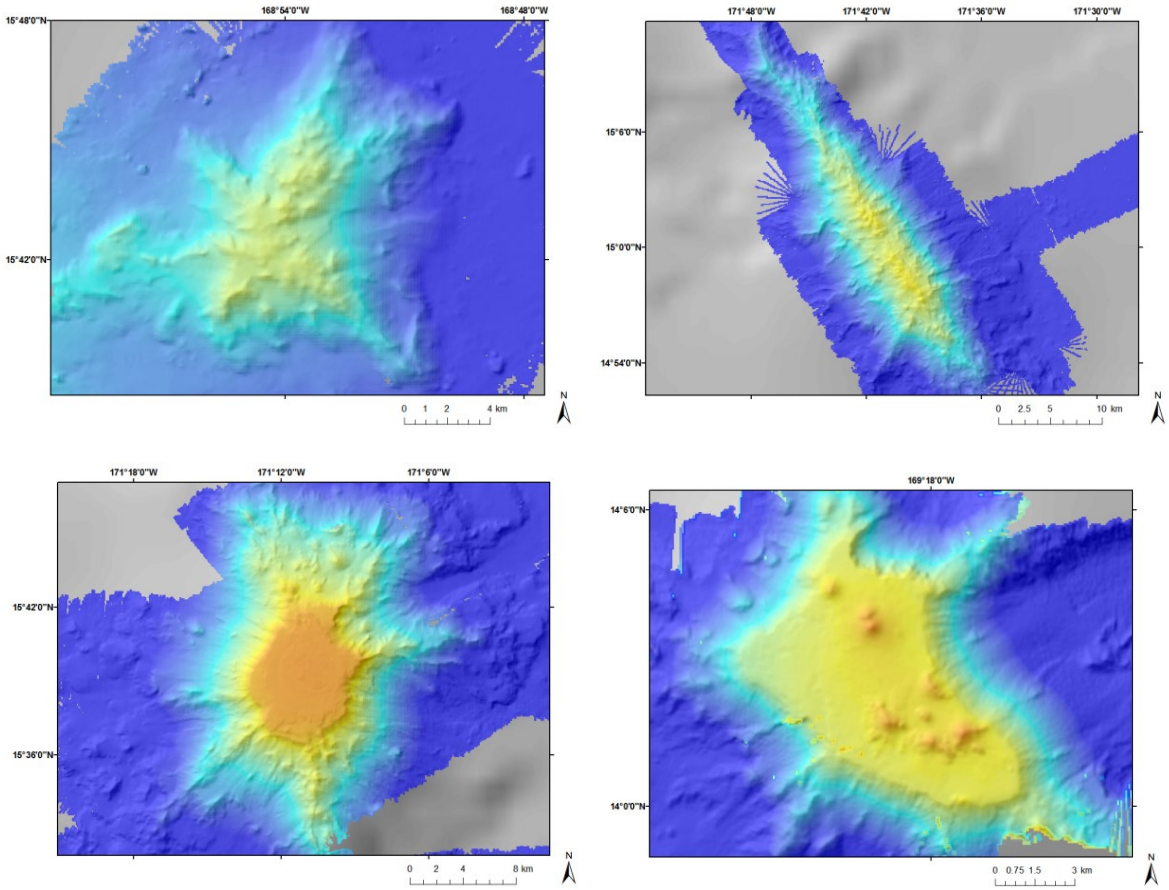

Figure 12: *Examples of new seamounts mapped during EX-17-06. a) deep conical seamount, b) ridge seamount, c) guyot, and d) guyot with volcanic cones on summit.*

Operations also included adding coverage to existing mapping data. Transit mapping and focused mapping surveys were planned to add coverage to existing multibeam data acquired in the region in 2009, 2015, and 2016 during four *Okeanos Explorer* cruises; in 2016 by R/V *Falkor*; and from other expeditions that provided publicly available data (***Fig. 13-14***).

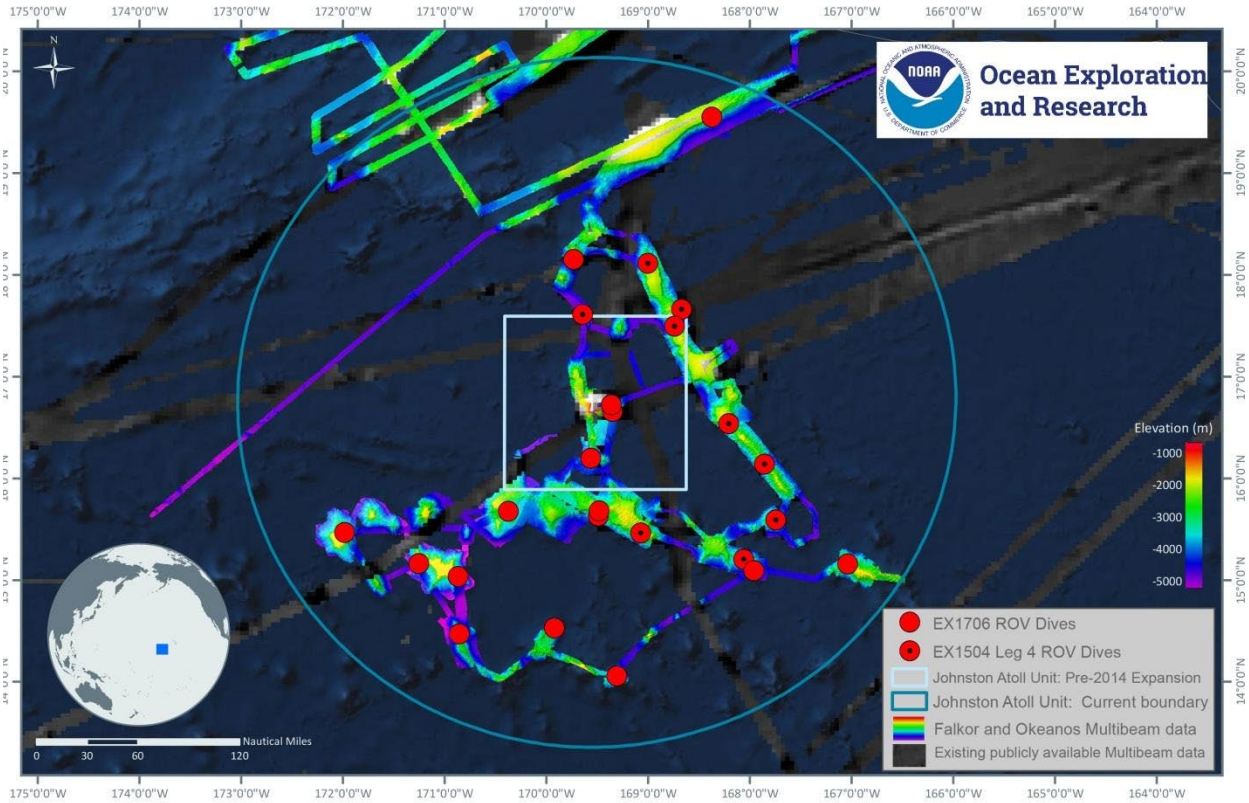

Figure 13: *Bathymetry Data Compilation and ROV Dives from NOAA Ship Okeanos Explorer and R/V Falkor Expeditions to the JAU since 2009. The grey bathymetry shows existing publicly available multibeam data.*

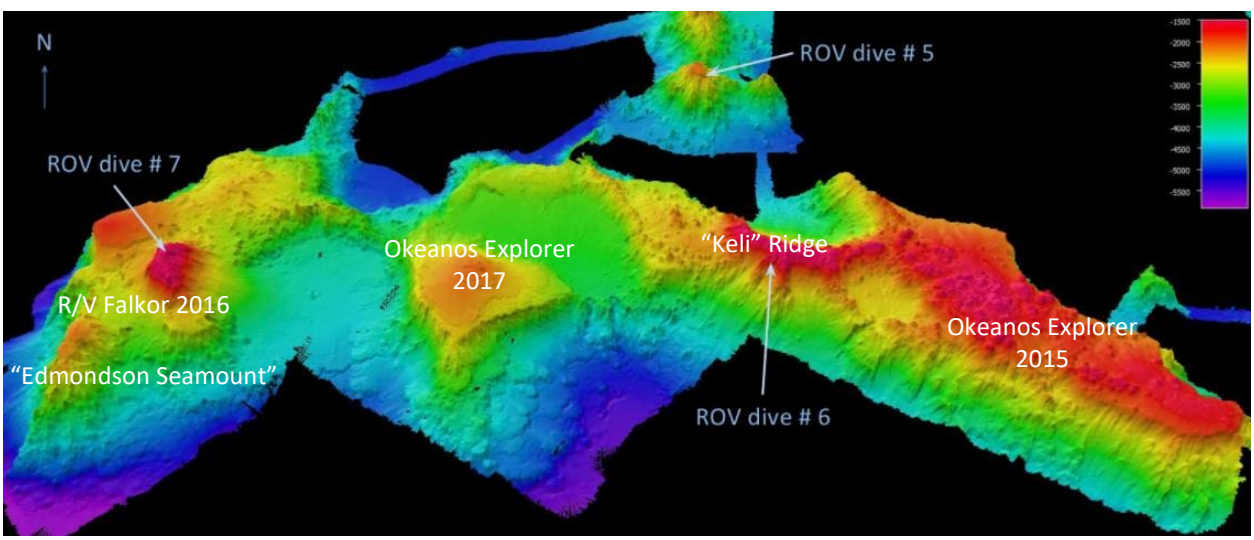

Figure 14: *Three-dimensional perspective view of high-resolution bathymetric data in the vicinity of "Keli" Ridge; data collected by R/V Falkor in 2016 and by NOAA Ship Okeanos Explorer in 2015 and 2017. Mapping conducted July 19-21, 2017, shows "Keli" Ridge, "Edmondson" Seamount, and an unnamed seamount to the west are geologically connected.*

7. Data Deposition and Archival

The EX-17-06 Data Management Plan can be found in Appendix E of the EX-17-06 cruise plans, available at: ftp://ftp.library.noaa.gov/oedv.lib/Okeanos_Explorer_2017_EX1706/doc/EX1706_cruise_plan.pdf (last accessed March 2020). The NOAA Ship *Okeanos Explorer* Data Types and Product List can be found in Appendix H.

A. OER Data Discoverability Tools

All data collected by NOAA Ship *Okeanos Explorer* are archived and publicly available within 90 days of the end of each cruise via the NCEI online archives. Data can be accessed via the following websites:

- OER Digital Atlas at: https://www.ncei.noaa.gov/maps/oer-digital-atlas/mapsOE.htm (last accessed March 2020)
- OER ROV Data Archives at: https://service.ncddc.noaa.gov/rdn/oer-rov-cruises/ex1706 (last accessed March 2020)

Additional data requests are handled through the OER Program Data Access Request Form which can be found here: https://docs.google.com/a/noaa.gov/forms/d/1pU3jbcV5ffunMKUbYgnA2OK-ZT9qj2Dh6JgZ79TTORM/viewform?formkey=dHAycC1MYndJb0hTdGRaYXAzVTVBdWc6MA&fromEmail=true (last accessed March 2020)

B. Sonar Data

Sonar data collected onboard NOAA Ship *Okeanos Explorer* undergoes quality assurance/quality control (QA/QC) after a cruise and is then made publicly available through the OER Data Discoverability Tools (section 7 A), the National Centers for Environmental Information, and the following websites:

- National Centers for Environmental Information (NCEI) (formerly National Geophysical Data Center (NGDC)) Interactive Bathymetry Data Viewer at: http://maps.ngdc.noaa.gov/viewers/bathymetry/ (last accessed March 2020)
- ADCP archives for EX-17-06 at: https://www.nodc.noaa.gov/archive/arc0112/0165181/1.1/data/0-data/vessel/Ship_Sensor_Raw_Data/ADCP_Data/ (last accessed March 2020)

- NCEI (formerly NGDC) Interactive Water Column Sonar Data Viewer at: http://maps.ngdc.noaa.gov/viewers/water_column_sonar/ (last accessed March 2020)

C. Physical Samples

Biologic samples collected during *Okeanos Explorer* expeditions are archived in the collections of the National Museum of Natural History, Smithsonian Institution. Here, they are catalogued, curated, and made publicly available. Biological samples of invertebrate organisms are archived in the Invertebrate Zoology Collections (https://naturalhistory.si.edu/research/invertebrate-zoology, last accessed March 2020) and information on how to request access to these samples can be found here: https://naturalhistory.si.edu/research/invertebrate-zoology/collections-access/specimen-loans (last accessed March 2020). Biological samples of fishes are archived in the Division of Fishes of the Vertebrate Zoology Collections (https://naturalhistory.si.edu/research/vertebrate-zoology/fishes, last accessed March 2020), and information on how to request access to these samples can be found here: https://naturalhistory.si.edu/research/vertebrate-zoology/fishes/collections-access/specimen-loans (last accessed March 2020).

Selected coral and sponge specimens were split; one aliquot was sent to the Bishop Museum (https://www.bishopmuseum.org/collections-3/invertebrate-zoology/, last accessed March 2020) and another sent to the SI. If it was determined that splitting would be too destructive to a particular specimen, it was provided to the SI intact in order to provide public access to as many researchers as possible.

An additional small tissue sample for genetic analysis was taken of corals, sponges, and all other specimens when doing so would not effectively destroy the specimen. This tissue sample was preserved for later genomic DNA extraction at the Ocean Genome Legacy Center at Northeastern University (https://www.northeastern.edu/ogl/, last accessed March 2020). Information on how to request access to these results and any remaining DNA samples can be found at: https://www.northeastern.edu/ogl/request-2/ (last accessed March 2020).

All geological samples collected during *Okeanos Explorer* expeditions were sent to the Marine Geology Repository at Oregon State University (http://osu-mgr.org/noaa-ex/, last accessed March 2020) where they were described from a petrology perspective (e.g. mineral content, texture, alteration, rock type), photographed, and made publicly accessible. The repository provides photographs (including microphotographs) and online metadata information about each geological specimen. Information on how to request access to these geological samples can be found here: http://osu-mgr.org/request-samples/ (last accessed March 2020).

8. Additional Information

Daily Situation Reports and internal operational records are also on file with OER. For questions, please contact OER.

9. References

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Kelley, C., France, S.,Parrish, F., Wagner, D., Gerringer, M., and Garcia, M. (2016). CAPSTONE's First Year: 2015 Hohonu Moana: Exploring Deep Waters off Hawaiʻi Expedition. *Oceanography*. vol. 29:1. Supplement. pp. 68-73. DOI: 10.5670/oceanog.2016.supplement.01

APPENDIX A: Data Types and Products List

PRODUCTS AVAILABLE DURING A CRUISE: *A variety of data and products will be collected and/or developed aboard Okeanos Explorer (EX) and at shore-side Exploration Command Centers (ECCs) during the EX 2017 Field Season. Operational products and datasets will be made available to participants during and after the cruise, and can be accessed from several internet-based tools. Below is a summary of products anticipated to be developed for operational uses, product descriptions and information on where to go to access these products during a cruise.*						
Product	**Description**	**Format**	**Developer**	**Developer Location**	**Access Location**	**Access Level**
OPERATIONS						
Daily Science Team Emails	Brief summary of today's operations and plans and participation info for next two days.	Emails	Science Leads	Ship	Email	Participants/Listserv
Plan of the Day	Plan of the day detailing ship operations	DOCX	Operations Officer	Ship	FTP site / Cruise Data File Server	Participants
SITREPs	Internal Document; Daily status report detailing EX operations	DOCX, PDF	Expedition Coordinator	Ship	FTP Site; Email	OER staff
Mapping						
Raw EM302 Data	Selected full resolution bathymetry and bottom backscatter data. Water column backscatter where appropriate and on a limited basis.	.all, .wcd	Mapping team	Ship/Shore	FTP site / Cruise Data File Server	Participants
EK60 Single Beam Data	Raw water column data. Where appropriate, a processed level 2 image.	.raw, Fledermaus .sd, Image (.jpeg, .TIFF)	Mapping team	Ship/Shore	FTP site / Cruise Data File Server	Participants
Sub-Bottom Profiler Data	Raw data. Where appropriate, a processed geo-referenced vertical curtain.	.seg-y, .keb, .kea, GeoTIFF, .sd.	Mapping team	Ship/Shore	FTP site / Cruise Data File Server	Participants
Daily mapping progress bathymetry	Site-specific or cumulative daily bathymetry	GeoTIFF; Fledermaus .sd; Google Earth .kmz, ASCII text file, Arc Grid .asc	Mapping team	Ship	FTP site / Cruise Data File Server	Participants
Multibeam backscatter data	Where appropriate, site specific backscatter data (seafloor / water column backscatter as needed)	GeoTIFF, .sd, Tiff	Mapping team	Ship	FTP site / Cruise Data File Server	Participants
Science Operations Products						
ROV Dive Planning Form	Planning form detailing desired ROV Ops including waypoints	DOCX, PDF	Science & ROV Team	Ship	Email; FTP site / Cruise Data File Server	Participants
ROV Dive Summary Form	Summary detailing completed ROV dive, summarizing observations, sample collections and including summary maps	DOCX, PDF	Science & ROV Team	Ship	FTP site / Cruise Data File Server	Participants
ROV Tracklines	File containing XYZ + T (1 min avg.) data of the ROV during a dive.	.csv table, KML	ROV Team; Script	Ship	FTP site / Cruise Data File Server	Participants
Hypack Targets	File containing the targets dropped during a dive	KML	ROV Team; Script	Ship	FTP site / Cruise Data File Server	Participants
SeaScribe Annotation Log	Scientific observation log noting fauna, geology and other observations from an ROV dive	CSV	Expedition science participants contribute; SeaScribe server auto-generates	Geographically Distributed	FTP site / Cruise Data File Server	Participants

Chat Log	Literally a group chat room with UTC time-coded and stamped observations that are saved and output as .txt files, and as excel files with associated lat, long, and depth for each entry.	TXT, XLSX	Expedition Science Participants contribute; Automated server generates	Geographically Distributed	FTP site / Cruise Data File Server	Participants
Datasets	Raw oceanographic data, SCS, CTD, DO, LSS, ORP, etc.	various	Automated process; STs	Ship	FTP site / Cruise Data File Server	Participants
CTD Rosette Summary Form	Summary detailing completed ROV dive, summarizing observations, sample collections and including summary maps	DOCX	Science Team	Ship	FTP site / Cruise Data File Server	Participants
Imagery						
Raw Video Clips – Low Res	Video clips from ROV dives, onboard cameras.	.mov (H.264 at 1.5 MB at 640x320)	Video team	Ship	FTP site / Cruise Data File Server	Participants, Web Coordinator and Science Participants
Cruise Highlight Video	OPTIONAL: video highlighting OER mission	.mov HR & LR	Video Team	Ship	FTP site / Cruise Data File Server (Low Res Only)	Public
Daily Highlight Videos	Edited & Scored video of best clips from a specific dive (one per dive)	.mov HR & LR	Video team	Ship	FTP site / Cruise Data File Server (Low Res Only)	Public
Custom Video Products	OPTIONAL: One-off products for the OER website and outreach (Timelapses, "Sea Poke" video, etc)	.mov HR & LR	OER Program Personnel	Shore	FTP site / Cruise Data File Server (Low Res Only); OceanExplorer website	Participants
Highlight Imagery	HD Screengrabs; best 10-15 per dive; Edited for sharing online	Color corrected .jpg	Video team	Ship	FTP site / Cruise Data File Server (Low Res Only)	Participants
Still Images	frame grabs from underwater video which map to the video clips	JPG; TIFF	Video team	Ship	FTP site / Cruise Data File Server (Low Res Only)	Participants
News Articles	Provides more context or info on expedition events	Online	Various	Various	OceanExplorer Website	Participants/ Public
Sampling						
Daily Sample Report	Daily output from SODA that includes information about every sample, lab preparation, and identifies associated images and video	.pdf	Sample Data Manager	Ship	FTP site / Cruise Data File Server	Participants
Daily List of Sampling Associated Images and Video	List of all samples and associated video. This list is used to build the folders of in situ video and stills. Output from the database?	.txt	Sample Data Manager	Ship	FTP site / Cruise Data File Server	Participants
In situ images (via symlinks)	Symbolic links that create a folder of all images associated with a particular sample	JPG via Symlinks	Images - Video team; Identification of Images - Sample Data Manager; Symlinks- Data Manager	Ship	FTP site / Cruise Data File Server	Participants

Video of collection (via symlinks)	Symbolic links that create a folder of all videos associated with a particular sample	.mov via Symlinks	Identification of videos - Sample Data Manager; Symlinks- Data Manager	Ship	FTP site / Cruise Data File Server	Participants
Lab images	Images of samples taken with a color pallet and sample label	RAW, JPG, CR2	Sample Data Manager	Ship	FTP site / Cruise Data File Server	Participants
Microscope images	Images taken using a Caltex LX-100 Series Digital Microscope (when applicable)	JPG	Sample Data Manager	Ship	FTP site / Cruise Data File Server	Participants
Microscope video	Video taken using a Caltex LX-100 Series Digital Microscope (when applicable)	MP4	Sample Data Manager	Ship	FTP site / Cruise Data File Server	Participants
Records in ROV Dive Summary Form	Tables located in the dive summary report that includes summary collection information, field ID, preparation, and any relevant notes about the specimen	.docx	Sample Data Manager	Ship	FTP site / Cruise Data File Server (Once Final)	Participants
Final copy of cruise SODA (database)	Microsoft Access database used during sampling operations to document the metadata of each biological or geological sample collected during a dive	Microsoft Access 2013 database (.accdb)	Sample Data Manager	Ship	FTP site / Cruise Data File Server (at conclusion of the cruise)	Participants
Final Sampling Table	Table of all samples collected, associated data, preparations, planned archival locations, and names of associated imagery	.xls	Sample Data Manager	Ship	FTP site / Cruise Data File Server (at conclusion of the cruise)	Participants

PRODUCTS AVAILABLE AFTER A CRUISE

The following is a list and descriptions of quality assured products and data to be developed and made available after the cruise. Availability timing depends on level of processing required. All data and products listed below are available for direct access from the OER Digital Atlas / Data Access tab. Documents, data and information are added to the Digital Atlas as they are processed and become available. If you cannot find the data you are looking for, please submit a data request form for assistance from the OER data management team.

Product	Description	Format	Developer	veloper Locatio	ccess Location	Access Level
OPERATIONS						
Cruise Report	Cruise report summarizing the operations and results of the cruise	DOCX, PDF	Expedition Coordinator (with input from team leads)	Shore	OER Digital Atlas; NCEI	Participants
Initial Expedition Summary	Initial, first look at the results of the cruise	DOCX	Science, Expedition Coordinator	Ship	Email	Partners
Expedition Summary	Summary of major initial expedition findings	PDF	Engagement Team	Shore	OceanExplorer Website	Public
Expedition Infographic	Summary of expedition statistics	PDF	Engagement Team	Shore	OceanExplorer Website	Public
Science Operations Products						
ROV Dive Summary Forms	Summary of dive with operational info, site description and overview of observations	DOCX, PDF	ROV Team, Science Lead	Ship	OER Digital Atlas; NCEI	Participants
CTD Summary Forms	Summary of CTD cast results; detail sample collection	DOCX, PDF	Science Team	Ship and Shore	OER Digital Atlas; NCEI	Participants
Water Column Profile Data	Water Column profiles of sound velocity, XBT, and CTD data collected for mapping.	.asvp, .txt, .cnv	UNH (Mapping Team)	UNH, Ship	OER Digital Atlas; NCEI	Public
Sampling						
Final Sample Database	Microsoft Access database used during sampling operations to document the metadata of each biological or geological sample collected during a dive	Microsoft Access 2013 database (.accdb)	Sample Data Manager	Ship	OER Digital Atlas; NCEI	Public

Final Sample Sumary Table	Table of all samples collected, associated data, preparations, planned archival locations, and names of associated imagery	.xls	Sample Data Manager	Ship	OER Digital Atlas; NCEI	Public
Sample Layer in Okeanos Explorer Atlas	Geospatial layer in the Okeanos Explorer Digital Atlas that associates the locations of samples with digital data collected	Okeanos Explorer Atlas layer	OER Data Manager	NCEI	Okeanos Explorer Atlas; NCEI	Public
Biologic Samples	Biologic samples collected durign the cruise are made available through the Smithsonian	Specimen	CAPSTONE Science Adviser; Smithsonian	University of Hawaii	Invertebrate Zoology Collection	Public
Ocean Genome Legacy Samples	Biologic samples preserved for genetic analysis for the Ocean Genome Legacy Project collected durign the cruise are made available through the Northeastern's OGL Project.	Specimen	CAPSTONE Science Adviser; OGL at Northeastern	University of Hawaii	Ocean Genome Legacy Center	Public
Geologic Samples	Geologic samples collected durign the cruise are made available through the Smithsonian	Specimen	CAPSTONE Science Adviser, Oregon State University	University of Hawaii	OSU Marine Geology Repository	Public
Mapping						
Expedition Summary Map	Standard map showing bathymetry data, ROV dive sites, CTD casts and possibly XBTs	PDF	Mapping Team	Ship	OceanExplorer Website; OER Digital Atlas	

Mapping Data Processing Log	Excel sheet of metadata describing mapping data files information, notes, processing checklist, and QC.	Excel Spreadsheet (.xlsx)	UNH (Mapping team)	UNH, Ship, Shore	OER Digital Atlas; NCEI	Public
Level 0 EM302 Data	Raw uncleaned multibeam sonar files.	Raw EM302 multibeam files (.all, .wcd)	UNH (Mapping team), SST	UNH, Ship	OER Digital Atlas; NCEI	Public
Level 0 EK60 Data	Raw EK60 split-beam sonar files.	.bot, .idx, .raw	UNH (Mapping Team)	UNH, Ship	OER Digital Atlas; NCEI	Public
Level 0 Sub-Bottom Profiler Data	Knudsen 3260 Sub-Bottom Profiler sonar data.	.sgy, .keb, .kea	UNH (Mapping Team)	UNH, Ship	OER Digital Atlas; NCEI	Public
Level 1 EM302 Multibeam Data	Edited & cleaned full resolution multibeam bathymetry data by line	.gsf	UNH (Mapping Team)	UNH, Ship	.gsf to NCEI, HDCS to NOAA OCS	Public
Level 2 EM 302 Multibeam Bathymetry and Bottom Backscatter Data	Cleaned and gridded bathymetry files at summary 25-100 meter resolution, backscatter mosaics (as available)	gridded data (ASCII .xyz), geotiff (.tif/.tfw or .tif), Fledermaus objects (.sd), Google Earth (.kmz), ArcGIS Grid (.asc), backscatter mosaic images (.tif)	UNH (Mapping team)	UNH, Ship	OER Digital Atlas; NCEI	Public
Level 2 EM302 Multibeam Data Coverage Polygons	Survey coverage shapefile used to calculate square km mapped and to show EX activities on the IOCM SeaSketch site.	ArcGIS shapefile (.shp)	UNH (Mapping team)	UNH	OER Digital Atlas; NCEI	Internal to NOAA
Mapping Data Report	Summary of Mapping operations and accomplishments. Given a DOI # and archived with data.	Doc and PDF	Expedition Mapping Lead	UNH, Shore	OER Digital Atlas; NCEI	Public
Imagery						
Raw Video Clips – Full Res	Video clips from ROV dives, onboard cameras.	.mov (ProRes 422 LT at 145 Mb @ 1920 x 1080)	Video team	Ship	By Request (use data request form)	TBD

Highlight Images	"Best of" compilation of imagery from expedition (Ship and Shore)	JPG (with Excel document containing captions, credit & additional info)	Web Coordinator	Shore	NCEI; OE Website	Participants/ Public
All Expedition Video	All video streamed from the ship to shore will be captured aboard ship and stewarded by NOAA.	digital	Ship	Shore (ISC)	By request (form) Archives	Public
Low resoultion video at SeaTube	Deck to deck video, searchable with annotations, with associated environmental data	Digital	ONC / OER	ONC	Web based portal	Public: Viewing, searching Log in protected: Creating / editing annotations

APPENDIX B: Exploration Project of Opportunity Form

NASA Maritime Aerosols Network Survey of Opportunity

Survey or Project Name

Maritime Aerosol Network

Lead POC or Principle Investigator (PI & Affiliation)

POC: Dr. Alexander Smirnov

Supporting Team Members Ashore

Supporting Team Members Aboard (if required)

Activities Description(s) (Include goals, objectives and tasks)

The Maritime Aerosol Network (MAN) component of AERONET provides ship-borne aerosol optical depth measurements from the Microtops II sun photometers. These data provide an alternative to observations from islands as well as establish validation points for satellite and aerosol transport models. Since 2004, these instruments have been deployed periodically on ships of opportunity and research vessels to monitor aerosol properties over the World Oceans.

During the cruise the marine aerosol layer observations will be collected for the NASA Maritime Aerosol Network (MAN). Observations will be made by mission personnel (as time allows) with a sun photometer instrument provided by the NASA MAN program. Resulting data will be delivered to the NASA MAN primary investigator Alexander Smirnov by the expedition coordinator. All collected data will be archived and publicly available at: http://aeronet.gsfc.nasa.gov/new_web/maritime_aerosol_network.htmlhttp://aeronet.gsfc.nasa.gov/new_web/maritime_aerosol_network.html

Equipment resides on the ship and is stewarded by the expedition coordinator.

