IODP Expedition 384: Engineering Testing

Week 3 Report (2–8 August 2020)

Operations

Week 3 of International Ocean Discovery Program (IODP) Expedition 384, Engineering Testing, began on 2 August 2020 with the ship waiting on weather after completing Hole U1555A, with the drill string suspended below the ship and the bit ~100 m above the seafloor. At 1200 h the heave became safe for operations to resume.

For the second drilling test with a 12¼ inch Kymera hybrid bit, deployment of the drill string was completed and drilling in Hole U1555B began at 1400 h. The water depth of 1516 m was adopted from Hole U1555A for this and the remaining tests of this week for lack of better measurements. The sediment was penetrated at the same controlled rate of ~40 m/h as was done in the first test with the TCI bit. At 2030 h we encountered the hard basement formation at 186.6 m driller's depth below seafloor (DSF), where the rate of penetration (ROP) dropped by an order of magnitude. At 1600 h on 3 August and a bit depth of 210.8 m DSF, we decided to terminate drilling based on the low ROP of <1 m/h over 6 h. The drill string was retrieved and the bit cleared the rig floor at 2225 h, ending Hole U1555B operations. The 12¼ inch Kymera hybrid bit showed significant damage. Several of the polycrystalline diamond compact (PDC) cutters were damaged and pieces of metal were missing from the PDC arms. The cone bearings appeared to be stuck. The outer diameter (gauge) was also significantly damaged. It was later noted that one of the carbide jet nozzles had come out, which was possibly the cause of the damage to the bit. We will be requesting a more complete run analysis by the bit vendor.

For the third test, the rig crew made up a Schlumberger 12¼ inch IAD 647Y (SN RK4875) TCI bit, a Schlumberger Rhino XS, 12¼ to 14½ inch hydraulically expandable reamer, the mud motor, and the bottom-hole assembly (BHA). The TCI bit was the same type of bit run during the first test. The mud motor was the same motor used on the previous tests. The bearing play on the motor was checked and fell well within the acceptable range. The assembly was flow-tested at the rig floor. The activation ball was placed on the seat in the underreamer because a ball-drop activation once the reamer is downhole is impossible with a motor above the reamer. The underreamer cutting blocks shifted at ~600 psi. The cutting blocks opened at ~45 strokes/min and were fully open at 50 strokes/min, corresponding to the design parameters of 220 to 245 gal/min, respectively. The drill string was deployed in the early morning of 4 August and drilling in Hole U1555C began at 0650 h, using as low a flow rate as possible so as not to engage the underreamer until necessary. At 1000 h, the pumping rate was increased to 60 strokes/min to expand the cutting blocks of the reamer, with the bit at 130.6 m DSF. At 1225 h we reached the top of the basement at 186.6 m DSF. Drilling in Hole U1555C continued until 1045 h on 5 August, when the underreamer had reached 20 h of operation

and the bit was at 225.8 m DSF. The drill string was retrieved and the bit cleared the rig floor at 1745 h, ending the third drilling test and operations in Hole U1555C. The motor and underreamer assembly were flushed with fresh (drill) water. The underreamer had several PDC cutters damaged and the blocks were still extended just over 1 inch.

For the fourth drilling test, the rig crew made up a Smith Bits/Schlumberger StingBlade (SN 1678) 12¼ inch PDC bit and mud motor with the BHA. This was the first time this newer type of PDC bit with conical-shaped inserts was run on the *JOIDES Resolution* (JR). The mud motor bearings were confirmed to be still in good condition. The drill string was deployed and drilling in Hole U1555D began at 0245 h on 6 August. The top of the basement was encountered at 0800 h, with the bit at 189.0 m DSF. Drilling continued until 0545 h on 7 August when failure of the mud motor was indicated by a pressure loss of >200 psi. The depth reached with the PDC bit was therefore limited to 222.9 m DSF. The drill string was retrieved and the bit cleared the rig floor at 1040 h, ending Hole U1555D. Once on the rig floor, the mud motor was flow-tested. Rotation started at a higher rate than the previous run, and the motor appeared to be responding with an intermittent stall in its rotation. Note that this was done with no weight on the motor while the BHA was racked. The rule of thumb for this type of motor is to perform up to 200 rotating hours under normal operating conditions. Although this motor had only ~125 rotating hours, these were in extreme conditions compared to general oil field use. The rental motor will be returned to the vendor for evaluation and refurbishment.

The fifth drilling test aims at advancing the bit that has performed best so far to its performance limit. We altered the test plan slightly by using the Schlumberger Gemini 12¼ inch TCI bit used for the third test rather than a third, brand new bit, but without a mud motor to preserve the second mud motor aboard for upcoming operations. This will provide additional information about running the TCI bit with and without a mud motor. The 20.3 on-bottom hours this bit accumulated during the third test will be extended by ~40 h rather than 20 h to account for the ~50% lower rotational speed with the top drive alone. The TCI bit and BHA were made up and deployed, and drilling in Hole U1555E began at 1645 h on 7 August. The top of the basement was encountered before 2400 h with the bit at 191.8 m DSF. Drilling continued throughout the day on 8 August, advancing the bit to 276.9 m DSF by the end of week 3.

Science Results

Basalt drilling tests

Four drilling tests have been completed so far and the fifth test is in progress. The following overview is a preliminary assessment and further analysis will be carried out by the bit vendors and IODP JRSO staff. Each of the drilling tests had a target of ~100 m

basaltic basement penetration after washing through ~190 m of sediment, or ~40 h on-bottom drilling time in basalt, whichever would come first.

