



## **CRUISE SUMMARY**

***R/V Atlantis / DSV Alvin Expedition AT-41***  
**August 19 to September 2, 2018**

for

### **DEEP SEARCH**

**DEEP Sea Exploration to Advance Research  
on Coral/Canyon/Cold seep Habitats**

**Deepwater Atlantic Habitats II:  
Continued Atlantic Research and Exploration  
in Deepwater Ecosystems with Focus on  
Coral, Canyon and Seep Communities  
Contract - M17PC00009**

## Expedition Background

The AT41 expedition on board the RV *Atlantis* with the DSV *Alvin* is the first submersible sampling cruise of the project. . The primary goals of this cruise are as follows:

1. Sampling of corals and associated fauna for biodiversity and biogeography
2. Community sampling at seep and coral habitats
3. Sediment sampling at soft sediment sites for biogeochemistry and diversity
4. Collections of corals for live coral experiments
5. Water sampling for water chemistry and microbial diversity
6. Sediment, water, and faunal samples for eDNA work
7. Geological observations and sampling for geomorphology
8. Site selection for lander deployments
9. Description of the communities surrounding ADEON moorings

## General Dive Plans

Each dive will have a specific plan based on the type of habitat, the sampling needs at the site, the capacity of the Alvin “basket,” the results of the previous dive(s), and the overall needs of the entire project in mind. Although much of this information will only be available the evening before the dive, there is enough existing information to present generalized dive plans for the three habitats that are the focus of this study: canyons, corals, and cold seeps.

### Canyons

The canyon dives will focus on coral diversity, biogeochemistry, macro-infauna, geology, and water sampling. If bubble plumes and seeps are present, they will also be investigated. Dives will begin in the deepest parts of the chosen targets, and proceed upslope.

Basket: 24 push cores, 5 niskins, 1-chamber slurp, biobox w/ partitions, coral quivers

Priorities: corals for barcoding, key coral and mussel species with associates for pop gen, push cores in canyon axis and near corals and/or mussels, water samples near scleractinians and large coral colonies, rocks for geology

### Corals

These dive plans are primarily focused on the *Lophelia*-dominated habitats in the southern part of the study area.

Basket: 12 push cores, 5 niskins, 1-chamber slurp, 2 bioboxes, coral pots, coral quivers

Priorities: Coral community samples (near ADEON mooring, if present), push cores associated with community samples and away, water samples associated with community samples, rocks (if present), other corals for barcoding, video survey of area surrounding ADEON mooring (if present), *Lophelia* in bioboxes for live coral experiments

### Seeps

These plans are based on the habitats found at the main seep sites: Blake Ridge, Cape Fear, and Norfolk. Other seeps that are associated with the shallow parts of some of the canyons are handled within those plans.

Basket: 36 push cores, 5 niskins, 1-chamber slurp, sample quivers, 2 mussel pots

Priorities: Mussel community sampling, push cores associated with community samples and away, mussel sampling into bioboxes for pop gen plus gill/host genomics, water samples associated with all mussel samples, carbonates

## **Expedition Activities**

### **August 16-18: Cruise mobilization**

The first of the expedition participants, including the chief scientist, arrived at the ship on the morning of the 16<sup>th</sup>. We began loading gear onto the ship, some of which had been shipped to the WHOI facility and some that had been transported up by the participants. Everything went smoothly and preparations were made to embark.

During this time, sites were sent to the Navy for clearance of the activity areas. In the past, this had been conducted by a single point of contact at the Navy, but now each individual field office had to be contacted for approval of our sites. One of the sites (Norfolk Seep) was denied, so two additional sites were submitted for clearance (Wilmington Canyon and Pea Island Seep). While Wilmington Canyon is outside of the area of highest priority for BOEM, it was considered relevant to the study and relevant to the objectives of the NOAA Deep Sea Coral and Research Technology Program, which paid for 2 of the operations days on the cruise. All of the sites were cleared in time for departure, except for Pea Island.

All of the science party was on board by the morning of the 18<sup>th</sup>, and the first science party orientation meetings and safety videos were held on the 18<sup>th</sup>.

### **Aug 19: Departure**

The ship left on time around 0530 on the 19<sup>th</sup>. Safety drills were conducted and a series of science meetings were held about sampling and labeling protocols for the different categories of samples anticipated (community collections, corals, sediments, and water). The Alvin basket was prepared and the first dive plans were composed.

