

IODP Expedition 395: Reykjanes Mantle Convection and Climate

Week 5 Report (9–15 July 2023)

Operations

Week 5 of IODP Expedition 395 began while coring at Hole U1602D (61°11.7259'N, 38°10.7967'W; 2709.1 m water depth). Core U1609D-19H, recovered from 166.3 to 175.8 meters below seafloor (mbsf), was a partial stroke indicating that advanced piston corer (APC) refusal was reached. The half-length APC (HLAPC) was deployed for Cores 20F to 37F and advanced to a depth of 260.4 mbsf. Piston coring refusal was reached on Core 37F with a partial stroke. The extended core barrel (XCB) system was used to cut Cores 38X to 66X (240.0–540.7 mbsf). The cutting of Core 66X was very slow compared to the other XCB cores. When the core barrel was retrieved, it was immediately noticed that the XCB cutting shoe was severely damaged, with large pieces missing. Coring could not continue because the location of the broken metal from the cutting shoe was not known, and therefore Hole U1602D was terminated at a depth of 540.7 mbsf. The drill string was pulled from the hole with the bit clearing the seafloor at 1130 h on 11 July. The vessel was offset 20 m south of Hole U1602D and the drill pipe and bottom-hole assembly (BHA) continued to be pulled up to the rig. At 1645 h, the bit cleared the rig floor ending Hole U1602D. The BHA for the rotary core barrel (RCB) was made up in anticipation of RCB coring.

A total of 450.45 m of sediment was recovered from a 540.7 m cored interval (83%) at Hole U1602D. Core recovery for the XCB cored section was highly variable, ranging between 0% and 101%.

The drill string was deployed to the seafloor and Hole U1602E (61°11.7150'N, 38°10.7961'W) was spudded at 0630 h on 12 July. A seafloor depth of 2709.2 meters below sea level (mbsl) was used based upon the offset of Hole U1602B, which recovered the best-preserved mudline core. The hole was advanced without recovery to a depth of 529.3 mbsf, the center bit was retrieved, and rotary coring began. Cores U1602E-2R to 40R (529.3–908.8 mbsf) were recovered with 251.4 m of sediment (66%).

The plan is to continue coring in Hole U1602E to a depth of 1390 mbsf, which will extend the hole ~14 m into the basement. This is contingent on the condition of the hole and of the drill bit.

Science Results

Sedimentology

From Site U1602, Cores U1602D-1H to 66X (0–532.36 mbsf) and U1602E-2R to 36R (529–866 mbsf) were described. The sediments in Hole U1602D are predominantly dark gray to black silty clay and dark greenish gray silty clay with nannofossils. Minor lithologies include silty clay

with sand, silt with sand, and silty clay with carbonate. Biosiliceous microfossils are observed in varying but minor amounts until approximately 337 mbsf. Intervals with laminations and graded beds fining upward are observed throughout. Clasts are observed from Core U1602D-1H to 28F, and there is green and dark gray mottling and color banding present throughout the hole. The cores are severely biscuited below 220 mbsf due to drilling disturbance.

The sediments in Hole U1602E are predominantly very dark gray to black silty clay/claystone and dark gray to dark olive gray nannofossil silty clay/claystone. Minor lithologies include clayey silt and silty clay with foraminifers. Extensively bioturbated intervals, commonly with nannofossils, are interbedded with darker laminated intervals. Thin sandstone layers (<1 cm) are present beginning in Core U1602E-22R. Fractures, commonly with slickensides, become a consistent feature beginning in Core 32R. There is slight to moderate biscuiting and fragmentation throughout the hole, especially in the upper part of the hole.

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. The alteration petrologists are creating elemental maps of thin sections using the scanning electron microscope/energy dispersive spectroscopy (SEM/EDS) to characterize the mineralogy of the samples.

Micropaleontology

The micropaleontologists sampled, processed, and observed more than 110 core catcher samples spanning >620 m of sediment recovered from Holes U1602D and U1602E. Additional samples from the working half-core sections were also taken to further refine calcareous nannofossil biohorizons or when core catcher (CC) samples had very few nannofossils. Both calcareous nannofossils and planktonic foraminifers were recovered in moderate abundances in most samples, but an interval of very low (or barren) abundance of both groups was observed between 200–300 mbsf in Hole U1602D. Preservation of calcareous microfossils was moderate to good, with occasional samples of poor preservation in the deeper parts of Hole U1602E. At ~400 mbsf in Hole U1602D, the sediment progressively lithified and it became harder to process for planktonic foraminifers. Subsequent CC samples were placed in the freeze dryer, which will hopefully facilitate their processing during the upcoming week. Only one early Pliocene calcareous nannofossil biohorizon was identified during this week, and although coiling direction changes in one planktonic foraminifer species were observed, they are difficult to correlate. Altogether, it is difficult to estimate the ages of the drilled interval until further evidence is forthcoming.

Physical Properties

Whole-round (WR) physical properties measurements were conducted on cores from Holes U1602D and U1602E. Discrete measurements (compressional *P*-wave velocity, moisture and density [MAD]) were conducted on Cores U1602C-35F and 37F, Cores U1602D-37F to

66X, and Cores U1602E-2R onward. Thermal conductivity was acquired from multiple cores in Holes U1602D and U1602E. Core recovery in the lower part of Hole U1602D is variable, but the cores for which recovery is high show cyclical variability on physical properties such as natural gamma radiation (NGR) and magnetic susceptibility (MS). NGR and MS also show cyclic variability in Hole U1602E. For Site U1602, NGR values increase rapidly between ~300–380 mbsf, MAD bulk density values increase rapidly between ~325–375 mbsf, and discrete *P*-wave velocity values increase markedly within the interval ~425–625 mbsf. X-ray images continue to show some geological features, but image processing may be affected by the geometry of the material in the RCB cores.