APPENDIX C: NEPA Categorical Exclusion Worksheet

Categorical Exclusion (CE) Determination Worksheet

Project Title: EX-17-06, Johnston Atoll (ROV & Mapping)

Date Review Completed: June 29, 2017

Completed by: Craig Russell, NOAA Office of Ocean Exploration and Research

Signature:

Step 1. CE applicability

1. **What is the proposed federal action?**
   The proposed action is to collect baseline mapping data using the NOAA Ship *Okeanos Explorer*'s sonar systems and to conduct baseline characterizations of unexplored areas using NOAA's two-body remotely operated vehicle (ROV) and CTD rosette system on the NOAA Ship *Okeanos Explorer*.

   The expedition will commence on July 7 and end on August 2, 2017 in Honolulu, HI (21° 22' 2.7" N, 157° 57' 51.41" W), conducting operations in the vicinity of Oahu, the Pacific Remote Islands Maine National Monument's (PRIMNM) Johnston Atoll Unit (JAU) and high seas locations crossed during transit to and from JAU. See Project Instructions EX-17-06 for more details.

2. **Which class of CE in Appendix E of the NAO 216-6A Companion Manual is applicable to this action and why?**
   The topical scope of this action is consistent with CE number E4 in Appendix E of the Companion Manual to NOAA Administrative Order (NAO) 216-6A:

   Activities that remotely survey or observe living resources in the field using non-invasive techniques, which have little to no potential to adversely affect the environment or interfere with organisms or habitat.

Step 2. Extraordinary Circumstances Consideration

3. **Would the action result in adverse effects on human health or safety that are not negligible?**
   No. The NOAA Ship *Okeanos Explorer* will be operating in remote deep sea areas of the Pacific Ocean. Expedition EX-17-06, an expedition of the NOAA CAPSTONE campaign, will focus

operations in the Johnston Atoll Unit of PRIMNM with some operations in Hawaii and the high seas (see Figure 3 and Table 2 of EX-17-06 Project Instructions) and does not involve any procedures or outcomes known to result in impacts on human health and safety more than would be negligible.

4. **Would the action result in adverse effects on an area with unique environmental characteristics that are not negligible?**
This survey/expedition overlaps with the following area with unique environmental characteristics: the Pacific Remote Island Marine National Monument (PRIMNM). However, the survey effects will be negligible or less than negligible, based on determinations made by management authorities affiliated with these areas. The expedition is being planned and conducted in partnership with NOAA National Marine Fisheries Service (NMFS) Pacific Islands Regional Office (PIRO) Marine National Monument Program (MNMP) to ensure no more than negligible effects on these Pacific Island areas with unique environmental characteristics. Though NOAA research is exempted from standard permit requirements to work in the PRIMNM, OER made requests and received approvals to conduct operations in the abovementioned protected areas.

5. **Would the action result in adverse effects on species or habitats protected by the ESA, MMPA, MSA, NMSA, or MBTA that are not negligible?**
OER has taken measures to ensure that any effects on species or habitats protected by the ESA, MMPA, MSA or NMSA meet the definition of "negligible". In January 2016, a request from OER was submitted to the NMFS PIRO Protected Resources Division to initiate consultation under Section 7 of the ESA. Accompanying this request was a biological assessment that described the planned operations proposed for 2016-2017 expeditions in the Pacific and identified all ESA-listed species, including corals, in the vicinity of the operations. On February 7, 2016, OER received a letter that concurred with our determination that these 2016-2017 operations are not likely to adversely affect ESA-listed species. The ESA Section 7 concurrence letter is provided as Appendix X in the Project Instructions document for EX-17-06.

Given the offshore focus area of our work, it is highly improbable that we will encounter marine mammals protected under the MMPA or sea birds protected under the MBTA. If we did encounter any marine mammals or seabirds, our effect would be negligible because of the best management practices to which we adhere to avoid or minimize environmental impacts.

OER also initiated a request for a Magnuson-Stevens Essential Fish Habitat (EFH) consultation for this same series of cruises and subsequently received a determination that the proposed cruises would not will not reduce the quality and/or quantity of EFH adversely affect EFH, provided

there is adherence to the OER proposed procedures and the NMFS guidance conveyed via email from NMFS PIRO's Richard Hall, dated November 30, 2016.

6. **Would the action result in the potential to generate, use, store, transport, or dispose of hazardous or toxic substances, in a manner that may have a significant effect on the environment?**
   No. The cruise operations will be in compliance with FEC 07 Hazardous Materials and Hazardous Waste Management Requirements for Visiting Scientific Parties (or superseding OMAO procedures) to ensure generation, use, storage, transport, and disposal of such substances will not result in significant impacts.

7. **Would the action result in adverse effects on properties listed or eligible for listing on the National Register of Historic Places authorized by the National Historic Preservation Act of 1966, National Historic Landmarks designated by the Secretary of the Interior, or National Monuments designated through the Antiquities Act of 1906; Federally recognized Tribal and Native Alaskan lands, cultural or natural resources, or religious or cultural sites that cannot be resolved through applicable regulatory processes?**
   During EX-17-06, we will not visit sites that fall under any of these categories.

8. **Would the action result in a disproportionately high and adverse effect on the health or the environment of minority or low-income communities, compared to the impacts on other communities (EO 12898)?**
   No, the NOAA Ship *Okeanos Explorer* will be operating in remote deep sea areas of the Pacific Ocean (see Figure 3, EX 17-06 Cruise Plan Instructions). There are no minority communities or low-income communities within or near the geographic scope of the cruise, and the cruise does not involve actions known or likely to result in adverse impacts on human health.

9. **Would the action contribute to the introduction, continued existence, or spread of noxious weeds or nonnative invasive species known to occur in the area or actions that may promote the introduction, growth, or expansion of the range of the species?**
   No. During EX-17-06 the ship will not make landfall in areas other than commercial ports. The ship and OER mission team will comply with all applicable local and federal regulations regarding the prevention or spread of invasive species. At the completion of every ROV dive or CTD cast, the ROVs will be thoroughly rinsed with fresh water and completely dried to prevent spreading organisms from one site to another. Also the Engineering Department aboard the NOAA Ship *Okeanos Explorer* attends yearly Ballast Management Training in accordance with NOAA Form

57-07-13 NPDES VGP Annual Inspection and Report to prevent the introduction of invasive species.

10. Would the action result in a potential violation of Federal, State, or local law or requirements imposed for protection of the environment?

The proposed action **will not** result in any violations of Federal, State, or local law or requirements imposed for protection of the environment. The survey coordinators obtained (or are in the process of obtaining) authorizations and/or consultations pursuant to applicable laws. See responses to questions #4, 5, and 6 for details.

11. Would the action result in highly controversial environmental effects?

No. The exploration activities will be localized and of short duration in any particular area at any given time. Given this project's scope and breadth, no notable or lasting changes or highly controversial effects to the environment will result.

12. Does the action have the potential to establish a precedent for future action or an action that represents a decision in principle about future actions with potentially significant environmental effects?

No. While each cruise contributes to the overarching goal of exploring, mapping, and sampling the ocean, every cruise is independently useful and not connected to subsequent cruises.

13. Would the action result in environmental effects that are uncertain, unique, or unknown?

No. The techniques and equipment used are standard for this type of field activity.

14. Does the action have the potential for significant cumulative impacts when the proposed action is combined with other past, present and reasonably foreseeable future actions, even though the impacts of the proposed action may not be significant by themselves?

By definition, actions that a federal agency classifies as a categorical exclusion have no potential, individually or cumulatively, to significantly affect the environment. This cruise is consistent with a class of CE established by NOAA, and there are no extraordinary circumstances for this action that may otherwise result in potentially significant impacts.

APPENDIX D: ESA Section 7 LOC

U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
Pacific Islands Regional Office
1845 Wasp Blvd., Bldg 176
Honolulu, Hawaii 96818
(808) 725-5000 • Fax: (808) 725-5215

Mr. John McDonough
Deputy Director
NOAA Office of Ocean Exploration and Research

Dear Mr. McDonough:

This letter responds to your January 14, 2016 Request for Consultation by the Office of Exploration and Research (OER) regarding efforts aboard the NOAA vessel *Okeanos Explorer* with the proposed action consisting of activities to explore and improve understanding of the distribution and diversity of deep water habitats in the Pacific, and in particular in the Marine National Monuments. You have requested our concurrence under Section 7 of the Endangered Species Act of 1973 (ESA), as amended (16 U.S.C. §1531 et seq.), with your determination that the proposed action may affect but is not likely to adversely affect green, hawksbill, leatherback, olive ridley, and north Pacific loggerhead sea turtles; Main Hawaiian Islands false killer whale distinct population segment, humpback whales, blue whales, fin whales, sei whales, sperm whales, north Pacific right whales, the Indo-West Pacific and Central Pacific distinct population segment of the scalloped hammerhead shark, Hawaiian monk seals; and the coral species *Acropora globiceps,* A. *jacquelineae, A. retusa, A. speciosa, Euphyllia paradivisa, Isopora crateriformis,* and *Seriatopora aculeata.*

Proposed Action/Action Area: The proposed activity is more fully described in your request for consultation and the associated biological evaluation (CAPSTONE 2016). The proposed action (Okeanos Explorer cruises) includes the use of various ship and submersible-deployed electronic systems to collect data on the distribution and diversity of deep water habitats in the Marine National Monuments. The activity would occur during two years with up to 20 research cruises scheduled between February 2016 and December 2017. The expedition teams (26 crew and up to 20 rotating scientists and/or technicians on each cruise leg) would be authorized to conduct mapping and Remotely Operated Vehicle (ROV) surveys using the Okeanos Explorer's multibeam, split beam, subbottom profiler and acoustic Doppler current profiler (ADCP) sonar systems, utilizing the ship's conductivity-temperature-depth (CTD) sampling rosette for various water measurements and deploying an ROV. No activities are scheduled to occur on land.

The suite of sonars aboard the vessel includes a Kongsberg EM302 30 kHz multibeam system, which collect bathymetry and backscatter data; several Simrad EK 60 split-beam sonars that

range from 18 to 333 kHz which are designed to gather measurements of biological and gaseous targets in the water column; and a Knudsen 3.5 kHz chirp sub-bottom profiler. The 300 kHz and 38 kHz ADCPs provide information about current velocity and direction at various depths. Sonar mapping activities will be conducted throughout the proposed action area and during transits to and from sites where operations will be conducted in an effort to fill in gaps in data knowledge and to build on data already collected. The maps generated from these activities will improve understanding of the geology and important biological habitats in the project area.

Conductivity, temperature and depth data will be collected by both an Underway CTD and a CTD rosette instrument. The CTD rosette, which is deployed while the ship is stopped and holding dynamic position, is lowered by a winch and wire to a maximum depth of 6800 m to collect water samples through 24 2.5 L niskin bottles. The CTD rosette will be deployed at select sites where ROV operations are conducted to allow for an improved understanding of the environmental conditions at that particular site. The deployment and retrieval of the CTD rosette takes up to several hours (depending on depth), while the Underway CTD can be deployed while the ship is moving, saving hours of time and fuel. The instrument is mounted on the stern railing and outfitted with a re-useable probe that is deployed and retrieved through the use of motorized spool. The Underway CTD will be used to collect water column profiles to a maximum depth of 700 m.

ROV operations will be designed to provide interdisciplinary site characterization at priority targets in and around monuments, sanctuaries and protected areas, through visual observation of priority targets while acquiring environmental data with onboard sensors. Sampling will be focused on corals and sponges, but will target specimens believed to be new species or new records for an area. No ESA-listed corals would be sampled. As many as 200 deployments of the ROV may occur during the 2016 – 17 field season resulting in 1600 hours of total dive time. The dives will better enable scientists and managers to understand the diversity and distribution of deep water habitats.

The action area covered by the accompanying biological evaluation encompasses the marine environments of Papahānaumokuākea Marine National Monument (PMNM); Oahu and the big island of Hawai'i; the area south and west of Molokai, Lana'i, and Kaho'olawe, the Geologists Seamounts located about 100 nm south of Honolulu; the Musicians Seamounts located about 150 nm NNE of Nihoa Island; all of the Pacific Remote Island Areas composing the Pacific Remote Islands Marine National Monument (PRIMNM); the Commonwealth of the Northern Marianas Islands (CNMI) and the Marianas Trench Marine National Monument (MTMNM); the vicinity of American Samoa and the National Marine Sanctuary of American Samoa (NMSAS); the Rose Atoll Marine National Monument (RAMNM); and the vessel transit areas between Honolulu, Hawai'i, Guam, Saipan, Kwajalein, Pago Pago where ESA-listed marine species or their habitats may be impacted by the proposed activities.

Species That May Be Affected: OER determined that the proposed action may affect but is not likely to adversely affect green sea turtles (*Chelonia mydas*), hawksbill sea turtles (*Eretmochelys imbricata*), North Pacific distinct population segment of loggerhead sea turtles (*Caretta caretta*),

olive ridley sea turtles (*Lepidochelys olivacea*), leatherback sea turtles (*Dermochelys coriacea*), Main Hawaiian Islands false killer whale distinct population segment (*Pseudorca crassidens*), humpback whales (*Megaptera novaeangliae*), sperm whales (*Physeter macrocephalus*), fin whales (*Balaenoptera physalus*), blue whales (*Balaenoptera musculus*), sei whales (*Balaenoptera borealis*), north pacific right whales (*Eubalaena japonica)*, the Indo-West Pacific and Central Pacific distinct population segments of the scalloped hammerhead shark (*Sphryna lewini*), Hawaiian monk seals (*Neomonachus schauinslandi*), Hawaiian monk seal critical habitat and the coral species *Acropora globiceps, A. jacquelineae, A. retusa, A. speciosa, Euphyllia paradivisa, Isopora crateriformis,* and *Seriatopora aculeata*. Detailed information about the biology, habitat, and conservation status of sea turtles can be found in their recovery plans and other sources at http://www.nmfs.noaa.gov/pr/species/turtles/. The same can be found for Hawaiian monk seals and cetaceans at http://www.nmfs.noaa.gov/pr/species/mammals/; and more information on listed corals can be found at http://www.fpir.noaa.gov/PRD/prd_coral.html.

Critical Habitat: The proposed action would take place within designated monk seal critical habitat. Critical habitat was designated under the ESA for the Hawaiian monk seal on April 30, 1986 and revised on May 26, 1988 (53 FR 18988) and again on August 21, 2015 (80 FR 50926). Designated critical habitat includes all beach areas, lagoon waters, and ocean waters out to a depth of 200 m around Kure Atoll; Midway Islands (except Sand Island), Pearl and Hermes Reef, Lisianski Island, Laysan Island, Gardner Pinnacles, French Frigate Shoals, Necker Island, Maro Reef, and Nihoa Island, and includes the seafloor and all subsurface waters and habitat within 10 meters of the seafloor. Around the Main Hawaiian Islands, critical habitat extends in designated areas from the beach out to the 200 meter depth contour, and includes the seafloor and subsurface waters within 10 meters of the seafloor.

Analysis of Effects: In order to determine that a proposed action is not likely to adversely affect listed species, NMFS must find that the effects of the proposed action are expected to be insignificant, discountable, or beneficial as defined in the joint USFWS-NMFS Endangered Species Consultation Handbook: (1) insignificant effects relate to the size of the impact and should never reach the scale where take occurs; (2) discountable effects are those that are extremely unlikely to occur; and (3) beneficial effects are positive effects without any adverse effects (USFWS & NMFS 1998). This standard, as well as consideration of the probable duration, frequency, and severity of potential interactions, was applied during the analysis of effects of the proposed action on ESA-listed marine species, as is described in detail in the OER consultation request. The OER determined that the risk of collisions with vessels and the risk of entanglement would be discountable; and that the risk from exposure to elevated noise level, disturbance from human activity, as well as exposure to wastes and discharges would result in insignificant effects on ESA-listed sea turtles, marine mammals, sharks and corals; and that the potential effects of the proposed action to designated or proposed critical habitat would also be insignificant.

Considering the information and assessments presented in the OER consultation request, and in the best scientific information available about the biology and expected behaviors of the ESA-listed marine species considered in this consultation; NMFS agrees that: 1) the list of ESA-listed species and critical habitats potentially exposed to the effects of the action is correct, 2) the suite

of identified stressors is comprehensive, and 3) the assessment of exposure risk and significance of exposure to those stressors is accurate. Therefore, NMFS agrees that:

- the risk of collisions with vessels for marine mammals, turtles, sharks and the listed coral species in the action area is discountable;
- the risk of entanglement with marine mammals, sea turtles and sharks is discountable; and,
- ESA-listed species in the action area are unlikely to respond to anticipated elevated noise levels, disturbance from human activity, and exposure to wastes and discharges. Further, if any response were to occur, it would be temporary in nature and never reach the scale where it would affect the individual's health, and as such, have insignificant effects.

Conclusion: NMFS concurs with your determination that conducting the proposed Okeanos Explorer cruises are not likely to adversely affect ESA-listed marine species. This concludes your consultation responsibilities under the ESA for species under NMFS's jurisdiction. However, this consultation focused solely on compliance with the ESA. Additional compliance review that may be required of NMFS for this action (such as assessing impacts on Essential Fish Habitat) would be completed by NMFS Habitat Conservation Division in separate communication, if applicable.

ESA Consultation must be reinitiated if: 1) a take occurs; 2) new information reveals effects of the action that may affect listed species or designated critical habitat in a manner or to an extent not previously considered; 3) the identified action is subsequently modified in a manner causing effects to listed species or designated critical habitat not previously considered; or 4) a new species is listed or critical habitat designated that may be affected by the identified action.

If you have further questions please contact Richard Hall on my staff at (808) 725-5018. Thank you for working with NMFS to protect our nation's living marine resources.

Sincerely,

Michael D. Tosatto
Regional Administrator

cc: Justin Rivera, Papahanaumokuakea Marine National Monument
Aaron Nadig, ESA Section 7 Program, USFWS, Honolulu

NMFS File No.: PIR-2016-9774
PIRO Reference No.: I-PI-16-1347-AG

Literature Cited

Campaign to Address Pacific Monument Sciecne, Technology and ocean Needs (CAPSTONE) 2016. Request for Informal Consultation. Letter from John McDonough to Ann Garrett dated January 14, 2016 and attachments.

U.S. Fish and Wildlife Service and National Marine Fisheries Service. 1998. Endangered Species Consultation Handbook. Procedures for Conducting Consultation and Conference Activities Under Section 7 of the Endangered Species Act. http://www.nmfs.noaa.gov/pr/pdfs/laws/esa_section7_handbook.pdf

APPENDIX E: EFH Consultation LOC

Kelley Elliott - NOAA Federal <kelley.elliott@noaa.gov>

EFH Consultation Response for CAPSTONE cruises

Richard Hall - NOAA Federal <richard.hall@noaa.gov> Wed, Nov 30, 2016 at 4:21 PM
To: Kelley Elliott - NOAA Affiliate <kelley.elliott@noaa.gov>
Cc: Ian Lundgren - NOAA Affiliate <ian.lundgren@noaa.gov>, Samantha Brooke <samantha.brooke@noaa.gov>, Kasey Cantwell - NOAA Affiliate <kasey.cantwell@noaa.gov>

Kelley,

On November 14, 2016, the Office of Exploration and Research (OER), through personal communication, initiated a request for an Essential Fish Habitat consultation for a series of cruises by the NOAA Ship *Okeanos Explorer*. The cruises would run from early-December 2016 through late-September 2017, and include the waters around the Main Hawaiian Islands, the Musician Seamounts (north of Hawaii), the American Samoa Archipelago; Johnston, Howland, Baker, Jarvis, Kingman and Palmyra Atolls of the Pacific Remote Islands, and portions of the Cook Islands. The operational minimum depth during the cruises would be 250 m, with the majority of the cruise activities would be in water depths over 500 m.

The Magnuson-Stevens Fishery Conservation and Management Act (16 U.S.C. 1855 et seq.) requires review of federally permitted projects for potential impacts to EFH (§305(b)). Pursuant to this authority, I have reviewed and provided comments as necessary for the Habitat Conservation Division of NOAA's Pacific Islands Regional Office.

The proposed cruises are the final legs of the larger 2-year Campaign to Address Pacific Monuments Science, Technology and Ocean Needs (CAPSTONE Project), which is designed to improve the understanding of the distribution and diversity of deepwater habitats within the Pacific monuments and protected areas.

The primary activities to be conducted during this series of cruises would be: remotely operated vehicle (ROV) dives to conduct engineering trials and sonar calibration and testing during two shakedown cruises scheduled for the waters of the Main Hawaiian Islands (no biological or geological samples would be collected); and mapping and ROV dives in the waters of American Samoa, West Samoa, the Pacific Remote Islands, the Musician Seamounts, and portions of the Cook Islands. Five cruises would be dedicated mapping cruise, resulting in 92 days of constant mapping, while six cruises would be combined ROV and mapping cruises which would result in approximately 96 ROV dives and 110 days of overnight mapping. Other activities to be performed during the cruises would include: deployment and recovery of a conductivity-temperature-depth (CTD) sampling rosette and underway CTDs, and possible deployment of Argo floats to acquire ocean chemistry data. During ROV dives various biological and geological samples would be collected.

In order to avoid/minimize impacts to EFH, the OER and the *Okeanos Explorer* have proposed to institute the following procedures:

- The vessel would employ the use of dynamic positioning during ROV dives (no anchoring);
- ROVs would be operated in a manner to avoid seafloor disturbance, and setting the ROV on the seafloor will be held to a minimum. For those situations when the ROV does make contact with the seafloor, visual observations will confirm that the area is sand, mud, or hard-bottom;
- Sample collections would be limited (typically 4 - 6 total rocks and primary biological specimens per dive) that represent new species, new records, or the dominant morphotype animal in a community. Clonal biological specimens (corals, sponges) would be subsampled; and
- Instruments deployed to collect water samples and current data (except for expendable instruments) would not be allowed to contact the seafloor;

In addition to the management practices proposed by OER and the *Okeanos Explorer*, NMFS provides the following guidance to further avoid/minimize impacts to EFH from the proposed cruise activities and vessel operations:
1. Except in an emergency, the vessel should not anchor while at sea;
2. The vessel should adhere to MARPOL discharge regulations at all times during the proposed cruises;
3. The ROV should be thoroughly rinsed between dives, allowed to dry, and checked for the presence of biological

organisms to prevent the spread of invasive or non-endemic species from one location to another.
4. The use detergents and other pollutants which may be washed into the marine environment should be avoided or held to a minimum;

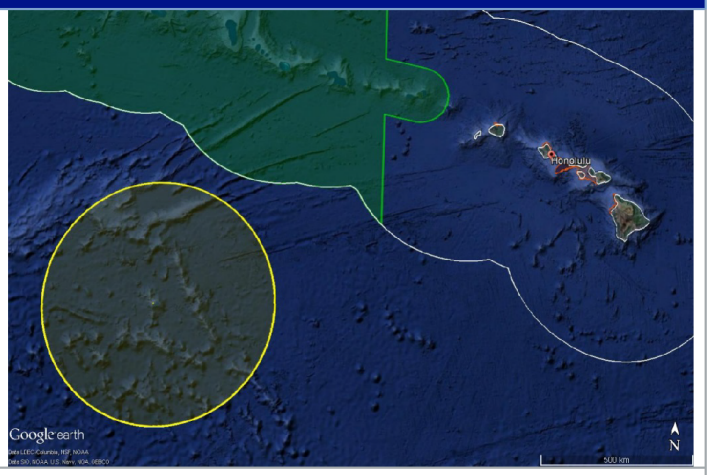
Based on my review of the documents provided, and through our personal communications, NOAA Fisheries has determined that the proposed cruises of the NOAA Ship *Okeanos Explorer* would not adversely affect EFH provided adherence to OER proposed procedures and the NMFS guidance made above. Thank you for the opportunity to review the plans for the upcoming field season of the *Okeanos Explorer*, and to provide our comments. This completes your obligation to consult with our office with regards to EFH for this series of actions. If you have any questions or comments feel free to contact me at your convenience.

--
Richard Hall
Fishery Policy Analyst
Pacific Islands Regional Office
NOAA Inouye Regional Center
1845 Wasp Blvd., Building 176
Honolulu, HI 96818
808-725-5018

APPENDIX F: ROV Dive Summary Forms

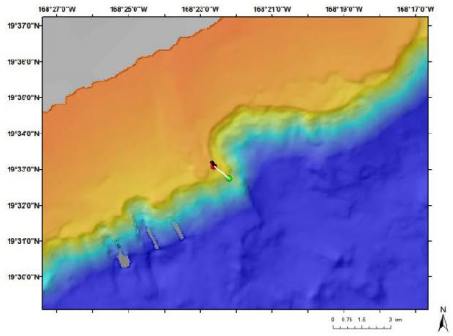
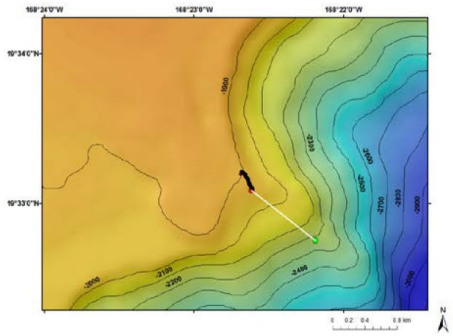
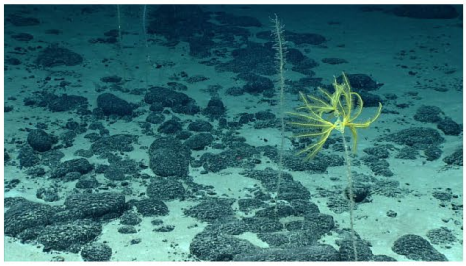
Ocean Exploration and Research

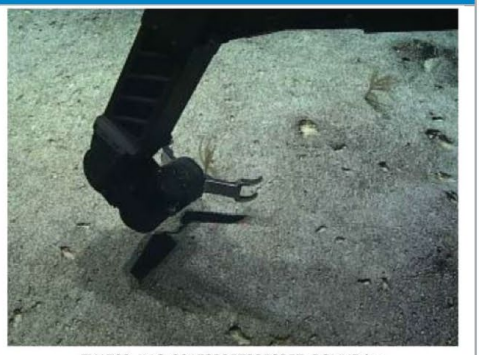
Okeanos Explorer ROV Dive Summary

Dive Information			
Dive Map			
Site Name	Horizon Guyot		
ROV Lead(s)	Dan Rogers		
Expedition Coordinator(s) / Mapping Lead	Kelley Elliott / Mashkoor Malik		
Science Team Lead(s)	Chris Kelley & Chris Mah		
General Area Descriptor	Johnston Atoll Unit of PRIMNM		
ROV Dive Name			
Cruise	EX1706		
Leg			
Dive Number	2		
Equipment Deployed			
ROV	Deep Discoverer (D2)		
Camera Platform	Seirios		
ROV Measurements	☒ CTD	☒ Depth	☒ Altitude
	☒ Scanning Sonar	☒ USBL Position	☒ Heading

	☒ Pitch	☒ Roll	☒ HD Camera 1
	☒ HD Camera 2	☒ Low Res Cam 1	☒ Low Res Cam 2
	☒ Low Res Cam 3	☒ Low Res Cam 4	☒ Low Res Cam 5
	☒ LSS	☒ ORP	
Equipment Malfunctions	None		
ROV Dive Summary (from processed ROV data)	Dive Summary: EX1706_DIVE02 ^^^

	Timothy Shank, Woods Hole Oceanographic Institution, tshank@whoi.edu Tina Molodtsova, P.P. Shirshov Institute of Oceanology RAS, tina.molodtsova@gmail.com
Purpose of the Dive	This is a Mn-crusted guyot located in the PCZ. The edge of the summits of these types of flat-topped seamounts may be targeted by future deep sea mining efforts to extract Mn crusts because they are generally free of sediment, are flat, and the crust is coating soft carbonate or lithified lagoonal sediments and therefore can be relatively easily extracted by mining equipment. Guyot summit edges are also likely locations of deep water coral and sponge communities that could be impacted by crust extraction. This site was selected to explore and gain a better understanding of mn crust communities but also for logistical reasons, since this was the furthest site in the monument that the ship could reach in time to do a dive.
Description of the Dive	This start of this dive was delayed until 12 pm due to a problem with the ship's DP and Gyro system. D2 reached the bottom at 22:00 UTC at a depth of 1,930 m. The substrate was mixed rock and sediments, the former being more dominant and consisting primarily of manganese covered boulders and cobbles. Most of the sediment formed a relatively thin layer except for a couple of small areas of thicker cover where bedforms were present. The general topography was relatively flat because time constraints required the start point be relocated closer to the Waypoint 2 on the summit. The community observed at the dive site was dominated by hexactinellid sponges including colonies of *Tretopleura* sp, *Walteria* cf *leuckarti*, euretids *Farrea* nr *occa erecta* and a strange colony that was collected that was possibly in the genus *Chonelasma*, and pheronematid in the genus *Poliopogon* and *Sericolophus*. Many of these sponges were observing with associates that included brittle stars (cf. Amphiuridae), small squat lobsters, hydroids. These were widely distributed along the dive track. Also present within this area were apparently dead sponges (white, brown, discolored) laying on their sides, in areas where living sponges were also present. Feather stars (comatulid crinoids) were present on the tops of several standing dead or inert glass sponge stalks. There was also one "sunburst" cladorhizid demosponge. Present in relatively low abundance were several octocorals and antipatharians. Highlights included bamboo corals (*Jasonisis* sp), primnoids (*Candidella gigantea* and *Calyptrophora* cf *angularis*), "mushroom" soft corals (*Pseudanthomastus*), cup corals, (Scleractinia), chrysogorgiids (*Chrysogorgia* sp. and *Irridigorgia magnispiralis*), and a stoloniferan. Other observed invertebrates included several members of the Echinodermata. At least two hyocrinid stalked crinoids, including one in the genus Tiburonocrinus were observed. Multiple ophiuroids were observed, including ophiacanthids which were present as commensals on both octocorals and glass sponges, as well as tiny ophiuroids (likely to be members of the Amphiuridae) which were observed inside glass sponges and on rocks. One very large ophiurid, which resembled *Ophiomusium* was also seen on a sandy bottom. A large spatangoid urchin with prominent spines was observed in conjunction with sediment traces on a large sediment bed. Synallactid sea cucumbers were observed as well as two observations of freyellid brisingidans, probably in the genus Freyella. The brisingids were sitting on dead sponge stalks in a manner similar to the feather stars as described above.