Test 1 (Hole U1555A): The first test, carried out during the previous week, used a Schlumberger 12¼ inch Gemini IAD 647Y (SN RK4875) TCI bit with a more robust build than similar tricone bits previously used on the JR. The bit was run with a high-torque, low revolution per minute (rpm), 8 inch mud motor to approximately double the rotational speed of the top drive (~70 rpm) to a total speed of 120–140 rpm. The final depth of 97.4 m into basement was achieved with ~23.1 h on-bottom, with an average rate of penetration (ROP) of ~4 m/h. Drilling conditions became more difficult toward the bottom of the hole, which led to the decision for a cautionary termination slightly before we reached 100 m basement penetration. Upon bit retrieval the roller cones showed little wear, whereas the gauge cutters on the outside of the bit showed more serious wear.

Test 2 (Hole U1555B): The second test used a Baker Hughes Kymera hybrid bit, a bit type never used before on the JR. This bit was run with the same mud motor used in the first test. After penetrating ~20 m of basalt, the ROP dropped to <1 m/h over 6 h and we decided to terminate at a total basalt penetration of 24.2 m. Upon retrieval, the bit showed various types of damage to PDC cutters and arms, the cone bearings, and the outer diameter. Perhaps most importantly, one of the carbide jet nozzles had come out, possibly causing the damage.

Test 3 (Hole U1555C): The third test was dedicated to the Schlumberger XS Rhino underreamer with hydraulically expandable cutting blocks with a range of 12¼ to 14½ inches. The reamer was made up with a new 12¼ inch TCI bit of the same type used in the first test, and the same motor used in the previous two tests. Drilling was terminated after the targeted 20 h of reaming action were completed, at a basalt penetration of 39.2 m. Upon retrieval, the underreamer had several damaged PDC cutters and the blocks were still extended by just over 1 inch.

Test 4 (Hole U1555D): The fourth test used a Smith Bits/Schlumberger StingBlade (SN 1678) 12¼ inch PDC bit paired with the same mud motor used in the previous tests. This was the first time this newer type of PDC bit with conical-shaped inserts was run on the JR. This test ended with the failure of the mud motor at 33.9 m penetration into basement. The tentatively calculated ROP of ~1.7 m/h is less than in the previous three tests. However, this must be viewed with caution because it may be related to the failing mud motor.

Test 5 (Hole U1555E): The best performing bit type at this time, given the various circumstances, was the Schlumberger Gemini 12¼ inch TCI bit. The fifth test was intended to push this bit to its limits. We decided to run the bit used in the third test, with the underreamer, because it already had some on-bottom hours. We also decided to run it

without the second mud motor available aboard because the upcoming casing operations at Site U1554 will require a new motor to minimize operational risks. Casing at Site U1554 was added to the plan to use remaining Expedition 384 time most effectively in support of Expedition 395 objectives.

After completion of the fifth test, we plan to test the PDC coring bits that have been on the JR for several years but have never been deployed. Next we will attempt to core the top ~130 m of basalt at Site U1555 with our regular coring bits to obtain rock samples for both engineering analysis and Expedition 395 science objectives. The tentative plan is to return to Site U1554 and RCB core the sediment section for safety before setting casing through the sediment section for future basement coring. Should time remain, we may return to Site U1555 and deploy the StingBlade PDC bit once more to repeat the fourth test, but this time with the second mud motor.

Core orientation tests

Following the completion of all routine measurements and observations of the Site U1554 cores for general characterization of the sediment section, paleomagnetic measurements were completed on all core sections as well. The sediments, which are younger than ~0.6 Ma, proved to be high fidelity recorders of the Brunhes normal polarity geomagnetic field, with the exception of Core U1554B-5H, which suffered drilling disturbance throughout. The extreme disturbance is relatively imperceptible from visible examination of the split-core surface but is clearly observed in the X-ray images, and in hindsight is also recognizable in other proxy data sets with careful examination. The paleomagnetic declinations from the other 24 cores will provide the basis for assessing the core orientation methods and tools.

Technical Support and HSE Activities

Laboratory Activities

- Processed core sections and samples from Site U1554 through the Core Laboratory.
- Conducted experiments on the Section Half Multisensor Logger (SHMSL) to determine the optimal measurement time for the magnetic susceptibility Bartington MS3 meters.
- Documented the drill bit tests with before and after images of the drill bits.
- Fitted the conductivity-temperature-depth recorder and mounting bracket to the vibration isolated television frame with the assistance of the Siem Offshore electricians.
- Replaced the flowmeter on the Bruker D4 X-ray Diffractometer, which resolved the occurrence of the low flow error.
- Brought the liquid nitrogen generator back on line.

- The issue reported last week with the Bathy2010 Echosounder has not been resolved. Staff have contacted SyQwest for assistance.
- Technical staff worked on projects including;
    - GEODESC project programming and testing.
    - Catwalk Module testing.
    - Miscellaneous individual small projects including 3D printer projects.

IT Support Activities

- Worked with Siem Offshore crew to configure and deploy SnapTV boxes.
- Updated Firefox browsers on the video display Mac OS computers.
- Performed maintenance on printers and plotter.

Application Support Activities

- Continued work on the Catwalk Module.
- Deployed a new build of the Drill Report web services, which appears to have fixed the issue.
- Deployed a fix for an error in LIVE when users tried to delete a template.
- Continued work on creating a lengthwise concatenated core summary image with the Virtual Photo Table. Created images with and without a scale.
- Fixed a bug in the MUT orientation data upload to prevent uploading of data to the wrong hole and core.

HSE Activities

- Tested the safety shower and eye wash stations.