



<b>Scientists Involved</b> <i>(please provide name / location / affiliation / email)</i>	Jamie Austin	University of Texas/Austin	jamie@utig.ig.utexas.edu
	Amy Baco-Taylor	Florida State University	abacotaylor@fsu.edu
	Bernard Ball	Duke University Marine Lab	bernie.ball@duke.edu
	Jason Chaytor	USGS	jchaytor@usgs.gov
	Mike Cheadle	University of Wyoming	cheadle@uwyo.edu
	Erik Cordes	Temple University	ecordes@temple.edu
	Dannise Ruiz-Ramos	independent	dannise821@gmail.com
	Amanda Demopoulos	USGS Ocean Genome Legacy Center,	ademopoulos@usgs.gov
	Dan Distel	Northeastern University	d.distel@neu.edu
	Mike Ford	NOAA Fisheries University of Louisiana at Lafayette	michael.ford@noaa.gov
	Scott France	Lafayette	france@louisiana.edu
	Christopher Kelley	University of Hawaii	ckelley@hawaii.edu
	Martha Ninski	NOAA NMFS	nizinski@si.edu
	Andrea Quattrini	USGS Woods Hole Oceanographic Institution	aquattrini@usgs.gov
	Santiago Herrera	Interdisciplinary Center for Coastal Studies, UPR-M	tiagohe@gmail.com
	Michelle Scharer	Coastal Studies, UPR-M	michelle.scharer@upr.edu
	Susan Schnur	Oregon State University Woods Hole Oceanographic Institution	sschnur@coas.oregonstate.edu
	Timothy Shank	Delaware Museum of Natural History	tshank@whoi.edu
	Liz Shea	USGS	eshea@delmnh.org
	Uri Ten Brink	USGS NMFS National Systematics Lab	utenbrink@usgs.gov
Michael Vecchione	Lab	vecchiom@si.edu	
Christopher Moore			

**Purpose of the Dive**

- i) To make geological and biological observations along a transect from 3900m to 3200m directly beneath the dive track of E/V Nautilus/Hercules dive H1300 which began at 2900m below sea level.
- ii) To look for and examine the late Cretaceous to Middle Eocene arc rocks which lie immediately below the Middle Oligocene to Late Miocene platform carbonate sequence.
- iii) To identify features that could be related to failure of the canyon wall.
- iv) To carry out five 10-minute horizontal mid water transects every 100m from 800-1200m to observe mid water biology.
- v) To document benthic communities along the canyon wall.

**Description of the Dive:**

This deep dive was located on a 22° dipping slope on the west wall of Mona Canyon directly beneath the dive track of E/V Nautilus/Hercules dive H1300 which began at 2900m below sea level. The bottom of the track dive track was located on the top of a very large slump deposit which is clearly visible in the bathymetry and may have formed by slope failure caused by the magnitude 7.5 1918 San Fermin Earthquake.

The dive began at 10:28 UTC and D2 descended to 800m at 11:20 UTC and began to carry out the mid water transects. The transects were complete at 12:47 UTC and D2 headed down, landing on a muddy slope at 14:26 UTC (3927m). The dive track headed WSW up a slope of mud and outcrops of carbonate, which was likely the head wall of the large slump and ended at 20:48 UTC (3173m). Little to no bottom current was apparent during the 6 hours of the dive on the seafloor.

