IODP Expedition 336: Mid-Atlantic Ridge Microbiology

Week 7 Report (30 October – 5 November 2011)

Science Results

This week we continued RCB coring with a second bit, conducted downhole logging and hydrologic (packer) experiments, and assembled a multi-level CORK observatory. This follows on the last two weeks of work preparing Hole U1383C for an observatory deep into oceanic crust.

This week Cores U1383C-19R to 32R penetrated from 211.6 to 331.5 mbsf and recovered 21.8 m (18%). The section recovered shows a gradational change from glassy to variolitic with abundant hyaloclastite to more massive microcrystalline to fine-grained basalt with rare glassy margins. All basalts are non-vesicular and aphyric to sparsely plagioclase-phyric. The extent of alteration is weak to moderate. Hyaloclastites are noticeably palagonitized. Vein densities increase somewhat down section with up to 50 veins per meter. Zeolite veins are abundant in the upper parts of the section, while carbonate veins predominate in the lowermost part. Sparse vesicles are filled with zeolite and clay.

Microbiological sampling: This week we collected 28 additional hard rock whole rounds for microbiological analysis, for a total of 79 hard rock whole round microbiology samples from Hole U1383C. Samples were selected in the core splitting room as quickly as possible after core recovery, following initial discussion with petrologists on sample representation and photographing of the sample before removal from the core liner. Samples were preserved for ship-based (deep UV fluorescence scanning, culturing and enrichment, fluorescent microsphere analysis) and shore-based (DNA and RNA analysis, shore-based fluorescence in situ hybridization, cell counting analysis, isotopic analysis) studies. Generally, one to three microbiological hard rock samples were collected from every core section. Hard rock samples span a range of lithological units, alteration states, presence of chilled margins, and some contain veins/fractures. Additionally, a few recovered plastic bags that held the fluorescent microsphere solutions in the core catcher have been collected as a contamination check in DNA analysis. Examination of the microsphere abundance in/on the recovered samples is ongoing.

Logging: We conducted a very successful 22.5-hour logging program in the 331.5 m deep Hole U1383C. Two full passes were completed with the first tool string containing the DEBI-t deep UV-induced fluorescence sonde, density/caliper (HLDS) and spectral gamma ray (HNGS) tools. Following this, two full passes were completed with a second tool string with the spectral natural gamma ray sonde, dipole sonic imager (DSI) and formation microscanner (FMS). As soon as the logs were obtained, we made preliminary depth shifts and processed the FMS data so that we could use the data to plan the hydrologic (packer) experiments and the CORK observatory configuration. The log data indicate that Hole U1383C is in great shape with a large portion of the hole ‘in gauge’. The logging data are currently being processed, but provisional processing suggests good data quality, and high-quality electrical images.

Hydrologic (Packer) Experiment: We intended to conduct hydrologic (packer) experiments of the oceanic crust at three different levels in the borehole. The first level was to test the entire hole by setting the packer in the lowermost portion of the casing. Due to heave and the smoothness of the interior of the casing, we could not get the packer to set. We were able to set the packer in open hole at ~141 mbsf (~105 m into basement) and conducted constant flow injection tests. Our last attempt to set the packer at ~196 mbsf was not possible as the packer would not inflate. After recovering the packer it was observed to have been damaged during the experiment. Furthermore, the data downloaded from the pressure logger indicated that the packer may have been leaking even during the experiment at ~141 mbsf.

Physical Properties: We have completed all whole-round as well as half-section measurements. Velocity, density, and porosity measurements on discrete samples are partially completed (through Core 27R); these were chosen to represent the observed lithology and alteration. Altered samples showed higher porosity and lower bulk density with a low of 2% for the less altered samples to 19% for the more highly altered samples. Velocity also strongly correlates with alteration and porosity with the 4.74 km/s for the most porous sample and a maximum of 7.73 km/s for an unaltered sample. At least one thermal conductivity measurement has been done per core; values obtained for this measurement ranged from 1.37 to 1.78 W/(m·K).