	Only one fish was observed which was a cutthroat eel in the family Synaphobranchidae.
Overall Map of the ROV Dive Area	**Close-up Map of Main Dive Site**
	
Representative Photos of the Dive	
	
Walteria sp glass sponge and *Glyptometra* sp crinoid commonly seen during the dive.	*Tretopleura* sp glass sponge commonly seen during the dive

Samples Collected		
Sample		
Sample ID	D2_DIVE10_SPEC01BIO	EX1702_IMG_20170225T222953Z_ROVHD.jpg
Date (UTC)	20170225	
Time (UTC)	22:38:11	
Depth (m)	623.388	
Temperature (°C)	6.25730	
Field ID(s)	Hexactinellida sponge	
Comments		
Sample		
Sample ID	D2_DIVE10_SPEC02BIO	 EX1702_IMG_20170225T225825Z_ROVHD.jpg
Date (UTC)	20170225	
Time (UTC)	23:05:47	
Depth (m)	610.9940	
Temperature (°C)	6.33438	
Field ID(s)	Antipatharia	
Comments		
Sample		

Sample ID	D2_DIVE10_SPEC03GEO	EX1702_IMG_20170225T233930Z_ROVHD.jpg
Date (UTC)	20170225	
Time (UTC)	23:42:16	
Depth (m)	568.0900	
Temperature (°C)	6.93560	
Field ID(s)	rock	
Comments		

Sample

Sample ID	D2_DIVE10_SPEC04BIO	EX1702_IMG_20170226T014240Z_ROVHD.jpg
Date (UTC)	20170226	
Time (UTC)	01:43:52	
Depth (m)	361.5599	
Temperature (°C)	14.67788	
Field ID(s)	Gorgonocephalus?	
Comments		

Sample		
Sample ID	D2_DIVE10_SPEC05GEO	
Date (UTC)	20170226	EX1702_IMG_20170226T021728Z_ROVHD.jpg
Time (UTC)	02:20:54	
Depth (m)	325.4760	
Temperature (°C)	16.68620	
Field ID(s)	Rock with associate soft octocoral	
Comments		

Sample		
Sample ID	D2_DIVE10_SPEC06GEO	EX1702_IMG_20170226T030048Z_ROVHD.jpg
Date (UTC)	20170226	
Time (UTC)	03:02:05	
Depth (m)	315.2899	
Temperature (°C)	16.97638	
Field ID(s)	Rock with scleractinian and sponge	
Comments	Rock had pink spots (likely calcareous algae)	

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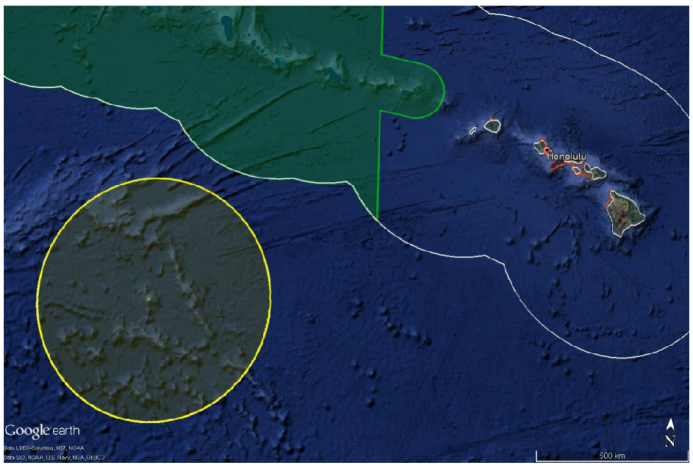
(301) 734-1014

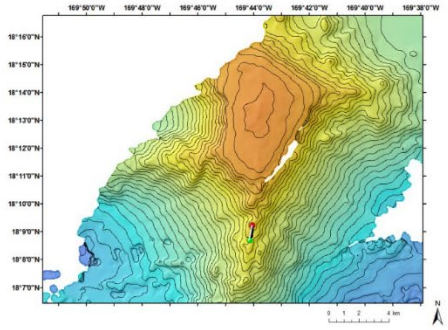
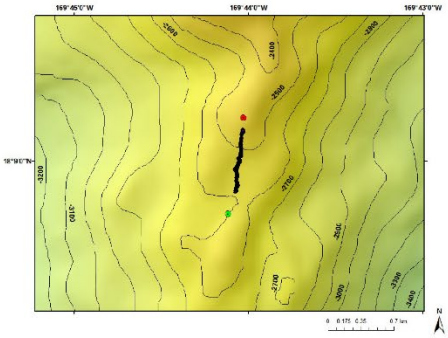
Okeanos Explorer ROV Dive Summary

Dive Information			
Dive Map			
Site Name	Un-named Guyot north of Johnston Atoll		
ROV Lead(s)	Dan Rogers		
Expedition Coordinator(s) / Mapping Lead	Kelley Elliott / Mashkoor Malik		
Science Team Lead(s)	Chris Kelley & Chris Mah		
General Area Descriptor	Johnston Atoll Unit of PRIMNM		
ROV Dive Name			
Cruise	EX1706		
Leg			
Dive Number	3		
Equipment Deployed			
ROV	Deep Discoverer (D2)		
Camera Platform	Seirios		
ROV Measurements	CTD	Depth	Altitude
	Scanning Sonar	USBL Position	Heading
	Pitch	Roll	HD Camera 1
	HD Camera 2	Low Res Cam 1	Low Res Cam 2
	Low Res Cam 3	Low Res Cam 4	Low Res Cam 5

	LSS	ORP	
Equipment Malfunctions	None		
ROV Dive Summary	Dive Summary: EX1706_DIVE03 ^^ In Water: 2017-07-14T18:21:08.509000 18°, 08.730' N ; 169°, 44.340' W Out Water: 2017-07-15T04:36:10.251000 18°, 09.354' N ; 169°, 43.979' W Off Bottom: 2017-07-15T01:15:34.995000 18°, 09.167' N ; 169°, 44.053' W On Bottom: 2017-07-14T19:48:20.031000 18°, 08.831' N ; 169°, 44.071' W Dive duration: 10:15:1 Bottom Time: A 5:27:14 Max. depth: 2600.1 m		
Special Notes			

Scientists Involved (please provide name, location, affiliation, email)	Amy Baco Taylor, Florida State University, abacotaylor@fsu.edu Asako Matsumoto, Planetary Exploration Research Center, Chiba Institute of Technology, Japan, amatsu@gorgonian.jp Chris Kelley, UH, ckelley@hawaii.edu Chris Mah, SI NMNH, brisinga@gmail.com Dhugal Lindsay, JAMSTEC, dhugal@jamstec.go.jp Donald Kobayashi, NOAA NMFS PIFSC, donald.kobayashi@noaa.gov Heather Judkins, University of South Florida St. Petersburg, Judkins@mail.usf.edu John Smith, University of Hawaii/SOEST, jrsmith@hawaii.edu Ken Sulak, U.S. Geological Survey, ksulak@usgs.gov Kevin Kocot, The University of Alabama , kmkocot@ua.edu Les Watling, University of Hawaii at Manoa, watling@hawaii.edu Michael Vecchione, NMFS, vecchiom@si.edu Mike Ford, NOAA Fisheries, michael.ford@noaa.gov Nikola Rodriguez, NOAA EPP, nikola.rodriguez@noaa.gov Nolan Barrett, FAU Harbor Branch Oceanographic Institute, barrettnh@g.cofc.edu Scott France, University of Louisiana at Lafayette, france@louisiana.edu Steven Auscavitch, Temple University, steven.auscavitch@temple.edu Tara Harmer-Luke, Stockton University, luket@stockton.edu Timothy Shank, Woods Hole Oceanographic Institution, tshank@whoi.edu Tina Molodtsova, P.P. Shirshov Institute of Oceanology RAS, tina.molodtsova@gmail.com Tracey Sutton, Nova Southeastern University, tsutton1@nova.edu
Purpose of the Dive	This is a Mn-crusted guyot located in the PCZ. Guyot summit edges, cones, and rift zone ridges are also likely locations of deep water coral and sponge communities that could be impacted by crust extraction. This particular guyot was selected in part for logistical reasons since this is located within an overnight transit from the first site and is also within and overnight transit for the next site. The dive site is on a presumed Mn-crusted rift zone ridge extending south from the summit. These ridges are a CAPSTONE priority because previous surveys have found large scale, high density communities of deep water corals and sponges on this type of topography as well as the many other animals they support. Ridges act as barriers to bottom current flow and their crests are locations where currents accelerated, which is where the corals and sponges are most heavily aggregated. Ridges are also sites where basalt can be found and are therefore desirable locations for obtaining rocks for dating seamounts.

Description of the Dive	The D2 ROV landed at 2571 m on a flat bottom composed almost entirely of moderately large, Mn nodules covering a lighter-colored sediment. There were several places where the D2 ROV touched down clearly showing the nodules were loose and not consolidated. Megafauna were sparse dominance was primarily occupied by large hexactinellid sponges in the genus *Semperella*, approximately 0.5 to 1.0 meter tall sitting on convex sandy patches amidst the Mn nodules. While traversing the Mn nodule field, notable invertebrate observations included a hermit crab (*Sympagurus* cf. *burkenroadi*.) with a zoanthid replaced shell as well as smaller "goblet" sponges in the family Hyalonematidae (genus *Hyalonema*?). One notable observation was that of an antipatharian, *Schizopathes*, which had "cleaned" the organic detritus off the Mn nodules in a circle around it using a circular brushing motion. After a few hours travel (at about 10-11 am), the substrate transitioned from a Mn nodule covered sediment field to a steeper more consolidated rock that included Mn crusted basalt pillows, boulders, and cemented sediment. We collected two rock samples, one of which appeared to be Mn crusted sediment when a piece broke off in the lab. Megafauna abundance increased at this point further upslope where sea anemones and various corals including chrysogorgiids (*Pleurogorgia* sp and *Chrysogorgia* sp) were observed. A striking diversity of deep-sea animals and in some cases, their behavior and relationships was observed. Among the highlights included a stalked crinoid in the Bathycrinidae (*Bathycrinus*) which displayed a heavy cover of hydroids on its stalk as well as what appeared to be a small eulimid snail attached to the cup, possibly parasitizing on the crinoid. A second, stalked crinoid in the Hyocrinidae displayed only four arms with a fifth suffering a missing arm but with a eulimid snail attached onto the stump where the arm was originally present. Other animals included a swimming sea cucumber cf. *Amperrima* as well as several ophiacanthid ophiuroids. A potentially new synallactid sea cucumber with a translucent body wall was collected since its identification has been problematic. A new record of *Chyrsogorgia* sp. which had been previously known from the East Pacific was also collected along with its associates that included a squat lobster, amphipods and several small polychaetes. A striking observation of what was perceived as swimming/escape behavior in a black cerianthid anemone which the D2 attempted to collect. The specimen moved out of the way of the manipulator arm and avoided placement within the Biology sample box. <u>Midwater Transect Highlights</u> Following the end of the benthic segment of the dive we undertook a set of midwater transects beginning at 800 m. A total of six transect depths was undertaken at 100 m intervals, with additional transects at 700, 600, 500, 400 and 300 m. Highlights of these transects included observations of numerous larvacean houses, many with the original larvacean present as well as several narcomedusae (genus Bathykorus), several hydromedusae and an opaque reddish jellyfish in the genus Periphyllopsis. Fish diversity included a hatchet fish, bristlemouths (Cyclothone) and a striking observation of a Sawtooth eel, Serravomer sp.

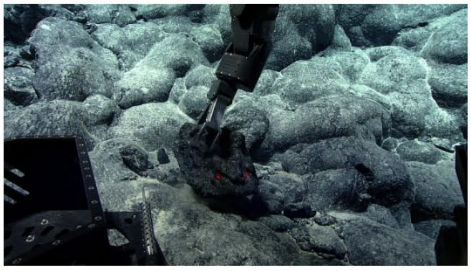
Overall Map of the ROV Dive Area	Close-up Map of Main Dive Site
	

Representative Photos of the Dive	
Glass sponge (*Semperella*) in Mn nodule field	Crinoids, corals, and sponges further upslope on rocky steeper substrate

Samples Collected

Sample

Sample ID	D2_DIVE03_SPEC01BIO	
Date (UTC)	20170714	
Time (UTC)	21:43:14	
Depth (m)	2563	
Temperature (°C)		
Field ID(s)	*Chrysogorgia* sp.	

Comments		
Sample		
Sample ID	D2_DIVE03_SPEC02GEO	
Date (UTC)	20170714	
Time (UTC)	215108	
Depth (m)	2562	
Temperature (°C)		
Field ID(s)	Mn crusted rock	
Comments		
Sample		
Sample ID	D2_DIVE03_SPEC03GEO	
Date (UTC)	20170714	
Time (UTC)	215627	
Depth (m)	2561	
Temperature (°C)		
Field ID(s)	Mn crusted rock	
Comments		
Sample		
Sample ID	D2_DIVE10_SPEC04BIO	
Date (UTC)	20170714	
Time (UTC)	231001	
Depth (m)	2501	
Temperature (°C)		
Field ID(s)	Laetmogonidae?	
Comments		

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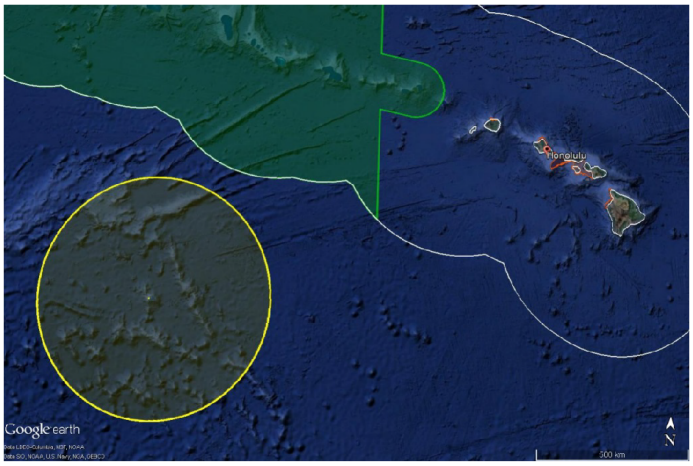
Okeanos Explorer ROV Dive Summary

Dive Information			
Dive Map			
Site Name	Johnston Atoll Site 1		
ROV Lead(s)	Dan Rogers		
Expedition Coordinator(s) / Mapping Lead	Kelley Elliott / Mashkoor Malik		
Science Team Lead(s)	Chris Kelley & Chris Mah		
General Area Descriptor	Johnston Atoll Unit of PRIMNM		
ROV Dive Name			
Cruise	EX1706		
Leg			
Dive Number	4		
Equipment Deployed			
ROV	Deep Discoverer (D2)		
Camera Platform	Seirios		
ROV Measurements	CTD	Depth	Altitude
	Scanning Sonar	USBL Position	Heading
	Pitch	Roll	HD Camera 1
	HD Camera 2	Low Res Cam 1	Low Res Cam 2

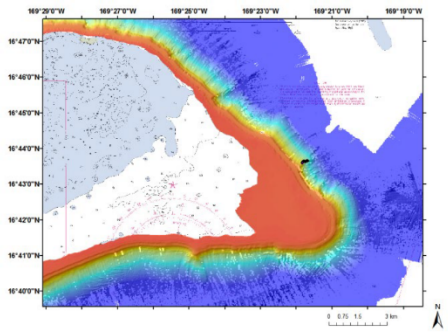
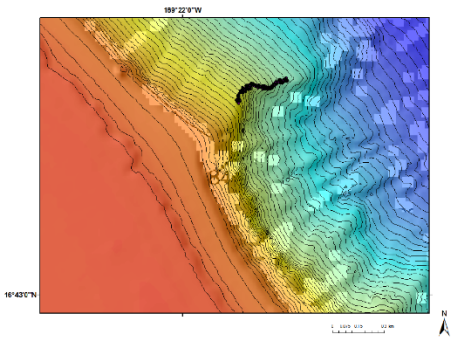
	Low Res Cam 3	Low Res Cam 4	Low Res Cam 5
	LSS	ORP	
Equipment Malfunctions	None		
ROV Dive Summary (from processed ROV data)	Dive Summary: EX1706_DIVE04 ^^^

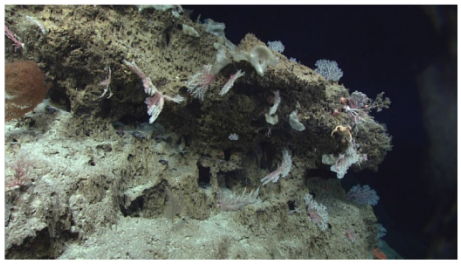
Purpose of the Dive	Commercially valuable precious corals in the depth range of 350-600 m have never been documented in this monument. Johnston Atoll itself is the only location shallow enough to support these species and therefore this is one of two dive plans submitted to survey for gold, red, and pink precious corals. Very little topography stands out within this depth range. The two sites chosen are ledges where these corals are likely to aggregate.
Description of the Dive	Deployment of the D2 began at 600m with bottom time at about 10 am (HST). The D2 entered a high southerly directed current region composed primarily of a rocky carbonate bottom. Numerous coral colonies were observed as the D2 descended to the bottom. This area included a community composed predominantly of black corals (*Stauropathes*) and yellow *Acanthogorgia* sp. and *Metallogorgia melanotrichos*, the latter each with a commensal euryalid ophiuroid. Also present throughout the dive were cup corals (*Polymyces wellsi)*, including both living and dead calyxes. Onshore scientist Les Watling commented that the observed cups were "quite old." The goniasterid sea star *Plinthaster* was observed at 477 m on a sandy field adjacent to corals. D2 next encountered a region of karstic rock formations that varied from small boulders and rock that eventually transitioned into massive cliff faces, which were often present in conjunction with high currents, which created significant issues for the D2. Species observed on these karstic rock substrates were predominantly colonial cnidarians (*Acanthogorgia*, several antipatharians, and a *Paragorgia* being overgrown by zoanthids. Most importantly however was the discovery of the precious coral *Hemicorallium*, one of the mission's primary objectives. These were present in low abundance at first but increased significantly when the D2 encountered an area of high current and large carbonate blocks. Some colonies reached large sizes (approximately 1 m across?). Some areas showed terminal populations of *Hemicorallium* at the bottom of several slopes. Further upslope, the *Hemicorallium* bed ended even though larger blocks were still present. At this location, the community transitioned into one dominated by colonies of the scleractinian coral *Enalllopsammia rostrata*. Amongst the living colonies were areas looking like "graveyards" of dead coral skeletons where the colonies had died and fallen to the bottom of the slope or valley. One section on the karstic rock area had significant current flow and the substrate was covered with several different octocorals, antipatharians and sponges. Several genera of goniasterid sea stars were present in this area, including pentagonal "cookie stars" such as *Plinthaster* and *Ceramaster* as well as *Circeaster* and a new record of a rarely seen goniasterid, *Gilbertaster anacanthus*. Ceramaster was observed feeding on a ribbon sponge (demosponge). Multiple individuals of *Circeaster pullus* were observed feeding on different species of cnidarians including isidid octocorals (i.e. bamboo corals) and precious corals (Hemicorallium). One of the "cookie" stars, *Plinthaster* was observed in abundance in this area. On two separate occasions we observed large blocks with one side covered by a huge community of glass sponges in the genus *Farrea* while the other side was covered by numerous colonies of *Acanthogorgia*. It was noted that there was high current along the *Acanthogorgia* side suggesting that the sponge community was more closely associated with non-high current settings. Two unusual communities of highly abundant and dense micro-invertebrates were also observed. One was dominated by thin tube-like projections that were approximately 3-8 cm long and were sometimes so dense that they

created a “fuzzy” layer along the surface of the rock. Another large block was almost completely covered by tiny, white zoanthids. One specimen of Ceramaster was observed on this rock in a position which suggested predation on the zoanthids.

Different crustaceans were also observed that included a brachyuran inachid crab *Cyrtomaia* with extremely long legs and claws, hermit crabs (*Parapagurus*) with sea anemones replacing their shells, and small xanthid crabs.

Two other unusual invertebrate groups were observed: the benthic ctenophore Lyroccteis cf. imperatoris which was often on dead colonies of Enallopsammia, and numerous small white members of the phylum Brachiopoda (aka the lamp shells) with longitudinal notches along each valve. Finally, various fishes were also documented that included the ray, Plesiobatis daviesi, deep water cardinal fishes (Epigonus sp.), alfonsins (Beryx sp), scorpaenids, setarchids (Setarches guentheri), a few gropos (Grammatonotus sp), the spike fish Hollardia goslinei, and two observations of the commercially valuable snapper, Randallichthys filamentosus).

Overall Map of the ROV Dive Area	Close-up Map of Main Dive Site
	

Representative Photos of the Dive	
	
Community of precious corals (*Hemicorallium* sp)	Glass sponge wall (Farrea nr occa) and fish (Beryx sp)

Samples Collected		
Sample		
Sample ID	D2_DIVE05_SPEC01BIO	
Date (UTC)	20170715	
Time (UTC)	22:50:39	
Depth (m)	497	
Temperature (°C)		
Field ID(s)	*Hemicorallium* sp	
Comments	Associates were found with the specimen that included an Uroptychus sp squat lobster and several as yet unidentified small invertebrates.	
Sample		
Sample ID	D2_DIVE05_SPEC02BIO	
Date (UTC)	20170715	
Time (UTC)	23:13:52	
Depth (m)	492	
Temperature (°C)		
Field ID(s)	Ceramaster sp.	
Comments	The initial field id of *Peltaster* sp. was changed to *Ceramaster* sp. after ship lab examination.	
Sample		
Sample ID	D2_DIVE05_SPEC03BIO	
Date (UTC)	20170715	
Time (UTC)	00:34:44	
Depth (m)	430	
Temperature (°C)		
Field ID(s)	Keratoisidinae	

Comments	Intermodal branching. A small crustacean was also found in the box with the coral but there is uncertainty if it was an associate or just swam in the box when it was open.
Sample	

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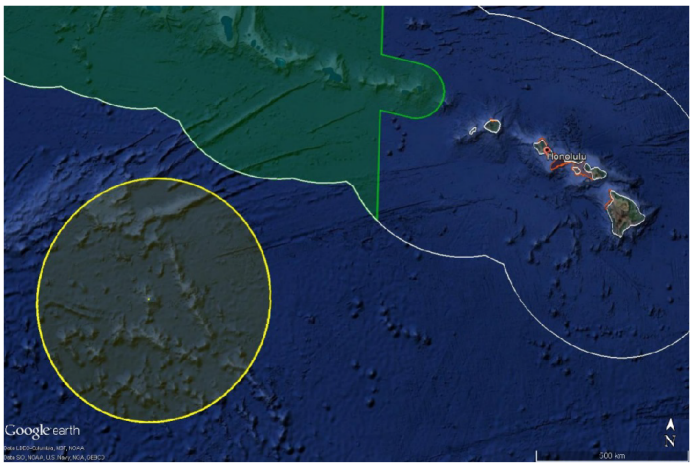
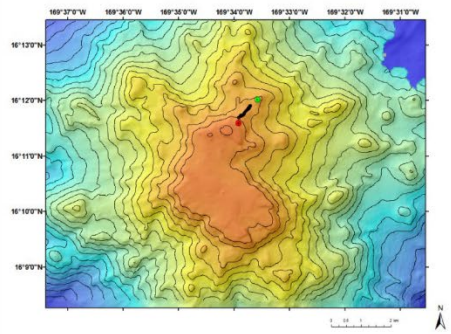
Okeanos Explorer ROV Dive Summary

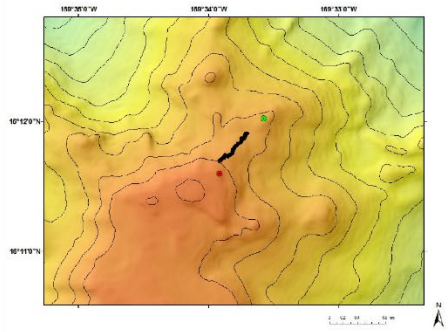
Dive Information			
Dive Map			
Site Name	"Sally" Seamount		
ROV Lead(s)	Dan Rogers		
Expedition Coordinator(s) / Mapping Lead	Kelley Elliott / Mashkoor Malik		
Science Team Lead(s)	Chris Kelley & Chris Mah		
General Area Descriptor	Johnston Atoll Unit of PRIMNM		
ROV Dive Name			
Cruise	EX1706		
Leg			
Dive Number	5		
Equipment Deployed			
ROV	Deep Discoverer (D2)		
Camera Platform	Seirios		
ROV Measurements	CTD	Depth	Altitude
	Scanning Sonar	USBL Position	Heading
	Pitch	Roll	HD Camera 1
	HD Camera 2	Low Res Cam 1	Low Res Cam 2

	Low Res Cam 3	Low Res Cam 4	Low Res Cam 5
	LSS	ORP	
Equipment Malfunctions	None		
ROV Dive Summary (from processed ROV data)	Dive Summary: EX1706_DIVE05 ^^ In Water: 2017-07-17T18:30:09.992000 16°, 11.970' N ; 169°, 34.027' W Out Water: 2017-07-18T04:31:06.296000 16°, 11.704' N ; 169°, 33.447' W Off Bottom: 2017-07-18T01:32:26.456000 16°, 11.697' N ; 169°, 33.934' W On Bottom: 2017-07-17T19:46:35.904000 16°, 11.911' N ; 169°, 33.720' W Dive duration: 10:0:56 Bottom Time: 5:45:50 Max. depth 2183.7		
Special Notes			
Scientists Involved (please provide name, location, affiliation, email)	Amanda Netburn, FAU CIOERT/OER, amanda.netburn@noaa.gov Amy Baco Taylor, Florida State University, abacotaylor@fsu.edu Asako Matsumoto, Planetary Exploration Research Center, Chiba Institute of Technology, Japan, amatsu@gorgonian.jp Brian Greene, Association for Marine Exploration, bgreene@hawaii.edu Chris Kelley, UH, ckelley@hawaii.edu Chris Mah, SI NMNH, brisinga@gmail.com Dhugal Lindsay, JAMSTEC, dhugal@jamstec.go.jp Donald Kobayashi, NOAA NMFS PIFSC, donald.kobayashi@noaa.gov George Matsumoto, MBARI, mage@mbari.org Heather Judkins, University of South Florida St. Petersburg, Judkins@mail.usf.edu John Smith, University of Hawaii/SOEST, jrsmith@hawaii.edu Jonathan Tree, University of Hawaii at Manoa, jtree@hawaii.edu Katie Mussser, University of Louisiana at Lafayette, katielynnmusser@gmail.com Ken Sulak, U.S. Geological Survey, ksulak@usgs.gov Kevin Kocot, The University of Alabama , kmkocot@ua.edu Les Watling, University of Hawaii at Manoa, watling@hawaii.edu Luke McCartin , Woods Hole Oceanographic Institution, lmccartin@whoi.edu Michael Vecchione, NMFS, vecchiom@si.edu Mike Ford, NOAA Fisheries, michael.ford@noaa.gov Nikola Rodriguez, NOAA EPP, nikola.rodriguez@noaa.gov Nolan Barrett, FAU Harbor Branch Oceanographic Institute, barrettnh@g.cofc.edu Scott France, University of Louisiana at Lafayette, france@louisiana.edu Sonia Rowley, University of Hawai'i at Manoa, srowley@hawaii.edu		

