IODP Expedition 330: Louisville Seamount Trail

Week 6 Report (17-23 January 2011)

OPERATIONS

Rotary coring on Rigil Guyot continued in Hole U1374A until 0545 hr on 18 January when erratic pump pressure indicated that there was a problem at the bottom of the drill string. Instead of continuing to core with a bit that far outlasted its expected life with 133.4 rotating hr, we decided to end coring at a final depth of 522.0 mbsf. The penetration into basement was 505.3 m with an average recovery of 88.0% and an average rate of penetration of 2.5 m/hr. The average recovery for the entire hole was 87.8% with an average ROP of 3.9 m/hr.

After a routine wiper trip, which suggested that the hole was in good condition, the rotary shifting tool was deployed to release the bit. However, several attempts to release the bit failed. It was eventually decided to trip the drill pipe, remove the bit and mechanical bit release on the rig floor, and make up a shorter logging bottom hole assembly with a 9¼" diameter logging/clean-out bit that would allow more of the open hole to be logged. As the drill pipe was being recovered, sepiolite-laden mud was being discharged under pressure on the rig floor with the opening of each connection. In order to remedy this, the circulating head was made up and the pipe was flushed out. It is speculated that during this process, the bit may have been released and fell to the seafloor because no further mud was discharged as the remaining pipe was recovered. The exact time and position of the bit release can only be speculated.

The end of the pipe cleared the rotary table at 2015 hr on 18 January. A shorter logging bottom hole assembly was made up with the cleanout bit and deployed at 0145 hr. The bit entered the free fall funnel (FFF) at 0430 hr on 19 January and was positioned at a logging depth of 101.2 mbsf. The standard Triple Combo suite was made up and run in at 1045 hr. The tool was not able to advance into the open hole because of a bridge only ~7 m further down. The tool was recovered and the bit lowered to 143.6 mbsf to clear the bridge. The bit was then pulled back and placed at 110.8 mbsf. When the Triple Combo logging tool was

unable to advance past 138.0 mbsf, the tool was again recovered and reconfigured to a shorter assembly using the density and gamma ray sensors only in the hope that this would more easily negotiate an entry into the hole. After this attempt was unsuccessful, the drill pipe was recovered with the bit clearing the rotary table at 1115 hr on 20 January.

A 4-stand RCB coring assembly was made up with a new mechanical bit release and a used bit (recovered from Hole U1373A). The drill string entered the FFF at 1540 hr on 20 January. From 1730 hr to 2315 hr, the hole was washed and reamed to bottom (522 mbsf), flushed with mud, and then displaced with 165 barrels of heavy (10.5 ppg) mud. The bit was dropped at the bottom of the hole and the end of pipe placed at a logging depth of 128.1 mbsf, which was ~18 m deeper than the previous logging attempt and below a potentially unstable zone in the formation. An extra stand of drill collars was added to the bottom hole assembly (BHA) to keep the tapered drill collar as close to the seafloor as possible. This is the usual “choke point” where a BHA gets stuck.

The Triple Combo logging tool was made up and deployed again at 0540 hr on 21 January and succeeded in logging the hole up from 520 mbsf. The second instrument deployed was the Göttingen Borehole Magnetometer (GBM), which made one full pass down from the rig floor to 520 mbsf and back up. The communication with the GBM was lost while being retrieved in the pipe, however because a sighting of the tool was carried out at the start of deployment, the rotation history of the GBM is still obtainable. The third logging run was performed with the Formation MicroScanner (FMS)-sonic, which also successfully came within 2 m of the bottom of the hole. The fourth log was conducted with the Ultrasonic Borehole Imager. The fifth log was a re-deployment of the GBM tool. All runs were successful.

While the GBM was deployed for the second time, the driller noticed that the suspended string weight was getting slightly lighter indicating that the formation was starting to squeeze the BHA. To compensate for this, the driller picked up the string an additional 3 m. When the logging tool was being retrieved, the

vessel had to be offset 75 m to lower the pipe connection the additional 3 m so that the slips could be set. From 2215 hr on 22 January to 0930 hr on 23 January, the driller attempted to free the drill string. Although circulation was maintained, there was no rotation and the drill pipe could not be raised or lowered. Realizing that further efforts would be fruitless, the crew made the necessary preparations to sever the drill string directly above the tapered drill collar. The top of the tapered drill collar was ~13 m below the seafloor. The drill pipe was severed at 1500 hr on 23 January.

