

IODP Expedition 395: Reykjanes Mantle Convection and Climate

Week 4 Report (2–8 July 2023)

Operations

Week 4 of IODP Expedition 395 began while coring at Hole U1562C. Cores U1562C-14H to 16H (110.8 to 139.3 meters below seafloor [mbsf]) were recovered using the advanced piston corer (APC) system. Core U1562C-16H had 100,000 lb of overpull and required a drillover to free the core barrel. Refusal of the full-length APC system was reached and the half-length APC (HLAPC) was deployed for the remainder of the hole. Cores U1562C-17F to 53F advanced the hole to 300.4 mbsf. Four short drilled intervals (1.5 to 2 m in length) were used to offset coring gaps between Holes 395C-U1562A and 395-U1562C. After reaching the target depth of 300 mbsf, the drill pipe was pulled from the hole with the bit clearing the seafloor at 0405 h on 3 July 2023. A total of 48 cores were collected at Hole U1562C, recovering 308.45 m of sediment over a 293.4 m cored interval (105% recovery). The bottom-hole assembly (BHA) was broken down and the rig secured for transit. At 0900 h the ship was switched from dynamic positioning (DP) to cruise mode, ending Site U1562. The vessel began the transit to proposed Site REYK-14B (Site U1602), located within the Greenland exclusive economic zone.

The ship completed the 350 nmi transit to proposed Site REYK-14B at 1701 h on 4 July. At that time the thrusters were lowered, and the ship was in DP mode at 1718 h, marking the start of Site U1602. The APC/extended core barrel (XCB) BHA and drill string were assembled, 105 ft of drill line was cut off, and the top drive was picked up. The bit was spaced out to initiate Hole U1602A, which was spudded at 0425 h on 5 July. Core U1602A-1H recovered 8.8 m of core, establishing a seafloor depth of 2708.6 meters below sea level (mbsl). However, Core 1H also recovered part of the “pig,” a foam device with metal bristles used to clean rust from the inside of the drill pipe, which disturbed the mudline interval. Hole U1602A was terminated in order to recover an undisturbed mudline.

Hole U1602B was spudded at 0535 h from the same ship position and Core U1602B-1H recovered 5.15 m of core with a good mudline. Coring continued from Cores 2H to 16H (5.2 to 147.7 mbsf). Temperature measurements using the advanced piston corer temperature tool (APCT-3) were collected on Cores 4H, 7H, 10H, and 13H. Core 16H required 100,000 lb of overpull to extract the core barrel from the sediment. The HLAPC was deployed for Cores 17F to 38F (147.7 to 251.5 mbsf). Cores 18F and 26F had partial strokes. Piston coring refusal was reached at Core 38F, which required 80,000 lb of overpull to free the barrel from the formation. A total of 38 cores were collected from Hole U1602B, with 262.37 m of core recovered over a 251.1 m interval (104%). The drill string was pulled from the hole, with the bit clearing the seafloor at 1600 h on 6 July, marking the end of Hole U1602B.

The vessel was offset 20 m to the north. After performing maintenance on the rig and cutting off 150 m of core winch line, the top drive was picked up and the bit spaced out to a depth of

2719 meters below rig floor (mbrf). Hole U1602C was spudded at 1920 h. Core U1602C-1H recovered 7.07 m of core, placing the seafloor at 2710.0 mbsl. Cores U1602C-1H to 20H (0 to 180.0 mbsf) were recovered. Within this cored interval, an interval of 2 m was drilled without recovery (64.0 to 66.0 mbsf) to offset coring gaps for stratigraphic correlation. After three partial strokes using the APC system, the HLAPC was deployed for Cores U1602C-21F to 39F (180.0 to 269.3 mbsf). Partial strokes were recorded on Cores 23F and 39F and the overpull on Core 38F was 100,000 lb. Piston coring refusal was reached and the hole was ended. The drill pipe was pulled out of the hole and the bit cleared the seafloor at 0525 h, ending Hole U1602C. A total of 38 cores were recovered from Hole U1602C, with 272.63 m of sediment recovered from a 267.3 m cored interval (102% recovery).