	Steven Auscavitch, Temple University, steven.auscavitch@temple.edu Tara Harmer-Luke, Stockton University, luket@stockton.edu Timothy Shank, Woods Hole Oceanographic Institution, tshank@whoi.edu Tina Molodtsova, P.P. Shirshov Institute of Oceanology RAS, tina.molodtsova@gmail.com Tracey Sutton, Nova Southeastern University, tsutton1@nova.edu
Purpose of the Dive	Most dives in 2015 were at depths of 2000 m or greater (exceptions were on the slopes of Johnston Atoll or on cones). Large scale, high density coral and sponge communities were found at depths between 2,000-2500 m at other locations but were all but lacking on seamounts explored in JAU in 2015. This dive will take place on an unexplored seamount in this depth range to continue efforts to locate these communities in new locations. Also, on the southern JAU seamounts, most dives took place on the south side of the features, and sessile communities were relatively low density. Could current flow result in different communities on the north slopes? Here I propose to dive on a guyot-like feature with radiating arms whose plateau is at approx. 2040 m, specifically on a north-side ridge leading to the plateau. The primary objective for this dive is to characterize the distribution and abundance of benthic fauna, in particular corals and sponges. The dive satisfies CAPSTONE science themes to "Acquire data to support priority monument and sanctuary science and management needs" and to "Identify and map vulnerable marine habitats – particularly high-density deep-sea coral and sponge communities Mid-Water: The water column is one of the most underexplored environments on the planet. Basic information is lacking on the distributions and abundances of midwater organisms in most parts of the globe, and the vicinity of Johnston Atoll remains a poorly explored region. ROV visual surveys provide crucial data on the distributions, abundances, and behaviors of a variety of midwater animals. ROV surveys are especially well-suited to observe the understudied gelatinous fauna, which commonly fall apart using traditional net sampling methods. Collecting acoustic backscatter data (Simrad EK60) throughout the cruise - including during ROV transects – will complement the ROV surveys by providing critical information on the depth and extent of deep scattering layers, diel vertical migrations, and ROV avoidance behavior.
Description of the Dive	Deployment of the D2 began at 8:30 am with the ROV reaching bottom at 2171m (9:45 AM), landing on a rocky substrate composed primarily of Mn encrusted rocks with a moderate to high light colored sediment. During our initial contact with this area we observed numerous dead bamboo coral skeletons several of which showed strongly calcified calcium carbonate nodes suggesting that they were of some age before they died. Many dead skeletons from glass sponges were also observed in this area prompting discussion of whether this might have been natural versus an acutely catastrophic event. This rocky, Mn encrusted area continued throughout the entire dive with only minor changes in habitat throughout as we proceeded along the survey region. Two rock samples were collected that were thought to potentially contain basalt for age analysis. Numerous octocorals and antipatharians were encountered throughout the survey region, the octocorals including primnoids (e.g. *Narella*, *Calyptophora*), "bamboo" corals (Isididae), the chrysogorgiid *Iridigorgia* magnispiralis, and antipatharians

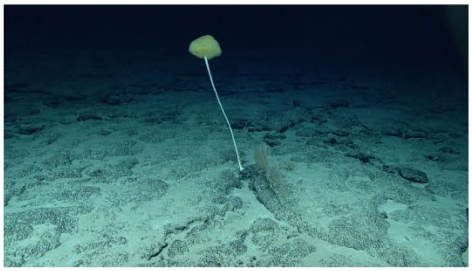
	including *Heteropathes* and *Parantipathes*. Following these observations, we entered a region where several large, well-developed bamboo corals that formed moderately abundant patches on elevated mounds of Mn crusted pillow lava. Some of these individuals were large (standing up to 8-10 feet tall) and apparently quite old. One bamboo coral was observed to have had a large section of the fleshy tissue stripped off a significant portion of the skeleton. Two aplacophorans, worm-like mollusks, were observed on these barren areas suggesting predation by this species on the bamboo corals, as has been observed with other aplacophorans. Benthic ctenophores potentially in the genus *Lyrocteis* were also perched on these colonies. Several unidentified species of cup corals (single polyp scleractinians) were documented during the dive. A potential new species of bamboo coral and antipatharian coral (*Lillipathes* sp) were collected. Moderate to large sized glass sponges were documented that included *Poliopogon* sp, *Walteria* cf. *leuckarti* and *Bolosoma* sp) as well as others not mentioned here. One unusual glass sponge that had only been photographed during a couple of previous Capstone cruises was collected and is tentatively identified for now as Auloplax sp based on colony morphology although it's spicules are not consistent with known members of that genus. Echinoderms included a large sea star from the genus *Henrica*, several brittle stars in the genus *Ophoplinthaca* which are primarily commensal on octocorals, the swimming sea cucumber likely in the genus *Hansenothuria* and what appear to be several species of feather stars. A small individual feather star displayed a disproportionately large eulimid snail. Eulimids are parasites of echinoderms and it was unusual to observe one parasitizing such a disproportionately sized host. Also observed was what appeared to be a juvenile *Hymenaster* (a slime star) present on the side of a rock face displaying its full skeletal morphology through its transparent body wall. One sea urchin in the family Aspidodiadematidae was also observed. Other invertebrates included the long-legged shrimp, *Nematocarcinus* and a large (10 cm!) purple, polynoid polychaete that took to swimming at the approach of the D2. Fishes observed on the benthic portion of the dive were few. They included an unidentified grenadier (Macrouridae) and a cusk eel (Ophidiidae). The benthic portion of the dive ended at approximately 3:30 pm (HST) with the D2 leaving the bottom from 2040 m to start the midwater portion of the dive. The first 10 minute transect began at 4:00 pm (HST) when the D2 reached a depth of 900 m. A number of other transects were also conducted between that depth and 350 m. Among the most striking of the midwater animals encountered was an undescribed comb jelly identified by Dhugal Lindsay as "Intacta". Notable fish included a bristle mouth (Cyclothone sp), swimming cusk eel (Borodinula infans) several vertically positioned Serrivomer and the hatchet fish, Sternoptyx. Other interesting observations included larvacean houses and a bizarre three to four armed glassine protist Coelodendrid called Phaeodarian. as well as numerous hydrozoan jellyfish, a hyperiid amphipod and several salps.
Overall Map of the ROV Dive Area	**Close-up Map of Main Dive Site**





Representative Photos of the Dive

Bamboo corals (Keratoisidinae) in an area of higher abundance.

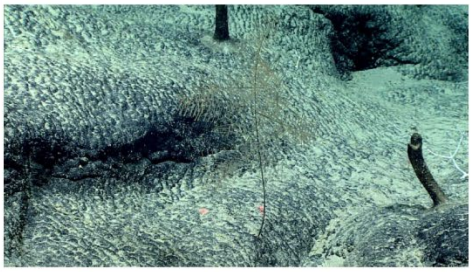


Stalked glass sponge (Bolosominae) in area of lower abundance.

Samples Collected

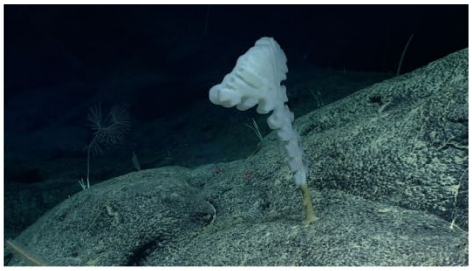
Sample

Sample ID	D2_DIVE_SPEC01BIO
Date (UTC)	20170717
Time (UTC)	205912
Depth (m)	2172
Temperature (°C)	
Field ID(s)	*Lillipathes* sp?



Comments	

Sample

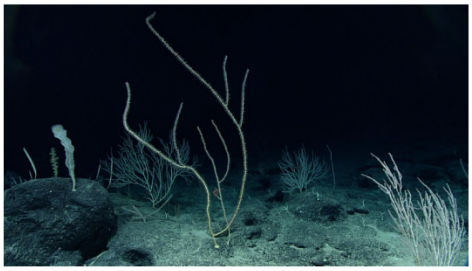
Sample ID	D2_DIVE_SPEC02BIO	
Date (UTC)	20170717	
Time (UTC)	215932	
Depth (m)	2164	
Temperature (°C)		
Field ID(s)	*Auloplax* sp?	
Comments		

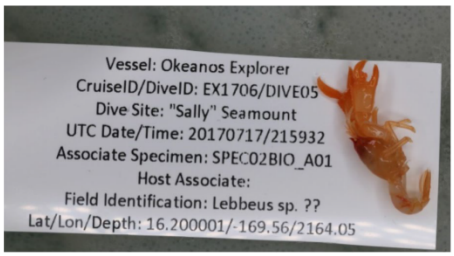
Sample

Sample ID	D2_DIVE_SPEC03GEO	
Date (UTC)	20170717	
Time (UTC)	222511	
Depth (m)	2158	
Temperature (°C)		
Field ID(s)	Mn crusted rock	
Comments		

Sample

Sample ID	D2_DIVE_SPEC04GEO	
Date (UTC)	20170717	
Time (UTC)	231940	
Depth (m)	2151	
Temperature (°C)		
Field ID(s)	Mn crusted rock	
Comments		

Sample		
Sample ID	D2_DIVE_SPEC05BIO	
Date (UTC)	20170717	
Time (UTC)	012339	
Depth (m)	2106	
Temperature (°C)		
Field ID(s)	Sparse branch D clade	
Comments		

Sample		
Sample ID	D2_DIVE_SPEC02BIO_A01	
Date (UTC)	20170717	
Time (UTC)	215932	
Depth (m)	2164	
Temperature (°C)		
Field ID(s)	*Lebbeus* sp?	
Comments	Also small amphipod found on sponge that's listed A02	

Please direct inquiries to:

NOAA Office of Ocean Exploration & Research
1315 East-West Highway (SSMC3 10th Floor)
Silver Spring, MD 20910
(301) 734-1014

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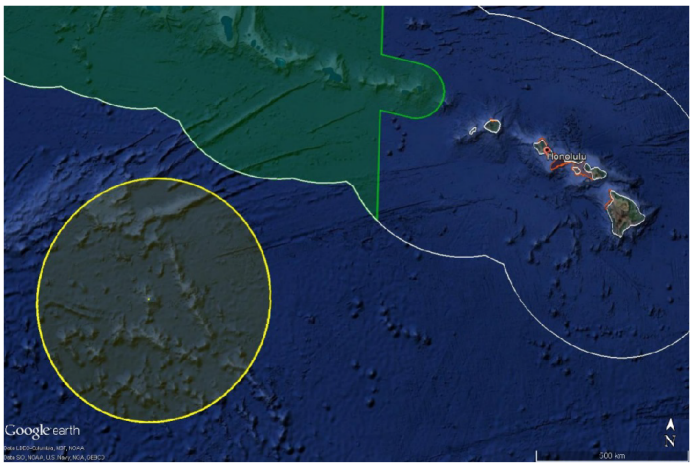
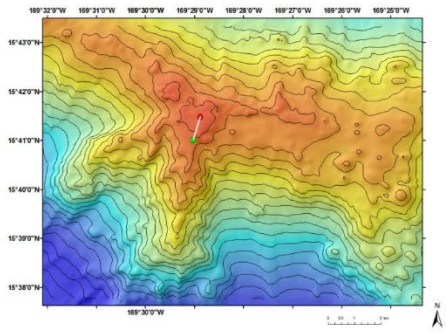
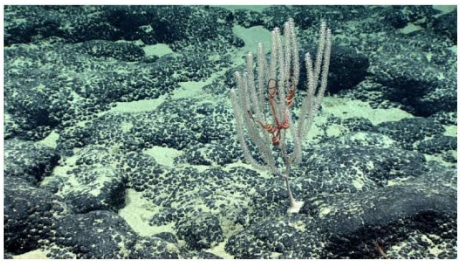
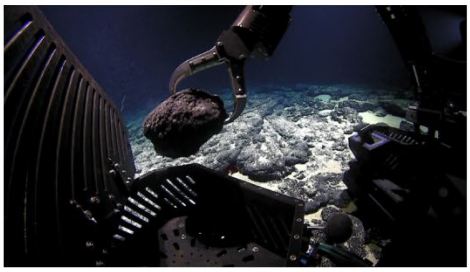
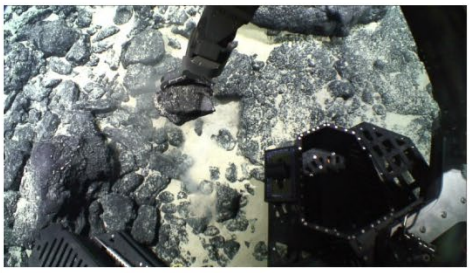
Dive Information			
Dive Map			
Site Name	"Keli" Ridge Seamount		
ROV Lead(s)	Dan Rogers		
Expedition Coordinator(s) / Mapping Lead	Kelley Elliott / Mashkoor Malik		
Science Team Lead(s)	Chris Kelley & Chris Mah		
General Area Descriptor	Johnston Atoll Unit of PRIMNM		
ROV Dive Name			
Cruise	EX1706		
Leg			
Dive Number	6		
Equipment Deployed			
ROV	Deep Discoverer (D2)		
Camera Platform	Seirios		
ROV Measurements	CTD	Depth	Altitude
	Scanning Sonar	USBL Position	Heading
	Pitch	Roll	HD Camera 1
	HD Camera 2	Low Res Cam 1	Low Res Cam 2

	Low Res Cam 3	Low Res Cam 4	Low Res Cam 5
	LSS	ORP	
Equipment Malfunctions	This dive was riddled with challenges. About an hour into the seafloor component of the dive, all video feeds to shore stopped transmitting off the ship. The feeds were restored shortly after 1:00 pm HST. At approximately 1:15 pm HST, power was lost to the D2 and recovery of the D2 began immediately which ended the dive.		
ROV Dive Summary (from processed data)	Dive Summary: EX1706_DIVE06 ^^ In Water: 2017-07-18T18:53:33.169000 15°, 41.047' N ; 169°, 29.046' W Out Water: 2017-07-18T23:12:22.995000 15°, 41.203' N ; 169°, 29.421' W Off Bottom: 2017-07-18T22:53:22.250000 15°, 41.182' N ; 169°, 28.931' W On Bottom: 2017-07-18T19:50:10.665000 15°, 41.013' N ; 169°, 29.014' W Dive duration: 4:18:49 Bottom Time: 3:3:11 Max. depth: 1249.7 m		
Special Notes			
Scientists Involved (please provide name, location, affiliation, email)	Asako Matsumoto, Planetary Exploration Research Center, Chiba Institute of Technology, Japan, amatsu@gorgonian.jp Chris Kelley, UH, ckelley@hawaii.edu Chris Mah, SI NMNH, brisinga@gmail.com John Smith, University of Hawaii/SOEST, jrsmith@hawaii.edu Les Watling, University of Hawaii at Manoa, watling@hawaii.edu Scott France, University of Louisiana at Lafayette, france@louisiana.edu Elisabeth Mcelwee, Woods Hole Oceanographic Institute, emcelwee@whoi.edu		

Purpose of the Dive	Most dives in 2015 were at depths of 2000 m or greater (exceptions were on the slopes of Johnston Atoll or on cones). There are few areas with shallower topography, and it may be interesting to explore what is available in this depth range. Scott France proposed a pair of dives for the 2015 expedition along a N-S trending ridge on one of the most rugged of the Johnston seamounts. The intent was to explore a wide depth interval from ≈2700m to 1300 m; only the deeper dive was conducted (Dive 05 from 2436 to 2090 m). Here I propose to sample the same ridge at the shallower depth range, ending at the local high. The primary objective for this dive is to characterize the distribution and abundance of benthic fauna, in particular corals and sponges. The dive satisfies CAPSTONE science themes to "Acquire data to support priority monument and sanctuary science and management needs" and to "Identify and map vulnerable marine habitats – particularly high-density deep-sea coral and sponge communities.

Description of the Dive	The ROV D2 was deployed at 8:45 am and reached bottom a little over an hour later at a depth of 1232 m. The substrate was relatively flat and composed of Mn encrusted cobbles, boulders, and light to moderate (30-50%) sediment cover between rocks. Relatively small lobed Mn encrusted pillow lavas were encountered further upslope and two rocks were sampled in this area for geologic aging. Individual organisms were widely spaced at this dive site and included primarily sponges and colonial cnidarians. Consistently encountered throughout the day were several colonies of the primnoid octocoral (*Narella* sp), each of which hosting a commensal euryalid ophiuroid (i.e., snake star that appeared to be the same species. Other colonial octocorals included an unbranched bamboo coral (Isididae), a coralliid (*Hemicorallium* sp), *Anthomastus tahinodus* (over 15 cm in height), a small colony of an unidentified member of the same genus, and the sea pen *Umbellula* sp. Other cnidarians included a giant solitary hydroid in the family Corymorphidae found in a sandy bottom "pool" among Mn coated rocks, a very large hydrozoan colony in the genus *Solanderia* extending nearly 10 feet across was observed under a basalt overhang, tube anemones (*Ceriantharia*), and a venus flytrap anemone (Hormathiidae). Glass sponges included the stalked euplectellid *Bolosoma* sp, a vase-shaped euplectellid (*Dictyaulus* sp), *Tretopleura* sp in the family Uncinateridae, a paper thin euretid (*Chonelasma* sp) as well as an unidentified species in that family, and a very unusual glass sponge that was collected and later identified by microscopic spicules as being in the family Tretodictyidae, possibly in the genus *Tretodictyum*. Several colonies of this sponge were encountered and they all hosted other invertebrate species, including rarely seen benthic ctenophores, a large squat lobster, a gastropod, and several hydroid commensals. Echinoderms included a comatulid crinoid, as well as several asteroids, one being a large, prominent goniasterid identified in the field as *Atelorias* based on size and arm shape. However based on closer study of the image, it appears likely that this was a new genus and species. A white "cookie" type goniasterid, possibly *Bathyceramaster*, was observed feeding on a glass sponge. Two others were documented including a species in the genus *Hymenaster*, and a species of *Leptycaster*. Ophiacanthid ophiuroids were also imaged on dead sponge stalks along with a synallactid holothurian. The highlights of the arthropod observations were a large solitary archaeobalanid barnacle in the genus *Chirona* and a homolid crab (genus *Lomoha*) carrying an anemone in its hind legs. Other arthropods included squat lobsters and shrimp. Fish were observed throughout the dive, including at least 3 "cusk eels" that included several large individuals of *Lamprogrammus* sp and a very small transparent individual that appeared to be a juvenile of a different species. Several synaptobranchid eels as well as a grenadier (*Coryphaenoides* sp) were also observed. At approximately 1:15 pm HST, power was lost to the D2 and recovery of the D2 began immediately which ended the dive.

Overall Map of the ROV Dive Area	Close-up Map of Main Dive Site
 **Note: the dive tracking data was not available due to the ROV power issue.**	
Representative Photos of the Dive	
	
Hymenaster seastar seen on a mixed sediment, cobble, and boulder substrate that predominated the dive site.	Primnoid coral (Narella sp) with an snake star attached to Mn crusted pillow lava formations.

Samples Collected		
Sample		
Sample ID	D2_DIVE_SPEC01GEO	
Date (UTC)	20170718	
Time (UTC)	203320	
Depth (m)	1245	
Temperature (°C)		
Field ID(s)	Mn crusted rock	
Comments		
Sample		
Sample ID	D2_DIVE_SPEC02GEO	
Date (UTC)	20170718	
Time (UTC)	212917	
Depth (m)	1220	
Temperature (°C)		
Field ID(s)	Mn crusted rock	
Comments		
Sample		
Sample ID	D2_DIVE_SPEC03BIO	
Date (UTC)	20170718	
Time (UTC)	223446	
Depth (m)	1214	
Temperature (°C)		
Field ID(s)	Unidentified hexactinellid sponge	
Comments	Initially identified as a potential calcaracean sponge in the genus Clathrina. A bleach prep was conducted on a small piece after the specimen was brought on board and the sponge was determined to be a very unusual glass sponge with a morphology of anastomosing tubes.	

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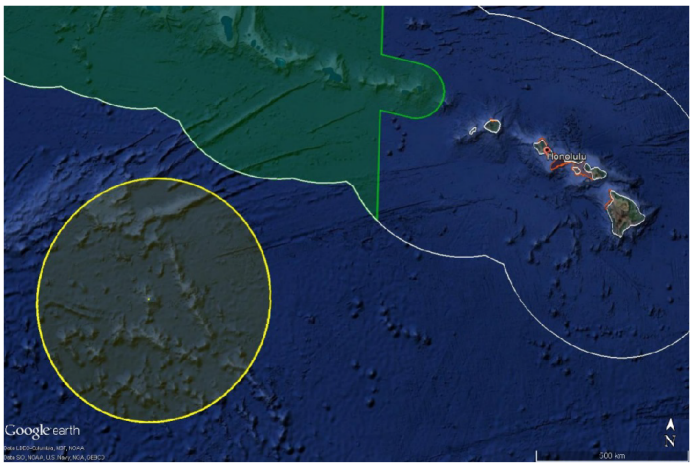
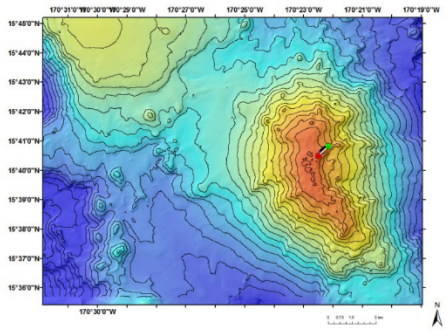
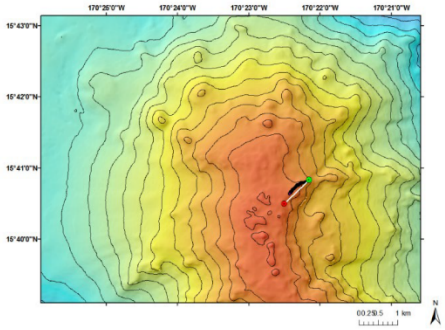
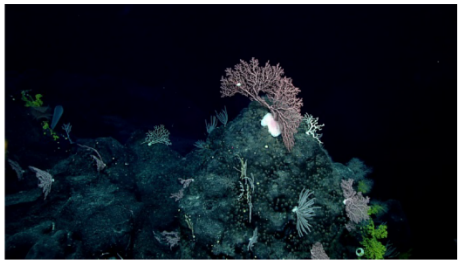
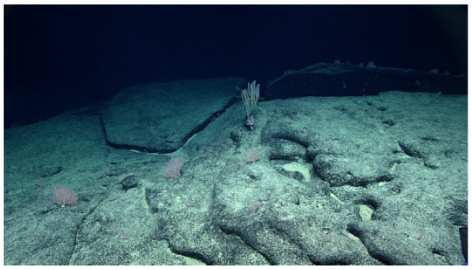
Ocean Exploration and Research

Okeanos Explorer ROV Dive Summary

Dive Information			
Dive Map			
Site Name	"Edmondson" Seamount		
ROV Lead(s)	Dan Rogers		
Expedition Coordinator(s) / Mapping Lead	Kelley Elliott / Mashkoor Malik		
Science Team Lead(s)	Chris Kelley & Chris Mah		
General Area Descriptor	Johnston Atoll Unit of PRIMNM		
ROV Dive Name			
Cruise	EX1706		
Leg			
Dive Number	7		
Equipment Deployed			
ROV	Deep Discoverer (D2)		
Camera Platform	Seirios		
ROV Measurements	CTD	Depth	Altitude
	Scanning Sonar	USBL Position	Heading
	Pitch	Roll	HD Camera 1
	HD Camera 2	Low Res Cam 1	Low Res Cam 2

	Low Res Cam 3	Low Res Cam 4	Low Res Cam 5
	LSS	ORP	
Equipment Malfunctions	None		
ROV Dive Summary (from processed data)	Dive Summary: EX1706_DIVE07 ^^ In Water: 2017-07-21T18:25:39.730000 15°, 40.907' N ; 170°, 22.182' W Out Water: 2017-07-22T02:28:59.341000 15°, 40.611' N ; 170°, 22.022' W Off Bottom: 2017-07-22T01:44:34.334000 15°, 40.641' N ; 170°, 22.432' W On Bottom: 2017-07-21T19:21:11.791000 15°, 40.836' N ; 170°, 22.156' W Dive duration: 8:3:19 Bottom Time: 6:23:22 Max. depth: 1275.3m		
Special Notes			
Scientists Involved (please provide name, location, affiliation, email)	Asako Matsumoto, Planetary Exploration Research Center, Chiba Institute of Technology, Japan, amatsu@gorgonian.jp Chris Kelley, UH, ckelley@hawaii.edu Chris Mah, SI NMNH, brisinga@gmail.com John Smith, University of Hawaii/SOEST, jrsmith@hawaii.edu Katie Musser, University of Louisiana at Lafayette, katielynnmusser@gmail.com Ken Sulak, U.S. Geological Survey, ksulak@usgs.gov Les Watling, University of Hawaii at Manoa, watling@hawaii.edu Mike Ford, NOAA Fisheries, michael.ford@noaa.gov Nolan Barrett, FAU Harbor Branch Oceanographic Institute, barrettnh@g.cofc.edu Scott France, University of Louisiana at Lafayette, france@louisiana.edu Timothy Shank, Woods Hole Oceanographic Institution, tshank@whoi.edu Tina Molodtsova, P.P. Shirshov Institute of Oceanology RAS, tina.molodtsova@gmail.com Bruce Mundy, NOAA NMFS Pacific Islands Fisheries Science Center, Bruce.Mundy@noaa.gov Nicole Morgan, Florida State University, nmorgan@fsu.edu		

Purpose of the Dive	This particular site was selected mostly for the unusual geology. This feature is believed to represent secondary volcanism after the guyot it is on sunk well below the surface. While secondary volcanism is common and is seen on many seamounts here in the Johnston Atoll area, this particular example is much larger than any others and is covering a large extent of the summit of the guyot it is on. Collecting a rock on this site would provide valuable information on how and when the feature formed. The exact location of the dive is along a sharp ledge at the top of the feature where deep water corals and sponges may likely be found.
Description of the Dive	The D2 was deployed today at 8:30 AM and reached bottom depth (1260m) at 9:18 AM. The landing site was primarily rocky composed of Mn crusted basalt bedrock and boulders with 20-50% sediment cover. The benthos observed during the first segment of the dive was sparse and widely distributed. Commonly encountered cnidarian species included the primnoid octocoral *Narella* sp that was almost always had an orange euryalid ophiuroid associate. A few colonies of the precious coral Hemicorallium sp were also observed. Two other species seen only once were a tall, "whip" bamboo coral (Isididae) with a large flytrap anemone on its tip and a colony of *Victorgorgia nuttingi* with an ophiuroid and pedunculate barnacles. A synallactid sea cucumber, Hansenothuria was the only echinoderm observed. At approximately 11 am, the D2 encountered a blocky pinnacle region composed of heavy Mn crusted basalt blocks with a high density of colonial cnidarians, stalked sponges, and their associated faunas. This area was composed of steep walls and included several valleys and strikingly acute features where current flow was likely accelerated. The community was dominated by the precious coral Hemicorallium sp which was present in several large and very tall colonies. Some of these were partially or completely overgrown by yellow zoanthids. Other cnidarians were also present in lesser abundance, including the chrysogorgiid *Chrysogorgia* sp, a white species of *Paragorgia*, stoloniferans, corallimorpharians, and several ocurrences of zoanthids proliferating over a wide rocky surface. The largest colonial cnidarian observed today was a species of hydrozoan (*Solanderia* sp), one colony being easily over 2 meters tall and 3 meters wide. This colony harbored a number of commensals including a large squat lobster (Munidae) and numerous ophiacanthid brittle stars. Associated fauna on other colonial cnidarians included several species of squat lobsters, stalked and unstalked barnacles, ophiacanthid ophiuroids and in some cases, aplacophorans. Several swimming shrimps and hermit crabs were observed throughout today's dive. Large echinoderm predators of corals included two large individuals of the goniasterid seastar *Hippasteria muscipula* (diameter = ~15 cm across) as well as another goniasterid Calliaster ? sp. Both of which were observed in feeding position, with *Calliaster* having extended its cardiac stomach over its precious coral prey. Other echinoderms included two white echinothuriid urchins in the genus Sperosoma(?), several very large individuals of feather stars, including one dark bodied species with yellow cirri (family Zygrometridae?), and numerous ophiacanthid and amphiurid ophiuroids. Aside from the *Hansenothuria* sp observed during the early part of the dive, one other species of sea cucumber was encountered that was tentatively indentified as being in the family Laetmogonidae. The zygometrid crinoid and a piece of the Hemicorallium coral it was sitting on were collected along with a goniasterid sea star in the genus Bathyceramaster. Sponges included two species of euplectellid glass sponges, several small

	unidentified spherical sponges and several observations of an undescribed glass sponge collected during dive 6 and tentatively identified as a tretodictyid species (*Tretodictyum* sp). This latter species had commensal sea anemones or zoanthids growing throughout its branches. Fish included several cusk eels, two species of grenadiers, and a large angler fish in the genus *Sladenia*. In spite of this highly dense cnidarian community, there were several notable absences, specifically that of antipatharians (black corals), bamboo corals and plexaurids. Finally, the high current/basalt pinnacle region gave way to a more gradual sloping mixed substrate of Mn crusted blocks, boulders, cobbles, and sediment as the ROV moved further away from the edge of the escarpment. Colonies of Hemicorallium sp and primnoids persisted in this area but in much lower abundance.
Overall Map of the ROV Dive Area	Close-up Map of Main Dive Site
	
Representative Photos of the Dive	
	
High topography with a dense invertebrate community dominated by the precious coral Hemicorallium sp was encountered during the first part of the dive.	**Lower relief with a more sparse community was encountered away from the edge of the escarpment toward the summit of the seamount.**

Samples Collected		
Sample		
Sample ID	D2_DIVE_SPEC01GEO	
Date (UTC)	20170721	
Time (UTC)	193657	
Depth (m)	1275	
Temperature (°C)		
Field ID(s)	Mn crusted rock	
Comments		
Sample		
Sample ID	D2_DIVE_SPEC02GEO	
Date (UTC)	20170721	
Time (UTC)	232044	
Depth (m)	1157	
Temperature (°C)		
Field ID(s)	Mn crusted rock	
Comments		
Sample		
Sample ID	D2_DIVE_SPEC03BIO	
Date (UTC)	20170722	
Time (UTC)	000816	
Depth (m)	1165	
Temperature (°C)		
Field ID(s)	Hemicorallium sp	
Comments		

Sample		
Sample ID	D2_DIVE_SPEC03BIO_A01	
Date (UTC)	20170722	
Time (UTC)	000816	
Depth (m)	1165	
Temperature (°C)		
Field ID(s)	Thalassometridae ? (crinoid)	
Comments	Other associates included ophiuroidea, a polychaete worm, and a barnacle.	