## Geology

The dive began on a muddy/sandy slope at 3927m (14:26 UTC) which showed some lighter patches of sediment disturbance due to bioturbation and possibly rockfall. Scattered angular and rounded 20-30cm clasts of carbonate were present on the muddy surface. Some of the more angular clasts were Fe-Mn coated, but the majority were rounded and without appreciable Fe-Mn crusts. Occasional large metre scale boulders were observed (e.g. 3816m, 16:11 UTC). No ripples were observed in the sediment, throughout the dive. The frequency of the clasts was irregular, but in general they increased in number until 3788m (16:02) when carbonate outcrop was reached. The outcrop formed a steep face which extended for 80 vertical metres from 3788m to 3708m (16:43 UTC) and was likely the source of the clasts seen below. It consisted of sediment dusted, massive, pale coloured carbonate mostly without Fe-Mn coatings. Some of the carbonate was soft and therefore likely chalk (3710m; 16:43 UTC) (See photo below); downslope channels were recorded in the lower part of the outcrop (3770m, 16:23 UTC). Possible weak bedding was observed, highlighted by a thin layer of Fe-Mn coated carbonate. Similar Fe-Mn coated layers are visible in the *in-situ* carbonates higher up the canyon wall as observed by the E/V Nautilus/Hercules dive H1300. Presumably, some layers within the carbonate are chemically more receptive to growing Fe-Mn coatings. The carbonates appeared to dip relatively steeply, into the slope to the SW and if so, would suggest the outcrop is a large rotated slump block. This interpretation is also supported by the depth of the outcrop, which if *in-situ*, would mean the platform carbonate is ~2100m thick in this cliff face, which seems larger than estimates of thickness (1650m) in this area from seismic data. Sediment debris shoots were observed over the outcrop (e.g. 3754m, 16:32 UTC).

Immediately above the outcrop, the slope once again became a more gentle sediment covered slope with only rare carbonate clasts. The number of carbonate clasts began to increase at 3577m (17:24 UTC) and continued to increase until outcrop was reached at 3382m (18:30 UTC). The clasts were similar to those seen at the start of the dive, being mostly 20-30 cm in size, rounded, with little Fe-Mn coating. However, some more angular blocks were Fe-Mn coated and occasional larger blocks were observed. Some clasts showed bedding. Rills & trails of small clasts heading downslope were observed at 3477m (17:57 UTC), 3454 m (18:07 UTC) and 3420m (18:18 UTC) and increased in frequency as the outcrop was approached.

The second limestone outcrop extended for 112 vertical metres from 3382 m until 3270m (19:43 UTC). The outcrop consisted of sediment dusted, massive, pale coloured carbonate mostly without Fe-Mn coatings (see photo below). Very clear, metre deep and a few metres wide, channel-like depressions within the outcrop extended up the slope. Often they contained sediment and pebbles. They may be caused by downslope movement of debris flows. Some *in-situ* small debris flows were observed at the top of the outcrop (3270m, 19:43 UTC). Bedding was clearly observed in much of the outcrop and appeared to be dipping SW at approximately 15-20°. If this dip is correct, then this outcrop would also likely be part of a large, coherent, greater than 120m tall, rotated slump block. The base of this outcrop occurs approximately 1700m below the top of the west wall of the canyon and so the depth of the outcrop does not exceed the overall thickness of the platform carbonate sequence. Sediment cover increased towards the top of the

outcrop and debris chutes and debris flows were common (3624m, 19:46 UTC). Above the outcrop, the slope shallowed and became a muddy slope with occasional carbonate clasts of all sizes. The transect ended in sediment with sparse 10-20cm diameter clast at 3173m (20:45 UTC).