Once the drill pipe was recovered and the beacon retrieved, the vessel was secured for sea. The vessel departed for Prospectus Site LOUI-2B at 1945 hr on 23 January with an estimated time of arrival of 0500 hr on 25 January.

SCIENCE RESULTS

Eight different lithofacies were defined in the sedimentary cover and in sedimentary intervals of the volcanic basement of Site U1374 on Rigil Guyot, permitting the overall characterization of the depositional environment. The volcanic basement between 291.27 and 116.45 mbsf comprises thin bedded basalt sandstone with local occurrences of shallow-marine fossils. These intervals are interpreted to have deposited in a submarine environment on the slope of a former oceanic island. The lowermost occurrence of fossil-bearing sediment at 291.27 mbsf correlates to a significant change in the nature of volcanic rocks (see below) and possibly corresponds to an unconformity related to the shoaling of the island. The volcanic sequence between 116.45 and 16.70 mbsf includes three thicker intervals of volcanic sandstone and basalt conglomerate-breccia with local occurrences of shallow-marine bioclasts. This interval is interpreted to have deposited in a shallow marine to subaerial environment on the slope of a former island. A major erosional surface possibly occurs at 16.70 mbsf, as notably suggested by changes in the dip of the sediment bedding between the volcanic sequence and the sedimentary cover. We interpret this surface to have been induced by summit erosion and original flattening of the guyot. The erosional surface is capped between 16.70 and 15.31 mbsf by a transgression deposit that consists of a basalt conglomerate with

shallow-marine bioclasts and intertidal-subtidal cements. The conglomerate is followed from 15.31 to 15.05 mbsf by a condensed, calcareous interval with ferromanganese-phosphatic encrustments. Limestone of the condensed interval probably deposited at “hemipelagic” depth and could be assigned to the late Campanian by foraminifer and nannofossil investigations. This interval is interpreted to record the drowning of Rigil Guyot at Site U1374. Interestingly, volcaniclastic deposits between 15.05 and 6.64 mbsf can be biostratigraphically assigned to the late Maastrichtian and could be interpreted to represent a record of possible rejuvenated volcanism. A second (undated) condensed interval occurs at ~6.64 mbsf depth, which is capped by the younger Pleistocene pelagic sediment cover.

The lowermost occurrence of fossil-bearing sediment correlates to a downhole change from breccia with aphyric basalt clasts to a thick (61.34 m) unit of plagioclase-augite-olivine-phyric basalt breccia at 290.32 mbsf. The augite phenocrysts in this unit and in the subsequent units below are no longer distinctive titanaugite as found previously. At 335.9 mbsf, the first of a series of intrusive units was encountered, which are probably subvertical dikes. A total of eleven of these aphyric basalt intrusive bodies were cored and they were found to continue to the bottom of the hole. Thanks to the excellent recovery at Hole U1374A, the margins of these dikes were nearly always observed and included chilled margins and baked zones, but also, in two cases, interesting peperitic textures. The thickness of these intrusions and the presence of the margins provide a high confidence that these bodies are in situ. A brief interval of aphyric breccias occurs between 351.66 and 375.19 mbsf before plagioclase again becomes the dominant phenocryst phase in the clasts at 375.19 mbsf. At 445.02 mbsf the plagioclase-phyric basalt breccias again gave way to aphyric basalt breccias with lithic vitric sand intervals in its lower part.

In addition to the structures recorded in cores from this hole during previous weeks (i.e., sedimentary bedding, joints, veins, vein networks, magmatic foliations, and geopetal structures), cores recovered in the lower two hundred meters of Hole U1374A contain near vertical sheet or dike intrusions of variably vesicular aphyric basalt. These sheet intrusions generally have steeply dipping

vesicle bands that are parallel to the contacts, indicating steep magma flow within these intrusions. Therefore, the structural observations corroborate the interpretation that these sheet intrusions could be dikes. Hole U1374A terminated in aphyric basalt (Lithological Unit 148) that is visually similar to the aphyric basalt sheet intrusions. Although the upper contact was preserved, the hand samples are ambiguous as to whether this unit represents a flow or an intrusion. Lithological Unit 148 also contains abundant fractures, and zones of both shallow and steep magmatic foliation; features not observed in the steeply dipping aphyric sheet flows above. As it is important to establish if Lithological Unit 148 represents the lowermost lava flow from Hole U1374A (i.e., providing the oldest samples for paleomagnetisim, geochronology, and geochemistry), or a subsequent intrusion, structural investigation of the upper contact is continuing into the next week.