Sample		
Sample ID	D2_DIVE_SPEC04BIO	
Date (UTC)	20170722	
Time (UTC)	001757	
Depth (m)	1165	
Temperature (°C)		
Field ID(s)	Bathyceramus sp? (seastar)	
Comments		

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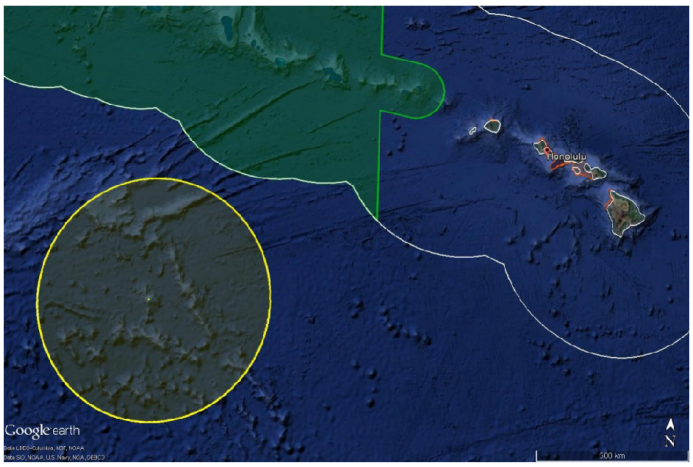
Silver Spring, MD 20910
(301) 734-1014

Okeanos Explorer ROV Dive Summary

Dive Information			
Dive Map			
Site Name	"Pierpont" Seamount		
ROV Lead(s)	Dan Rogers		
Expedition Coordinator(s) / Mapping Lead	Kelley Elliott / Mashkoor Malik		
Science Team Lead(s)	Chris Kelley & Chris Mah		
General Area Descriptor	Johnston Atoll Unit of PRIMNM		
ROV Dive Name			
Cruise	EX1706		
Leg			
Dive Number	8		
Equipment Deployed			
ROV	Deep Discoverer (D2)		
Camera Platform	Seirios		
ROV Measurements	CTD	Depth	Altitude
	Scanning Sonar	USBL Position	Heading
	Pitch	Roll	HD Camera 1
	HD Camera 2	Low Res Cam 1	Low Res Cam 2

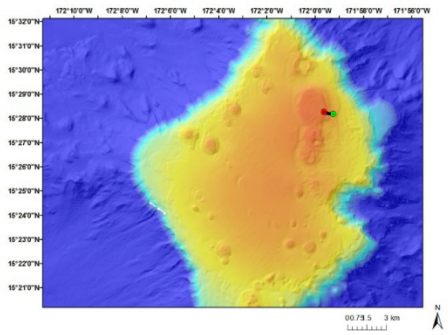
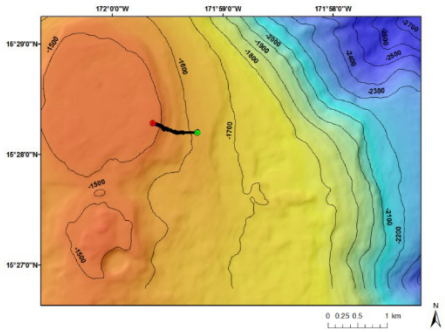
	Low Res Cam 3	Low Res Cam 4	Low Res Cam 5
	LSS	ORP	
Equipment Malfunctions	None		
ROV Dive Summary (from processed ROV data)	Dive Summary: EX1706_DIVE08 ^^^

Purpose of the Dive	Piermont Seamount is a Mn-crusted guyot located in the JAU of the PRIMNM as well as in the PCZ. The edge of the summits of these types of flat-topped seamounts will be the first targeted by future deep sea mining efforts to extract Mn crusts because they are generally free of sediment, flat, and therefore can be relatively easily extracted by mining equipment. Guyot summit edges are also likely locations of deep water coral and sponge communities that could be impacted by crust extraction. This particular site is on a potential "pancake volcano" created by secondary volcanism that should yield valuable rocks for geologic aging. The site is also along the edge of the summit that was likely a Cretaceous reef. Backscatter data shows a hard substrate suitable for deep sea corals and sponges. Mid-Water: The water column is one of the most underexplored environments on the planet. Basic information is lacking on the distributions and abundances of midwater organisms in most parts of the globe, and the vicinity of Johnston Atoll remains a poorly explored region. ROV visual surveys provide crucial data on the distributions, abundances, and behaviors of a variety of midwater animals. ROV surveys are especially well-suited to observe the understudied gelatinous fauna, which commonly fall apart using traditional net sampling methods. Collecting acoustic backscatter data (Simrad EK60) throughout the cruise - including during ROV transects – will complement the ROV surveys by providing critical information on the depth and extent of deep scattering layers, diel vertical migrations, and ROV avoidance behavior.
Description of the Dive	The Deep Discoverer was deployed at 8:20AM and reached bottom depth (1600m) at 9:20 AM. Habitat today was hard bottom mostly covered by Mn crust with light to heavy sediment cover. Fauna was relatively sparse throughout the dive with sessile octocoral taxa perhaps being the dominant fauna. Among the most frequently seen were chrysogorgiids, including *Chrysogorgia* and *Metallogorgia* (with ophiuroid commensal), several species of bamboo corals, several members of the primnoid genera Narella, at least one and potentially 2 species of bubblegum corals (*Paragorgia*), all but one of which was overgrown with a yellow zoanthid. Two other octocorals observed were the distinctive purple *Victogorgia nuttingi* and a yellow plexaurid, possibly in the genus *Paramuricea*. One of the bamboo corals (*Keratoisis* sp?) and the yellow plexaurid were collected. Black corals included *Bathypathes, Stauropathes, Trissopathes*, *Alternatipathes*, and a potential record of a juvenile unidentified schizopathid that was small and unbranched. Several "soft corals" such as the mushroom coral *Anthomastus* as well as several sea pens (*Umbellula* and *Halipteris* sp), rock pens (*Anthoptilum*) and sea anemones of different sizes were also observed. An unusual benthic, predatory hydromedusae (jellyfish), *Aegina citraea* was observed on the underside of the branches on a moderately sized bamboo coral. Polyps adjacent to the jellyfish appeared damaged or withdrawn. Other benthic animals included several predatory tunicates (similar to those in the genus *Megalodicopia*), stalked glass sponges in the genera *Bolosoma* and *Caulophacus, Poliopogon* and possibly *Dictyocalyx*. Perhaps the most noteworthy observations from today's dive were those of the echinoderms. Numerous observations of the stalked crinoid *Proisocrinus ruberrimus* were made as well as one yellow stalked hyocrinid. Predation by seastars was perhaps the highlight of the dive with numerous observations of Evoplosoma and *Circeaster* feeding on

Iridigorgia, an unidentified primnoid coral (probably *Narella*), and *Chrysogorgia*. One goniasterid, tentatively identified as Evoplosoma ("*Calliaster*" in the video log/database) was not observed feeding but was in close proximity to a rock pen (*Anthoptilum)*. Related sea pen species are well known as prey for hippasterine goniasterids such as Evoplosoma and Hippasteria. One very novel observation was that of a goniasterid, possibly Ceramaster, feeding on the stalk of calyx-less stalked crinoid *Proisocrinus ruberrimus*. It's unclear if the asteroid fed directly upon the crinoid or if it was scavenging upon it. Other asteroids seen on the substrate were a possibly new, red pedicellasterid, and several individuals of Zoroaster sp., brisingids and a few other goniasterids. Arthropods were not particularly abundant but those observed included large pedunculate (i.e. stalked) barnacles, a homolid crab (*Lomoha longirostris*), shrimps, and several squat lobster commensals associated with octocorals. The arthropod highlight was a large sea spider (Collossendeidae). The only fishes observed were a few cutthroat eels (Synaphobranchidae) and halosaurs (*Aldovandria* sp).

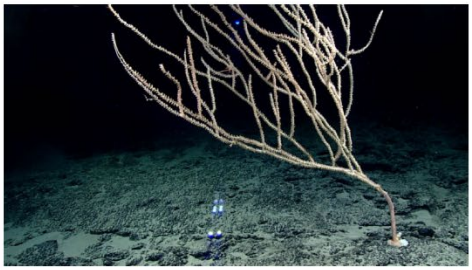
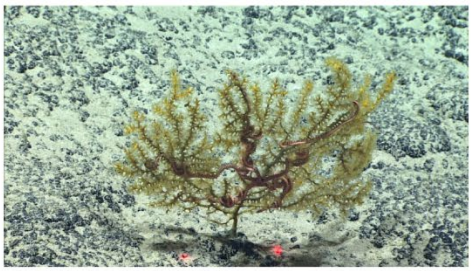
The benthic component of today's dive ended at approximately 15:30 HST with a series of midwater transects beginning at 16:00 HST at a depth 800 m. Transects continued at 100 m increments until a final depth of between 200-300m.

Midwater fauna observed included both pelagic metazoans and protists. Among the most abundant were siphonophores (e.g., Praya), colonial gelatinous hydrozoans, numerous medusae, comb jellies, and salps (both single and in chains). Many of the lobate comb jellies show very distinctive morphologies. Larvaceans and their mucous houses were observed with some frequency. Distinctive along with strikingly colored arrow worms (chaetognaths). Perhaps most striking among the deep-water organisms were protists, including a very striking "starburst" colored, shimmering radiolarian as well as a coelodendrid phaeodarian that possessed four bizarre glassine tentacles. Midwater fishes included the vertical inhabiting Serrivomer, as well as Gonostoma gracile, and Sternoptyx (hatchet fish)

Overall Map of the ROV Dive Area	Close-up Map of Main Dive Site
	

Representative Photos of the Dive	
Flat sediment covered hard pan substrate seen most of the dive, with this image showing a stalked red crinoid (Proisocrinus sp) and a stalked sponge (Caulophacus sp).	A seastar apparently predating on a stalked crinoid at a gently sloping terrace where Mn crusted pillow lavas were found.

Samples Collected		
Sample		
Sample ID	D2_DIVE_SPEC01BIO	
Date (UTC)	20170722	
Time (UTC)	203742	
Depth (m)	1603	
Temperature (°C)	3.0	
Field ID(s)	Calliaster sp?	
Comments		
Sample		
Sample ID	D2_DIVE_SPEC02GEO	
Date (UTC)	20170722	
Time (UTC)	223653	
Depth (m)	1554	
Temperature (°C)		
Field ID(s)	Mn crusted rock	

Comments		
Sample		
Sample ID	D2_DIVE_SPEC03GEO	
Date (UTC)	20170722	
Time (UTC)	234210	
Depth (m)	1528	
Temperature (°C)		
Field ID(s)	Mn crusted rock	
Comments		
Sample		
Sample ID	D2_DIVE_SPEC04BIO	
Date (UTC)	20170723	
Time (UTC)	002039	
Depth (m)	1523	
Temperature (°C)	2.9	
Field ID(s)	Keratoisis sp	
Comments		
Sample		
Sample ID	D2_DIVE_SPEC05BIO	
Date (UTC)	20170723	
Time (UTC)	005407	
Depth (m)	1509	
Temperature (°C)	2.9	
Field ID(s)	Plexauridae	
Comments		

Sample		
Sample ID	D2_DIVE_SPEC05BIO_A01	
Date (UTC)	20170723	
Time (UTC)	005407	
Depth (m)	1509	
Temperature (°C)	2.9	
Field ID(s)	Asteroschematidae	
Comments		

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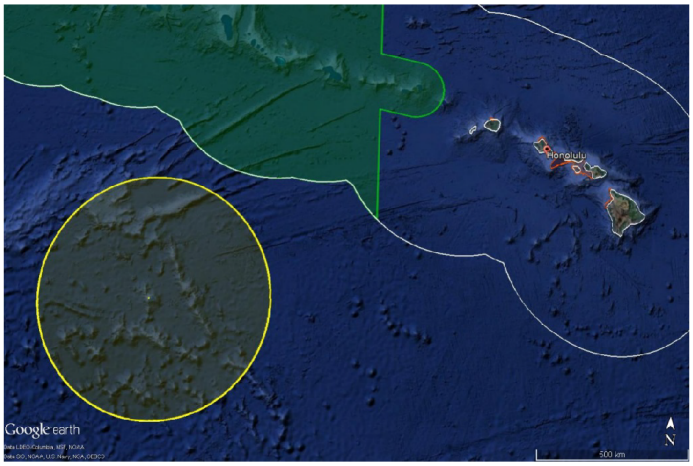
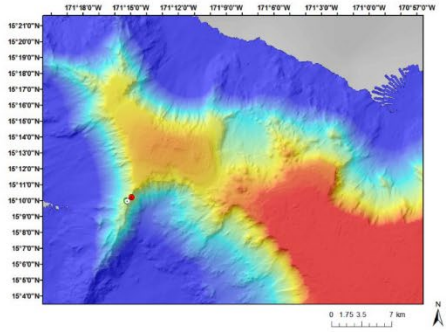
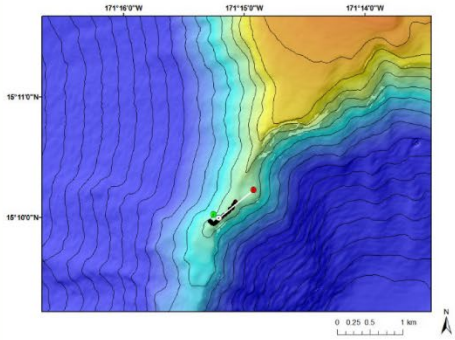
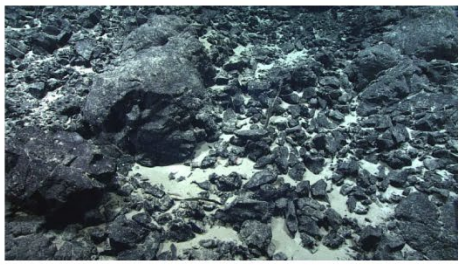
Okeanos Explorer ROV Dive Summary

Dive Information			
Dive Map			
Site Name	"Wetmore" Seamount		
ROV Lead(s)	Dan Rogers		
Expedition Coordinator(s) / Mapping Lead	Kelley Elliott / Mashkoor Malik		
Science Team Lead(s)	Chris Kelley & Chris Mah		
General Area Descriptor	Johnston Atoll Unit of PRIMNM		
ROV Dive Name			
Cruise	EX1706		
Leg			
Dive Number	9		
Equipment Deployed			
ROV	Deep Discoverer (D2)		
Camera Platform	Seirios		
ROV Measurements	CTD	Depth	Altitude
	Scanning Sonar	USBL Position	Heading
	Pitch	Roll	HD Camera 1
	HD Camera 2	Low Res Cam 1	Low Res Cam 2

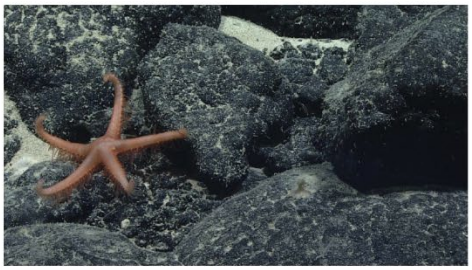
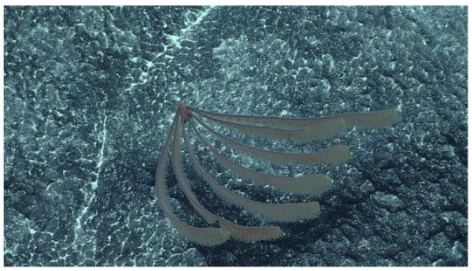
	Low Res Cam 3	Low Res Cam 4	Low Res Cam 5
	LSS	ORP	
Equipment Malfunctions	None		
ROV Dive Summary (from processed ROV data)	Dive Summary: EX1706_DIVE09 In Water: 2017-07-23T18:25:02.053000 15°, 09.855' N ; 171°, 15.366' W Out Water: 2017-07-24T02:30:20.915000 N/A ; N/A Off Bottom: 2017-07-24T01:05:54.530000 15°, 10.140' N ; 171°, 15.069' W On Bottom: 2017-07-23T19:57:44.094000 15°, 09.980' N ; 171°, 15.295' W Dive duration: 8:5:18 Bottom Time: 5:8:10 Max. depth: 2574.8 m		
Special Notes			
Scientists Involved (please provide name, location, affiliation, email)	Asako Matsumoto, PERC/CIT, Japan, amatsu@gorgonian.jp Chris Kelley, UH, ckelley@hawaii.edu Chris Mah, SI NMNH, brisinga@gmail.com Ken Sulak, U.S. Geological Survey, ksulak@usgs.gov Les Watling, University of Hawaii at Manoa, watling@hawaii.edu Nicole Morgan, Florida State University, nmorgan@fsu.edu Scott France, University of Louisiana at Lafayette, france@louisiana.edu Timothy Shank, Woods Hole Oceanographic Institution, tshank@whoi.edu Tina Molodtsova, P.P. Shirshov Institute of Oceanology RAS, tina.molodtsova@gmail.com Jaymes Awbrey, University of Louisiana, Lafayette, jawbrey@louisiana.edu		
Purpose of the Dive	This dive site is on a Mn-crusted rift zone ridge extending SW from Wetmore Seamount, a guyot located in the JAU of PRIMNM and also in the PCZ. These ridges are a CAPSTONE priority because previous surveys have found large scale, high density communities of deep water corals and sponges on this type of topography as well as the many other animals they support. Ridges act as barriers to bottom current flow and their crests are locations where currents accelerated, which is where the corals and sponges are most heavily aggregated. Ridges are also sites where basalt can be found and are therefore desirable locations for obtaining rocks for dating seamounts. This particular dive is designed to explore a ridge site just below 2500m that based on previous ridge dives, may be a potential lower depth boundary for high density communities.		

Description of the Dive	The Deep Discoverer deployed at 8:30AM reaching bottom (2150 m) at approximately 8:45 AM where it arrived on substrate of Mn encrusted pillow lava flows, large blocks, and boulders. Volcanic substrate alternating with patches of sediment and Mn encrusted nodules continued throughout the dive and 2 rocks were collected for geochemical analysis and aging. Fauna overall was sparse with most species being found in low abundance. The one exception was a species of stalked glass sponge (*Bolosoma* sp B) that was moderately numerous and reached a height of up to a meter or more. Other less regularly encountered glass sponges included several different species in the genus *Poliopogon*. A never before yellow species of *Poliopogon*, or at least pheronematid was observed during the final minutes of the dive. A cladorhizid sponge was observed today using its fine spines to capture small crustaceans for food. Colonial cnidarians were also observed in low to moderate abundance and included octocorals ("whip" forms of bamboo coral (Isididae), *Chrysogorgia* and *Pleurogorgia* species, and primnoids in the genus Narella. Black corals (antipatharians) were also observed including a potentially new species of H*eteropathes* (tentatively identified for now as H. cf Americana) that was collected. Of particular interest was a benthic siphonophore in the genus *Thermopalia*; the first seen so far on this cruise. Observations were also made of several noteworthy echinoderms, particularly the first in situ observation ever of the unusual "sea star-like" brittle star *Astrophiura*. A new genus and species of what appears to be a solasterid or a ganeriid was also observed and collected. Feather stars were also present including a young pentacrinid juvenile still attached the substrate but a stalk. Several deposit feeding sea cucumbers were also observed including purple species from the families Synallactidae and Elpidiidae. Both displayed either translucent or a completely transparent body wall permitting observation of sediment swallowed in the gut. The arthropod highlights were an ostracod and squat lobster (Munidopsis sp) while noteworthy chordates included the solitary stalked tunicate *Culeolus*, two cusk eels (*Bassogigas* sp.) and a grenadier (*Kumba* sp.)

Overall Map of the ROV Dive Area	Close-up Map of Main Dive Site
	

Representative Photos of the Dive	
	
View of the landing area for the D2 showing the mixed substrate of pillow lavas, boulders, and light sediment cover.	Further upslope, the substrate transitioned to more consolidated pillow lava formations. A yellow species of the stalked glass sponge Bolosoma was the dominant invertebrate found on this site.

Samples Collected		
Sample		
Sample ID	D2_DIVE_SPEC01GEO	
Date (UTC)	20170723	
Time (UTC)	202846	
Depth (m)	2570	
Temperature (°C)	1.8	

Field ID(s)	Mn Crusted Rock	
Comments		
Sample		
Sample ID	D2_DIVE_SPEC02BIO	
Date (UTC)	20170723	
Time (UTC)	203305	
Depth (m)	2569	
Temperature (°C)	1.8	
Field ID(s)	Solasteridae	
Comments		
Sample		
Sample ID	D2_DIVE_SPEC03BIO	
Date (UTC)	20170723	
Time (UTC)	211137	
Depth (m)	2542	
Temperature (°C)	1.8	
Field ID(s)	Heteropathes cf americana	
Comments	If this turns out to be H. americana, the type specimen has apparently be misplaced according to Tina Molodsova.	
Sample		
Sample ID	D2_DIVE_SPEC04GEO	
Date (UTC)	20170723	
Time (UTC)	211953	
Depth (m)	2542	
Temperature (°C)	1.8	
Field ID(s)	Mn Crusted Rock	
Comments	Three associates were obtained that include possible tubeworms, hydroids, and a sponge	

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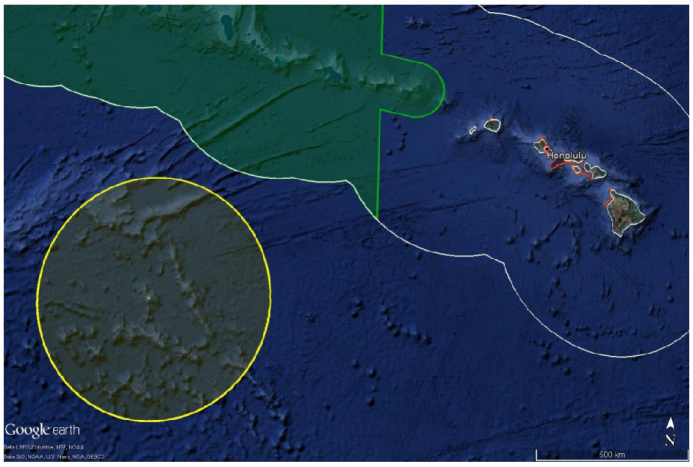
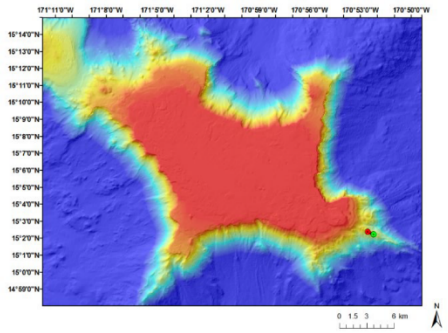
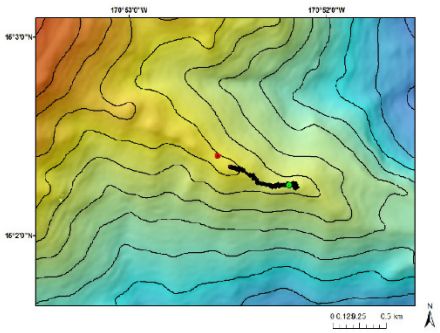
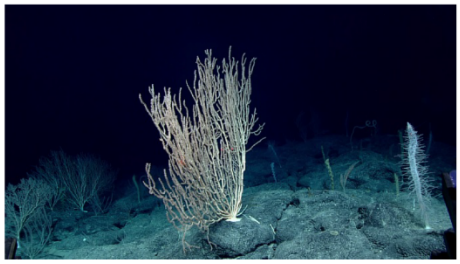
(301) 734-1014

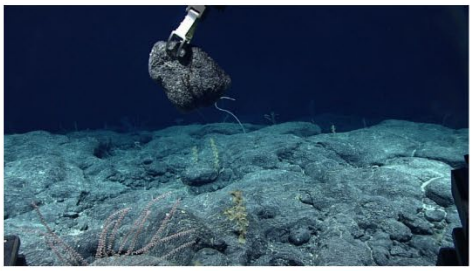
Okeanos Explorer ROV Dive Summary

Dive Information			
Dive Map			
Site Name	"Wetmore" Seamount East		
ROV Lead(s)	Dan Rogers		
Expedition Coordinator(s) / Mapping Lead	Kelley Elliott / Mashkoor Malik		
Science Team Lead(s)	Chris Kelley & Chris Mah		
General Area Descriptor	Johnston Atoll Unit of PRIMNM		
ROV Dive Name			
Cruise	EX1706		
Leg			
Dive Number	10		
Equipment Deployed			
ROV	Deep Discoverer (D2)		
Camera Platform	Seirios		
ROV Measurements	CTD	Depth	Altitude
	Scanning Sonar	USBL Position	Heading
	Pitch	Roll	HD Camera 1
	HD Camera 2	Low Res Cam 1	Low Res Cam 2

	Low Res Cam 3	Low Res Cam 4	Low Res Cam 5
	LSS	ORP	
Equipment Malfunctions	None		
ROV Dive Summary (from processed ROV data)	Dive Summary: EX1706_DIVE10 ^^^

Purpose of the Dive	This is a presumed Mn-crusted rift zone ridge extending SE from the east side of Wetmore Seamount, a guyot located in the JAU of PRIMNM and also in the PCZ. These ridges are a CAPSTONE priority because previous surveys have found large scale, high density communities of deep water corals and sponges on this type of topography as well as the many other animals they support. Ridges act as barriers to bottom current flow and their crests are locations where currents accelerated, which is where the corals and sponges are most heavily aggregated. Ridges are also sites where basalt can be found and are therefore desirable locations for obtaining rocks for dating seamounts. This particular dive was designed to explore a ridge site right around 2000 m that previous dives have shown to be a productive depth for discovering high density communities.
Description of the Dive	The Deep Discoverer was deployed at approximately 8:35 AM reaching bottom depth (2052) at approximately 9:45 AM. The "Wetmore Seamount East" site was primarily hard bottom composed of large boulders and blocks and then later almost entirely of cemented lava boulders and basalt. A light sediment overlay was present and the current was initially strong coming from the southeast, later changing to coming from the north. Two Mn crusted rocks were collected during the dive for geochemical and aging analyses. The community at this site could be described as high density even though the numbers of animals decreased and increased in patches as the ROV continued along the crest of the ridge. Octocorals were the dominant group of animals and included isidids (both branched and unbranched species), primnoids (both branched and unbranched species of *Narella, Candidella gigantea*, *Calyptrophora angularis*), chrysogorgiids (*Iridogorgia magnispiralis* and several *Chrysogorgia* species, coralliids in the genus *Hemicorallium, Paragorgia* sp, at least 3 different species of mushroom corals (Anthomastus) and a few sea pens. One species of an unbranched Narella was collected. Hexacorals included several species of antipatharians (*Trissopathes, Alternapathes*, and an undescribed species of *Antipathes* living in association with a farreid glass sponge), zoanthids and small anemones. Hexactinellid glass sponges were also abundant, particularly unstalked euplectellids (*Walteria* sp). Less abundant sponges included scattered *Poliopogon, Caulophacus, Bolosoma*, and *Aspidoscopulia* species. One colony of the latter was collected that also had the associated *Antipathes* sp. Some echinoderm observations, such as those from commensal or associate faunas such as ophiuroids or crinoids were present widely. Feather stars (at least three species of comatulid crinoids) and brittle stars (ophiacanthids, likely in the genus *Ophioplinthaca*, and euryalids were abundant on *Walteria* sp and octocorals). One genus of stalked crinoid, tentatively identified as *Bathycrinus* was observed twice. Small pentacrinoid larvae (juvenile feather stars) were also observed. Sea cucumbers were not particularly abundant presumably due to the lack of sediment. Those that were encountered were in the families Elpidiidae and Synallactidae. Large (>10 cm across) purple echinothuriid urchins in the genus *Tromikosoma* were also at this site along with two genera of asteroids (a large white species of *Henricia* and two individuals of the coral predator *Hippasteria*). A small individual of *Hippasteria* was collected as an associate with an unbranched *Narella* and appeared to be observed predating on the primnoid. An unusually small cidaroid urchin was also observed.

