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Purpose of the Dive

- i) To determine the lithology and stratigraphy of the rocks exposed in the east wall of the Guayanilla Canyon.
- ii) To traverse across the trace of the Investigator Fault in the canyon wall and to look for deformation related to the movement of that fault.
- iii) To document benthic communities living on and around the east wall of the canyon from 2150m to 1690m depth.

Description of the Dive:

This dive was located on the east wall of Guayanilla Canyon at the approximate location of the intersection of the canyon with the Investigator Fault. The proposed dive track trended to the north-east, obliquely traversing along the valley wall in order to attempt to cross the sub-vertical trace of the Guayanilla Fault. The ROV landed on the seafloor at 2139m (11:57 UTC). During the dive, the heading of the ROV was modified in order to spend as much time as possible on steeper slopes, resulting in a dive track that initially headed just north of east to the top of the first and major, 35° dipping, scarp at 1860 m. The ROV then “flew” NNW off the seafloor for 250m and returned to the seafloor at 1910m and continued in a north-easterly direction up the scarp until the top of the scarp was reached at 1806m. The ROV continued to traverse in a north-easterly direction across a sediment covered 7° slope until 1755m, when the ROV headed north to meet a second smaller scarp. The ROV traversed up this second scarp in an easterly direction until 1736m, at which point, the ROV continued in a northeasterly direction across sediment until 1709m, when it headed due east until the end of the dive at 1689m, leaving bottom at 21:30 UTC. The traverse was entirely within the Oligocene to Early Pliocene stratigraphic succession that occurs on the southern flank of Puerto Rico. Moderate bottom currents were noticed throughout the 9 hour dive.

Geology:

The dive started with D2 landing on a gently dipping, bioturbated sediment covered surface at 2139m (11:57 UTC). The sediment was very fine grained (muddy), contained lots of shell debris, notably pteropod shells, and holothurian trails were common. After heading east, a ~ 2m high outcrop was with a small debris apron at its base was reached at 2127m (12:14 UTC). This outcrop consisted of sub-horizontal, well bedded, 10 cm thick shale units with one 70cm thick sandstone unit near the top of the section. A north dipping cleavage was observed in the more fine-grained units. After

passing over muddy sediments a more substantial 6m high outcrop was reached at 2081m (12:34 UTC). This outcrop was more sediment covered, and less shale rich than the first outcrop, but was well bedded with 10cm to 40cm layers of dominantly sandstone. There seemed to be a pile of angular blocks forming a layer on top of the outcrop. A distinct south-dipping joint cuts this outcrop. After transiting another stretch of sediment with one talus block, more outcrop was reached 2052m (12:42 UTC). This outcrop was less well bedded and might be more fractured and was partially sediment covered; however, a north dipping cleavage was still visible. The first two outcrops are very likely of the Late Oligocene Clastic Juanna Diaz Formation, possibly from the lower marine clastic sequence. The rock type of the third outcrop could not be determined well enough to confidently relate to the stratigraphic succession, however they could be carbonates from either the carbonate Juanna Diaz Formation or from the base of the Middle Miocene Ponce Formation.