The Alteration Petrology laboratory group is also continuing their work on the lowermost cores from Hole U1374A. The rocks show alternating oxidation states and alteration processes through the volcanic breccias in the upper part of the hole. During this week, the description eventually reached a depth where a different alteration state with a more greenish alteration indicative of reducing conditions was observed. Down to this point the most abundant breccia cement was carbonate, but now zeolite has become the dominant cement. As in the previous week, three main groups of alteration phases in veins and vesicles can be distinguished: carbonates, clay minerals (saponite, nontronite, montmorillonite, celadonite) and other secondary phases (such as zeolites, clinochlore, Fe oxyhydroxides, and some pyrite/chalcopyrite).

The Geochemistry laboratory group has selected 20 samples from the different units that were described this week in the Site U1374 cores for ICP-AES analysis of major and trace elements. Processing of these samples is now completed. No samples were analyzed for determination of carbonate, organic carbon, or organic nitrogen content during this week.

The Paleomagnetism laboratory group has alternate-field (AF) demagnetized the archive halves of Cores U1374A-38R through -70R in the cryogenic

magnetometer system. By the end of this week, only five sections from this site are still to be measured. All archive half-core data (including data from previous Holes U1372A and U1373A) are currently being re-processed using a more sophisticated automatic principal component picking protocol. Shipboard sampling for the last Hole U1374A cores has been completed and 18 discrete samples are waiting to be thermally demagnetized and 25 are waiting to be AF-demagnetized. Steep normal polarity inclinations are dominant.

The Physical Properties laboratory group also continued running tests on whole-core and discrete samples from Hole U1374A this week. Whole-round and split-half measurements have been completed for the remaining sections from Site U1374 (through Core U1374A-73R), along with natural gamma ray testing with total count times of either 30 minutes or 60 minutes depending on the observed lithology. Count times of one hour were used for sections containing potential lava flow intervals, while sections composed entirely of volcaniclastics were limited to 30 minutes. This adjustment had to be made to keep up with the extraordinary recovery at this site. No thermal conductivity measurements were made this week due to testing equipment failure. Further attempts to repair the full-space thermal probes were unsuccessful. Discrete samples from Cores U1374A-39R through -73R were chosen in collaboration with the Paleomagnetism group, and the entire set of paleomagnetic, compressional wave velocity, and moisture and density measurements have been completed for samples up to Core -47R. The automated data-filtering program continues to be revised to make it more user-friendly and fix bugs. Filtered physical property data remain useful for identifying changes in magnetic susceptibility, natural gamma ray radiation, and color reflectance and helps with the selection of shipboard and personal samples.

Two samples were collected for microbiology on the last day of drilling at Site U1374. Both were processed for shore based cell counts, molecular biology analyses and in situ stable isotope analysis of sulfur and carbon. One was further sampled and used to initiate a stable isotope addition bioassay. During downhole logging that followed the end of coring, the Microbiology group worked on their

site report and continued to sample the ongoing stable isotope addition bioassays, which are kept incubating for six months post inoculation. Visual inspection of culturing efforts via increased turbidity from Site U1374 revealed positive results from culturing in media targeting sulfur oxidizing bacteria and general heterotrophic bacteria from depths as deep as 400 mbsf.

After the termination of drilling in Hole U1374A, and following an extensive hole preparation program (see operations section above) logging operations began at 0630 on 19 January. Logging pipe depth was set at 1671 drf (drilling depth below rig floor in meter). The Triple-Combo (TC) tool string, which comprised spectral gamma ray, neutron porosity, density, caliper and resistivity sensors, was deployed first. At 1245 there were indications that the drill pipe may be stuck in the hole (while the logging tool was still in pipe), however wireline heave compensation (WHC) optimization was performed in the pipe, following which the tool string was run downhole and logging down started at 1551 wrf (wireline log depth below rig floor in meter) to pick out the seafloor. The logging tool reached (with some effort) a depth of 1677.1 wrf, but could not break through a bridge across the borehole. Therefore, only ~6 m of the 30 m logging tool string was in open hole. Logging was aborted with the hope of having a second attempt and the TC tool string brought back to the surface. At 1829 it was confirmed that the pipe had become stuck, but was freed.