	Other taxa included large patches of dead barnacles seen along the edges of large boulders and rocks, the stone crab (*Paralomis* sp), squat lobsters, swimming shrimp in the genus *Acanthophyra*, and small lyrate-shaped invertebrates that may or may not have been cladorhizid demosponges. Relatively few fish were observed, including only a cutthroat eel (*Synaphobranchus brevidorsalis*) and two grenadiers (family Macrouridae). Finally, a finned octopod in either the genus *Cirrothauma* or *Grimpoteuthis* sp was caught on Seirios video toward the end of the dive.
Overall Map of the ROV Dive Area	**Close-up Map of Main Dive Site**
	
Representative Photos of the Dive	
	
Corals and sponges observed near the landing site.	Coral and sponge community toward the end of the dive suggesting the dive suggesting that the densities persist for some distance along this area of the ridge.

Samples Collected		
Sample		
Sample ID	D2_DIVE_SPEC01GEO	
Date (UTC)	20170724	
Time (UTC)	212036	
Depth (m)	2065	
Temperature (°C)	2.13	
Field ID(s)	Mn crusted Rock	
Comments	Four specimen lyrate associates removed from the underside (Demosponge lyrate?)	
Sample		
Sample ID	D2_DIVE_SPEC02BIO	
Date (UTC)	20170724	
Time (UTC)	213533	
Depth (m)	2065	
Temperature (°C)		
Field ID(s)	Farreidae	
Comments	Colony had commensal antipatharian	
Sample		
Sample ID	D2_DIVE_SPEC03GEO	
Date (UTC)	20170724	
Time (UTC)	221443	
Depth (m)	2065	
Temperature (°C)	2.14	
Field ID(s)	Mn Crusted Rock	
Comments	One small associate was recovered (demosponge?)	

Sample		
Sample ID	D2_DIVE_SPEC04BIO	
Date (UTC)	20170724	
Time (UTC)	003701	
Depth (m)	1994	
Temperature (°C)	2.03	
Field ID(s)	Narella unbranched	
Comments		
Sample		
Sample ID	D2_DIVE_SPEC04BIO_A01	
Date (UTC)	20170724	
Time (UTC)	003701	
Depth (m)	1994	
Temperature (°C)	2.03	
Field ID(s)	Goniasteridae	
Comments	Found on the Narella	

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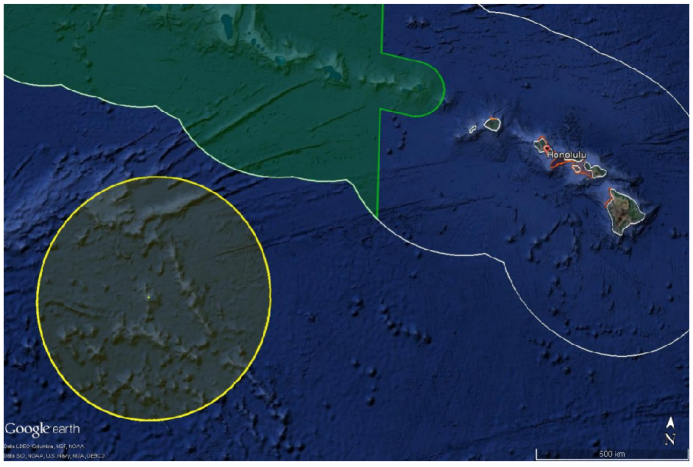
Ocean Exploration and Research

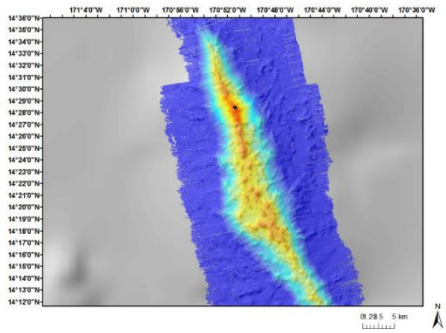
Okeanos Explorer ROV Dive Summary

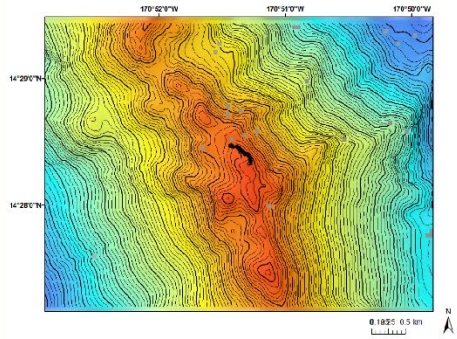
Dive Information			
Dive Map			
Site Name	"Ridge" Seamount		
ROV Lead(s)	Dan Rogers		
Expedition Coordinator(s) / Mapping Lead	Kelley Elliott / Mashkoor Malik		
Science Team Lead(s)	Chris Kelley & Chris Mah		
General Area Descriptor	Johnston Atoll Unit of PRIMNM		
ROV Dive Name			
Cruise	EX1706		
Leg			
Dive Number	11		
Equipment Deployed			
ROV	Deep Discoverer (D2)		
Camera Platform	Seirios		
ROV Measurements	CTD	Depth	Altitude
	Scanning Sonar	USBL Position	Heading
	Pitch	Roll	HD Camera 1
	HD Camera 2	Low Res Cam 1	Low Res Cam 2

	Low Res Cam 3	Low Res Cam 4	Low Res Cam 5
	LSS	ORP	
Equipment Malfunctions	None		
ROV Dive Summary (from processed ROV data)	Dive Summary: EX1706_DIVE11 ^^^

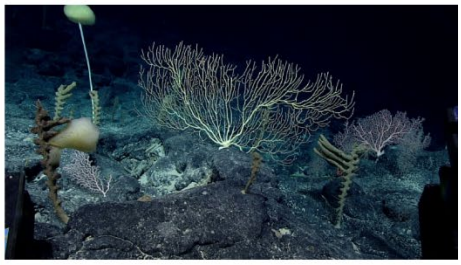
Purpose of the Dive	This dive was designed to be one of four placeholder sites for exploring seamounts in the southern part of the monument where no previous mapping or ROV surveys have been conducted. This area has a complex distribution of seamounts some of which may be guyots and others conical in shape based on satellite altimetry data. Rocks collected at these sites may help clarify the geologic history of this region of the monument. This seamount was mapped two nights ago and found to have a ridge shape running northwest to southeast. A pre-dive briefing was held at the end of dive 10 and the decision was made to dive just below its summit then coming on the crest and running along it in the hopes of finding a community of corals and sponges.
Description of the Dive	The Deep Discoverer was deployed at 8:30 AM and arrived at bottom at 9:55 AM. The bottom was characterized by large boulders, cemented basalt and rocks with a heavy manganese crust. A light dusting of sediment was observed. Today's dive was largely composed of a sustained community of porifera as well as other filter-feeding colonial octocorals and associated invertebrates. No fish were seen today. The dive began with a mixed assemblage of corals and sponges following arrival of the D2 at the sea bottom. This mixture of sponges and corals continued consistently as they began the upward slope until they reached a ridge where current changed and the sessile fauna changed to one composed almost exclusively of medium to large sized glass sponges. Diversity in that zone was also perceived as increasing. A subsequent region remained abundance-rich but faunal composition changed between these zones from glass sponges to octocorals. Porifera Glass sponges were observed as the dominant invertebrate taxon present on today's dive. Starting early in the dive they were present in relatively moderate abundance and diversity especially in balance to sessile octocorals but upon reaching the summit, glass sponge abundance and diversity increased dramatically becoming the overwhelmingly dominant taxon in the area with only minimal representation by corals and other metazoans. Dead glass sponge skeletons were also observed, in some cases with high abundance. During the initial period of the cruise, commonly encountered glass sponges included members of the Farreidae, the genus *Bolosoma*, and a high abundance of the genus *Poliopogon* growing on dead sponge bodies of the genus *Aspidoscopulia* at unusual angles relative to the axis of the latter. The *Poliopogon/Aspidoscopulia* were abundant and frequently encountered all throughout the cruise. Upon reaching the ridge the abundance and diversity of glass sponges increased dramatically, forming a strikingly dominated hexactinellid community. Some genera, such as *Poliopogon* and *Aspidoscopulia* attained unusually large sizes, with individuals reaching up to 5 feet tall and 2 to 5 feet wide. Multiple glass sponges in addition to *Poliopogon* and *Aspidoscopulia* were observed, including taxa belonging to the Farreidae, the Euplectellidae, a new genus in the Bolosominae, and further members of the Pheronematidae were present. Many of the observed sponges had their concave sides directed towards the current. A new sponge species in the genus *Poliopogon* was observed and collected. Cnidaria Colonial octocorals were the second most abundant group of organisms

	observed during the dive today and were among the most notable, This included members of the Chrysogorgiidae (esp. in Chrysogorgia, Pleurogorgia), the Primnoidae (esp. *Narella* and *Calyptophora*), Corallidae (genus *Hemicorallium*) and the Isididae. Approximately five or six species of bamboo corals (Isididae) were observed today including species from *Eknomisis*, the Keratoisidinae as well as new members from the B1 clade. Notable among the observations that members of the Isididae have been among the tallest known isidid "whip" forms recorded during this expedition with two individuals reaching over 4.0 and 4.7 meters respectively. A minority of hexacorallian cnidarians were observed today including the black coral Parantipathes, a "stoloniferous" zoanthid, and at least two species of sea anemones including several small individuals repeatedly covering a primnoid coral and several belonging to the Actinoscyphidae. Other notable cnidarians included numerous small epizoic hydroids, small benthic ctenophore present on a glass sponge, a 4 armed narco medusae and a small jellyfish, similar to the genus Halicreas, discovered adhering to the underside of a rock and a small benthic comb jelly with elongate tentacles extended. Echinodermata Relatively few observations of echinoderms were made during this dive. Among the most noteworthy was a single observation of a stalked crinoids in the genus *Bathycrinus*, which displayed epizoic hydroids present on the stalk. Numerous other feather stars (comatulid crinoids) were observed perched on rocks, corals and sponges. We observed one feather star with eulimid snails, which had parasitized the arms of one observed comatulid. Two individuals of the solasterid sea star, *Lophaster* were observed as well as one filter-feeding brisingid. The only sea urchin observed today was an echinothuriid in the genus *Tromikosoma*. Numerous ophiuroid commensals on corals were observed, some belonging to the family Asteroschematidae displayed closer obligate relationships with their hosts (e.g. on *Hemicorallium*), whereas some ophiacanthids (*Ophioplinthaca*?) were present on numerous octocorals, such as those in the Chrysogorgiidae. One exceptional ophiuroid, *Astrophiura* sp., which shows small arms and a well developed flush disk was observed. At least two species of deposit feeding sea cucumbers were observed, one completely transparent species in the family Elpidiidae and another purple, translucent species in the Synallactidae, possibly Hansenothuria. Miscellaneous taxa Other organisms observed today include several shrimps (genus *Nematocarcinus*) as well as seveal squat lobsters in the family Munidae which were present as associates on sponges and Chrysogorgiidael Varous small swimming polychaetes and other worms of unknown affinity were seen on coral surfaces as commensals. Also observed in some abundance were many more small lyrate shaped organisms which were not identified.
Overall Map of the ROV Dive Area	**Close-up Map of Main Dive Site**





Representative Photos of the Dive



The moderate community of corals and sponges encountered shortly after arriving on bottom

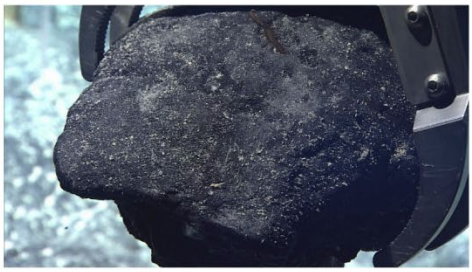
The amazing sponge-dominated community encountered on the ridge crest just below the summit.

Samples Collected

Sample

Sample ID	D2_DIVE_SPEC01GEO
Date (UTC)	20170725
Time (UTC)	202518
Depth (m)	2439
Temperature (°C)	1.8
Field ID(s)	Mn crusted rock
Comments	

Sample		
Sample ID	D2_DIVE_SPEC02BIO	
Date (UTC)	20170725	
Time (UTC)	210909	
Depth (m)	2405	
Temperature (°C)	1.8	
Field ID(s)	Unidentified octocoral (*Paragorgia* sp or Anthothelidae)	
Comments		

Sample		
Sample ID	D2_DIVE_SPEC03GEO	
Date (UTC)	20170725	
Time (UTC)	220315	
Depth (m)	2403	
Temperature (°C)	1.8	
Field ID(s)	Mn crusted rock	
Comments		

Sample		
Sample ID	D2_DIVE_SPEC04BIO	
Date (UTC)	20170725	
Time (UTC)	233450	
Depth (m)	2375	
Temperature (°C)	1.8	
Field ID(s)	*Poliopogon* sp yellow	
Comments		

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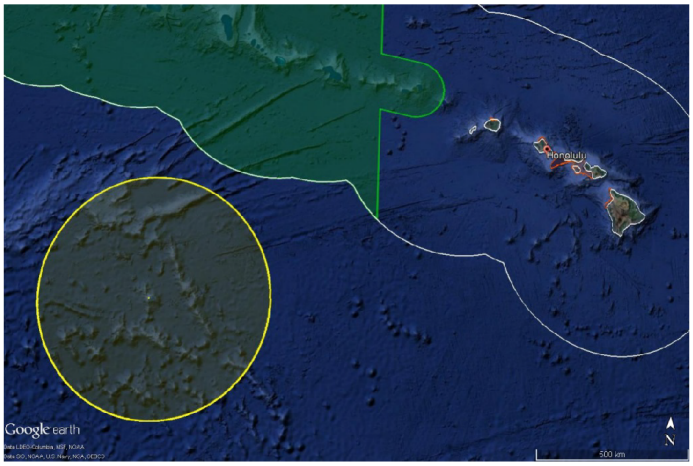
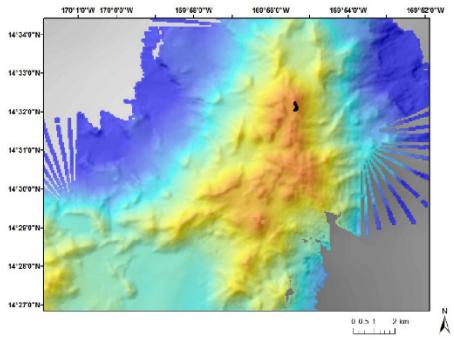
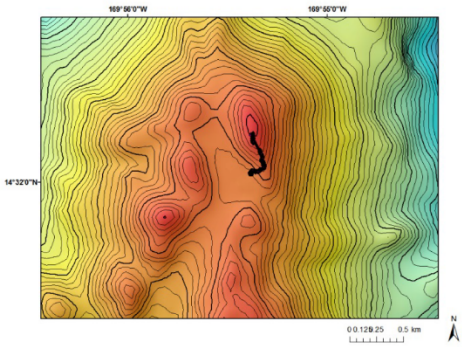
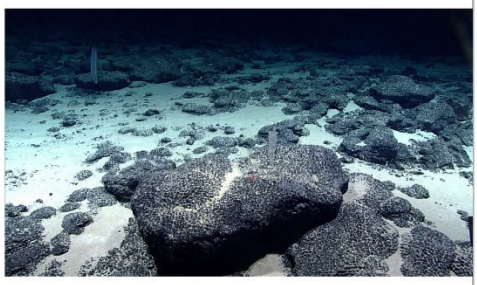
Okeanos Explorer ROV Dive Summary

Dive Information			
Dive Map			
Site Name	New Seamount 5		
ROV Lead(s)	Dan Rogers		
Expedition Coordinator(s) / Mapping Lead	Kelley Elliott / Mashkoor Malik		
Science Team Lead(s)	Chris Kelley & Chris Mah		
General Area Descriptor	Johnston Atoll Unit of PRIMNM		
ROV Dive Name			
Cruise	EX1706		
Leg			
Dive Number	12		
Equipment Deployed			
ROV	Deep Discoverer (D2)		
Camera Platform	Seirios		
ROV Measurements	CTD	Depth	Altitude
	Scanning Sonar	USBL Position	Heading
	Pitch	Roll	HD Camera 1
	HD Camera 2	Low Res Cam 1	Low Res Cam 2

	Low Res Cam 3	Low Res Cam 4	Low Res Cam 5
	LSS	ORP	
Equipment Malfunctions	None		
ROV Dive Summary (from processed ROV data)	In Water: 2017-07-25T18:31:06.424000 14º°, 28.568' N ; 170º°, 51.551' W Out Water: 2017-07-26T01:59:38.680000 14º°, 28.341' N ; 170º°, 51.028' W Off Bottom: 2017-07-26T00:41:30.165000 14º°, 28.330' N ; 170º°, 51.298' W On Bottom: 2017-07-25T19:58:07.475000 14º°, 28.462' N ; 170º°, 51.435' W Dive duration: 7:28:32 Bottom Time: 4:43:22 Max. depth: 2441.1 m		
Special Notes			
Scientists Involved (please provide name, location, affiliation, email)	Amanda Netburn, FAU CIOERT/OER, amanda.netburn@noaa.gov Asako Matsumoto, PERC/CIT, Japan, amatsu@gorgonian.jp Bruce Mundy, NOAA NMFS PIFSC, Bruce.Mundy@noaa.gov Chris Kelley, UH, ckelley@hawaii.edu Chris Mah, SI NMNH, brisinga@gmail.com John Smith, University of Hawaii/SOEST, jrsmith@hawaii.edu Kevin Kocot, The University of Alabama , kmkocot@ua.edu Les Watling, University of Hawaii at Manoa, watling@hawaii.edu Scott France, University of Louisiana at Lafayette, france@louisiana.edu Timothy Shank, Woods Hole Oceanographic Institution, tshank@whoi.edu Tina Molodtsova, P.P. Shirshov Institute of Oceanology RAS, tina.molodtsova@gmail.com Jaymes Awbrey, University of Louisiana, Lafayette, jawbrey@louisiana.edu Megan McCuller, Southern Maine Community College, mccullermi@gmail.com		
Purpose of the Dive	This site was one of several placeholder sites for exploring seamounts in the southern part of the monument where no previous mapping or ROV surveys have been conducted. This area has a complex distribution of seamounts some of which may be guyots and others conical in shape based on satellite altimetry data. Rocks collected at these sites may help clarify the geologic history of this region of the		

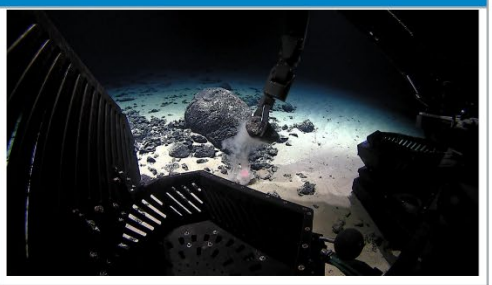
	monument. This site had to be mapped prior to conducting the ROV dive. The selected dive site was on the summit of a pinnacle formation on the shallowest part of the seamount.
Description of the Dive	The Deep Discoverer (D2) was deployed at approximately 8:20 AM reaching the bottom depth of 2325 m at approximately 10AM. Dive plan for the D2 dictated transit upslope to 2191 m. Transit began from a saddle on the seamount with upward movement up the ridge and upslope along the crest. **Summary and bottom characterization** Following arrival at the bottom, transit up the saddle was composed primarily of a sandy bottom with a strong water current moving from north to south, leaving evenly spaced, distinct current ripples in the sediment. Sediment was interrupted with widely spaced array of rocks and talus spread out the sandy field. The sediment covered region terminated at the base of a massive boulder cliff as the D2 transited upslope. Subsequent benthos were composed primarily of hard bottoms including a mixture large basalt rocks and boulders, sediment, and cemented hardpan. The crest was heterogeneous containing several platforms and valleys. Occurrence of organismal was sparse with minimal cover by sessile octocorals and sponges in vivid contrast to yesterday's highly abundant and dense communities. Following departure from the saddle, the fauna shifted to more rocky bottom forms such as colonial corals and stalked glass sponges. Structures perceived to be foraminifera, within the class Xenophyophorea were abundant throughout the entire dive. This included a small, white arborescent forms, larger fan-shaped structures, tiny round capsule-like forms and short, uneven branching forms. Porifera were largely absent on the sediment-covered sandy region but began appearing with greater abundance on the rocky substrates following the D2's trek through the ridge and crest areas. Most glass sponges observed were solitary with few occurring in groups. Glass sponges were most frequently encountered. This included *Bolosoma*, the euplectellid *Regadrella*, *Caulophacus, Farrea*, *Poliopogon, Walteria* and *Hyalonema*. Sponges in the Cladorhizidae were observed on at least two occasions. Cnidarians of many different types were observed throughout the dive as different species were associated with the changing regions along the transit area. The sediment covered saddle region for example featured two observations of "rock pens", pennatulaceans tentatively identified as *Anthoptilium* sp. Octocorals and black corals were absent from the saddle regioon. More typical cnidarian fauna for this region began to appear as the benthic landscape changed from rippled sediments to basalt hard bottoms. Cnidarians observed in this region were dominated by a diversity of octocorals, including genera within the chrysogorgiidae (*Chrysogorgia* and *Iridigorgia*), bamboo corals (Isididae), precious corals (Corallidae), and mushroom corals (*Anthomastus*). Also present were sea anemones and black corals. (Antipatharia). Antipatharia observed included *Alternapathes, Bathypathes, Heteropathes, Parantipathes*, and *Stauropathes*. A large dark purple cerianthid sea anemone apparently lacking a tube and residing on a rock face was observed and collected. Also observed was a single benthic ctenophore which was present on the surface of a glass sponge. Echinoderms were few. The most abundant forms observed were either

	feather stars (Crinoidea) or sea cucumbers (Holothuroidea). Most sea cuccumbers observed were tentatively identiifed as *Hansenothuria* or some representative of the Synallactidae. One or two aberrant species include a species using sand as camouflage (*Mesothuria*? sp) and a transparent sea pig (Elpidiidae) were also observed. Both types of ophiuroids, "snake stars" present in the arms of a host octocoral were observed on *Hemicorallium* and "normal ' brittle stars in the family Ophiacanthidae were present wrapped around dead glass sponge stalks for a sustained distance along the transect. One stalked crinoid in the *Bathycrinus* was observed as was one specimen of *Callliaster*, a species known primarily as corallivorous. Among the most unusual of species collected during today's dive was a large (10.0 cm length) brown pleuorbranchaeid "side gill slug." Opisthobranchs are seldom observed from abyssal depth, making this a very unusual occurrence record. It was collected. Worms were represented by several swimming polychaetes, possibly in the genus Swima and several observations of chaetognaths. Arthropods observed included a large member of the Pycnogonida, probably *Colossendeis* feeding on an individual of the octocoral *Iridigorgia*. Observed crustaceans included swimming shrimps in the genus *Acanthophyra* and the commonly encountered *Nematocarcinus*. Fishes were represented by few observations, including several observations of grenadiers (Macouridae) and one observation of a halosaur.
Overall Map of the ROV Dive Area	**Close-up Map of Main Dive Site**
	
Representative Photos of the Dive	

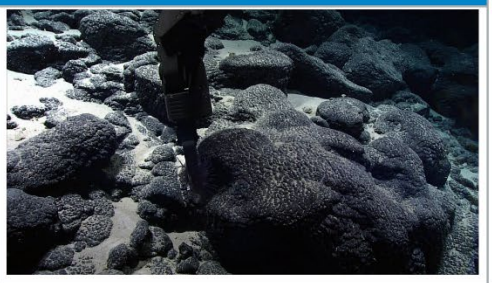
	
Region with the basalt hard bottom showing two species of glass sponges.	**The glass sponge Bolosominae new genus.**

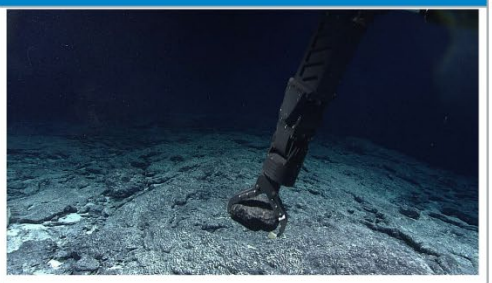
Samples Collected

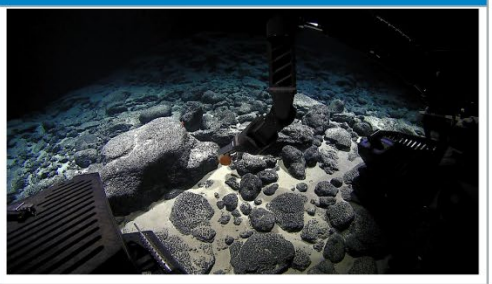
Sample

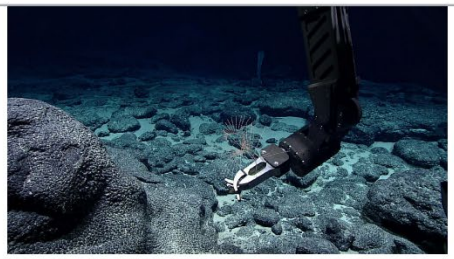
Sample ID	D2_DIVE_SPEC01	
Date (UTC)	20170726	
Time (UTC)	203303	
Depth (m)	2321.9299	
Temperature (°C)		
Field ID(s)	Mn encrusted rock	
Comments		

Sample

Sample ID	D2_DIVE_SPEC02	
Date (UTC)	20170726	
Time (UTC)	211803	
Depth (m)	2307.3401	
Temperature (°C)		
Field ID(s)	Ceriantharia?	
Comments	subsample ID SPEC02BIO_SO1	

Sample		
Sample ID	D2_DIVE_SPEC03	
Date (UTC)	201707	
Time (UTC)	224536	
Depth (m)	2256.51	
Temperature (°C)		
Field ID(s)	Mn encrusted rock	
Comments		

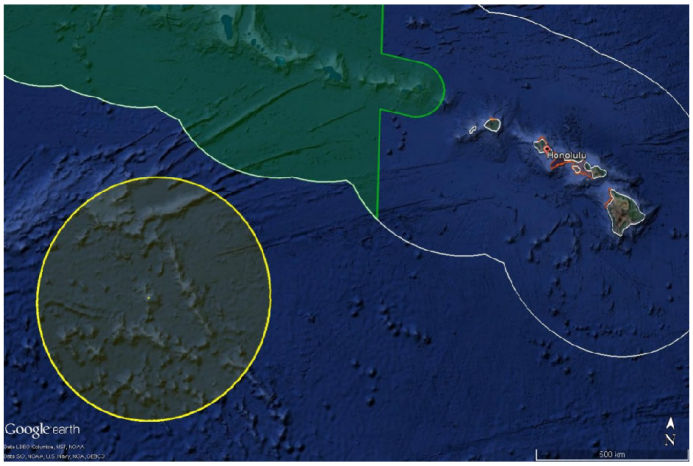
Sample		
Sample ID	D2_DIVE_SPEC04	
Date (UTC)	20170727	
Time (UTC)	1348	
Depth (m)	2207.52	
Temperature (°C)		
Field ID(s)	Pleurobranch	
Comments		

Sample		
Sample ID	D2_DIVE_SPEC05	
Date (UTC)	20170727	
Time (UTC)	11737	
Depth (m)	2180.52	
Temperature (°C)		
Field ID(s)	Pycnogonida on Iridigorgia sp.	
Comments		

Please direct inquiries to:

NOAA Office of Ocean Exploration & Research
1315 East-West Highway (SSMC3 10th Floor)
Silver Spring, MD 20910
(301) 734-1014

Okeanos Explorer ROV Dive Summary

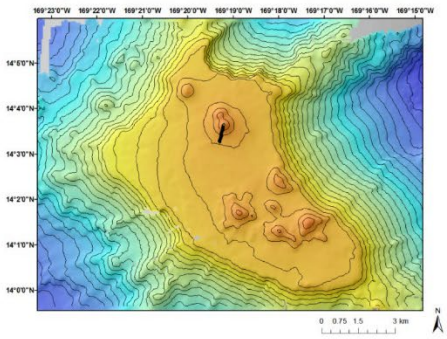
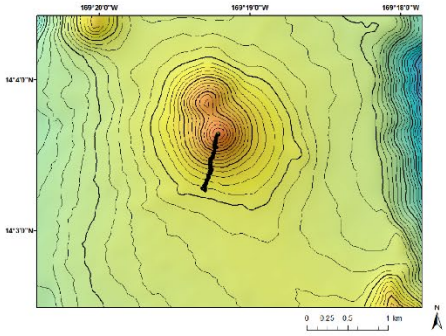
Dive Information			
Dive Map			
Site Name	New Seamount Summit Cone		
ROV Lead(s)	Dan Rogers		
Expedition Coordinator(s) / Mapping Lead	Kelley Elliott / Mashkoor Malik		
Science Team Lead(s)	Chris Kelley & Chris Mah		
General Area Descriptor	Johnston Atoll Unit of PRIMNM		
ROV Dive Name			
Cruise	EX1706		
Leg			
Dive Number	13		
Equipment Deployed			
ROV	Deep Discoverer (D2)		
Camera Platform	Seirios		
ROV Measurements	CTD	Depth	Altitude
	Scanning Sonar	USBL Position	Heading
	Pitch	Roll	HD Camera 1
	HD Camera 2	Low Res Cam 1	Low Res Cam 2

	Low Res Cam 3	Low Res Cam 4	Low Res Cam 5
	LSS	ORP	
Equipment Malfunctions	None		
ROV Dive Summary (from processed ROV data)	Dive Summary: EX1706_DIVE13 ^^ In Water: 2017-07-27T19:00:00.004000 N/A ; N/A Out Water: 2017-07-28T02:30:22.567000 N/A ; N/A Off Bottom: 2017-07-28T01:46:09.176000 14°, 03.648' N ; 169°, 19.212' W On Bottom: 2017-07-27T19:25:55.664000 14°, 03.582' N ; 169°, 18.523' W Dive duration: 7:30:22 Bottom Time: 6:20:13 Max. depth: 1597.9 m		
Special Notes			
Scientists Involved (please provide name, location, affiliation, email)	Abby Lapointe, University of Hawaii, abbylap@hawaii.edu Amanda Netburn, FAU CIOERT/OER, amanda.netburn@noaa.gov Amy Baco Taylor, Florida State University, abacotaylor@fsu.edu Asako Matsumoto, Planetary Exploration Research Center, Chiba Institute of Technology, Japan, amatsu@gorgonian.jp Chris Kelley, UH, ckelley@hawaii.edu Chris Mah, SI NMNH, brisinga@gmail.com Dhugal Lindsay, JAMSTEC, dhugal@jamstec.go.jp Donald Kobayashi, NOAA NMFS PIFSC, donald.kobayashi@noaa.gov Heather Judkins, University of South Florida St. Petersburg, Judkins@mail.usf.edu John Smith, University of Hawaii/SOEST, jrsmith@hawaii.edu Ken Sulak, U.S. Geological Survey, ksulak@usgs.gov Kevin Kocot, The University of Alabama , kmkocot@ua.edu Les Watling, University of Hawaii at Manoa, watling@hawaii.edu Michael Vecchione, NMFS, vecchiom@si.edu Mike Ford, NOAA Fisheries, michael.ford@noaa.gov Nikola Rodriguez, NOAA EPP, nikola.rodriguez@noaa.gov Nolan Barrett, FAU Harbor Branch Oceanographic Institute, barrettnh@g.cofc.edu Scott France, University of Louisiana at Lafayette, france@louisiana.edu Steven Auscavitch, Temple University, steven.auscavitch@temple.edu Tara Harmer-Luke, Stockton University, luket@stockton.edu		

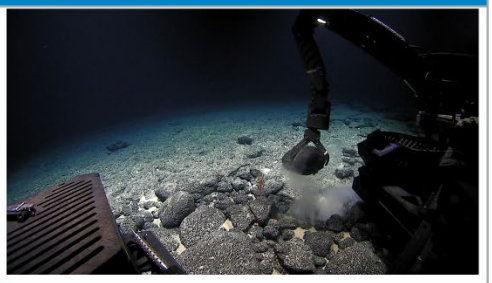
	Timothy Shank, Woods Hole Oceanographic Institution, tshank@whoi.edu Tina Molodtsova, P.P. Shirshov Institute of Oceanology RAS, tina.molodtsova@gmail.com
Purpose of the Dive	This dive was designed to be one of 4 placeholder sites for exploring seamounts in the southern part of the monument where no previous mapping or ROV surveys have been conducted. This area has a complex distribution of seamounts some of which may be guyots and others conical in shape based on satellite altimetry data. Rocks collected at these sites may help clarify the geologic history of this region of the monument. This seamount was mapped last night and found to be a guyot having volcanic cones on the top of its flat summit. The largest and most shallow cone was selected as the dive site. The dive track had the ROV first landing on the flat summit next to the cone then moving onto its southern flank and proceeding up until it reached its top. The objective was to determine whether a significant community of corals and sponges existed on the cone and if so, where it was located.

