

## **IODP Expedition 396: Mid-Norwegian Continental Margin Magmatism**

### **Week 7 Report (19–25 September 2021)**

During Week 7 of the International Ocean Discovery Program (IODP) Expedition 396, Mid-Norwegian Continental Margin Magmatism, we completed coring operations at Site U1573 (proposed Site VMVM-09A) and began coring operations at Site U1574 (proposed Site VMVM-80A). We also spent 88.5 h (3.7 days) cruising on a heavy weather avoidance course in the Norwegian Sea waiting for weather and sea conditions to improve before moving to Site U1574.

### **Operations**

Week 7 began while coring with the rotary core barrel (RCB) system at 386.5 m below seafloor (mbsf) in Hole U1573A. Because of the very slow penetration rate on Core U1573A-11R, the core barrel was pulled for inspection after just a 2.2 m advance to determine if there was a problem, such as the core catcher being jammed. The core contained 1.6 m of basalt and no indications of a problem were observed. The next core finished coring out the single joint of drill pipe to 396.2 mbsf. Combined, both cores required 240 min of drilling to complete the 9.7 m advance. Coring resumed with full-length coring advances for Core 15R to 425.4 mbsf, and then we switched to coring with half-length advances from Core 16R to 19R to improve core recovery. Coring was ended after recovering Core 19R from 440.9 mbsf because of impending heavy seas and high winds. The weather forecast was severe enough to force the abandonment of Site U1573. The last core on deck was recorded at 1925 h on 20 September 2021.

After laying out the last core, the coring systems were secured, the top drive was set back, and the bit was pulled clear of the seafloor at 2200 h. The bottom-hole assembly (BHA) was broken down and laid out to the main deck because of the impending rough weather. The rig floor was secured for transit and the bridge was notified of the end of operations in Hole U1573A at 0705 h on 21 September. The time spent in Hole U1573A was 101.0 h or 4.2 days.

After securing the rig floor, the thrusters and hydrophones were retrieved, and we got underway on a southwest heading to avoid the strongest side of the low-pressure system. The first 235 nmi leg of the transit was designed to position the vessel in more favorable seas while waiting out the strong weather system moving through the Norwegian Sea. We experienced the roughest seas and highest winds on 22 September while steaming into the weather in a south-southwest direction. Seas ranging from 10 m to 15 m were experienced during the day. By late afternoon, the winds and seas began to subside. The following morning, the winds had lessened, and the seas were beginning to flatten out. At 1400 h on 23 September, we turned around and began to navigate toward our next site. The remaining 110 nmi to Site U1574 (proposed Site VMVM-80A) were completed at 1130 h on 24 September. The vessel arrived on site after cruising on a heavy weather avoidance course for 88.5 h. The thrusters and hydrophones were lowered, and the vessel's navigation system was shifted from cruise to dynamic positioning (DP) mode.

The bridge cleared the drill floor for operations at 1200 h on 24 September, beginning Hole U1574A. The rig crew assembled an outer core barrel with an RCB bit and a mechanical bit release, and lowered the drill pipe to the seafloor, filling the pipe with seawater every 20 stands. The bit was spaced out, and Hole U1574A was spudded at 2320 h using a water depth measurement of 2825.1 m below sea level (mbsl) based on the precision depth recorder (PDR). Coring continued with nonmagnetic RCB core barrels from the seafloor to 156.8 mbsf (Core U1574A-16R) with full length coring advances. The science office advised that the basement interface was expected at approximately 170 mbsf and requested to continue coring with half-length advances hereafter for increased core recovery across the sediment/basement transition and in basement. Basement was first sampled in Core 19R (166.5–171.4 mbsf), and the week ended after retrieving Core 20R from 176.3 mbsf at 2400 h on 25 September.

## **Science Results**

This week, the Expedition 396 scientists acquired and analyzed samples and data from Holes U1572B, U1573A, and U1574A. The scientists continued to write and revise the reports for Sites U1569 to U1572.

Science, laboratory, outreach, and catering activities were paused for a few hours on 22 September to pick up and clean the ship's facilities after some discombobulation caused by rolling of the vessel during the mid-week storm.

In the morning of 24 September, we held a meeting with the participation of all expedition scientists, including those onshore, to present the results from Sites U1571 and U1572.

### *Lithostratigraphy*

The core description team described and imaged the cores recovered from Hole U1573A and started to measure, image, and describe the cores from Hole U1574A.