Stratigraphic Correlation

Stratigraphic correlation has been successful for Site U1602, with distinctive patterns in MS between holes from the seafloor to ~160 mbsf, which correspond to silty or sandy intervals. In Core U1602C-18H, the sediments are highly disturbed by the coring process, leading to the first stratigraphic correlation gap at ~175 m composite depth. Below that level the correlation between holes is intermittent, and it appears that a combination of core suck-in and poor recovery of certain lithologic types are the reasons for gaps in the stratigraphy. Overlapping intervals between holes extend to ~260 mbsf and wireline logging data will be required to improve the stratigraphy between the base of the continuous splice and 260 mbsf.

Paleomagnetism

We measured the natural remanent magnetization (NRM) of archive half-core sections at 2.5 cm resolution for Cores U1602C-11H to 39F, for the entirety of Hole U1602D, and for Cores U1602E-2R to 31R. Alternating field (AF) demagnetization was performed at 10, 15, and 20 mT, with measurements of the remaining NRM made after each step from Core U1602C-34F to Core U1602D-46F. An additional demagnetization step of 25 mT was added starting with Core U1602D-47X and including Hole U1602E, and at this point we began running core catchers through the SRM as well. Overall, over 630 m of core was measured on the SRM this week.

The NRM intensity measured on cores from Hole U1602C varies from a minimum of 3.3×10^{-3} to a maximum of 3.1 A/m (averaging 0.28 A/m). For Hole U1602D the NRM intensity values range from 2.3×10^{-3} to 2.8 A/m, with an average value of 0.35 A/m. For Hole U1602E the NRM intensity is between 6.5×10^{-4} and 0.4 A/m, with an average of 0.12 A/m. NRM intensity at the demagnetization step of 10 mT roughly follows the trend of MS.

The drilling overprint is usually removed after the 10 mT demagnetization step, and the NRM inclinations remaining after 20 or 25 mT demagnetization were used to identify magnetic reversals. It is difficult to isolated magnetic reversals in Hole U1602C based solely on NRM inclination and this did not allow for interpretation of the reverse polarities; however, five normal polarities are recognized. Eight normal and eight reversed polarities were recognized in Hole U1602D, and three normal and three reversed polarities are observed in Hole U1602E so far.

We collected six discrete oriented samples from Hole U1602C, 24 samples from Hole U1602D, and 55 samples from Hole U1602E. 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 spinner magnetometer, then 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 confirm the polarities indicated by the SRM inclination values.

Geochemistry

Geochemical analyses continued in Hole U1602D (Cores U1602D-37F to 65X) and Hole U1602E (Cores U1602E-2R to 39R). Sampling was completed for interstitial water (IW) from WR core samples, gas headspace, microbiology, and sediment. At Holes U1602D and U1602E, 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 residues 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 subsampled from the IW samples from XCB and RCB cores and processed shipboard for postexpedition analyses.

Outreach

The Outreach Officer spent the week engaged in various endeavors. There were four ship-to-shore events as well as a successful open house. In addition to this, the Outreach Officer communicated with outside media for both an article about Expedition 395 and an interview for a local television station. She also continues to create and post educational social media content.

Social Media

- [Facebook](#): Seven posts with 5,768 engagements and five new followers.
- [Twitter](#): 34 posts with 55,000 impressions and 43 new followers.
- [Instagram](#): 11 posts and five stories with 4,357 engagements and 14 new followers.
- [YouTube](#): One new video with 82 views.

Ship-to-Shore Broadcasts:

There were four ship-to-shore events and one open house with a total engagement of 217 people over the week.

- 9 July—Gifu Science World Museum, Japan: 125 people
- 10 July—Wesleyan University undergraduates: three people

- 11 July—Open House: 50 people
- 12 July—Georgia Southern Natural History Museum: 25 people
- 13 July—Seishin Gakuen High School, Japan: 14 people

Expedition Log (blog posts):

- “How Big is a Microbe?”—a blog written about Melody Lindsay and her research on microbes.

Feedback:

“Big thanks from Japan. Explanations were very kind. It was a good chance for students to talk with real scientists, and they experienced the atmosphere of onboard work.”

Technical Support and HSE Activities

Laboratory Activities

- Staff received and processed cores and samples from Holes U1602D and U1602E.
- Natural gas analysis (NGA) calibration and integration parameters were adjusted so that there are no longer anomalous peaks for hydrocarbons that are not actually present.
- Freeze drying samples for paleontology to help break down material for easier processing.

Developer Activities

- GEODESC: Applied further modifications to the DataCapture application to create sticky Expedition/Site/Hole filters.
- Whole-Round Multisensor Logger (WRMSL)
 - The occurrence of multiple measurements for the same offset was found and is being investigated. This seems to occur for ~4 data points in every 100 sections measured.
 - We are looking into discrepancies between the gamma ray attenuation (GRA) and MS measurement offsets. While this could be due to the WRMSL code, it could also be due to slightly different measurements in the length of the core sections if a core is rerun on the track system. These offsets are between 1 to 6 mm only.
- LORE:
 - SRM section report was corrected so that data are sorted consistently.
 - In the carbonate report, samples are not organized by depth. This is still under investigation.

HSE Activities

- Emergency shower and eye wash stations were tested.
- A lifeboat drill was held on 9 July.