


Okeanos Explorer ROV Dive Summary

Site Name	Platform			
ROV Lead/Expedition Coordinator	Brian Bingham/ Brian Kennedy			
Science Team Leads	Andrea Quattrini and Mike Cheadle			
General Area Descriptor	Puerto Rico and US Virgin Islands			
ROV Dive Name	Cruise Season	Leg	Dive Number	
	EX1502	3	DIVE06	
Equipment Deployed	ROV:	Deep Discoverer		
	Camera Platform:	Seirios		
ROV Measurements	<input checked="" type="checkbox"/> D2 CTD	<input checked="" type="checkbox"/> Depth	<input checked="" type="checkbox"/> Altitude	
	<input checked="" type="checkbox"/> Scanning Sonar	<input checked="" type="checkbox"/> USBL Position	<input checked="" type="checkbox"/> Heading	
	<input checked="" type="checkbox"/> Pitch	<input checked="" type="checkbox"/> Roll	<input checked="" type="checkbox"/> HD Camera 1	
	<input checked="" type="checkbox"/> HD Camera 2	<input checked="" type="checkbox"/> ROV HD 2	<input checked="" type="checkbox"/> Seirios CTD	
	<input checked="" type="checkbox"/> Temperature Probe	<input checked="" type="checkbox"/> D2 DO Sensor	<input type="checkbox"/> Seirios DO sensor	
Equipment Malfunctions	Operating with a secondary DO sensor that was last calibrated in 2013. CTD had to be restarted during descent.			
ROV Dive Summary (From processed ROV data)	In Water at:	2015-04-15T10:47:37.203000 18°, 09.060' N ; 067°, 31.356' W		
	Out Water at:	2015-04-15T20:28:16.781000 18°, 10.037' N ; 067°, 30.894' W		
	Off Bottom at:	2015-04-15T20:14:55.140000 18°, 09.977' N ; 067°, 30.937' W		
	On Bottom at:	2015-04-15T11:28:06.984000 18°, 08.960' N ; 067°, 31.322' W		
	Dive duration:	9:40:39		
	Bottom Time:	8:46:48		
	Max. depth:	606.2 m		
Special Notes				
Scientists Involved <i>(please provide name / location / affiliation / email)</i>	Bernard Ball	Duke University Marine Lab	bernie.ball@duke.edu	
	Jason Chaytor	USGS	jchaytor@usgs.gov	
	Mike Cheadle	University of Wyoming	cheadle@uwyo.edu	
	Amanda Demopoulos	USGS	ademopoulos@usgs.gov	
	Dan Distel	Ocean Genome Legacy Center, Northeastern University	d.distel@neu.edu	
	Mike Ford	NOAA Fisheries	michael.ford@noaa.gov	

	Scott France	University of Louisiana at Lafayette	france@louisiana.edu
	Graciela Garcia-Moliner	Caribbean Fishery Management Council	graciela.garcia-moliner@noaa.gov
	Christopher Kelley	University of Hawaii	ckelley@hawaii.edu
	Cheryl Morrison	USGS	cmorrison@usgs.gov
	Martha Nizinski	NOAA NMFS	nizinski@si.edu
	Andrea Quanttrini	USGS	aquatrini@usgs.gov
	Santiago Herrera	Woods Hole Oceanographic Institution	tiagohe@gmail.com
	Michelle Schärer	Interdisciplinary Center for Coastal Studies, UPR-M	michelle.scharer@upr.edu
	Michelle Taylor	University of Oxford	michelle.taylor@zoo.ox.ac.uk
	Uri ten brink	USGS	utenbrink@usgs.gov
	Michael Vecchione	NMFS National Systematics Lab	vecchiom@si.edu
	Ben Frable	Oregon State	ben.frable@oregonstate.edu
	Steve Haddick	MBRI	

Purpose of the Dive

- i) To explore benthic habitats for deep water snappers and groupers
- ii) To document the biology living on and around the un-named fault scarp from 600m to 300m depth.
- iii) To determine the lithology and stratigraphy of the rocks exposed by and in front of the fault.
- iv) To identify structural features that could be related to the fault.

Description of the Dive:

This was a shallow dive which started on a gentle, smooth 10° slope, but then traversed an area of irregular bathymetry before ascending a 17° dipping, highly weathered, fault scarp. This fault is the easterly extension of an ~100km long anastomosing fault system that forms the northern wall of a WNW-ESE trending rift between the Dominican Republic and Puerto Rico. The traverse was entirely within the Middle Oligocene to Pliocene platform carbonate sequence. The dive began at 10:37 UTC. D2 descended to 605m and landed on a gently dipping sandy slope to the south of the fault scarp. The dive ended at 20:16 UTC at 301m at the top of the scarp. Near the top of the scarp there were several pits/depressions that contained mostly dead coral rubble. Moderate bottom currents of 0.06 to 0.09 m/s were noticed throughout the 9 hour dive. Steep temperature and dissolved oxygen gradients were noted during the dive, including a large decrease in DO near the approach to the top of the ridge.