The transect continued over gently dipping muddy, pteropod shell bearing, sediments until 1989m (13:04 UTC) where loose blocks of bedded and burrowed carbonate overlie outcrops of carbonate rock. From here until ~1793m, the carbonate forms a moderately steep slope (mean dip of 35°), sometimes (80%) sediment covered with limestone blocks, and sometimes (20%) with steep outcrops of near horizontally bedded, sometimes chalky, limestone, especially at the top of the scarp. Essentially, the slope consist of differentially eroded carbonate layers draped by debris and sediment. A significant part of the dive was spent examining this slope and outcrops in two separate W-E transects (see Description of the Dive above). Notable features included, Fe-Mn coated horizons (1885m, 14:00 UTC; 1887m, 15:52 UTC; 1904m, 14:42 UTC; 1882m, 16:10 UTC) similar to those seen in the west wall of Mona Canyon, ubiquitous apparent bioerosion/burrows in most exposures and both fine 10cm scale bedding (1885 m, 14:00 UTC; 1805, 16:44 UTC) and massive bedding (1865m, 14:07 UTC, 1853, 16:27 UTC; 1803, 16:47 UTC). The other conspicuous feature of the slope was the evidence for sediment/talus transport and slope failure. One metre wide downslope channels were seen in the slope face at 1889m (15:54 UTC), 1878m (16:14 UTC), 1867m (16:22 UTC), 1823m (16:42 UTC), 1806, (18:30 UTC) as were downslope sediment trails at 1793 m (17:55 UTC) and 1798m (17:1 UTC). At the top of the outcrop, spectacular 20m wide, arcuate, head wall scarps were present. Interestingly, at the very top of the slope, the carbonates seemed to not be horizontal, but instead dip steeply (60°) to the west, perhaps because the carbonates had rotated over the top of the slope during the process of slope failure. Inspection of the multi-beam bathymetry, shows that the top of this slope forms a continuous southward dipping surface for 6 km down the eastern wall of the Guayanilla Canyon, perhaps suggesting a relatively un-faulted and continuous stratigraphy in this area. Seismic data (Chaytor et al., in prep.) show that the shelf sequence near to this dive is relatively gently dipping, continuous and up to 900m thick.

From 1806m (18:30 UTC), the ROV returned to traversing gently sloping carbonate sediment, with the frequency of clasts/boulders of carbonate increasing as the final steeper slope was approached at 1747m (20:24 UTC). This slope provided a 20m high section of outcropping, sub-horizontal, parallel bedded carbonate rocks. Down-slope erosion channels were also present (1747, 20:28 UTC). The ROV dive returned to traversing muddy, pteropod sediments from 1725m (20:37 UTC) until the end of the dive at 1689m (21:30 UTC).

The carbonate outcrops traversed during this dive were from the Middle Miocene to Early Pliocene Ponce Formation of shallow to open shelf carbonates. If there was no faulting between the outcrops, a minimum of 250 vertical metres of carbonate were traversed (a typical on shore thickness for the Ponce Formation is 300m (Mann et al, 2005)) and a minimum of 140m of the underlying Juanna Diaz Formation (typical on shore thickness is 285m). Therefore, in summary, this dive was spent in the Late Oligocene to Early Pliocene shelf sequence that's found on and offshore of the south coast of Puerto Rico.

We did not recognize the Investigator Fault in the east valley wall during this dive. Post dive, examination of the 50m resolution bathymetry suggests the Investigator Fault may run through the northern end of our dive.

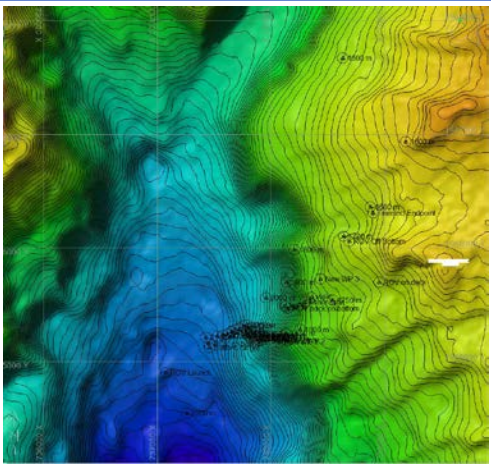
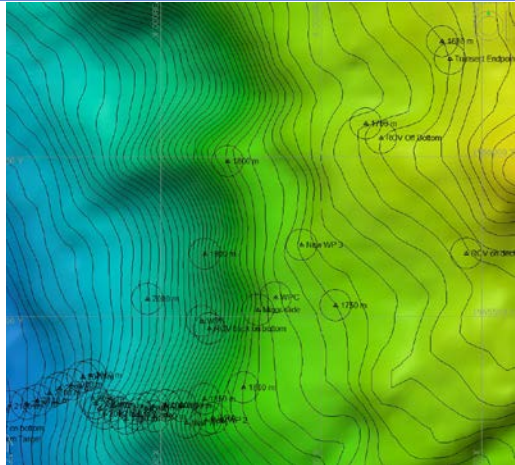
Biology