### **Aug 20**

#### **0200 Multibeam**

We arrived on site around 0200 and began multibeam mapping around the head of Wilmington Canyon. We were on station for the first dive by 0700

#### **0800 Alvin 4960 - Wilmington Canyon**

The first dive of the series began right at 0800. It was a PIT dive, the last one for pilot-in-training Danik Forsman. Amanda Demopoulos was the observer. Unfortunately, when the sub hit the bottom around 700m depth, it encountered 3.5kt currents and near-zero visibility. They fought this for a while, but fishing line was observed and there was little control of the vehicle in these harsh conditions. They came up to about 600m depth but there was no change in conditions. Given the presence of fishing line in the area, the

relative lack of control of the vehicle, and the low visibility, the decision was made to call the dive and recover the submersible.

### **1300 Alvin recovery**

Following recovery, the ship transited to Pea Island Seeps. During the morning, we received clearance to dive at the site. However, we also had our clearance for the Blake Mounds site revoked, and were informed that we should remain very close to the center of the area that we had clearance for at the Million Mounds site. We are hopeful that the rest of the sites remain clear for diving.

## **Aug 21**

### **0400 Multibeam**

We arrived in the vicinity of the Pea Island seeps around 0400. The ship lost its heading and compass feed around the same time, so they went to manual steering. We ran a few multibeam lines over the Pea Island site to confirm that it was still active. Large bubble plumes were apparent in the water column data from the multibeam, indicating that the site is still very active in roughly the same places that it was when it was last examined approximately 1 year ago.

### **0800 Alvin 4961 – Pea Island Seeps**

The dive went well. There was a squad of squid surrounding the sub during the entire dive. There were two main seep areas, and these appeared to be very active with large bacterial mats and visible bubble plumes in places. There was some outcropping carbonate at one site, quill worms in one of the bacterial mats, and *Chaceon* crabs scattered throughout. A series of push cores were acquired in mats and in a control area. Towards the end of the dive, the fingers of the port manipulator froze and the remaining sampling had to be done with the less dexterous starboard manip.

### **1700 Alvin recovery**

We took some great drone footage towards the end of the dive and during recovery. Flight conditions were pretty good, although landing was a little challenging in the wind.

### **1800 CTD 01 and 02**

After recovery, two CTD casts were conducted. One was right over the position of the most active bubble plume according to the water-column multibeam data from the morning, and the other was approximately 1km to the east away from the seep. The CHL max was at approximately 80m depth over the seep, and 60m depth away from the seep. Following the CTD casts, we transited to Pamlico Canyon.

## **Aug 22**

### **0200 Multibeam**

We arrived at Pamlico Canyon around 0200 and began multibeam surveys of the deeper parts of the canyon where it gets much wider and there are holes in the existing data. Once these holes were filled in, and we could clearly see the dog-butt-and-tail shape of the bottom of the canyon, we set up at the dive site.

The seas were about 5-7 feet and the winds were up between 25-30 knots on the dive site. We waited for about an hour and watched the weather, but the forecast suggested that the conditions would not improve. The decision was made to move on to the more southern sites. Rather than go to the next site (Cape Fear Seep), we took advantage of the extra time to transit all the way to the Stetson Deep site, approximately 200 miles to the south.

## **Aug 23**

The transit to the Stetson Deep site (on a feature that was referred to as Richardson Ridge during the *Okeanos Explorer* cruise of May 2018) took a bit longer than we thought it would because we were battling a 3 knot current most of the way down to the site. We arrived a bit later than planned, and the dive got in a bit late.

### **0930 Alvin 4962 – Richardson Ridge**

The dive was over *Lophelia* rubble the entire length of the 1.5 km dive track. The currents were very strong, approximately 3 knots at times, and the sub battled them all day. The vehicle reached the bottom nearly 1 km from its launch position, so we began working where we landed rather than chasing arbitrary waypoints. The substrate was mainly dead rubble near the bottom of the feature. As we began up the hill, a high density of small plexaurid octocorals were observed. On the leeward side, most of the coral was dead, but at the crests and the windward sides of the mounds, there was a high cover of live coral. A series of *Lophelia* collections were made, along with a large *Madrepora* colony, and some smaller *Enallopsamia* colonies. These came with a variety of octocorals and associates including brittle stars and crinoids. Early in the dive, a large swordfish swam around the sub and through the *Lophelia* reef. A nice 4K highlight video was captured of the event. This was the first dive that the 4K camera was available, and it was used on a number of occasions to capture highlight video. Although the dive went in late, the high currents resulted in heavy battery use and a relatively early recovery.

