IODP Expedition 384: Engineering Testing

Week 4 Report (9–15 August 2020)

Operations

Week 4 of International Ocean Discovery Program (IODP) Expedition 384, Engineering Testing, began on 9 August 2020 while carrying out the fifth drilling test in Hole U1555E with the Schlumberger Gemini 12¼ inch TCI bit at 276.9 m driller's depth below seafloor (DSF). This test used the best performing bit type up to that time. The bit was run without a mud motor to keep the second mud motor available aboard for upcoming casing operations at Site U1554, as well as to compare performance of the TCI bit run with and without a motor. The maximum bit depth of 290.6 m DSF was reached at 0300 h. The next 2 h were spent working tight hole conditions, circulating high-viscosity mud sweeps, pulling the pipe 30 m off bottom, and attempting to get back to bottom without success. At 0500 h we terminated drilling and retrieved the drill pipe. The bit cleared the rig floor at 1020 h, ending operations in Hole U1555E.

The next test was dedicated to the first deployment of one of the 9⅞ inch rotary core barrel (RCB) polycrystalline diamond compact (PDC) coring bits that were acquired several years ago but never used. The bit and bottom-hole assembly (BHA) were made up and deployed. The drilling line was slipped and cut from 1715 to 1915 h, and coring in Hole U1555F began at 2200 h. Core U1555F-1R was an attempt at establishing the seafloor depth; it recovered 2.5 m of sediment, which resulted in a calculated water depth of 1523 m, 7 m deeper than the precision depth recorder (PDR) computed depth used so far at this site. After the recovery of this first core we drilled ahead without recovery through the sediment section with a wash barrel until the basement was tagged at 0415 h on 10 August, with the bit at 176.3 m DSF. The wash barrel was retrieved and basement coring began. We retrieved the core barrel after average advances of just ~1 m because the rate of penetration was very low. We terminated RCB coring with the PDC bit at 0600 h on 11 August, at a total depth of 184.3 m DSF. Although the cores we recovered in Hole U1555F were better trimmed than the typical RCB cores cut with our regular bits, the rate of penetration became unacceptably low. Cores U1555F-3R through 9R advanced a total of 8.1 m over a period of ~26 h with a recovery of 5.81 m (72%). We retrieved the drill string with the bit clearing the rig floor at 0935 h, ending operations in Hole U1555F.

The PDC bit was heavily damaged, with most of the PDC cutters broken or missing. The cutter pedestals were severely worn, indicating that the bit face itself had been turning against the formation. The cutters in the throat of the bit, where the core trimming takes place, were still fairly intact, explaining the superior core quality compared with regular RCB coring bits. The recovery rate was also relatively high (72%), but that may have been the result of the short (~1 m) lengths cored.

A standard RCB C7 coring bit was made up with the BHA, including a mechanical bit release (MBR) so we could follow up with wireline logging. The drill string was deployed with the objective to core ~130 m of basement, or to ~300 m DSF, for engineering testing as well as the science objectives of postponed Expedition 395. Drilling in Hole U1555G began at 1620 h on 11 August. We drilled ahead through the sediment section to 168.6 m DSF and deployed the first core barrel to recover the sediment/basement interface. Core U1555G-2R advanced from 168.6 to 178.3 m DSF and recovered 0.66 m of sediment above a 5 cm long piece of basalt. We continued coring the basalt basement in Hole U1555G and reached the final depth of 309.5 m DSF at 2000 h on 14 August. Basement Cores U1555G-3R through 27R advanced 131.2 m and recovered a total of 59.6 m of basalt (45%) in 70 h of coring operations.

In preparation for logging, the hole was first swept with 50 barrels of sepiolite mud. At 2230 h the coring bit was released to the bottom of the hole using the release shifting tool to trigger the MBR. The hole was then displaced with heavy mud (barite-weighted to 10.5 lb/gal) and the end of the drill pipe was raised to 202.4 m DSF (~24 m below the sediment/basalt interface).

The triple combo tool string was rigged and deployed from 0300 to 1000 h on 15 August. This tool string measured electrical resistivity, density, porosity, magnetic susceptibility, and natural gamma radiation in the formation. The first of two logging passes with the tool string reached a maximum depth of 305.5 m wireline log depth below seafloor (WSF), where tight hole conditions were encountered.