The first core from Hole U1573A was retrieved from a depth of 300 mbsf, and basalt was encountered in Section U1573A-10R-4 at a depth of 381.51 mbsf. Formal lithostratigraphic units are not yet defined for Site U1573. The retrieved sediments mainly consist of dark greenish gray to dark gray to very dark gray claystone. Trace siltstone or sandstone or volcanic ash beds are present. Parallel laminations are present regularly throughout the sedimentary sequence, with occasional cross lamination, fining-upward sequences, and organic-rich intervals. Intervals showing slight to heavy bioturbation are also commonly observed. Pyrite is observed occasionally. Volcaniclastic claystone occurs in Core 10R, and from Section 10R-4 downhole, the sequence mainly consists of basalt and interbasaltic sediment. The top of the basalt consists of sparsely augite-, olivine-, and plagioclase-phyric basalt. The rest of the sequence is primarily composed of aphyric basalt with a variable degree of vesicularity with interbedded dark greenish gray to very dark gray to black claystone with varying amounts of silt and sand. The exception is

Core 14R, where basaltic andesite with chill-margins was retrieved. Slightly to moderately bioturbated, and finely (mm) to thickly (0.6–1 cm) laminated intervals are present.

### *Biostratigraphy*

All core catcher samples from Hole U1573A and a few sedimentary beds between the igneous rocks were processed for biostratigraphy. Both, the ~81 m of the cored sediment overburden and the interbasaltic sediment are dated to late early Eocene by palynology. Calcareous and siliceous microfossils were unable to provide additional biostratigraphic support because of the absence of microfossils or their poor preservation. The upper part of the sedimentary section in Hole U1573A yielded massive remains of the freshwater fern *Azolla*. The final set of Hole U1573A samples was processed before the arrival of heavier seas and is currently being examined.

### *Paleomagnetism*

All archive core sections of Hole U1573A were measured on the superconducting rock magnetometer (SRM) at 2.5 cm intervals. The cores were subjected to a series of stepwise in-line alternating field (AF) demagnetization steps at 5, 10, 15, and 20 mT for sedimentary units, and 2, 4, 6, 8, 10, 15, and 20 mT for basalts. Thirteen discrete samples from Hole U1573A, six from sedimentary units and seven from basalts, were measured for natural remanent magnetization (NRM) in the JR-6 spinner magnetometer. For sediments, an AF demagnetization sequence of 5, 10, 15, 20, 30, 40, 50, and 60 mT, and up to 70, 90, 100, and 120 mT followed, and a similar sequence, but up to 150 mT was run for basalts using the DTECH D-2000 AF demagnetizer. The demagnetization behavior for basalts was relatively more stable than that for the sedimentary samples. Overall, it was possible to achieve complete demagnetization for most of the samples. For eleven out of these thirteen samples, the inclination values matched the ones in the core section at AF 20 mT. Nine of the samples were measured for magnetic susceptibility on the KappaBridge KLY-4S.

### *Geochemistry*

A total of 10 interstitial water (IW) samples were collected from Hole U1573A, and 9 have been taken from Hole U1574A and analyzed for their alkalinity and pH. At Hole U1573A, alkalinity decreases from ~2 mM at 300 m CSF-A to below 1 mM at the basalt/sediment transition (around 380 mbsf). A similar decreasing trend is observed in Hole U1574A, where alkalinity decreases from 3.9 mM at the seafloor to 2.2 mM, close to the sediment/basalt transition at ~160 mbsf. The measured pH profiles are more variable and range between 7.5 and 8.1. These preliminary data suggest ongoing basaltic alteration of the lowermost section, with carbonate precipitation driving alkalinity reduction.

The squeezed sediments derived from the IW samples were freeze-dried and crushed. Samples from Hole U1573A were analyzed for total carbon (TC), nitrogen, sulfur, and hydrogen by elemental analyzer. Sulfur, nitrogen, and TC content is highest at the top of the analyzed interval,

before decreasing to lower values closer to the basalt. Total inorganic carbon (IC) analysis is ongoing.

Twenty-four hard rock samples from Hole U1572A were digested and analyzed for their geochemical composition. These data indicate basaltic to basaltic andesite lithologies, which are basic to intermediate in composition. The basalts are titanium rich.

### *Physical Properties and Downhole Measurements*

The physical properties team finished processing the moisture and density (MAD) samples from Site U1572, carried out whole-round physical property measurements of cores from Hole U1573A, and started to measure cores from Hole U1574A. *P*-wave velocity measurements were taken on one section per core to calibrate the automated Whole-Round Multisensor Logger data acquisition. The team also carried out a comparison test between MAD methods C and D that includes measurements on almost 200 cubic samples.

