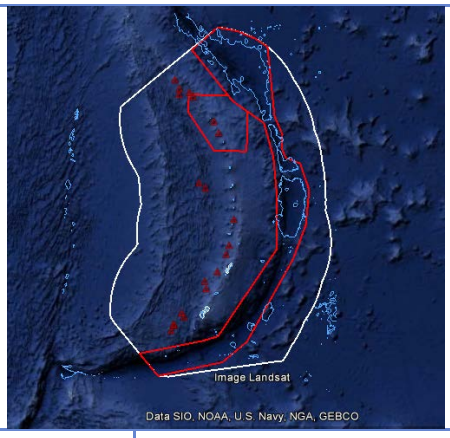
OKEANOS EXPLORER ROV DIVE SUMMARY

Site Name	Daikoku Seamount	
ROV Lead/Expedition Coordinators	Jim Newman/ Kasey Cantwell	
Science Team Leads	Shirley Pomponi (HBOI-FAU, CIOERT) Patty Fryer (UH)	
General Area Descriptor	Areas in and around the Marianas Trench Marine National Monument	

ROV Dive Name	Cruise	Leg	Dive Number
	EX1605	3	DIVE09
Equipment Deployed	ROV:	Deep Discoverer	
	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 2
Equipment Malfunctions			

ROV Dive Summary (From processed ROV data)

Dive Summary: EX1605L3_DIVE09

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In Water:	2016-06-25T20:51:07.498000 21°, 19.591' N ; 144°, 11.272' E
Out Water:	2016-06-26T06:31:56.349000 21°, 19.509' N ; 144°, 11.730' E
Off Bottom:	2016-06-26T05:10:33.300000 21°, 19.502' N ; 144°, 11.525' E
On Bottom:	2016-06-25T22:42:27.878000 21°, 19.513' N ; 144°, 11.490' E
Dive duration:	9:40:48
Bottom Time:	6:28:5
Max. depth:	436.0 m

Special Notes	

Scientists Involved

Name	Institution	Email

(please provide name / location / affiliation / email)			
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	Derek Sowers	OER	derek.sowers@noaa.gov

Purpose of the Dive

Daikoku Seamount is a part of the Vents Unit and is within the area of the Islands Unit of the Mariana Trench Marine National Monument. In 2004-6 during NOAA OER-funded ROV cruises, PMEL discovered active hydrothermal venting near the summit and pools of molten sulfur surrounded by dense chemosynthetic communities, including of a new species of flatfish. In December 2014, the seamount was apparently erupting (based on high hydrogen in CTD water samples over the summit), but a PMEL expedition team in the area at the time was unable to make a dive there to confirm. This dive investigated recent changes at Daikoku since the 2014 eruption- including surveying new topography, and the if the sulfur pond and flatfish communities still exist, explore the new crater and its surroundings, search for evidence that an eruption indeed occurred in 2014, and assess the impacts of these changes on the local chemosynthetic ecosystem.

Two days prior to the dive, overnight mapping with *Okeanos*'s EK60 and multibeam sonars indicated a strong plume (potentially a hydrothermal bubble plume) near the summit of Daikoku. With this new information, the planned water column transects for Eifuku were transferred to this dive as no similar plume was detected at Eifuku. The main objectives of the water column transects were to 1) observe a gradient of fauna and water column characteristics as the vehicles moved away vertically and horizontally from the plume; and 2) to test a new method of conducting water column transects. This new method, similar to a "step-ladder," conducted short (10-15 m transects) with the *Okeanos Explorer* and *Seirios* remaining in place, and only D2 moving on its tether in the E-W axis.