The vessel was offset 20 m to the east and Hole U1602D was spudded at 0805 h on 8 July. The seafloor depth was determined based on the recovery of Core U1602D-1H, which was 9.6 m. Cores 1H to 18H advanced from 0 to 166.3 mbsf. A partial stroke was recorded on Core 17H and Core 18H, and it required 100,000 lb of overpull to free it from the formation.

Science Results

Sedimentology

From Site U1554, Cores U1554H-22H to 38X (196.08 to 354.59 mbsf) were described. The sediment color varies from dark gray (5Y 4/1) to black (5Y 2.5/1). The sediments are predominantly silty clay, with some minor intervals of silty clay with biogenics. Biosilica and carbonates are present throughout, although in very minor amounts. Green and dark gray mottling and color banding are present throughout, with no discernable compositional difference between bands of different color. Bioturbation is generally sparse to moderate, while cores below Core 30H are severely fragmented and biscuited.

From Site U1562, Cores U1562C-1H to 53F (0 to 300.68 mbsf) were described. The sediments in the upper portion of this site (from Core U1562C-1H to approximately Core 31F) are predominantly brown (10YR 5/3), gray (2.5Y 5/1), and dark gray (5Y 3/1) silty clay, with some intervals of silty clay with biogenics and silty clay with carbonate. Biosilica and carbonates are present throughout in varying amounts. Green and dark gray mottling and color banding are present throughout, with no discernable compositional difference. From Core U1562C-32F to 53F, the sediments grade from greenish gray (10Y 5/1), dark olive gray (5Y 3.2), to black (5Y 2.5/1) and are predominantly silty clay and carbonate silty clay with some nannofossil ooze. From Core U1562C-44F to 53F, soft sediment deformation is observed in most cores over several meters. This deformation is characterized by sharp angular contacts, lenticular bedding, dewatering structures, and rip-up clast-like features.

From Site U1602, on Eirik Drift, Cores U1562A-1H (0 to 8.76 mbsf), U1602B-1H to 38F (0 to 251.4 mbsf), and U1602C-1H to 39F (0 to 269.19 mbsf) were described. The sediments at this

site are predominantly gray (5Y 5/1) to very dark gray (2.5Y 3/1) and dark greenish gray (10Y 4/1) silty clay with interbedded dark gray (5Y 4/1) silt with sand. Biosilica and carbonates are present in some beds in minor amounts, while other beds are barren of biogenic material. Green and dark gray mottling and color banding is present throughout, with no discernable compositional difference. The cores at Site U1602 display multiple thin (<3 cm) layers of silt to sand-sized material, or singular thicker beds of coarser material. These coarser beds are characterized by fining-upward sequences grading from silty sand (occasionally sandy silt) at the base to silty clay at the top, leading to a tentative interpretation of them being the distal signature of turbidite deposits. These beds often have sharp, erosive bases, and often contain cross-bedding and/or laminations, as observed primarily from X-ray scanned images.

Igneous and Alteration Petrology

The petrology group spent the week working on site reports, analyzing thin sections from Expedition 395C, and assisting in the Core Laboratories.

Micropaleontology

Micropaleontologists sampled, processed, and observed up to 97 core catcher and section half samples from Hole U1562C spanning ~300 m of upper Miocene to upper Pleistocene sediments. Calcareous microfossils are typically abundant, with preservation mostly very good, except for cores between ~54 and 127 mbsf, where there were intervals with little calcareous microfossil recovery and/or moderate preservation. From ~127 to 256 mbsf, the upper Miocene to Pliocene sediments yielded consistently abundant calcareous microfossils with very good preservation. The base of the recovered section, at ~300 mbsf, is estimated to be older than 8.8 Ma, but the interpretation of the biostratigraphy is complicated by clear sediment slumping and disturbance toward the base of the hole.

At Site U1602, micropaleontologists analyzed up to 73 core catcher and section half samples from Holes U1602A, U1602B, and U1602C. Biostratigraphic constraints for the ~250 m of Pleistocene sediments recovered were based on samples from Hole U1602B. Recovery of calcareous microfossils from core catcher samples was variable, especially below ~90 mbsf, with multiple samples barren of calcareous microfossils. Additional samples taken from core section half carbonate-bearing intervals were used to supplement the core catcher samples. The resultant observations allowed the development of a robust biostratigraphy for the last 1.82 My, with seven calcareous nannofossil and one planktonic foraminifer biohorizon determined in this succession. Sedimentation rates for this interval average ~10 cm/ky but may be increasing toward the base of the succession.