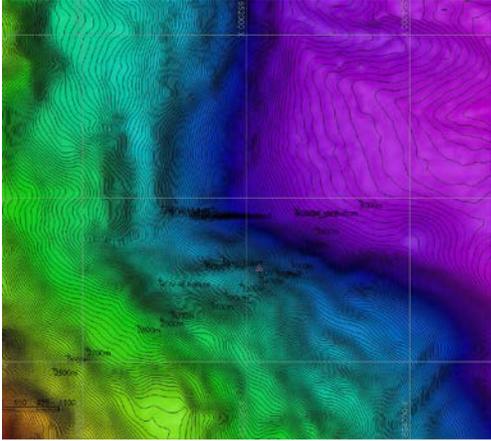
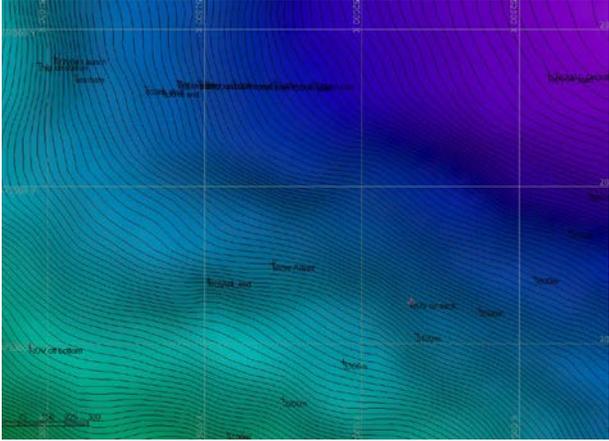
We did not manage to see the late Cretaceous to Middle Eocene arc rocks that lie beneath the platform carbonates.

### Biology

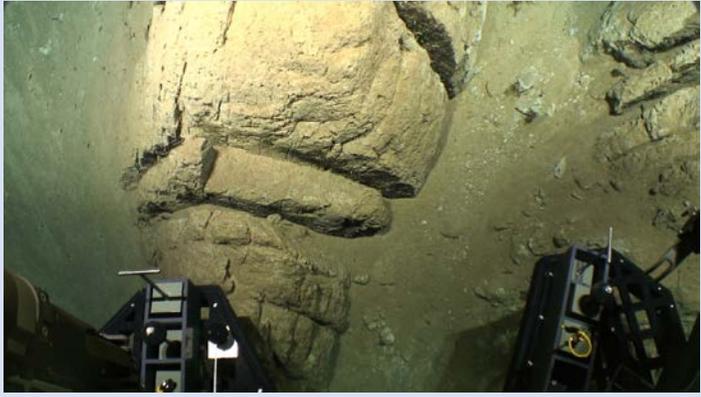
The D2 reached (14:26 UTC, 3927 m) a muddy bottom with various amounts of scattered rock rubble and rock debris. Amongst the rock, anchored in the sand, several sea pens (*Umbellula* sp.) and black corals (?*Bathypathes* sp.) were evident. The black whip coral (?*Stichopathes* sp.) was also observed attached to hard substrates in the beginning of the dive. A few sponges (Cladorhizidae, Hexactinellidae) and anemones colonized the rocks, but densities were fairly low. Further up slope (3588 m), one species of bamboo coral (Isididae) was observed. Interestingly, on the massive (80 m tall) carbonate blocks further up slope (~ 3700 and 3300 m), which appeared to be chalky, no visible colonizing species were found.

Approximately five species of fish were seen: *Aldrovandia* sp., *Coryphaenoides* spp., *Bathypterois* *grallator*, *Bassozetus* sp., and *Bathysaurus mollis*. Numerous holothurians (4-5 species) were evident, with an abundance of swimming forms (?*Peniagone* or *Amperima* sp.). Other echinoderms included brisingids (*Freyastera* sp.), sea stars (*Pteraster* sp.) and brittle stars (Ophiuroidea), and spiny urchins (unidentified). As for the crustaceans observed, numerous shrimp were present (*Aristaeopsis edwardsiana*), yet only one squat lobster (*Munidopsis* sp.) was observed.

A notable observation included several predatory tunicates, each with, seemingly, a symbiotic polychaete. Wood falls were prevalent throughout the dive, with typical wood fall fauna present (e.g., limpets, serpullids, *Idas* sp.). Sediment traces from echiurans and holothurians were evident in the muddy areas of the survey area. Five midwater transects (10 min each) conducted every 100 m from 800-1200 m were successful, with several amazing image captures of jellyfish, larvaceans, hatchetfish, dragonfish, and siphonophores.

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 10<sup>th</sup> Floor)  
Silver Spring, MD 20910  
(301) 734-1014