Overall, it was noted that sessile, faunal colonization was not very dense throughout the entire dive. Most of the sponges (Hexactinellidae, Cladorhynchidae) and corals (*Metallogorgia melanotrichos*, *Lepidisis* sp.) were attached to the rock boulders and blocks at depths <1800 m. The *Metallogorgia* had its obligate associate brittle star with it. A few sea pens were also present (Protoptiidae, *?Anthoptilum* sp., *Umbellula* sp.) There was little to no colonization evident on the face of the massive scarp at ~1800 m; however, some of the layers were heavily bio eroded. Additionally, tube anemones (Ceriantheria) were present in this layer.

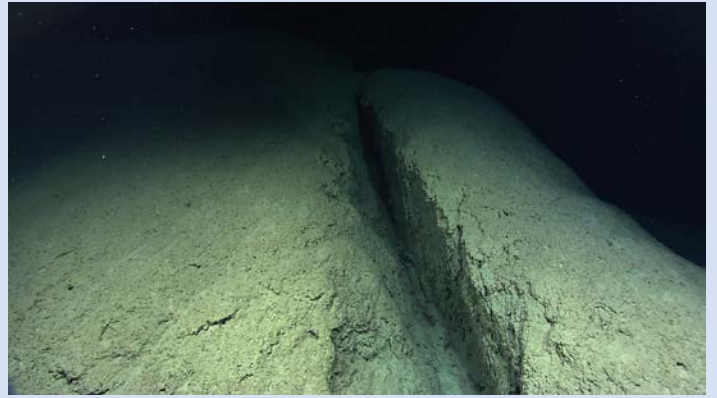
Upon reaching the bottom, it was noticed that holothurians were quite abundant at this site compared to the other sites surveyed to date. At least six species of holothurians were observed throughout the dive, including *Benthoodytes* sp., *Enypniastes* sp., *?Peniagone/Amperima* sp. an elasiopod, and two additional, unidentified species. Additionally, numerous sea urchins (*Phromosoma* sp.) were observed during the beginning of the dive, some moving fairly quickly over the seafloor. These observations suggest that this area has considerable organic input, consistent with notions on delivery of increased organic matter to submarine canyons.

Several different species of squat lobsters were observed on this dive, including *Munidopsis* sp. and *Munida* sp., which had not yet been observed during this expedition. Other crustaceans included pagurid hermit crabs, one with an anemone on its back, and different species of mysid, nematocarcinid and crangonid shrimps. Several species of seastars, crinoids, and brittle stars were also observed. As for fishes, at least eight demersal species were observed, including 1-2 species of *Bathysaurus* lizardfish, snailfish (Liparidae), halosaurs (*Aldrovandia* sp.), ophidiid (*?Xyelacyba* sp.), a cutthroat eel (Synaphobranchidae), and tripod fish (*Bathypterois phenax*, *Ipnops murrayi*, *Bathytyphlops* sp.). Additionally, several midwater fishes were observed during the descent.

Comatulid crinoids and sea lilies were common throughout the dive. Notable observations included a benthic, platyctenid ctenophore on an *?Anthoptilum* sea pen (19:05, 1763 m), a solitary hydroid (Corymorphidae, (17:22 UTC, 1796 m), a dandelion siphonophore “tethered” into a vertical rock face (17:51 UTC, 1792 m), and several observations of benthic jellyfish (*Ptychogastris* sp.) (16:23 -1741 UTC, 1790-1865 m) attached to a vertical rock face. In addition, at least one wood fall was observed, with little colonization of fauna (?bivalves and serpulid tubeworms).

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

Representative Photos of the Dive



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