

## **IODP Expedition 395: Reykjanes Mantle Convection and Climate**

### **Week 2 Report (18–24 June 2023)**

#### **Operations**

Previous operations took place at Site U1564 during Expedition 395C in 2021. Holes 395C-U1564A through 395C-U1564C had total hole depths ranging from 9.5 to 628.9 meters below seafloor (mbsf). The remaining operations for Site U1564 include (1) coring to piston core refusal for stratigraphic correlation, (2) replicating the record of Hole U1564C down to ~700 mbsf, and (3) installing casing and a reentry system to access the deepest sediments at this site and to core ~120 m into the basement. Downhole logging operations were planned at two of the three remaining holes.

Week 2 began as the ship continued the transit from Ponta Delgada, Azores, Portugal to Site U1564 (proposed Site REYK-2A). During this time, all COVID-19 mitigation procedures were lifted. Following a 1349.5 nmi voyage at an average speed of 11.2 kt, the vessel arrived onsite at 1424 h on 21 June 2023. The thrusters were lowered and secured at 1456 h and the ship was fully in dynamic positioning (DP) mode at 1502 h. The rig crew removed the core barrels from their shucks and made up a 163.1 m long advanced piston corer/extended core barrel (APC/XCB) bottom-hole assembly (BHA) and began tripping the drill pipe. Hole U1564D was spudded at 0500 h with the first core on deck at 0530 h on 22 June. The stratigraphic correlators monitored coring gaps between Holes 395C-U1564C and 395-U1564D using data from the Special Task Multisensor Logger (STMSL), which was run at a low resolution. Hole U1564D is located at 59°51.0483'N, 23°16.0080'W and in 2208.2 m water depth.

Piston coring using the APC advanced from Core U1564D-1H through 22H (0–209.0 mbsf), with 218.87 m of core recovered (105%). APC refusal was reached at Core 22H, which was drilled over with the drill bit to recover the core barrel. The half-length APC (HLAPC) system was deployed for Cores 23F to 29F (209.0–239.2 mbsf). The stratigraphic correlators requested a 2 m drilled interval (26-1), from 223.2–225.2 mbsf, to offset coring gaps. Because of the challenges associated with covering coring gaps in sections that used the HLAPC, the extended core barrel (XCB) using a polycrystalline diamond compact (PDC) bit and cutting shoe was deployed as a test to see if the core quality was similar to that of the HLAPC. Core 30X was recovered, and based on initial magnetic susceptibility measurements and X-ray images, the core appeared to be in good condition. The decision was made to continue with the XCB system. The HLAPC cored section recovered 29.99 m of core over a 28.2 m long section (106%).

Because of the good weather and favorable hole conditions, the decision was made to continue coring to ~700 mbsf at this hole. Coring with the XCB system extended from Core 30X (239.2 mbsf) to Core 66X (585.03 mbsf), recovering 327.69 m of core (95%). The week ended while continuing XCB coring in Hole U1564D.

## Science Objectives

All laboratory teams worked on Methods chapters and on reports for Site U1555, which was cored during Expeditions 384 and 395C. The teams also began processing and describing cores from Hole U1564D.

### *Sedimentology*

Cores U1564D-1H to 22H (0–209.0 mbsf), Cores 23F to 29F (209.0–239.2 mbsf), and Cores 30X to 40X (239.2–338.9 mbsf) were described. The sediments are predominantly silty clay, with some minor intervals including sand-sized grains predominantly composed of glass. Biosilica and carbonates are present throughout, in varying amounts. The sediment color ranges from gray to very dark gray. Color banding with thin gray-green layers is present, with no discernable compositional difference. Cycles beginning with coarse grains, including mud clasts, and grading up to slightly lighter gray sediment are present. Dropstones, sand, and pumice are present but rare. Bioturbation is generally sparse to moderate and difficult to observe in the XCB cores. Shell fragments are absent in the first six cores, and the first shell fragment is observed in Core 7H; more shell fragments are present, but rare below this level. Core disturbance is generally absent to slight in APC cores but moderate to severe in HLAPC and XCB cores. The latter cores are fragmented and biscuited with some voids, mostly at the upper portion of Sections 1 and the core catchers (CC).

Examination of smear slides (mostly two per core) shows that the grains are dominantly terrigenous (80%). Biogenic components make up an average of 20% with nannofossils, foraminifers and sponge spicules most abundant, diatoms relatively common, and rare radiolarians and silicoflagellates. Quartz, feldspar, glass, opaque grains, and pyrite are common. Glauconite is also present in some slides.

### *Igneous and Alteration Petrology*

The igneous and alteration petrology group worked on the Methods chapter, the Site U1555 report, and redescribed thin sections from Site U1555.