CORK Observatory: At the end of the week, we had just finished assembling a 247.6 m long CORK observatory for deployment. This includes three packer assemblies to isolate three separate depth intervals in oceanic crust. Five external umbilicals allow access to these three zones for microbiological, geochemical, pressure sampling. The CORK tubing (coated steel and fiberglass) extends to 247.6 mbsf and includes perforated and slotted intervals (67.4 to 129.4, 154.8 to 181.1, and 203.7 to 246.6 mbsf) that provide access to the three isolated intervals. An internal OsmoSampler string extends the full length of the CORK and includes seals isolating the three zones and microbiological, geochemical, and temperature experiments.

Operations

The week began with deploying a second RCB bit to continue coring in Hole U1383C. After the bit was lowered to the bottom of the hole it was circulated clean and an RCB core barrel was dropped and coring resumed with Core U1383C-19R. We decided to core with drilling knobbies because of high vessel motion and operating in deep water. RCB coring continued through Core 23R where we made a short wiper trip to both clean a short section of hole and to replace 3 drilling knobbies with a stand of 5.5 inch drill pipe. Once the bit was back on bottom, we circulated a mud sweep and resumed coring. Two 20-barrel sweeps were pumped on every core to keep the hole clean. We decided to stop RCB coring at 4756.7 mbrf (331.5 mbsf) due to accumulating bit hours and because sufficient depths had been reached to achieve the CORK objectives. Thirty-one cores recovered 50.31 m from a 262.0 m interval. Overall recovery was 19%, but varied from 13% to a maximum of 28% near the bottom of the hole.

At 1400 hours on 1 November, the first wiper trip began and hole cleaning continued until the following day. Three wiper trips were made from total depth (TD) to the 10.75 inch casing shoe and back to TD. Tight spots were recorded at 4692, 4703, 4708, 4716, 4724, 4743, 4751, and 4752 mbrf. These were reamed and rechecked

during the first wiper trip. At the end of the first wiper trip, 4 m of fill were found on bottom and cleaned out. We circulated a 70 barrel sweep of high viscosity mud and then the hole was displaced with salt water. The subsequent two wiper trips did not detect tight spots or fill on bottom. At 0545 hours on 2 November, we started to pull the string out of Hole U1383C and it cleared the seafloor at 0625 hours. The RCB bit was back on the rig floor at 1315 hours.

Before we started assembling the logging/packer BHA, we picked up and assembled six 6.75 inch perforated drill collars into a stand. The exterior of the stand was then completely coated with an epoxy paint and set back in the derrick to cure. This stand is the lowermost portion of the CORK completion string.

The logging and drill string packer BHA was then assembled and lowered to the seafloor. After ~3 minutes of maneuvering, we reentered Hole U1383C at 2342 hours on 2 November 2011. The logging bit was then positioned ~5 m from the base of the 10.75 inch casing shoe.

The logging equipment was rigged up to run the Adapted Microbiology Combo II tool string – this included the DEBI-t deep UV-induced fluorescence, density/caliper (HLDS) and spectral gamma ray (HNGS) tools. During assembly, the resistivity sonde failed and had to be removed from the string. The tool string was run into the hole and two full passes were conducted tagging bottom and confirming drill pipe depth and lack of fill in the hole. After this first tool string was back on board, the FMS-Sonic tool string was rigged up – this included the spectral natural gamma ray, dipole sonic imager (DSI) and formation microscanner (FMS) tools. This second string also completed two successful passes; it was pulled out of the hole and rigged down at 2315 on 3 November 2011.

Following logging, we picked up the top drive and prepared for the first of 3 scheduled packer tests. The packer was unable to be set in the casing and the packer test at this level was abandoned. The packer was then moved to 4566 mbrf (140.8 mbsf) in open hole. The packer was inflated and flow tests were completed as scheduled. The packer was then moved to the final position, but was unable to pressure up. The packer experiment was concluded, the top drive set back, and the drill string pulled out of the hole to just above the seafloor.