### **1700 Alvin recovery**

### **1730 CTD 03 and 04**

We immediately took two CTD casts, firing all of the bottles near the seafloor, to get enough water to keep the corals alive. It was noted that there wasn't a clear thermocline, with a steady decline in temperature all the way to the 800 m deployment depth, where the temperature was approximately 9 deg C.

### **1830 CTD 05**

After dinner, another CTD cast was obtained to collect a full water column profile. We then began multibeam mapping in the area overnight. This helped to determine the full extent of the linear cold-water coral mound features in the area.

### **Aug 24**

Overnight, some of the corals that were collected were fragmented, mounted on small PVC pedestals, and stained with alizarin red. They were then placed onto concrete blocks and prepared for deployment.

### **0800 Alvin 4963 – Richardson Ridge**

This dive was on coral rubble and live coral the entire time, just as the previous dive. This dive started deeper (over 800 m) in the trough to the west of the line of coral mounds. We expected to find some core-able mud here, but the seafloor was still entirely composed of coral rubble. The sub climbed from here up to the top of the closest mound in the line of mounds. More live coral was encountered as the sub ascended. There appeared to be more particulates in the water here than there were the day before. A few fish were noted, including roughy and small orange hagfish. There were a few small octocorals, including our first sighting of *Paragorgia* in the area. A suitable place for the coral growth deployments was located and they were deployed along with a 2-3m high marker. A series of *Lophelia* collections were made into the sterilized quivers for microbial work. At this point, the port arm developed a leak in the pressure compensator, and the arm was secured and the sub had to remain in place rather than changing depth and raising the probability of water intrusion. Some 4K highlights were obtained in this location, and then the sub came up a bit early.

### **1400 Alvin recovery**

It appears as if this feature is entirely made up of a linear series of coral mounds. Overall, it extends approximately 15 nm and consisting of multiple lines of mounds, all likely composed of dead coral with living coral on the crests. In total, there was approximately 86 miles of coral mounds in the Richardson area. This was all released as a story in the Huffington Post on Aug 26<sup>th</sup>.

### **1600 CTD 06 and 07**

A CTD cast was taken near the dive site, and a second was taken away from the dive track. Then we filled in some of the gaps in the multibeam so we got a clear picture of the full extent of the lines of coral mounds. The Atlantis then headed for the Blake Deep site a few hours away.

## **Aug 25**

### **0800 Alvin A4964 – Blake Deep**

Alvin set down near the intended launch target in an area of small boulders with corals on them surrounded by sandy sediments and occasional patches of coral rubble (primarily *Solenosmilia*). At first, it was mainly large bamboo colonies and a variety of other octocorals and antipatharians. A few collections and cores were taken, and then the sub headed for the first waypoint. They then turned to approach the wall, but the coral cover declined a bit near the base of the wall. The rubble here was primarily *Madrepora*. The sub started up the wall, in low coral abundance at first, but increasing towards the top. Colonies of *Madrepora*, *Enallopsamia*, and *Solenosmilia* were collected along with a variety of octocorals and a large dead bamboo coral skeleton.

### **1700 Alvin recovery**

### **1830 CTD 08 and 09**

Two CTD casts were obtained to get bottom water for the coral tanks and to complete a full water column profile. We then began our transit over to the Stetson Banks sites.

## **Aug 26**

Upon arrival at the site, there was a strong, 4 knot current on the surface. The ship moved approximately 1 km to the WSW of the bottom target for launch.

### **0800 Alvin A4965 – Stetson Banks**

After launch, the current continued in roughly the same direction. The sub moved almost 2km from its launch position to the bottom location. Rather than attempting to return to the list of waypoints, the sub moved straight towards the wall feature that was the subject of the dive. There was a heavy amount of marine snow in the water during the entire dive. On the way to the wall, there was cobble and carbonate pavement with occasional *Leiopathes* colonies and small *Lophelia* and *Enallopsamia* colonies. There were a good number of squid swimming around the sub during the transit. A variety of scleractinians and octocorals were collected into quivers and a rock was placed on the basket during the run to the wall. The wall came up steeply, with a pile of debris near the foot of the wall and plate-like ledges on the way up. There were few corals near the base of the wall, but higher abundances towards the top, particularly on overhanging ledges. More squid came

back to the sub near the top of the wall. The sub transited laterally along the top of the wall for a time, which had a number of Lophelia colonies and small white plexaurids. These were collected along with a bamboo coral. A large white Leiopathes colony with chirostylid crabs was observed and filmed near the top. Near the end of the dive, the sub came to the top of the wall and transited over the plateau. The current was moving quickly on top, and there were occasional, small Lophelia colonies and more of the short white plexaurids. A coral pot was obtained over one of the small Lophelia colonies.