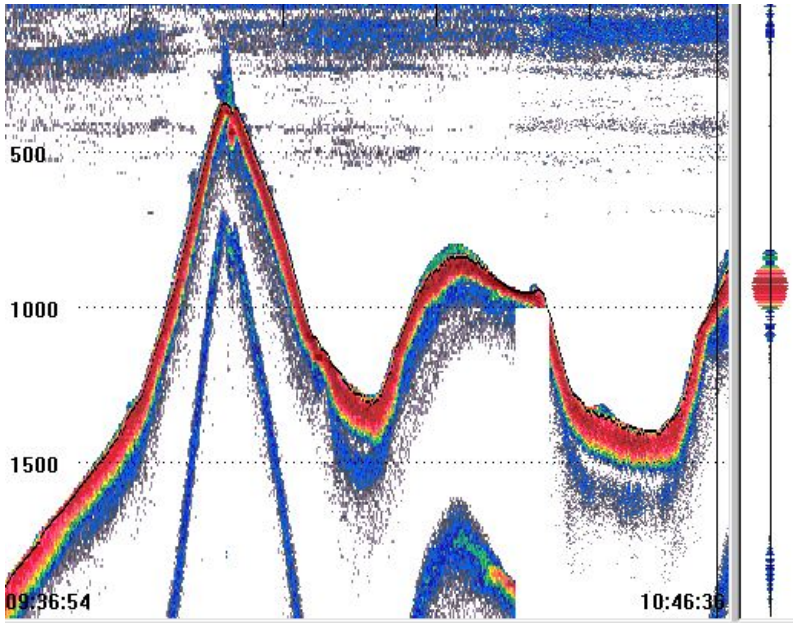


Figure 1: Active plume detected by the Okeanos Explorer EK60.

Description of the Dive:

ROV *Deep Discoverer* (D2) first landed on the upper northwest flank of Daikoku Seamount, on a seafloor that exposed large broken blocks (a right-angle fracture at 21:49:12 Z) of what appeared to be consolidated volcaniclastics. Unfortunately, D2 had to rise up into the water column to be positioned out of the thick plume of sulfur "smoke" that made visibility impossible for maneuvering. D2 settled again at ~410 m where the seafloor was covered with volcanic ash and lapilli-sized (pea-to grape-sized) volcaniclastics, sulfur splatter covered with bacterial mats, blebs of sulfur with trailing threads, a general white patina of sulfur with bacterial mat and where patches of darker ash were uncovered there were tons of flat fish. The vehicles headed up slope to the southeast for an area where the *Okeanos Explorer* had mapped a distinct plume in the water over the past 2 days. The plume was centered above a small crater near the summit crater rim, where we saw bubbles of CO2 gas and sulfur "smoke" emanating from a series of small depressions. Some of the depressions were surrounded by 10- to 20-cm high encrustations of solid sulfur stained by dark minerals. We collected a rock from a part of the crust near one of these depressions and then moved along contour to the south.

The slope was covered with mostly ash and small volcaniclastics and almost everywhere it was stained by white sulfur encrustation and covered with bacterial mat or the tonguefish, *Symphurus thermophilus*. It's unlikely that bottom-dwelling fish are as abundant anywhere else! The fish were constantly moving, stirring up the sediment in search of food (polychaetes and crustaceans in the sediment). These fish have only been found in high sulfur environments, and they seem to be attracted to sulfur deposits. That observation has led scientists to hypothesize that the fish may be eating the sulfur deposits to "feed" gut microbes: they may be farming the gut flora—a new spin on chemoautotrophy! Unfortunately, the hypothesis hasn't been tested because the tonguefish collected on previous expeditions weren't preserved in a way that gut microbes could be detected. But we were delighted when the ROV crew brought us a flatfish that was found on the sled of D2; a second sample was found the next day when they were preparing to launch D2.