## **Education and Outreach**

Outreach activities during this week included updates to the IODP social media channels: [Twitter](#), [Facebook](#), and [Instagram](#); and five ship-to-shore educational and outreach events with the University of Oslo (Norway), Penn State University (United States), Trinity College Dublin (Ireland), and Universidad de los Andes (Venezuela).

## **Technical Support and HSE Activities**

### *Laboratory Activities*

- The JRSO technical staff helped process cores from Holes U1573A and U1574A and assisted the scientists in the laboratories.
- In the Underway Geophysics Laboratory, we lost signal from the echo sounder. We inspected the output cable and found it to be in good condition. We did an EchoSIM transmitter test and measured  $>144 \Omega$  return from a  $160 \Omega$  output, which indicated the cable is functional. After switching the echo sounder off and on again, the signal returned.
- We repaired the desiccator seal in the X-ray diffraction (XRD) instrument.
- On 22 September, the ship experienced a significant roll from a large (13–15 m) wave—many items fell off the desks/shelves, and some broke. No chemical spills and no major injuries happened. All personnel spent several hours securing, cleaning, reorganizing, resealing, and repairing items.
  - In the Core Laboratory, the auxiliary sample table rolled out of the splitting room at high speed and broke a hole into the wall. The hole was repaired.

- On the Catwalk, the flammable locker fell over and acetone dispensers fell onto deck. We secured the cabinet with Helly stubs into the bulkhead. A new acetone dispenser was ordered.
- In the Physical Properties area of the Core Laboratory, samples, books, drierite, and many other items spilled over the floor. One of the Mettler balances' glass shields was cracked by a falling book. Likewise, a scientist's iPad suffered a broken screen. A new glass shield for the balance was ordered.
- In the XRD Laboratory, samples and glass crucibles fell onto the floor. Most of the glass crucibles broke.
- Some deionized water containers fell over.
- On the Upper Tween deck, many supply boxes fell off the shelves, but nothing was damaged, and the 3-D printer supplies were spilled onto the floor.
- One of the  $-86^{\circ}\text{C}$  freezer power cables came off, causing the freezer to warm up.
- In the core reefer, empty D-tubes, samples boxes, and play cores fell on the floor and many of the play cores suffered broken liners/caps. Several Expedition 396 core boxes slid off the shelves, but the core boxes held together.
- In the science planning room on the Bridge Deck, supplies from the coffee machine shelf fell across the room, several containers spilled their contents, and glass jars broke.
- Various items in offices and staterooms, including laptop computers, keyboards, mice, monitors, TVs, etc. fell off the desks.
- In the Chemistry Laboratory, the source rock analyzer (SRA) is fully functional and the drierite trap test confirmed that there is no moisture in the laboratory air. We refilled the  $\text{CO}_2$  trap with fresh NaOH, and it is working well.
- The end of expedition calendar was distributed.

### *IT Support Activities*

- We conducted monthly computer maintenance and installed new Windows updates to 10 of the spare laptops.
- We installed a newer version of PMAG Agico Safyr7 software upon a request from the Assistant Laboratory Officer. The new version required RS232 drivers from second party vendor to get Safyr7 communicating with the Agico instrument.
- We assisted multiple shipboard personnel with access to their shore email after the conversion to Microsoft 365 Outlook.
- Some damage to IT equipment was reported after the big roll the ship experienced during heavy seas. The Fo'c's'le deck hallway video screen had the HDMI cable pulled out of it

and the connector broke. The monitor was secured to prevent movement and the HDMI cable was replaced.

- The conference room computer and monitor fell over during the storm. The PC tower was secured on the shelf and the monitor is temporarily standing on the floor.
- The freight for shore was entered into AMS and prepared for the end of expedition.
- HP determined that our Tape Drive #1 of the HP MSL6480 failed and they sent a replacement unit to Texas A&M to be sent to the ship.
- macOS Big Sur 11.6 was made available by the vendor and was downloaded and tested successfully on the MCS Mac.
- Multiple software and security updates are available. They have been downloaded or are in progress for staging. They will be applied during the next break in operations.

#### *Developer Support Activities*

- Work continued on the Sample and Data Request (SaDR) replacement application.
- We continued to work on a new version of LabVIEW LDAQ Library.
- We worked with scientists and technicians to resolve various data and uploading issues.
- Worked with shore-based developers on planning and designing the new scanning electron microscope (SEM) Uploader application.

#### *Health and Safety Activities*

- An abandon ship and fire drill was held at 1030 h on 26 September.
- The emergency shower and eye wash stations were tested.