IODP Expedition 396: Mid-Norwegian Continental Margin Magmatism

Week 5 Report (5 to 11 September 2021)

During Week 5 of the International Ocean Discovery Program (IODP) Expedition 396, Mid-Norwegian Continental Margin Magmatism, we completed coring and logging operations at Sites U1570 and U1571 (proposed Sites VMVM-56A and VMVM-61A), and began coring operations at Site U1572 (proposed Site VMVM-07A).

Operations

Week 5 began while coring with the rotary core barrel (RCB) system at a depth of 178.4 m below seafloor (mbsf) in Hole U1570D. The last two cores taken, U1570D-27R and 28R, extended the hole from 178.4 mbsf to 200.0 mbsf, which was the maximum depth of penetration approved by the IODP Environmental Protection and Safety Panel (EPSP) for Site U1570. After coring operations ended at 0230 h (UTC + 0 h) on 5 September 2021, the hole was swept clean of cuttings with a 50-barrel sweep of high viscosity mud, and then displaced with 65 barrels of 10.5 ppg mud. The top drive was set back and the drill string was pulled back to 76 mbsf in preparation for wireline logging operations. The rig floor personnel and the Schlumberger engineer reviewed safety issues surrounding the upcoming logging operations and the rig floor was rigged up for logging.

We assembled a modified triple combo tool string, which included the Magnetic Susceptibility Sonde (MSS), the Hostile Environment Litho-Density Sonde (HLDS; with source), and the Natural Gamma Ray Spectrometry Tool (NGT). The triple combo was tested and deployed at 0820 h on 5 September and a downhole log was performed from just above the seafloor to 199.8 mbsf. Hole U1570D was logged up for an open hole calibration pass, then the tool was lowered back to 199.8 mbsf, and the hole was logged up again all the way to the seafloor. The caliper was closed prior to entering the drill string. The tool string was recovered and rigged down by 1255 h on 5 September.

Next, we rigged up and deployed the Formation MicroScanner (FMS)-sonic tool. Natural gamma ray (NGR) was logged through the drill pipe to identify the seafloor depth and match the depth results on the triple combo logging run. We conducted two upward passes from 199.3 mbsf. At 1800 h, after retrieving the FMS-sonic tool and rigging down all the logging equipment, the rig floor was cleared for pipe tripping operations. The drill pipe was recovered and stacked, the bottom-hole assembly (BHA) drill collar stands were set back, and all core barrel components were broken down, inspected, and laid out. The rig floor was secured for transit at 2345 h on 5 September, the thrusters were raised, and we departed for Site U1571. The time spent on Hole U1570D was 47.25 h or 2.0 days.

We completed the 97 nmi transit to Site U1571 in 9.1 h, arriving over the site coordinates at 0918 h on 6 September. The vessel was switched to dynamic positioning (DP) mode and the drill floor was cleared for operations at 0952 h, beginning Hole U1571A. The rig crew began assembling the RCB BHA with a new bit and bit release system and deployed them to the seafloor. Using an estimated depth from the precision depth recorder (PDR) of 1205.8 m below sea level (mbsl), Hole U1571A was spudded at 1500 h. The PDR measurement was used for the official seafloor depth. We continued RCB coring with full-length advances through Core U1571A-13R (to 121.1 mbsf), and then switched to half-length advances for Cores 14R (121.1 mbsf) to 38R (237.9 mbsf) to improve core recovery. The last core for the hole was Core 39R, which was a full-length advance to reach the final hole depth of 247.6 mbsf. Core 39R was recovered at 0525 h on 9 September.