Physical Properties

In Hole U1562C, cyclic variation is seen throughout the color and physical properties of whole-round and split core track measurements, with lower amplitude cycles found in the upper ~140 m in the RGB color, color reflectance, and magnetic susceptibility (MS) values, and with a

distinctive set of larger amplitude and greater period cycles in MS between 190 and 270 mbsf. Between 290 and 350 mbsf, the cycle character is much like in the top 140 m, and below 350 m, the MS values are lower and the color reflectance data are brighter in an interval with high carbonate content.

At Site U1602 the pattern of variability shows higher values of MS, gamma ray attenuation (GRA) density, and natural gamma radiation (NGR) in sandy intervals and lower values in the silty clay intervals, similar to the values found in the Gardar Drift (Site U1564) and Björn Drift (Sites U1554 and U1562) sites. The MS values are high with discrete peaks in the silty/sandy intervals, probably due to the concentrations of heavy minerals along specific laminae.

Stratigraphic Correlation

Stratigraphic correlation between Holes 395C-U1562A and 395-U1562C resulted in a complete stratigraphic splice from 0 to 155 m composite core depth below seafloor (CCSF). Alignment of coring gaps led to several small gaps between 155 and 195 m CCSF. Below 195 m CCSF, cores are continuously tied to ~282 m CCSF.

At Site U1602, Hole U1602A recovered one core, which can be tied to the uppermost cores from Holes U1602B and U1602C. Thus far, a complete splice was recovered from cores spanning 0 to ~151 mbsf. Below this depth, core gaps align due to sand layers. The HLAPC cores can be correlated but only tied every few cores.

Paleomagnetism

We measured the natural remanent magnetization (NRM) of archive half core sections from Holes U1554H and U1562C. An alternating field (AF) demagnetization was performed at 10, 15, and 20 mT, with measurement of the remaining NRM being taken after each step. At Site U1602, the NRM was measured in cores from Holes U1602A, U1602B, and U1602C. Cores from Holes U1602A and U1602B were measured and demagnetized every 2.5 cm with steps of 0, 10, 15, and 20 mT. Cores from Hole U1602C were analyzed for NRM only, except for Cores U1602C-35F to 37F, which were demagnetized every 2.5 cm with steps of 0, 10, 15, 20, and 25 mT. Hole U1602C will not be demagnetized, and thus will be preserved for postexpedition studies.

The NRM intensity in Hole U1554H varies from a minimum of 2.9×10^{-3} to a maximum of 2.0 A/m, with an average of 0.3 A/m. For Hole U1562C the NRM intensity values range from 8.37×10^{-4} to 2.21 A/m and the average is 1.87×10^{-1} A/m. For Hole U1602A the NRM intensity values range from 2.11×10^{-2} to 7.08×10^{-1} A/m, with an average value of 2.46×10^{-1} A/m. For Hole U1602B the NRM intensity is between 1.12×10^{-3} and 1.71 A/m, with an average of 2.48×10^{-1} A/m. For Hole U1602C the NRM intensity varies between 3.3×10^{-3} and 3.13 A/m with an average intensity of 3.08×10^{-1} A/m. NRM intensity roughly follows the trend of MS.

Inclination values from the NRM remaining after 20 mT demagnetization were used to tentatively identify magnetic reversals. In Holes U1554H and U1562C, up to five normal and

five reversed polarity intervals are recognized. In Hole U1602A, only one normal polarity chron is recognized. In Hole U1602B, four normal and four reversed polarity intervals are recognized, and finally, in Hole U1602C, only three normal and three reversed polarity intervals are recognized.

In Hole U1602B, 45 discrete, oriented samples were collected and measured. For each sample we measured the anisotropy of magnetic susceptibility (AMS) using the MFK2 KappaBridge unit. After AMS measurements, the NRM of all samples was measured in the JR-6 magnetometer, then the samples were demagnetized using AF demagnetization at steps of 5, 10, 15, 20, 25, 30, 40, 50, 60, 80, and 100 mT. The inclinations from the discrete samples collected from 4.6 to 250.2 mbsf confirm the polarities suggested by the inclination values measured on the archive half core sections.