### **1700 Alvin recovery**

### **1830 CTD 10**

After the recovery of the sub, 2 CTD casts were obtained. The first was a complete water column profile and the second was a collection of bottom water for the live corals. Following these, a block of multibeam was obtained to try to connect some of the maps that had been made by the Okeanos earlier in the year.

## **Aug 27**

### **0800 Alvin A4966 – Stetson Banks**

The goal of this dive was to locate the ADEON lander at the site and determine the community structure surrounding the area. The sub was launched over a km from the bottom target because of the strong surface currents. When the sub reached the bottom, it was still 1200 m from the mooring target. There was a hard ground in the pump for the main ballast tank, so that was secured during the dive.

The seafloor was a hard carbonate pavement with sponges, small stylasterids, very short octocoral colonies and sargassum. In small depressions in the carbonate, there was a sandy bottom with ripples from the obviously strong currents that are typically present at this site. Further along, there were patches of two different species of primnoids (one may be Callogorgia?) and larger yellow Acanthogorgia and Leiopathes colonies. There were also occasionally patches of baseball sized cobble with a heavy manganese crust. In some areas, there were small, interspersed Lophelia and Enallopsamia colonies.

During all of the transits, the sonar was ranged between 50 and 300 m out, and the sub maintained a constant scan for the floats of the lander. The sub ran north over the lander target, continuing for about 100m. The sub then came south east and then back to the west, running another line of the target. No sign of the mooring. The sub continued to the west another few hundred meters, and then came north and ran another parallel line, all the time scanning with the sonar. An effort was made to circle larger rock outcrops to avoid sonar shadows behind them and complete a thorough search. After running east, the sub went south so that it was about 100 m to the SE of the target. The sub came up

off the bottom and drifted with the prevailing current in the hopes of running across the lander, but it was never seen. The sub left the bottom at 1500 local.

### **1530 Alvin recovery**

### **1630 CTD 11 and 12**

Following recovery, there were two CTD casts obtained over the site, the first for a water column profile and the second for bottom water. We then made our way to the Blake Ridge site (approximately 120 miles away). Now that we are going with the Gulf Stream, we are making excellent time, traveling nearly 15 knots for much of the transit.

The ship had to stop at one point so that the sub could be rolled out and the cover of the main ballast tank removed. The J-box was opened and inspected, but the ground was eventually traced to the penetrator behind the ballast tank. This was repaired by about midnight.

## **Aug 28**

Upon arrival, the currents had slowed to about 0.2 kts and the seas were flat calm. Ivan was allowed to get in the small boat and shoot video of the launch as a swimmer.

During the pre-dive in the morning, there were power issues with some of the systems on the port side, but this was eventually traced to a computer error that was corrected in time for a normal launch time. Putting the ballast tank together took a little extra time but we still got a full dive.

### **0830 Alvin 4967 – Blake Ridge**

The sub landed right on the numbers and began to cruise the crater at the center of the site. There was a lot of authigenic carbonate around the perimeter, but little bacterial mat was observed. The mussel bed was sampled and a mussel pot obtained along with a set of push cores. The sub then went to the second target, where there were a lot of live mussels, including smaller mussels. All of the observed mussels were *Bathymodiolus heckerae*. There were no *B. childressi* observed or collected. There were also numerous lucinid clams and heart urchins burrowing through the reduced sediments. At the third target, there were 3 long lines of mussels, apparently arranged in linear faults overlying the diapir. Some of the mussels had bacterial mats on the shells. This may indicate that there was actually sulfide up in the water column at this location. There were many large empty shells at this location. A mussel pot and a set of cores were obtained here. They completed the loop around the different waypoints and then returned to the main crater to complete the sampling.

### **1700 Alvin recovery**

### **1800 CTD 13**

The CTD cast was deep and the wire was fouled at one point, so the entire cast took nearly 3 hours. At that point, it was decided that there was not time for a multicore sample offsite. However, since the sub obtained apparently off-site cores, this sample wasn't as necessary as was thought.