At the end of coring, we cleaned the hole by pumping 50 barrels of high viscosity mud and then lowered the rotary shifting tool (RST) and released the bit at the bottom of the hole. We displaced the hole with 75 barrels of 10.5 ppg mud, raised the drill string, and set the end of the pipe at 87 mbsf in preparation for wireline logging. At 1000 h, we rigged up the triple combo tool string and deployed it to 246.9 mbsf. We made two upward passes collecting data through the open hole and then recovered and rigged down the logging tool. Starting at 1400 h, we rigged up and deployed the FMS-sonic tool. The NGR was logged through the drill pipe to identify the seafloor depth and match the depth with the results on the triple combo logging run. The FMS-sonic tool also reached 246.9 mbsf and two upward logs were carried out through the open hole with the calipers open. The tool string was recovered at 1745 h and rigged down by 1830 h on 9 September. After rigging down the FMS-sonic tool string, the rig floor was cleared of logging equipment and the drilling knobbies were removed from the top of the drill string. The end of the mechanical bit release (MBR) was run back down to 242.9 mbsf. The circulating head was attached to the top of the drill string and the hole was circulated clean with salt water in preparation for running the Ultrasonic Borehole Imager (UBI) tool string. At the end of the circulation period, the end of the pipe was pulled back and set at 104.9 mbsf. The UBI logging tool string was assembled and tested. At 2230 h, the tool string was deployed without difficulty through the drill pipe and turned on at 1198.7 mbsl (just above the seafloor). The hole was logged down and up two times to a depth of 237.9 mbsf. Both passes were made slowly and without incident, at a speed of ~122 m/h. The tool string was pulled back to the surface and rigged down by 0345 h on 10 September. At 0430 h, all logging tools were rigged down and the logging wireline was secured. No damage was found to any of the logging tools.

After logging operations concluded, the drilling knobbies were removed from the drill string and this was recovered back onboard. The BHA reached the rig floor at 0645 h. The four stands of drill collars were racked back in the derrick and the outer core barrel components were disassembled, inspected, and laid out. The top half of the MBR cleared the rig floor at 0730 h, ending Hole U1571A. The time spent on Hole U1571A was 93.75 h or 3.9 days.

Coring with the advanced piston coring and extended core barrel systems (APC/XCB) in Hole U1571B began at 0730 h on 10 September with the aim to increase the recovery of the sedimentary succession and the sediment/basalt transition sampled in Hole U1571A. An APC/XCB outer core barrel and a BHA were assembled, and the drill pipe deployed to the seafloor. The top drive and drilling knobby were picked up and the bit spaced out based on the water depth for Hole U1571A. A shot depth of 1200.8 mbsl was selected. An APC core barrel was dropped in and run to bottom, the drill string was pressured up, and the hole was spudded at 0730 h. The mudline core returned 5.05 m of core and the calculated seafloor depth was 1205.3 mbsl. The APC coring system advanced from the seafloor to 57.2 mbsf when we recorded a partial stroke for Core U1571A-7H with only 4.7 m advanced (4.75 m core recovery). We switched to the XCB system and coring continued with full-length advances to 115.5 mbsf (Core 13X). Beginning with Core 14X, cores were obtained using half-length advances through Core 20X to a final depth of 143.7 mbsf at 1005 h. The coring systems were secured, the top drive was set back, and the bit was pulled back, clearing the seafloor at 1110 h on 11 September. The bridge was notified when the bit cleared the seafloor and began moving the vessel in DP mode to the next site, U1572, at 0.5 kt. A total of 7 APC and 13 XCB cores were taken with an overall recovery of 112.5 m (78%). The time spent on Hole U1571B was 30.25 h or 1.3 days.

Pipe tripping operations continued over the 3.1 nmi transit in DP mode to Site U1572. All APC/XCB BHA components were retrieved and stored, the rig's traveling equipment was serviced, and a new RCB BHA was assembled. We arrived at Site U1572 at 1600 h on 11 September, while deploying the drill string down to the seafloor. At 1930 h, with the end of the pipe at 1172.6 mbsl, we spaced out the bit above the seafloor and attempted to spud Hole U1572A based on a PDR depth of 1207.6 mbsl, but the core was retrieved empty. We added a single joint of pipe and dropped an RCB core barrel for a second attempt. This time we recovered 5 m of core, spudding Hole U1572A at 2145 h, and calculating a water depth of 1210.5 mbsl. We continued coring with the RCB system, retrieving Cores U1572A-2R to 4R (5 to 38.5 mbsf) before midnight on 11 September.