Geology:

The dive started with D2 landing on a gently dipping, irregularly rippled, sandy seafloor near a rubbly, low standing, outcrop of carbonate at 605m (11:28 UTC). D2 then traversed to the NNE up a gentle slope covered by rippled sandy sediments, often with shell fragments until 585 m (13:02 UTC). The ripples had variable character and orientation, but a common N-S to NW-SE trend was observed. Ripple asymmetry suggests they were formed by a north-easterly flowing current. At 581m (13:04 UTC) a resistant crust on sub-horizontally bedded carbonate emerged through the sandy sediment. In one location a 20cm high section of undercut limestone was seen below the more resistant crust. At 576m (13:37 UTC), limestone pavement with frequent 30cm diameter, partially sediment filled depressions (sinkholes?) was observed and this limestone pavement was continuously exposed until 448 m (16:45 UTC). The limestone pavement is likely swept clean by the strong currents in the area. Occasional elongate, depressions, with more coarse sediment, were seen (e.g. 566m, 13:50 UTC & 527m, 14:58 UTC). These are likely eroded vertical cracks in the limestone pavement. The depressions began to increase in frequency at 485 m (14:40 UTC) as the top of the gentle slope was approached and the amount of sandy sediment increased.

From 448m (15:40 UTC), D2 descended 15m from a local topographic high to a depth of 433m (17:34 UTC). In this part of

the dive, sediment cover was more extensive and rippled (NW-SE trending), and the topography of the limestone was more complicated. A small, 2m high, NE-SW trending, burrowed and undercut carbonate ridge was observed at 442m (16:58 UTC), together with another small, 1m high, scarp at 439m (17:20 UTC).

At 433m (17:34 UTC) D2 began the ascent up the WNW-ESE trending fault scarp. Initially large talus blocks were observed on sediment, but very quickly, more extreme topography was observed with both north (435m, 17:44 UTC) and south facing scarps. At 434m (17:52 UTC) a relatively deep (5-10m) ~E-W trending, chasm was encountered. Large metre scale, angular, blocks, lacking sediment cover or karstic topography, were present in the south side of the chasm having detached from the northward facing wall. The absence of karstic weathering and the relative lack of sediment cover suggests these blocks might have recently fallen from the scarp. This scarp is therefore the best candidate for the most recent fault activity. The gradient of the slope began to increase at 444m (18:18 UTC) and the topography became even more complicated (e.g. 430m 18:25 UTC), with extensive karst weathering superimposed on what was likely once a structurally complicated fault scarp consisting of several WNW-ESE trending fault blocks. Outcrops are very rounded and large 1m diameter coral debris filled sinkholes are present. At 320m (19:43 UTC) the bedding appeared to be back-tilted and dipped at 60° towards the fault scarp, suggesting that this was a back tilted fault block. At 306m (19:54 UTC), the top of the scarp was reached and the topography flattened out into a limestone pavement with coral debris filled depressions. D2 left the seafloor from 301m at 20:16 UTC.

The carbonate sequence, likely consists of interbedded limestones and sandstones from the Pliocene to Late and Middle Miocene Ayamon and Los Puertos Limestones. They were exposed by the un-named 100km long normal fault system with ~300m of total throw. This fault system may also have a strike slip component of motion, but no evidence of the actual fault surfaces were found, likely having been eroded away by the differential erosion exhibited by the scarps. This erosion, and the sedimentation indicates that most of the fault system has not been recently active. Chaytor & ten Brink (2010) suggested that this fault system was created by oblique extension in the Mona Passage area due to the rotation of the Puerto-Rico-USVI microplate within the North American/Caribbean Plate Boundary. They use the age of the faulted rocks to suggest the faulting must be post Miocene in age.

Biology:

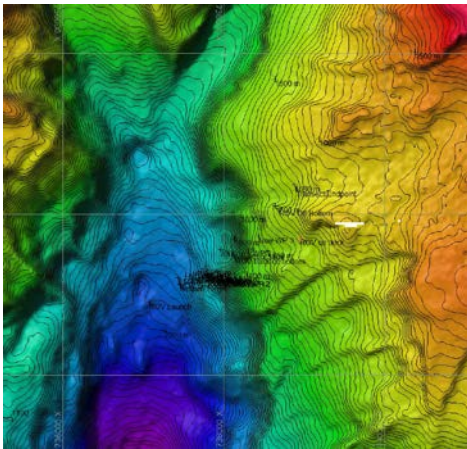
The dive on the east side of the Mona Passage was conducted at a similar depth range as Pichincho (Dive 3), and contrasted in several important ways, in terms of the ecology and biodiversity of fishes and invertebrates. Overall, there was a higher diversity of corals, sponges, and fishes observed during this dive compared with other dives. The dive began on a sedimented slope and continued upslope where we encountered at least 30 putative species of fishes, including a draconet (*?Centrodraco acanthopoma*), spike fish (Triacanthodidae, new for the expedition), green eyes (*Chlorophthalmus agassizi*), deepwater cardinalfish (*Synagrops bellus*), scorpionfish (Scorpaenidae), beardfish (*Polymixia* spp.), 2-3 shark species (e.g., *?Scyliorhinus torrei*, *S. cubensis*), Darwin's slimehead (*Gephyroberyx darwinii*), Alfonsino (*Beryx decadactylus*), cusk eels (*?Benthocometes robustus*, unidentified ophidiid), flatfish, and sea robins (*Peristedion antillarum*). Toward the end of the dive, we observed one of our target fish species, the queen snapper (*Etelis oculatus*). Notably, a slender dory (*Parazen* sp.) was imaged puffing up the sediment, possibly trying to feed. Also, a species currently in the process of being described (by C. Baldwin et al., Smithsonian Institution) was observed (*Polylepion* sp. A). Finally, we observed a sea robin (*Peristedion antillarum*) picking up an ophiuroid with rostrum.

Throughout the dive, several coral species were observed, including black corals (*?Parantipathes*-branched and unbranched forms, *?Leiopathes* sp.), soft corals (*?Aquaumbridae*), colonial and solitary scleractinians (*?Oculina* sp. *Lophelia pertusa*, the latter confirmed by S. Cairns, unidentified cup corals), primnoid and chrysogorgiid octocorals, and hydrocorals (stylasterids). However, along the top of the platform, many of the scleractinians and black coral colonies were small (< 10 cm tall colonies). Associates observed on the corals included crustaceans (*?Rochinia*, chrostylid squat lobsters-e.g., *Gastrotychus* sp.), brittle stars (Ophiuroidea) and large basket stars (Gorgonocephalidae). On the sediment surface, we observed a new species of squat lobster for the expedition, Agononida, type of Munidae. Decorator crabs were found climbing the rock substrate and several species of shrimp were observed, including some gravid with green eggs and white and red striped forms. Other cnidarians documented on the dive included colonial zoanthiids on coiled

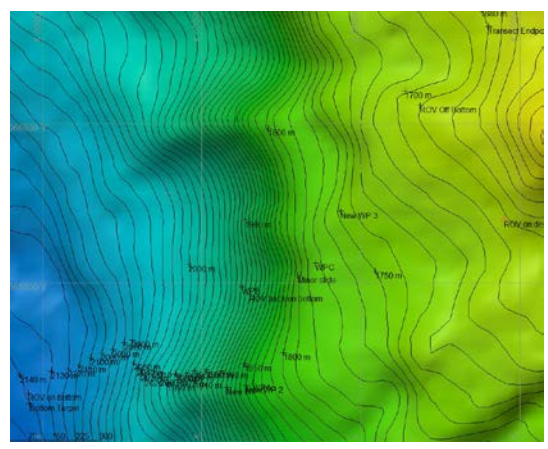
stalks and fans, and a few anemones not observed on previous dives. Notably, we observed a predation event of an urchin eating black coral tissue.

We encountered several yellow terribellid polychaetes on the sediment surface, with their tentacles undulating in the water column. Other notable observations included a few large slit shell gastropods on the soft sediment substrate, a large nemertean crawling along the rock surface and interesting tunicates, including predatory forms and flower shaped forms found attached to the rocks. Additionally, several sponge species were found encrusting the rock substrate, including cup sponges Corallistidae and Astrophorids. Several types of echinoderms were encountered, including sea stars (e.g., brisingids, *Tamaria passiflora*), crinoids (e.g., *Holopus* sp.), urchins (?*Cidaris rugosa*, *C. blakei*, aspidodiadema with curved spines, *Phorosoma* sp.), and holothurians (at least 2 species) some of which had some amphipods associated.

Overall Map of ROV Dive Area

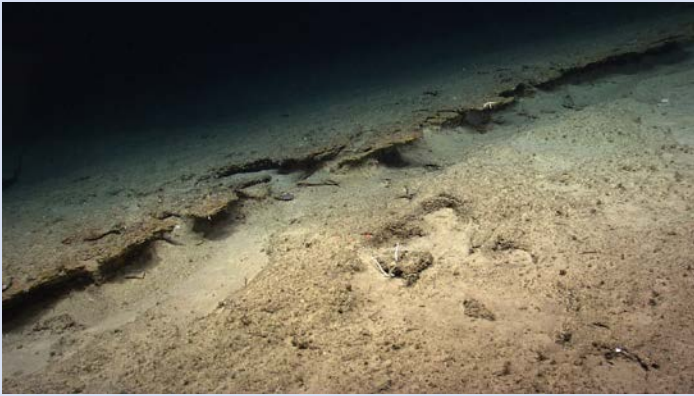


Close-up Map of Main Dive Site



Representative Photos of 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