Before the second logging attempt the hole was pumped down and the logging pipe depth set a little lower at 1680.48 drf, to cover the previously troublesome area in the borehole. At 2256 the TC tool string was rigged up and at 00:37 was run into the hole. Logging down started at 0143 and the end of the pipe was reached around 0155. Attempts were made to get the tool string down the borehole in the open hole section for approximately 45 minutes, however the tool experienced numerous tight spots (1697.6, 1698.1, 1698.3, 1698.7, 1706.6, 1708.2 wrf), and eventually the tool began it's ascent back to the rig floor. It was unknown whether the eccentralizer (associated with the neutron porosity sonde) near the top of the tool could be causing the sticking problems, therefore as a last attempt a shortened tool string was deployed at 0500. This string comprised

the natural gamma ray sonde and caliper (without radioactive source loaded). The same tight spot issues were encountered (the tool reached just 9 m below the bottom of the pipe) and the TC was brought back to the surface and rigged down.

Because of the importance of downhole logging in this deep hole it was decided that a total reconditioning of the hole should be done (see operations section above). Logging operations began again at 0400 on the 21 January and these were very successful. The TC tool string (in its full configuration) was run and made one full main pass of the hole and a 100 m repeat. The second tool string deployed was the Goettingen Borehole Magnetometer (GBM). We encountered some connection and communication issues with the tool while on the rig floor, however these were worked through and the tool was run into the hole at 1550. The tool begins its log during the orientation (sighting) process on the rig floor and continuously collects data until its return to the rig floor following a down- and up-log portion. At around 1000 wrf on the upward journey, communication with the tool was lost (while in the pipe), however following the initial sighting; it should still be possible to reconstruct a full rotation history for the tool. The GBM was rigged down by 0015 (22 January). The third tool string deployed was the FMS-Sonic. The tool string was run into the hole and successfully reached the target depth. Two full passes were measured with the FMS-Sonic. The fourth tool to be deployed was the GBM, but following some further signal issues, the Ultrasonic Borehole Imager (UBI) was deployed so that operations could continue smoothly. Images from five main sections of the borehole were collected where the borehole was at the optimum size of ≤12”. The final tool string deployed was the GBM. It was run down the hole at 1500 and reached its target depth at 1759. The tool was rigged down at 2144, and the logging program at Site U1374 was completed. Currently the logging data are being provisionally processed onboard and the standard Schlumberger tool data have been transferred to Lamont-Doherty Earth Observatory borehole research group for full processing.

EDUCATION AND OUTREACH

The education officer has continued posting daily blogs on the JR website and Facebook page. The JR website had 1,178 visits between January 16 and 22. Of those, 592 were new visitors. The JR Facebook posts had 84,152 views during the week, and has increased its followers from 2,274 fans on January 15 to 2,285 fans on January 22. Six videoconferences were conducted this week, one with the Auckland Museum and five others with U.S. schools. Scientists Louise Anderson, Christoff Beier, Ben Cohen, Michael Dorais, Patrick Fulton, Lara Kalnins, Anthony Koppers, Kazu Moriya, Alex Nichols, Nicola Pressling and Becky Williams all participated in question-and-answer periods with the students this week. In total, over 400 participants were reached in the first 11 video conferences during this expedition.

The expedition videographer finished a new video “Coring Seafloor Cake,” that was approved and uploaded to the Ocean Leadership YouTube Channel and to the JR Facebook page. She wrote new lyrics for the song “Blue Moon” to tell the tale of drilling at Site U1374. She has collaborated, practiced and recorded the song, finished shooting and editing of the final music video. She is also working on a new song and wrote a first draft script for the video “Visualizing Rock.” In addition, a short interview with scientists Godfrey Fitton on thin sections was conducted.

TECHNICAL SUPPORT AND HSE ACTIVITES

The technical staff was engaged in providing full support for coring operations at Site U1374. Work continues on clearing backlog of cores while logging activity takes place. Other support technical activities included the following.

1. Hard rock sample selection activities were held in conference room.
2. Minor software upgrades to various applications continued.
3. Planning started for the reorganization of the pallet storage area.
4. Logistical planning started for upcoming port call and end of expedition activities.

The weekly fire and boat drill was held as scheduled. No HSE incidents to report.