Science Results

The scientists acquired and analyzed samples and data from Holes U1570D, U1571A, U1571B, and U1572A, and continued to prepare site reports. On 10 September we held the science summary meeting for Sites U1569 and U1570, and on 11 September we held the first meeting to discuss the short-term and long-term Paleocene/Eocene Thermal Maximum research objectives. The Staff Scientist gave an overview of the IODP sample, data, and obligations policy. Both meetings were held with the participation of the onshore members of the science party through the virtual video conference system.

Lithostratigraphy

The core description team described and measured all cores from Holes U1570D, U1571A, and U1571B, and began to describe cores from Hole U1572A. They finalized the correlation of ten lithostratigraphic units defined across the five holes cored along the transect between Holes U1569A and U1570B. Lithostratigraphic Unit I is glacial/interglacial brown and gray mud. Unit II consists of dark greenish gray, slightly bioturbated mudstone. Unit III is sand-rich mudstone with some intervals containing nodules. Unit IV is a very dark gray mudstone. Unit V is black to very dark gray parallel-laminated mudstone with ash and trace pyrite. This unit is subdivided into two subunits based on ash alteration. Unit VI is a garnet cordierite dacite. Unit VII consists of an ash-rich dark gray parallel laminated claystone with pyrite, similar to Unit V. Unit VIII is a dark greenish gray bioturbated claystone. Unit IX is a limestone, and Unit X is an ash-rich claystone with carbonate and volcaniclastic conglomerate intervals.

The team ended the week defining the Lithostratigraphic Units at Site U1571, where Holes U1571A and U1571B sampled a ~120 m succession of unconsolidated clay with varying amounts of silt and sand, diatom ooze, and sand-rich claystone, overlying mostly aphyric basalt interbedded with volcaniclastic and terrigenous sediment.

Biostratigraphy

Sediment samples from core catchers and areas of interest in cores from both holes of Site U1571 were processed and analyzed for siliceous, organic-walled, and/or calcareous microfossils, when opportune. The mudline in all holes was processed for calcareous biota. Typically, the analysis of the biosiliceous content judged from smear slides was taken as guidance for additional, notably palynological, sampling and processing. Siliceous and organic-walled microfossils were found in various abundances below Quaternary strata. These include upper middle Miocene, and upper lower and lower middle Eocene strata, before igneous rocks were reached.

Paleomagnetism

The archive sections of Holes U1570D, U1571A, and U1571B were measured on the superconducting rock magnetometer (SRM) at a 2.5 cm interval. After measuring the natural remanent magnetization (NRM), the cores were subjected to a series of stepwise, in-line alternating field (AF) demagnetization steps at 5, 10, 15, 20, and up to 100 mT for sediment and 2, 4, 6, 8, 10, 15, and 20 mT for rock and/or indurated sediment. Discrete samples were collected from the sedimentary and basalt lithologies at Holes U1570D (6 samples), U1571A (17 samples) and U1571B (3 samples) and were measured for magnetic susceptibility (MS) in the KappaBridge KLY-4S. The NRM was measured in the JR-6 spinner magnetometer, followed by an AF demagnetization sequence of 5, 10, 15, 20, 30, 40, 50, 60, and up to 70, 90, 100 mT for sedimentary samples, and up to 200 mT for basalts, using the DTECH D-2000 AF demagnetizer.

A preliminary review of the magnetostratigraphic data from Hole U1570D suggests a good agreement with the biostratigraphy results.