Description of the Dive	The ROV arrived on bottom at approximately 9:30 AM at a depth of 1598 m. The guyot summit next to the cone was composed primarily of large, broken pieces of Mn crusted rock and unconsolidated rubble, most of which appeared to be cemented together and was dusted with a light to moderate sediment overlay. This transitioned to more consolidated Mn crusted pillow flows once the ROV began ascending the flank of the cone. The slope increased steadily up the flank, reaching 45 degrees just below the peak. The most rugose topography was found on the peak that had what appeared to be Mn crusted vents, shallow crevices, and blocks. The community on the flats next to the cone as well as most of the way up the flank showed low diversity and abundance. However, the abundance of animals increased significantly just below the peak, which was found to have a relatively high density of corals, sponges, other invertebrates, as well as a couple of fishes. Colonial octocorals were the dominant taxon present during today's dive. Initially these colonies were sparse and present in low abundance. This included colonies of *Iridigorgia, Metallogorgia,* and several colonies of *Victorgorgia.* Bamboo coral (Isidide) colonies were present in abundance with several colonies attaining very large sizes. A small but steady number of antipatharians (*Bathypathes* and *Trissopathes*) as well as flytrap and other anemones were also observed. There were also several observations of the soft coral *Anthomastus*. Several pennatulaceans, including the deep-sea sea pen Umbellula and the rock pen *Anthoptilum* were also observed. The latter rock pen species was collected. As the D2 approached the peak and the adjoining area, the number of sea fans in the family Plexauridae dramatically increased. This area was dominated by a yellow plxeaurid sea fan colonies forming a high-density community of this species present on cliff faces, large boulders, etc. Other notable cnidarians include several sightings of the hydrozoan jellyfish *Aegin*a, a small medusae which feeds on the polyps of bamboo corals. Other observations included anemones of different species sitting on rocks and colonial octocorals. Foraminifera The area around the D2 landing spot in and around the rubble contained several different varieties of sediment tests associated with xenophyophoreans present on sediment ponds. This included a triple spherical mound-like form and frond to leaf like structures. Porifera While not dominant, sponges-especially glass sponges were a significant group during today's dive. Initially sponges, glass sponges such as Acanthascus and Atlantisella were not observed very regularly. Following D2's trek though the Mn zone there were increased observations of more "typical" hard-bottom glass-sponge fauna including genera such as *Bolosoma, Poliopogon* and *Dictyalus.* Near the peak and within the peak we also observed many colonies of a new species of Teretodictyidae with commensal zoanthid cnidarians. Echinodermata By far the most abundant and frequently encountered echinoderm today was the brilliant red stalked crinoid *Proisocrinus ruberrimus* which was the first species observed by the D2 upon landing and seen throughout the dive. Various species of miscellaneous feather stars (comatulids) were also noted, including a

	large *Thaumatocrinus*. Ophiuroids were represented by at least three species of Ophiacanthidae, including at least one species of *Ophioplinthaca*. Several snake stars (Euryalida) were observed as commensals on several observed corals. Sea stars were represented primarily by the Goniasteridae, including *Calliaster*, *Bathyceramus*, and *Plinthaster*. Two examples of the *Benthopectinidae* were observed as well as a single example of the rarely seen *Pythonaster* sp. Perhaps most striking during today's dive were the sea urchins. Two aspidodiadematid sea urchins were observed in the former half of the dive. None were seen until the D2 surveyed the peak of the cone. One very large urchin with elongate spines (10-15 cm diameter), close to the genus *Caenopedina* was observed in addition to three extremely large echinothuriid urchins with diameter ranging from 15-20 cm and height ranging from 10-15 cm tall. (comparable to pumpkins in size!) Crustacea Notable among the crustaceans observed today was a lobster in the family Polychelidae, *Homeryon* sp. which demonstrated a pronounced escape response upon being faced by the D2. Other crustaceans included various shrimps, such as *Nematocarcinus*, stalked barnacles, and several chirostylid squat lobsters. Mollusca At least two species of snails were observed during the dive today. One species with a whelk-like shell bearing at least two zoanthid cnidarians.There were at least two other morphospecies, including one present as a commensal on a glass sponge and another crawling on basalt rock surface. Chordata Fish were among the first animals observed during the dive today. At least six observations of halosaurs were made today (genus *Aldrovandia*), in addition to two observations of cutthroat eels (genus *Synaphobranchus*), three genera of cusk eels (Ophidiidae), and approximately four genera of grenadiers (Macouridae).

Overall Map of the ROV Dive Area	Close-up Map of Main Dive Site
	

Representative Photos of the Dive	
Two colonial octocorals on boulder before cone ridge.	Coral rich community on cone ridge (Plexauridae and Antipatharians shown).

Samples Collected		
Sample		
Sample ID	D2_DIVE13_SPEC01GEO	
Date (UTC)	20170727	
Time (UTC)	210810	
Depth (m)	1569	
Temperature (°C)		
Field ID(s)	Mn Encrusted Rock	
Comments		

Sample		
Sample ID	D2_DIVE13_SPEC02BIO	
Date (UTC)	20170727	
Time (UTC)	224154	
Depth (m)	1515	
Temperature (°C)		
Field ID(s)	Anthoptilum sp?	
Comments		

Sample		
Sample ID	D2_DIVE_SPEC03GEO	
Date (UTC)	20170727	
Time (UTC)	230408	
Depth (m)	1501	
Temperature (°C)		
Field ID(s)	Mn crusted rock	
Comments		

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Silver Spring, MD 20910
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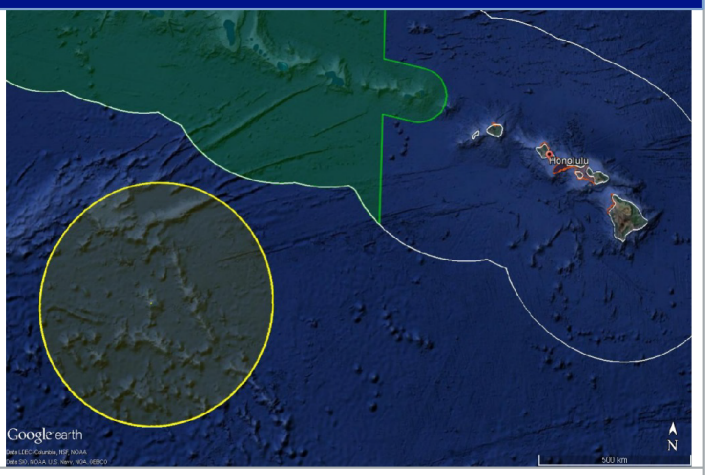
Ocean Exploration and Research

Okeanos Explorer ROV Dive Summary

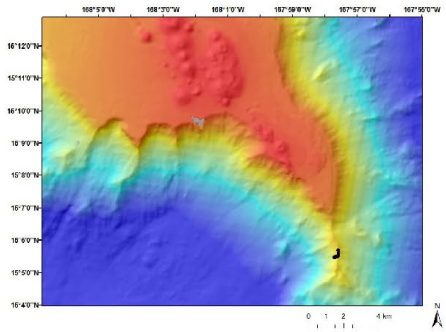
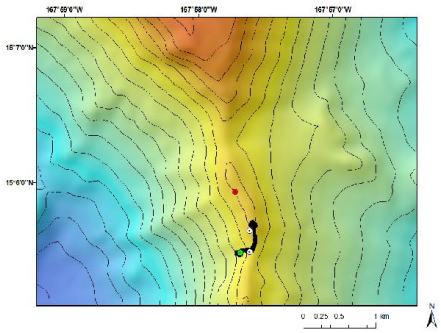
Dive Information			
Dive Map			
Site Name	South East Guyot Ridge – "Keli" Ridge		
ROV Lead(s)	Dan Rogers		
Expedition Coordinator(s) / Mapping Lead	Kelley Elliott / Mashkoor Malik		
Science Team Lead(s)	Chris Kelley & Chris Mah		
General Area Descriptor	Johnston Atoll Unit of PRIMNM		
ROV Dive Name			
Cruise	EX1706		
Leg			
Dive Number	14		
Equipment Deployed			
ROV	Deep Discoverer (D2)		
Camera Platform	Seirios		
ROV Measurements	☒ CTD	☒ Depth	☒ Altitude
	☒ Scanning Sonar	☒ USBL Position	☒ Heading

	☒ Pitch	☒ Roll	☒ HD Camera 1
	☒ HD Camera 2	☒ Low Res Cam 1	☒ Low Res Cam 2
	☒ Low Res Cam 3	☒ Low Res Cam 4	☒ Low Res Cam 5
	☒ LSS	☒ ORP	
Equipment Malfunctions	None		
ROV Dive Summary (from processed ROV data)	Dive Summary: EX1706_DIVE14 ^^^

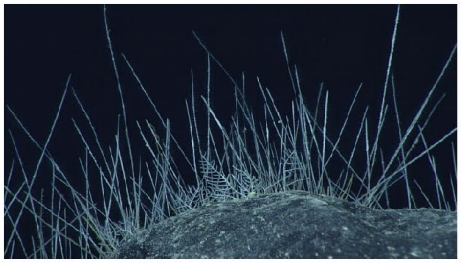
Purpose of the Dive	This is a presumed Mn-crusted rift zone ridge extending SE from a guyot located in JAU as well as the PCZ. These ridges are a CAPSTONE priority because previous surveys have found large scale, high density communities of deep water corals and sponges on this type of topography as well as the many other animals they support. Ridges act as barriers to bottom current flow and their crests are locations where currents accelerated, which is where the corals and sponges are most heavily aggregated. Ridges are also sites where basalt can be found and are therefore desirable locations for obtaining rocks for dating seamounts. Mid-Water: The water column is one of the most underexplored environments on the planet. Basic information is lacking on the distributions and abundances of midwater organisms in most parts of the globe, and the vicinity of Johnston Atoll remains a poorly explored region. ROV visual surveys provide crucial data on the distributions, abundances, and behaviors of a variety of midwater animals. ROV surveys are especially well-suited to observe the understudied gelatinous fauna, which commonly fall apart using traditional net sampling methods. Collecting acoustic backscatter data (Simrad EK60) throughout the cruise - including during ROV transects – will complement the ROV surveys by providing critical information on the depth and extent of deep scattering layers, diel vertical migrations, and ROV avoidance behavior.

Description of the Dive	Benthic Dive details The D2 was deployed at 8:30AM and reached bottom at approximately 10AM at a starting depth of 2470 m. The bottom was rocky composed of a solid, cemented surface, including boulders and rocks. As the D2 progressed up the slope, the bottom became increasingly steep with large blocks and boulders and craters. Porifera Porifera were the dominant taxon observed during today's dive. Several large and moderate to small sized glass sponges were observed during the former half of the transit. These include commonly encountered taxa such as Bolosoma and Caulophacus as well as smaller vase sponges such as Atlantisella. An unusual glass sponge similar to Walteria was observed and collected. The latter half of the dive is denoted by the sudden appearance of a huge abundance of narrow, needle-like carnivorous sponges (Cladorhizidae?). These covered numerous rocky surfaces in dense but evenly spaced aggregations along the survey line, especially on large boulders and cliffs where currents ran over the edges. Abundance varied across the distance surveyed with dense aggregations present near areas of high current flow with less abundant populations present on rock away from these areas. In one area near the end of the dive, we observed these cladorhizids as part of a widespread community with bryozoans and zoanthids. Cnidaria Among the most notable of cnidarians observed during the dive was a red/orange benthic siphonophore present in a concavity on the underside of a large basalt boulder. Numerous colonial octocorals and hexacorals were also observed. Among the octocorals observed frequently during today's dive were in the family Chrysogorgiidae (e.g., Chrysogorgia and Pleuorgorgia), Primnoidae (Narella and 3 undescribed genera), Isididae (including Jasonisis, Lepidisis and several unbranched forms and whips) and several precious corals (Hemicoralium). Hexacorals included two genera of black corals (Antipatharia), including Alternatipathes and Umbellapathes. A scleractinian cup coral (Polymyces), zoantids and sea anemones were also observed. Various tubulariid hydroids were also observed. Echinodermata Among the asteroids observed today were a new brown morph of the pterasterid Hymenaster, a large Lophaster sp. (10 cm diameter) which has previously been observed predating upon feather stars, a 16 armed brisingid, tentatively identified as Hymenodiscus, and a new genus/species of goniasterid which was observed feeding on a branch with Pleurogorgia and some sponges. A small white urchin which was tentatively classified as being an "irregular urchin" (i.e within the Irregularia) was observed. The purple crinoid Cytocrinus was observed in addition to several feather stars observed on perches throughout the dive. Several ophiacanthids were observed as commensals on corals and sponges. Crustacea: Crustaceans observed today included numerous dead barnacles present in unusual wave-shaped forms on the rock edges. Also frequently encountered were shrimps in the genus Nematocarcinus and multiple squat lobster commensals on different octocoral colonies. Bryozoa: Multiple colonies of a frond-like bryozoan were identified during the dive

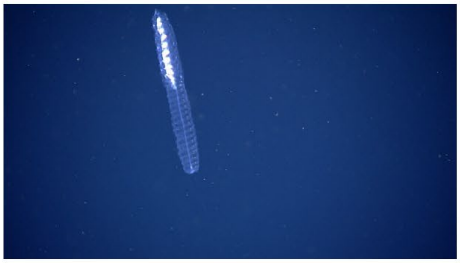
	today, varying from very small to very large (deep to shallow). Lophophores were definitely identified on the colonies from the cladorhizid sponge community. Chordata: The highlight of today's observed fishes was the observation of what seemed to be a likely new genus/species of snailfish (family Liparidae). Other fishes included several grenadiers in the genus Kumba, and at least two observations of cusk eels (Ophidiidae). The protocol for the mid-water transect followed that of the one previously performed, starting at 800m and ascending to 200m. This transect involved additional personnel visiting from Karen Osborn's lab at the NMNH Dept. of Invertebrate Zoology. Observations were dominated primarily by siphonophores. Larvaceans were also frequently observed. A diversity of pelagic were observed including comb jellies, medusozoans, alciopid worms (Polychaeta), shrimps, radiolarian colonies, and other protists. Chaetognaths (arrow worms) were also frequently observed. Several fish, including leptocephalus larvae (juvenile eels) and bristle mouths (Cyclothone) were observed. Surprisingly, few to any members of the genus Serrovomer were observed.

Overall Map of the ROV Dive Area	Close-up Map of Main Dive Site
	

Representative Photos of the Dive



Cladorhizid demosponge bed with apparent bryozoan colonies

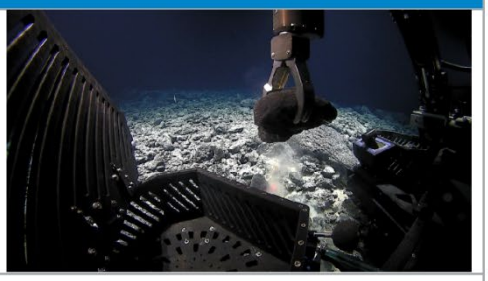


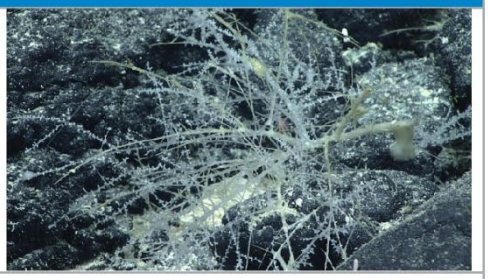
Siphonophore imaged during the midwater portion of the dive

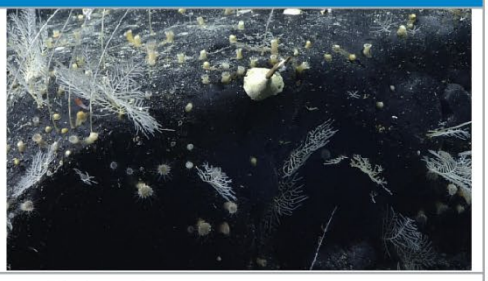
Samples Collected

Sample

Sample ID	D2_DIVE14_SPEC01GEO
Date (UTC)	20170728
Time (UTC)	202356
Depth (m)	2546
Temperature (°C)	
Field ID(s)	Mn crusted rock
Comments	

Sample		
Sample ID	D2_DIVE_SPEC02GEO	
Date (UTC)	20170728	
Time (UTC)	225754	
Depth (m)	2431	
Temperature (°C)		
Field ID(s)	Mn crusted rock	
Comments		

Sample		
Sample ID	D2_DIVE14_SPEC03BIO	
Date (UTC)	20170728	
Time (UTC)	230719	
Depth (m)	2430	
Temperature (°C)		
Field ID(s)	Hexactinellida?	
Comments		

Sample		
Sample ID	D2_DIVE14_SPEC04BIO	
Date (UTC)	201707	
Time (UTC)	010425	
Depth (m)	2367	
Temperature (°C)		
Field ID(s)	Bryozoan	
Comments	Also collected two cladorhizid sponges with the grab	

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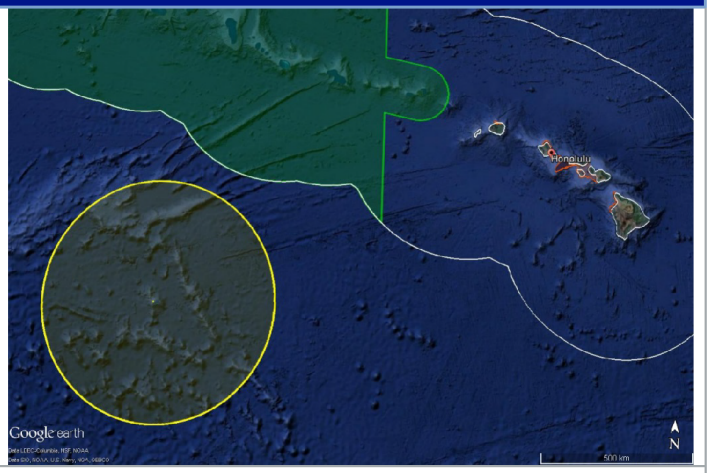
(301) 734-1014

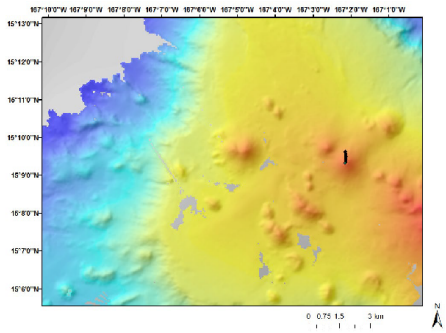
Okeanos Explorer ROV Dive Summary

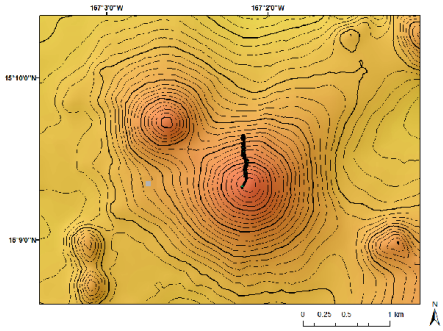
Dive Map	
Site Name	New Seamount 8 cone
ROV Lead(s)	Dan Rogers
Expedition Coordinator(s) / Mapping Lead	Kelley Elliott / Mashkoor Malik
Science Team Lead(s)	Chris Kelley & Chris Mah
General Area Descriptor	Johnston Atoll Unit of PRIMNM
ROV Dive Name	
Cruise	EX1706
Leg	
Dive Number	15
Equipment Deployed	
ROV	Deep Discoverer (D2)
Camera Platform	Seirios
ROV Measurements	☒ CTD ☒ Depth ☒ Altitude

	☒ Scanning Sonar	☒ USBL Position	☒ Heading
	☒ Pitch	☒ Roll	☒ HD Camera 1
	☒ HD Camera 2	☒ Low Res Cam 1	☒ Low Res Cam 2
	☒ Low Res Cam 3	☒ Low Res Cam 4	☒ Low Res Cam 5
	☒ LSS	☒ORP	
Equipment Malfunctions	None		
ROV Dive Summary (from processed ROV data)	Dive Summary: EX1706_DIVE15 ^^^

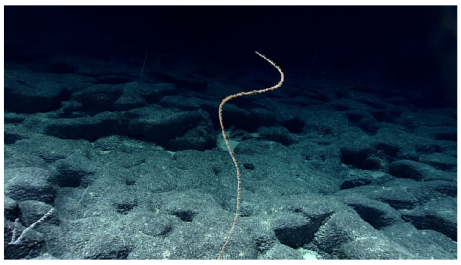
	so, where it was located.
Description of the Dive	The Deep Discoverer was deployed at 8:30 AM reaching bottom at 9:30AM with starting depth at 2006 m. The dive began along the northern side of the cone proceeding up to the top along a total length of 600m, concluding at approximately 1800m. Bottom Characterization: Video observations reveal a hard bottom composed of heavily consolidated manganese crust with small to moderate sediment pools present throughout. Coral and sponges moderate to heavily abundant ranging from widely spaced to more densely spaced closer to the top of the cone. Cnidaria Most abundant of the fauna observed during this dive were colonial octocorals, specifically bamboo corals (family Isididae) in various morphotypes (e.g., branching forms, whips, etc.) which composed over 60% of the cnidarian observations). Multiple Isidid genera were observed including Keratoisis, Lepidisis, and Isadella in addition to several unidentified bamboo coral genera and species. Other relevant octocorals included Chrysogorgiidae (Chrysogorgia, Iridigorgia, and Metallogorgia), Primnoidae (e.g, Candidella), Coraliidae (e.g. Hemicorallium), Anthohelidae (Victorgorgia) and Paragorgiidae. As with other Paragorgia colonies observed in this area, its skeleton was being overrun by a yellow zoanthid colony. Other alyconacean octocorals observed included the mushroom coral Anthomastus and the rockpen Anthoptilum. Many hydroids were also observed. Other cnidarians observed included at least 3 species of acintosolid sea anemones, a closed homathiid, and several black corals (antipatharians) including Umbellapathes, Bathypathes, and Stauropathes. One scleractinian cup coral was observed during the dive. Porifera Glass sponges were the next most abundant animals observed during the dive with several commonly encountered species observed during the dive. The most commonly encountered was in the genus Walteria sp. Many Walteria were observed with many commensals, including large isopods, shrimps, and ophiuroids present within the internal chamber. Other observed glass sponge genera included Bolosoma (medium to large sized), Caulophacus, Dictyaulus (small thistle sized), Poliopagon, Regardrella and Stelladoryx. Echinodermata Asteroids were the most prominent echinoderms observed during this dive. Upon reaching the top of the cone, a high abundance of what appeared to be Evoplosoma cf. forcipifera were observed consistently feeding on bamboo corals (clade D2 as per L. Watling). These smaller and less abundant farther away from the peak. Upon reaching the top of the cone, they became far more abundant and were significantly larger (up to 10 cm diameter). Also observed was a 7 armed member of the genus Asthenactis, a member of the rarely encountered Myxasteridae.

	Sea urchins were represented by large individuals of the echinothuriid Tromikosoma which were only encountered at the peak and which were relatively large. Sea cucumbers were relatively uncommon but included a synallactid which was tentatively idnetified as Hansenothuria, as well as species in the Deimatidae (Oneirophanta?) and a membere of the Elpidiidae. At least 2 species of feather stars were observed in addition to one unusual observation of a stalked crinoid which might have been a juvenile pentacrinid larvae of a feather star in the genus Psyathrometra which were present in abundance around the survey track. This individual also had eggs or some gonadal structures present on the proximal pinnules adjacent to the cup. Observations of feather stars present as commensals on corals, sponges, and rocks were made throughout the dive. Similarly brittle stars, particularly ophiacanthids, were ubiquitous as commensals on sponges and corals. Amphiurid brittle stars were observed with their arms splayed out on basalt boulders. Euryalid ophiuroids were observed on several octocoral colonies observed throughout the dive, including regular commensals of Metallogorgia and Victogorgia. Mollusca: Although many small snails were observed throughout the dive as commensals on sponges and corals, most notable was the observation of aplacophorans, tiny vermiform mollusks present on bamboo corals as predators of the tissue present on the surface. Crustacea: Numerous smaller crustaceans were observed during the dive. Most evident were multiple species of squat lobsters (eg. Unidopsis, Urptychus) present among octocoral colonies, such as Chrysogorgia. Several smaller caridean shrimps were also observed. Nematocarcinus was regularly observed during the dive. Moderatelly sized isopods, were observed living on the Walteria glass sponges as were multiple individuals of shrimps which permanently reside within the internal sponge chamber. A prominent isopod parasite was observed riding on the epideris of a relativley large grenadier (Coryphenoides). Worms: Several arrow worms (Chaetognatha) were observed during the dive as was a unique observation of a swimming ribbon worm (Nemertea). Chordata: Many fishes were observed during today's dive. This included approximatley six grenadiers (Macouridae) which were primarily identiifed as being in the genus Kumba. Approximately four cusk eels (Basogigas) were also observed as were cutthroat eels.
Overall Map of the ROV Dive Area	**Close-up Map of Main Dive Site**

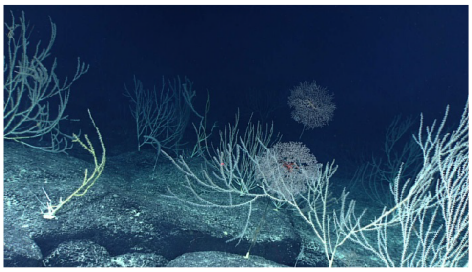




Representative Photos of the Dive



Moderate density of corals and sponges observed at the landing site.