The second tool string included the Dipole Sonic Imager and Formation MicroScanner systems and was deployed from 1000 to 1545 h. This second tool string was deployed to a maximum depth of 295.4 m WSF due to the problems during the first pass. The tool string encountered tight hole conditions at 270.4 m WSF, where the calipers had to be temporarily closed to make the tool pass.

The third tool string included the Versatile Seismic Imager (VSI). It was deployed from 1545 to 2245 h while maintaining the appropriate marine mammal and protected species observation procedures. Successful recordings were achieved at two depth stations in the open basement hole.

The hole was displaced with heavy mud (10.5 lb/gal) and the end of pipe was raised to 85.4 m DSF in preparation for logging the sediment section.

Science Results

Basalt drilling and coring tests

The fifth drilling test, using the 12¼ inch tungsten carbide insert (TCI) bit run without a motor, revealed no significant difference in performance compared to the first drilling test when the same bit type was run with the mud motor. The test ended with difficult hole conditions just short of the target depth or time. The struggle with getting the bit back to the bottom of the hole could be related to the size of the hole, with washouts and excessive debris created in intervals with more fractured and altered basalt.

The sixth test, using one of the RCB PDC coring bits that have been on board the *JOIDES Resolution* (JR) for several years, confirmed that PDC bits are capable of cutting high-quality core pieces, but at a very slow rate in hard basalt formation. Furthermore, PDC bits are short lived in such formations, as demonstrated by the damage to the bit we used in this test. PDC bits also tend to perform better at a higher rotational speed than the JR top drive can provide.

Support of Expedition 395 objectives

The Expedition 384 drilling tests conveniently used proposed Site REYK-13A (Site U1555) of the postponed Expedition 395. This site has a suitably shallow water depth, the appropriate sediment thickness to support the BHA before penetrating basement, and is in international water. Given the time available under the current and unusual operating circumstances imposed by the COVID-19 pandemic, we planned a number of operations that would directly benefit the science objectives of Expedition 395.

The first such activity consisted of coring the entire 130 m target section in the basalt basement at Site U1555 using a regular RCB coring bit. This was executed without incident over a period of 3 d and recovered a total of 59.6 m of basalt from the 131.2 m cored section. A few samples will be used to complement the engineering tests, and the vast majority of material will be available for Expedition 395 science objectives. We established a protocol to engage the Expedition 395 science party on shore in selecting pilot samples by sending daily batches of whole-round core section images as well as section-half images to shore. Expedition 395 petrologists are in the process of selecting the locations of thin section and geochemistry samples that we will be taking and processing on board using standard JR laboratory procedures.

The second activity carried out for Expedition 395 was the acquisition of a complete set of wireline logs from ~70–100 m of the basalt section, to complement the incomplete core recovery.

Technical Support and HSE Activities

Laboratory Activities

- Processed core sections and samples from Sites U1554 and U1555 through the Core Laboratory.
- Set up the G Gun Parallel Cluster (Sercel) sound source for vertical seismic profiling (VSP) operations. Deployed the cluster for one operation.
- Documented the drill bit tests with before and after images of the drill bits.
- The issue reported previously with the Bathy2010 Echosounder has not been resolved. Staff have contacted SyQwest for assistance.
- A worn lifting leg and deformed rollers were found during preventative maintenance to the scissor lift platform in the pallet stores. Siem Offshore crew fixed the lifting leg, then fabricated and installed new rollers.
- The project to replace lighting in the pallet stores to create more storage space is underway.
- Technical staff worked on projects including;
    - GEODESC project programming and testing.
    - Catwalk Module program testing.
    - Miscellaneous small 3D printer projects.

IT Support Activities

- Reorganized the IT office to improve workflow and increase available space.
- Built a new systems monitoring server.
- The RigWatch computer in the telemetry office run by Schlumberger lost network connectivity. We resolved the issue but we recommend replacing the specialized National Instruments-brand PC hardware that is more than a decade old in order to increase performance and reliability.

Application Support Activities

- Continued work on the Catwalk Module.
- Performed research on shipboard applications related to TAMU accessibility requirements.
- Made minor changes to the Coulometer and CahnBalance applications that became necessary due to their interactions with the new Catwalk Module.

HSE Activities

- Safety shower and eye wash stations were tested.