Geochemistry

The geochemistry team collected and measured 47 interstitial water (IW) samples from Holes U1571A (19 samples) and U1571B (28 samples), and prepared 27 hard rock samples from Hole U1571A for inductively coupled plasma–atomic emission spectroscopy (ICP-AES) analyses. All 19 samples from Hole U1571A were analysed for alkalinity, pH, and the full standard range of elemental composition. pH in the porewater samples from Hole U1571A does not vary significantly downhole and has an average value of 7.73. Alkalinity shows a sharp increase at 17.25 mbsf, reaching ~6 mM at 25 mbsf, and then gradually decreases. Similar trends are observed in the NH_4^+ and PO_4^{3-} profiles. Measurements of total carbon (TC), nitrogen, sulfur, and hydrogen (by elemental analyser) and total inorganic carbon (TIC) (by coulometer) are ongoing.

Physical Properties and Downhole Measurements

Core physical properties were measured on all whole-round and section-half cores from Holes U1570C, U1570D, U1571A, and U1571B. The Core Laboratory technicians helped run the whole-round cores through the X-Ray imager, Natural Gamma Radiation Logger (NGRL), and the Whole-Round Multisensor Logger (WRMSL), while the physical properties science team focused their efforts on discrete sample measurements, wireline logging data analyses, and report writing. Discrete measurements included the acquisition of acoustic velocities on core section-halves, as well as velocity, moisture and density analysis, and thermal conductivity analysis for discrete samples taken from the core working halves.

Downhole logging was conducted in Holes U1570D and U1571A. The raw logging data were sent to Columbia University for processing and quality control. Processed wireline data were transmitted back to the ship, and the petrophysics and downhole measurements team is reviewing the data and integrating them with the associated core-based petrophysics data.

Education and Outreach

Outreach activities during this week focused on updates to the IODP social media channels: Twitter, Facebook, and Instagram.

Technical Support and HSE Activities

Laboratory Activities

- JRSO staff helped process cores from Holes U1571A, U1571B, and U1572A, and assisted the scientists in the laboratories.

- We are analyzing and comparing data from clay and bulk samples measured on both the Bruker and Aeris X-ray diffraction (XRD) systems. A report with the results was sent to shore for review. The JRSO staff will analyze standards on both XRD systems to add these data to the report.
- Staff assisted in a shore request to document the Master Flat (Granite Flat) issue in the Thin Section Laboratory.
- The source rock analyzer (SRA) is now fully functional. However, the flame ionization detector (FID) still requires manual lighting.
- The JRSO staff tested all individual instrument hosts and workstations to ensure all connections were back online after the ship database system failed.
- The Gantry IMS software did not recognize samples taken for personal mini-cores. A script was written to replace all "XXXX" with the correct sample ID.

IT Support Activities

- The Marine Computer Specialists (MCS) worked with TAMU Exchange group to stage server updates and coordinated with the shipboard personnel.
- We successfully configured the Yellowstone server to send and receive logging data with Columbia University.
- We released and installed a Microsoft patch to all general workstations.
- A routine power generator test resulted in the total loss of power to the IODP data center. The power surge protector (UPS) of the IODP data center failed immediately, causing a complete crash of the IODP network, servers, internet, and all related systems. After power was restored, it took the MCSes several hours to stabilize the shipboard IT environment and bring each system back online.

Developer Support Activities

- Work continued on the Sample and Data Request (SaDR) replacement application.
- The developer assisted in the recovery efforts from the major power failure (see IT Support Activities).
- Created a Powershell script to preprocess several gantry data files that show "XXXX" in place of the text ID (see Laboratory Activities).
- Investigated two issues in the Catwalk application:
    - The user interface sometimes doesn't come to the front when other windows are on the screen and the user clicks somewhere in the main window.
    - If the user reverts a change made to a section while in the process of adding Catwalk samples, the upload button disappears, and the user must start over.

Health and Safety Activities

- An abandon ship and fire drill was held at 1030 h on 11 September.
- The emergency shower and eye wash stations were tested.