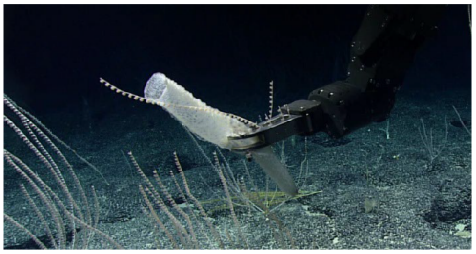


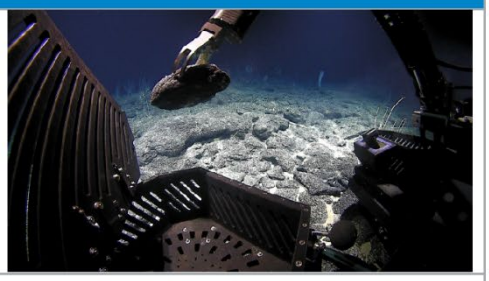
High density community dominated by bamboo corals found further upslope on the flank of the cone.

Samples Collected

Sample

Sample ID	D2_DIVE15_SPEC01BIO
Date (UTC)	20170729
Time (UTC)	224022
Depth (m)	1905
Temperature (°C)	
Field ID(s)	Dictyaulus sp with shrimp
Comments	Collected sponge to get the paired shrimp. Also found an isopod and 2 polychaete worms inside. Sponges had what appeared to be commensal cnidarians that were preserved in formalin.



Sample		
Sample ID	D2_DIVE15_SPEC02GEO	
Date (UTC)	20170730	
Time (UTC)	010128	
Depth (m)	1805	
Temperature (°C)		
Field ID(s)	Mn crusted rock	
Comments	Collected both rocks at same site. May only be Mn crust.	

Sample		
Sample ID	D2_DIVE15_SPEC03GEO	
Date (UTC)	20170730	
Time (UTC)	010648	
Depth (m)	1805	
Temperature (°C)		
Field ID(s)	Mn crusted rock	
Comments	Collected both rocks at same site. May only be Mn crust	

Sample		
Sample ID	D2_DIVE15_SPEC04BIO	
Date (UTC)	20170729	
Time (UTC)	224022	
Depth (m)	1905	
Temperature (°C)		
Field ID(s)	Bamboo coral	
Comments	Grabbed unintentionally with the sponge.	

Sample		
Sample ID	D2_DIVE15_SPEC05BIO	
Date (UTC)	20170729 or 30	
Time (UTC)	Unknown	
Depth (m)	Unknown	
Temperature (°C)	Unkown	
Field ID(s)	Bamboo coral	
Comments	Found in ROV frame after the dive	

Please direct inquiries to:

NOAA Office of Ocean Exploration & Research
1315 East-West Highway (SSMC3 10th Floor)
Silver Spring, MD 20910
(301) 734-1014

APPENDIX G: Sample Table

Sample ID#	Initial Identification	Date Collected	Dive Site	Latitude	Longitude	Depth (m)	Preservation Method	Archival Location
EX1706_20170714T005002_D2_DIVE02_SPEC01BIO	Euretidae	20170714	Horizon Guyot	19.54999924	-168.3800049	1904.449951	95% Ethanol.	SNMNH
EX1706_20170714T005002_D2_DIVE02_SPEC01BIO_A01	Mysidae	20170714	Horizon Guyot	19.54999924	-168.3800049	1904.449951	95% Ethanol	SNMNH
EX1706_20170714T214314_D2_DIVE03_SPEC01BIO	Chrysogorgia	20170714	Unnamed Seamount N. of Johnston Atoll	18.14999962	-169.7299957	2563.439941	95% Ethanol	SNMNH
EX1706_20170714T214314_D2_DIVE03_SPEC01BIO_A01	Uroptychus	20170714	Unnamed Guyot north of Johnston Atoll	18.14999962	-169.7299957	2563.439941	95% Ethanol	SNMNH
EX1706_20170714T214314_D2_DIVE03_SPEC01BIO_A02	Polychaeta	20170714	Unnamed Guyot north of Johnston Atoll	18.14999962	-169.7299957	2563.439941		SNMNH
EX1706_20170714T214314_D2_DIVE0	Gastropoda	20170714	Unnamed Guyot north	18.14999962	-169.7299957	2563.439941	95% Ethanol	SNMNH

3_SPEC01BIO_A03			of Johnston Atoll					
EX1706_20170714T214314_D2_DIVE03_SPEC01BIO_A04	Pleustidae	20170714	Unnamed Guyot north of Johnston Atoll	18.14999962	-169.7299957	2563.439941	95% Ethanol	SNMNH
EX1706_20170714T214314_D2_DIVE03_SPEC01BIO_A05	Amphipoda	20170714	Unnamed Guyot north of Johnston Atoll	18.14999962	-169.7299957	2563.439941	95% Ethanol	SNMNH
EX1706_20170714T231001_D2_DIVE03_SPEC04BIO	Echinodermata Holothuroidea	20170714	Unnamed Guyot north of Johnston Atoll	18.14999962	-169.7299957	2501.27002	95% Ethanol	SNMNH
EX1706_20170715T225039_D2_DIVE04_SPEC01BIO	*Hemicorallium* sp.	20170715	Johnston Atoll Site 1	16.72999954	-169.3600006	497.2399902	95% Ethanol	SNMNH
EX1706_20170715T225039_D2_DIVE04_SPEC01BIO_A01	Squat lobster	20170715	Johnston Atoll Site 1	16.72999954	-169.3600006	497.2399902	95% Ethanol	SNMNH
EX1706_20170715T225039_D2_DIVE0	?Hydroid	20170715	Johnston Atoll Site 1	16.72999954	-169.3600006	497.2399902	95% Ethanol	SNMNH

4_SPEC01BIO_A02								
EX1706_20170715T225039_D2_DIVE04_SPEC01BIO_A03	Porifera	20170715	Johnston Atoll Site 1	16.72999954	-169.3600006	497.2399902	95% Ethanol	SNMNH
EX1706_20170715T225039_D2_DIVE04_SPEC01BIO_A04	Polyps	20170715	Johnston Atoll Site 1	16.72999954	-169.3600006	497.2399902	95% Ethanol	SNMNH
EX1706_20170715T225039_D2_DIVE04_SPEC01BIO_A05	Polychaete	20170715	Johnston Atoll Site 1	16.72999954	-169.3600006	497.2399902	95% Ethanol	SNMNH
EX1706_20170715T231352_D2_DIVE04_SPEC02BIO	*Peltaster* sp.	20170715	Johnston Atoll Site 1	16.72999954	-169.3600006	491.9899902	95% Ethanol.	SNMNH
EX1706_20170716T003444_D2_DIVE04_SPEC03BIO	Keratoisidinae	20170716	Johnston Atoll Site 1	16.72999954	-169.3600006	430.4100037	95% Ethanol	SNMNH
EX1706_20170716T003444_D2_DIVE0	Shrimp	20170716	Johnston Atoll Site 1	16.72999954	-169.3600006	430.4100037		SNMNH

4_SPEC04BIO								
EX1706_20170717T205912_D2_DIVE05_SPEC01BIO	?*Lillipathes*	20170717	"Sally" Seamount	16.20000076	-169.5599976	2171.73999	95% Ethanol	SNMNH
EX1706_20170717T215932_D2_DIVE05_SPEC02BIO	Farreidae	20170717	"Sally" Seamount	16.20000076	-169.5599976	2164.050049	Top of sponge dried. Bottom stalk preserved in 95% Ethanol.	SNMNH
EX1706_20170717T215932_D2_DIVE05_SPEC02BIO_A01	?*Lebbeus* sp.	20170717	"Sally" Seamount	16.20000076	-169.5599976	2164.050049	95% Ethanol	SNMNH
EX1706_20170717T215932_D2_DIVE05_SPEC02BIO_A02	Amphipoda	20170717	"Sally" Seamount	16.20000076	-169.5599976	2164.050049	95% Ethanol	SNMNH
EX1706_20170718T012339_D2_DIVE05_SPEC05BIO	Isididae Sparse branch D clade	20170718	"Sally" Seamount	16.19000053	-169.5700073	2105.77002	95% Ethanol	SNMNH
EX1706_20170718T203320_D2_DIVE0	?Tubeworm	20170718	“Keli” Ridge	15.68000031	-169.4799957	1245.430054	95% Ethanol	SNMNH

6_SPEC01GEO_A01								
EX1706_20170718T212917_D2_DIVE06_SPEC02GEO_A01	Unknown Goo	20170718	"Keli" Ridge	15.68000031	-169.4799957	1220.310059	95% Ethanol	SNMNH
EX1706_20170718T223446_D2_DIVE06_SPEC03BIO	*Sclerothamnus* sp.	20170718	"Keli" Ridge	15.68999958	-169.4799957	1213.5	95% Ethanol	SNMNH
EX1706_20170718T223446_D2_DIVE06_SPEC03BIO_A01	*Tjalfiella* sp.	20170718	"Keli" Ridge	15.68999958	-169.4799957	1213.5	95% Ethanol	SNMNH
EX1706_20170718T223446_D2_DIVE06_SPEC03BIO_A02	Squat lobster	20170718	"Keli" Ridge	15.68999958	-169.4799957	1213.5	95% Ethanol	SNMNH
EX1706_20170722T000816_D2_DIVE07_SPEC03BIO	Coralliidae	20170722	"Edmonson" Seamount	15.68000031	-170.3699951	1165.349976		SNMNH
EX1706_20170722T000816_D2_DIVE0	Crinoidea	20170722	"Edmonson" Seamount	15.68000031	-170.3699951	1165.349976		SNMNH

7_SPEC03BIO_A01								
EX1706_20170722T000816_D2_DIVE07_SPEC03BIO_A02	Ophiuroidea	20170722	"Edmonson" Seamount	15.68000031	-170.3699951	1165.349976		SNMNH
EX1706_20170722T000816_D2_DIVE07_SPEC03BIO_A03	Scalpellidae	20170722	"Edmonson" Seamount	15.68000031	-170.3699951	1165.349976		SNMNH
EX1706_20170722T000816_D2_DIVE07_SPEC03BIO_A04	Polychaeta	20170722	"Edmonson" Seamount	15.68000031	-170.3699951	1165.349976		SNMNH
EX1706_20170722T001757_D2_DIVE07_SPEC04BIO	Goniasteridae	20170722	"Edmonson" Seamount	15.68000031	-170.3699951	1164.98999	95% Ethanol	SNMNH
EX1706_20170722T203742_D2_DIVE08_SPEC01BIO	?*Calliaster* sp.	20170722	"Pierpont" Seamount	15.47000027	-171.9900055	1603.25		SNMNH
EX1706_20170723T002039_D2_DIVE0	*Keratoisis*	20170723	"Pierpont" Seamount	15.47000027	-171.9900055	1523.27002	95% Ethanol	SNMNH

8_SPEC04BIO								
EX1706_20170723T005407_D2_DIVE08_SPEC05BIO	Plexauridae	20170723	"Pierpont" Seamount	15.47000027	-171.9900055	1508.969971	95% ethanol	SNMNH
EX1706_20170723T005407_D2_DIVE08_SPEC05BIO_A01	Asteroschematidae	20170723	"Pierpont" Seamount	15.47000027	-171.9900055	1508.969971	95% Ethanol	SNMNH
EX1706_20170723T203305_D2_DIVE09_SPEC02BIO	Solasteridae	20170723	"Wetmore" Seamount	15.17000008	-171.25	2568.530029	95% Ethanol	SNMNH
EX1706_20170723T211137_D2_DIVE09_SPEC03BIO	*Heteropathes* cf. *americana*	20170723	"Wetmore" Seamount	15.17000008	-171.25	2542.889893		
EX1706_20170723T211137_D2_DIVE09_SPEC03BIO	*Heteropathes* cf. *americana*	20170723	"Wetmore" Seamount	15.17000008	-171.25	2542.889893		
EX1706_20170723T211953_D2_DIVE0	?Hydroid	20170723	"Wetmore" Seamount	15.17000008	-171.25	2542.419922	95% Ethanol	SNMNH

9_SPEC04GEO_A01								
EX1706_20170723T211953_D2_DIVE09_SPEC04GEO_A02	?Tubeworms	20170723	"Wetmore" Seamount	15.17000008	-171.25	2542.419922	95% Ethanol	SNMNH
EX1706_20170723T211953_D2_DIVE09_SPEC04GEO_A03	?Sponge	20170723	"Wetmore" Seamount	15.17000008	-171.25	2542.419922	95% Ethanol	SNMNH
EX1706_20170724T212036_D2_DIVE10_SPEC01GEO_A01	Demospongiae Lyrate	20170724	"Wetmore" Seamount East	15.03999996	-170.8699951	2064.939941	95% Ethanol	SNMNH
EX1706_20170724T213533_D2_DIVE10_SPEC02BIO	Farreidae	20170724	"Wetmore" Seamount East	15.03999996	-170.8699951	2065.199951	95% Ethanol	SNMNH
EX1706_20170724T213533_D2_DIVE10_SPEC02BIO_A01	Antipatharian	20170724	"Wetmore" Seamount East	15.03999996	-170.8699951	2065.199951	95% Ethanol	SNMNH

EX1706_20170724T213533_D2_DIVE10_SPEC02BIO_A02	Polychaeta	20170724	"Wetmore" Seamount East	15.03999996	-170.8699951	2065.199951	95% Ethanol	SNMNH
EX1706_20170724T221443_D2_DIVE10_SPEC03GEO_A01	?Demospongiae	20170724	"Wetmore" Seamount East	15.03999996	-170.8699951	2065.439941	95% Ethanol	SNMNH
EX1706_20170725T003701_D2_DIVE10_SPEC04BIO	*Narella* sp. unbranched	20170725	"Wetmore" Seamount East	15.03999996	-170.8699951	1993.939941	95% Ethanol	SNMNH
EX1706_20170725T003701_D2_DIVE10_SPEC04BIO_A01	Goniasteridae	20170725	"Wetmore" Seamount East	15.03999996	-170.8699951	1993.939941	95% Ethanol	SNMNH
EX1706_20170725T210909_D2_DIVE11_SPEC02BIO	*?Paragorgia* sp.	20170725	"Ridge" Seamount	14.47000027	-170.8800049	2405.120117	95% Ethanol	SNMNH
EX1706_20170725T210909_D2_DIVE11_SPEC02BIO_A01	Crinoidea	20170725	"Ridge" Seamount	14.47000027	-170.8800049	2405.120117	95% Ethanol	SNMNH

EX1706_20170725T233450_D2_DIVE11_SPEC04BIO	*Poliopogon* sp. Yellow	20170725	"Ridge" Seamount	14.47000027	-170.8500061	2375.389893	95% Ethanol	SNMNH
EX1706_20170725T233450_D2_DIVE11_SPEC04BIO_A01	Polychaeta	20170725	"Ridge" Seamount	14.47000027	-170.8500061	2375.389893	95% Ethanol	SNMNH
EX1706_20170725T233450_D2_DIVE11_SPEC04BIO_A02	Porifera	20170725	"Ridge" Seamount	14.47000027	-170.8500061	2375.389893	95% Ethanol	SNMNH
EX1706_20170726T211803_D2_DIVE12_SPEC02BIO	?Ceriantharia	20170726	"New Seamount 5"	14.52999973	-169.9199982	2307.340088	Formalin 10% buffered	SNMNH
EX1706_20170726T211803_D2_DIVE12_SPEC02BIO	?Ceriantharia	20170726	"New Seamount 5"	14.52999973	-169.9199982	2307.340088	Formalin 10% buffered	SNMNH
EX1706_20170727T001348_D2_DIVE12_SPEC04BIO	Bathydorididae	20170727	"New Seamount 5"	14.53999996	-169.9199982	2207.52002	Formalin 10% buffered	SNMNH

EX1706_20170727T001348_D2_DIVE12_SPEC04BIO	Pleurobranchidae	20170727	"New Seamount 5"	14.53999996	-169.9199982	2207.52002	Formalin 10% buffered	SNMNH
EX1706_20170727T011737_D2_DIVE12_SPEC05BIO	Pycnogonida	20170727	"New Seamount 5"	14.53999996	-169.9199982	2180.52002	95% Ethanol	SNMNH
EX1706_20170727T011737_D2_DIVE12_SPEC05BIO_A01	*Iridogorgia* sp.	20170727	"New Seamount 5"	14.53999996	-169.9199982	2180.52002	95% Ethanol	SNMNH
EX1706_20170727T224154_D2_DIVE13_SPEC02BIO	?*Anthoptilum* sp.	20170727	"New Seamount Summit" Cone	14.06000042	-169.3200073	1515.209961	95% Ethanol	
EX1706_20170727T230408_D2_DIVE13_SPEC03GEO_A01	Anemone	20170727	"New Seamount Summit" Cone	14.06000042	-169.3200073	1501.25	95% Ethanol	SNMNH
EX1706_20170727T230408_D2_DIVE13_SPEC03GEO_A02	?Porifera	20170727	"New Seamount Summit" Cone	14.06000042	-169.3200073	1501.25	95% Ethanol	SNMNH

EX1706_20170728T225754_D2_DIVE14_SPEC02GEO_A01	Cladorhizidae	20170728	"Southeast Guyot" Ridge	15.09000015	-167.9600067	2430.899902	95% ethanol	SNMNH
EX1706_20170728T230719_D2_DIVE14_SPEC03BIO	?Hexactinellida	20170728	"Southeast Guyot" Ridge	15.09000015	-167.9600067	2429.75	95% Ethanol	SNMNH
EX1706_20170729T010425_D2_DIVE14_SPEC04BIO	Bryozoan	20170729	"Southeast Guyot" Ridge	15.09000015	-167.9600067	2367.23999	95% Ethanol	SNMNH
EX1706_20170729T010425_D2_DIVE14_SPEC04BIO_A01	Cladorhizidae	20170729	"Southeast Guyot" Ridge	15.09000015	-167.9600067	2367.23999	95% ethanol	SNMNH
EX1706_20170729T224022_D2_DIVE15_SPEC01BIO	*Dictyaulus* sp.	20170729	"New Seamount 8" Cone	15.15999985	-167.0399933	1904.660034	95% Ethanol	SNMNH
EX1706_20170729T224022_D2_DIVE15_SPEC01BIO	*Dictyaulus* sp.	20170729	"New Seamount 8" Cone	15.15999985	-167.0399933	1904.660034	95% Ethanol	SNMNH

EX1706_20170729T224022_D2_DIVE15_SPEC01BIO_A01	Sponge Shrimp	20170729	"New Seamount 8" Cone	15.15999985	-167.0399933	1904.660034		SNMNH
EX1706_20170729T224022_D2_DIVE15_SPEC01BIO_A02	Zoanthid	20170729	"New Seamount 8" Cone	15.15999985	-167.0399933	1904.660034	Preserved part of sponge in 10% Formalin, and stored long term in 70% Ethanol	SNMNH
EX1706_20170729T224022_D2_DIVE15_SPEC01BIO_A03	Polychaeta	20170729	"New Seamount 8" Cone	15.15999985	-167.0399933	1904.660034	95% Ethanol	SNMNH
EX1706_20170729T224022_D2_DIVE15_SPEC01BIO_A04	Isopoda	20170729	"New Seamount 8" Cone	15.15999985	-167.0399933	1904.660034	95% Ethanol	SNMNH
EX1706_20170729T224022_D2_DIVE15_SPEC04BIO	Bamboo Coral	20170730	"New Seamount 8" Cone	15.15999985	-167.0399933	1904.660034	95% Ethanol	SNMNH
EX1706_20170729T224022_D2_DIVE1	Bamboo Coral	20170729	"New Seamount 8" Cone	15.15999985	-167.0399933	1904.660034	95% Ethanol	SNMNH

5_SPEC05BIO								
EX1706_20170714T215108_D2_DIVE03_SPEC02GEO	FeMn-crusted rock	20170714	Unnamed Guyot North of Johnston Atoll	18.14999962	-169.7299957	2561.649902	Dried	OSU
EX1706_20170714T215627_D2_DIVE03_SPEC03GEO	FeMn-crusted rock	20170714	Unnamed Guyot North of Johnston Atoll	18.14999962	-169.7299957	2561.419922	Dried	OSU
EX1706_20170717T222511_D2_DIVE05_SPEC03GEO	FeMn-crusted rock	20170717	"Sally" Seamount	16.20000076	-169.5599976	2158.25	Rinsed and dried.	OSU
EX1706_20170717T231940_D2_DIVE05_SPEC04GEO	FeMn-crusted rock	20170717	"Sally" Seamount	16.20000076	-169.5599976	2150.97998	Rinsed and dried.	OSU
EX1706_20170718T203320_D2_DIVE06_SPEC01GEO	FeMn-crusted rock	20170718	“Keli” Ridge	15.68000031	-169.4799957	1245.430054	Rinsed and dried	OSU
EX1706_20170718T212917_D2_DIVE0	FeMn-crusted Rock	20170718	“Keli” Ridge	15.68000031	-169.4799957	1220.310059	Rinsed and dried	OSU

6_SPEC02GEO								
EX1706_20170721T193657_D2_DIVE07_SPEC01GEO	FeMn-crusted rock	20170721	"Edmonson" Seamount	15.68000031	-170.3699951	1275		OSU
EX1706_20170721T232044_D2_DIVE07_SPEC02GEO	FeMn-crusted rock	20170721	"Edmonson" Seamount	15.68000031	-170.3699951	1156.98999		OSU
EX1706_20170722T223653_D2_DIVE08_SPEC02GEO	FeMn-crusted Rock	20170722	"Pierpont" Seamount	15.47000027	-171.9900055	1553.810059		OSU
EX1706_20170722T234210_D2_DIVE08_SPEC03GEO	FeMn-crusted Rock	20170722	"Pierpont" Seamount	15.47000027	-171.9900055	1527.780029		OSU
EX1706_20170723T202846_D2_DIVE09_SPEC01GEO	FeMn-crusted rock	20170723	"Wetmore" Seamount	15.17000008	-171.25	2569.679932		
EX1706_20170723T211953_D2_DIVE0	FeMn-crusted rock	20170723	"Wetmore" Seamount	15.17000008	-171.25	2542.419922		

9_SPEC04GEO								
EX1706_20170724T212036_D2_DIVE10_SPEC01GEO	FeMn-crusted rock	20170724	"Wetmore" Seamount East	15.03999996	-170.8699951	2064.939941	Rinsed and dried	OSU
EX1706_20170724T221443_D2_DIVE10_SPEC03GEO	FeMn-crusted rock	20170724	"Wetmore" Seamount East	15.03999996	-170.8699951	2065.439941	Rinsed and dried	OSU
EX1706_20170725T202518_D2_DIVE11_SPEC01GEO	FeMn-crusted rock	20170725	"Ridge" Seamount	14.47000027	-170.8600006	2439.01001	Rinsed and dried	OSU
EX1706_20170725T220315_D2_DIVE11_SPEC03GEO	FeMn-crusted rock	20170725	"Ridge" Seamount	14.47000027	-170.8600006	2402.929932	Rinsed and dried	OSU
EX1706_20170726T203303_D2_DIVE12_SPEC01GEO	FeMn-crusted rock	20170726	"New Seamount 5"	14.52999973	-169.9199982	2321.929932	Rinsed and dried	OSU
EX1706_20170726T224536_D2_DIVE1	FeMn-crusted Rock	20170726	" New Seamount 5"	14.52999973	-169.9199982	2256.51001	Rinsed and dried	OSU

2_SPEC03GEO								
EX1706_20170727T210810_D2_DIVE13_SPEC01GEO	FeMn-crusted Rock	20170727	"New Seamount Summit Cone"	14.06000042	-169.3200073	1569.189941		
EX1706_20170727T230408_D2_DIVE13_SPEC03GEO	FeMn-crusted rock	20170727	"New Seamount Summit Cone"	14.06000042	-169.3200073	1501.25		
EX1706_20170728T202356_D2_DIVE14_SPEC01GEO	FeMn-crusted rock	20170728	"Southeast Guyot" Ridge	15.09000015	-167.9600067	2546.310059	Rinsed and dried	OSU
EX1706_20170728T225754_D2_DIVE14_SPEC02GEO	FeMn-crusted rock	20170728	"Southeast Guyot" Ridge	15.09000015	-167.9600067	2430.899902	Rinsed and dried	OSU
EX1706_20170730T010128_D2_DIVE15_SPEC02GEO	FeMn-crusted Rock	20170730	"New Seamount 8" Cone	15.15999985	-167.0500031	1804.619995	Rinsed and dried	OSU

EX1706_20170730T010648_D2_DIVE15_SPEC03GEO	FeMn-crusted Rock	20170730	"New Seamount 8" Cone	15.14999962	-167.0399933	1804.619995	Rinsed and dried	OSU

APPENDIX H: List of Acronyms

3D—Three-dimensional

$^{40}Ar/^{39}Ar$—Argon-argon

AERONET—Aerosol Robotic Network

ADCP—Acoustic Doppler current profiler

ASCII—American Standard Code for Information Interchange

CAPSTONE—NOAA's Campaign to Address Pacific monument Science, Technology, and Ocean NEeds

CARIS—Teledyne Computer Aided Resource Information System

CIOERT—Cooperative Institute for Ocean Exploration, Research & Technology

CIT—Chiba Institute of Technology

CTD—Conductivity, temperature, and depth

D2—ROV *Deep Discoverer*

DNA—Deoxyribonucleic acid

DO—Dissolved oxygen

DP—Dynamic Positioning

ECC—Exploration Command Center

ECDIS—Electronic Chart Display and Information System

EEZ—Exclusive economic zone

EFH—Essential Fish Habitat

EPO—Exploration Project of Opportunity

EPP—NOAA's Educational Partnership Program

ESA—Endangered Species Act

ET—Electronics Technician

EtOH—Ethanol

EVS—A brand of broadcast equipment

EX—NOAA Ship *Okeanos Explorer*

FAU—Florida Atlantic University

FeMn—Ferromanganese

FTP—File transfer protocol

GAMS—GPS Azimuth Measurement Subsystem

GFOE—Global Foundation for Ocean Exploration

GPS—Global Positioning System

HD—High-definition

I-1—Internet1

IO RAS—Institute of Oceanology, Russian Academy of Science

IRC—NOAA's Inouye Regional Center

ISC—Inner Space Center

JAMSTEC—Japan Agency for Marine-Earth Science and Technology

JAU—Johnston Atoll Unit

KMZ—Keyhole Markup language Zipped

LED—Light-emitting diode

LSS—Light-scattering sensor

MAN—NASA's Maritime Aerosol Network

MB—Megabytes

MBARI—Monterey Bay Aquarium Research Institute

MPA—Marine protected area

NAO—NOAA Administrative Order

NASA—National Aeronautics and Space Administration

NCEI—National Centers for Environmental Information

NEPA—National Environmental Policy Act

NGDC—NOAA's National Geophysical Data Center

NMFS—NOAA's National Marine Fisheries Service

NOAA—National Oceanic and Atmospheric Administration

NTSB—National Transportation Safety Board

O_2—Oxygen

OER—NOAA's Office of Ocean Exploration and Research

OMZ—Oxygen minimum zone

ONC—Ocean Networks Canada

ORP—Oxygen reduction potential

OSU—Oregon State University

PCZ—Prime Crust Zone

PERC—Planetary Exploration Research Center

PhenixP2P—Phenix peer-to-peer

PIFSC—Pacific Islands Fisheries Science Center

PIRO—NOAA's Pacific Islands Regional Office

PMEL—NOAA's Pacific Marine Environmental Laboratory

PMNM—Papahānaumokuākea Marine National Monument

POS MV— Position and Orientation System for Marine Vehicles

PRIMNM—Pacific Remote Islands Marine National Monument

QA/QC—Quality assurance/quality control

ROV—Remotely operated vehicle

RNA—Ribonucleic acid

SBE—Sea-Bird Electronics

SD—Scientific Data

SERC—Smithsonian Environmental Research Center

SI—Smithsonian Institution

SIS—Seafloor Information Software

SOEST—UH School of Ocean and Earth Science and Technology

SOP—Standard operating procedure

SST—Senior Survey Technician

SVP—Sound velocity probe

TB—Terabytes

TBD—To be determined

TSG—Thermosalinograph

UCAR—University Corporation for Atmospheric Research

UH—University of Hawaʻi

URI—University of Rhode Island

USBL—Ultra-short baseline

USFWS—U.S. Fish and Wildlife Service

USGS—U.S. Geological Survey

USNM—National Museum of Natural History

UTC—Universal Time Coordinated

VoIP—Voice over Internet Protocol

VSAT—Very Small Aperture Terminal

WebRTC—Web real-time communication

WGS94 — World Geodetic System 1984

WHOI—Woods Hole Oceanographic Institute

XBT—Expendable bathythermograph