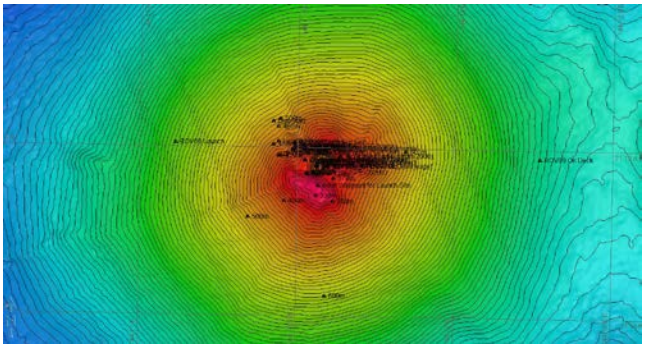
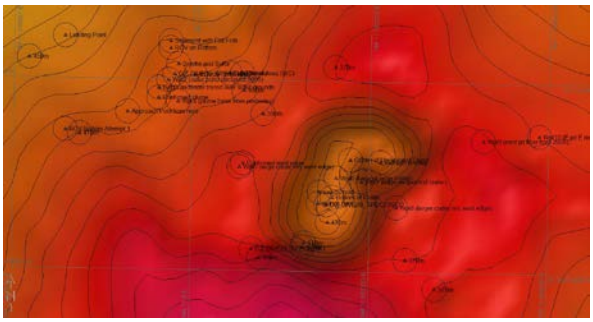
The "yunohana" crab (*Gandalfus yunohana*) was also present. We can guess the origin of the genus name; the species name has its origin in the Japanese for "flowers of hot water". In hot springs in Japan, the sulfur looks like white flowers in the water.

As we approached the summit crater the rim fell away into nearly vertical outcrops of the bacterially encrusted volcaniclastics. As we moved around the rim of the crater, there were barnacles with "fuzzy" cirri underneath overhangs of the rocks. We were excited to find tube worms (*Lamellibrachia*) and even more excited to find anemones (never before reported from this site) growing on both the tubes and the bottom. The scarps had numerous fractures. The "smoke" eventually cleared sufficiently that the ROV drove into the water column and then descended to the bottom of the south part of the summit crater. As it was descending, it passed through thick volcanic smoke and abundant particulate material in the water column. At the bottom of the crater we saw angular cobbles and boulders as well as some irregular-shaped pieces of solid sulfur. We recovered one rock and proceeded to the northern part of the crater where we saw numerous plumes of sulfur and CO2 bubbles emanating from cracks, orifices, and diffuse regions along the lower wall of the crater. We ended the dive in that crater and proceeded to do the mid-water transect portion of the dive.

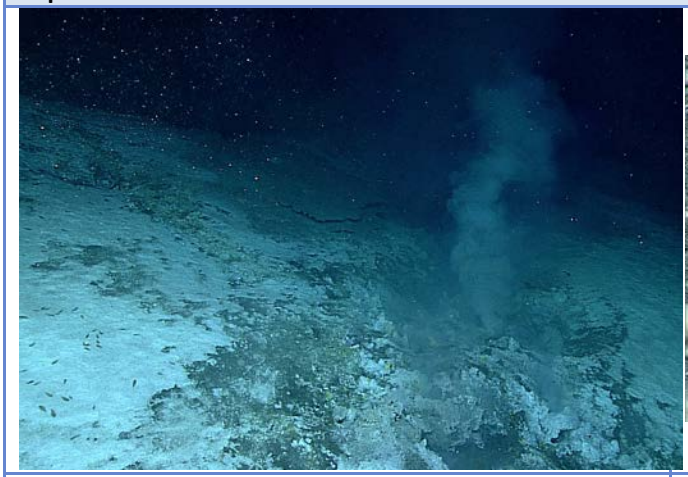
The objective of the midwater portion of this dive was to explore the water column in the vicinity of the vents. Extremely little is known about the effects of hydrothermal fluids and their effects on pelagic animals that encounter it. We were interested to see if there was any evidence of an association (or avoidance) of animals either within the plume or at the border of the vent plume. The central vent plume was outputting a lot of particulate matter, so we transited to the sulphurous plume for the transects, and conducted the midwater portion of the dive there. It was important that the transects be stacked over each other, as we wanted to survey