### *Micropaleontology*

The micropaleontologists sampled, processed, and observed more than 55 core catcher samples spanning ~500 m of sediment recovered during the drilling of Hole U1564D. Both calcareous nannofossils and planktonic foraminifers were recovered in moderate to high abundances in nearly all samples. Preservation of calcareous microfossils was mostly excellent, with occasional samples of good preservation. A series of detailed biohorizons for both groups was established spanning the last 1.7 My, allowing sedimentation rates to be constrained as approaching 8 cm/ky. Sedimentation rates between 1.7 and 3.8 Ma are higher, averaging around 16 cm/ky. Samples below 500 mbsf still yield abundant calcareous microfossils with excellent preservation, and

these are now being studied to refine the Hole U1564D age model for the early Pliocene. The sediments are more lithified with depth, making sample washing and sieving increasingly difficult. As well as calcareous plankton, abundant biogenic siliceous material is present in most samples, including diatoms, radiolarians, siliceous dinoflagellates, silicoflagellates, and sponge spicules.

### *Physical Properties*

Measurements were made on the STMSL at low resolution (5 cm) to correlate Hole U1564D to Holes 395C-U1564C (mostly) and 395C-U1564A (top core). X-ray images were collected while waiting for the cores to thermally equilibrate. Features including those interpreted as ice rafted debris were observed in these images. The Whole-Round Multisensor Logger (WRMSL) and Natural Gamma Ray (NGR) logger continued to be run. Discrete *P*-wave measurements were collected on the Gantry and samples for moisture and density (MAD) analyses started to be processed. The thermal conductivity instrument was not initially working properly, and only a few measurements were collected at Hole U1564D.

### *Stratigraphic Correlation*

The stratigraphic correlators began the week practicing with the Correlator software. As an exercise, the Site U1554-ABCD splice made by Peter Blum during Expedition 384 was reproduced by both Expedition 395 correlators, with a good reproducibility of all main features. Alignment of the top cores of Holes 395C-U1564A, 395C-U1564B, and 395C-U1564C using the core images and the magnetic susceptibility data was used to guide the start of drilling operations for Hole 395-U1564D to optimize the chances of filling stratigraphic gaps. Preliminary alignments suggest there is the potential for a fully spliced record until the base of the lowest full APC core (U1564D-22H). APC coring in Hole U1564E is important to complete the remaining connections between holes in the upper part of the section. There are several gaps in the lower HLAPC interval (Cores 23F–29F) that could be filled in at Hole U1564E. Comparison of the Hole 395C-U1564C and 395-U1564D XCB cores further downhole results in the detection of multiple gaps and some stretches of cores that can be correlated. Following splitting of the cores, some biscuiting is identified but the stratigraphy appears to be intact.

### *Paleomagnetism*

Natural remanent magnetization (NRM) of Sections U1564D-1H-1A through 33X-2A was measured every 2.5 cm with the superconducting rock magnetometer (SRM). Additionally, an alternating field (AF) demagnetization was performed at 10, 15, and 20 mT, with measurement of the remaining NRM being taken after each step. Overall, over 270 m of core was measured. The NRM intensity varies from 1.27 to  $4.5 \times 10^{-3}$  A/m and the average is 0.24 A/m. At the maximum magnetization step measured onboard (20 mT), these values decrease, ranging from 0.67 to  $3.8 \times 10^{-3}$  A/m. NRM intensity roughly mimics that of the magnetic susceptibility.

The inclinations from the NRM remaining after 20 mT demagnetization were used to find magnetic reversal events. Up to four normal and four reverse polarities were recognized. For the most recent normal chron, the Brunhes, the average inclination is 70°, which is similar to the present-day inclination at the site of 73° (calculated using the IGRF2024 model for 22 June 2023 at the site coordinates of 59.85°N and 23.266°W).

The Icefield MI-5 core orientation was deployed to orient the APC cores. The present-day declination of -11.2° is used to correct the magnetic tool face value and then to reorient the core to a true north. These values are used to calculate the Virtual Geomagnetic Pole orientation (VGP).

### *Geochemistry*

Whole-round core samples (5–10 cm in length) were collected for interstitial water (IW) analyses from Hole U1564D. IW sampling was completed at a resolution of one per section for a total of six samples for the uppermost core (U1564D-1H). In subsequent cores, IW samples were collected at a resolution of one sample per core. Shipboard IW analyses include pH, alkalinity, ammonium and phosphate by spectrophotometry, and major/minor elemental composition by ion chromatograph and inductively coupled plasma–atomic emission spectrometry (ICP-AES). Sediment samples from squeeze cake residues and discrete intervals from the working half of split cores were collected and measured for wt% total carbon, organic carbon, nitrogen, sulfur, and CaCO<sub>3</sub>. Discrete samples for bulk elemental and mineralogical composition were also selected from the squeeze cakes for X-ray diffraction analyses. Microbiology samples (5 mL) were collected adjacent to the IW samples with a cut-end sterile syringe and processed shipboard for postexpedition analyses. Headspace gases were previously measured at Site U1564 on Expedition 395C to a depth of ~629 mbsf; therefore, no headspace gas analyses were conducted on Hole U1564D this week.