## **Aug 29**

Overnight, we transited to the Cape Fear seep site to complete a multibeam survey over the active part of the site. After running a single line over the site, we continued on to the Cape Fear coral site, running perpendicular to the Gulf Stream on the way. We arrived on station for the scheduled dive time.

### **0800 Alvin 4968 – Cape Fear coral mound**

The dive started on the western side of the coral mound. The sub approached the mound, going almost straight into the current. A coral pot and a series of cores were obtained in coral rubble near the base of the mound. The sub continued upslope, fighting the current the whole way. A second coral pot was obtained in standing dead coral skeleton, and a series of push cores were taken. A few octocoral collections were made, and the sub made it near to the top of the mound. At this point, the batteries were running low. The final coral pot was taken in mostly live coral, and live coral was collected into the biobox. A colony of *Paramuricea* was also collected. The sub then sat down and waited for the ship to be ready for recovery, and 4K video of a number of fish and crabs on the coral habitat was filmed.

### **1530 Alvin recovery**

### **1630 CTD 14 and 15**

Following the recovery of the vehicle, two CTD casts were taken. The first was a full water column profile, and the second was a collection of bottom water for the live coral maintenance. Temperature sensor 1 was changed out on the CTD after the second cast. Then the ship began the transit to Pamlico Canyon.

## **Aug 30**

We arrived on station early in the morning, and there was a 3.5 knot current on the surface. We adjusted the launch position from the ship to be 1.2 km down-stream (230 deg) of the bottom target.

### **Alvin 4969 – Pamlico Canyon**

The sub drifted most of the way over to the bottom target on descent, but had to drive the rest of the way over there. They landed right on the numbers, safely away from the side of the canyon wall and with little current in the area. There were a few boulders here, and

a set of push cores were taken in soft sediment. The sub headed for the next waypoint, which was inside the “dog tail” of the canyon. There were a series of short ledges and walls climbing up into the tail. There was a lot of sediment away from the walls and another set of push cores was taken out here. The canyon axis did not appear to be very active. The sub began the climb up the wall, which appeared to be mud stone with occasional ledges and overhangs. Most of the corals here, *Desmophyllum* and *Solenasmilia* along with *Acanthogorgia* and *Paramuricea*, and *Acesta* clams were under the overhangs. Occasionally, there were small piles of dead coral rubble accumulating on the ledges, and a few larger antipatharian colonies. As the sub approached the top of the wall, the current picked up a bit, but was still not like we had been dealing with on shallower dives. Near the top of the wall, at approximately 1100 m, there was a large *Paragorgia* and a subsample was taken.

### **1700 Alvin recovery**

The sub was on deck right at 1700, and the ship started its transit to Pea Island.

### **2100 Multicore**

The multicore was acquired over the most active part of the Pea Island seep. This was the location of the CTD cast following the dive here. The sampling went well, and the cores were offgassing on the surface.

### **2230 CTD 16**

The CTD cast was taken over the northern part of the previous dive track, in a different active area of the seep. Following the CTD, the ship continued to transit to the Norfolk Canyon site. We realized on the way that the planned dive was outside of our clearance area, and the dive was re-located to the deeper part of the canyon. While this was not part of the plan, no one on board could think of a time when a dive was made in this part of one of the canyons, so it is a true exploration.

## **Aug 31**

### **0800 Alvin 4970 @ Norfolk Canyon**

The sub landed off in the flat, central part of the canyon. The Dan Cam was placed out in front of the camera and filmed itself flying by and landing in front of the camera. The camera was retrieved, and they took a set of push cores. The sub went towards the wall at the edge of the canyon, running over sediment most of the way. There was a small rise and some scattered boulders at the bottom of the wall, but still primarily sediment. Towards the top of the wall, there was a small field of *Acanella* bamboo corals. Further up, there were groups of sea pens, first very short and then long, slender forms. Some of each were collected into the biobox and quivers.

### **1700 Alvin Recovery**

Following recovery, the sub was stripped down and washed in the car wash.

### **1830 CTD 17 and 18**

The first CTD cast was for a complete water column profile, and the second was to collect bottom water for the live corals as we prepared to head to port.

### **Sept 1**

We spent the day transiting back to Woods Hole while finishing up some final analyses and packing up the labs.

**END AT-41**