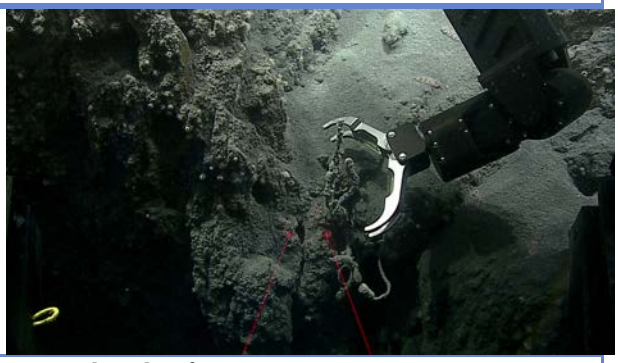
within the same plume at increasing distances from its source using a "step-ladder" method of transects. We conducted transects at the following depths: 408, 396, 400, 395, 390, 350, 325, 300 and 275 m. Close to the seafloor, there was a lot of particulate matter in the water column. We saw some fibrous looking material in the water column that we believe may be part of the bacterial mat that was suspended into the water column by venting. There were very few if any pelagic animals observed within ~15 m of the seafloor. At 390 m, we saw what we believe may be munopsid decapods. We later saw a cluster of ~6-7 individuals at 350 m. We also saw salps, both occupied and abandoned larvacean houses, a siphonophore, and chaetognaths. At 275-300 m, we saw a swarm of amphipods, which could potentially be associated with the edge of the plume.

In follow up discussion, the scientists agreed that this "step-ladder" approach to sampling likely did not provide enough time at each stratum to obtain an effective characterization of the resident fauna in the water column, although the approach did succeed at the goal of surveying the full extent of the plume in the water column. Good fodder for future conversations on adapting midwater protocols for specific exploration and scientific objectives!

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

Representative Photos of the Dive

	
The area around a liquid sulfur pool had scattered fumaroles that were releasing sulfur gases, which created smoky plumes (at right) in the water column. White patches of bacterial mat covered most of the sea floor surrounding the fumaroles and provided nutrient-rich	Without a doubt, the tongue fish, *Symphurus thermophiles*, were the biological highlight of this dive! It's unlikely that bottom-dwelling fish are as abundant anywhere else!

feeding ground for hundreds of small flat fish that foraged there (zoom on the bottom left to see the fish).		
Samples Collected		
Sample ID	SPEC01GEO	
Date (UTC)	20160625	
Time (UTC)	235808	
Depth (m)	407.15	
Temperature (°C)	12.48	
Field ID(s)	SULFUR CRUST	
Comments	Sulfur sphericals and volcanic ash. Part of a layered deposit, on the edge fumarole depression.	
Sample ID	SPEC02BIO	
Date (UTC)	20160626	
Time (UTC)	020104	
Depth (m)	358.16	
Temperature (°C)	15.04	
Field ID(s)	ANEMONE ON TUBEWORM	
Comments	2 individuals in formalin, 2 individuals in 95% ethanol, 1 for DNA	
Sample ID	SPEC03GEO	
Date (UTC)	20160626	
Time (UTC)	031400	
Depth (m)	432.96	
Temperature (°C)	13.99	
Field ID(s)	ROCK; IGNEOUS	
Comments	Possible hydrothermal rock sample	

Sample ID	SPEC04BIO
Date (UTC)	20160626
Time (UTC)	031400
Depth (m)	432.96
Temperature (ºC)	13.99
Field ID(s)	Tongue Fish

Comments	Two tongue fish were recovered from the frame of the ROV. All sample information will be associated with SPEC03GEO Fish 1: found approximately 2 hours after surfacing. Immediately bagged and frozen in a standard freezer. Two days later, sample was transferred to -80 freezer. Fish 2: Found approx 12 hours after surfacing in desiccated state. Bagged in 95% EtOH and put in standard freezer.

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