Geochemistry

Geochemical analyses continued at Hole U1602B. Each core from Cores 1H to 17H and every other HLAPC core from Cores 19F to 37F was sampled. At Hole U1602C, Cores 36F and 38F were sampled. Sampling was completed for interstitial water (IW) from whole-round core samples (5 cm), gas headspace, and sediment geochemistry. At Holes U1602B and U1602C, IW sampling was completed at a resolution of one sample per 10 m. Shipboard IW analyses include pH, alkalinity, ammonium and phosphate by spectrophotometry, and major/minor elemental composition by ion chromatography (IC) and inductively coupled plasma–atomic emission spectrometry (ICP-AES). Sediment samples from squeeze cake residue and discrete intervals from the working half of split cores were collected and measured for wt% total carbon, organic carbon, nitrogen, sulfur, and CaCO₃. Discrete samples for bulk elemental and mineralogical composition were also selected from the squeeze cakes for X-ray diffraction (XRD) analyses. Microbiology samples were collected adjacent to the IW samples with a cut-end sterile syringe (5 ml) from APC or HLAPC cores and processed shipboard for postexpedition analyses.

Downhole Measurements

Four APCT-3 temperature measurements were collected in Hole U1602B, with Cores U1602B-4H, 7H, 10H, and 13H. The formation temperature ranges from 3.22°C to 10.43°C.

Outreach

The Outreach Officer spent the week researching and creating content for multiple platforms and coordinating and providing ship-to-shore events.

Social Media:

- [Facebook](#): 16 posts with 40,000 impressions and 95 new followers.
- [Twitter](#): 23 Tweets with 83,900 impressions and 69 new followers.
- [Instagram](#): 22 posts and four stories with 14,000 impressions and 36 new followers.

Ship-to-shore Broadcasts:

- 4 July: A Pal(a)eoPERCS webinar was broadcast to graduate students interested in careers at sea. This was recorded and is available for graduate students in this program to view.
- 7 July: Zoom tour with Kiel University in Germany.
- 8 July: Zoom tour with Sci-camps America in Hawaii.

Expedition Log (blog posts):

- 5 July: Seeing in Snapshots: a brief overview of mapping and coring.
- 7 July: A New Mystery: a summary of what cores can tell us and why we correlate data.

Feedback:

“On behalf of the entire Pal(a)eoPERCS Steering Committee, we wanted to thank you again for participating in our Ship-to-Shore Pal(a)eoPERCS Seminar week! It was fantastic to hear about all of your work and paths toward landing on the JR, as well as see different aspects of life at sea!”

Sci-Camps: “Thank you so much for the tour and Q&A. It was really fascinating and really sparked an interest in some of our more sciency students.”

Technical Support and HSE Activities

- The staff received and processed cores and samples from Holes U1562C and U1602A–U1602D.

Laboratory Activities

- XSCAN: The Marine Computer Specialists (MCS) installed a 1 Tb solid state drive (SSD) as an additional hard drive. Images are frequently moved to the drive and to Data1. No further issues have been observed.
- One of the IceField MI-5 orientation tools was repaired. A ribbon plug was found to be disconnected.
- The monitor for the Section Half Imaging Logger (SHIL) began to display a “burn-in” mark. The MCS added a screensaver to prevent further damage to the monitor.

- O₂ levels in the nitrogen air line went up to >250 ppm. All five filters on the ship's air lines and the nitrogen generator were replaced. O₂ levels came back down to <30 ppm 12 h later.
- One of the stirrup wires on the Cahn balance was broken. We were able to reattach the wire and put the balance back into operation. However, the wire has a kink in it and it will need to be professionally repaired on shore.
- The spare Cahn balance was temporarily used; however, it was not calibrated. Attempts to calibrate the balance were unsuccessful and it will need to be professionally calibrated on shore.

Developer Activities

- XSCAN:
 - We made code corrections for section half sample identification.
 - Multiangle scans were misnamed. This was corrected.
- Stratigraphic Correlation: the first "multi-expedition" splice was successfully uploaded to the LIMS database.

HSE Activities

- Emergency shower and eye wash stations were tested.
- A lifeboat drill was held on 2 July.