Our next operation was to deploy an ROV platform at Hole U1383B to facilitate future observatory installation by ROV. We moved to Hole U1383B, deployed the camera system, and reentered Hole U1383B at 1350 hours on 4 November. We retrieved the camera system and then assembled a modified ROV platform around the drill pipe, and let it free fall down onto the reentry cone at the seafloor. The platform had been modified to self-center on the reentry cone as there is no CORK to help it center as normal. The camera was deployed and the platform was observed to be sitting in the cone – although perhaps only slightly off-center. The bit was pulled out of the hole of and ROV platform at 1818 hours. After pulling the bit well above the seafloor, we had to pause operations to slip and cut the drill line. At 2015 hours the trip out of the hole resumed and the logging bit arrived back on the rig floor at 0300 hours on 5 November. We observed that the drill string packer element had experienced a blowout. After we had the drill collars stored in the derrick, we then began assembly of the Hole U1383C CORK observatory.

The observatory assembly started with lowering the pre-assembled 6.75 inch perforated drill collar stand below the rig floor. We picked up, assembled, and painted (epoxy) four additional 15 foot-long perforated drill collars, which was added to the top of the first stand to provide weight to the bottom of the CORK. We then started assembling the various pieces of the CORK including (1) external umbilicals terminated at screens, (2) coated and perforated steel and slotted fiberglass tubing, (3) landing seats, (4) packers, and (5) a variety of required cross-overs. At the end of Saturday, 5 November, we had finished assembling the 247.6 m long CORK observatory and were preparing to lower it to the seafloor.

Education and Outreach

Outreach efforts for this expedition have continued through a variety of programs.

Blogs: Current bloggers this week include our onboard education officer Jennifer Magnusson (personal, educator ideas, and a blog for kids) and staff scientist Adam Klaus (operations). Katrina Edwards continues her blog on the *Scientific American* Expeditions page and the C-DEBI site, and was joined this week by guest blogger Geoff Wheat. Beth Orcutt continues to blog about microbiology on the Adopt-a-Microbe website and Amanda Haddad continues to provide science content and connect with a special needs audience on the Classroom Connections website. Heath Mills continues writing about Mid-Atlantic Ridge microbiology on Texas A&M's georesearch page.

Videoconferences: Nine live ship-to-shore interactive programs were conducted with the following audiences: 9th graders in North Carolina, a 4th-12th grade science club in New Jersey, 4th/5th graders in California, 7th graders in Virginia, 6th/7th graders in Texas, 7th graders in Nebraska, and 9th graders in Texas. In an additional classroom connection, one of our scientists performed a guest read-aloud of an ocean-themed book and answered questions for a kindergarten class. Seven interactions are scheduled for next week.

Social Media: The education officer continues to post daily updates on the JR Facebook page and Twitter account. Updates include links to the blog or other pages on the JR website, photos, videos, operational updates, and classroom activities. Daily math questions continued to be posted. Many pictures and blog posts were written about our experiences celebrating Halloween at sea.

Adopt-A-Microbe: Week 7 activities (classes cultured microbes from the Winogradsky columns) were submitted and Week 8 activities ("Microbe Farts:" how microbes process chemicals in the environment) were assigned.

Classroom Connection: This week's theme was "Marine Life," and students participated in a variety of related activities. These included learning about the food chain, exploring bizarre animals of the Atlantic, building a fish, and an interview with the ship's doctor, Jeffrey Hernandez.

Documentary: The videographers have continued full-time filming and interviewing for their documentary.

Technical support and HSE activities

Science Mission Support: During the 7th week of the expedition, technical staff provided analytical support for coring operations at Hole U1383C, hard rock

sampling party and CORK deployment. In addition, staff worked on various maintenance issues around the laboratories. Staff started preparing for the end of the expedition including preparation for shipping and communicating an end-of-expedition activity calendar to the scientific party.

Other Technical Activities:

- Continued to assist scientists with DESCLogik;
- Continued to work with staff to correct and test upgrades to Sample Master;
- Issues with the presentation of the coring line winch depths (XBOB) appears to be operational after serial port conflicts were resolved;
- Work continued on the 3D camera project:
    - Temporary mounting hardware installed for testing system on the SHMSL
    - Coding and testing of software modules in progress
- New rack for the Movie room entertainment system was fabricated and installed;
- WinFrog 1 (navigation computer) operating system was upgraded to Windows 7;
- Removed seismic streamer to return it to College Station for storage;
- Magnetometer tow cable was transferred to the seismic winch for easier and safer operations;
- The Solid Rock Analyzer (SRA) main board failed and will be returned for service.

The weekly fire and abandon ship drill was held as scheduled.