### *Downhole Measurements*

The downhole measurements team worked on the Methods chapter and the Site U1555 report.

## **Outreach**

Week 2 was spent continuing to get to know the ship, the coring process, and the laboratories. The Outreach Officer (OO) set up a weather station on the catwalk that gathers data and puts it online as an open data source. This activity is in conjunction with a school in South Africa. The OO worked on documenting the initial cores with video clips and helped in the Core Laboratory. Additionally, the OO created video clips that document and explain the process of obtaining and analyzing core in the laboratory.

### *Social Media*

- [Facebook](#): 9 posts, 27,610 impressions, and 3,924 engagements.
- [Twitter](#): 19 tweets with 28,682 impressions and 1,307 engagements.
- [Instagram](#): 16 posts which reached 7,163 people, 222 of which were not followers, and there were 323 engagements.

### *Ship-to-Shore Broadcast*

- Two practice ship-to-shore broadcasts were held in addition to one pre-Zoom test. Two more broadcasts were scheduled for the future.

### *Expedition Log (blog posts)*

The OO created and posted a blog about getting acquainted with ship life and then collaborated with the micropaleontology team to create a blog about microfossils.

## **Technical Support and HSE Activities**

### *General Activities*

- Received and processed cores from Hole U1564D.
- Conducted safety training for scientists in all the laboratories.
- Held curation training for the science party, including Sample Master and shipboard sampling.
- Provided protected species observation (PSO) training for all IODP staff anticipating logging operations using the Versatile Seismic Imager (VSI).
- Held instrument operation and training for scientists in all the laboratories.

### *Laboratory Activities*

- The Hitachi scanning electron microscope (SEM) software issue was resolved by lowering the screen resolution to 1280 × 768. The configure file for the software was corrupted. An old configure file was installed and the TM software launched without further issue.
- GEODESC has encountered several issues, including incorrect depths for the Expedition 395C templates, issues importing core data from LIMS, a broken summary template, etc. Most of the issues were found to be related to the templates that were made in an older version. These templates were created a year ago during the Expedition 395C core description party at the Gulf Coast Core Repository. New templates were created and the data were successfully migrated over.

- X-SCAN application is not allowing the user to pick whole round after a section half label is scanned. It was reverted to a previous version as a work-around until the issue is fixed.
- To import data from multiple expeditions into the Correlator application, the scientists need to change all file names to “395” for the application to recognize and accept the data.
- The laser engraver fan broke down for several hours when the first Hole U1564D cores were received. The first five cores were engraved using a Dremel tool.
- The STMSL was skipping the first 30 cm for every first section of a core. After rebooting the PC, the problem resolved by itself. We could not repeat the problem afterwards. Data could not be corrected as the core/sections were not run in order. Comments are made in LIMS.
- Thermal conductivity (TCON) pucks were not yielding proper results. Troubleshooting continues.
- SRM software is not recognizing discrete samples and can only run one sample at a time.
- The Aeris XRD is functioning properly.
- The Koach bench and Coy hard-shell chamber were set up for the microbiologist.
- The gas line for Coy hard-shell chamber was replumbed to be more user friendly. Now the user can use a set of valves to switch between shipboard N<sub>2</sub> and the MBIO mix gas.
- Liquid nitrogen is used to flash-freeze microbiology samples.
- Coulometer and Cahn software freezes up after 1–2 measurements. It is slowing down the measurement process. Troubleshooting continues.

#### *IT Support Activities*

- The SEM instrument host is working now after adjusting to lower screen resolution.
- Marlink internet outage on 19 June from 0155 h to 0329 h.
- Installed a language pack for Windows 10 on a PC in the User room computer laboratory.
- Changed the weekly backup tapes.

#### *Developer Activities*

- GEODESC: Blocking issues from older template configurations were resolved.
- IRIS software builds work on developer machines but not on engineering computers.
- All participants have logged into and used their accounts for laboratory work.
- XSCAN image processing repairs are in place and working.

#### *HSE Activities*

- Emergency shower and eye wash stations were tested.
- The COVID-19 mitigation period concluded at 0000 h on 19 June. No onboard cases were detected on Expedition 395.